



NATIONAL CERTIFICATE III

UTILITY LABORATORY TECHNICIAN SERVICES

Student
Learning
Materials



Ministry of Environment

ACKNOWLEDGEMENT

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INSTRUCTION TO TRAINERS

Competency Based Training (CBT) and assessment - An introduction for trainers

Learning Materials presented here can be used to deliver competency based training using the National Competency Standard developed for the respective occupation.

Competency

Competency refers to the ability to perform particular tasks and duties to the standard of performance expected in the workplace. It requires the application of specified knowledge, skills and attitudes relevant to effective participation, consistently over time and in the workplace environment. The essential skills and knowledge are either identified separately or combined.

Knowledge identifies what a person needs to know to perform the work in an informed and effective manner.

Skills describe the application of knowledge to situations where understanding is converted into a workplace outcome.

Attitude describes the founding reasons behind the need for certain knowledge or why skills are performed in a specified manner. Competency covers all aspects of workplace performance and involves:

- Performing individual tasks
- Managing a range of different tasks
- Responding to contingencies or breakdowns
- Dealing with the responsibilities of the workplace
- Working with others.

Unit of Competency

Like with any training qualification or program, a range of subject topics are identified that focus on the ability in a certain work area, responsibility or function. Each manual focuses on a specific unit of competency that applies in the hospitality workplace. In this manual a unit of competency is identified as a “unit”. Each unit of competency identifies a discrete workplace requirement and includes:

- Knowledge and skills that underpin competency
- Language, literacy and numeracy
- Occupational health and safety requirements.

Each unit of competency must be adhered to in training and assessment to ensure consistency of outcomes.

Element of Competency

An element of competency describes the essential outcomes within a unit of competency. The elements of competency are the basic building blocks of the unit of competency. They describe in terms of outcomes the significant functions and tasks that make up the competency. In this manual elements of competency are identified as an “element”.

Performance criteria

Performance criteria indicate the standard of performance that is required to demonstrate achievement within an element of competency. The standards reflect identified industry skill needs. Performance criteria will be made up of certain specified skills, knowledge and attitudes.

Learning

For the purpose of this manual learning incorporates two key activities:

- Training
- Assessment.

Both of these activities will be discussed in detail in this introduction.

Today training and assessment can be delivered in a variety of ways. It may be provided to participants:

- On-the-job – in the workplace
- Off-the-job – at an educational institution or dedicated training environment
- As a combination of these two options.

No longer is it necessary for learners to be absent from the workplace for long periods of time in order to obtain recognized and accredited qualifications.

Learning Approaches

Student learning materials developed here can support delivery of training and the expected learning can be facilitated through the following avenues:

Competency Based Training (CBT)

This is the strategy of developing a participant's competency. Educational institutions utilize a range of training strategies to ensure that participants are able to gain the knowledge and skills required for successful:

- Completion of the training program or qualification
- Implementation in the workplace.

The strategies selected should be chosen based on suitability and the learning styles of participants.

Competency Based Assessment (CBA)

This is the strategy of assessing competency of a participant. Educational institutions utilize a range of assessment strategies to ensure that participants are assessed in a manner that demonstrates validity, fairness, reliability, flexibility and fairness of assessment processes.

Flexibility in Learning

Even with the use of this book, it is important to note that flexibility in training and assessment strategies is required to meet the needs of participants who may have learning difficulties. The strategies used will vary, taking into account the needs of individual participants with learning difficulties. However they will be applied in a manner which does not discriminate against the participant or the participant body as a whole.

Catering for Participant Diversity

Participants have diverse backgrounds, needs and interests. When planning training and assessment activities to cater for individual differences, trainers and assessors should:

- Consider individuals' experiences, learning styles and interests
- Develop questions and activities that are aimed at different levels of ability
- Modify the expectations for some participants
- Provide opportunities for a variety of forms of participation, such as individual, pair and small group activities
- Assess participants based on individual progress and outcomes.

The diversity among participants also provides a good reason for building up a learning community in which participants support each other's learning.

Participant Centered Learning

This involves taking into account structuring training and assessment that:

- Builds on strengths – Training environments need to demonstrate the many positive features of local participants (such as the attribution of academic success to effort, and the social nature of achievement motivation) and of their trainers (such as a strong emphasis on subject disciplines and moral responsibility). These strengths and uniqueness of local participants and trainers should be acknowledged and treasured
- Acknowledges prior knowledge and experience – The learning activities should be planned with participants' prior knowledge and experience in mind
- Understands learning objectives – Each learning activity should have clear learning objectives and participants should be informed of them at the outset. Trainers should also be clear about the purpose of assignments and explain their significance to participants
- Teaches for understanding – The pedagogies chosen should aim at enabling participants to act and think flexibly with what they know
- Teaches for independent learning – Generic skills and reflection should be nurtured through learning activities in appropriate contexts of the curriculum. Participants should be encouraged to take responsibility for their own learning
- Enhances motivation – Learning is most effective when participants are motivated. Various strategies should be used to arouse the interest of participants
- Makes effective use of resources – A variety of teaching resources can be employed as tools for learning
- Maximizes engagement – In conducting learning activities, it is important for the minds of participants to be actively engaged
- Aligns assessment with learning and teaching – Feedback and assessment should be an integral part of learning and teaching
- Caters for learner diversity – Trainers should be aware that participants have different characteristics and strengths and try to nurture these rather than impose a standard set of expectations.

Active Learning

The goal of nurturing independent learning in participants does not imply that they always have to work in isolation or solely in a classroom. On the contrary, the construction of knowledge in tourism and hospitality studies can often best be carried out in collaboration with others in the field. Sharing experiences, insights and views on issues of common concern, and working together to collect information through conducting investigative studies in the field (active learning) can contribute a lot to their eventual success.

Active learning has an important part to play in fostering a sense of community in the class. First, to operate successfully, a learning community requires an ethos of acceptance and a sense of trust among participants, and between them and their trainers. Trainers can help to foster acceptance and trust through encouragement and personal example, and by allowing participants to take risks as they explore and articulate their views, however immature these may appear to be. Participants also come to realize that their classmates (and their trainers) are partners in learning and solving.

Trainers can also encourage cooperative learning by designing appropriate group learning tasks, which include, for example, collecting background information, conducting small-scale surveys, or producing media presentations on certain issues and themes. Participants need to be reminded that, while they should work towards successful completion of the field tasks, developing positive peer relationships in the process is an important objective of all group work.

Competency Based Training (CBT)

Principle of Competency Based Training

Competency based training is aimed at developing the knowledge, skills and attitudes of participants, through a variety of training tools.

Training Strategies

The aims of this curriculum are to enable participants to:

- Undertake a variety of subject courses that are relevant to industry in the current environment
- Learn current industry skills, information and trends relevant to industry
- Learn through a range of practical and theoretical approaches Be able to identify, explore and solve issues in a productive manner
- Be able to become confident, equipped and flexible managers of the future
- Be „job ready“ and a valuable employee in the industry upon graduation of any qualification level.
- To ensure participants are able to gain the knowledge and skills required to meet competency in each unit of competency in the qualification, a range of training delivery modes are used.

Types of Training

In choosing learning and teaching strategies, trainers should take into account the practical, complex and multi-disciplinary nature of the subject area, as well as their participant's prior knowledge, learning styles and abilities. Training outcomes can be attained by utilizing one or more delivery methods:

Lecture/Tutorial

This is a common method of training involving transfer of information from the trainer to the participants. It is an effective approach to introduce new concepts or information to the learners and also to build upon the existing knowledge. The listener is expected to reflect on the subject and seek clarifications on the doubts.

Demonstration

Demonstration is a very effective training method that involves a trainer showing a participant how to perform a task or activity. Through a visual demonstration, trainers may also explain reasoning behind certain actions or provide supplementary information to help facilitate understanding.

Group Discussions

Brainstorming in which all the members in a group express their ideas, views and opinions on a given topic. It is a free flow and exchange of knowledge among the participants and the trainer. The discussion is carried out by the group on the basis of their own experience, perceptions and values. This will facilitate acquiring new knowledge. When everybody is expected to participate in the group discussion, even the introverted persons will also get stimulated and try to articulate their feelings.

The ideas that emerge in the discussions should be noted down and presentations are to be made by the groups. Sometimes consensus needs to be arrived at on a given topic. Group discussions are to be held under the moderation of a leader guided by the trainer. Group discussion technique triggers thinking process, encourages interactions and enhances communication skills.

Role Play

This is a common and very effective method of bringing into the classroom real life situations, which may not otherwise be possible. Participants are made to enact a particular role so as to give a real feel of the roles they may be called upon to play. This enables participants to understand the behavior of others as well as their own emotions and feelings. The instructor must brief the role players on what is expected of them. The role player may either be given a ready-made script, which they can memorize and enact, or they may be required to develop their own scripts around a given situation. This technique is extremely useful in understanding creative selling techniques and human relations. It can be entertaining and energizing and it helps the reserved and less literate to express their feelings.

Simulation Games

When trainees need to become aware of something that they have not been conscious of, simulations can be a useful mechanism. Simulation games are a method based on "here and now" experience shared by all the participants. The games focus on the participation of the trainees and their willingness to share their ideas with others. A "near real life" situation is created providing an opportunity to which they apply themselves by adopting certain behaviour. They then experience the impact of their behaviour on the situation. It is carried out to generate responses and reactions based on the real feelings of the participants, which are subsequently analyzed by the trainer.

While use of simulation games can result in very effective learning, it needs considerable trainer competence to analyse the situations.

Individual /Group Exercises

Exercises are often introduced to find out how much the participant has assimilated. This method involves imparting instructions to participants on a particular subject through use of written exercises. In the group exercises, the entire class is divided into small groups, and members are asked to collaborate to arrive at a consensus or solution to a problem.

Case Study

This is a training method that enables the trainer and the participant to experience a real life situation. It may be on account of events in the past or situations in the present, in which there may be one or more problems to be solved and decisions to be taken. The basic objective of a case study is to help participants diagnose, analyse and/or solve a particular problem and to make them internalize the critical inputs delivered in the training. Questions are generally given at the end of the case study to direct the participants and to stimulate their thinking towards possible solutions. Studies may be presented in written or verbal form.

Field Visit

This involves a carefully planned visit or tour to a place of learning or interest. The idea is to give first-hand knowledge by personal observation of field situations, and to relate theory with practice. The emphasis is on observing, exploring, asking questions and understanding. The trainer should remember to brief the participants about what they should observe and about the customs and norms that need to be respected.

Group Presentation

The participants are asked to work in groups and produce the results and findings of their group work to the members of another sub-group. By this method participants get a good picture of each other's views and perceptions on the topic and they are able to compare them with their own point of view. The pooling and sharing of findings enriches the discussion and learning process.

Practice Sessions

This method is of paramount importance for skills training. Participants are provided with an opportunity to practice in a controlled situation what they have learnt. It could be real life or through a make-believe situation.

Games

This is a group process and includes those methods that involve usually fun-based activity, aimed at conveying feelings and experiences, which are everyday in nature, and applying them within the game being played. A game has set rules and regulations, and may or may not include a competitive element. After the game is played, it is essential that the participants be debriefed and their lessons and experiences consolidated by the trainer.

Research

Trainers may require learners to undertake research activities, including online research, to gather information or further understanding about a specific subject area.

As National Competency Standards require Competency Based Assessment, following paragraphs provide an overview of the Competency Based Assessment.

Competency Based Assessment (CBA)

Principle of Competency Based Assessment

Competency based assessment is aimed at compiling a list of evidence that shows that a person is competent in a particular unit of competency. Competencies are gained through a multitude of ways including:

- Training and development programs
- Formal education
- Life experience
- Apprenticeships
- On-the-job experience
- Self-help programs.

All of these together contribute to job competence in a person. Ultimately, assessors and participants work together, through the „collection of evidence“ in determining overall competence. This evidence can be collected:

- Using different formats
- Using different people
- Collected over a period of time.

The assessor, who is ideally someone with considerable experience in the area being assessed, reviews the evidence and verifies the person as being competent or not.

INSTRUCTIONS TO CANDIDATE

Introduction to trainee manual

Congratulations on joining this course. The “Student Learning Materials” developed and compiled here is a complete resource book developed in alignment to the respective National Competency Standard and hence will support the students to learn and understand comprehensive theoretical aspects related to the standard. This “Student Learning Materials” will be used for student learning and the method of instruction is called Competency Based Skill Training (CBST).

Aim of the training is to enable trainees to perform tasks and duties at a standard expected by employers. CBT seeks to develop the skills, knowledge and attitudes (or recognize the ones the trainee already possesses) to achieve the required competency standard.

While progressing with the training, make sure you participate with ongoing sessions and systematically develop the required theoretical knowledge and make sure to develop the theoretical competencies in all the units prescribed in the relevant National Competency Standard. Once each competency unit is learnt or the full set of competency units are covered, you may register and undertake the assessment. Do note that, formal assessments related to the TVET programs of Maldives are done by the TVET Authority and the assessments are undertaken within the principles of Competency Based Assessment.

CBA (Competency Based Assessment) involves collecting evidence and making a judgment of the extent to which a worker can perform his/her duties at the required competency standard.

What is a competency standard?

Competency standards are descriptions of the skills and knowledge required to perform a task or activity at the level of a required standard. You will find a description of each competency at the beginning of each Unit. The unit descriptor describes the content of the unit you will be studying in the Manual and provides a table of contents which are divided up into ‘Elements’ and its ‘Performance Criteria’

An element is a description of one aspect of what has to be achieved in the workplace. The ‘Performance Criteria’ details the level of performance that needs to be demonstrated to be declared competent. There are other components of the competency standard:

- Unit Title: statement about what is to be done in the workplace
- Unit Number: unique number identifying the particular competency
- Contact hours: number of classroom or practical hours usually needed to complete the competency. We call them ‘nominal’ hours because they can vary e.g. sometimes it will take an individual less time to complete a unit of competency because he/she has prior knowledge or work experience in that area.

Competency based assessment requires trainees to be assessed in at least 2 – 3 different ways, one of which must be practical. Assessments will be carried out and includes work projects, written questions and oral questions. Your trainer and/or assessor may also use other assessment methods including 'Observation Checklist' and 'Third Party Statement'. An observation checklist is a way of recording how you perform at work and a third party statement is a statement by a supervisor or employer about the degree of competence they believe you have achieved. This can be based on observing your workplace performance, inspecting your work or gaining feedback from fellow workers.

Your trainer and/or assessor may use other methods to assess you such as:

- Journals
- Oral presentations
- Role plays
- Log books
- Group projects
- Practical demonstrations.

Remember your trainer is there to help you succeed and become competent. Please feel free to ask them for more explanation of what you have just read and of what is expected from you and best wishes for your future studies and future career.

UNIT 01

APPLY OCCUPATIONAL HEALTH AND SAFETY REQUIREMENTS

This unit of competency describes the skills and knowledge in applying various aspects of occupational health and safety to work and ensure safety and health of personnel undertaking workplace tasks

INTRODUCTION

Occupational Health and Safety remained as a crucial element of every workplace task as the process is designed to create a safe, healthy work environment for all. It can generally be considered as two separate entities.

Occupational Safety covers the risk factor in your workplace, and potential safety hazards that could possibly cause injury. Occupational Health, on the other hand, looks at potential health concerns and wellbeing. Think of Safety as an employee's physical well-being, and Health as everything else, including mental health.



Like all industrial tasks, any activity within the Water and Sanitation Sector (WATSAN) should give due importance and apply proper measures relevant to occupational health and safety aspects, no matter how big or small the task may be. Everyone including you and the employers has a responsibility to minimize those risks and reduce the likelihood of any workplace accident or mistreatment.

Whether you are an employee or an employer involved with the WATSAN works, it is our duty to apply and implement occupational health and safety tasks. Following are considered as Employer responsibilities:

- ✓ provision and maintenance of plant and systems of work that are crucial to complete the work tasks with safety and are risk free.
- ✓ provision of access to and exit from the workplace that is safe and without risk
- ✓ provision of adequate facilities and arrangements for welfare at work.

Likewise, employee responsibilities under the scope of health and safety aspects related to work are as follows:

- ✓ take reasonable care at work of your own health and safety and that of others who may be affected by what you do or do not do.
- ✓ do not intentionally or recklessly interfere with or misuse anything provided for your health and safety
- ✓ Co-operate with your employer on health and safety matters. Assist your employer in meeting their statutory obligations
- ✓ bring to your employer's attention any situation you think presents a serious and imminent danger
- ✓ bring to your employer's attention any weakness you might spot in their health and safety arrangements.



CLEAN WORK PREPARATION AREAS

Work areas remain as the most important site where work tasks are being performed and it is important that the work areas are always kept clean and healthy.

When you are attending work related to plumbing, operation of water plants, sewerage works, laboratory testing or any other works, it is important that the primary work areas is always kept clean and tidy. A messy workshop not only hampers your productivity, but it also can also be extremely hazardous.



According to experts, a messy workshop can be even more dangerous. That fact's especially true for various mechanical works that involve use of sharp tools and equipment. If you don't clean your workshop regularly, the tiny scraps that are produced through work preparation activities can cause accidents or long-term health and safety problems. To avoid such accidents, it is essential to keep your workplace tidy.

Overview of cleaning equipment across workshop areas

Whether its work area or any other cleaning operations, different cleaning equipment are used today.

There are many different types of equipment, like pressure cleaners, sweepers and polishers, but also vacuum cleaners. It is important to choose the right equipment for a certain cleaning job. Pressure cleaners are machines that use high-powered steam to get rid of stains and dirt. They are especially ideal for cleaning concrete regions such as walls, patios, and walkways. The next essential tool for commercial cleaning is sweepers. These are large machines with a rotatory sweeping head located underneath the front of the machine. A sweeper is controlled by a driver who sits on a commercial sweeper and use a driving wheel to steer the device. These are especially useful for cleaning vast outdoor areas like the pavement outside a huge commercial place or on roads. A carpet cleaner is another essential. These cleaners have the ability to remove stubborn stains from almost any carpet area.



Scrubbers are designed to clean stains from hard floored regions. They are ideal for use in huge commercial buildings that have wood or marble flooring. They come in either sit on form or handheld form. The type to choose depends on the size of the region you need to clean.

A polisher is another essential equipment when it comes to commercial cleaning. A polisher is able to turn a dirty hard floor it a brand new in a timely fashion. Polishers are usually used in institutions such as universities, schools, museums and hospitals. Sit-on polishers are perfect for larger spaces while handheld polishers are used on relatively small areas.

As we all know, a vacuum cleaner removes dust and dirt from both carpeted and hard floors. Commercial vacuum cleaners are usually more powerful than household vacuum cleaners. They are ideally packed with numerous features that allow you to reach and clean unreachable areas. There're also wet vacuum cleaners that are used to suck up water. Others come with a dry and wet function to allow you to switch between your preferred modes easily.

How to clean spillages across work area floors

Oil, water and fuel spillages are potential Health and Safety Hazards in a home, workshop, garage or any workshop. It is vital that such spillages are quickly attended prior to slipping or falling that may injure you or your colleagues. Following are the basic steps of attending such spillages.

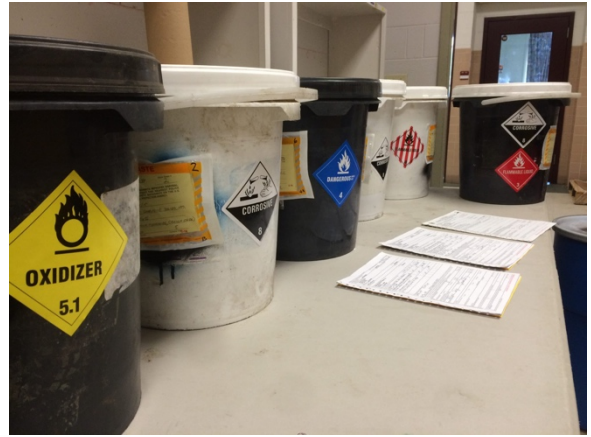
- ✓ Sprinkle sawdust, clay, coconut husks, or a commercial oil-absorbing product on the stain. If you have none of these products on hand, set paper towels on the floor to soak up any wet oil while you make a trip to the store.
- ✓ Allow the absorbent materials to work on the oil for 24 to 48 hours. Then, sweep up the debris with a broom and dustpan.
- ✓ Repeat with fresh absorbent materials as needed to remove any remaining oil.



Manage workplace wastage

Waste produced in work areas where engineering works are undertaken can be dangerous and need to be properly managed and handled.

Storing hazardous waste requires extra care. It should be stored under cover and in a bunded and secure area, or in an underground tank. Storage systems must contain any leaks or spills and prevent waste coming in contact with the ground or escaping to the environment via stormwater drains or gutters. And for proper handling of waste in referred eras, it is felt vital that consultations are made with Waste Management Corporation (WAMCO) or Environment Protection Agency (EPA).



CLEAN AND STORE EQUIPMENT

While repairing, it is important that through inspection is made on the determining faculty equipment and properly manage and handle them accordingly.

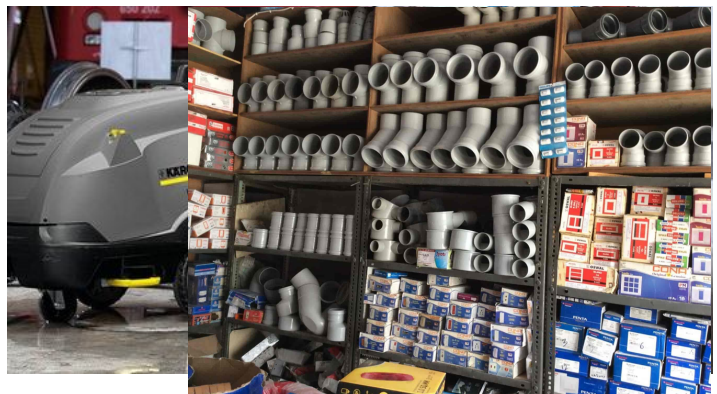
Collect used equipment, inspect for faults and, where necessary, remove from service

With the water plants and other industrial machineries, it is important that continuous inspections are undertaken to determine faulty parts that will affect operational efficiency of the system. For this reason, it is important that the faulty component or part is isolated and if possible, replaced on timely basis. Isolated parts may be either serviced or repair and it is vital that proper inspection is undertaken and repaired to be used for next time.



Use appropriate agents, apparatus and techniques to clean equipment

Dismantled parts need to be properly cleaned using appropriate cleaning methods prior to storing them for a safe, clean and hygienic environment within the work premises. Cleaning may consist of brushing, mopping, sweeping, dusting, polishing and wiping. The exact role and details of the cleaning process and the cleaning agents to be used will depend on the type of machinery being cleaned.



Pressure washers and water cannons are ideal for cleaning industrial equipment of

grease and grime. These harmful materials act as abrasives and friction agents, contributing to issues in your machinery if they're left unaddressed.

Store clean equipment in the designated locations

After, the repair, the part or the equipment need to be properly stored.

MONITOR STOCKS OF MATERIALS AND EQUIPMENT

Maintaining adequate supply of spare parts and other equipment are vital for effective and smooth operation of water plants and similar machinery. Besides that, managing adequate stock of spare parts are vital for sustained provision of services.

Perform stock checks and maintain records of usage as directed

Stock checking, is the systematic process of checking the quantity of the inventory. This helps in the decision making of the company as the experts are able to understand if the stock that they currently have on hand will be able to meet the required production and the resultant output will meet the demand for replacement of spare parts for effective and smooth operation of the industrial machines or equipment. Proper management of stock levels need to be maintained with systematic recording to ensure services are not interrupted.

Store labelled stocks for safe and efficient retrieval

Stock items need to be properly labelled for easy retrieval as confusions may arise if the labels are not properly undertaken. For this purpose, following rules need to be applied when labelling.

- ✓ Labels should be durable and fixed in place (i.e., don't use magnets or labels that can be easily moved).
- ✓ Labels should be easy to read, preferably from across a room.
- ✓ Consider using easy-to-spot colors such as black on yellow or white on red. (If you decide that easy-to-spot colors are too "ugly" or you can't easily make new labels with the same color scheme, you may not want to do this.)
- ✓ It should be easy to change or create labels (use an office printer or label maker to make them).
- ✓ They should be mounted so as not to obstruct normal activity or get easily ripped off or damaged.
- ✓ They should show the FULL NAME of the location, and no two labels should be the same.



- ✓ They should have arrows that point to the location, making identifying the correct location easier, especially with shelf labels.

Inform appropriate personnel of impending stock shortages to maintain continuity of supply

Having stock sit idly on the shelves will pile up the storage and maintenance costs, risk wastage and even be susceptible to theft from staff. Conversely, not having enough stock will put your operation at risk as you won't be able to keep up with the demand for replacement of parts. It is therefore vital to ensure proper personnel are continuously communicated for order placement for parts and maintain the engineering store at optimal level with spares for continued and sustained operational efficiency.

MAINTAIN SAFE WORKING ENVIRONMENT

For continued productivity, we all need to maintain a safe and healthy workplace. A safety and health management system, or safety program, can help to focus our efforts at improving work environment.

Participate in OHS activities within scope of responsibilities

Irrespective of the work being performed, it is mandatory that all participate in the occupational health and safety aspects related to the work being performed across the workplaces. A health and safety program is a definite plan of action designed to prevent accidents and occupational diseases. We all need to participate in the program being implemented under occupational health and safety scope across the different work practices. Because organizations differ, a program developed for one organization cannot necessarily be expected to meet the needs of another, although participation of all is vital and is considered as a responsibility of all involved with the different workplace tasks.



Irrespective of the work being performed, it is mandatory that all participate in the occupational health and safety aspects related to the work being performed across the workplaces. A health and safety program is a definite plan of action designed to prevent accidents and occupational diseases. We all need to participate in the program being implemented under occupational health and safety scope across the different work practices. Because organizations differ, a program developed for one organization cannot necessarily be expected to meet the needs of another, although participation of all is vital and is considered as a responsibility of all involved with the different workplace tasks.

Use established safe work practices and PPE to ensure personal safety and that of other personnel

Depending on the nature of the work involved, work practices may vary and need to be reviewed and agreed upon and following are some examples of safe work practices. That need to be followed while undertaking work activities.

Construction (Health, Safety and Welfare Regulations)

These regulations lay down key requirements for the safety of construction sites:

- ✓ generally ensuring a safe place of work
- ✓ precautions against falls from height or into excavations
- ✓ protection against falling objects
- ✓ Protection against structural collapse (while work is taking place), i.e. the building falling down!
- ✓ safeguards when working in excavations
- ✓ prevention of drowning (falling into water)
- ✓ provision of safe traffic routes (on sites)
- ✓ Prevention and control of emergencies (site emergency evacuation procedures, etc.)
- ✓ provision of welfare facilities – WCs, washing facilities, canteens/rest areas, shower facilities (if required)
- ✓ Provision of site-wide issues – clean and tidy sites, adequate lighting, constant and fresh air supply, etc.
- ✓ Training, inspection and reports – proper training of staff, use of properly trained staff to do the work, proper supervision of staff and monitoring the work carried out by staff to ensure it is carried out in a safe manner.

The Electricity at Work Regulations

These regulations lay down requirements for safe working with electricity:

- ✓ duties of those involved in undertaking the electrical work
- ✓ systems, work activities and protective equipment
- ✓ strength and capability of electrical equipment
- ✓ insulation, protection and placing of conductors
- ✓ earthing and other suitable precautions
- ✓ integrity of reference conductors
- ✓ making connections
- ✓ means for protecting from excess current
- ✓ means of cutting off the supply and isolation
- ✓ precautions for work on equipment made dead
- ✓ work on or near live conductors
- ✓ working space, access and lighting
- ✓ competence to prevent danger and injury

Safety with Electrical Tools

The Electricity at Work Regulations lay down the requirements for electrical power tool safety. Here are some of the key requirements:

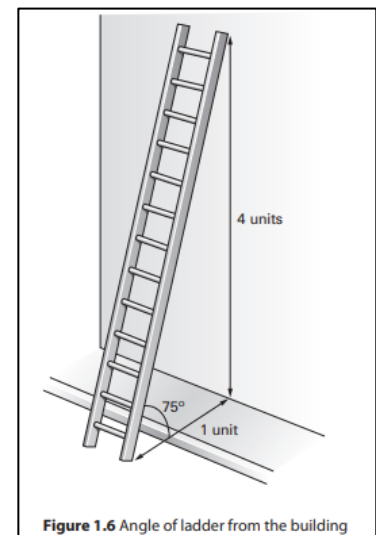
- ✓ low-voltage (cordless) power tools tend to be preferred to their mains fed counterparts, as they are safer to use
- ✓ on construction sites in particular, 110-volt power tools tend to be used as an alternative to the standard 240 volts found in domestic properties – lower voltage is again safer by design
- ✓ all power tools should be visually checked for signs of damage before they are used – damaged cables, plugs and casings, etc. Damaged tools must be taken out of service until disposed of or repaired

- ✓ all power tools should be subject to a Portable Appliance Test (PAT), this is a periodic check for electrical safety by a competent trained person, the recommended frequency of test for construction applications is three-monthly; all tested appliances should include a test label showing that the appliance has passed the test and the date of the next test should be displayed
- ✓ a Residual Current Device (RCD) is a type of electrical protection device that can be used in the electrical circuit supplying the power tool in order to provide added protection to the user
- ✓ power tools, e.g. circular saws, may also be supplied with adjustable guards. The tool must always be used with the guard firmly in place – it's there to protect the user! On no circumstances must it be removed to make the job easier.

Safety with work at Heights

Falls from ladders account for a high proportion of accidents in the construction industry. Here are some of the key points of ladder safety:

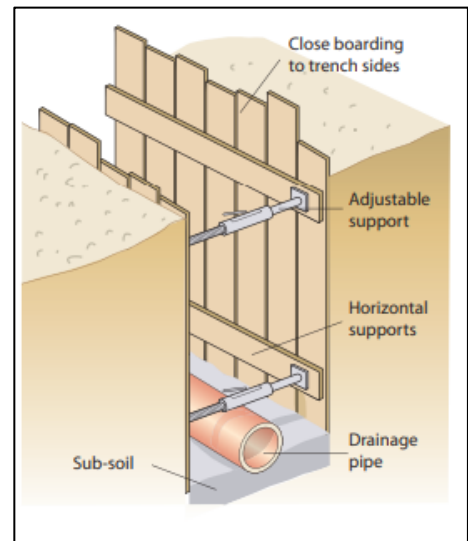
- ✓ A ladder should only be used to gain access to a work platform such as a scaffold, or for short-term work of usually less than 30 minutes' duration. Work at heights for longer periods should be carried out using safer access equipment such as a mobile tower scaffold
- ✓ there are a number of classes of ladder – Class 1 (industrial ladders) should normally be used for construction activities
- ✓ the ladder should be checked for safety and for visible signs of damage each time it is used – if in any doubt the ladder should not be used
- ✓ care must be taken when transporting the ladder around site and when erecting it
- ✓ the ladder must only be used on firm, level ground.
- ✓ if the ladder is to be used on or near a public footpath or road, there should be barriers around its base
- ✓ the angle of the ladder to the building should be 75°, or 4 up to 1 out
- ✓ the ladder should preferably be secured at the top and bottom, footing by a co-worker is an alternative method of securing at the bottom
- ✓ the top of the ladder should project 1m or approximately five rungs above a working platform or roof access point.



Safety with Work in excavations

Work in excavations can be particularly hazardous and therefore a risk assessment must be conducted before the work is commenced to ensure that proper control measures are applied to safely do the work. The following are typical measures:

- ✓ an assessment of the ground material type must be undertaken to determine the need for shoring
- ✓ only properly trained plumbers must work in excavations
- ✓ any work carried out should be in pairs, one plumber carrying out the work in the trench, the other passing tools and materials
- ✓ fencing must be erected around trenches over 2m in depth to prevent persons falling into the trench



Safety with work on hazardous substances

Work with hazardous substances falls under the COSHH Regulations, requiring an assessment of the risk of using the substance to be carried out before the work begins. Manufacturers of substances in support of the risk assessment process are required to adequately package the product, showing the dangers that the substance presents, and provide instruction on its use.



TOXIC



HARMFUL



CORROSIVE



IRRITANT



OXIDISING



EXTREMELY FLAMMABLE

Hazardous substances tend to fall into the following categories:

- ✓ toxic – poisonous liquids and gases
- ✓ harmful – a general term that is used as a classification for many hazardous substances
- ✓ corrosive – products that may corrode such as bleach
- ✓ irritant – products, such as loft insulation, that may cause irritation to parts of the body
- ✓ extremely flammable – substances that may lead to fire, e.g. LPG
- ✓ oxidizing – these are substances that remove oxygen from the surrounding air, e.g. ABS cement for jointing plastic pipework

Work with LPG gas heating equipment

Work with gas heating equipment can be a particularly dangerous activity as it can lead to:

- ✓ risk of fire through the ignition of combustible substances in the vicinity of the work area. Many insurance companies, in order to provide insurance to plumbing companies, require them to cease using LPG gas heating equipment at least 1 hour before leaving a site, so that any burning material is seen to be properly extinguished, and on high-risk jobs plumbing contractors may be asked to use a permit-to-work system.
- ✓ Risk of gas leakage:
 - gas heating equipment must be properly assembled and checked for leaks using soap solution
 - leaking gas, as it is heavier than air, will sink to the lowest points in a room, with the ability to form an explosive concentration
 - storage of cylinders should preferably take place in an open-air secure compound, all cylinder valves should be fully closed and protective dust caps should be in place, cylinders should be kept in an upright position.

Irrespective of the work u undertake, it is imperative that you wear proper personal protective equipment to ensure safe and healthy working condition for you and others.

Personal Protective Equipment

Personal protective equipment, commonly referred to as "PPE", is equipment worn to minimize exposure to hazards that cause serious workplace injuries and illnesses. These injuries and illnesses may result from contact with chemical, radiological, physical, electrical, mechanical, or other workplace hazards. Personal protective equipment may include items such as gloves, safety glasses and shoes, earplugs or muffs, hard hats, respirators, or coveralls, vests and full body suits.

Report potential hazards and/or maintenance issues in own work area to designated personnel



Eye protection

Eye protection comes in the form of:

- ✓ safety glasses – a typical application could be lead welding
- ✓ safety goggles – these provide a higher level of protection than safety glasses, as they should fit closely to the face
- ✓ welding goggles – these include specialist coloured lenses.



Eye protection that is used to guard against the threat created by flying objects should include lenses that are of the high-impact resistant type.

Hand protection

Hand protection that is normally used in plumbing includes:

- ✓ general-purpose gloves – these help protect against cutting or puncture wounds; an example of their use could be lifting concrete blocks or lifting steel tube
- ✓ specialist gloves – these are typically used to deal with hazardous substances such as dry ice used in pipe-freezing applications
- ✓ rubber gloves – these help protect against contact with used soil and waste systems and sanitary appliances. Gloves also provide protection against a disease known as dermatitis, which is caused by the hands coming into contact with materials classed as irritants.



Head protection

It is a mandatory requirement to wear a safety helmet on new-build and major construction sites. In addition, a safety helmet will need to be worn when work is taking place at heights or above the point where you are working – that could be in a trench. A safety helmet must:

- ✓ be properly adjusted to fit you
- ✓ be replaced if it becomes defective or damaged



Importance of Wearing Safety Helmets at Work



Foot protection

It is important to wear adequate foot protection for the majority of plumbing installation work carried out, owing to the weight of the components used. Adequate foot protection (which can be in the form of a safety shoe) usually includes:

- ✓ metal toe protection
- ✓ strong rubber soles and sturdy uppers. In addition, some forms of safety footwear can provide additional protection against electric shock.



Knee protection

Plumbing work can include a certain amount of kneeling, which can lead to painful conditions such as Housemaid's Knee. Knee protection should therefore be considered which can be in the form of:

- ✓ external fasten-on knee pads, or
- ✓ knee pads built into workwear.



Protective overalls

Protective overalls, alternatively known as workwear, will need to be worn for most plumbing activities. Protective overalls are available in many styles, they essentially:

- ✓ protect the worker's clothing
- ✓ assist in preventing the removal of hazardous or contaminated substances from the work-site. Disposable overalls are available and tend to be used for more specialist activities such as work on drains or sewers, or working with asbestos.



Ear protection

Ear protection should be worn when working in noisy areas or with equipment that generates high levels of noise. Ear protection is usually in the form of:

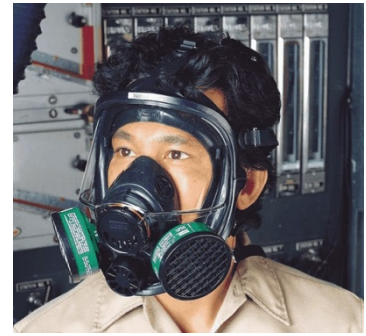
- ✓ ear defenders, or
- ✓ ear plugs.

The need to wear ear protection may be indicated by safety signs or through risk assessments carried out by construction or plumbing companies.

Respiratory protection

There are many forms of respiratory protection:

- ✓ simple dust mask – an example of its use could be working with loft insulation
- ✓ cartridge-type respirator – these can guard against a range of substances such as high levels of dust or fumes; different disposable cartridges are required to protect against different types of substances
- ✓ full breathing apparatus – usually used in specialist work in confined spaces such as drains or sewers.



FOLLOW INCIDENT AND EMERGENCY RESPONSE PROCEDURES

Workplace injuries cost employers significant cost of money every year. Therefore, it is vital that appropriate steps are taken to reduce the chances of injury, illness and property damage. An incident is an event or chain of events which has or could cause occupational injury, ill health, and/or damage (loss) to people, assets or reputation.

Identify incident and emergency situations

You are responsible not only for the safety and well-being of both your business and your workers. While it is not always possible to prevent accidents and disasters, they can be easier to cope with when you and your staff are prepared.



For this purpose, it is always important to review workplace tasks for the purpose of performing hazard assessment of the workplace to identify any physical or chemical hazards that may exist and could cause an emergency.

Report and record incident and emergency situations according to workplace procedures

The Reporting of accidents, injuries, or dangerous occurrences lays down the requirements for the reporting the following in advance.

- ✓ injuries – fatalities (including members of the public) or injuries to you or to the work colleague
- ✓ diseases that have the potential to spread among the staff
- ✓ Dangerous occurrences such as something that could have resulted in a reportable injury, due to the collapse of an excavation.

Detail of reportable accidents should be forwarded to the respective person in the workplace.

It is advised that the enterprises maintain an accident book for recording detail of all types of injury that occur while carrying out work, however minor. The accident book is used by the employing firm to monitor the level of accidents that occur and establish whether any additional safety controls are required to do the work.



If an accident occurs, an employee may be required to complete an accident report form; this should preferably be completed by the injured employee as soon after the accident as possible. If it is completed by a third party, then the employee must carefully check that the details are a clear identification of the events that took place, as once signed, an accident report could be used in legal proceedings!

Train staff to manage emergency procedures including use emergency equipment

It is critical to develop an effective disaster or crisis response strategy, no matter what industry your organization is involved in or what your geographic location is. Organizations must be able to respond quickly and competently should an emergency situation unfold. Having a response plan in place and ensuring staff members are both prepared and trained to respond to the emergency at hand are key to being successful.

Training staff in advance can, quite simply, mean the difference between life and death. Instead of being thrown in at the deep end in a real-life emergency situation, your employees will be more prepared to handle the situation, and therefore more likely to survive. Training also helps your employees to follow emergency plans which reduces the incidence of injuries and fatalities and also reduces damage to buildings, facilities and other property. Proper emergency response training also gives your employees instruction and guidance in using safety equipment such as hose reels, fire extinguishers and fire blankets which saves time in an actual emergency. It's important that every single employee in your organization understands what to do in an emergency through education, training, drills, and written policies and procedures. They should know how to sound an alarm in the event of an emergency and know how to respond when one is activated. They should know which evacuation route they are expected to use.

PPE – Personal Protective Equipment – TIER 1			
FIRE FIGHTING SUIT <small>EN469:2005, c/w: Fire Helmet, EN443:2008 Fire Glove, 659:2003 Fire Boots, EN15090:2006</small> 	SCBA, TYPE 2 <small>EN137:2006</small> 	CHEMICAL SUIT <small>Level A Gas-Tight / Level B</small> 	HAZMAT EQPT Over Pack Drum
PPE – Personal Protective Equipment – TIER 2 / 3			
FIRE RETARDANT GARMENT <small>NOMEX 111A</small> 	HELMET c/w: VISOR & Neck Curtain 	SAFETY GLOVE <small>Fire-Resistant Cut-Resistant Level 5 (Allergy Free)</small> 	SAFETY BOOTS <small>Fire & Chemical Resistant</small>
MITIGATION / FIRST AID / COMMUNICATION			
FIRST AID KIT 	LOUD Hailer 	FOLDABLE STRETCHER 	AED
FIRE BLANKET 	FIRE EXTINGUISHER 	DIVIDER BREECH FIRE HOSE 	FIRE NOZZLE

MANAGEMENT OF WORKPLACE OCCUPATIONAL HEALTH AND SAFETY

Safety of workers (also known as worker safety and occupational health and safety) refers to the provision of a safe working environment, safe equipment, policies, and procedures in order to ensure workers' health and safety. Occupational Health and Safety issues in the immediate workplace are continuously assessed and action need to be taken to rectify the problem is reported or managed on timely basis.

Following are important aspects of health and safety and it is vital that the employees have developed basic knowledge and skills related to the following.

Understand the aspects of First aid

The requirements for providing first aid are laid down in the First Aid at Work Regulations, which require the employer to conduct a risk assessment of first-aid arrangements for the company, this will include establishing the need for first-aid kits and trained first-aiders.

The following shows the typical contents of a first-aid kit.

The kit should only contain items for first aid, no other medicines must be stored in the kit (this includes headache tablets). Where plumbers are working in domestic properties it is normal practice for a first-aid kit to be provided on each company vehicle and for each plumber to receive a basic level of first-aid training.



Typical areas for first-aid training

A typical first-aid course for a plumber will cover:

- ✓ electric shock – removing the casualty from a live supply using an insulating material such as wood; Cardio Pulmonary Resuscitation (CPR); dealing with unconsciousness (no sign of breathing)
- ✓ placing the injured person in the recovery position (so long as they do not bear signs of a damaged back), and keeping them warm until the emergency services arrive
- ✓ treatment for burns – flood the injury with cold clean water
- ✓ dealing with broken bones – prevention of movement at the site of the injury until it is properly secured and supported

- ✓ substance in the eye – bathing the eye in eye-wash (clean water).

Understand the aspects of Fire Respond

Fire safety

Plumbers need to be aware of the fire risk that may be associated with their work. Some of the dangers are:

- ✓ igniting combustible materials in the location of hot working
- ✓ faults caused by electrical work. In order for a fire to occur the following need to be present:
- ✓ fuel – combustible material
- ✓ oxygen – air supply
- ✓ heat – ignition source. Remove any of these three items and fire will not take place.



Classes of fire

Fires are classed into groups according to the fuel type:

- ✓ Class A – fires involving solid materials, extinguished by water
- ✓ Class B – fires involving flammable liquids, extinguished by foam or carbon dioxide
- ✓ Class C – fires involving flammable gases, extinguished by dry powder
- ✓ Class D – fires involving flammable metals, extinguished by dry powder.

Fire-fighting equipment

There are a variety of different types of fire-fighting equipment. In undertaking plumbing work you are more likely to come across the fire extinguisher as the main source of protection; here are some points to its use:

Type of extinguisher	Colour code	Main use
Water	Red	Wood, paper or fabrics
Foam	Cream	Petrol, oil, fats and paints
Carbon dioxide	Black	Electrical equipment
Dry powder	Blue	Liquids, gases, electrical equipment

- ✓ an extinguisher should be kept in the immediate work area when hot working, e.g. using LPG gas heating equipment
- ✓ a fire extinguisher should only be used when it is safe to do so, personal safety must come before attempts to contain a fire
- ✓ fire extinguishers should only be used by those trained in their use
- ✓ the following shows the colour coding for extinguishers for dealing with the different types of fire.

Action in the event of a fire

Your employer will normally have procedures for actions in the event of a fire; if it's a larger site then the client or main contractor will have their own procedures. Whatever the case, you must be familiar with those procedures, which will include:

- ✓ the various fire escape routes from the building
- ✓ the location of designated safe fire assembly points, which you must go to in the event of an emergency
- ✓ if you discover the fire
 - raise the alarm immediately
 - leave by the nearest exit
 - ensure that the emergency service is summoned

Summoning the emergency services

These procedures apply to a range of different type of emergencies including fire:

1. find a telephone in a safe environment, well away from the emergency
2. dial the emergency service number
3. keep calm, and when asked by the operator, give the name of the emergency service required, e.g. fire
4. when you get through, provide the location of the emergency first and then the nature of the emergency, e.g. fire in cellar; also provide details of any specialist hazards that the emergency service may encounter, e.g. storage of flammable liquids

When the call has been completed, ensure that someone is available to meet the emergency service and to show them the location of the incident

Occupational Health and Safety documents are provided to all work stations

It is important that all the enterprises follow moral and legal responsibility to provide a safe and healthy work environment for employees, clients and visitors. This commitment extends to ensuring that the organisation's operations do not place the local community at risk of injury, illness or property damage.



For this purpose, an Occupational Health and Safety Manual need to be developed for the purpose of the following.

- ✓ Ensure employees are provided with a working environment that is safe and without risk to health;
- ✓ Implement and maintain safe systems of work;
- ✓ Consult with all employees on OHS matters;
- ✓ Take reasonable steps to ensure risk are controlled at the client's workplace;

- ✓ Monitor and review the effectiveness of measures to protect employees.
- ✓ Ensure compliance with legislative requirements and current industry standards;
- ✓ Provide employees with necessary information, instruction, training and supervision.

It is therefore vital that the referred Manual be distributed to all departments and ensure everyone is made aware of the occupational health and safety requirements of the respective organization.

UNIT 02

APPLY WORK ETHICS AND OPTIMIZE PROFESSIONALISM

This module covers the knowledge, skills and attitudes required in demonstrating proper work values and professionalism at work
Besides ethical values, knowledge and skills also developed on maintaining integrity at work

Introduction

Work ethics and professionalism is defined as the capacity to demonstrate personal accountability and effective work habits, such as punctuality, working productively with others, and time workload management, and understand the impact of non-verbal communication on professional work image. The individual demonstrates integrity and ethical behavior, acts responsibly with the interests of the larger community in mind, and is able to learn from their mistakes.

Referred behavioral traits are vital to ensure all working useful team members for the benefits and wellbeing of their professions with enhanced productivity through their career and life.

PURPOSE OF WORK AND ALIGNING TO COMPANY'S HARMONY

It is important that we have developed purpose to work and provide meaning to the work we do as they add values to the different jobs we perform. It is also believed that clear identification of the purpose and meaning to work are example of good work values and these values have a significant impact on employees' job satisfaction, and the success of businesses and teams.

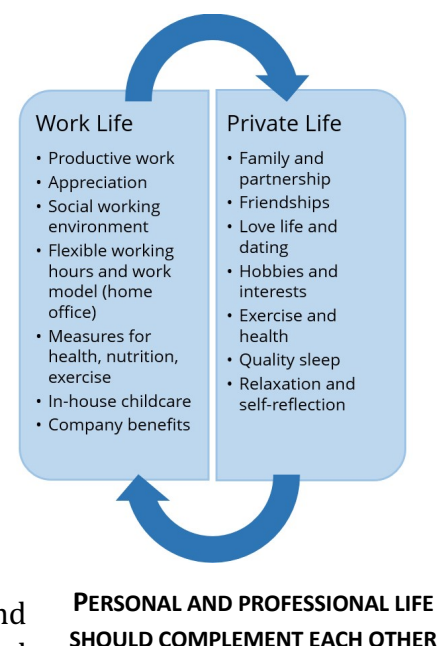
Being aware of workers values, how such individual arrives at decisions on the importance, worth, or usefulness of something and gives strategic insights into managing teams, and in hiring the 'best fit'.



It is evident that staff are happier when their values align with their career choices.

It is a fact that the work adds economic value, generates sustainable well-being for the individual and his family. Besides the direct benefits to the individual, this is also important to strengthen and promote progress in the social fabric, and it is a major factor for constructively and productively integrating into the social environment they belong and to which they owe something.

While some careers allow a relaxed relationship between work and private life, many others demand significant reductions in the area of leisure and family. With this in mind, employers are becoming more aware of the growing expectations of their workforce in terms of the work-life balance. Companies are now considering how to achieve a work-life balance and implementing targeted measures to promote this. The goal



is not only to make employees more productive, but also happier and more balanced.

APPLY WORK VALUES/ETHICS

Work values/ethic is a valuable attribute that employers look for in every industry. Showing the values associated with a good work ethic can increase employability and help to position for better job opportunities. Employees with excellent work values and ethics often receive for special projects and opportunities because they're reliable, dedicated and disciplined.

Work Values and Ethics Skills

Following are some of the important skills related to work values and ethics linked to any job being performed.

1. Reliability

Employees with a strong work ethic are very reliable. You can expect these individuals to be on time for shifts and meetings. They meet their deadlines and offer quality work. A reliable coworker makes an excellent teammate because they contribute fairly to projects.

2. Dedication

Part of a good work ethic is commitment and dedication to the job. They know how to focus on tasks without being distracted. These employees usually work until they finish their duties. They stay with one company for long periods of time.

3. Discipline

Discipline is an essential part of showing a good work ethic. Highly disciplined employees show determination and commitment to the job. They strive to meet or exceed expectations and seek opportunities to learn new skills and improve their performance.

4. Productivity

A strong work ethic translates to outstanding productivity. Productive employees often have a higher output than their counterparts. They complete projects early and do more than the minimum requirements.

5. Cooperation

A good work ethic is something that employees often spread to those around them by cooperating willingly on projects. They show good teamwork and readily assist others when needed.

6. Integrity

Professional integrity means holding oneself to high moral principles. Those with a strong work ethic also have outstanding integrity. They're honest, polite and fair to others.

7. Responsibility

Demonstrating strong work ethic requires a keen sense of responsibility. Those who are

ethical and responsible hold themselves accountable for their actions. They will accept the blame for errors they've contributed to and proactively work to fix these issues.

8. Professionalism

Employees with a good work ethic almost always maintain their professionalism. They exhibit a professional attitude clear in the way they dress, speak and carry themselves. They're respectful, focused, organized and neat.

Strong work ethics/values are vital to position and progress through career irrespective of the job or industry in which the staff is working.

How to improve work values/ethic skills

Following techniques at work will help to improve and strengthen work values/ethic skills on any job being performed, irrespective how big or small the organization may be.

1. **Act as an ambassador of the company.** Maintain a positive attitude toward the company in both professional and personal interactions. Seek ways to further the business even if they're outside the scope of your job. For example, a finance professional may pass a potential lead along to a sales representative.
2. **Prioritize your professional responsibilities.** Maintain good attendance, return promptly from lunch and arrive for meetings early. Strive to make personal appointments that don't interfere with your work schedule and only take personal calls on your cell phone when you're at lunch.
3. **Seek professional development.** Independently seek ways to improve your work performance, such as taking night classes, attending weekend seminars or reading industry publications.
4. **Review your work.** Submit thorough work that you have double-checked for quality and consistency. Manage your time properly so you can deliver projects early and give each task the time and attention it requires.
5. **Show respect to others.** Speak politely to and about others in the workplace. Keep your interactions professional to show your respect for others.

Above skills need to be continuously developed among the staff and together as team towards development of company's values as whole.

DEAL WITH ETHICAL PROBLEMS

Irrespective of the job and size of the organization, any employee is bound to face ethical problems during their professional life and could happen across the places of work.

Common ethical problems

It is important that all are aware of ethical issue and following are some of the common ethical problems and issues.

1. Unethical Leadership

Having a personal issue with your boss is one thing, but reporting to a person who is behaving unethically is another. This may come in an obvious form, like manipulating numbers in a report or spending company money on inappropriate activities; however, it can also occur more subtly, in the form of bullying, accepting inappropriate gifts from

suppliers, or asking you to skip a standard procedure just once.

2. Toxic Workplace Culture

Organizations helmed by unethical leadership are more often than not plagued by a toxic workplace culture. Leaders who think nothing of taking bribes, manipulating sales figures and data or pressuring employees or business associates for “favors” (whether they be personal or financial), will think nothing of disrespecting and bullying their employees. With the current emphasis in many organizations to hire for “cultural fit,” a toxic culture can be exacerbated by continually repopulating the company with like-minded personalities and toxic mentalities.

3. Discrimination and Harassment

Laws require organizations to be equal employment opportunity employers. Organizations must recruit a diverse workforce, enforce policies and training that support an equal opportunity program, and foster an environment that is respectful of all types of people. Unfortunately, there are still many whose practices break with existing guidelines. When discrimination and harassment of employees based on race, ethnicity, gender, disability or age occurs, not only has an ethical line been crossed but a legal one as well.

4. Unrealistic and Conflicting Goals

Your organization sets a goal—it could be a monthly sales figure or product production number—that seems unrealistic, even unattainable. While not unethical in and of itself (after all, having driven leadership with aggressive company goals is crucial to innovation and growth), it’s how employees, and even some leaders, go about reaching the goal that could raise an ethical red flag. Unrealistic objectives can spur leaders to put undue pressure on their employees, and employees may consider cutting corners or breaching ethical or legal guidelines to obtain them. Cutting corners ethically is a shortcut that rarely pays off, and if your entire team or department is failing to meet goals, company leadership needs that feedback to revisit those goals and re-evaluate performance expectations.

5. Questionable Use of Company Technology

While this may feel like a minor blip in the grand scheme of workplace ethics, the improper use of the internet and company technology is a huge cost for organizations in lost time, worker productivity and company dollars. Such practices are not only misuse of company tools and technology, but it’s also a misuse of company time. Whether you’re taking hourly breaks to check your social media news feed or know that your coworker is using company technology resources to work on freelance jobs, this “little white lie” of workplace ethics can create a snowball effect.

6. Too frequent Coffee or Cigarette Breaks

Too frequent coffee or cigarette breaks contribute to loss of productive time to any enterprises. Such breaks are vital to main continued productivity as staff feel relaxed and motivated with such breaks. However, break interval and frequency of such breaks need to be maintained at normal and acceptable to the company policies on taking breaks to ensure work ethics and values are not compromised.

All the above or any other ethical issues or values need to be dealt properly with shortest possible time to ensure workplace tasks attended by the staff is always remain focused and aligned to the productivity of different workplaces.

Solving Ethical Issues at Workplace

Following are strategies and methods on dealing with ethical issues at workplaces.

1. Gather as much information as possible.

Before taking action to solve an ethical issue, we need to have thorough understanding of that issue as possible. The problem may not be as straightforward as it first appears and it is important to gather enough information to determine what's going on. Gather all relevant facts concerning the issue at hand, and ensure we are not making assumptions. Everyone has their own personal and professional biases. Some of those biases are grounded in experience, but with limited facts or information, it could be skewed to perspectives and be lacking reality.



2. Identify the parties involved

Identify the parties involved and determine who else is involved in this issue. Involvement can be direct or indirect and on a direct level, those participating in the ethical violation are certainly involved. On an indirect level, those who will be impacted regardless of having no say in the issue are also involved. Among others, this can include coworkers, customers, and stockholders. It is important to determine who, among those involved. While fixing the issue, ensure the case is within your scope of duty and if not refer to the relevant seniors within the organization.



3. Pinpoint the ethical issues involved.

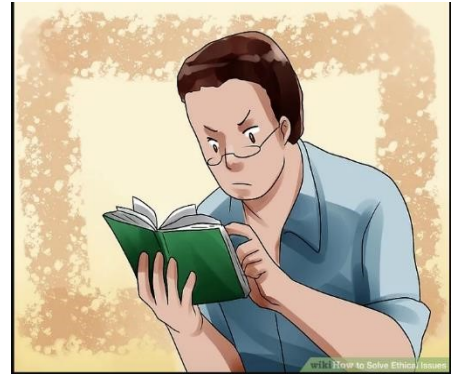
Instead of settling for a general sense that something is wrong, you need to ask yourself which ethical principles are being abused. Some ethical violations are more obvious than others. For instance, if you caught a coworker stealing expensive equipment, you could make the clear distinction that theft is wrong. In situations dealing with small violations or interdepartmental strife, though, the violation may not be as clear. Review the circumstances again and ask yourself which fundamental principle is affected.



Possible options include violations of power, integrity, honesty, objectivity, professional competence, confidentiality, or fairness.

4. Review the company's standard procedure.

Find out if your company currently has an internal system set up for dealing with ethical issues like this. If you have a company manual or similar documentation, review it now. Look into the organization's policies concerning workplace ethics. Pay close attention to the chain of command. Find out who you should involve at which points, and the correct procedure for doing so. If the company doesn't have a set structure for dealing with ethical issues, you will need to determine who to go to using your own experience and understanding.



5. List and evaluate your options.

Think of every possible option available to you instead of settling for the most obvious. Write out each of these options and consider the impact each one might have. When evaluating your options, consider how each one fares in the light of your company's internal procedures, any external laws involved, and any general ethical values upheld by society as a whole. Predict the consequences that will result from each option. This includes both positive and negative outcomes. Understand that, in some circumstances, each option may come with both negative and positive consequences.



6. Execute the best option.

After reviewing all of your options, determine which is best and put it into practice. In most cases, the solution will require you to escalate the issue to an authority within the company. The correct person may depend upon who within the company is guilty of the violation. Moreover, if the highest authorities in the company are guilty, you may need to bring the violation to the attention of an external authority. The best option should address the ethical issue in a productive manner. If multiple ethical values are involved, your solution should usually correct as many violations as possible. Whatever option you choose, be prepared to stand by it. There will always be critics, and there is no guarantee that you can remain anonymous throughout the entire corrective process.



7. Keep a record as you monitor the outcome.

Unfortunately, your work doesn't end just because you've reported the issue. Keep an eye on how things progress to make sure that the issue is genuinely addressed. As a general rule, it's a good idea to document nearly everything in writing. This includes your own investigations, the reports you've filed, and the discussions you've had concerning this issue. You may need to use these written records to defend yourself later.



8. Take things to the next level when needed.

If the initial solution you implement doesn't work, keep trying. Continue through the hierarchy until you've exhausted every possibility. Don't be afraid of going above someone's head if he or she isn't getting the job done. Be reasonable when evaluating how that supervisor has handled things, but don't let yourself be bullied into submission by someone trying to sweep things under the rug.



MAINTAIN INTEGRITY OF CONDUCT IN THE WORKPLACE

Ability of staff to maintain professional integrity in the workplace has a powerful impact on productivity, performance and reputation. Behaving with professional integrity takes practice, strength of character and self-awareness. In this section, we will evaluate why professional integrity is important in the workplace and share techniques to help maintain own integrity and even create a culture of integrity throughout the entire organization.



Professional integrity is the practice of maintaining appropriate ethical behavior. It is the practice of showing strong adherence to moral and ethical principles and values such as honesty, honor, dependability and trustworthiness. People who behave with professional integrity generally uphold a moral standard of conduct, both in professional as well as personal endeavors. These standards govern how professionals conduct themselves, their work ethic and their communication practices.

Reasons for maintaining professional integrity in the workplace is important Integrity is one of the most important attributes associated with the employees and the reasons for maintaining professional integrity are summarized as follows.

- ✓ **Employee satisfaction:** Employees are typically happier working for someone who they believe is trustworthy and dependable, someone who would never ask them to compromise their own principles. Integrity in a supervisor has been linked to job satisfaction and engagement, employee health and even life satisfaction.
- ✓ **Reputation:** In order for people to trust you— both in- and outside of your organization— you need to behave with integrity. Investors need to trust you in order to consider investing in your business. Vendors need to trust that you will pay for goods and services. Maintaining professional integrity will allow you to build a strong reputation that will increase the trust and comfort others have in doing business with you
- ✓ **Clearer focus:** Consistently behaving with professional integrity means you have the energy to focus on what is important rather than wasting energy covering up bad practice.
- ✓ **Stronger sales:** Customers today are motivated to buy from companies that are socially and environmentally responsible. The most effective way to create a culture of integrity and ethical behavior is to behave with professional integrity.

Skills to be developed in maintaining integrity within the workplaces

Following skills need to be developed among the employees in order to maintain own professional integrity and encourage an entire culture of ethical behavior within the workplace.

1. Treat everyone the same

Integrity is about honesty, wholeness and being the same person in all situations and with all people. Treat supervisors, coworkers and even the intern with the same level of professionalism and respect, regardless of their level of seniority. The same applies to customers. Every customer should be given the best treatment, regardless of the level of service they pay for.

2. Reward honesty

Create a culture of integrity by encouraging others to be honest with you, even when they make costly mistakes. Reward honesty publicly and repeatedly until everyone on your team understands that it's always safe— and always the best idea— to be honest with you.

3. Admit your mistakes

Everyone makes mistakes and no one, from customers to employees, expects everyone to be perfect all the time. The key to behaving with professional integrity is admitting mistakes and apologizing when you're wrong. You must also demonstrate your regret through your actions and demeanor. You'll generally find that not only do people not think less of you, they actually think more highly of you by your ability to admit error.

4. Encourage teams to speak freely

Encourage your team to come up with fresh and creative approaches to everyday business challenges you encounter. Team discussions regarding new ideas should be honest and critical, yet respectful and open-minded of other perspectives. Encourage

your team to speak freely as well as give and receive constructive criticism to improve ideas.

5. Conduct self-assessments

Periodically evaluate whether you are behaving with professional integrity. Evaluate whether you are heavily influenced by stronger personalities, pressured by your boss or tempted by easy money. You could even ask a trusted coworker their objective viewpoint. Make a non-judgmental inventory of your own integrity and determine whether you need to take action based on potential areas of self-improvement.

6. Keep your commitments

If you want to develop a reputation as being someone who delivers on their promises, make a habit of always keeping your word. This means that yes needs to mean yes and no means no, without excuses or a change of conditions. This also means being on time— or even early— when you say you will be. It means demonstrating respect for others' time and notifying them right away if you'll be late.

7. Put in maximum effort

Putting all of your focus and effort into something to reach a goal is a character trait that others admire. It demonstrates a strong work ethic and a commitment to results for the betterment of the organization. Giving your work your maximum effort every day and being unwilling to give in to distractions speaks volumes about your integrity.

WORKPLACE EFFICIENCY

The three components of excellent service quality

Service quality is one of the most important competitive factors in today's business landscape. Here's how to make it excellent.

Defining excellent service is not a one-way street. It depends on how the customer experiences the service. That being said, one fact is without question; if the service quality is not sufficiently high, the service provider is likely to disappoint its customers regardless of their expectations.

Great service climate is a key to excellent service quality

The concept of service climate plays an important role in understanding how to deliver excellent service quality, as it captures what employees experience in terms of organizational practices regarding service delivery. It also influences employee motivation regarding service behavior.

If employees experience excellent service quality on the inside, they are more likely to be motivated to deliver excellent quality on the outside of the organisation. Thus a strong service climate leads to service quality.

In order to create a great service climate and deliver excellent service quality, these three key components need to be in place:

Service Strategy

With a service strategy, the service provider can decide the service parameters, build the service value chain and design the internal service platform. The stronger each of these elements are - the better and more robust the service strategy will be.

Various studies have proven that an effective service delivery platform built on a solid service value chain concept greatly affects customer quality.

When managers ensure that service constantly is communicated as a strategic imperative, employees are likely to perceive service to be important. As a result, their behaviors towards customers are likely to reflect their orientation towards service excellence.

Service Performance

Research highlights that training, empowerment and rewards are the three most significant factors, which determine the level of performance and, in turn, lead to delivery of service strategy and excellent service quality.

Training

Training of service employees has long been identified as the most important factor behind higher service quality. For years, studies have proved that there is a strong correlation between the number of employee training hours and the degree of service quality.

To make it a success, the employer should focus on more than the basic service-specific competencies. The main emphasis should rather be on training of service management and other soft skills such as social skills, attitude and language abilities.

This will enhance the overall capabilities of service employees and improve the overall performance of the service system.

Empowerment

Empowerment means providing employees with enough autonomy to allow them to handle unforeseen situations and challenges and let them be more self-sufficient in their work.

Empowerment has five dimensions:

1. **Meaning:** the extent to which the employee experiences a task as personally meaningful
2. **Competence:** the extent to which the individual feels confident about their ability to perform the task
3. **Self-determination:** the degree of influence the individual has over how to perform the job
4. **Strategic autonomy:** the degree of influence an individual has on the content of the job
5. **Impact:** the degree of influence an individual has on their direct work environment

Empowerment motivates employees to greater service performance and creates a greater sense of accomplishment or satisfaction in their jobs by reducing dependency and encouraging teamwork.

Rewards

Service employees should be properly rewarded for their work. The term *reward* should in this context be understood as a broad term referring to more than just monetary reward. Contrary to common perceptions, monetary rewards play a much smaller role in aligning performance with the service organization's value and

goals compared to non-monetary rewards. For both types of goals, it is of high importance that the goals are realistic and achievable and that the employee has been involved in the goal-setting process.

The intangible nature of services means that performance can be difficult to measure. Therefore employees must be trusted to monitor their own performance. Performance appraisals should include input from employees as well as customers and the appraisal results must be used in determining training needs.

Customer Results

As detailed above service quality is centered on the perception and experience of the customer. Hence, measuring and tracking customer results are ways to provide feedback to the service delivery chain and to increase the value of each customer relationship.

To make this successful it is of high importance that the service provider and the customer organization are aligned on the purpose, objective and goal of the service exchange.

If, for example, a customer organization aspires to become the world's greatest entertainment company, the service provider needs to ask: *How can our company design a value proposition and our service delivery system to fulfill this customer vision?*

If a customer would like the full benefit of an external service management provider, it is important to insist that the service provider both supports and understands the mission of the company. For this to happen the relationship must move from being input- or task-oriented to being collaborative.

UNIT 03

PRACTICE EFFECTIVE WORKPLACE COMMUNICATION

This unit covers the knowledge, skills and attitudes required to gather, interpret and convey information in response to workplace requirements

Introduction

Communication is the process of transmitting information and common understanding from one person to another. Communication in the workplace is critical to establishing and maintaining quality working relationships in workplaces.

It is more important than ever (in this highly competitive job-hunting environment) that students focus on improving their communication skills. Whether it is working at a part-time job or focusing more on graduate opportunities once you've finished your course, employers all say they want graduates who are 'expert communicators, team players, creative and innovative thinkers'. It does not seem to matter what industry you apply it to; most employers are saying the same thing – excellent communicators get the best paying jobs and the most rewarding careers.

OBTAIN AND CONVEY WORKPLACE INFORMATION

Better communication leads to a more productive workplace, which in turn increases a company's revenue. The consequences of poor and ineffective communication can be serious. Miscommunication between colleagues can lead to a halt in business operations. Miscommunication with customers often results in the loss of business. Good communication between colleagues and customers begins with effective communication skills and knowledge of successful workplace communication strategy.

Communication Channels

Communication channels are the means through which people in an organization communicate and interact with each other. Without the right communication channels in place, it becomes extremely challenging to align employees with the business goals, break down silos, and drive innovation in the workplace.

Types of Communication Channels

When looking at all the possible communication channels, we can segment them into two main groups:

1. Communication channels by formality
2. Communication channels by means of communication

Communication channels by formality

There are three different communications channels based on formality: formal, informal and unofficial.

1. Formal communication channels

Formal communication includes exchange of information such as the goals, policies and procedures of an organization. Some of the most common examples of formal communication include company business plans, strategy, goals, annual reports, agreements, company-wide communications, workplace safety guidelines and procedures, board presentations etc.



2. Informal communication channels

Informal communication channels are also used to deliver official business messages but in a more relaxed way. Some examples of informal communication include conversations at work addressing various issues that team members may have, lunch time conversations and continuous collaboration among team members.

3. Unofficial communication channels

In addition to official communication channels, there is also an unofficial mode of communication that is quite common in the workplace. Unofficial communication includes employee communication outside of work environment on topics not related to work.

Communication channels by mean

Besides formality, communication channels can be divided by mean. In other words, the way and tools employees use to communicate with each other. Three types of main means of communication in the workplace are as follows.



1. Digital communication channels

Electronic means of communication include various online tools that employees use to stay connected with each other and keep up with the company news and updates. Today, digital communication channels are the most popular and most used channels in the workplace. Some of the examples include email, internal communication platforms, employee collaboration software and intranets.

2. Face-to-face communication

Even though electronic means of conversation in the workplace are taking over, face-to-face communication is still extremely important. This mean is much more personal, and it has more human touch into it.

3. Written communication

This type of communication is almost completely dead within organizations. However, written communication is still necessary when important policies, letters, memos, manuals, notices and announcements are being communicated to the employees.

SPEAKING LANGAUGE AT AN OPERATIONAL LEVEL

Whether you are speaking in English or Dhivehi starting a conversation can be one of the most stressful things in life, but also one of the most rewarding. Being good at starting conversations is essential in your career and many other aspects of life. The following are examples of opening statements that can help you get the ball rolling.
Examples:

- ✓ How are you?
- ✓ How did your shift go?
- ✓ How's the weather today?
- ✓ Anything new today? Are you busy?
- ✓ What time do you finish work?
- ✓ Good morning.
- ✓ Good to see you.
- ✓ Nice to meet you.
- ✓ Where are you from?

Language Tips

Here are some suggestions for starting conversations:

- ✓ Research interesting things to talk about
- ✓ Before you approach somebody to talk, relax
- ✓ Be prepared to listen
- ✓ Avoid controversial subjects, complaining or gossip
- ✓ Be yourself!

Workplace interactions with colleagues

A good direction in your business, and therefore its success, is largely the ability to create and maintain social relationships, whether they are more ephemeral or more lasting and deeper.

In the workplace, anyone should be able to have a conversation with their colleagues and clients, and have a good attitude with them; but unfortunately it is not the most common. That is why we must learn to manage the way we interact with others.

There are some basic rules when it comes to building social relationships, which will be useful to us on a daily basis. Interacting with your coworkers in a positive way is crucial.

Identify the presence of your classmates

We mean to greet or recognize the other person who is close to you. A smile or a look is enough to show that you have seen that person, basically nothing but good education.

Work with the conversation

Starting the conversation, yourself by telling your own experiences or asking the other person about your life is a good way to improve social relationships. In this way you will demonstrate your inclination to know that person more. By finding something that interests you or that you have in common, you will be creating the basis for future interactions. Do not forget to observe the details and focus on them, but always avoiding judging.

Share a bit of yourself

A conversation is not only based on asking and listening, it is an interaction between two people, in which both can and should contribute their views.

In this way, we must try not to fall into an “interrogation” and reveal our own feelings

and opinions at the same time, since this will allow us to see our own perspective and create a true connection.

Empathy

It is the basic quality to develop when interacting with other people and that can be demonstrated in different ways. We refer to the ability to put ourselves in the place of

the other person, and show a real interest in connecting with them. This desire is also demonstrated through our body gestures and facial expressions; such as smiling or bowing are examples of nonverbal language that convey an idea of attention for what the other person expresses.


Short responses include:

- Ok, I understand
- So you want me to ...?
- Yes, sir/madam
- I understand you would like me to ...

Short responses include:

- Nodding your head
- Using thumbs up or ok hand gestures
- Following the instructions.

Note: You should repeat difficult instructions to make sure you understand.



Active listening

These tips will not help us, if we are not able to correctly attend to what our interlocutor is trying to convey to us.

If we join a conversation that has already begun, it is best to keep an eye on the rest of the people who participate and what they are commenting on. It is at the moment in which they arrive at a pause when you will be better received, and if you ask questions about what they have said and even offer a comment in reference to their statements, you will show true interest in your colleagues or clients.

Now is the time to implement all these tips and achieve with an open attitude, that your customers and colleagues are willing to collaborate, that they are more receptive to new opinions and challenges that there is a great working environment to achieve the success of your company.

Verbal instructions or requests are responded to at an operational level

When a supervisor or manager gives employee instructions to carry out a task, they expect that it will be done correctly. It is the responsibility of the employee to clarify the instruction or request to ensure no miscommunication of the supervisor's expectations. This unit will give you the language tools you need to confirm instructions or requests in order to avoid frustrating and embarrassing misunderstandings.

When you are given instructions it is important to confirm that you understand them and respond appropriately.

Confirm Understanding

You should use short responses and body language to confirm that you understand instructions.

Appropriate nonverbal communication

There are several ways nonverbal communication can support your ability to communicate effectively in the workplace, including:

- ✓ **Supports your message.** When having a conversation, participating in a meeting or engaging in conversation, nonverbal cues can emphasize and underscore the content of your message. For example, using hand gestures to indicate the importance of an idea may tell your listeners to pay attention to and remember a key point.
- ✓ **Communicates messages.** You may also use nonverbal communication completely to communicate with others. For example, if someone is explaining a sentiment you admire and agree with, you might nod your head up and down to express solidarity.
- ✓ **Communicates intention.** Your body language may also intentionally or unintentionally express your current condition. For example, people may pick up nonverbal cues that you are being dishonest, unengaged, excited or aggressive.
- ✓ **Conveys feelings.** You can also use nonverbal communication to show your feelings, such as disappointment, relief, happiness, contentment and more.
- ✓ **Offers support.** Nonverbal cues are also a great way to show support. Whether it's a simple smile or pat on the back, action may speak louder than words in many cases.
- ✓ **Showcases your personality.** Nonverbal communication is a great way to show who you are. For example, a kind and optimistic person might frequently smile with open body language and offer friendly touches.
- ✓ **Indicates a desired action.** This might include inching toward a door to indicate your desire to leave the room, raising your hand to offer an idea or putting your hand out to meet someone new.
- ✓ **Deescalates tension.** Using a calm tone of voice, open body language, and directive gestures may help to resolve a difficult situation.

Simple requests

Whether it's a chance for more responsibility or a request for annual leave, making requests effectively in English is an important part of any English-speaking workplace. Ask in the wrong way and you can lose your chance of getting what you want or even make a bad impression on your colleagues so it's vital to get it right. Follow these simple tips to make sure you get exactly what you want when you make a request in English.

Don't demand

People always resent being ordered around so make sure to avoid using imperatives when making requests. Saying, “Give me some time off” will never please your boss. Instead, start your request politely, for example, “I’d like to request some annual leave” or “I’d appreciate it if you could give me your feedback”.

Eliminate “I need”

Always talking about what you “need” can make you sound bossy and offensive because it shows that you think your needs are more important than other people’s. Use questions like “Could you please...?” and “Would you be able to...?” to sound more considerate and polite.

Avoid assumption

Even if you have an understanding boss, it’s best not to make assumptions about being allowed to do certain things. If you want to leave early, it’s much better to say “Would it be OK if I slipped out a bit early today?” than “I’m going to leave a bit early today”. Think of the consequences of your request and what you will do to make up for any inconvenience caused. For example, if you need to leave a little early, explain when you will make up for the work you’ve missed.

Steer clear of accusations

If your manager seems to have forgotten about your request, don’t accuse him or her of not doing the work by saying, “Where are those figures I asked for?” For a simple yet effective reminder, just say, for example, “I was wondering if you’ve had the chance to calculate those figures.” It’s a non-threatening way to remind your boss of something he or she promised to do.

Try a second time

If your manager has denied a request, it can be easy to just give up. Instead, check what the problems are with your request, explain clearly how you will solve them and then ask your manager to reconsider your request.

Remember, whenever you are making a request, considering how the other person will feel about it is a great way to guess how they will react. Think about the impact your request will have on the other person and bear in mind the tips above and you will be in a strong position to have your request granted.

Routine procedures

All organizations have rules for the transfer of information. Knowing how to use the different types of communication and following the correct procedures to ensure that information goes to the correct place and person.

Communication can be internal or external or both. Internal communication is between staff. External communication is between staff and guests or other community members including the media.

Routine workplace protocols exist for:

- ✓ written communication (sending and receiving information), and
- ✓ Verbal communication (giving and following instructions and messages).

Different forms of expression in English and Dhivehi

Students often ask me if we can use idioms and slang in professional situations – the answer is, it depends. Some expressions are not appropriate for the workplace, but there are many that you can use in conversations among co-workers and less formal emails.

In this unit, you'll learn 15 English idioms and phrasal verbs you CAN use at work.

Put Something Off

If you put something off, you delay doing it.

"I put off writing the report until the last day, and now I have to work overtime to finish it!"

Take Off

If something takes off, it increases or becomes popular very quickly.

"Sales have really taken off this year and the company is making record profits."

People Person

Somebody who is a people person is extroverted, has great social skills, and loves interacting with people.

"Ashley's been promoted to director of human resources. She'll do a great job – she's a real people person."

Crunch the Numbers

Crunching the numbers means to do a lot of calculations.

"After crunching the numbers, our accounting department informed us that we don't have enough money to buy the new equipment."

Have a Lot on Your Plate

If you have a lot on your plate, it means you have a lot of work and responsibilities at the moment.

"Sorry I didn't call you back sooner; I have a lot on my plate right now."

Selling Like Hotcakes

If a product is selling like hotcakes, it means a lot of customers are buying it very fast.

"The new product is selling like hotcakes. We'll need to produce more to keep up with the demand!"

Think Outside the Box

To think outside the box means to think in a creative way that is different from usual.

"We need to come up with a really good advertising campaign. Let's try to think outside the box."

Win-Win Situation

A win-win situation is a cooperative agreement that is good for both people or companies. "This partnership will bring increased publicity to their company and new customers to ours. It's a win-win situation."

Test The Waters

If you test the waters, you try something new to see if it will be successful or not.

"We're testing the waters to see if changing the product's packaging will increase sales."

Bang for The Buck

If something provides more bang for the buck, it means it has more value for the money spent.

"I think we should use online ads instead of TV commercials. They give more bang for the buck."

Learning Curve

The learning curve is the time it takes to learn an activity or system.

"Our database system has an easy learning curve – you'll be able to use it perfectly within a day."

Off The Top of One's Head

If you know something off the top of your head, it means you know it immediately without needing to look for the information in books, on the internet, etc.

"I don't know the exact number off the top of my head, but I'd estimate that we spent about \$400,000 on training for employees last year."

On The Back Burner

If a project is on the back burner, it means it is less important at the moment.

"The preliminary market analysis is on the back burner; I have some other projects that are taking priority."

In the Red / In the Black

If a company is in the red, it means it is operating with debt. A company operating in the black means that it has a profit.

"Our company ended the year in the red with a debt of \$5,000,000."

Ramp Up

If you ramp up something, it means you increase it.

"We need to ramp up our efforts to find new customers."

MANAGE WORKPLACE CALLS AND MESSAGES

Speaking slowly and clearly, with pauses, is even more important when you're calling on a cell phone, because the sound produced over cell phones is already harder to hear than sound on a land line.



And what about your actual message?

Hi. (pause) My name is Jezra Kaye. (pause) That's J-E-Z-R-A, and my last name is K-A-Y-E. (pause) I'm calling about the bicycle you're selling. (pause) If it's still for sale, please call me at 123-456-7890. (pause) That's 1-2-3 (pause) 4-5-6 (pause) 7-8-9-0. (pause) Again, this is Jezra Kaye, calling about the bicycle, and I'll try you again later. (pause) Have a great day.

As this example shows, a good phone message is a "paint by the numbers" exercise, where

you fill in each pre-determined step with color. (This is true for good thank you notes, too.) When you've called someone else (presumably because you want something), you can make it easy for them to respond by:

Leave instructions that aren't a dead end. If you leave a phone number that doesn't have voice mail, specify that people should text. If you leave an email address, make sure it's one you actually check!

Even better, leave two ways for them to reach you in your original message, so that they can pick the one they like best.

WORKPLACE MEETINGS AND DISCUSSIONS

Every workplace will have staff meetings/team meetings, formal and informal discussions. When a business places a proper value on the time spent by people preparing for and attending meetings, it is quickly seen that they are a very expensive exercise.



Workplace meetings if not properly planned may not produce the best results and hence it is important that the meetings need to be planned and organized. Effective meeting procedures are essential to ensure that the maximum output is gained from a meeting.

Pre-requisites for a successful Meeting

For workplace meetings to be successful, following need to be planned and implemented.

1. A clearly defined purpose for the meeting

Ask questions such as; why are we meeting? What are we trying to achieve? Are we meeting for meetings sake? However, consider that at times the purpose of bringing people together for a meeting may be to achieve other important interpersonal objectives like team building, brain storming or group problem solving. Make sure that you clearly communicate the meeting purpose well before hand, this gives attendees time to gather ideas or research issues prior to attending the meeting.

2. Advise people of the meeting in time for them to be able to attend

It is amazing how often key people are left out of meetings or are not able to attend simply due to a lack of planning and sufficient notice.

3. Set an agenda

An agenda aims to keep discussions on track and to keep everyone focused on the issues. The agenda should be distributed to attendees before the meeting.

4. Start and finish on time

Make sure the meeting starts and finishes on time so participants feel that their time is valued and that they can plan for effective meeting participation to fit within their work load.

5. Manage the participants

It is important that every person feels their attendance and contribution is valued. People must be given the opportunity to express their opinion as well as recognizing they must also listen to others without interruption. Clear conflict management strategies must be in place.

HANDLE RELEVANT WORK-RELATED DOCUMENTATION

Whether big or small, all businesses use workplace documents that need to be properly managed to effectively maintain their business activities. Among them, some documents need to be always kept on site for compliancy purposes, while others are developed to ensure the efficient delivery of services and products to customers.

Types of Workplace Document

Documents play an essential role in protecting the interests of the business and business owners over the course of a company's lifetime. Here is a list of common workplace documents important for any businesses.

1. Registration and Permit Certificates

Whether it's a company or Sole Proprietorship, relevant registration certificates need to be carefully stored and kept as referred registration certificates may need to be produced for different purposes.

2. Lease Contracts

Companies big or small may have several lease contracts involving lease of the office space, equipment or land. Such lease contracts need to be properly managed and stored to ensure lease terms and other contractual terms are properly managed and implemented.

3. Employment Contracts, Appraisal reports

This contract sets and the appraisal reports need to be stored in order to minimize future disputes. Not every hire requires an employment agreement, but the document can be a useful if you want to dissuade certain new hires from leaving your company too soon, disclosing confidential information about your business, or going to work at a competitor. The contract should be reviewed by an experienced employment expert before given to an employee to sign.

4. Warranty and Insurance Certificates

Companies often procure expensive items that becomes part of their operational

expenses and hence such equipment or tools may play a crucial role in the survival or growth of the enterprises.

For this purpose, it is important that the Warranty or Insurance Certificates be kept safe and accessible to ensure business operations remain smooth and healthy always.

5. Memorandum of Understanding (MOUs)

An MOU falls somewhere between a formal contract and a handshake. It documents any important conversations you have with suppliers, potential partners and others involved in the business. MOUs are great ways to lay out the terms of a project or relationship in writing, but do not rely on the document to be legally binding.

6. Memos, Policies, Letters, Meeting Minutes

Memos, company policies, letters and meeting minutes are also important documents while managing and operating enterprises. Properly managing and them will ensure the operational process of the enterprises are linked to an official account of what was done or talked about at formal meetings, including any decisions made or actions taken. They can help settle a dispute about what happened or didn't happen in a past meeting.

7. Financial Records

Managing good financial records are vital to prepare accurate financial statements. These details will help with the decisions that are made for business management and growth purposes.

Whether big or small, any enterprise should maintain the following financial records.

- ✓ Profit & Loss (Income Statement)
- ✓ Balance Sheet
- ✓ Cash Flow Statements
- ✓ Payroll Processing Reports

These are just a few examples of financial information that might be needed for all the enterprises although specific requirements may vary depending on the size of the business and your industry.

8. Inventory Records

Whether big or small, inventory management of the enterprise is linked its growth as inventory management save money and allows to fulfill your customers' needs. In other words, it enables successful cost control of operations. Knowing what we have, what is in our warehouse, and how to manage the supply chain properly is the backbone of business.

Managing Workplace Document

Documents can get a little out of hand in an office, particularly when people are constantly exchanging contracts and notices. Although we're living in a technological age, there are still times paper copies are required and hence workplace documents need to be properly managed.

1. Re-Organize Your Workspace

This is the first and most important step to a more organized workplace. Take the time to go through your existing files and documents, and sort out which documents are important enough to be kept on file, and which ones need to be shredded. Any duplicates can be thrown away, and anything you haven't used in the last 6 months can be put into recycling. Be sure to clear out any drawers and filing cabinets so you can start from scratch and organize a system that works for everyone



2. Get Filing

There's good reason why filing cabinets are one of the most common forms of storage for documents, in the home and in the office. Broad headings will help to decrease filing time. However, you might want to consider adding subheadings to the more generalized folders to prevent cluttering and allow for easy finds



3. Label Clearly

This is vital to keeping your filing system organized and free of accidental category mixing. Document folders can be labelled in order of topic and purpose. Dates are also good to include within the subcategories. Alphabetically ordering files is another popular way of organizing documents. While organizing things alphabetically is a good idea, many organizers recommend keeping an index of all the document folder names, allowing you to keep track of added categories.



4. Sort Out Loose Documents

Some offices have baskets for documents that need to be filed or shredded. In order to keep on top of everything, it's best to get onto these documents as soon as you can to avoid piling up. Make sure you go through your 'to-file' basket carefully and filter out any documents you won't need in the immediate future, as well as duplicates.

5. Use Storage Boxes

Documents build up over time and sometimes a filing room isn't enough to store all your papers. To save room, you might look toward the good old-fashioned archive box. Choose between classic cardboard and the more modern and sleek plastic storage containers. Your filing system can still be applied on a smaller scale to these boxes, just store them horizontally and label them accordingly

6. Use a Digital Filing System

Now we live in a technological age, it's inevitable that you'll eventually move all your documents to an online filing system. You can still keep hard copies, but moving to a digital filing system saves a lot of time and money. Documents are all in one place and can be accessed on nearly any computer or mobile device.



Basics of bookkeeping

Bookkeeping is the process of recording company's financial transactions into organized accounts on a daily basis. It can also refer to the different recording techniques businesses can use. Bookkeeping is an essential part of accounting process for a few reasons. When you keep transaction records updated, it can generate accurate financial reports that help measure business performance. Detailed records will also be handy in the event of a tax audit.

Following details will outline different methods of bookkeeping, how entries are recorded, and the major financial statements involved.

Methods of bookkeeping

Before we begin bookkeeping, business must decide what methods will be used to maintain bookkeeping. When choosing, consider the volume of daily transactions the business has and the amount of revenue it earns. If it happens to be a small business, a complex bookkeeping method designed for enterprises may cause unnecessary complications. Conversely, less robust methods of bookkeeping will not suffice for large corporations.

1. Single-entry bookkeeping

Single-entry bookkeeping is a straightforward method where one entry is made for each transaction in your books. These transactions are usually maintained in a cash book to track incoming revenue and outgoing expenses. You do not need formal accounting training for the single-entry system. The single-entry method will suit small private companies and sole proprietorships.

2. Double-entry bookkeeping

Double-entry bookkeeping is more robust. It follows the principle that every transaction affects at least two accounts, and they are recorded as debits and credits. For example, if you make a sale for \$10, your cash account will be debited for \$10 and your sales account will be credited by the same amount. In the double-entry system, the total credits must always equal the total debits. When this happens, your books are "balanced."

3. Cash-based or accrual-based

The next step is choosing between a cash or accrual basis for your bookkeeping. This decision will depend on when your business recognizes its revenue and expenses. In cashbased, you recognize revenue when you receive cash into your business. Expenses are recognized when they are paid for. In other words, any time cash enters or exits your accounts, they are recognized in the books. In the accrual method, revenue is

recognized when it is earned. Similarly, expenses are recorded when they are incurred, usually along with corresponding revenues. The actual cash does not have to enter or exit for the transaction to be recorded.

How to record entries in bookkeeping

Generating financial statements like balance sheets, income statements, and cash flow statements helps you understand where your business stands and gauge its performance. For these reports to portray your business accurately, you must have properly documented records of your transactions. Keeping these records as current as possible is also helpful when reconciling your accounts.

Recording transactions begins with source documents like purchase and sales orders, bills, invoices, and cash register tapes. Once you gather these documents, you can record the transactions using journals, ledgers, and the trial balance. If you are a very small company, you may only need a cash register. The information can then be consolidated and turned into financial statements.

1. Cash registers

A cash register is an electronic machine that is used to calculate and register transactions. Usually, cash registers are used to record cash flow in stores. The cashier collects the cash for a sale and returns a balance amount to the customer. Both the collected cash and balance returned are recorded in the register as single-entry cash accounts. Cash registers also store transaction receipts, so you can easily record them in your sales journal.

Cash registers are commonly found in businesses of all sizes. However, they aren't usually the primary method of recording transactions because they use the single-entry, cash-based system of bookkeeping. This makes them convenient for very small businesses but too simplistic for enterprises.

2. The journal

The journal is called the book of original entry. It is the place where a business chronologically records its transactions for the first time. A journal can be either physical

(in the form of a book or diary), or digital (stored as spreadsheets, or data in accounting software). It specifies the date of each transaction, the accounts credited or debited, and the amount involved. While the journal is not usually checked for balance at the end of the fiscal year, each journal entry affects the ledger. As we'll learn, it is imperative that the ledger is balanced, so keeping an accurate journal is a good habit to keep. This form is useful for double-entry bookkeeping.

3. The ledger

A ledger is a book or a compilation of accounts. It is also called the book of second entry. After you enter transactions in a journal, they are classified into separate accounts and then transferred into the ledger. These records are transcribed by accounts in the order: assets, liabilities, equity, income, and expenses. Like the journal, the ledger can also be physical or electronic spreadsheets.

A ledger contains a chart of accounts, which is a list of all the names and number of accounts in the ledger. The chart usually occurs in the same order of accounts as the transcribed records.

Unlike the journal, ledgers are investigated by auditors, so they must always be balanced at the end of the fiscal year. If the total debits are more than the total credits, it's called a debit balance. If the total credits outweigh the total debits, there is a credit balance. The ledger is important in double-entry bookkeeping where each transaction changes at least two subledger accounts.

4. Trial balance

The trial balance is produced from the compiled and summarized ledger entries. The trial balance is like a test to see if your books are balanced. It lists the accounts exactly in the following order: assets, liabilities, equity, income, and expenses with the ending account balance.

An accountant usually generates the trial balance to see where your business stands and how well your books are balanced. This can then be cross-checked against ledgers and journals. Imbalances between debits and credits are easy to spot on the trial balance. It is not always error-free, though. Any miscalculated or wrongly-transcribed journal entry in the ledger can cause an incorrect trial balance. It is best to look out for errors early, and correct them on the ledger instead of waiting for the trial balance at the end of the fiscal year.

Financial statements

The next, and probably the most important, step in bookkeeping is to generate financial statements. These statements are prepared by consolidating information from the entries you have recorded on a day-to-day basis. They provide insight into your company's performance over time, revealing the areas you need to improve on. The three major financial reports that every business must know and understand are the cash flow statement, balance sheet, and income statement.

The cash flow statement

The cash flow statement is exactly what its name suggests. It is a financial report that tracks incoming and outgoing cash in your business. It allows you (and investors) to understand how well your company handles debt and expenses. By summarizing this data, you can see if you are making enough cash to run a sustainable, profitable business.

1. The balance sheet

The balance sheet reports a business' assets, liabilities, and shareholder's equity at a given point in time. In simple words, it tells you what your business owns, owes, and the amount invested by shareholders. However, the balance sheet is only a snapshot of a business' financial position for a particular date. It must be compared with balance sheets of other periods as well. The balance sheet allows you to understand the liquidity and financial structure of your business through analytics like current ratio, asset turnover ratio, inventory turnover ratio, and debt-to-equity ratio.

2. The income statements

The income statement, also called the profit and loss statement, focuses on the revenue gained and expenses incurred by a business over time. There are two parts in a typical income statement. The upper half lists operating income while the lower half lists expenditures. The statement tracks these over a period, such as the last quarter of the fiscal year. It shows how the net revenue of your business is converted into net earnings

which result in either profit or loss. The income statement does not focus on receipts or cash details.

3. Bank reconciliation

Bank reconciliation is the process of finding congruence between the transactions in your bank account and the transactions in your bookkeeping records. Reconciling your bank accounts is an imperative step in bookkeeping because, after everything else is logged, it is the last step to finding discrepancies in your books. Bank reconciliation helps you ensure that there is nothing amiss when it comes to your money.

MANAGE WORKPLACE CALLS AND MESSAGES

Answering calls promptly

Customers can use the phone to:

- ✓ Make reservations for food (breakfast-dinner)
- ✓ Check, query, modify or cancel arrangements already made
- ✓ Make enquiries about functions
- ✓ Seeks information about prices and products
- ✓ Lodge compliments and complaints

Failure to answer the telephone promptly and correctly can result in:

- ✓ Loss of revenue
- ✓ Loss of jobs
- ✓ Poor or negative customer relations
- ✓ Customers who are more difficult to deal with
- ✓ Reduced business image in the eyes of the customer

Staff also use the phone on behalf of and for business/kitchen related reasons to:

- ✓ Communicate with other staff or department
- ✓ Seek clarification about work directions
- ✓ Contact nominated people in the event of an emergency situation
- ✓ Provide feedback to management and co-workers
- ✓ Obtain help or stock

Common, big mistakes telephone users make is to:

- ✓ Not answer calls promptly
- ✓ Take the telephone for granted
- ✓ Believe use of the telephone comes naturally

An appropriate telephone manner must be applied when using the telephone:

- ✓ Using polite language at all times
- ✓ Using appropriate welcoming or greeting phrases
- ✓ Showing enthusiasm when taking a call
- ✓ Being friendly
- ✓ Making an offer of help to the caller Enterprise standards may relate to:

The use of appropriate greetings or welcoming phrases when answering the telephone. These may require you to:

- ✓ Greet the caller
- ✓ Identify the business
- ✓ Identify yourself
- ✓ Make an offer of assistance
- ✓ It is never acceptable to simply pick up the phone and say; ⑦ Yes, or Hello

When placing a call 'on hold':

- ✓ Do it courteously
- ✓ Ask the caller if they want to be placed 'on hold'
- ✓ Listen to their answer and act accordingly
- ✓ Get back to all calls 'on hold' every 30 seconds

Offering assistance and establishing the purpose of the call

Always use a friendly tone when answering the phone

The key to answering caller enquiries is to be genuinely helpful:

- ✓ Focus just on the call
- ✓ Try to understand the caller's problem or situation
- ✓ Ask questions
- ✓ Put yourself in the caller's shoes
- ✓ Take time with the call
- ✓ Check the caller's level of satisfaction with what is being provided and what is happening with their call

When you have provided an appropriate greeting and welcome you need to: Quickly identify why the caller has phoned:

- ✓ Ask questions
- ✓ Never assume anything from one or two words spoken by the caller
- ✓ Use active listening
- ✓ Take brief notes

Repeating call details

Where you need to interrupt one call to answer another call, the following is a useful guide on how handle this situation:

- ✓ Excuse yourself from the caller you are talking to
- ✓ Answer the other incoming call and process it in some way, quickly
- ✓ Go back to the original caller, apologise for the interruption and continue on that call

Answering caller enquiries or transferring calls to respond effectively yourself to caller enquires:

- ✓ Identify exact nature of enquires as soon as possible
- ✓ Have resources handy you can refer to help deal with calls
- ✓ Develop a detailed internal telephone list
- ✓ To optimize customer service when answering caller enquiries:
- ✓ Put a smile in your voice

- ✓ Ensure the caller can see you are trying to help them
- ✓ Keep them informed
- ✓ Always be honest
- ✓ Refer to documents or other staff where you are unsure
- ✓ Realise as quickly as you can when you cannot help the caller anymore
- ✓ Try harder when you are on the telephone

To respond effectively yourself to caller enquires:

- ✓ Apologize-if appropriate- for the need to transfer the call
- ✓ Explain why you need to transfer the call
- ✓ Tell them who you want to transfer them to
- ✓ Ask permission to transfer their call
- ✓ Transfer the call and monitor it

If you are having difficulty obtaining answers to their questions:

- ✓ Ring
- ✓ Apologize
- ✓ Explain the situation
- ✓ Let them know you are still following up

Make a time to phone them back with the required answers Tips to follow when

- ✓ Transferring a telephone call include:
- ✓ Transfer calls promptly
- ✓ Locate the required person for the caller
- ✓ Not transferring calls to people you know are not there
- ✓ Only try to transfer a call once to an extension
- ✓ Give caller choices if the required person is unavailable

All promises made on the telephone must be kept, when promised, as promised Keeping promises made on the telephone:

- ✓ Build confidence
- ✓ Values and respects the caller
- ✓ Differentiates the business from others

Recording and passing on messages

Where a telephone message has to be taken, do so:

- ✓ Cheerfully
- ✓ Using the designated telephone message from

Making sure you capture all the information the caller gives you

Ensuring you get the details correct

- ✓ Repeating the message back to the caller to confirm it

- ✓ Thanking the caller

When a telephone message has been taken it must be passed on:

- ✓ To the appropriate person
- ✓ Promptly
- ✓ In hard copy form

It is never sufficient just to take a telephone message:

- ✓ Check the person has picked up their message
- ✓ Check they have acknowledged your email
- ✓ Speak to the person to ask if they have received the message

Most business use a standard form telephone message pad/form to record telephone messages:

- ✓ They are duplicate- top copy goes to receiver of message, bottom copy stays in book/pad

Relaying telephone messages

Check with the Supervisor for company procedures for relaying telephone messages.

Options include:

- ✓ Placing in person's pigeon hole
 - ✓ Pinning it on the staff notice board
 - ✓ Sending the person an email
 - ✓ Physically taking the message and handing to them
 - ✓ Leaving the person, a voice message to let them know they leave a message
- Additional points to note regarding relaying telephone message include:

- ✓ Never leave telephone message in the telephone message book
- ✓ Always follow up on messages
- ✓ Relay all telephone messages promptly
- ✓ Notify Supervisor where messages have not or cannot be delivered

UNIT 04

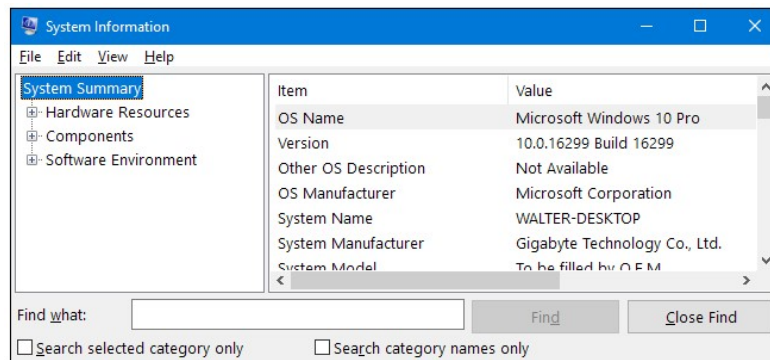
PERFORM COMPUTER OPERATIONS

This unit describes the performance outcomes, skills and knowledge required to start up a personal computer or business computer terminal; to correctly navigate the desktop environment; and to use a range of basic functions.

PERFORM COMPUTER OPERATIONS

Computer use is prevalent in many workplaces, and some companies may find functioning without them virtually impossible. As a result, computers have become an important part of how companies conduct business as well as how workers perform their job tasks. Computers can even impact where employees do their jobs, as they can often work many miles from their official place of business.

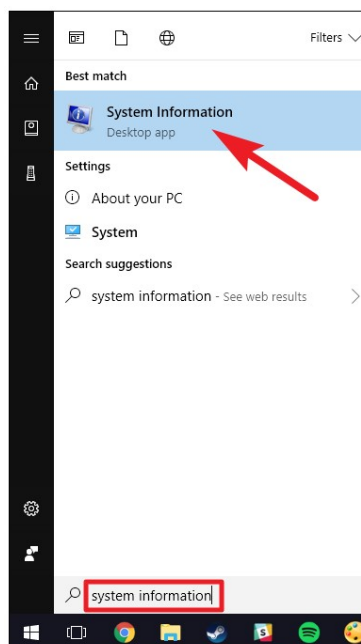
START COMPUTER, SYSTEM INFORMATION AND FEATURES



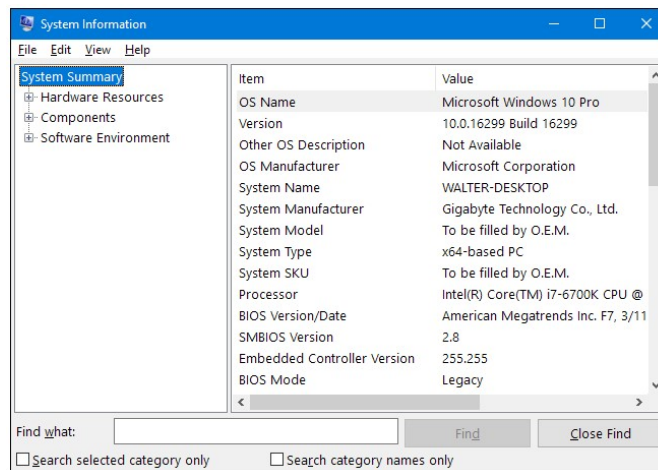
The System Information provides a quick way get information about your system, but how you open it depends on what version of Windows you're using. Here's how to do it.

Windows 7 or 10: Use the Start Menu

If you're using Windows 7 or 10, hit Start, type "system information" into the search box, and then select the result.



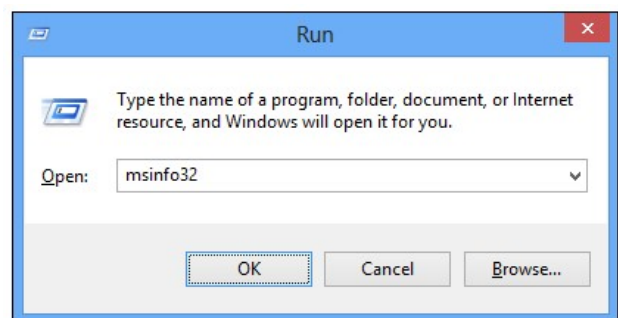
The System Information window opens, giving you access to all kinds of great information about your PC's hardware and software environment.



Windows 7, 8, or 10: Use the Run Box

For some reason, typing “system information” into a Start search doesn’t work in Windows 8. Instead, you’ll have to use the Run box, which you can also use in Windows 7 or 10 if you prefer.

Hit Windows+R to open the Run box. Type “msinfo32” into the “Open” field, and then hit Enter.



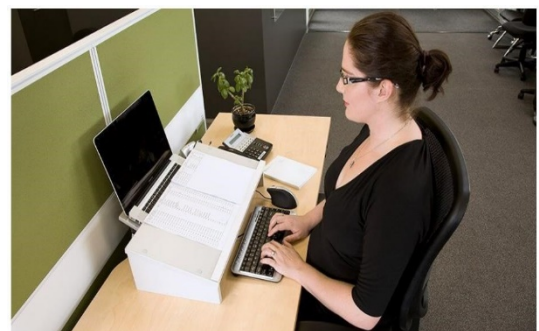
You should immediately see the System Information panel.

You can also find the msinfo.exe executable in the \Windows\System32 directory, should you want to make a shortcut for even easier access.

Adjust workspace, furniture and equipment to suit user ergonomic requirements

Are you sitting for long periods of time at a desk? Is your body feeling strained and causing discomfort? Sitting for long periods of time can have serious health issues, especially if your workstation is not set up correctly. Back Centre’s occupational therapist can visit and assess your workstation and advise on the best adjustments and arrangements for your needs. An ergonomically correct workstation has all the best practices to help maintain a healthy posture and improve your health and productivity.

Here are some tips on how to set up your workspace.



Maintain a healthy posture

It's easy to adjust your workstation to fit your ergonomic requirements and maintain a healthy posture. Ensuring that you're sitting comfortably in front of a computer is a great way to avoid pain and fix your posture for better health. Follow these steps to improve your posture and prevent lower back pain.

1. Adjust the chair height
If your chair isn't at the correct height, you can adjust it by using the lever on the right-hand side. Adjust the chair to a height that is comfortable for you.
2. Ensure your feet are firmly on the floor
Sit well back into the seat and check that your feet are firmly on the floor. If your feet aren't firmly flat on the floor, a footrest will be required to improve your posture.
3. Adjusting the chair angle
An ergonomic office chair allows the seat to be adjusted horizontally or slightly angled. Usually, the lever for this is on the right toward the back.
4. Adjusting the backrest angle
The lever for adjusting the backrest angle is usually on the right, showing backward and forwards arrows.
5. Setting the Backrest height
6. The Backrest can be adjusted by loosening the lever or knob at the base of the backrest. If there isn't a knob or lever, you most likely have a ratchet style adjustment.
7. Positioning the armrest height
8. If the armrest can be adjusted, position them so that they fit under the desk.
9. If you are taller than average, the above recommendations for adjusting your chair may not be suitable. Consider an Adjustable Standing Desk or a Sit Stand Workstation to bring the desk to your level.

To find out more about ergonomics for taller than the average height have a read of our blog article.

How to correctly set up your workspace

When setting up an ergonomically workstation, it's important to have everything in the correct place.

By following these tips we can help you set up your workspace to improve posture and provide the correct support.

- ✓ Adjust the location of the keyboard to be 10-15cm in front of the edge of the desk.
- ✓ The wrists should be straight and hovering over the desk.
- ✓ The mouse should be as close as possible to the keyboard.
- ✓ If you are using one monitor, position it directly in front. It should be an arm length away and angled slightly upward towards the eyes.
- ✓ A document holder should be ideally positioned between the monitor and the keyboard.
- ✓ Phone, calculators, and note-pads are all ideally positioned within easy reach.

Does your workstation require a footrest?

When setting up an ergonomic workstation, ensuring your legs and feet are well supported is crucial. If your feet aren't firmly flat on the floor, a footrest will be needed to improve your posture. A footrest will help in attaining the right foot elevation, leg and knee position. If you need more support to set up your workstation and struggling with poor posture contact Back Centre today to book in an Ergonomic Assessment to improve your posture.

Ensure work organization meets organizational and occupational health and safety (OHS) requirements for computer operation

Today's computer workstation has few hazards other than ergonomic that the typical worker will be exposed to if all components are functioning properly. Many injuries or illnesses associated with a computer workstation will be of an ergonomic nature and thus may be difficult to diagnose. Accurate and timely recording as outlined in OHS's Injury and Illness Recordkeeping and Reporting Requirements Safety and Health Topics Page can be a useful means of proactive intervention.

Standards

There are no specific OHS standards that apply to computer workstations or extremely low frequency electric and magnetic field exposure. Existing OHS standards on electrical safety, radiation exposure, and noise apply to all workplaces including office environments. In most cases, only a few general industry standards such as electrical or radiation hazards may apply.

Hazards and Solutions

Provides references that may aid in recognizing potential hazards associated at computer workstations and gives possible solutions to address those hazards.

Start computer or log on according to user procedures

How to start a computer?

Turning on your computer isn't always easy. Some manufacturers hide the 'on' button – for instance, on top of the case or flat on the front where you can't see it. When you get your computer, don't be embarrassed to ask: 'Where's the "on" button?'

Follow these step-by-step instructions to help you turn on your computer

Step 1: Find the 'on' button. It probably looks like this (but might be square or oblong!):



This is a typical PC **on** button, on the front, in the middle of the tower



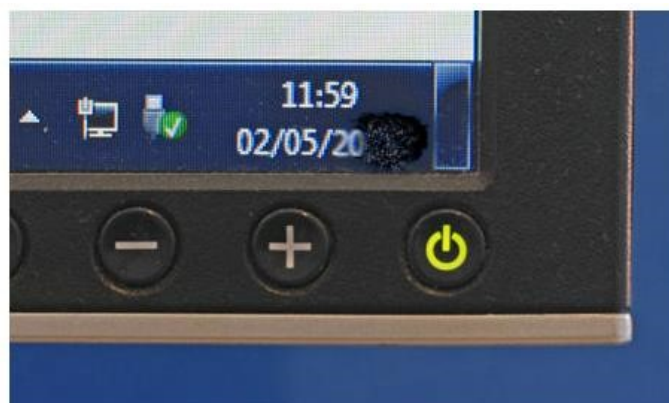
This is a typical laptop **on** button. Most laptops have the **on** button just above the keyboard but below the screen

Step 2: Push the button.

On some computers, the button lights up when the computer is on. On laptops, there's often a light on the front that comes on. You may have to keep pushing for a couple of seconds to make this happen, but don't worry – you'll soon get to know how your computer works.

If nothing happens, there are a few things you can check easily:

- ✓ If you're using a laptop, the battery might be flat. So plug in the charger, plug the charger into the mains and let the laptop recharge. You can continue to use it while it's doing this.
- ✓ If you have a PC, make sure that the plug or any of the other wires haven't become disconnected.
- ✓ Ensure that the monitor is turned on. Most PC monitors have an 'on/off' button on the bottom corner of the screen (see below). The button often lights up green when the monitor is on.



Step 3: Now you need to log in.

If you're the only user of your computer, once it's turned on it may go straight to the desktop:

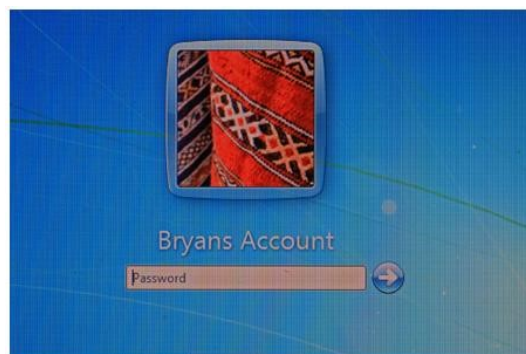


If you're using a public computer – for example, in a library – you'll be given instructions (and help if you ask for it) on how to log in.

If you're sharing your computer with other people, each one will usually have their own account. When you turn on the computer, the screen will look something like this:



When you click the icon above your name, you'll be asked for a password. The main user or administrator should set this up for you before you begin. Type in your password and click the arrow.



Top tip: surge protectors

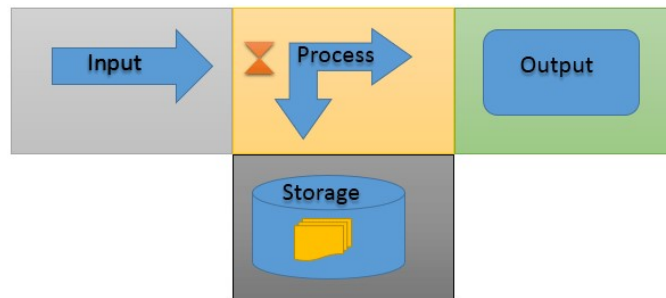
If you have a PC, it's a good idea to buy a 'surge protector'. This prevents your computer being damaged if there's a sudden problem with your electricity supply. You can buy surge protectors that let you plug all your separate pieces of equipment into them, in addition to your computer. Then when you turn your computer on or off, this automatically turns them on or off, too.

Identify basic functions and features using system information

This unit explains the basic functions, operations, and characteristics of a computer. Learn the four major functions of a computer through diagrams and examples.

Taking data and instructions from a user, processing the data as per instructions, and displaying or storing the processed data, are the four major functions of a computer. These functions are also known as the input function, process function, output function, and storage function, respectively.

The following diagram shows an example of these functions.



To provide these functions, a computer uses its components or devices. Usually, components of a computer are designed to perform only one of these four functions. But, some specialized components or devices are designed to perform two, three or all four functions. For example, a hard disk can perform three functions: input (when files are read), storage (when files are saved), and output (when files are written).

Components or devices of a computer, based on the function in which they are used, can be classified into four major types: the input devices, output devices, storage devices, and processing devices. For example, if a component processes the given instructions, the component is known as the processing device. Or if a device displays the processed data, the device is known as the output device.

Input function and devices

A computer is a data processing machine. It does nothing until a user (or a script or a program) provides the data that needs to be processed and the instructions that tell it how to process the data.

Any standard device or component that a user uses to instruct a computer is known as the standard input device. In other words, a computer uses its standard input devices or components to get instructions from a user.

The most common input devices are the keyboard and mouse. Almost all modern computers have these devices. Other common input devices are scanners, microphones, USB drives, and webcams.

Input data and instruction can also be generated from a non-standard input device such as the hard disk and CD/DVD. For example, a batch file in the Windows system may instruct the CPU to execute a program or a script at a particular time.

Installation disks are another good example of non-standard input devices. Usually, they contain a script or an executable program that automatically starts the installation process as soon as the disk is read.

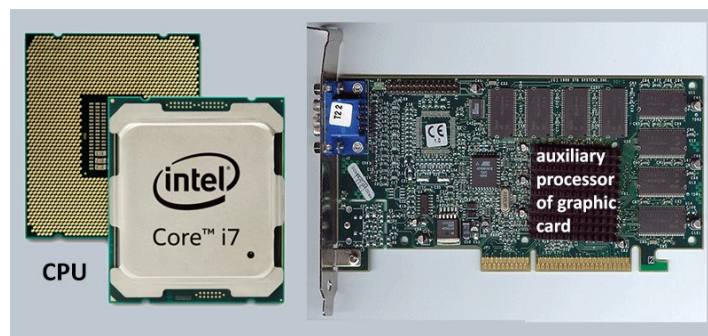
Process function and devices

Once the data and instructions are received by the input function, the computer starts the processing function. In this function, a computer processes the received data according to the instructions.

To process the input data according to the instructions, the computer uses the CPU. A CPU is the main processing component of a computer. It processes user instructions, executes scripts and programs, and runs commands of the OS that provide a platform for installing and using application software.

Other important processing components are auxiliary processors. Auxiliary processors are also known as onboard processors. Auxiliary processors are used in devices to enhance their functionalities. You can think of an auxiliary processor as the private CPU of a device. Only components or devices that provide the complex functionality such as Graphics cards, I/O devices, and network interface cards use auxiliary processors. For example, if a user draws an image, the auxiliary processor on the graphics card performs all calculations that require in drawing the image on the display device.

The following image shows a sample of both a CPU and an auxiliary processor.



The following table lists the main differences between a CPU and an auxiliary processor.

Output function and devices

CPU	Auxiliary processor
A CPU is a compulsory component. Without it, a computer does not work.	An auxiliary processor is an optional component.
A CPU is an individual component. It is installed separately in the system.	An auxiliary processor is an integrated part of a device. It can't be installed separately.
A CPU is designed to perform all types of tasks.	An auxiliary processor is designed to perform only a specific type of task.

After processing the input data, the CPU, auxiliary processor, or the process function sends the processed data to the output function or to the default or configured output device. By default, computers use monitors as the default output device.

Aside from monitor, a variety of output devices are also available. Each output device presents the processed data in a different form, for example, a monitor, a printer, and a speaker displays, prints, and plays the processed data, respectively.

A user, based on his requirement, can connect and use two, three or more output devices

to the computer. For example, after viewing the processed data, a user can send it to the printer for printing.

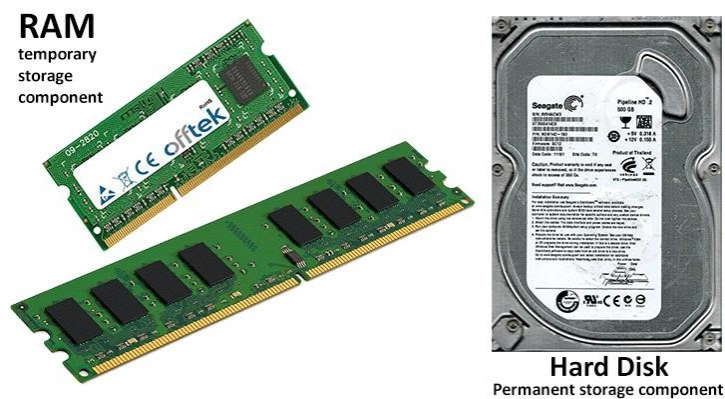
Storage function and devices

Storing data and information is the fourth major function of a computer. This function allows us to save the processed data for later use. To store data and information, a computer uses two types of storage components: temporary and permanent.

Temporary storage components are used to store data temporarily. Data stored in a temporary storage component is erased when the system is shutdown. RAM is a compulsory temporary storage component. A computer uses the ram to store the running applications and their data.

Permanent storage components are used to store data permanently. Data stored in a permanent storage component is not erased when the system is shutdown. The hard disk is the most common permanent storage component. Usually, all computers have at least one hard disk to store data. Other common permanent storage components or devices are external drives, USB drives, and CD/DVD.

The following image shows an example of both types of storage components.



Storage devices are also used in the input and output functions, allowing data to be saved (output function) and then accessed again later (input function).

Examples

The following table lists a few sample actions along with the name of devices and functions that are used when they are performed.

Action	Device	Function
A user running a text-editor program types the letter Z on the keyboard. The keyboard sends a code representing the letter Z to the CPU.	Keyboard	Input
The CPU processes the code and determines what letter was typed. Then the CPU sends instructions to the monitor to display the letter Z.	CPU	Process
The monitor displays the letter Z.	Monitor	Output
The user clicks the save button. The mouse sends a code representing the click.	Mouse	Input
The CPU processes the code and determines what action was clicked.	CPU	Process
The CPU saves the file on the disk.	Hard disk	Storage

Customize desktop configuration with assistance from appropriate persons

From the moment you first power on your new computer, you'll be asked to choose how to manage your privacy and security. But once you complete that short process, the fun begins: You can select backgrounds, configure your Start menu, and choose apps and shortcuts.

Windows offers many different ways to do the same thing—in this case, launch apps. The Windows 10 Start menu (accessed by clicking the Windows icon in the bottom-left corner) is an amalgamation of Windows 7's list of apps and the tiled interface of Windows 8. Right next to it is the Search box, where you can type an app name to launch it. And right next to that is the Taskbar, where you can pin frequently used apps for easy access. (Your currently active windows will also show up in the Taskbar.)

How you organize things will be a matter of preferences.

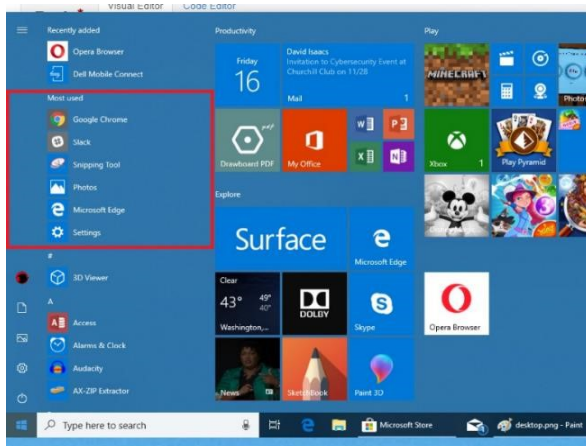
But consider a few suggestions. To help you get started:

- ✓ If you prefer a list of apps, navigate to Settings > Personalization > Start, then toggle on Show most used apps. That will place your most frequently used apps at the top of the list, eliminating the need to scroll through them.
- ✓ If you right-click a tile or app and go to More > Pin to Taskbar, you can create a shortcut icon that will live on the row of icons on your Taskbar at the bottom of the screen. That will save you from opening Start. Remember, the more *If you select "Show most used apps" in the icons you pin, the less space you'll have* Settings > Personalization > Start preferences, for shortcuts to active windows. If you *Windows will group your most frequently used* hover over the Taskbar icons, you'll see *apps at the top of the stack* a popup thumbnail of each active windows within that app.



If you don't use the list of apps, just the tiles, you can toggle off the list entirely from the same menu. You can even open the Start menu in full-screen mode for a "Windows 8.1-like" experience.

Each of the tiles appears in one of three groups, which you can right-click to rename and move around. Right-clicking a tile allows you to adjust its size. That's useful for apps that update information, like Mail, Calendar, or News. Microsoft's diminished this last feature over time, however, so you may want to leave the icons small.



ORGANIZE FILES USING BASIC DIRECTORY AND FOLDER STRUCTURES

create folders/subfolders with suitable names

Creating and assigning document folders and sub-folders

This unit will show you how to create document folders, how to organize your documents, add documents to those folders, and assign the documents out for signature in bulk. You'll be able to organize your documents in folders ("parent folders") and sub-folders ("child folders"). You'll also be able to assign these folders to individuals and groups for signature, eliminating the need to ask each individual separately to sign the documents. Also gives users the ability to assign multiple documents for signature at once to an individual or group.

The same rules go for folder security users can grant rights over a folder and every document within it at once, giving individuals or groups privileges to the entire folder and all its contents.

An introduction to folders

You'll notice the root documents folder is viewable from your find anything sidebar. This is the initial default level under which all your existing documents and folders will live. You can drag and drop folders and documents into other folders as needed if you've been assigned sufficient privileges over those folders.

Administrators will want to make sure to give the right users the necessary access to the appropriate folders.

Create folders/subfolders with suitable names

Creating a new folder

1. To create a new folder, simply navigate in your left sidebar menu to the parent folder you wish to nest the new folder in then click the three dots to the left of that parent folder name and select new folder from the menu that pops up.
2. Type in the new folder's name and click create.
3. The new sub folder/child folder will automatically appear under the parent folder.

Keep in mind that you can have multiple folders with the same name as long as they live under different parent folders. For example, the hr department folder and the communications department folders can both contain a sub/child folder called "policies."

Managing folder details

1. To manage a folder's details, hover over the folder name in the sidebar, click the three dots to the right of the folder title, then click manage.
2. This will bring up the folder record's general tab. Here, you can rename or delete the folder.
3. Adding existing documents to a folder
4. You can add documents to a folder, similarly to how you add members to a group.
5. Go to the content tab of your folder.

6. Click the document icon () to the right of the add folders or documents drop-down list.
7. Click advanced filters to expand your filtering options.

Select the show only non-members option to only search documents and folders that don't already exist in your current destination folder, or to search both existing and not existing documents, select show members & non-members.

1. If you'd like to move any content from another folder, you can use the folder dropdown menu to choose the folder the document(s) currently live in. You will also want to use the name drop-down list to choose the name or keywords of the document(s) you'd like to move.
2. Click apply filter.
3. In the list that appears to the right, select the boxes next to the documents you'd like to move to your open folder. To select all documents listed, select the top checkbox. Click save. Your selected documents are now part of the current folder.

The example below shows the user used advanced filters and moved all of the documents from the "administrative policies" folder to the folder, "daily observation report."

Note: when using the top checkbox to select all documents, make sure you have the show only non-members option selected under advanced filters. Otherwise, you may accidentally copy over or remove documents of the same name from the destination folder. -

Creating a new document in a folder

1. To create a new document inside a folder, navigate in your left sidebar menu to the parent folder you wish to nest the new document.
2. Click the three dots to the right of the folder name.
3. Select new document from the drop-down menu that appears.
4. You can also create a new document by selecting new > document from the top menu bar.
5. A new document window will appear for you to either drag and drop an existing file from your computer, upload it by browsing your files, or create it from scratch.
6. If you don't have access to the root documents folder and try step 4, a pane will popup asking you to choose the folder in which to house the new document. The drop-down list will be populated with folders you already have edit rights over.

Note: you can reorganize your documents and folders into other folders later using the drag-and-drop feature, which will change their location for everyone on the site. See the organizing folders and documents section below for further instructions.

Save files with suitable names in appropriate folders

If you have write permission, you can create, copy, remove, and rename files and directories for the directory shown in the current directory browser. If you do not have write permission, you can still copy files and directories to another directory, or you can use equivalent functions, such as move file.

Naming files and folders

Naming conventions are rules which enable the titling of electronic and physical folders, documents and records in a consistent and logical way. This ensures that the correct records can be located, identified and retrieved from a filing system in a timely fashion, and that they are stored in an appropriate secure location. Ideally, the best time to think how to name and structure the documents and directories you create is at the start of a project.

The principles of naming conventions can equally be applied to electronic and physical files/folders/material.

Benefits of naming conventions

Naming records consistently, logically and in a predictable way will distinguish similar records from one another at a glance, and by doing so will facilitate the storage and retrieval of data. Through consistency and the application of logical standards we benefit from secure storage, and the ability to locate and access information.

File identifiability

Good practice dictates that all information (files, datasets, documents, or records) should be identifiable and traceable. This can be achieved by following good practices by applying referencing to all documents/files.

Document/file references will include:

- ✓ file name, or full file path including file name
- ✓ name/role of file author(s) or originator(s)
- ✓ date of creation, edit or event which is the subject of the document/file ✓ version number if applicable

Suggested file and folder naming conventions

1. Keep file and folder names short, but meaningful.
2. Avoid unnecessary repetition and redundant words in file names and file paths.
3. Use capital letters to delimit words, not spaces.
4. When including a number in a file name always give it as a two-digit number rather than one, i.e. 01, 02 ... 99, unless it is a year or another number with more than two digits.
5. If using a date in the file name always state the date 'back to front', and use four digit years, two digit months and two digit days: yyyyymmdd or yyyyymm or yyyy or yyyy-yyyy.
6. When including a personal name in a file name give the family name first followed by the initials.
7. Avoid using common words such as 'draft' or 'letter' at the start of file names, unless doing so will make it easier to retrieve the record.
8. Order the elements in a file name in the most appropriate way to retrieve the record.
9. The file names of records relating to recurring events should include the date and a description of the event, except where the inclusion of any of either of these elements would be incompatible with rule 2.

10. The file names of correspondence should include the name of the correspondent, an indication of the subject, the date of the correspondence and whether it is incoming or outgoing correspondence, except where the inclusion of any of these elements would be incompatible with rule 2.
11. The file name of an email attachment should include the name of the correspondent, an indication of the subject, the date of the correspondence, 'attach', and an indication of the number of attachments sent with the covering email, except where the inclusion of any of these elements would be incompatible with rule 2.
12. The version number of a record should be indicated in its file name by the inclusion of 'd' followed by the version number and, where applicable, 'd' indicating 'draft version'.
13. Avoid using non-alphanumeric characters in file names.

Rename and move folders/subfolders and files as required

Click the file or folder to select it.

- ✓ Click the organize button on the toolbar, and then click rename.
- ✓ with the name selected, type a new name, or click to position the insertion point, and then edit the name.

Press enter.

- ✓ Timesaver
- ✓ Right-click the file or folder you want to rename, click rename, type a name, and then press enter. You can also select the file, click the file name, type a name, and then press enter.

Did you know?

You can rename a group of files. Select all the files you want to rename, right-click one of the selected files, click rename from the shortcut menu, type a name, and then press enter. The group name appears with numbers in consecutive order

Identify folder/subfolder and file attributes

A file attribute (often just referred to as an attribute or a flag) is a specific condition in which a file or directory can exist.

An attribute is considered either set or cleared at any given time, which means it's either enabled or isn't.

Computer operating systems, like windows, can tag data with specific file attributes so that data can be treated differently than data with an attribute turned off.

Files and folders aren't actually changed when attributes are applied or removed, they're just understood differently by the operating system and other software.

What are the different file attributes?

A number of file attributes exist in windows, including the following:

- ✓ archive file attribute
- ✓ directory attribute
- ✓ hidden file attribute
- ✓ read-only file attribute
- ✓ system file attribute

- ✓ volume label attribute

The following file attributes were first available to the windows operating system with the ntfs file system, meaning they aren't available in the older fat file system:

- ✓ compressed file attribute
- ✓ encrypted file attribute
- ✓ indexed file attribute

Here are several additional, albeit more rare, file attributes recognized by windows:

- ✓ device file attribute
- ✓ integrity file attribute
- ✓ not content indexed file attribute
- ✓ no scrub file attribute
- ✓ offline file attribute
- ✓ sparse file attribute
- ✓ temporary file attribute
- ✓ virtual file attribute

Why are file attributes used?

File attributes exist so that you, or a program you're using, or even the operating system itself, can be granted or denied particular rights to a file or folder.

Learning about common file attributes can help you understand why certain files and folders are referred to as "hidden" or "read-only," for example, and why interacting with them is so different than interacting with other data.

Applying the read-only file attribute to a file will prevent it from being edited or changed in any way unless the attribute is lifted to allow write access. The read-only attribute is often used with system files that shouldn't be altered, but you could do the same with your own files that you'd rather someone with access not edit.

Files with the hidden attribute set will actually be hidden from normal views, making these files really difficult to accidentally delete, move, or change. The file still exists like every other file, but because the hidden attribute is toggled, it prevents the casual user from interacting with it. You can set windows to view hidden files and folders as an easy way to see these files without toggling the attribute off.

You can also combine attributes so that a file is, for example, not only hidden but also marked as a system file and set with the archive attribute.

File attributes vs folder attributes

Attributes can be toggled on and off for both files and folders, but the consequences of doing so differ a bit between the two.

When a file attribute like the hidden attribute is toggled on for a file, that single file will be hidden, nothing else.

If the same hidden attribute is applied to a folder, you're given more options than to just hide the folder: you have the option to apply the hidden attribute to the folder alone or to the folder, its subfolders, and all of its files.

Applying the hidden file attribute to a folder's subfolders and its files mean that even after you open the folder, all the files and folders that are contained within it will be hidden as well. The first option of just hiding the folder alone would make the subfolders

and files visible, but just hide the main, root area of the folder.

How file attributes are applied

Although all of the available attributes for a file have common names, which you saw in the lists above, they aren't all applied to a file or folder in the same way.

A small selection of attributes can be turned on manually. In windows, you can do this by right-clicking (or tap-and-hold on touch interfaces) a file or folder, opening its properties, and then enabling or disabling an attribute from the list provided.

In windows, a larger selection of attributes can also be set with the attrib command, available from command prompt. Having attribute control via a command allows thirdparty programs, like backup software, to easily edit file attributes.

Move folders/subfolders and files using cut and paste, and drag and drop techniques

Copying (and moving) files and folders

Windows 7 provides two basic methods for copying files and folders from one disk to another or from one folder to another on the same disk:

- ✓ drag and drop: you select items in one open explorer window and then drag them to another open explorer window (on the same or different disk), where you drop them into place.
- ✓ cut and paste: you copy or cut selected items to the windows clipboard and then paste them into another folder (on the same or different disk).

Using the drag-and-drop method

The technique of moving files and folders with the drag-and-drop method is really straightforward:

1. Open two separate explorer windows and arrange them on the windows 7 desktop with as little overlap as possible: the first is the source explorer window that contains the item(s) you want to move, and the second is the destination explorer window where these items are to be moved.
2. Tip to eliminate all overlap between the source and destination explorer window and thereby make it easy to drag from one to the other, right-click the taskbar and then choose either the show windows side by side option or the show windows stacked option from the shortcut menu that appears.
3. Select the item(s) you want to move in the first source explorer window.
4. While continuing to hold down the mouse button, drag the folder/document icon representing the selected items (and showing the number of items selected) to the destination explorer window.
5. Windows 7 displays a screentip that says move to such and such folder (where such and such a folder is the actual name of the destination folder). When you've positioned the icon somewhere within the destination explorer window, release the mouse button to drop the items there. They then appear in the destination window in the order (usually alphabetical by filename) that that explorer window currently uses.

To copy files with the drag-and-drop method rather than move them, you only have to

vary these foregoing steps by remembering to hold down the ctrl key as you drag the selected items from the source explorer window to the destination window. Windows 7 lets you know that you're copying rather than moving the selected items by displaying a + (plus) sign under the folder/document icon and displaying a copy to such and such folder screentip when you reach a place in the destination folder where the items being copied can be dropped.

Tip when moving or copying files using the drag-and-drop method, you don't even have to bother opening the destination folder in its own window: just drag the folder/document icon representing the selected items from the source explorer window to the destination folder's icon and then drop it on this icon. Note that this drop-directly-on-the-destinationicon method works on shortcuts of other drives (both local and on your network) as well as shortcuts for folders and printers (to print the selected documents) on the windows 7 desktop.

Remember keep in mind that when you drag files or folders from one drive to another, windows 7 automatically copies the files and folders, instead of moving them. This copying means that you don't have to hold down the ctrl key when you intend to copy them from one disk to another. It also means that you must still delete them from their original disk after making the copies if you need to free up the disk space.

Warning dragging and dropping items from folder to folder is great because it's really fast. This method does have a major drawback, however: it's pretty easy to drop your file icons into the wrong folder. If you forget to undo your last action (ctrl+z), instead of panicking when you open what you thought was the destination folder and find that your files aren't there, locate them by using the search feature; see "searching for files" later in this part. Using the cut-and-paste method

Instead of turning to the drag-and-drop trick, you can use the cut-and-paste method, the oldest way of moving and copying items in windows. The the first, you cut or copy the selected files or folders to a special area of the computer memory known as the windows clipboard. In the second, you paste the item(s) saved on the clipboard into the new folder. You can perform the cut, copy, and paste commands by selecting the cut, copy, and paste commands on the organize button on the explorer window's toolbar, or by using standard ctrl+x (cut), ctrl+c (copy), and ctrl+v (paste) keyboard shortcuts.

To move or copy files by cutting and pasting (using either method), follow these steps:

1. Open the folder with windows explorer (documents, computer, or network) that holds the subfolders or files that you're moving or copying.
2. Select all the items to be copied and then either press ctrl+c (or choose copy from the organize button's drop-down menu) or press ctrl+x (or choose cut from the organize button's drop-down menu).
3. Use the navigation pane in the explorer window to open the destination folder (that is, the one into which you're moving or copying the selected folder or file items).
4. Don't forget to click the folders button in the navigation pane to display the hierarchy of components and folders on your computer.

5. Press ctrl+v (or choose paste from the organize button's drop-down menu) to paste the items into the destination folder.

When using the cut-and-paste method to move or copy files or folders, keep in mind that you don't have to keep the folder with the files or folders you're moving or copying open during the paste part of the procedure. You can close this folder, open the folder to which you're moving or copying them, and then do the paste command. Just be sure that you don't use the copy or cut commands again in windows 7 until after you've pasted these files and folders in their new location.

If the classic menus are displayed in the explorer window, you can also access the cut, copy, and paste commands by choosing edit → cut, edit → copy, and edit → paste respectively from the source and destination explorer window's drop-down menus. If not, you can press ctrl+x to cut, ctrl+c to copy, and ctrl+v to paste.

Tip in addition, when the classic menus are displayed, you have access to the special edit → copy to folder and edit → move to folder commands (or if they're not displayed, you can press alt+ef for copy to folder and alt+ev for move to folder). When you choose either of these menu commands (after selecting the items to be moved or copied), windows 7 displays a copy items or a move items dialog box (depending upon which you command you choose). You then select the icon of the destination folder in the outline map of your system before clicking the move or copy button to perform the move or copy operation. Remember keep in mind that if all you want to do is back up some files from your hard drive to a cd or dvd in your computer's cd-rom/dvd drive (d:, e: or some other letter), you can do so with the send to shortcut menu command. After selecting the files to copy, just right-click to open the shortcut menu attached to one of the file icons and then choose the correct drive on the send to menu, such as dvd-rw drive (d:). Oh, and one more thing: don't forget to insert a blank cd-rom or dvd or one to which you can append new files before you start this little operation.

Save folders/subfolders and files to appropriate media where necessary

When it comes to getting organized, you don't need to start from scratch. Windows comes with a handful of common folders that you can use as anchors to begin organizing your files. Here's a list of some of the most common folders you can store your files and folders in:

- ✓ documents. Use this folder to store your word-processing files, spreadsheets, presentations, and other business-oriented files.
- ✓ pictures. Use this folder to store all of your digital pictures, whether you get them from your camera, scanner, or in e-mail from other people.
- ✓ music. Use this folder to store all of your digital music, such as songs that you copy from an audio cd or download from the internet.
- ✓ videos. Use this folder to store your videos, such as clips from your digital camera, camcorder, or video files that you download from the internet.
- ✓ downloads. Use this folder to store files and programs that you download from the web.

There are many ways to find these folders. The easiest method is to open the personal folder, which gathers all of your common folders in one place. The personal folder isn't

actually called "personal"—it's labeled with the user name that you used to log on to the computer. To open it, click the start button, and then click your user name at the top of the start menu's right pane.

Search for folders/subfolders and files using appropriate software tools

When you need to find a particular file, you'll often know that it's located somewhere in a common folder like documents or pictures. Unfortunately, actually locating the file you want might mean browsing through hundreds of files and subfolders— not an easy task. To save yourself time and effort, use the search box to find your file.

Restore deleted folder/subfolders and files as necessary

With data recovery, now anybody can recover data themselves, painlessly. Safe, complete data recovery is just a few clicks away: scan, preview and recover.

Latest powerful scanning algorithms, it can scan any mac-based hard drive or external hard drive without destroying any data, and lets you recover data in no time at all.

Complete recovery modes cover virtually all data loss scenarios, such as accidental deletion, formatting, improper operation etc.

- ✓ wizard mode recovery - simply answer 2 easy questions and the rest of the recovery will be finished by the program.
- ✓ lost data recovery - retrieve lost data emptied from your trash bin or deleted by command + delete
- ✓ partition recovery - recover data from lost, deleted, resized and corrupted partitions.
- ✓ resume recovery - save your scan results to perform data recovery later. Recover everything you need
- ✓ recover almost any file, including but not limited to documents, photos, video, music, email, and archive files.
- ✓ recover from any internal and external hard drive, sd card, usb flash drive, digital camera, memory cards, ipod, media player and other portable devices.
- ✓ restore data lost due to deletion, formatting, virus infection, improper operation, unexpected power failure, software crash and other unknown reasons.
- ✓ fully compatible with 10.8 (mountain lion), 10.7, 10.6 and 10.5.
- ✓ recover data from hfs+, hfsx, fat16, fat32, exfat, and ntfs files systems.

Preview recoverable files

How do you know whether each recoverable file is exactly what you want? Data recovery lets you preview lost files before they are recovered, help you recover data at your pace and quickly find the files you need.

- ✓ view photos in thumbnail or cover flow view and easily check image quality before recovery.
- ✓ preview video and audio files to check whether or not they're what you are searching for.
- ✓ open documents, email and archive files to see they're intact and the ones you need.
- ✓ only scan files of the selected file type to save time.
- ✓ find your files in seconds with file filters and folder trees.
- ✓ easily distinguish valid and invalid files before data recovery.

- ✓ recover lost files complete with original file names and file folders.

PRINT INFORMATION

Each file and document, and the programs used to open them, are different. Therefore, we are only able to give a basic overview of the steps in printing. These steps are a general guideline and may not apply to the document or file that you are trying to print. That being said, many programs have adopted a standard method of printing.



Before proceeding, make sure your printer is turned on, and is installed and configured correctly.

1. Open the document or file you want to print.
2. Near the top of the program window, look for a print icon that should resemble any of the below icons. As seen in the picture below, each of the icons resembles a printer with a piece of paper.

Examples of Print Icons



- or -

1. Open the document or file you want to print.
2. In the top portion of the program window or browser you're using, open the file menu by clicking file and then print from the drop-down menu.

Once either of the above options is done, a print properties window appears and allows you to specify additional printing options (e.g., number of copies). Once you've selected the options, click ok or print to start the printing process.

Printing selected text or picture from an internet web page

For printer-friendly pages like computer hope, when you print a page, all navigation menus and other non-important sections are automatically removed. If you come across a web page that's not printer-friendly or if you only want to print a section of a page or picture, follow the steps below.

To print only sections of text or images, it may be easier to copy the text or picture, and paste it into a document. Once all information is gathered into a single document, you can print it out.

Print only a picture from a web page

To only print a picture contained on a web page, we recommend opening the picture by itself. To do this, right-click the image and select "open image in a new tab" or "open

image." once the image is displayed by itself, press ctrl+p on a pc or cmd+p on an apple computer to start the print process. You can try these steps now on the image below.

SHUT DOWN A COMPUTER

Shutting down a computer closes all the programs that are open and exits the operating system safely so hardware isn't damaged and your operating system isn't corrupted.

Shut down in Windows 10

Press the Windows key on the keyboard, or click Start. The Start menu opens. In the Start menu, click Power, then click Shut down.

-or-

Press Ctrl+Alt+Del and click the power button in the bottom-right corner of the screen.

-or-

From the Windows desktop, press Alt+F4 to get the Shut Down Windows screen shown here.



If you have no mouse, use the Tab key and arrow keys to switch between fields. Use the Enter key or the spacebar to select what is highlighted.

Shut down in Microsoft Windows 95, 98, NT, ME, 2000, and XP

All these versions of Microsoft Windows can be shut down through the Start menu. Press the Windows key on the keyboard or click Start. From the Start menu, click **Shut Down...**

BASIC WEB SKILLS/USING A WEB BROWSER

The Web, also known as the World Wide Web (WWW), is essentially a collection of an uncountable number of pages of information displayed on the Internet. It is an information-sharing tool that is growing at an unbelievable rate. According to a Google study, there are over a trillion unique web pages and over 4.5 million new websites are registered each month! You can view this information with the help of a "web browser"—a window that allows you to view online content (e.g., Internet Explorer, Mozilla Firefox, Safari, and Google Chrome). Because there is so much information on the Internet, and so many individual sites and pages, it would be nearly impossible to

find what you were looking for by just “browsing” or flipping through sites, not only because of the sheer size of the collection, but also because you wouldn’t know what address to go to! To deal with this, we use a web browser to access a search engine which allows us to search for a particular topic, word, or phrase.

The Internet is a communications network that connects computers from all around the world. To reach different websites, we use search engines like Google or Bing to search for websites about a particular topic, word, or phrase. Just like you might use the library catalog to find a book or the phone book to find a business, search engines organize information and make it accessible for Internet users. If you can think of a topic, there is probably a website about it!

Locate and Open a Web Browser

A web browser is a program that lets you see information and images on web sites. A browser reads the information on a web page and displays it on your computer screen. The three most popular web browsers are called “Microsoft Internet Explorer”, “Mozilla Firefox”, and “Google Chrome”. You should be able to use at least one of these browsers at your local public library.

To open one of these browsers

Point to the browser’s icon on the desktop (see images below) with your mouse and double-click on it with the left mouse button (alternatively, left-click once, and then press the “Enter” key). A window like the one pictured below should come up on the screen.



Using the Browser’s Menu Options

Typical Menu Bars are not usually included in updated browsers. They now have menu options that can be accessed via icons on the right side of your screen, just below the X.



The picture on the left is of the Google Chrome menu icons. To access menu options, click on the icon with three horizontal lines. The picture on the right is of the Firefox menu

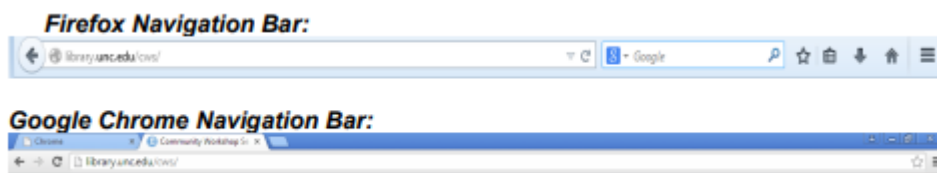
icons. To access its menu options, click on the three horizontal lines icon, i.e., “Open Menu.” To select one, point with your mouse and left-click once.

Each menu item contains many options. Here’s a brief overview of the things you can do with each menu item:

- ✓ **Print:** Use this option to print your current web page.
- ✓ **File:** Here you can change your browser to and from Full Screen, Save, Find a word or phrase in a web page, and view suggested sites.
- ✓ **Zoom:** Zoom in or out to more easily view pages in your web browser.
- ✓ **View:** You can change the display of your browser here, including text size. Safety: Here you can manage your browsing history and activate filters for browsing.
- ✓ **Favorites or Bookmarks:** This is a place to store and access your favorite and most used websites. Access these options by clicking on the star icon.
- ✓ **Options:** These are more advanced settings for your web browser; most likely you will never need to use these options.
- ✓ **Help (or? icon):** If you need more help with the browser, try this menu item.

Using the Brower’s Navigation Bar

The Navigation Bar is located directly above or below the Menu Bar and contains buttons that provide shortcuts to frequently used navigation and menu options, such as forward, back, stop, refresh, and home.



The following is a description of the most frequently used Navigation bar buttons:



The **Back** button takes you back to the previous web page that you viewed.



The **Forward** button takes you forward to the web page that you viewed *before* you clicked “Back.”



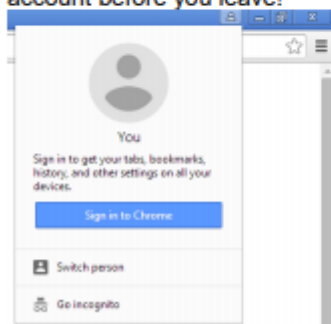
The **Refresh** button will reload the web page that you are currently viewing. Web pages (especially news sites) will change throughout the day, so it is important to refresh them periodically to see the most recent changes.



The **Stop** button will stop a web page from loading. If a page is taking a particularly long time to load, you can try clicking Stop, then Refresh. Sometimes the Stop button will only show up if a page is loading and will replace the Refresh button in the navigation bar.



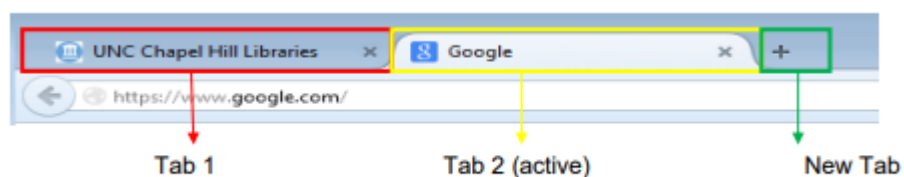
The **Home** button will take you to the webpage that opened when you first opened your browser window. If you are at a library, this is most likely the library's home page. It is possible to change your web browser's settings to open a different Home site. In Google Chrome, you will need to sign into your Google account (you have one if you have a Gmail address) in order to view your bookmarks and Home page. (See image below). You can do this on any computer, just make sure you sign out of your Google account before you leave!



The address bar is a long, white box where you will type the address of the site you wish to go to. We will learn more about web addresses and the address bar in a little bit.

Using Tabs

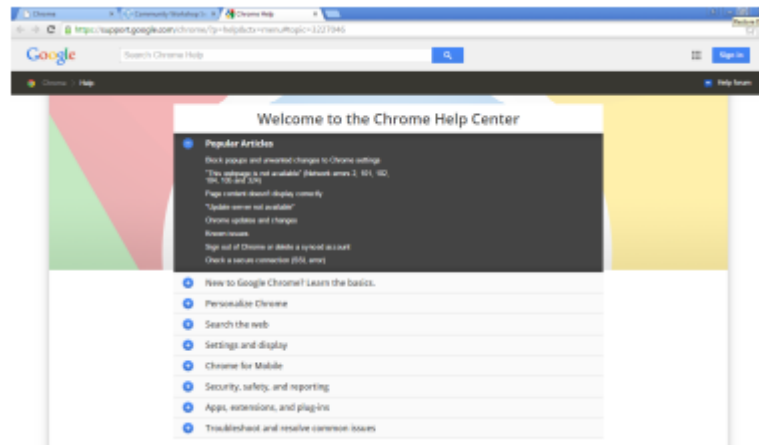
Tabs work just like tabbed dividers in a filing cabinet or a binder—they allow you to organize different pages while keeping them all accessible. You can open a new tab by going to File◇New Tab, OR by clicking the small button with the plus sign (+) to the right of the last tab, OR by holding down the control (CTRL) key and typing the letter ‘T.’



The benefit of using tabs, instead of new windows, is that you can view multiple tabs within one window, and can switch between tabs very quickly by simply clicking on the tabs. In the example above, if I wanted to view the Google page, I would simply click the tab that says “Google.” To switch back to the UNC page, I would click the tab that says “UNC.” It is possible to have multiple windows open, and for each window to have more than one tab open.

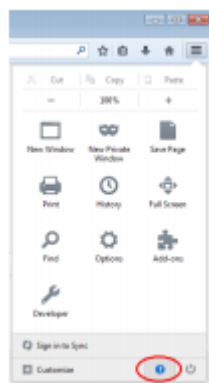
Using the Browser's Help Feature

As with many other programs, web browsers have Help features that you can use if you ever need a hand. The help feature can be found in the browser's menu options. To easily access Help options in Google Chrome, click the F1 key on your keyboard, or select the Help option in the horizontal lines menu.



In Firefox, you can access Help options by following these steps:

3. Left Click once on the icon that is three horizontal lines at the top right of your screen.
4. Slide the mouse down to the Question Mark (?) icon at the bottom of those menu options.
5. The icon will turn blue (meaning it is highlighted and ready to be selected).



6. Click once with the left mouse button to open specific help options

*It is important to note that all web browsers are not the same. Like different televisions that all display the same channels, all web browsers take you to the same Internet, but can be designed differently. The "Help" feature on many web browsers may not be found the way it is shown here, but there is very often a "Help" menu option, or a "Help" button at the top of the browser window.

Feel free to explore the help features. You can even search for a particular item if it does

not appear to be in the index. In fact, you can also search the Internet for help on a variety of topics using a search engine—your instructor can tell you how to do this!

Changing Text Size

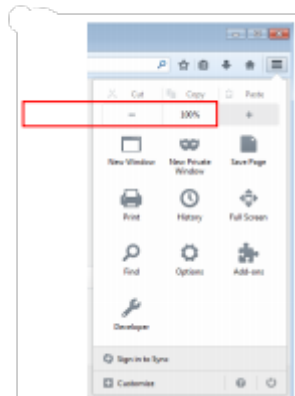
If you are not comfortable with the text size on a web page, you can zoom in or out according to your preferences. (Most browsers are defaulted to a 100% zoom – zooming in (+) makes things larger, and zooming out (-) makes them smaller).

In Google Chrome:

1. Left-Click once on the horizontal lines icon to open the menu options.
2. Move your mouse down to the “Zoom” option.
3. You can click on the + or – icons that surround the number in order to zoom in or out.

In Firefox:

1. Left-Click once on the three horizontal lines icon to open the menu options.
2. You will see at the top of the options that there is a 100% surrounded by a minus icon on the left and a plus icon on the right.



3. Left-click once on either the minus or the plus to zoom out or in – you can click more than once on either icon to continue to zoom out or in.

The appearance on the web page that you are currently looking at should change according to what you have chosen. This tool can be very useful, considering that web pages come in all shapes and sizes—it essentially magnifies or “zooms in” on the text so that it becomes easier to read!

WEBSITE ADDRESSES/URLS

Going to a Specific Web Address Every day, you are probably bombarded with web addresses. Web addresses are also called URLs, which stands for Universal Resource Locator. On the radio, on television commercials, in the newspaper and magazines: “Visit us online at www.businessname.com!” Almost every business and organization has a website now. You can recognize websites because they will almost all start with “www” or “http” and end with “.com” “.org” “.edu” or “.gov” (these endings are called “extensions”). Recently, new specialized extensions were made available such as “.bike”

and “technology” and “.photography”.

Here is an example of a typical web address: www.google.com

You would type this into your address bar to access Google’s website.

Let’s take a look at the anatomy of a web address:



Now that you know what a web site address looks like, you can go to a specific site by typing it in the browser’s address bar, which is located just below the toolbar. Other popular websites include www.amazon.com, www.wikipedia.org, and www.youtube.com.

Here’s another look at the address bar:



To go to a specific website, you’ll need to:

1. Left-click once inside the white part of the address bar. This will highlight the address already in the bar. You can also click and drag your mouse from left to right to highlight the text.
2. Press Delete or Backspace to empty the address bar.
3. Type the new address into the address bar (e.g. www.wikipedia.org).
4. Press Enter on the keyboard. Voilà! The website should then appear on your screen:



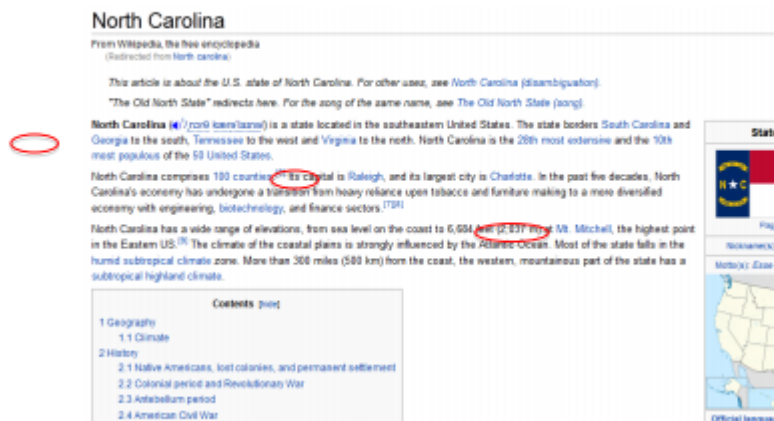
Following Links on a Web Page

A link (also called a hyperlink) is an underlined word or phrase or an image on a web page that links to either another place on the same page, or to an entirely different web page. You can tell that you are on a link when you slide the mouse over text or an image and your mouse pointer becomes a hand with a pointing finger.

Go ahead and type a topic into the search box on the Wikipedia site (for example, search for “North Carolina”), and then press Enter on your keyboard.

Run your mouse over the Wikipedia page that comes up. You’ll notice that as you hover your mouse over any of the blue words, the words become underlined, your mouse arrow changes to a pointing hand, and (if you allow it to hover for a few seconds) a small description will appear below the link. This should also happen if you hover over any of the images on the page.

Let's follow a link! Try clicking one of the blue words that appears on the Wikipedia page that you are looking at—your instructor can assist you if you need help.



Here is how to do it:

1. Slide the mouse down to a word that is blue, or an image that causes your mouse pointer to turn into a hand.
2. When the pointer turns into a hand, click once with the left mouse button. You should now see a new page with text and other links. You can go back to the previous page by clicking on the "Back" button on the browser's toolbar. Practice going to different links! Remember that you can use the "Back" button to go back to the previous page or use the "Forward" button to return to the page you were looking at before you clicked "Back."

USING SEARCH ENGINES

Finding Information with a Search Engine

To find information on the web, you will need to use a search engine. A search engine goes out and finds information for you on the World Wide Web. There are many search engines out available to use.

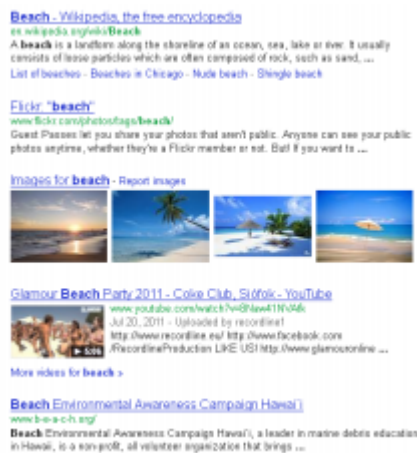
Google is currently the most popular search engine, but there are many others, such as Yahoo.com, Bing.com, and Ask.com. Today, we'll practice using Google.

Type the web address www.google.com into the address bar at the top of your screen. Then hit Enter on your keyboard.



This should bring up the Google homepage on your screen. A blinking cursor will appear in the text box to let you know you can start typing something. Type a word or a phrase that describes the information that you are looking for (the fewer words, the better—no

need to use complete sentences!). For example, type the word “beach” into your search box to see what Google finds.



Refining Your Search

Try the following steps to narrow down your search:

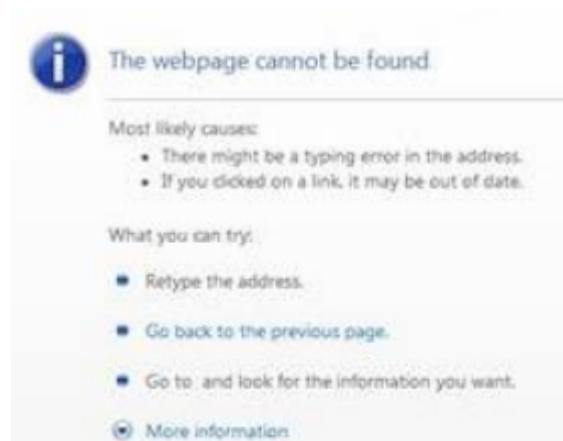
- ✓ If you get too many "hits" (listed websites), try adding extra words that describe what you want— if that gives more instead of fewer results, put “and” between each word. For example, “beach and vacation” will find only pages where both of those words are included.
- ✓ Put phrases in quotation marks, e.g. “North Carolina governors,” “Al Pacino,” or “Orange County Main Library.” This will find only those pages that contain these exact phrases.

Understanding Error Messages

Sometimes you will type a website address but an error page comes up instead of the website. This happens from time to time. The most common cause for this is that you have typed the web address incorrectly. You can also sometimes get an error message when you click on a link on a web page. This often means that either the link is “broken,” or the page no longer exists. An error page can mean a variety of things, including any of the following:

- ✓ The website is temporarily down
- ✓ The website does not exist anymore
- ✓ The link you clicked is broken (it was created incorrectly)
- ✓ Your browser can’t open the site because of some restrictions
- ✓ Too many people are trying to access the site at once

There may be nothing you can do to rectify the situation. In this case, you might just have to move on and go to another website or choose another link. In this day and age, major websites usually never stay down for a long period of time. It is the equivalent of a major television network going down— many, many people are working very hard to bring it back up as soon as possible!



NAVIGATING THE WEB

Identifying Advertisements

It is common to find advertisements on websites. Many of these advertisements are just trying to sell you things, but some of them are traps. They get you to enter your personal information and tell you that this is for a chance to win money or prizes, but most of the time it's just to get your email address so they can send you junk mail. In extreme cases, malicious websites may try to steal personal information such as your social security number or your credit card number to steal money from you or even your identity.

Some other advertisements will pop up and tell you that you need to "Click Here" because you have a virus and you need to clean up your computer or something similar. Again, these are just ways that a company tries to access your personal information or sell you something.

REMEMBER: You can always ignore advertisements, just like you can change the television channel at home. You are not forced to do anything on the Internet!



Viruses and Personal Safety

For your own safety, NEVER give out your personal information over the web to unsolicited advertisements or unknown websites. These are most likely not secure. If you are applying for or buying something from a legitimate organization or company, it will be done on a secure site. A secure site will display a little padlock somewhere in the browser:



In addition, the web address should begin with https://. The extra 's' in the web address means that the site is secure. It is a good idea only to make purchases from well-known, well-regarded sites, like www.amazon.com or www.target.com. You should also try to read companies' privacy policies before making a purchase.

Viruses are malicious programs that are loaded onto your computer without your knowledge. They can destroy or delete everything on your hard drive, such as your files and folders, or extract personal information. Your computer can become infected when you download pictures and files from the web or email messages, so avoid downloading files from the Internet unless you are sure it is safe. If you receive an e-mail from a friend with an attachment, especially if it seems strange, verify that they intended to send you the attachment before you open it.

Your home computer should be protected against viruses. You can equip it with virus protection software that stops viruses from attacking the computer's hard drive and your files. When you try to download something from the web, the virus protection software will scan the downloaded file or image to make sure that it does not contain any viruses.

MICROSOFT WORD 2016

What is Microsoft Word?

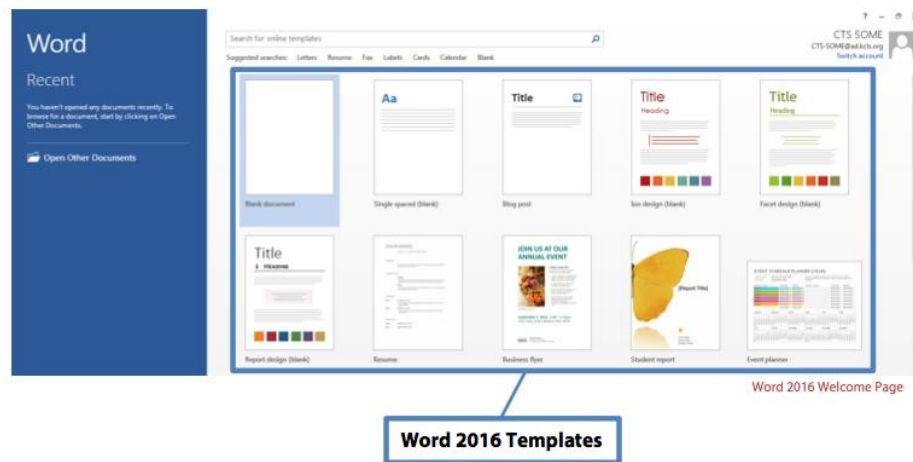
Word is used to "create beautiful documents, easily work with others, and enjoy the read." The types of documents you can create with Word include:

- ✓ Letters – personal, business (including résumés), creative or general notes
- ✓ Notices – basic flyers, menus, checklists
- ✓ Reports – for school, work or a special interest group

Word has excellent tools and a work area that resembles a sheet of paper. Word templates on the Welcome Page offer pre-designed documents. Browse them to visualize what is possible with Word. Click on a template to see a description and suggested use for the template.

Word 2016 welcome page

Open word 2016 from the computer desktop. On the welcome page, note the various popular templates available. Click "Facet Design (blank)" template for a full description. Click "Create" to open a document in this particular style.



Microsoft Word 2016 Interface

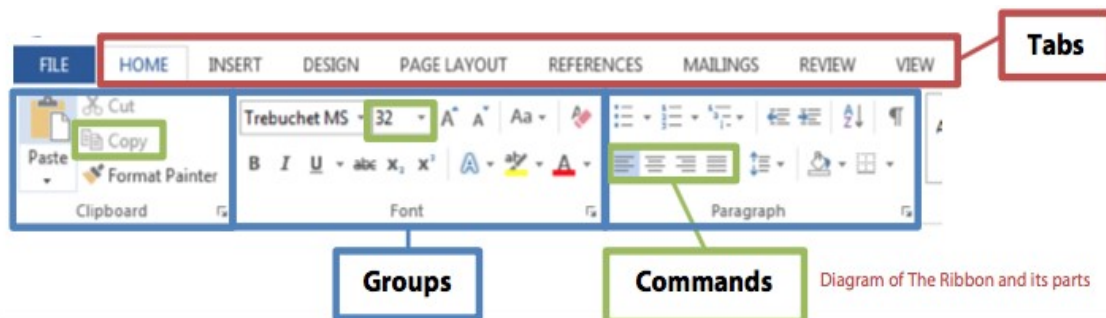
The way the tools and menus are organized in Word 2016 is known as the user interface. You will learn about *The Ribbon*, *Quick Access Toolbar*, *File Menu* and other key parts of Word.

The Ribbon

The Ribbon runs along the top, contains all the Word tools, and is organized into three parts:

- ✓ Tabs – represent a general activity area
- ✓ Groups – show related tools (commands) together
- ✓ Commands – a button, expandable menu, or a box for entering related information

Click the various Tabs: observe how the Groups and Commands change based on the



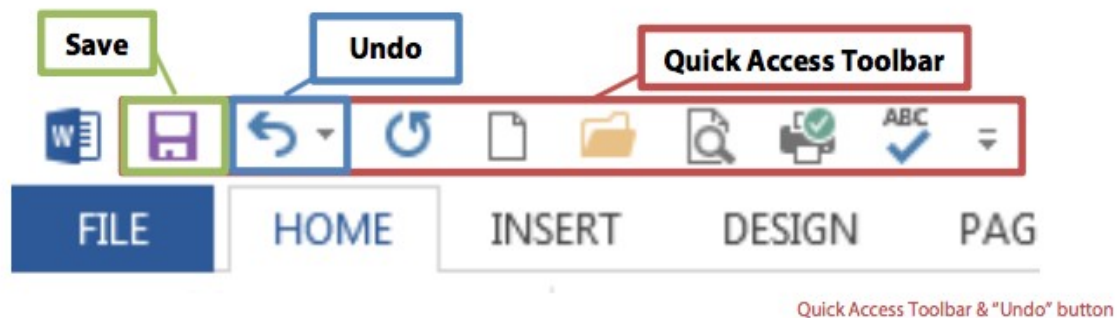
selected tab.

Quick Access Toolbar

The Quick Access Toolbar is above the Tabs and has commands used most often, including “Save”.

Place the mouse arrow over each icon (do not click) to see the name and use for each icon. You may customize the commands in the toolbar if you click the black arrow at the end of the toolbar.

The Undo command “takes back” any changes made to the document. For example, type “Undo” in the blank document you have open, then click Undo in the Quick Access Toolbar. Undo keeps track of actions by sequence; if you accidentally erase (change) data in your file, click Undo right away to get it back. On that note, it is important to “save early and save often.”



File Menu

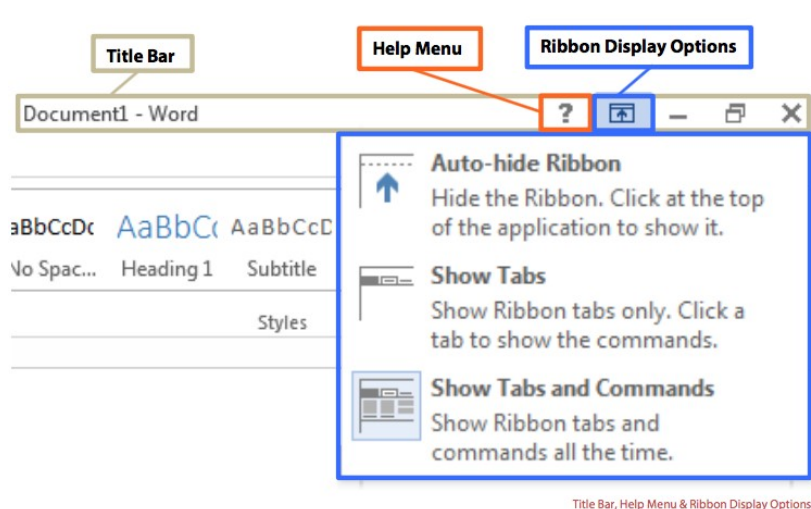
The File Menu contains actions at the file level. Click the blue “File” tab to the far left of the tabs. What you’ll see is the “backstage” area. From here, you can create a **New** document, **Open** an existing one, **Save** changes to the current document, **Save As** a different file with a different name, **Print** the current document, and other options. Click the “back arrow” at the top to exit the backstage area.

Title Bar, Help Menu, Ribbon Display Options

The Title Bar shows the name of the program and the name (title) of your document. (Top-most bar in program window.) A new document has a temporary title, Document1, until you “Save As” with a different name. To the far right on the Title Bar is the Help Menu and Ribbon Display options.

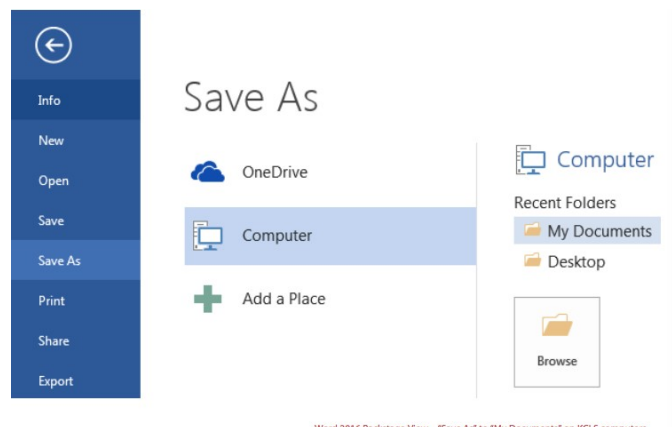
The **Help Menu** has articles on using the software. Not sure how to perform a certain action or where to find a command? Click the question mark icon to browse Help articles, or search for specific topics.

Ribbon Display options allow you to see more or less of the Ribbon and the work area, as a result. Take a moment to locate and explore these features in the Word program window.



Using Tools in Word

- ✓ Start learning about word processing by working in a Microsoft Word 2016 document.
- ✓ Save Your Work
- ✓ To make sure you don't lose your work on a document, you should "save early and save often." Let's start by saving the document you have open in Word 2016:
- ✓ Click the blue File Button near the Tabs. Learn more about "File Menu" on page 4.
- ✓ Click Save As. This option is for saving, or naming, a file for the first time. You may create different versions of a file by "saving as" a new name.
- ✓ Click "Computer".
- ✓ Click "My Documents" folder. On KCLS computers, files saved to "My Documents" folder are erased at the end of your session. Consider a USB drive, or OneDrive for long-term storage.
- ✓ Name file "My Practice Document". Generally, choose a name that is easy to remember.
- ✓ Click Save.



Word 2016 Backstage View - "Save As" to "My Documents" on KCLS computers

Get Ready for Typing

The main workspace in Word resembles a piece of paper on your screen. Note the vertical blinking line, the cursor, near the top left of the paper. Cursor and mouse pointer shape offer hints in Word.

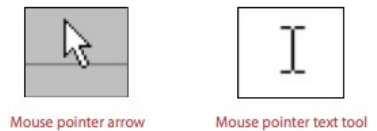
1. The Cursor

The cursor indicates where text will appear as you type; it also indicates font size for that spot. Earlier, you created a document from the "Facet design (blank)" template on the Welcome Page. Note the size of the cursor next to the word "Title". What is the font size value for the word "Title"? (Look toward the Font Group in the ribbon.)

Now move your mouse pointer in front of the word “Heading” and left-click once. This moves the cursor. Note the cursor size and font size value in the font size box. What is the font size value?

2. Mouse Pointer Shape

You may have noticed the mouse pointer changes shape as you move to different areas in Word. The two most common shapes indicate different functions. The mouse pointer arrow is for clicking commands, or buttons in general. The mouse pointer text tool (I-Beam) is for selecting text or positioning cursor for typing. You will use the document you have open now to practice using various key Groups and Commands in the Word Ribbon. Let’s select and change text in your document.



3. Selecting Text

Selecting text to make edits is an important word processing skill. A common way to select text is:

- ✓ Place mouse pointer text tool next to the text. In this case, place it next to next to “T” in “Title”.
- ✓ Press the left mouse button.
- ✓ Drag it across the text.
- ✓ Let go of the left mouse button.
- ✓ Notice “Title” is selected (highlighted). Go ahead and type “My Practice Document”.

Selecting Lines and Paragraphs

- ✓ To select a complete line of text (use paragraph in your practice document):
 3. Place mouse pointer arrow in left margin next to line of text (arrow will point to the right).
 4. Left-click once to select that line of text.
- ✓ To select several lines or a paragraph:
 5. Place mouse pointer arrow in left margin next to line of text (arrow will point to the right).
 6. Press (hold down) the left mouse button.
 7. Drag to the end of the paragraph. Let go of the left mouse button.
- ✓ Next, you will use commands from the ribbon to edit text you have selected.

Home Tab

The Home Tab has the groups of commands that people use most often.

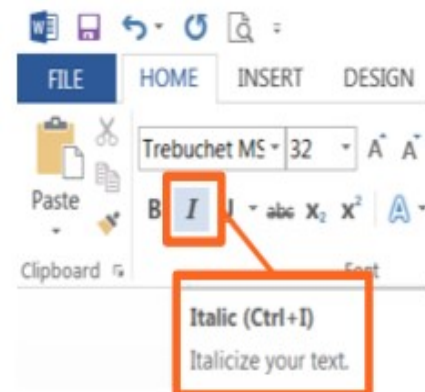
4. Font Group

The Font Group contains commands that change the appearance of the font. Font is the set of characters (letters, numbers, punctuation, etc.) in a particular style. For example,

the document you created from the “Facet design” template on the Welcome page uses “Trebuchet MS” font, but you can still use the font commands in your document.

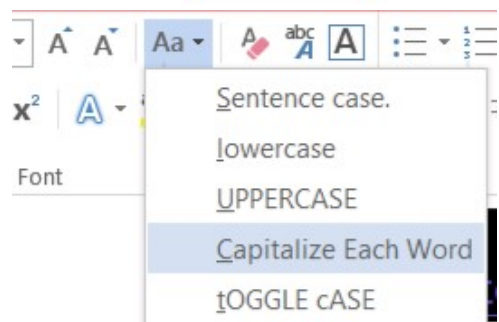
Here’s how to italicize text

- ✓ Select the word “Practice” in the document title.
- ✓ Click italics icon in Font Group (see screenshot).
- ✓ Notice Word automatically capitalized the first word in the sentence. If you want each word capitalized, as a title or header normally is, you may do it word by word or simply use Change Case.



To use Change Case command:

- ✓ Select “How to use this template”.
- ✓ Click “Change Case” command.
- ✓ Click “Capitalize Each Word” in menu.



5. Style Group

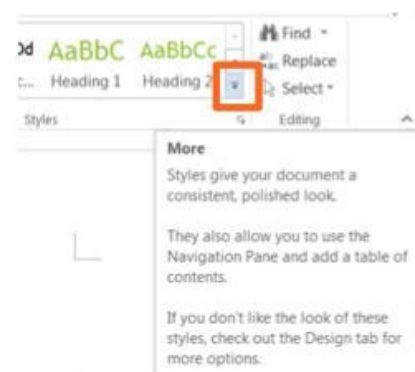
A document created from a template, like the one you opened earlier (Facet design blank), has pre- designed styles for different parts of the document, such as paragraphs and headers. To apply a different paragraph style:

- ✓ Select paragraphs under “How To Use This Template”.
- ✓ Click “More” button in Styles Group. ✓ Click “Emphasis” command.

The text remains selected. You may continue modifying, including Undo, if you wish. To deselect, press left arrow (cursor placed at beginning of text), right arrow (cursor placed at end of text) or click in an area outside the selection.

To create a new heading (section):

- ✓ Click “More” button in Styles Group.
- ✓ Click “Heading 1”.
- ✓ Type “Learning more about the home tab”.
- ✓ Press “Enter” once.
- ✓ Type “The Home Tab contains the following Groups:”
- ✓ Press “Enter” once.



“More” button in the Styles Group

You now have a new header and introductory sentence.

You will use commands from various groups at various times, so don’t be surprised that you will use a command from the Paragraph Group next.

To create a bulleted list:

- ✓ Click “Bullets” command in Paragraph Group.
- ✓ Type “Clipboard”.
- ✓ Press “Enter” once.
- ✓ Re-create list pictured to the right (Repeat step 2 & 3 for each word).
- ✓ After last item in your list, press “Enter” twice.



Learning More about the Home Tab

The Home Tab contains the following Groups:

- Clipboard
- Font
- Paragraph
- Styles
- Editing

Your document header and bulleted list will look this.



Bullets are good for general lists of items. A numbered list is good for steps in a procedure or order. The steps to make a numbered list are the same, except the icon for numbering is

Clipboard Group

The Clipboard Group has the commands to do “copy and paste” and “cut and paste”.

Before you start:

- ✓ Make a new sub-heading in your practice document.
- ✓ Use “Heading 2” style from Styles Group.
- ✓ Type “Clipboard Group”.
- ✓ Press “Enter” once.
- ✓ Type two sentences on one line.
- ✓ “I want to live in a warm place. I am moving to Hawaii.”

To Copy and Paste text:

- ✓ Select the text (the line of text you just typed).
- ✓ Click “Copy” icon in Clipboard Group.
- ✓ Move cursor to area where you want to paste (right arrow, then “Enter” once).
- ✓ Click “Paste” icon in Clipboard Group.



To Cut and Paste text:

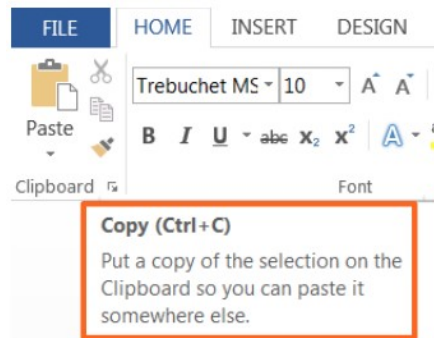
- ✓ Select the text (the sentence “I am moving...”).
- ✓ Click “Cut” icon in Clipboard Group.
- ✓ Move cursor to area where you want to paste (at beginning of first sentence on same line).
- ✓ Click “Paste” icon.

Can you think of a scenario where you might choose one command (Copy, Cut) over the other?

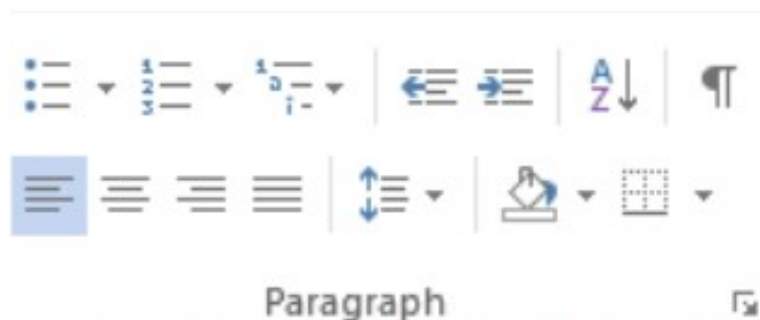
Paragraph Group

The Paragraph Group includes commands to adjust line and paragraph spacing and alignment.

Line spacing refers to when the text you're typing has reached the end of the line and moves down to the next line automatically. **Paragraph spacing** refers to any time you press the "Enter" key to start a new paragraph.



Floating box with name, shortcut and description of Copy command



Paragraph Group and "Line and Paragraph" command highlighted

Insert Tab

The Insert Tab commands insert different elements into your document like tables and illustrations.

Tables Group

You may choose preformatted tables or add the number of rows and columns you want. For this exercise, you will create a 3x5 table to track DVD's on loan to friends.

To insert a table into your document:

- ✓ Click the Add a Table icon under the Insert Tab.
- ✓ Select a 3-column, 5-row area in the grid.
- ✓ Left-click when you are ready to insert the table.

Apply a Table Style

- ✓ Click into the table to activate the Table Tools tab.
- ✓ Choose a new design from the Design Tab.

Illustrations

The Illustrations Group has commands to insert pictures, shapes, charts, and more.

How to insert a shape

- ✓ Click the Shapes button in the Illustrations Group
- ✓ Click the first shape (Explosion 1) in Stars and Banners.
- ✓ Place mouse pointer (cross) in a blank area.
- ✓ Click and drag your mouse to “draw” the shape.
- ✓ Let go of the mouse button when finished.

How to add text to a shape

- ✓ Place mouse pointer arrow in shape area.
- ✓ Click right mouse button once.
- ✓ Click “Add Text” from menu.
- ✓ Type “Hello”.

How to move a shape

- ✓ Place mouse pointer over shape.
- ✓ Look for cross-like move arrow tool.
- ✓ Click and drag your shape to a new spot.

How to re-size a shape

- ✓ Click into the shape.
- ✓ Look for squares around the frame.
- ✓ Click and drag a frame square.
- ✓ Drag a corner out to enlarge proportionally.

Steps for inserting other types of illustrations are similar; try inserting another illustration on your own.

Keyboard Shortcuts

These shortcuts are a handy way to use the mouse less. Activate them by holding down one of the Ctrl (Control) keys on the keyboard and tapping the corresponding key. For some shortcuts, you have to highlight the text first. Follow your instructor’s directions to apply these shortcuts to a document (if Paragraphs document is still open, use it as an example or write a few new sentences on a blank page).

Ctrl + P	print
Ctrl + A	select all
Ctrl + C	copy
Ctrl + V	paste
Ctrl + X	cut
Ctrl + N	opens new window/document
Ctrl + S	save

Ctrl + Z	undo
Ctrl + Y	redo
Ctrl + B	bolds text
Ctrl + I	<i>italicizes text</i>
Ctrl + U	<u>underlines text</u>
Ctrl +]	enlarges text by one size
Ctrl + [decreases text by one size
Ctrl + E	centers text
Ctrl + L	aligns text to the left
Ctrl + R	aligns text to the right

MICROSOFT EXCEL 2016

What is Microsoft Excel?

Excel is a spreadsheet program that allows you to store, organize, and manipulate data. Data can be text, numbers, and formulas. The data is entered into cells which are organized into columns and rows. Many people use Excel to keep a budget, use charts and graphs to show data, track sales for a business, and much more.

Microsoft Excel 2016 Interface

The Excel interface is where you see and use the tools in Excel on the screen. This includes the way the tools are organized and presented to you, the software user. You will learn about The Welcome Page, The Ribbon, Quick Access Toolbar, and File Tab.

The Welcome Page

When you first open Excel 2016, you will see the Welcome Page (see Figure 2). Take a moment to browse the many templates available for specific uses. Notice the Search Box near the top-center where you can search for templates for other uses.

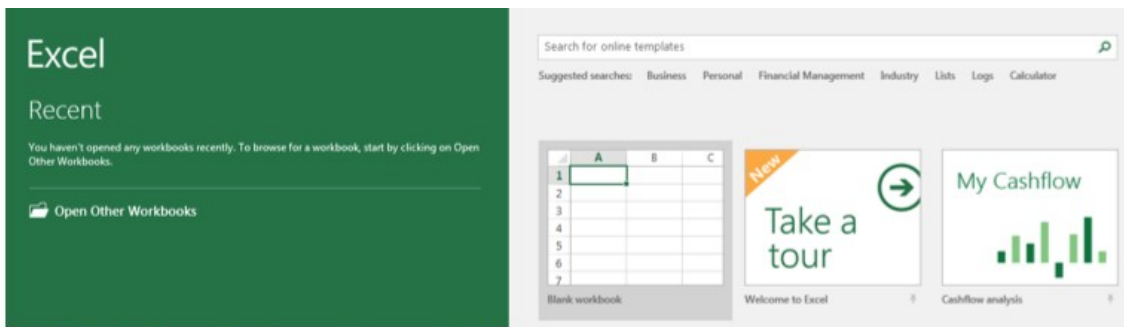


Figure 2 - Excel Welcome Page (zoomed in to upper left side)

The Ribbon

The Ribbon is a toolbox at the top of the screen. It's organized into three main parts

- ✓ Tabs – Tabs represent a general activity area. For example, the “Home” has the tools most often used, and the “Insert” tab has the tools to “put objects into” the work area.
- ✓ Groups – Groups show related “tools” together more specifically, like “Font” or “Alignment”.
- ✓ Commands – A command is one of the actual “tools”, which can be a button, expandable menu, or a box for entering information.

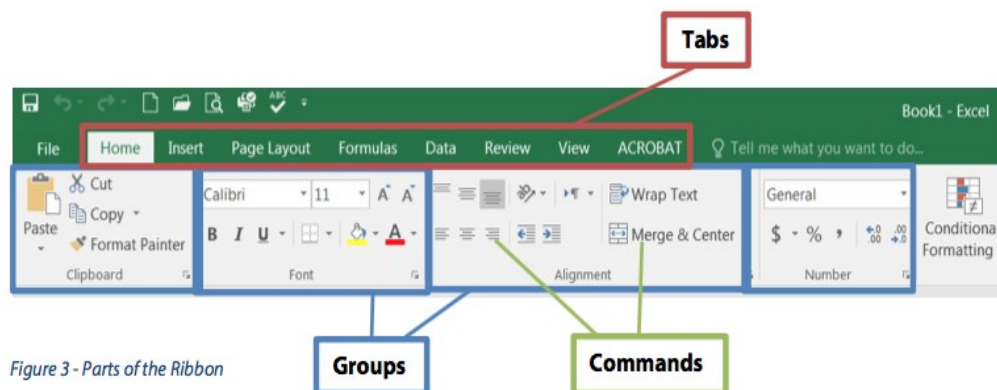


Figure 3 - Parts of the Ribbon

Quick Access Toolbar

The Quick Access Toolbar is above the Tabs and **has the commands used most often**. See below

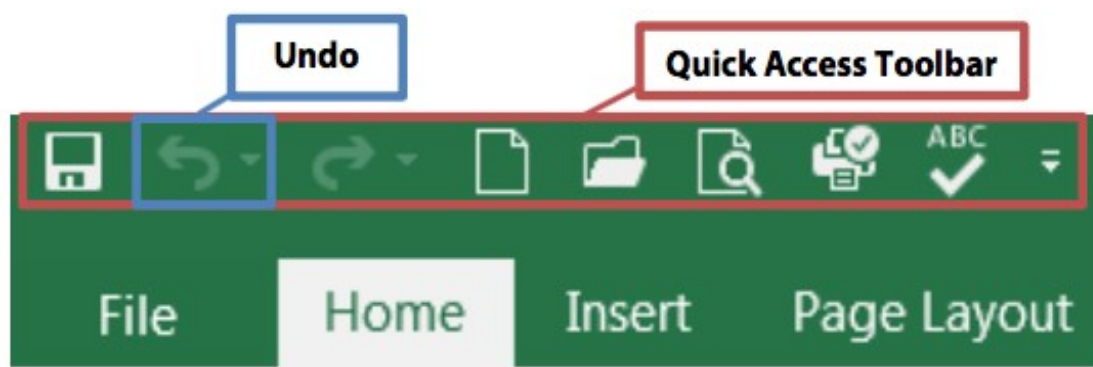


Figure 4 - Quick Access Toolbar & Undo button (zoomed in)

File Tab

The File Tab is where you can create a **New** document, **Open** an existing one, **Save** changes, **Save As** a different file with a different name, **Print** the current workbook, and many other options.

Basic Formatting - Labels

The words you type into a cell are called “labels”. Excel has many formatting tools to make labels look better and easier to read. For example, the label “Number Sold” is too long to fit into a cell **B2**.

	A	B	C	D	E
1	My Pet Store Earnings				
2	Type of Pet	Number Sold	Price	Total per type	
3	Dogs				
4	Cats				
5	Fish				
6	Birds				
7	Rodents				
8	Reptiles				
9	Arachnids				
10					

Figure 6 - Worksheet with column labels

Try it! Select cell range **A1:E1** (click and drag from cell **A1** to **E1**). Click the “Merge and Center” command in the *Alignment Group* of the *Home Tab*. Now add a little style: click the “Good” command in the *Styles Group* of the *Home Tab*. Your worksheet should look like Figure 7.

Try it! Place the mouse pointer on the thin line between column letters “B” and “C”. Double click, and the columns will automatically adjust to fit the text in column “B”. Make the text in every column easy to read. Your worksheet should look like Figure 7. You may also click and drag to adjust the width of the column.

	A	B	C	D	E
1	My Pet Store Earnings				
2	Type of Pet	Number Sold	Price	Total per type	
3	Dogs				
4	Cats				
5	Fish				
6	Birds				
7	Rodents				
8	Reptiles				
9	Arachnids				
10					

Figure 7 - Formatting and columns adjusted

Basic Formatting - Values

The numbers you type into a cell are called “values”. Working with values in Excel will begin to show you the power of the software.

Try it! Type the values you see in columns “B” and “C” in Figure 8. Click into cell **B3**, type “27”, then press “Enter” on the keyboard. Continue until you’ve added all the values in range **B3:C9**. Note: when typing the values in column “C” (prices), do not include the dollar sign.

	A	B	C	D
1	My Pet Store Earnings			
2	Type of Pet	Number Sold	Price	Total per type
3	Dogs	27	300	
4	Cats	20	160.5	
5	Fish	33	12	
6	Birds	26	45	
7	Rodents	18	25.5	
8	Reptiles	37	99.99	
9	Arachnids	43	80	

Figure 8 - Values in cell range B3:C9

Try it! Select cell range C3:C9. In the “Numbers” group under the “Home” tab, click the small arrow next to the dollar sign (Accounting Number Format) as seen in Figure 9. You will click “English (United States),” but browse the many options in the drop-down menu.

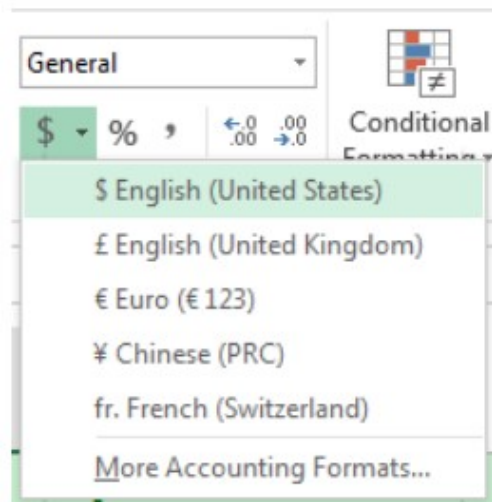


Figure 9 - "Accounting Number Format"

Calculating with Formulas

Let's learn how to perform basic calculations in Excel, called "formulas". For example, how much did the pet store make during this month from the sale of pet dogs?

Try it! Click into cell D3. Type the equal sign (=). Note: formulas always begin with an equal sign. Click cell B3. Type an asterisk (*). Note: in an Excel formula, an asterisk is used for multiplication. Click cell C3. Your worksheet should look like Figure 10. Press "Enter". How much did the pet store earn from sales of pet dogs? Repeat these steps similarly for the "Cats" row. Hint: start in cell D4.

C3				
	A	B	C	D
1	My Pet Store Earnings			
2	Type of Pet	Number Sold	Price	Total per type
3	Dogs	27	\$300.00	=B3*C3

Figure 10 - Basic multiplication formula

Copy a Formula with Autofill

You can speed up your work by calculating one formula and copying it to make other calculations quickly and efficiently. This is a powerful feature in Excel called "Autofill".

Try it! Select cell range **D3:D4**. Place your mouse over the "fill handle" in the bottom right corner of the selection. The mouse pointer changes from a large white cross to a thin black cross. Click and drag the fill handle down to cell **D9**. Release the mouse button and you observe the power of Autofill.

Try it! Let's suppose a store clerk misplaced a few receipts for rodent sales. Five more rodents sold than reported in the worksheet, so number of rodents sold is "23" and not "18". Make this change in cell **B7**, and press "Enter". Notice the Total dollar amount for "rodents sold" (cell **D7**) adjusts automatically (see Figure 11).

C8				99.99
	A	B	C	D
1	My Pet Store Earnings			
2	Type of Pet	Number Sold	Price	Total per type
3	Dogs	27	\$ 300.00	\$ 8,100.00
4	Cats	20	\$ 160.50	\$ 3,210.00
5	Fish	33	\$ 12.00	\$ 396.00
6	Birds	26	\$ 45.00	\$ 1,170.00
7	Rodents	23	\$ 25.50	\$ 586.50
8	Reptiles	37	\$ 99.99	\$ 3,699.63
9	Arachnids	43	\$ 80.00	\$ 3,440.00

Figure 11 - Adjusted totals in cells B7 and D7

Quick Addition with AutoSum

“AutoSum” lets you quickly add values in a cell range.

Try it! Click in cell **B10**. Then, in the “Editing” group of the “Home” tab, click the command called “AutoSum”. You should cell range **B3:B9** automatically selected and formula in cell **B10**. Press “Enter” and you will see the sum (total) of number of pets sold (see Figure 12). Note: you could also have manually written a formula that would look like this, “**=B3+B4+B5+B6+B7+B8+B9**”.

	A	B	C
1	My Pet Store Ear		
2	Type of Pet	Number Sold	Price
3	Dogs	27	\$ 300.00
4	Cats	20	\$ 160.50
5	Fish	33	\$ 12.00
6	Birds	26	\$ 45.00
7	Rodents	23	\$ 25.50
8	Reptiles	37	\$ 99.99
9	Arachnids	43	\$ 80.00
10		=SUM(B3:B9)	
11		SUM(number1, [number2], ...)	

Figure 12 - AutoSum command & the SUM function

Save Your Work

To make sure you don’t lose your work on a document, you should “save early and save often.” **Try it!**

- ✓ Click the File tab
- ✓ Click Save As
- ✓ Click “This PC”
- ✓ Click “My Documents”
- ✓ Type “My Pet Store Earnings” in the “File name” box 6. Click “Save”

UNIT 05

PROVIDE FIRST AID

This unit deals with the skills and knowledge required for the provision of essential first aid in recognizing and responding to emergency using basic life support measures.

ASSESS THE SITUATION

Identify physical hazards to own and others' health and safety

Introduction

When administering first aid your first concern must be to make sure you do not become a casualty of the situation. This means you must assess the situation you are facing and take time to identify the physical hazards that may be present to your own safety and that of others who may be present.

Defining First aid

First aid is any care given to an injured or ill person (called a 'casualty') before professional medical assistance (ambulance, paramedics, nurse, or doctor) arrives on the scene to take control of the situation.

First aid can include the provision of:

- ✓ Mouth-to-mouth resuscitation – if the casualty is not breathing
- ✓ Cardio-Pulmonary Resuscitation (CPR) – where there is no breathing and no pulse
- ✓ Control of bleeding – to limit blood loss
- ✓ Wound care – to limit blood loss and infection by covering wounds
- ✓ Treatment for burns and scalds – including treatment for electric shock
- ✓ Bandaging and splinting – to fractures and sprains.

Important points to note at the start

The following important points must always be taken into account when providing first aid:

- ✓ Protect yourself and others at all times against injury or harm – persons delivering first aid should not become casualties
- ✓ The casualty must be protected against further harm or injury
- ✓ Whenever there is a need to administer first aid make sure you notify your supervisor immediately to arrange for professional help to be called
- ✓ Wear protective gloves when administering first aid to protect against infection.

Types of hazards to be aware of

To protect first aid providers, bystanders and casualties against harm when providing first aid you must take care to identify physical and other hazards which may be present such as: Workplace and incident-specific hazards – including stock, plant, equipment, machinery, utensils and vehicles. It also includes the general environment in the form of heat, cold, wind, sunshine, rain

Hazards sometimes associated with casualty management – for example, first aid providers need to be aware there can be:

- ✓ A risk of being bitten
- ✓ Violence as a result of a casualty being confused and disoriented bodily fluids have the potential to contaminate and cause disease.

Some diseases are only spread through blood-borne viruses, but it is advisable to be alert to the potential dangers posed by all bodily fluids:

- ✓ Blood
- ✓ Saliva
- ✓ Urine and faeces

Mucus

- ✓ Pus
- ✓ Semen
- ✓ Sweat
- ✓ Tears.

You should always be safe and treat all body fluids as if they are infectious. Always wear protective gloves when providing first aid.

Risk of further injury to the casualty – which can be caused by a range of issues, for example:

- ✓ The casualty being burned by fire spreading toward them
- ✓ Something falling onto the casualty and adding to their existing injury.

How to identify hazards

The accepted ways to identify hazards when providing first aid are:

- ✓ Use common sense – this is the most important aspect
- ✓ Use your sense of sight – look for things that could present a problem or danger. Look carefully in all directions. Be alert to smoke, fire and emerging issues
- ✓ Use your sense of hearing – listen for escaping gas, crackling of flames or creaking of wood and metal
- ✓ Use your sense of touch – vibrations or heat
- ✓ Use your sense of smell – gas or smoke.

Also be prepared to listen to what people already at the scene may tell you about what they have identified as being hazards. They have the benefit of extra on-site experience with the casualty you will not have.

The important point here is you must never rush in and start first aid without first assessing the hazards posed by the situation you are facing.

Minimize immediate risk to self and health and safety of the casualty by controlling hazard/s in accordance with accepted practice

Introduction

If any hazards have been identified as a result of the evaluation undertaken when arriving „on scene“, you must take action to minimize risk to yourself, the casualty and others before rendering first aid.

What you may be able to do

The action you need to take to minimize risk will depend on the hazard you have identified. Only act to address identified issues where they pose a risk.

Generally speaking, casualties should not be moved until they have been assessed as being safe to move but if there is a serious and immediate risk of extra injury to a casualty from an identified hazard it is standard practice to move them away from the hazard.

If uninjured bystanders are near an identified hazard, they must be told to move away to a safe location.

Whenever there is identified danger from fire, gas leaks or smoke the emergency fire authorities must be called.

Where there is an identified hazard from electricity, the electricity supply company or someone from within the workplace with knowledge of how to turn off the power must be contacted.

Other action may include:

- ✓ If there is a fire near the casualty – call the fire brigade, move the casualty out of the danger zone or fight the fire with nearby hoses, fire blanket or extinguisher
- ✓ If the casualty's situation is being made worse by rain or sunshine – provide cover to the person
- ✓ If gas is leaking from a damaged appliance – turn off the gas at the stop valve and make sure no one is smoking
- ✓ If unstable items are near-by and posing a risk of – either move the items or casualty
- ✓ If the casualty is in a position where they are likely to be run over by vehicles – move them or take action to stop traffic.

Protect the neck

If you ever have to move a casualty because they, or you, may be in danger, do whatever you can to protect the neck against movement. This is vitally important where the casualty is unconscious and you are unsure what injuries they have. To help protect the neck:

- ✓ Keep the casualty still – tell the casualty not to move
- ✓ Kneel behind the head and place your hands on either side to support it – with the head, neck and spine in a straight line
- ✓ Put rolled up towels, blankets, or clothing on each side of the casualty's head to keep it from moving.

Be prepared to use bystanders to help you

- ✓ Always be alert to the possibility of asking others to assist you by:
- ✓ Calling emergency services
- ✓ Moving items helping to move the casualty
- ✓ Using fire-fighting equipment.

This could include other staff, bystanders, customers, management, friends or family of the casualty. Remember others are often prepared and willing to help if they are told what to do.

Using the 'fireman's carry' to move casualties

The "fireman's carry" is used to move unconscious people or casualties who are unable to walk.

Do not use the fireman's carry if the casualty has an injured arm, leg, ribs, neck, or back. The steps for the fireman's carry are:

- ✓ Place the casualty face down

- ✓ Grab the person around the waist, and help bring him or her to a standing position, facing you
- ✓ Keep one arm around his or her waist when you have him or her in the standing position grasp the casualty's right arm in your left hand and swing his or her arm around the back of your neck
- ✓ Pull him or her across your shoulders by bringing his or her raised arm around your neck and over your shoulder. In this position, the injured person's legs will be over one shoulder, and his or her arm and head will be over the other shoulder
Reposition your hand from the person's waist to the back of his or her knee ☑ Lift yourself with the injured person into a standing position.

Assess casualty's vital signs and physical condition in accordance with accepted practice

Danger – assess situation and check for danger

Before you give first aid, you must assess to the best of your ability the situation. To recap, the important aspects are:

- ✓ Check for danger to yourself, the casualty and others. Look for obvious, immediate, life-threatening hazards such as fire, the possibility of a gas explosion, and electrical hazards
- ✓ If there is danger around, you will need to move yourself and your casualty to prevent further injury to anyone
- ✓ If you think the casualty has a spinal injury, take care to stop more damage to the spine by stopping movement of the casualty's neck and back.

Response – check to see if the person is conscious or unconscious

"Response" is a step enabling you to determine if the casualty is conscious or unconscious.

- ✓ Try and get a response from the casualty by gently tapping his or her shoulder and calling his or her name
- ✓ Avoid shaking them as this may worsen an existing injury
- ✓ Get a history – ask the casualty or any witnesses who saw the incident: what happened? Does the casualty have a neck or back injury? Does the casualty have an allergic reaction?
- ✓ Identify how the casualty feels. Ask: „how do you feel?“, „do you feel dizzy or weak?“, „do you have pain? Where? For how long?“

Check the physical condition of the casualty – take a look at them and around them.
Is there evidence:

- ✓ Of bleeding? Where from? How badly?
- ✓ Bones are broken?
- ✓ Of swelling, bites, burns, scalds?
- ✓ Of possible neck or back injury?

They are suffering allergic reactions – perhaps to food, sting or bite?
the casualty is in shock – symptoms of shock include:

- sweaty but cool skin, pale colour or bluish skin around the mouth
- shallow, fast breathing
- rapid pulse that becomes weaker
- ✓ As shock progresses, you will see the casualty has:
 - anxiety – they will appear restless, agitated, worried
 - unusual thirst
 - yawning and sighing
 - Nausea.

Airway – check to make sure the airway is free of obstructions

- ✓ If casualty is not breathing, open the airway by placing one hand on their forehead and gently tilt the head back by lifting the chin
- ✓ Remove any visible obstructions (vomit, mucus, saliva, false teeth, loose or broken teeth, food, tongue) from the mouth and nose to unblock the airways
- ✓ If obstructions are present the casualty will not be able to breathe and the obstruction will also impede the provision of rescue breathing/mouth-to-mouth resuscitation also known as ear (expired air resuscitation).

Breathing – check to determine if casualty is breathing

Check breathing by looking (to watch the rise and fall of chest), listening (to the sounds of inhaling and exhaling) and feeling for breathing (by placing your cheek next to their mouth and feeling for exhaled breath on your cheek) for up to 10 seconds. Is the casualty's breathing regular or irregular?

If casualty is not breathing, administer rescue breathing/mouth-to-mouth resuscitation/ear.

If casualty is breathing:

- ✓ Continue to monitor it to ensure they continue to breathe
- ✓ Apply rescue breathing if their breathing stops
- ✓ Note their respiration rate so it can be communicated to professionals when they arrive.

Vital signs – respiration rate

"respiration rate" is the rate at which the casualty is breathing.

To determine the respiration rate for a casualty, watch their chest or stomach rise and fall for 15 seconds counting how many times it rises.

Multiply this figure by four to obtain respirations per minute.

Write down your findings so they can be passed on to professional medical help when they arrive.

Respiration rates

- ✓ The normal range of respiration rates in an adult when resting is 12 to 20 respirations per minute
- ✓ Respiration rate below 12 respirations per minute is called slow
- ✓ Respiration rate above 20 respirations per minute is rapid
- ✓ A breathing rate slower than 12 respirations per minute or faster than 20 respirations per minute may indicate a problem affecting the casualty's ability to get oxygen.

Circulation – check to see if the person has a pulse

- ✓ This will indicate whether or not their heart is beating
- ✓ Without a pulse, there is no heart beating and there is no circulation
- ✓ If you cannot detect a pulse, commence chest compressions
- ✓ If casualty is not breathing and there is no pulse, administer cpr (cardiopulmonary resuscitation) this is a first aid technique combining rescue breathing and external chest compressions.

How to find the pulse

It is important to take the pulse of a casualty to determine if their heart is still beating or not. No pulse means their heart is not beating and chest compressions must commence.

If there is no pulse and there is no sign of breathing, cpr (cardio-pulmonary resuscitation) must commence.

A good point for taking the pulse is the neck (carotid arteries). Place the middle and index fingers on the casualty's larynx (voice box).

Move the fingers to the side until you feel the groove (between the bone and the muscle) next to the trachea (wind pipe), then press on the groove until you feel the pulse.

Place the tips of your index and middle fingers over the pulse site and press gently. Using a watch with a second hand. Count the pulse for 15 seconds and then multiply by four to obtain beats per minute. Write down your findings.

Vital signs – pulse rate

A normal pulse rate for an adult when resting is 60 to 80 beats per minute.

The average is 72 beats per minute.

A resting pulse rate of more than 80 beats per minute is a higher than normal pulse rate. This can be caused by shock, bleeding, heat, dehydration, fever, pain or exercise.

Using history, signs and symptoms

If the casualty is conscious and able to talk, speak to them to obtain whatever history is available relating to their condition.

By putting the history, signs and symptoms together, you will have a better assessment of the injury.

For example:

- ✓ The casualty's chest pain came on quickly
- ✓ The casualty has had chest pain for more than 10 minutes and is short of breath and sweating
- ✓ The casualty is experiencing pain in the chest that is spreading down the arms. They also feels weak and dizzy

Assessment – it is possible the person has suffered a heart attack. Get professional medical help immediately. Call for an ambulance if the casualty becomes worse, stop your assessment and treat the life-threatening condition. While waiting for help to arrive, you should:

- ✓ Give whatever first aid to the casualty you can
- ✓ Keep watching the casualty to see if their condition changes and record those changes. This could relate to changes to respiration, heart beats or level of consciousness
- ✓ Re-assure them they are going to be alright

APPLY BASIC FIRST AID TECHNIQUES

First aid in the injured is generally consists of a series of simple and in some cases, potentially life-saving procedures that an individual can be trained to perform with minimal equipment.

In fact, certain self-limiting illnesses or minor injuries may not require further medical care past the first aid intervention, but in other cases, first aid is only the first step in the treatment of injured persons.

The key aims of first aid in the injured can be summarized in three key points:

1. **Preserve life:** the overriding aim of all medical care, including first aid, is to save lives and minimise the threat of death.
2. **Prevent further harm:** also, sometimes called prevent the condition from worsening, or danger of further injury. This covers both external factors, such as moving a patient away from any cause of harm, and applying first aid techniques to prevent worsening of the condition, such as applying pressure to stop a bleeding which becomes serious.
3. **Promote recovery:** first aid also involves trying to start the recovery process from the injury, and in some cases might involve completing a treatment, such as in the case of applying a plaster to a small wound.

Key skills of first aid

Certain skills are considered essential to the provision of first aid to injured persons and apply before all others if indicated. Particularly the "**ABC**" of first aid, which focus on critical life- saving intervention, must be rendered before treatment of less serious injuries. ABC stands for *Airway, Breathing, and Circulation*.

Obstruction (choking) is a life-threatening emergency. For these reasons, when we get to the injured, care must first be brought to the his or her **airway (A)** to ensure it is clear. Following evaluation of the airway, a first aid attendant would determine adequacy of **breathing (B)** and provide rescue breathing if necessary.

Assessment of **circulation (C)** is now not usually carried out for patients who are not breathing. First aiders must conclude indirectly that unconscious patients, without breathing have no circulation and go straight to chest compressions. Pulse checks may be done on less serious patients. Once the ABCs are secured, first aiders can begin additional treatments, as required.

First aid for wounds

A wound is any type of injury to the skin. In general, wounds can be classified as closed (where the skin stays intact) or open.

In open wounds, the skin is cracked open, leaving the underlying tissue exposed to the outside environment, which makes it more vulnerable to bleeding and infections.



In closed wounds, the skin is intact and the underlying tissue is not directly exposed to the outside world. Even with the skin intact, the damage can reach down to the underlying muscle, internal organs and bones. That is why these kinds of wounds can be complicated by severe bleeding, large bruises, nerve damage, bone fractures and internal organ damage.

Open wounds can be classified according to the object that caused the wound. The types of open wounds are:

- ✓ Incisions or incised wounds, caused by a clean, sharp-edged object such as a knife, razor, or glass splinter
- ✓ Lacerations, irregular tear-like wounds caused by some blunt trauma
- ✓ Abrasions, superficial wounds in which the topmost layer of the skin (the epidermis) is scraped off. Abrasions are often caused by a sliding fall onto a rough surface
- ✓ Avulsions, injuries in which a body structure is forcibly detached from its normal point of insertion.
- ✓ Puncture wounds, caused by an object puncturing the skin, such as a splinter, nail or needle.
- ✓ Penetrating wounds, caused by an object such as a knife entering and coming out from the skin.

The types of **closed wounds** are:

- ✓ Contusions, more commonly known as bruises, caused by a blunt force trauma that damages tissue under the skin.
- ✓ Hematomas, also called a blood tumor, caused by damage to a blood vessel that in turn causes blood to collect under the skin.

Crush injury is an injury that occurs because of pressure from a heavy object onto a body part or from squeezing of a body part between two objects. Depending upon their severity, crush injuries can be complicated by bleeding, bruising, broken bones, open wounds or so-called compartment syndrome. Compartment syndrome usually results from extreme swelling after an injury. The dangerously high pressure in the field of injury impedes the flow of blood to the affected tissues. Severe tissue damage can result, with loss of body

The following measures need to be taken in giving first aid to a victim of an open wound:

1. Stop the bleeding
2. Minor cuts and scrapes usually stop bleeding on their own.
Hematoma,
3. If they don't, apply gentle pressure with a clean cloth or bandage. Hold the pressure continuously for 20 to 30 minutes and if possible, elevate the wound.



4. Clean the wound
5. Rinse out the wound with clear water. Soap can irritate the wound, so try to keep it out of the actual wound. If dirt or debris remains in the wound after washing, use tweezers cleaned with alcohol to remove the particles.
To clean the area around the wound, use soap and a washcloth.



6. Cover the wound
7. If the bleeding slows, cover the wound with a clean dressing and bandage.

Dressings and bandages can help keep the wound clean and keep harmful bacteria out. A dressing is a sterile pad or compress (usually made of gauze or cotton wrapped in gauze) used to cover wounds, to control bleeding and/or prevent further contamination. A dressing should be large enough to totally cover the wound, with a safety margin of about 2.5 cm on all sides beyond the wound. A bandage is used to secure a dressing in place and to apply pressure to bleeding wounds.



8. The following measures need to be taken in giving first aid to a victim of a closed wound:
9. Application of direct pressure, preferably with ice wrapped in a cloth, for several minutes, in order to arrest the bleeding as well as to reduce the swelling.
10. Elevation of the affected region will also support in reducing the pressure as well as the re-absorption process and it should be practiced as and when appropriate.



When to seek help from health professional:

- ✓ If the wound is in the head, chest or abdomen
- ✓ (unless it is minor).
- ✓ If there is blue, white or cold skin, numbness, tingling, loss of feeling, or the person is unable to move a limb below the wound.
- ✓ If your tetanus shots are not up to date, especially if the object that caused the puncture was dirty, such as a rusty nail or farm implement.
- ✓ If a deep wound to the foot occurred through a shoe.
- ✓ If an animal bite is severe and may need stitches, or if it is on the hand or face.
- ✓ If you are unable to remove an object from the wound.
- ✓ If signs of infection develop – increased pain, swelling, redness, tenderness – heat or red streaks extending from the wound – discharge of pus – fever of 38 °C with no other cause.

First aid for bleeding

Bleeding is the loss of blood escaping from the circulatory system. It arises due to either traumatic injury, underlying medical condition, or a combination and can occur *internally*, where blood leaks from blood vessels inside the body, or *externally*, either through a natural opening such as the mouth, nose, ear, urethra, vagina or anus, or through a break in the skin.

External bleeding is generally described in terms of the origin of the blood flow by vessel type. The basic categories of external bleeding are:

1. **Arterial bleeding:** As the name suggests, blood flow originating in an artery. With this type of bleeding, the blood is typically bright red to yellowish in color, due to the high degree of oxygenation. Blood typically exits the wound in spurts, rather than in a steady flow. The amount of blood loss can be copious, and can occur very rapidly.
2. **Venous bleeding:** This blood is flowing from a damaged vein. As a result, it will be blackish in colour (due to the lack of oxygen being transported) and will flow in a steady manner. Caution is still indicated; while the blood loss may not be arterial, it can still be quite substantial, and can occur with surprising speed without intervention.
3. **Capillary bleeding:** Capillary bleeding usually occurs in superficial wounds, such as abrasions. The colour of the blood may vary somewhat (distal portion of circulation with oxygenated and unoxygenated blood mixing), and will generally ooze in small amounts, as opposed to flowing or spurting.



Internal Bleeding is one of the most serious consequences of trauma. It may occur after any significant physical injury. There are two main types of trauma, and either may cause internal bleeding:

1. **Blunt trauma** - This kind of trauma happens when a body part collides with something else, usually at high speed. Blood vessels inside the body are torn or crushed either by shear forces or a blunt object. Examples are car accidents, physical assaults, and most falls.
2. **Penetrating trauma** - This happens when a foreign object penetrates the body, tearing a hole in one or more blood vessels. Examples are gunshot wounds, stabbings, or falling onto a sharp object.

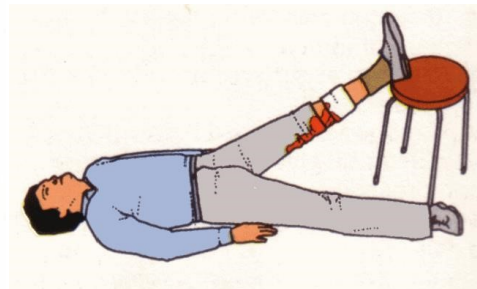
Almost any organ or blood vessel can be damaged by trauma and cause internal bleeding. The most serious sources of internal bleeding due to trauma are:

- ✓ Head trauma with internal bleeding (intracranial hemorrhage)
- ✓ Bleeding around the lungs (hemothorax)
- ✓ Bleeding around the heart (hemopericardium and cardiac tamponade)
- ✓ Tears in the large blood vessels near the center of the body (aorta, superior and inferior vena cava, and their major branches)
- ✓ Damage caused by trauma to the abdomen such as liver or spleen lacerations or perforation of other soft organs

Any of these signs of internal bleeding after a trauma should be treated as a medical emergency. The injured person needs to be evaluated in a hospital emergency room.

The following measures need to be taken in giving first aid to a victim of external bleeding:

1. Wash your hands to avoid infection and put on gloves
2. Lay on the injured person down and cover the person to prevent loss of body heat.
3. If possible, position the person's head slightly lower than the trunk or elevate the legs and elevate the site of bleeding
4. While wearing gloves, remove any obvious dirt or debris from the wound.
5. Don't remove any large or more deeply embedded objects. Your principal concern is to stop the bleeding.



Apply pressure directly on the wound until the bleeding stops

- ✓ Use a sterile bandage or clean cloth and hold continuous pressure for at least 20 minutes without looking to see if the bleeding has stopped.
- ✓ Maintain pressure by binding the wound tightly with a bandage or clean cloth and adhesive tape.
- ✓ Use your hands if nothing else is available.

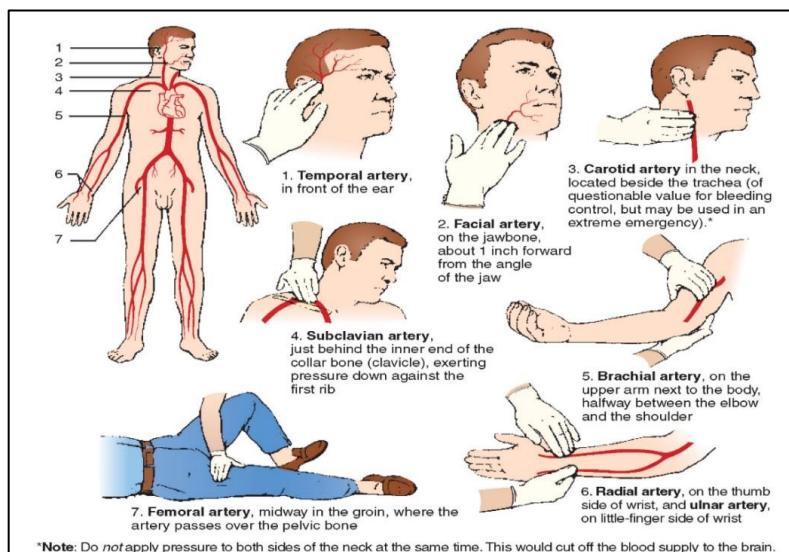


- ✓ If the bleeding continues and seeps through the gauze or other material you are holding on the wound, don't remove it. Instead, add more absorbent material on top of it



1. Squeeze a main artery if necessary

1. If the bleeding doesn't stop with direct pressure, apply pressure to the artery Delivering blood to the area.
2. Squeeze the main artery in these areas against the bone. Keep your fingers flat.
3. With your other hand, continue to exert pressure on the wound itself.



2. Immobilize the injured body part once the bleeding has stopped

1. Leave the bandages in place and get the injured person to the emergency room as soon as possible.
3. If continuous pressure hasn't stopped the bleeding and bleeding is extremely severe, a tourniquet may be used until medical help arrives or bleeding is controllable

1. It should be applied to the limb between the bleeding site and the heart and tightened so bleeding can be controlled by applying direct pressure over the wound.
2. To make a tourniquet, use bandages 5 -10 cm (2 to 4 inches) wide and wrap them around the limb several times. Tie a knot, leaving loose ends long enough to tie another knot. A stick should be placed between the two knots. Twist the stick until the bandage is tight enough to stop the bleeding and then secure it in place.
3. Check the tourniquet every 10 to 15 minutes. If the bleeding becomes controllable, (manageable by applying direct pressure), release the tourniquet.



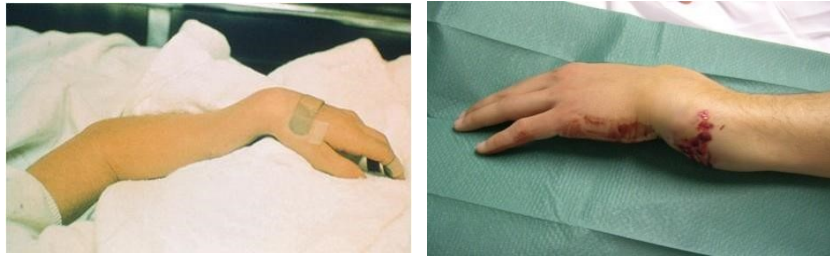
First aid for bone and joint injuries

Injuries of bones and joints can be bone fractures or dislocations and sprains of joints. A **fracture** is the medical term for a broken bone. There are many types of fractures, but the main categories are open, and closed.

- ✓ A closed fracture is when the bone breaks but there is no puncture or open wound in the skin.
- ✓ An open fracture is one in which the bone breaks through the skin. This is an important difference from a closed fracture because with an open fracture there is a risk of a deep bone infection.

The severity of a fracture depends upon its location and the damage done to the bone and tissue near it. Serious *Closed and open fracture* fractures can lead to serious complications if not treated promptly. Possible complications include damage to blood vessels or nerves and infection of the bone (osteomyelitis) or surrounding tissue.

Fractures can be identified by symptoms that can be represented by the acronym DOTS: **D** for deformity, **O** for open wounds, **T** for tenderness and **S** for swelling



Symptoms of a broken arm

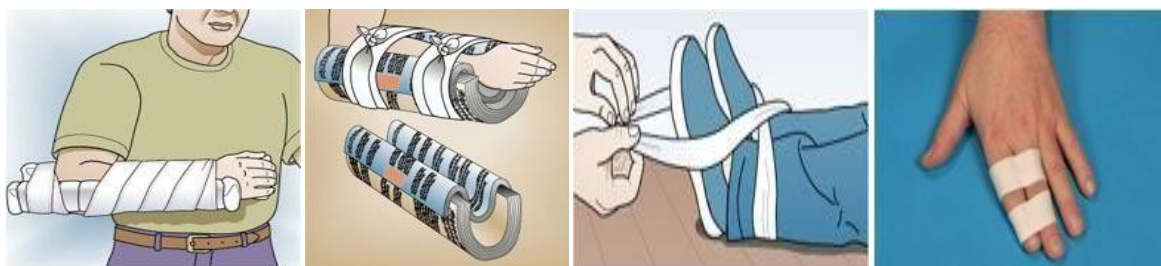
The following measures need to be taken in giving first aid to a victim with bone injury:

- ✓ Don't move the person except if necessary to avoid further injury. Take these actions immediately while waiting for medical help:
- ✓ Stop any bleeding
- ✓ Apply pressure to the wound with a sterile bandage, a clean cloth or a clean piece of clothing.

Immobilize the injured area

- ✓ Don't try to realign the bone or push a bone that's sticking out back in.
- ✓ If you've been trained in how to splint and professional help isn't readily available, apply a splint to the area above and below the fracture sites.

Splinting reduces pain, prevents further damage to muscles, nerves and blood vessels, prevents closed fracture from becoming open fracture and reduces bleeding and swelling. In an emergency, almost any firm object or material can serve as a splint such as sticks, boards, or even rolled up newspapers. If none can be found, use a rolled blanket or clothing. An injured body part can also be taped to an uninjured body part in order to prevent it from moving. For example, you can tape an injured finger to the finger next to it, or fractured leg to uninjured leg to keep it immobile (self-splint or anatomic splint).

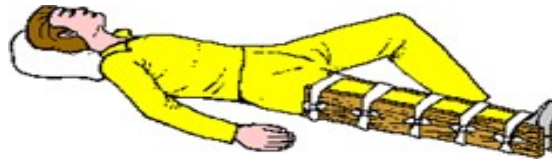


Improvise materials and techniques for splinting

Splint must be well padded on the sides touching the body; if they are not properly padded, they will not fit well and will not adequately immobilize the injured part. Before applying splint open wounds must be covered. We have to immobilize in position found.

A basic rule of splinting is that the joint above and below the broken bone should

be immobilized to protect the fracture site. For example, if the lower leg is broken, the splint should immobilize both the ankle and the knee.



Splinting of the lower leg

Fasten splints in place with bandages, strips of adhesive tape, clothing, or other suitable materials

- ✓ Use opposite arm to measure length of splint !
- ✓ If possible, one person should hold the splints in position while another person fastens them.



Although splints should be applied snugly, they should never be tight enough to interfere with the circulation of the blood.

- ✓ When you are applying splints to an arm or a leg, try to leave the fingers or toes exposed
- ✓ If the tips of the fingers or toes become blue or cold, you will know that the splints or bandages are too tight.



You should examine a splinted part approximately every half hour and loosen the fastenings if the circulation appears to be impaired. Remember that any injured part is likely to swell, and splints or bandages that are otherwise applied correctly may later become too tight.

Apply ice packs to limit swelling and help relieve pain until emergency personnel arrive.

- ✓ Don't apply ice directly to the skin — wrap the ice in a towel, piece of cloth or some other material



Treat for shock

- ✓ If the person feels faint or is breathing in short, rapid breaths, lay the person down with the head slightly lower than the trunk and, if possible, elevate the legs.

Injuries of joints can be dislocations or sprains of joints.

A **dislocation** is an injury in which the ends of bones are forced from their normal positions. The cause is usually trauma resulting from a fall, an auto accident or a collision during contact or high-speed sports.

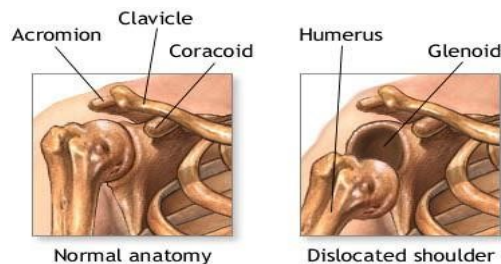


Figure 22. Normal and dislocated shoulder

A dislocation is likely to bruise or tear the muscles, ligaments, blood vessels, tendons, and nerves near a joint.

Rapid swelling and discoloration, loss of ability to use the joint, severe pain and muscle spasms, possible numbness and loss of pulse below the joint, and shock are characteristic symptoms of dislocations. The fact that the injured part is usually stiff and immobile, with marked deformation at the joint, will help you distinguish a dislocation from a fracture. In a fracture, there is deformity between joints rather than at joints, and there is generally a wobbly motion of the broken bone at the point of fracture.

A **sprain** is a stretching or tearing of ligaments — the tough bands of fibrous tissue that connect one bone to another in your joints. The most common location for a sprain is in ankle. Signs and symptoms will vary, depending on the

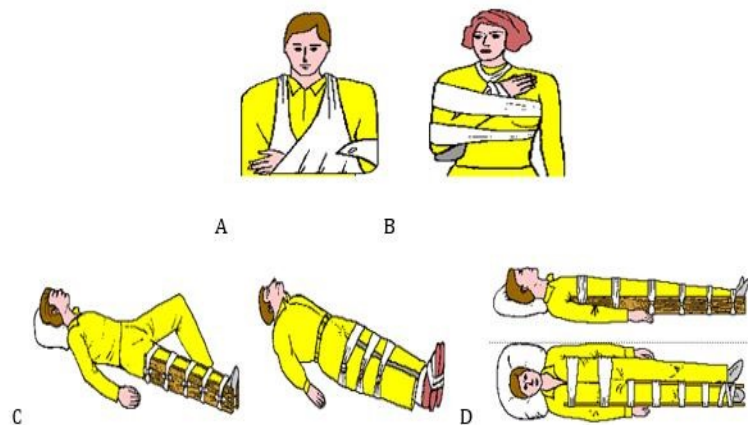
severity of the injury but pain and swelling are the main symptoms.

The following measures need to be taken in giving first aid to a victim with joint injury:

1. For dislocations, splint and provide care as you would for fracture.
2. For sprains, use RICE procedure - R=rest, I=Ice, S=compression and E=elevation



In both cases seek medical care (Referral).



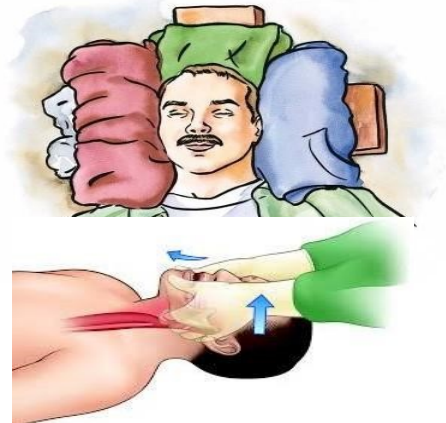
First aid for back and neck injury (spinal cord injury)

Any severe blow, fall, or other accident may result in injury to the neck, back, or spinal cord. Spinal cord injuries can cause long-term, irreversible damage and death. Symptoms can be loss of sensation, loss of motor functions (paralysis), loss of bowel/bladder functions, loss of involuntary functions like breathing, inability to control rate of heart beat, inability to sweat

The following measures need to be taken in giving first aid to a victim with suspected spinal cord injury:

1. Seek medical assistance immediately. Call for EMS (112) Until EMS arrives:

- DO NOT move victim unless absolutely necessary to save victim's life.
- DO NOT bend or twist victim's neck or body. Careful handling is extremely important.
- Maintain position in which victim was found and immobilize head, neck, shoulders, and torso - roll up towels, blankets, jackets, or clothing, and place around head, neck, shoulders, and torso



2. If the person is not breathing or showing signs of circulation, begin CPR but do not lift the chin to open an airway. Instead, you should gently pull the jaw forward
3. If victim must be moved to perform rescue breathing, to clean mouth of vomit or in danger of further injury, enlist help at least one other person to keep victim's head, torso, and legs in straight line as you turn victim.



First aid for burns





Burns are thermal injury caused by exposure to excess heat. According to the depth of injury to the skin, we distinguish three (or four) types of burns:

1. Burns that affect only the superficial skin are known as superficial or first-degree burns.
2. When damage penetrates into some of the underlying layers, it is a partial-thickness or second-degree burn.

3. In a full-thickness or third-degree burn, the injury extends to all layers of the skin.

Sometimes we talk about a fourth-degree burns when the injury affects deeper tissues, such as muscle or bone.

Symptoms and sign of various types of burns

Type	Layers involved	Appearance	Texture	Sensation	Healing Time	Prognosis	Example
Superficial (First degree)	Epidermis	Red without blisters	Dry	Painful	5–10 days	Heals well, Repeated sunburns increase the risk of skin cancer later in life!	
Superficial partial thickness (Second degree)	Extends into superficial (papillary) dermis	Redness with clear blister. Blanching with pressure.	Moist	Very painful	less than 2–3 weeks	Local infection/cellulitis but no scarring typically	
Deep partial thickness (Second degree)	Extends into deep (reticular) dermis	Yellow or white. Less blanching. May be blistering.	Fairly dry	Pressure and discomfort	3–8 weeks	Scarring, contractures (may require excision and skin grafting)	
Full thickness (Third degree)	Extends through entire dermis	Stiff and white/brown. No blanching	Leathery	Painless	Prolonged (months) and incomplete	Scarring, contractures, amputation (early excision recommended)	
Fourth degree	Extends through entire skin, and into underlying fat, muscle and bone	Black; charred with eschar	Dry	Painless	Requires excision	Amputation, significant functional impairment and, in some cases, death.	

To distinguish a minor burn from a serious burn, the first step is to determine the extent of damage to body tissues. In order to determine the need for referral to a specialized burn unit, the American Burn Association devised a classification system. Under this system, burns can be classified as major, moderate and minor. This is assessed based on a number of factors, including total body surface area affected, the involvement of specific anatomical zones, the age of the person, and associated injuries. Minor burns can typically be managed at home, moderate burns are often managed in hospital, and major burns are managed by a burn center!

American Burn Association severity classification

American Burn Association severity classification		
Minor	Moderate	Major
Adult <10% TBSA	Adult 10-20% TBSA	Adult >20% TBSA
Young or old < 5% TBSA	Young or old 5-10% TBSA	Young or old >10% TBSA
<2% full thickness burn	2-5% full thickness burn	>5% full thickness burn
	High voltage injury	High voltage burn
	Possible inhalation injury	Known inhalation injury
	Circumferential burn	Significant burn to face, joints, hands or feet
	Other health problems	Associated injuries

For minor burns, including first-degree burns and second-degree burns limited to an area no larger than 8 centimetres in diameter, take the following action:

1. Cool the burn.
 - ✓ Hold the burned area under cool (not cold) running water for 10 or 15 minutes or until the pain subsides.
 - ✓ If this is impractical, immerse the burn in cool water or cool it with cold compresses.
 - ✓ Don't put ice on the burn
2. Cover the burn with a sterile gauze bandage
 - ✓ Wrap the gauze loosely to avoid putting pressure on burned skin.
 - ✓ Bandaging keeps air off the burn, reduces pain and protects blistered skin.
3. Take an over-the-counter pain reliever

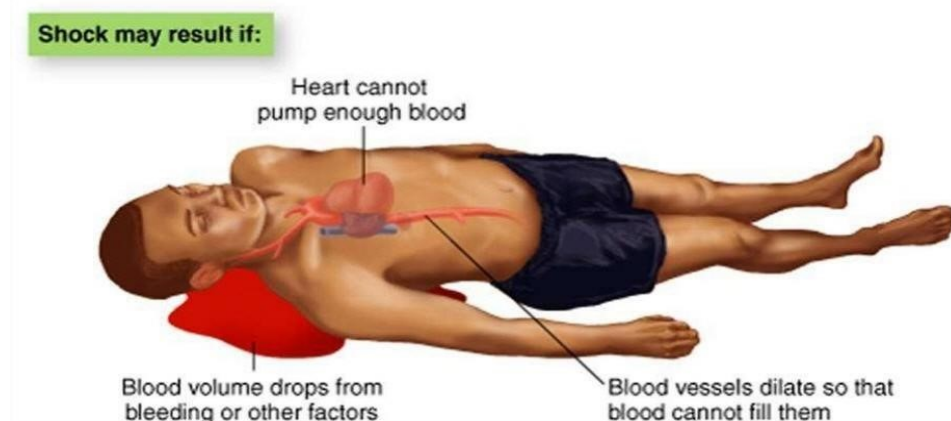
- ✓ These include aspirin, ibuprofen , naproxen or acetaminophen ➤ Use caution when giving aspirin to children or teenagers. ➤ Talk to your doctor if you have concerns.

For major burns, call 112 or emergency medical help. Until an emergency unit arrives, follow these steps:

1. Don't remove burned clothing.
- ✓ However, do make sure the victim is no longer in contact with smoldering materials or exposed to smoke or heat.
2. Don't immerse large severe burns in cold water
- ✓ Doing so could cause a drop in body temperature (hypothermia) and deterioration of blood pressure and circulation (shock).
3. Check for signs of circulation (breathing, coughing or movement).
- ✓ If there is no breathing or other sign of circulation, begin CPR.
4. Elevate the burned body part or parts.
- ✓ Raise above heart level, when possible.
5. Cover the area of the burn
- ✓ Use a cool, moist, sterile bandage, clean, moist cloth or moist cloth towels

First aid for shocked

Shock may result from trauma, blood loss, an allergic reaction, severe infection, poisoning, severe burns or other causes.



When a person is in shock, his or her organs aren't getting enough blood or oxygen. If untreated, this can lead to permanent organ damage or death. Shock can be a life- threatening problem. The best way to protect people from the serious damages that shock can have on the system is to recognize the symptoms before the person gets into serious trouble.

In most cases, only a few of the symptoms will be present, and many do not appear for some time. Common symptoms are:

- ✓ Pale, cold, clammy and moist skin
- ✓ Vacant or dull eyes, dilated pupils
- ✓ Anxiety, restlessness, and fainting
- ✓ Weak, rapid, or absent pulse
- ✓ Nausea and vomiting
- ✓ Shallow, rapid, and irregular breathing
- ✓ Excessive thirst
- ✓ Person may seem confused
- ✓ Look tired and fatigue

If you suspect shock, even if the person seems normal after an injury:

1. Call 112 or your local emergency number.
2. Have the person lie down on his or her back with feet higher than the head. If raising the legs will cause pain or further injury, keep him or her flat.
3. Check for signs of circulation (breathing, coughing or movement) and if absent, begin CPR.
4. Keep the person warm and comfortable by loosening any belts or tight clothing and covering the person with a blanket. Even if the person complains of thirst, give nothing by mouth.
5. Turn the person on his or her side to prevent choking if the person vomits or bleeds from the mouth.
6. Seek treatment for injuries, such as bleeding or broken bones.

MONITOR THE SITUATION

Call 911 instead of trying to take an injured or ill person to the hospital yourself. It seems like waiting for an ambulance will make it take longer to get help, but ambulance crews can start providing care as soon as they arrive. They can get the patient to hospital quickly, legally, and more safely.

1. Stay on the line with 911 and follow emergency instructions.
2. Stay calm and try to keep the patient calm.
3. Don't move a patient who was injured in an automobile accident or fall, or who was found unconscious.
4. If the patient is cold, cover them with a blanket.
5. Don't give an injured person anything to eat or drink (unless instructed by the 911 dispatcher).
6. Have someone watch for the ambulance and show the crew how to get to the patient. (This is especially important in an apartment or office building, or if your address is hard to see from the street).

PREPARE REQUIRED DOCUMENTATION

These efforts need to be kept parallel with documentation or in other words with systematic incident reports related to the various incidents occurring while the worker is on duty. Such reports will help the team or the organization with the

following:

1. Incidents Reports will maintain alertness among all the stakeholders
Most incident report forms identify the barriers that prevent adverse situations from developing into a major accident or disaster. Recording of the small to medium events will ensure major stakeholders of the organization is kept alert and hence reduce number of accidents or injuries to guests as well as to the staff of the organization.
2. Lessons learned within the organisation and benchmarks between industries
3. The gathered data can be used for comparisons both within and between organisations and industries. Even though the incident categories and types differ between industries, verticals and even functions, the habit of being aware in the field and documenting the observations is the same.
4. Reporting is cheaper than the costs of a major incident
5. The average cost of occupational accident ranges from thousands to tens of thousands of euros between industries and countries. Thus, even in a global organisation that has tens of thousands of employees and service-providers, the cost of maintaining the incident reporting program and/or software is many times cheaper than the cost of accidents or major incident.
6. Incident reporting is a key habit that creates culture
Each organisational culture is a set of habits, values, thoughts and beliefs. In organization level development areas such as health, safety, quality and environment, the habits are the keystones that affect the culture the most. If you want to create safety culture, start collecting safety observations. If you want to create culture of quality improvement, start collecting quality observations. If you want to raise environmental awareness, start collecting environmental observations.

UNIT 06

RESPOND TO FIRE

This unit covers the competency required to carry out initial response to suppress a fire.

It also includes the ability to identify the nature and classification of the fire, report the fire and carry out evacuation procedures.

PREPARE FOR FIRE

What is a fire?

Essentially, fire is very rapid oxidation. Rusting iron and rotting wood are common examples of slow oxidation. Fire, or combustion, is rapid oxidation as the burning substance combines with oxygen at a very high rate. Energy is given off in the form of heat and light. Because this energy production is so rapid, we can feel the heat and see the light as flames.

How fire happens

All matter exists in one of three states: solid, liquid or gas (vapour). The atoms or molecules of a solid are packed closely together, and those of a liquid are packed loosely. The molecules of a vapour are not really packed together at all and are free to move about.

In order for a substance to oxidise, its molecules must be well surrounded by oxygen molecules. The molecules of solids and liquids are packed too tightly for this to happen, and therefore only vapours can burn.

When a solid or liquid is heated, its molecules move about rapidly. If enough heat is applied, some molecules break away from the surface to form a vapour just above the surface. This vapour can now mix with oxygen. If there is enough heat to raise the vapour to its ignition temperature, and if there is enough oxygen present, the vapour will oxidise rapidly and it will start to burn.

What we call burning is the rapid oxidation of millions of vapour molecules. The molecules oxidise by breaking apart into individual atoms and recombining with oxygen into new molecules. It is during the breaking recombining process that energy is released as heat and light. The heat that is released is radiant heat, which is pure energy. It is the same sort of energy that the sun radiates and that we feel as heat. It radiates (travels) in all directions. Therefore, part of it moves back to the seat of the fire, to the 'burning' solid or liquid (the fuel). The heat that radiates back to the fuel is called radiation feedback.

Part of this heat releases more vapour, and part of it raises the vapour to the ignition temperature. At the same time, air is drawn into the area where the flames and vapour meet. The result is that there is an increase in flames as the newly formed vapour begins to burn.



Common Causes of Workplace Fires

Following are common causes of fire.

1. **Faulty Electrics** are a very common cause of workplace fires and include loose wires and antiquated or faulty equipment. Every employer needs to ensure that fixed electrical equipment is maintained on a regular basis.

2. **Flammable or combustible materials** represent a danger to your staff and your business. Every company should prioritize fire safety when undertaking risk assessments, and this is crucial in premises that hold any flammable or combustible materials or substances that must be stored appropriately stored and disposed of correctly. All staff should attend a fire safety training course to ensure correct procedure.
3. **Human Error** represents a common cause of fires in the workplace, be it the incorrect use of electrical equipment, burning food or leaving cooking unattended in the staff kitchen as well as lack of proper care or knowledge of procedures around flammable or combustible liquids and materials. Fire safety training is invaluable to avoid this.
4. **Negligence** may not seem a great deal different from human error but tends to be the result of sloppy or careless behaviour, or not following rules, regulation or correct procedures, from staff who should probably know better. Examples include the blocking or covering of machinery and equipment which requires venting thus causing overheating, not correctly disposing of cigarette ends, incorrectly storing flammable items – even paper – and overloading plug sockets. Again, robust fire training is imperative.
5. **Arson** is a common cause of fire around business premises, which can be particularly prone to vandalism. Such fires can rapidly spread if there are no proper fire control systems. If suitable, work places should install fire shutters and sprinkler systems to protect their property as far as possible; and deterrents such as CCTV and gating can deter potential vandals.

The fire triangle

The three things that are needed for combustion to take place are:

- ✓ fuel (to vaporize and burn)
- ✓ oxygen (to combine with fuel vapour)
- ✓ heat (to raise the temperature of the fuel vapour to its ignition temperature).

The fire triangle shows us that fire cannot exist without all three together:

- ✓ if any side of the fire triangle is missing, a fire cannot start
- ✓ if any side of the fire triangle is removed, the fire will go out

The fire triangle (which is also known as the combustion triangle) is a simple model for understanding the chemical reaction which must occur to create a fire. It is composed of three elements – fuel, heat and oxygen – which must all be present for a fire to ignite. It also demonstrates the interdependence of these ingredients in creating and sustaining a fire and teaches us that removing any



one of these elements would prevent or extinguish the fire.

Classes of fire

Classes of fire Combustible and flammable fuels have been broken down into five categories:

6. **Class A** fires are those involving organic solids such as paper or wood
7. **Class B** fires are those involving flammable liquids
8. **Class C** fires are those involving flammable gases
9. **Class D** fires are those involving metals
10. **Class F** fires are those involving cooking oils

Prevention of Fire

Fires can spread rapidly and once established, even a small fire can generate sufficient heat energy to spread and accelerate the fire to surrounding combustible materials. Fire prevention is largely a matter of common-sense and good housekeeping. For example, keep the workplace clean and tidy and remain conscious of possible fire happening at any time. Following activities need to be continuously performed in preventing fires from occurring in addition to having properly working fire safety systems to deal with a fire incident.

1. Risk Assessment

The first step in fire prevention is to assess the risks and record them in a risk register.⁷ This requires reviewing and assessing the means by which a fire might start and spread, the potential consequences and the available approaches to mitigate the risk. This includes assessing day-to-day operations, risks associated with periodic building and maintenance work and those arising from installing new equipment, or adopting new or changing technologies.

2. Fire prevention

Set out below are the principal actions that need to be taken to monitor the behaviour of workers and prevent fires from occurring:

Smoking is one of the greatest fire risks and it should be prohibited in all buildings and workplaces. Where there is no legal prohibition, smoking should only be allowed in designated smoking areas and fire-safe ashtrays and bins should be provided.

- ✓ Enforce good housekeeping practices; this includes implementing routines for the regular removal and disposal of waste.
- ✓ Establish and maintain out-of-hours inspection and security procedures, including means of preventing arson.
- ✓ Carry out routine checks, inspections, and tests, including monitoring the maintenance of heat generating equipment that could cause fires, chafing of cables, self-heating of cables due to electrical resistance and checks on fuel supplies and storage

- ✓ Issue and control work permit and associated procedures.
- ✓ Instruct and supervise contractors and subcontractors carrying out construction and maintenance operations within the building.
- ✓ Avoid conditions leading to gas and dust explosion hazards.
- ✓ Maintain integration with other systems (e.g. ventilation, communications).

3. Undertake regular fire risk assessment

The responsible person must ensure that a suitable and sufficient fire risk assessment of the premises is completed and reviewed on a regular basis.

A fire risk assessment is an organised and methodical look at the premises, the activities carried on there and the likelihood that a fire could start and cause harm to those in and around the premises. There is no set format or approach but a template is provided that may assist establishments in completing a fire risk assessment.

Where establishments feel that they do not have the necessary competency to complete a fire risk assessment they should seek the assistance of a competent person.

4. Follow fire precautions at all times

In the event of a fire occurring, there should be suitable measures in place to detect a fire, give warning of fire and that mitigate the spread of smoke and fire.

- ✓ Fire detection and warning systems should be installed
- ✓ Emergency lighting should be installed
- ✓ Firefighting equipment (fire extinguishers) should be installed
- ✓ Fire signs, notices and plans should be fitted
- ✓ Fire doors should be fitted in accordance with good practice and well maintained

5. Evaluate and ensure means of escape

The ability of the occupants of a building to evacuate in the case of fire is a fundamental aspect of fire safety. In the case of a fire, or indeed any other emergency, people should be able to turn away from the hazard and escape to the open air or other place of safety. Escape routes should be inspected regularly to check they are not obstructed and that fire exit doors are unlocked.

6. Undertake regular fire emergency planning

When a fire situation is detected, it is vital that establishments have in place appropriate procedures. All establishments need to prepare a fire emergency plan under the guidance of experts.

It is vital that the emergency plan is tested so as to ensure that all staff are aware of the procedures to be followed in the event of a fire. This can be achieved by undertaking a desktop exercise and also by completing regular fire drills (at least once every half-term).

7. Undertake regular training and sharing of information

To keep the staff up-to-date with prevention of fire, it is important that regular training and sharing of information is continued within every workplace. All members of staff should receive instruction and training appropriate to their responsibilities. This training should:

- ✓ take account of the findings of the fire risk assessment
- ✓ explain the emergency procedures
- ✓ take account of the work activities and explain the duties and responsibilities of staff
- ✓ take place during normal working hours and be repeated periodically where appropriate
- ✓ be easily understood by staff and other people who may be present ✓ be tested by fire drills

8. Maintain record Keeping or Log Books

To prepare well, it is important that appropriate records are kept in a specified log book or file and the records need to be checked for accuracy. In particular, the log book need to include the following.

- ✓ Details of any significant findings from the fire risk assessment and any action taken
- ✓ Testing and checking of escape routes, including final exit locking mechanisms, such as panic devices, emergency exit devices and any electromagnetic devices;
- ✓ Testing of fire-warning systems, including weekly alarm tests and periodic maintenance by a competent person; recording of false alarms;
- ✓ Testing and maintenance of emergency lighting systems;
- ✓ Testing and maintenance of fire extinguishers, hose reels and fire blankets
- ✓ Recording and training of relevant people and fire evacuation drills;
- ✓ Maintenance and audit of any systems that are provided to help the fire and rescue service
- ✓ The fire emergency plan

CARRY OUT NOTIFICATION AND ASSESSMENT

Whether big or small, staff within every workplace to be competent to undertake assessment related to possible fires and handle notification of any such possibilities to his/her superiors on a timely manner to avoid fire related incidents across workplaces.

Continuous Assessment and Maintenance

All fire related equipment and the workplace sites which may pose as fire hazards must be continuously assessed and repaired or maintained in accordance with regulatory requirements and good practice.

1. **Portable Fire Fighting Equipment:** All portable firefighting equipment has to be checked by a competent person on an annual basis (e.g. extinguishers, fire blankets and hoses).
2. **Fire Detection and Warning Systems (alarms):** Fire alarm tests need to be carried out in accordance with requirements. This requires weekly tests of the audible fire alarm system, quarterly and annual tests of all devices such as heat and smoke detectors, call points and sounders should also be carried out by a competent contractor.
3. **Emergency Lighting:** Emergency lighting should be tested by facility maintenance team on a regular basis to ensure the workplace is lit during emergency situations such as fire.
4. **Evacuation Paths:** Every workplace needs to have proper pathways worked out and displayed to the staff in the event of fire. Referred pathways and doors and need to be checked on regular basis to prevent fatalities and reduce damage to the staff in case of fire.

Following sections details the above parameters to ensure all staff is equipped with adequate knowledge and skills to undertake assessment and maintenance to carrying out initial notification of fire besides continuous assessment and maintenance of fire equipment,

Portable Fire-fighting equipment

Normally available fire-fighting equipment includes portable appliances such as extinguishers, buckets of sand or water and fire-resistant blankets. In larger premises you will find automatic sprinklers, hose reels and hydrant systems.

Portable Firefighting Equipment

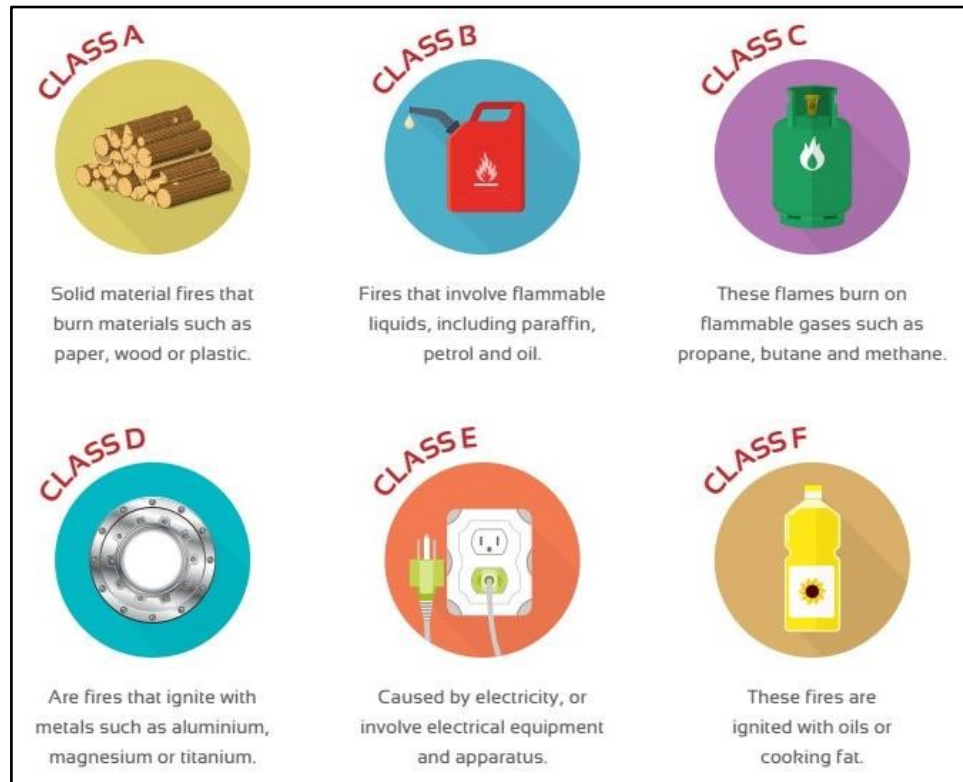


Fire extinguishers

There are many types of fire extinguisher, each with a specific set of situations in which they may or may not be used. In particular, different fire extinguishers are

used to manage different classes of fire and the various fire classes are detailed below.

Different classes of fire



Selection of fire extinguisher

Selection of the fire extinguisher need to be carefully done based on the class of fire identified at various points of risk within the workplaces.

There are five main fire extinguisher types and include Water, Foam, Dry Powder, CO₂ and Wet Chemical. To ensure adequate protection and to meet current fire safety regulations, we need to have the right types of fire extinguisher at the premises.

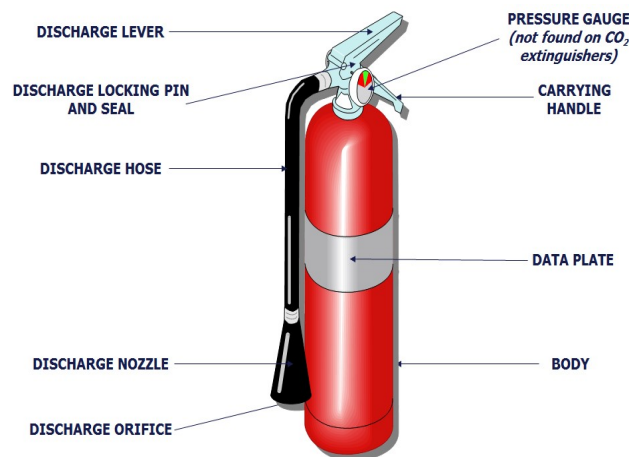
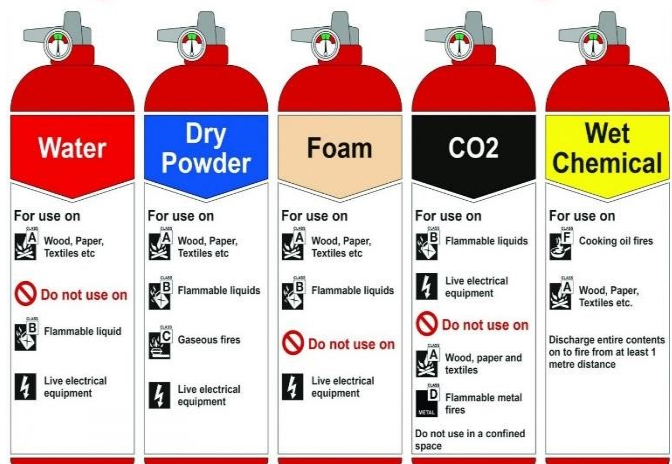
There are different 'classes' of fire, for which each extinguisher is designed to tackle. These classes are based on which fuels a fire starts with. It is the presence of these fuels within your business premises that will help determine which types of fire extinguisher you need and in which locations.

We also need the right type of fire extinguisher; you'll also need the right size and weight of each extinguisher.

Components of fire extinguishers

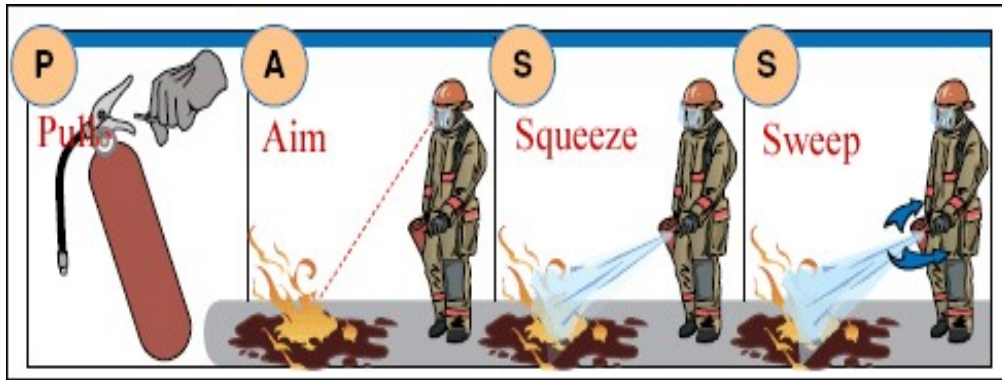
Following are the components of the fire extinguishers.

Using The Correct Fire Extinguisher



Fire extinguisher operation-PASS

Whenever possible, use the buddy system when using a fire extinguisher. If you have doubt about your personal safety or if you cannot extinguish a fire, leave immediately and close the doors (do not lock them). Leave the area, but contact 911 to relay whatever information you have about the fire. Apply the following if you are using the fire extinguisher.



In short, follow the procedures leading to extinguishing fire.

- ✓ Pull the safety pin, this will allow you to discharge the extinguisher.
- ✓ Aim the extinguisher the base of the fire, this will allow you to hit the fuel.
- ✓ S- Squeeze the top handle or lever, this will release the pressurized extinguishing agent.
- ✓ S- Sweep the extinguisher hose from side to side until the fire is completely out.

Wait and carefully check that the fire is out and has not reignited. If it has reignited, spray again – but remember that a typical fire extinguisher usually provides only 60 seconds of extinguishing power.

Fire extinguisher maintenance

Regular inspection and if required, fire extinguishers to be properly maintained at all times.

- ✓ Fire extinguishers should be mounted on the wall to prevent being damaged.
- ✓ The area in front of the extinguisher shall be kept clear at all times.
- ✓ The pressure gauge should be in the green zone at all times.
- ✓ Fire extinguishers should be inspected on a monthly basis.
- ✓ Know the location of all fire extinguishers in your facility.

Protective equipment used

1. Bunker Gear

The common term 'bunker gear' refers to the coat, trousers and coverall elements of the protective ensemble. Other parts of the ensemble include the helmet, hood, boots and gloves.

Bunker gear may not be appropriate PPE for all incidents, considering the potential for heat stress, reduced mobility and added weight.



2. Fire Helmets

Firefighters exposed to the hazards of head injury must wear appropriate PPE, which may include helmets and protective hoods. A fire helmet is not designed to protect personnel from all conditions or hazards. It provides limited protection to the head when worn during structural firefighting activities.



3. Protective Hoods

Protective hoods should be worn whenever there is a risk of injury from heat and/or flame to exposed skin. Helmet liners should be used in addition to protective hoods.



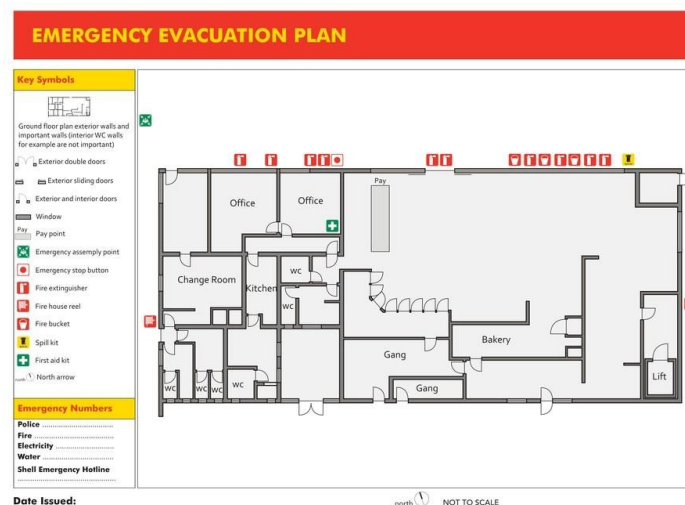
4. Boots and gloves

Fire fighters exposed to the hazard of foot or hand injury must wear protective boots or gloves appropriate the circumstances



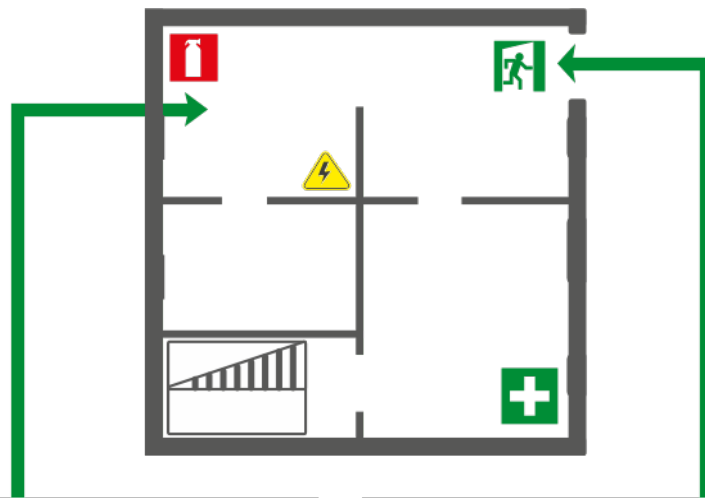
Apply emergency evacuation procedures

Fire represents one of the biggest **workplace safety threats** and can result in **serious injuries** or even **fatalities**. Workplace fires can also cause extensive **property damage**, and can render the worksite either destroyed or out of service indefinitely.



For these reasons, an effective **workplace fire evacuation plan** is important. In this article, we'll cover the workplace safety essentials to plan & create, update and implement thorough and effective workplace fire evacuation plans.

What to Do in Case of Fire in Your Workplace



Basic fire safety you must know for every worksite:

- Know the location of the fire extinguishers in the workplace. You should be aware where the nearest extinguisher is at all times.
- Know where your nearest emergency exits are.
- Know the difference between alarm signals to quickly recognize the situation.

If you discover a fire:

- Alert all other individuals within the workplace by activating the nearest fire alarm, shouting clearly or by using other procedures set in place by your company.
- Use the nearest exit to evacuate the workplace.
- Use a fire extinguisher to put the fire out. Be careful while doing this and do not attempt if yours or others safety is at risk or on large fires.

During evacuation of a worksite:

- Stay calm and evacuate the building immediately when you hear the fire alarm. For more check out our blog on evacuation checklists and procedures.
- Along the escape route, close (don't lock) all the doors and windows you pass by so that you can cut the fire and the smoke off from spreading to the other rooms.
- Go to the assembly point and alert your relevant supervisors that you are safe and outside the building.
- Adhere to any protocols put in place by your company

Fire Drills

Once a fire evacuation plan is created/updated, it's time to put that plan *into practice*. Literally practice, in this case, as your team must practice **fire drills** on a regular basis.

Effective fire drills are an *integral part* of your workplace safety plan.

Fire drills help **save lives** and **protect infrastructure** by getting the whole team on board with fire safety in the workplace.

Be sure to familiarize yourself and your coworkers with your company's fire procedure.

Make sure this information is well known, posted, in manuals and quizzed/tested more than once.

Next, we'll explore some key universal safety procedures and tips for fire safety at your workplace.



Essential Fire Evacuation Safety for Every Worksite

No matter the size, shape or scope of your workplace or job site, there are essential fire evacuation steps to be taken by every team, organization or company.

Know the location of the **fire extinguishers** in the workplace.

Every worker must be aware where the **nearest extinguisher** is *at all times*.

Know where your **nearest emergency exits** are. Know the

difference between **alarm signals** to quickly recognize the situation. Knowing all of these can make all the difference in saving lives and preventing unnecessary damage.



EXTINGUISH FIRE

When fire breaks out, ensure, you undertake the following.

What You & Your Team Must Do When Fire Breaks Out

Catching fire in its earliest stage is *highly important* in both capping the **extent** of the fire and in **preventing injuries & fatalities** as a result of the fire.

Alert all other individuals within the workplace by activating the nearest fire alarm, shouting clearly or by using other procedures set in place by your company.

Use the nearest exit to evacuate the workplace.

Use a fire extinguisher to put the fire out.

Be careful while doing this and do not attempt if your safety and/or the safety of others is at risk or on large fires.







Tips for Better Fire Evacuation of a Worksite

Stay calm and evacuate the building immediately when you hear the fire alarm. Along the escape route, close (*don't lock*) all the doors and windows you pass by so that you can cut the fire and the smoke off and prevent spreading to other areas of your workplace, and/or to neighboring facilities, residences, etc.

Have the team go to their designated assembly point, then alert relevant supervisors that team members are safe and have successfully evacuated outside the building or work site.



Fire extinguisher types		
Standard/Multi-purpose dry powder		
 <p>Dry powder fire extinguisher</p>	Colour	Blue
	Application	The powder 'knocks down' the flames. Safe to use on most kinds of fire. Multi-purpose powders are more effective, especially on burning solids; standard powders work well only on burning liquids.
	Dangers	The powder does not cool the fire well. Fires that seem to be out can re-ignite. Doesn't penetrate small spaces, like those inside burning equipment. The jet could spread burning fat or oil around.
	How to use	Aim the jet at the base of the flames and briskly sweep it from side to side.
Water		
 <p>Water fire extinguisher</p>	Colour	Red
	Application	The water cools the burning material. You can only use water on solids, like wood or paper. Never use water on electrical fires or burning fat or oil.
	Dangers	The water can conduct electricity back to you. Water actually makes fat or oil fires worse – they can explode as the water hits them.
	How to use	Aim the jet at the base of the flames and move it over the area of the fire.
CO2		
 <p>Carbon dioxide fire extinguisher</p>	Colour	Black
	Application	Displace oxygen with CO ₂ (a nonflammable gas). Good for electrical fires as they don't leave a residue.
	Dangers	Pressurized CO ₂ is extremely cold. DO NOT TOUCH. Do not use in confined spaces.
	How to use	Aim the jet at the base of the flames and sweep it from side to side.
Foam/AFFF (Aqueous Film Forming Foam)		
	Colour	White or Cream

 <p>Foam fire extinguisher</p>	Application	The foam forms a blanket or film on the surface of a burning liquid. Conventional foam works well only on some liquids, so it's not good for use at home, but AFFF is very
		effective on most fires except electrical and chip-pan fires.
	Dangers	'Jet' foam can conduct electricity back to you, though 'spray' foam is much less likely to do so. The foam could spread burning fat or oil around.
	How to use	For solids, aim the jet at the base of the flames and move it over the area of the fire. For liquids, don't aim the foam straight at the fire – aim it at a vertical surface or, if the fire is in a container, at the inside edge of the container.

When considering using a fire extinguisher remember the following points:

- ✓ never use a fire extinguisher unless you have been trained to do so
- ✓ do not use water extinguishers on electrical fires due to the risk of electric shock and explosion
- ✓ do not use water extinguishers on oils and fats as this too can cause an explosion
- ✓ do not touch the horn on CO2 extinguishers as this can freeze burn the hands
- ✓ do not use the CO2 extinguisher in a small room as this could cause suffocation
- ✓ read the operating instructions on the extinguisher.

UNIT 07

APPLY SCIENCE IN WATER TESTING

This unit of competency covers the ability to manage the day-to-day running of science teaching laboratories and the preparation of practical experiments, demonstrations and field trips

DEVELOP BASICS OF WATER SCIENCE

Introduction to water science

Water, a substance composed of the chemical elements hydrogen and oxygen and existing in gaseous, liquid, and solid states. It is one of the most plentiful and essential of compounds. A tasteless and odourless liquid at room temperature, it has the important ability to dissolve many other substances. Indeed, the versatility of water as a solvent is essential to living organisms. Life is believed to have originated in the aqueous solutions of the world's oceans, and living organisms depend on aqueous solutions, such as blood and digestive juices, for biological processes. Water also exists on other planets and moons both within and beyond the solar system. In small quantities water appears colourless, but water actually has an intrinsic blue colour caused by slight absorption of light at red wavelengths.



water rapids, Niagara Falls, Canada

Water is the most plentiful compound on Earth and is essential to life. Although water molecules are simple in structure (H_2O), the physical and chemical properties of water are extraordinarily complicated.

General and Physical Chemistry

Although the molecules of water are simple in structure (H_2O), the physical and chemical properties of the compound are extraordinarily complicated, and they are not typical of most substances found on Earth. For example, although the sight of ice cubes floating in a glass of ice water is commonplace, such behaviour is unusual for chemical entities. For almost every other compound, the solid state

is denser than the liquid state; thus, the solid would sink to the bottom of the liquid. The fact that ice floats on water is exceedingly important in the natural world, because the ice that forms on ponds and lakes in cold areas of the world acts as an insulating barrier that protects the aquatic life below. If ice were denser than liquid water, ice forming on a pond would sink, thereby exposing more water to the cold temperature. Thus, the pond would eventually freeze throughout, killing all the life-forms present.



polar bear on ice floe

Polar bear on an ice floe in the Svalbard archipelago. The sight of ice floating on water is commonplace, but it shows the unusual chemical behaviour of water, which is less dense as a solid than in its liquid phase.

Water occurs as a liquid on the surface of Earth under normal conditions, which makes it invaluable for transportation, for recreation, and as a habitat for a myriad of plants and animals. The fact that water is readily changed to a vapour (gas) allows it to be transported through the atmosphere from the oceans to inland areas where it condenses and, as rain, nourishes plant and animal life. (See hydrosphere: The hydrologic cycle for a description of the cycle by which water is transferred over Earth.)

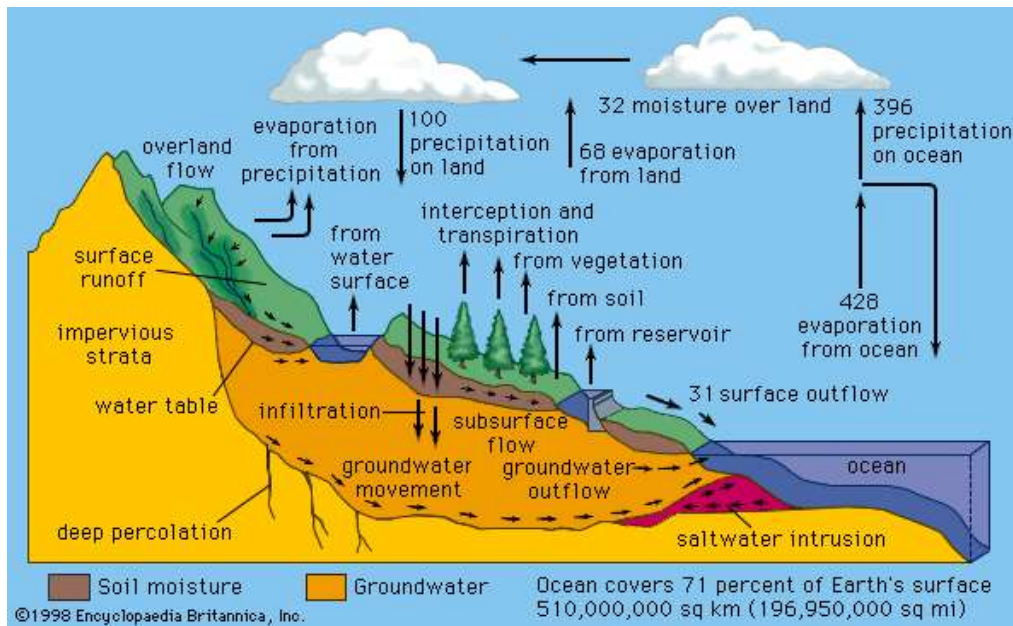


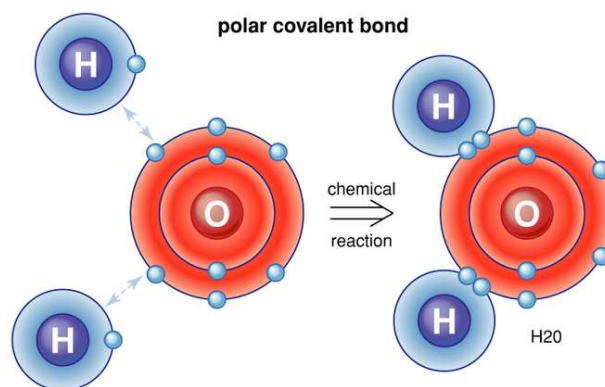
diagram of the hydrologic cycle of water

In the hydrologic cycle, water is transferred between the land surface, the ocean, and the atmosphere. The numbers on the arrows indicate relative water fluxes.

Structure of Water

Liquid water

The water molecule is composed of two hydrogen atoms, each linked by a single chemical bond to an oxygen atom. Most hydrogen atoms have a nucleus consisting solely of a proton. Two isotopic forms, deuterium and tritium, in which the atomic nuclei also contain one and two neutrons, respectively, are found to a small degree in water. Deuterium oxide (D_2O), called heavy water, is important in chemical research and is also used as a neutron moderator in some nuclear reactors.



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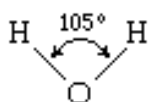
water molecule

A water molecule is made up of two hydrogen atoms and one oxygen atom. A single oxygen atom contains six electrons in its outer shell, which can hold a total of eight electrons. When two hydrogen atoms are bound to an oxygen atom, the outer electron shell of oxygen is filled.

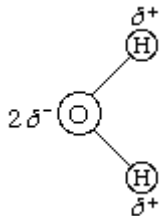
Although its formula (H_2O) seems simple, water exhibits very complex chemical and physical properties. For example, its melting point, $0\text{ }^\circ\text{C}$ ($32\text{ }^\circ\text{F}$), and boiling point, $100\text{ }^\circ\text{C}$ ($212\text{ }^\circ\text{F}$), are much higher than would be expected by comparison with analogous compounds, such as hydrogen sulfide and ammonia.

In its solid form, ice, water is less dense than when it is liquid, another unusual property. The root of these anomalies lies in the electronic structure of the water molecule.

The water molecule is not linear but bent in a special way. The two hydrogen atoms are bound to the oxygen atom at an angle of 104.5° .



The O—H distance (bond length) is 95.7 picometres (9.57×10^{-11} metres, or 3.77×10^{-9} inches). Because an oxygen atom has a greater electronegativity than a hydrogen atom, the O—H bonds in the water molecule are polar, with the oxygen bearing a partial negative charge (δ^-) and the hydrogens having a partial positive charge (δ^+).



Hydrogen atoms in water molecules are attracted to regions of high electron density and can form weak linkages, called hydrogen bonds, with those regions. This means that the hydrogen atoms in one water molecule are attracted to the nonbonding electron pairs of the oxygen atom on an adjacent water molecule. The structure of liquid water is believed to consist of aggregates of water molecules that form and re-form continually. This short-range order, as it is called, accounts for other unusual properties of water, such as its high viscosity and surface tension.

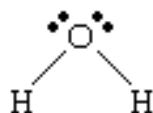


splitting water

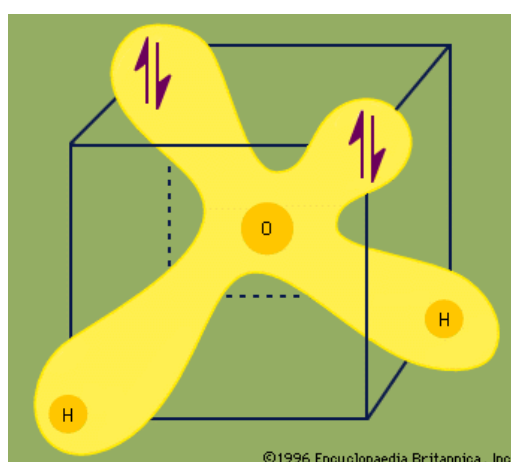
A catalyst that splits water into hydrogen and oxygen.

An oxygen atom has six electrons in its outer (valence) shell, which can hold a total of eight electrons. When an oxygen atom forms a single chemical bond, it shares one of its own electrons with the nucleus of another atom and receives in return a share of an electron from that atom. When bonded to two hydrogen atoms, the outer electron shell of the oxygen atom is filled.

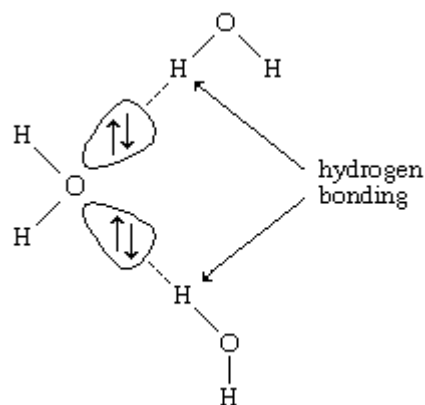
The electron arrangement in the water molecule can be represented as follows.



Each pair of dots represents a pair of unshared electrons (i.e., the electrons reside on only the oxygen atom). This situation can also be depicted by placing the water molecule in a cube.



Each $\uparrow\downarrow$ symbol represents a pair of unshared electrons. This electronic structure leads to hydrogen bonding.



Structures of ice

In the solid state (ice), intermolecular interactions lead to a highly ordered but loose structure in which each oxygen atom is surrounded by four hydrogen atoms; two of these hydrogen atoms are covalently bonded to the oxygen atom, and the two others (at longer distances) are hydrogen bonded to the oxygen atom's unshared electron pairs.

This open structure of ice causes its density to be less than that of the liquid state, in which the ordered structure is partially broken down and the water molecules are (on average) closer together. When water freezes, a variety of structures are possible depending on the conditions. Eighteen different forms of ice are known and can be interchanged by varying external pressure and temperature.

Significance of the structure of liquid water

The liquid state of water has a very complex structure, which undoubtedly involves considerable association of the molecules. The extensive hydrogen bonding among the molecules in liquid water produces much larger values for properties such as viscosity, surface tension, and boiling point than are expected for a typical liquid containing small molecules. For example, based on the size of its molecules, water would be expected to have a boiling point nearly 200 °C (360 °F) lower than its observed boiling point. In contrast to the condensed states (solid and liquid) of water, which exhibit extensive association among the water molecules, its gaseous (vapour) phase contains relatively independent water molecules at large distances from each other.

Water at high temperatures and pressures

The characteristic ability of water to behave as a polar solvent (dissolving medium) changes when water is subjected to high temperatures and pressures. As water becomes hotter, the molecules seem much more likely to interact with nonpolar molecules. For example, at 300 °C (572 °F) and high pressure, water has dissolving properties very similar to acetone (CH_3COCH_3), a common organic

solvent.

Water exhibits particularly unusual behaviour beyond its critical temperature and pressure (374 °C [705.2 °F], 218 atmospheres). Above its critical temperature, the distinction between the liquid and gaseous states of water disappears—it becomes a supercritical fluid, the density of which can be varied from liquid-like to gas-like by varying its temperature and pressure. If the density of supercritical water is high enough, ionic solutes are readily soluble, as is true for “normal” water; but, surprisingly, this supercritical fluid can also readily dissolve nonpolar substances—something ordinary water cannot do. Because of its ability to dissolve nonpolar substances, supercritical water can be used as a combustion medium for destroying toxic wastes. For example, organic wastes can be mixed with oxygen in sufficiently dense supercritical water and combusted in the fluid; the flame actually burns “underwater.” Oxidation in supercritical water can be used to destroy a wide variety of hazardous organic substances with the advantage that a supercritical-water reactor is a closed system, so there are no emissions released into the atmosphere.

Physical properties

Water has several important physical properties. Although these properties are familiar because of the omnipresence of water, most of the physical properties of water are quite atypical. Given the low molar mass of its constituent molecules, water has unusually large values of viscosity, surface tension, heat of vaporization, and entropy of vaporization, all of which can be ascribed to the extensive hydrogen bonding interactions present in liquid water. The open structure of ice that allows for maximum hydrogen bonding explains why solid water is less dense than liquid water—a highly unusual situation among common substances.

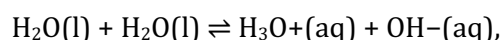
Selected physical properties of water	
molar mass	18.0151 grams per mole
melting point	0.00 °C
boiling point	100.00 °C
maximum density (at 3.98 °C)	1.0000 grams per cubic centimetre
density (25 °C)	0.99701 grams per cubic centimetre

Selected physical properties of water	
vapour pressure (25 °C)	23.75 torr
heat of fusion (0 °C)	6.010 kilojoules per mole
heat of vaporization (100 °C)	40.65 kilojoules per mole
heat of formation (25 °C)	–285.85 kilojoules per mole
entropy of vaporization (25 °C)	118.8 joules per °C mole
viscosity	0.8903 centipoise
surface tension (25 °C)	71.97 dynes per centimeter

Chemical Processes

Acid-base reactions

Water undergoes various types of chemical reactions. One of the most important chemical properties of water is its ability to behave as both an acid (a proton donor) and a base (a proton acceptor), the characteristic property of amphoteric substances. This behaviour is most clearly seen in the autoionization of water:



where the (l) represents the liquid state, the (aq) indicates that the species are dissolved in water, and the double arrows indicate that the reaction can occur in either direction and an equilibrium condition exists.

At 25 °C (77 °F) the concentration of hydrated H^+ (i.e., H_3O^+ , known as the hydronium ion) in water is 1.0×10^{-7} M, where M represents moles per litre. Since one OH^- ion is produced for each H_3O^+ ion, the concentration of OH^- at 25 °C is also 1.0×10^{-7} M.

In water at 25 °C the H_3O^+ concentration and the OH^- concentration must always be 1.0×10^{-14} : $[\text{H}^+][\text{OH}^-] = 1.0 \times 10^{-14}$, where $[\text{H}^+]$ represents the concentration of hydrated H^+ ions in moles per litre and $[\text{OH}^-]$ represents the concentration of OH^- ions in moles per litre.

When an acid (a substance that can produce H^+ ions) is dissolved in water, both the acid and the water contribute H^+ ions to the solution. This leads to a situation in which the H^+ concentration is greater than 1.0×10^{-7} M.

Since it must always be true that $[\text{H}^+][\text{OH}^-] = 1.0 \times 10^{-14}$ at 25 °C, the $[\text{OH}^-]$ must be lowered to some value below 1.0×10^{-7} . The mechanism for reducing the concentration of OH^- involves the reaction



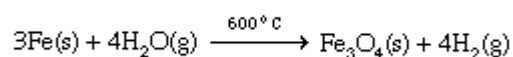
which occurs to the extent needed to restore the product of $[H^+]$ and $[OH^-]$ to 1.0×10^{-14} M. Thus, when an acid is added to water, the resulting solution contains more H^+ than OH^- ; that is, $[H^+] > [OH^-]$. Such a solution (in which $[H^+] > [OH^-]$) is said to be acidic.

The most common method for specifying the acidity of a solution is its pH, which is defined in terms of the hydrogen ion concentration: $pH = -\log [H^+]$, where the symbol log stands for a base-10 logarithm. In pure water, in which $[H^+] = 1.0 \times 10^{-7}$ M, the $pH = 7.0$. For an acidic solution, the pH is less than 7. When a base (a substance that behaves as a proton acceptor) is dissolved in water, the H^+ concentration is decreased so that $[OH^-] > [H^+]$. A basic solution is characterized by having a $pH > 7$. In summary, in aqueous solutions at 25 °C:

neutral solution	$[H^+] = [OH^-]$	$pH = 7$
acidic solution	$[H^+] > [OH^-]$	$pH < 7$
basic solution	$[OH^-] > [H^+]$	$pH > 7$

Oxidation-reduction reactions

When an active metal such as sodium is placed in contact with liquid water, a violent exothermic (heat-producing) reaction occurs that releases flaming hydrogen gas. $2Na(s) + 2H_2O(l) \rightarrow 2Na^+(aq) + 2OH^-(aq) + H_2(g)$ This is an example of an oxidation-reduction reaction, which is a reaction in which electrons are transferred from one atom to another. In this case, electrons are transferred from sodium atoms (forming Na^+ ions) to water molecules to produce hydrogen gas and OH^- ions. The other alkali metals give similar reactions with water. Less-active metals react slowly with water. For example, iron reacts at a negligible rate with liquid water but reacts much more rapidly with superheated steam to form iron oxide and hydrogen gas.



Noble metals, such as gold and silver, do not react with water at all.

Fluid Dynamics,

Fluids

A fluid is a substance that can flow when external force is applied on it. The term fluids include both liquids and gases. Though liquids and gases are termed as fluids, there are marked differences between them. For example, gases are

compressible whereas liquids are nearly incompressible. We only use those properties of liquids and gases, which are linked with their ability to flow, while discussing the mechanics of fluids.

Fluid dynamics

Fluid dynamics is the study of how fluids behave when they're in motion. This can get very complicated, so we'll focus on one simple case, but we should briefly mention the different categories of fluid flow.

Fluids can flow steadily, or be turbulent. In steady flow, the fluid passing a given point maintains a steady velocity. For turbulent flow, the speed and or the direction of the flow varies. In steady flow, the motion can be represented with streamlines showing the direction the water flows in different areas. The density of the streamlines increases as the velocity increases.

Fluids can be compressible or incompressible. This is the big difference between liquids and gases, because liquids are generally incompressible, meaning that they don't change volume much in response to a pressure change; gases are compressible, and will change volume in response to a change in pressure.

Fluid can be viscous (pours slowly) or non-viscous (pours easily).

Fluid flow can be rotational or irrotational. Irrotational means it travels in straight lines; rotational means it swirls.

For most of the rest of the chapter, we'll focus on irrotational, incompressible, steady streamline non-viscous flow.

The equation of continuity

The equation of continuity states that for an incompressible fluid flowing in a tube of varying cross-section, the mass flow rate is the same everywhere in the tube. The mass flow rate is simply the rate at which mass flows past a given point, so it's the total mass flowing past divided by the time interval. The equation of continuity can be reduced to:

$$\rho_1 A_1 v_1 = \rho_2 A_2 v_2 \quad (\rho = \text{density}, A = \text{cross-sectional area}, v = \text{velocity})$$

Generally, the density stays constant and then it's simply the flow rate (Av) that is constant.

Making fluids flow

There are basically two ways to make fluid flow through a pipe. One way is to tilt the pipe so the flow is downhill, in which case gravitational kinetic energy is transformed to kinetic energy. The second way is to make the pressure at one

end of the pipe larger than the pressure at the other end. A pressure difference is like a net force, producing acceleration of the fluid.

As long as the fluid flow is steady, and the fluid is non-viscous and incompressible, the flow can be looked at from an energy perspective. This is what Bernoulli's equation does, relating the pressure, velocity, and height of a fluid at one point to the same parameters at a second point. The equation is very useful, and can be used to explain such things as how airplanes fly, and how baseballs curve.

Bernoulli's equation

The pressure, speed, and height (y) at two points in a steady-flowing, non-viscous, incompressible fluid are related by the equation:

$$P_1 + \frac{1}{2} \rho v_1^2 + \rho g y_1 = P_2 + \frac{1}{2} \rho v_2^2 + \rho g y_2$$

Some of these terms probably look familiar...the second term on each side looks something like kinetic energy, and the third term looks a lot like gravitational potential energy. If the equation was multiplied through by the volume, the density could be replaced by mass, and the pressure could be replaced by force \times distance, which is work. Looked at in that way, the equation makes sense: the difference in pressure does work, which can be used to change the kinetic energy and/or the potential energy of the fluid.

Water Quantity and Quality,

There was often an unfortunate tendency to treat water-quantity and water-quality issues separately or to dismiss water-quality issues entirely. Although often done only for convenience, this artificial separation masks the importance of water quality in determining what water is available to serve what uses. Declines in water quality reduce the available water supply just as surely as does drought.

Accordingly, water quality is treated here as an integral dimension of water availability in an effort to underscore the fact that water quality will have to be managed effectively to prevent water supplies from dwindling over time.

The principal water problem in the early twenty-first century will be one of inadequate and uncertain supplies. Intensifying scarcity is likely to be the rule, as growing demands from nearly all water-using sectors will compete for finite levels of developed supply and remaining free-flowing water that support environmental and other instream uses.

Successful management of scarcity will require more systematic,

comprehensive, and coordinated approaches. All the available techniques and options will need to be regarded as alternatives, and most solutions will involve combinations of alternatives. In planning for the management of scarcity, good hydrologic (including water-quality) data will be absolutely essential.

Development of Supply-Enhancing Technology

As scarcity continues to intensify, the search for new supplies can be enhanced by (1) the development of new supply-enhancing technology and (2) reducing the costs of some existing technologies.

There are three technologies that seem to hold considerable promise for the future.

- First, many of the wastewater treatment technologies that permit water to be recycled are already cost-competitive in many of the arid and semiarid regions. Further reductions in cost will provide incentives for more widespread use of recycled water, thereby “expanding” the developed supply.
- Second, further development of desalting technology appears warranted under certain circumstances. Like wastewater treatment technology, some desalting technologies are now cost-competitive where source waters are brackish.
- Third, many regions will need to augment storage to ensure adequate supplies of water during drought and dry seasons. Because surface water storage opportunities will be far less attractive than they were in the past for reasons of cost and environmental impact, there will be pressure to develop additional storage capacity by utilizing underground aquifers. Aquifer storage systems should be developed with extreme caution because water residence times in aquifers are usually longer than in surface water reservoirs.

WATER QUALITY: FUNDAMENTAL AND APPLIED STUDIES

Future changes in land use will alter hydrologic and biogeochemical processes that control the quality of water derived from the watersheds. Current approaches to water-quality problems overlook important connections between local and regional hydrologic regimes. In particular, the monitoring and regulation of contaminants is currently carried out in a piecemeal manner that does not consider large-scale and long-range hydrologic and ecosystem processes or interactions between individual contaminants and major carbon and nutrient cycles.

For these reasons, managing the quality of our water resources will require a holistic conceptual and modeling framework and will depend on more water-quality data and other hydrologic data acquired through different techniques.

Development of this larger holistic framework will provide a means of better incorporating into water resource system management the results from several critical areas of water-quality research. It should be noted early on that preventing pollution is almost always less costly than cleaning it up after the fact. Nevertheless, the legacy of pollution that has already occurred must be

addressed, in addition to the new sources of pollution that are currently going unabated. In particular, greater research is required on nonpoint source pollution.

Nonpoint source contaminants are delivered to waters via runoff, shallow groundwater, and atmospheric deposition. Nonpoint source pollution is a complex and spatially variable mixture of nutrients, toxic chemicals, sediment, and microorganisms from the land surface, and its transport is highly dependent upon the hydrologic regime, especially extreme events such as floods. Irrigated agriculture is a particularly troublesome nonpoint pollution source because of salinization, erosion, and release of fertilizers, pesticides, and leachable minerals such as selenium, which can create toxic conditions in receiving waters.

In the water-quality arena, the water resources research agenda should give priority to:

- identifying physical, chemical, and microbial contaminants and understanding their fate and transport;
- identifying and developing innovative technologies for preventing pollution;
- controlling nonpoint source pollution;
- improving our ability to forecast the impact of land-use changes and best management practices on contaminant loading to surface water and groundwater;
- improving our ability to predict the impact of contaminant load changes on ecosystem services, biotic indices, and higher food chain organisms (fish and shellfish).
- determining the role of the environment in processing and converting contaminants;
- developing better techniques and data for assessing the capacity of the environment to buffer organisms from contaminants and to recover from the effects of contamination;
- improving the integrity of drinking water distribution systems; and
- enhancing the scientific bases for risk assessment, risk management, and communication and decision-making regarding risk.

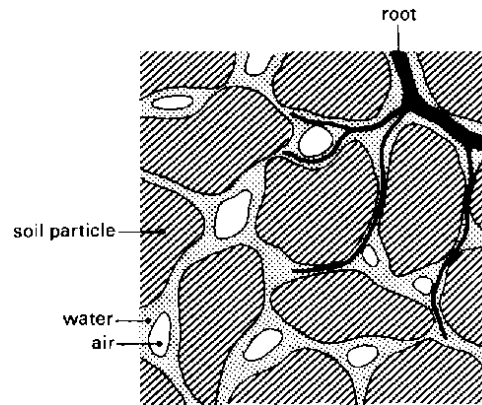
Soil and Water

Soil composition

When dry soil is crushed in the hand, it can be seen that it is composed of all kinds of particles of different sizes.

Most of these particles originate from the degradation of rocks; they are called mineral particles. Some originate from residues of plants or animals (rotting leaves, pieces of bone, etc.), these are called organic particles (or organic matter). The soil particles seem to touch each other, but in reality have spaces in between. These spaces are called pores. When the soil is "dry", the pores are mainly filled

with air. After irrigation or rainfall, the pores are mainly filled with water. Living material is found in the soil. It can be live roots as well as beetles, worms, larvae etc. They help to aerate the soil and thus create favourable growing conditions for the plant roots.



The composition of the soil

Soil structure

Soil structure refers to the grouping of soil particles (sand, silt, clay, organic matter and fertilizers) into porous compounds. These are called aggregates. Soil structure also refers to the arrangement of these aggregates separated by pores and cracks.

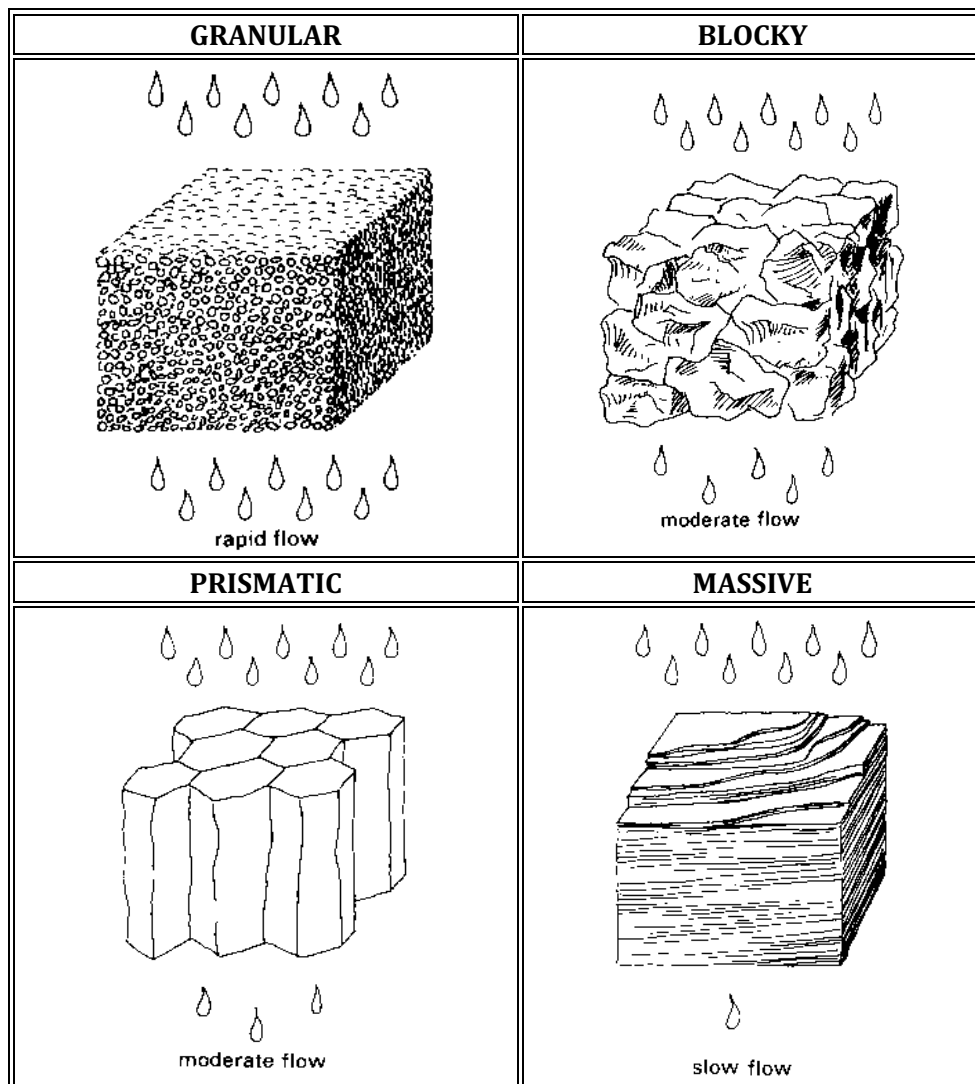
The basic types of aggregate arrangements are shown as follows, granular, blocky, prismatic, and massive structure.

When present in the topsoil, a massive structure blocks the entrance of water; seed germination is difficult due to poor aeration. On the other hand, if the topsoil is granular, the water enters easily and the seed germination is better.

In a prismatic structure, movement of the water in the soil is predominantly vertical and therefore the supply of water to the plant roots is usually poor.

Unlike texture, soil structure is not permanent. By means of cultivation practices (ploughing, ridging, etc.), the farmer tries to obtain a granular topsoil structure for his fields.

Some examples of soil structures

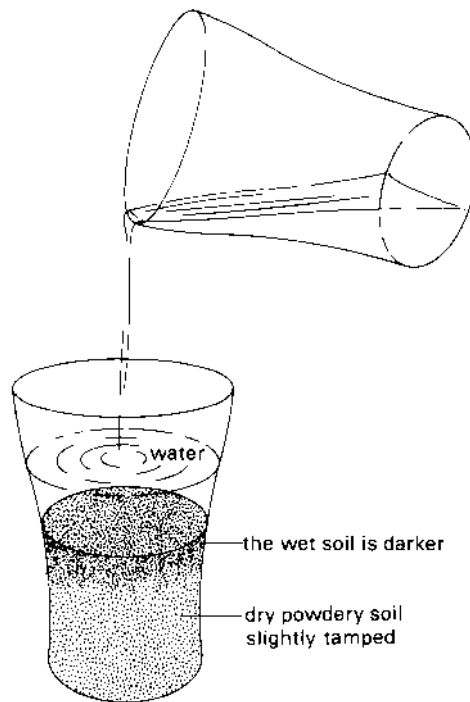


Entry of water into the soil

The infiltration process

When rain or irrigation water is supplied to a field, it seeps into the soil. This process is called infiltration.

Infiltration can be visualized by pouring water into a glass filled with dry powdered soil, slightly tamped. The water seeps into the soil; the colour of the soil becomes darker as it is wetted



Infiltration of water into the soil

Infiltration rate

Repeat the previous test, this time with two glasses. One is filled with dry sand and the other is filled with dry clay (see Fig. a and b).

The infiltration of water into the sand is faster than into the clay. The sand is said to have a higher infiltration rate.

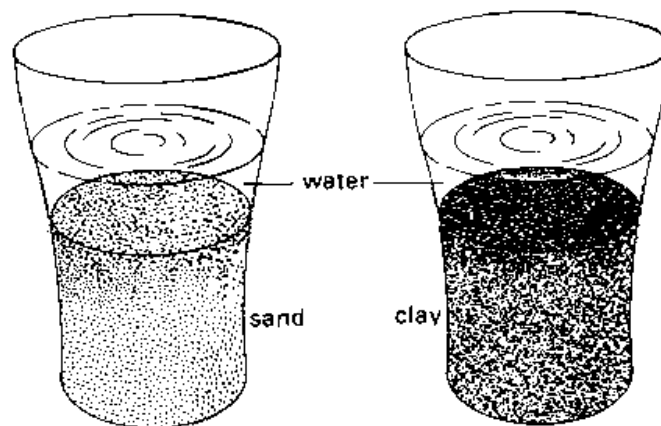


Fig. a. The same amount of water is supplied to each glass

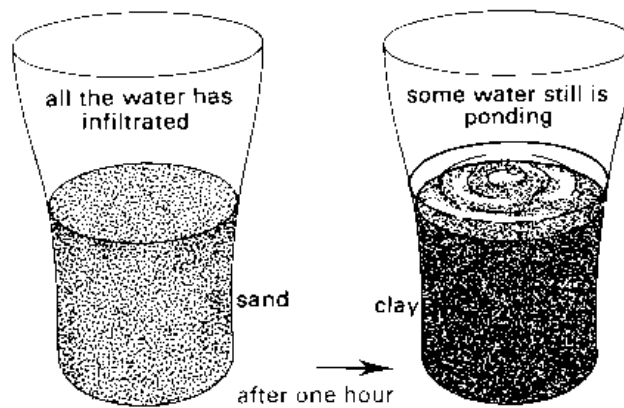
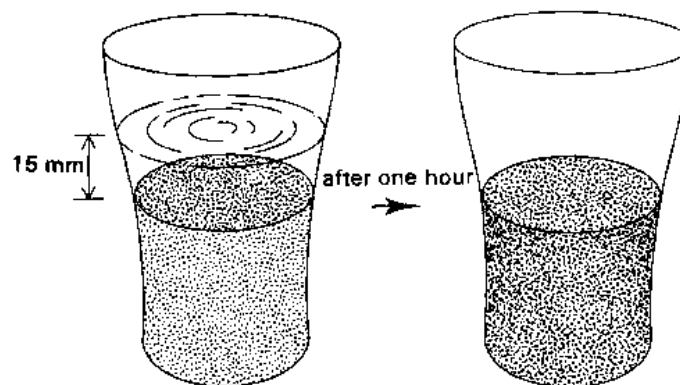


Fig.b. After one hour the water has infiltrated in the sand, while some water is still ponding on the clay

The infiltration rate of a soil is the velocity at which water can seep into it. It is commonly measured by the depth (in mm) of the water layer that the soil can absorb in an hour.

An infiltration rate of 15 mm/hour means that a water layer of 15 mm on the surface of the soil, will take one hour to infiltrate.



Soil with an infiltration rate of 15 mm/hour

A range of values for infiltration rates is given below:

<i>Low infiltration rate</i>	<i>less than 15 mm/hour</i>
<i>medium infiltration rate</i>	<i>15 to 50 mm/hour</i>
<i>high infiltration rate</i>	<i>more than 50 mm/hour</i>

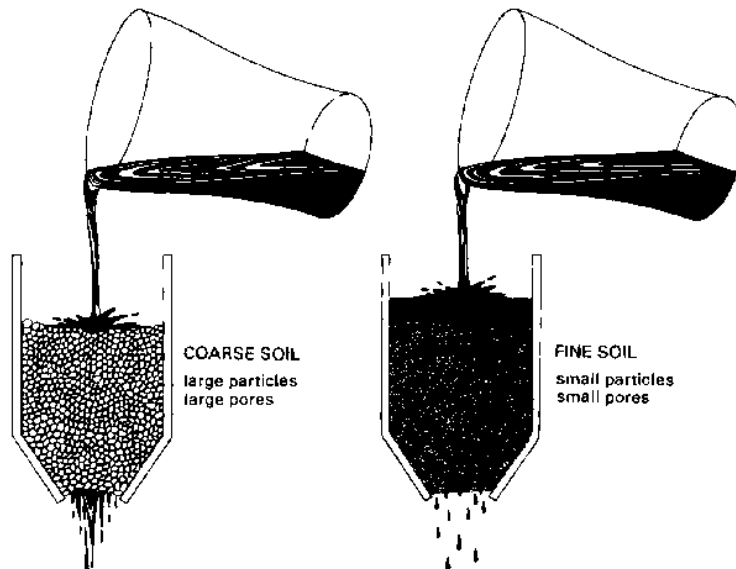
Factors influencing the infiltration rate

The infiltration rate of a soil depends on factors that are constant, such as the soil texture. It also depends on factors that vary, such as the soil moisture content.

Soil Texture

Coarse textured soils have mainly large particles in between which there are large pores.

On the other hand, fine textured soils have mainly small particles in between which there are small pores.

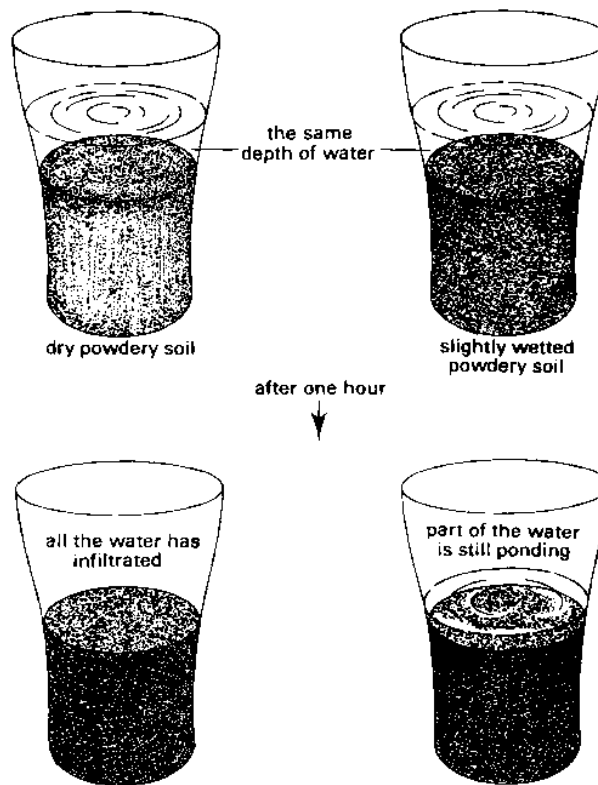


Infiltration rate and soil texture

In coarse soils, the rain or irrigation water enters and moves more easily into larger pores; it takes less time for the water to infiltrate into the soil. In other words, infiltration rate is higher for coarse textured soils than for fine textured soils.

The soil moisture content

The water infiltrates faster (higher infiltration rate) when the soil is dry, than when it is wet. As a consequence, when irrigation water is applied to a field, the water at first infiltrates easily, but as the soil becomes wet, the infiltration rate decreases.



Infiltration rate and soil moisture content

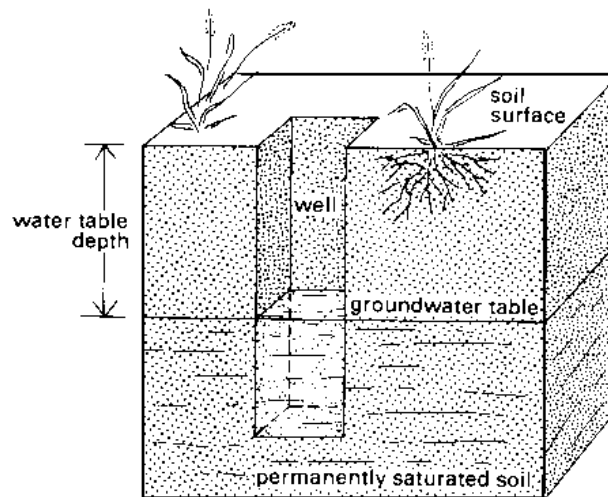
The soil structure

Generally speaking, water infiltrates quickly (high infiltration rate) into granular soils but very slowly (low infiltration rate) into massive and compact soils.

Because the farmer can influence the soil structure (by means of cultural practices), he can also change the infiltration rate of his soil.

Groundwater Table

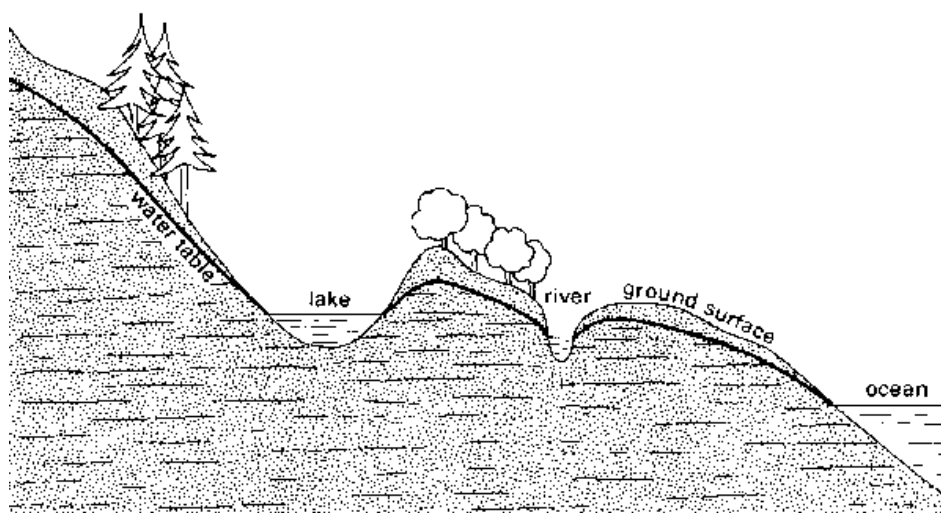
Part of the water applied to the soil surface drains below the rootzone and feeds deeper soil layers which are permanently saturated; the top of the saturated layer is called groundwater table or sometimes just water table.



The groundwater table

Depth of the groundwater table

The depth of the groundwater table varies greatly from place to place, mainly due to changes in topography of the area.



Variations in depth of the groundwater table

In one particular place or field, the depth of the groundwater table may vary in time.

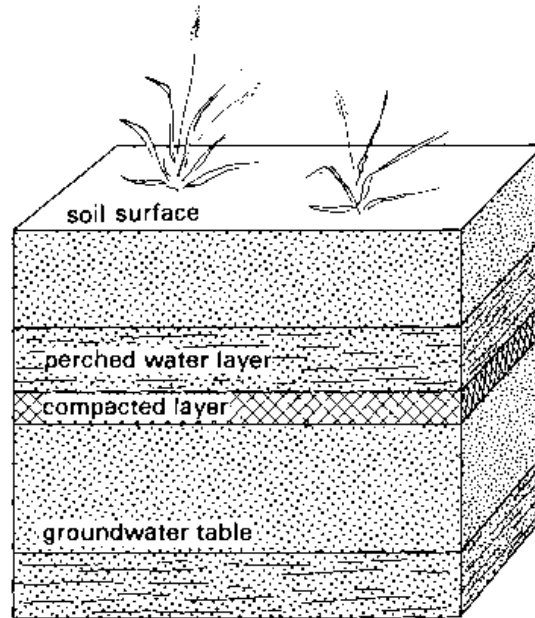
Following heavy rainfall or irrigation, the groundwater table rises. It may even reach and saturate the rootzone. If prolonged, this situation can be disastrous for crops which cannot resist "wet feet" for a long period. Where the groundwater table appears at the surface, it is called an open groundwater table. This is the case in swampy areas.

The groundwater table can also be very deep and distant from the rootzone, for example following a prolonged dry period. To keep the rootzone moist, irrigation is then necessary.

Perched groundwater table

A perched groundwater layer can be found on top of an impermeable layer rather close to the surface (20 to 100 cm). It covers usually a limited area. The top of the perched water layer is called the perched groundwater table.

The impermeable layer separates the perched groundwater layer from the more deeply located groundwater table.



A perched groundwater table

Soil with an impermeable layer not far below the rootzone should be irrigated with precaution, because in the case of over irrigation (too much irrigation), the perched water table may rise rapidly.

General and Environmental Microbiology.

The greatest risk from microbes in water is associated with consumption of drinking-water that is contaminated with human and animal excreta, although other sources and routes of exposure may also be significant. This chapter focuses on organisms for which there is evidence, from outbreak studies or from prospective studies in non-outbreak situations, of disease being caused by ingestion of drinking-water, inhalation of droplets or contact with drinking-water; and their control.

Microbial hazards associated with drinking-water

Infectious diseases caused by pathogenic bacteria, viruses and parasites (e.g., protozoa and helminths) are the most common and widespread health risk associated with drinking-water. The public health burden is determined by the severity of the illness(es) associated with pathogens, their infectivity and the

population exposed.

Breakdown in water supply safety may lead to large-scale contamination and potentially to detectable disease outbreaks. Other breakdowns and low-level, potentially repeated contamination may lead to significant sporadic disease, but is unlikely to be associated with the drinking-water source by public health surveillance.

Quantified risk assessment can assist in understanding and managing risks, especially those associated with sporadic disease.

Bacteria are classified into four major groups according to their feeding habits.

Saprophytic — these feed on dead organic matter and are commonly called "decomposers." Saprophytic bacteria play a significant role in water polluted with biodegradable wastes because they use up great amounts of oxygen as they break down the wastes.

Commensal — Commensal bacteria take food from living organism but in the process provide a valuable service to that organism. For example, bacteria present in the intestines of humans assist in the digestion of many foods. These bacteria couldn't live without us and, indeed, we would have difficulty digesting our food without them!

Parasitic -- Parasites live off another organism at the expense of its health. All pathogenic bacteria fall into this category.

Autotrophic — These bacteria make their own food from simpler inorganic substances. Some autotrophic bacteria contain chlorophyll and can carry on photosynthesis.

Autotrophic bacteria live in water or soil containing iron and sulfate compounds. The end products produced by the bacteria lower the pH (make it more acid) of water and soil. This may harm some plants and animals. Because potatoes like an acid soil, potato growers often add sulfur to their soil so sulfur bacteria (autotrophs) will lower its pH.

Pathogenic bacteria are our greatest concern because of the health problem they pose. Unfortunately, pathogens are hard to detect in water because:

1. There usually aren't very many of them, and
2. They can't survive for very long outside: the warm confines of the human or animal body.

Nevertheless, if pathogens get into a water supply from animal wastes or through the release of unprocessed toilet wastes, they may live long enough to find and infect a human or animal.

Even if we could test easily for the presence of pathogens in water it would not

be a good idea because we might get sick from exposure to the harmful bacteria. For this reason, we test for the presence of a relatively harmless (commensal) form of bacteria, called coliform bacteria. which, like pathogens, can live in the human body.

Coliform bacteria are common in the intestines of both warm- and coldblooded animals and aid in the digestion of foods. When animals "relieve themselves," some of these coliform bacteria (and pathogenic microbes, too, if present) pass out of their bodies with the waste. If these wastes find their way into a water supply, they will bring the bacteria and other microbes with them.

Consequently, if we find coliform bacteria in a water sample we can presume there also is human or animal excrement -- and in all probability, pathogens — there, too. Large numbers of coliform Organisms therefore indicate the possible presence of pathogens.

As previously mentioned, coliform bacteria are found in the intestines of warm and cold-blooded animals. However, cold-blooded animals don't. carry the same diseases as warm-blooded ones: For this reason, the APHA requires a special fecal test be used to separate out those bacteria found in the gut of warm-blooded animals.

INTERPRET WATER QUALITY AND TREATMENT PROCESSES

Familiarize with water quality suitable for human consumption

Drinking water quality standards and their development

The branch of science that examines the environmental factors that influence human health is called epidemiology. In 1855, John Snow proved statistically that in districts where water treatment with sand filtration was used, the incidence of cholera was lower than elsewhere. The epidemiological method has developed with an aim of explaining cases with high incident rate, such as infectious diseases like cholera and occupational diseases, or cases that are easy to distinguish from other populations. Medical science, including clinical medicine, has advanced, and the statistical approach and mathematical methods, have also been improved with the availability and power of computers. Consequently, cohort research and experimental epidemiological method have developed rapidly. The epidemiological method is a very useful tool in setting goals of environmental management for protecting public health from environmental organisms, and chemical and physical factors. This corresponds to WHO's EHC (Environmental Health Criteria).

Since human society exists in the natural/man made water metabolic system, human is not just affected not by physical properties and chemical impurities of water, but also by infectious microorganisms which co-exist with human beings and animals. The urban water metabolic system, which includes water supply and sanitation, has been established as a countermeasure against communicable diseases caused by pathogenic microorganisms. In Japan in the 1960s, more than 30 000 people were infected either by water or food-borne diseases such as dysentery or typhoid every year. However, today the number has decreased

significantly and opportunistic microorganisms cause the main infectious diseases. This indicates how safe water supply and sanitation have improved public health conditions, but, unfortunately, new emergent and re-emergent infectious diseases, which are not so familiar, have become increasingly serious problems, mainly as a consequence of increased international travel and food distribution. These diseases include E-coli O-157, Cryptosporidium and Giardia.

WHO drinking water quality guidelines:

Regulatory standards should include mandatory monitoring to verify whether the water quality meets the standard. If it does not meet the standard, some kind of countermeasures must be taken so that the standard can be achieved. On the other hand, unlike these regulatory standards, there is a guideline, which serves just as a reference when the goal or the standard for the desired water quality is provided. The WHO Drinking Water Quality Guidelines (DWQG) is a typical example of such a guideline. The WHO DWQG is used as a reference in development of national drinking water quality standards in many countries.

Type of water	Organisms	Guideline value
All water directly intended for drinking	E. coli or thermotolerant coliform bacteria	Must not be detectable in any 100 ml sample
Treated water entering the distribution system	E. coli or thermotolerant coliform bacteria	Must not be detectable in any 100 ml sample
Treated water in the distribution system	E. coli or thermotolerant coliform bacteria	Must not be detectable in any 100 ml sample

Parameter	Reference range
Free Chlorine	0.04 - 0.2 mg/l
pH	6.5 - 8.5
Physical Appearance	Clear & Colorless
Electrical Conductivity	<1000 µs/cm
Total Coliform	0/100ml CFU
Fecal Coliform	0/100ml CFU
Turbidity	<1 NTU
Total Dissolved Solids	<500 mg/L

Parameter	Reference range
Chlorides	<200 mg/l
Nitrates	<50 mg/l
Ammonia	<0.02 – 2.50 mg/l
Iron	<0.3 mg/l
Hydrogen Sulphide	0.05 mg/l
Total Hardness	<75 mg/l
Suspended Solids	5-750 mg/L

Parameter	Reference range
Total viable count at 22°C	100/1ml CFU
Total viable count at 37°C	20/1ml CFU

Parameter	Reference range
Anionic detergents	0.002 - 0.275 mg/l
Arsenic	<0.01 mg/l
Boron	<0.3 mg/l
Bromine	0.05 – 4.50 mg/l
Cadmium	<0.003 mg/l
Calcium hardness	<60 mg/l
Chromium	<0.05 mg/l
Copper	<2 mg/l
Cyanide	<0.07 mg/l
Enterococci	0/100ml CFU
Fluoride	<1.5 mg/l
Lead	<0.01 mg/l
Manganese	0.1 mg/l
Mercury	<0.001 mg/l
Phenolic compounds	0.002 - 0.2 mg/l
Phosphate	<5mg/l
Potassium	0 – 50 mg/l
Salmonella Typhi	0/100ml CFU
Shigella spp.	0/100ml CFU
Sodium	<200 mg/l
Sulphate	<250 mg/l
Total petroleum hydrocarbon	0 mg/l
Vibrio Cholerae	0/100ml CFU

Explain waterborne diseases

Waterborne diseases are illnesses caused by microscopic organisms, like viruses and bacteria, that are ingested through contaminated water or by coming in contact with feces.

If every person on the planet was able to practice safe sanitation and hygiene and have access to clean water, these diseases would not exist. Governments, NGOs, and communities themselves have made great strides in the past 20 years to end waterborne diseases. Still, there is much to be done.

Waterborne diseases and Prevention and treatment processes

Learn about a few waterborne diseases and Prevention and treatment processes

Typhoid Fever

Although rare in industrialized countries, typhoid fever is well-known in extremely poor parts of developing nations; it's estimated that up to 20 million people worldwide suffer from the illness each year. It's spread through contaminated food, unsafe water, and poor sanitation, and it is highly contagious.

Symptoms include:

- A fever that increases gradually
- Muscle aches
- Fatigue
- Sweating
- Diarrhea or constipation

Prevention and Treatment

Vaccines are recommended for people who are traveling in areas where poor sanitation and unsafe water are common. The vaccine can be injected via a shot or taken orally for a number of days. To prevent it, refrain from drinking any water that isn't bottled and sealed, and do not eat food from villages or street vendors. Typhoid is treated with antibiotics.

Cholera

Cholera is commonly found in humanitarian emergencies or marginalized villages where poverty and poor sanitation are rampant. The disease is spread through contaminated water and causes severe dehydration and diarrhea. Cholera can be fatal within days or even hours of exposure to the bacteria, but only 1 in 10 people will develop life-threatening symptoms.

Symptoms include:

- Nausea
- Vomiting
- Diarrhea
- Muscle cramps

Prevention and Treatment

Cholera is a waterborne illness that's easily prevented when traveling. Wash your hands often, only eat foods that are completely cooked and hot (no sushi), and only eat vegetables you can peel yourself, like avocados, bananas, and oranges. Of course, drink safe water.

When handwashing is unavailable, cholera can impact an entire village. In developing countries like Ethiopia, data shows that 40 percent of households do not have means to wash their hands properly, meaning they don't have safe water, soap, and a facility to wash. This makes hygiene management and disease prevention nearly impossible for these communities.

Lifewater helps prevent cholera in remote villages by teaching families how to construct their own handwashing devices. To date, 5,970 homes in Ethiopia

alone have built their own handwashing station (called a “tippy tap”) using locally-sourced materials.

Giardia

This waterborne disease is shared through contaminated water, most often in ponds and streams, but it can also be found in a town’s water supply, swimming pools, and more. The infection is caused by a parasite and typically clears up after a few weeks. However, it’s possible for those who have been exposed will experience intestinal problems for years to come.

Symptoms include:

- Abdominal pain
- Cramps and bloating
- Diarrhea
- Nausea
- Weight loss

Prevention and Treatment

While there is no vaccine for giardia, there are simple ways to avoid the infection. Wash your hands with soap often, don’t swallow water while swimming, and drink only bottled water.

With time, the immune system will typically beat giardia on its own. But, if symptoms worsen, doctors prescribe anti-parasite and antibiotic medications.

Water-poor communities cannot protect themselves from illnesses like giardia, and treatment for this illness can come at a high cost for a family living in poverty. For these reasons, Lifewater’s programs focus on long-term prevention. This includes constructing safe water sources and teaching health practices, one house at a time, until the entire community has the resources and the knowledge to prevent waterborne illness.

Dysentery

An intestinal infection, dysentery is a waterborne disease characterized by severe diarrhea as well as blood or mucus in the stool. Dysentery is good reason to always wash your hands, as the disease is spread mainly through poor hygiene. It can be caused by bacteria, viruses, or parasites in unsafe food and water and by people coming in contact with fecal matter. If someone experiencing dysentery cannot replace fluids quickly enough, their life could be at risk.

Symptoms include:

- Stomach cramps and pain
- Diarrhea
- Fever
- Nausea
- Vomiting
- Dehydration

Prevention and Treatment

To prevent dysentery, wash your hands with soap frequently, order all drinks without ice, don't eat food sold by street vendors, and only eat fruits you can peel. Drink only sealed, bottled water while traveling in places with higher dysentery risk, such as communities where proper hygiene practices are uncommon.

Mild dysentery usually clears up with rest and fluids, but over-the-counter medications such as Pepto-Bismol can help with stomach cramping. More severe cases can be treated with antibiotics, although some strains of the disease are resistant.

Escherichia Coli (E. coli)

E. coli is a bacteria with various strains, some dangerous and some beneficial. For example, E. coli bacteria is important in creating a healthy intestinal tract.

However, if animal waste has found its way into farmland where produce is grown or if strains of E. coli are spread through the process of making ground beef, those who consume these foods could experience symptoms of the waterborne illness. The bacteria is also found in unsafe water sources around the globe where human water sources and cattle coexist.

Symptoms of dangerous strains of E. coli are similar to that of dysentery and other waterborne diseases. Most bouts of E. coli pass within a week, but older people and young children have a greater chance of developing life-threatening symptoms. Anyone believed to have been exposed to contaminated food or water should contact a doctor if diarrhea contains blood.

Prevention and Treatment

As always, avoid water possibly contaminated by human and/or animal feces (like ponds, rivers, and swamps). If you are going to eat ground beef, cook thoroughly. Wash fruits and vegetables well, wash hands often, and drink only safe water.

To treat the disease, drink plenty of safe water, rest, and take over-the-counter diarrheal medication.

Hepatitis A

Hepatitis A is a liver infection caused by consuming contaminated food and water or by coming in close contact with someone who has the infection. People who travel in developing countries often or work in rural communities with poor sanitation and hygiene management are most exposed to the disease.

Symptoms include:

- Fatigue
- Clay-colored bowel movements
- Jaundice
- Nausea and vomiting
- Abdominal pain, especially near your liver
- Loss of appetite
- Sudden fever

The infection usually goes away in a few weeks, but it's possible that it can become severe and last several months.

Prevention and Treatment

The best way to prevent hepatitis A is by getting the vaccine. Eat only foods that are thoroughly cooked and served hot, and avoid eating anything at room temperature. Only eat fruit that you can peel and that you have peeled yourself. Don't eat from food vendors and don't eat runny eggs or raw/rare meat. For a full list of dos and don'ts, visit the CDC's page on Hepatitis A [here](#).

Once a person has hepatitis A, they build an immunity and will likely never get it again. However, the symptoms are serious, often forcing people to take time off work or school to recover. If you have contracted hepatitis A, rest, avoid drinking alcohol, and drink plenty of fluids. The disease will run its course, and full recovery is expected after three months.

Salmonella

Most cases of salmonella come from ingesting food or water contaminated with feces. Undercooked meat, egg products, fruits, and vegetables can also carry the disease. Most people don't develop complications, but children, pregnant women, older adults, and people with weakened immune systems are most at risk.

Symptoms include:

- Blood in stool
- Chills
- Headache

- Diarrhea

Prevention and Treatment

When preparing your own food, make sure to cook thoroughly and store or freeze within 30 minutes of use. Avoid touching birds or reptiles, and as always, wash your hands frequently.

Salmonella infection dehydrates the body. Treat it by drinking fluids and electrolytes. More serious infections can require hospitalization and antibiotics.

Interpret chemistry related to water treatment

Most chemicals arising in drinking-water are of health concern only after extended exposure of years, rather than months. The principal exception is nitrate. Typically, changes in water quality occur progressively, except for those substances that are discharged or leach intermittently to flowing surface waters or groundwater supplies from, for example, contaminated landfill sites.

In some cases, there are groups of chemicals that arise from related sources – for example, the DBPs – and it may not be necessary to set standards for all of the substances for which there are guideline values. If chlorination is practised, the THMs, of which chloroform is the major component, are likely to be the main DBPs, together with the chlorinated acetic acids in some instances. In some cases, control of chloroform levels and, where appropriate, trichloroacetic acid levels will also provide an adequate measure of control over other chlorination by-products.

Several of the inorganic elements for which guideline values have been recommended are recognized to be essential elements in human nutrition. No attempt has been made here at this time to define a minimum desirable concentration of such substances in drinking-water.

APPLY WATER SCIENCE TO DETERMINE QUALITY OF WATER

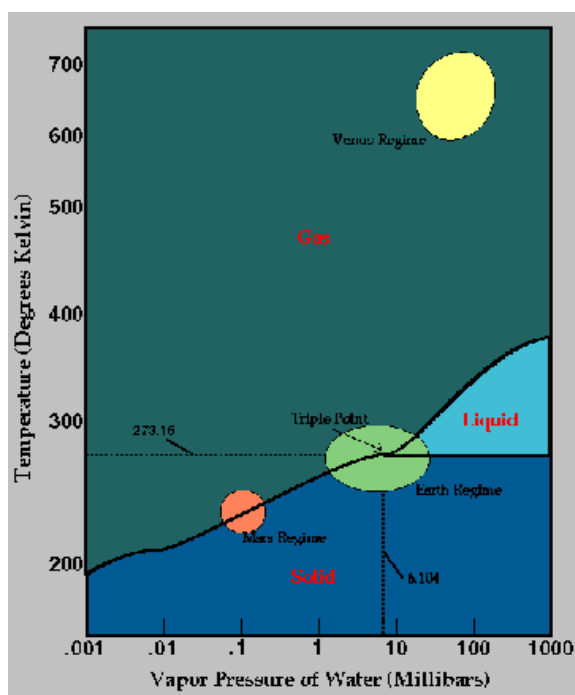
Identify chemical structure of water prior and after treatment

Structure of Water

It can be quite correctly argued that life exists on Earth because of the abundant liquid water. Other planets have water, but they either have it as a gas (Venus) or ice (Mars). This relationship is shown in Figure. Recent studies of Mars reveal the presence sometime in the past of running fluid, possibly water. The chemical nature of water is thus one we must examine as it permeates living systems: water is a universal solvent, and can be too much of a good thing for some cells to deal with.

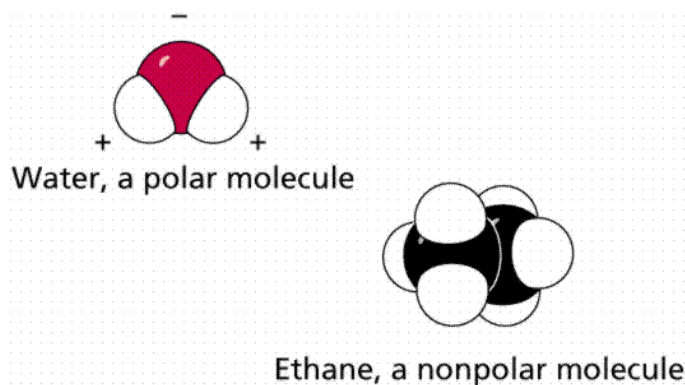
Water can exist in all three states of matter on Earth, while only in one state on

our two nearest neighboring planets.



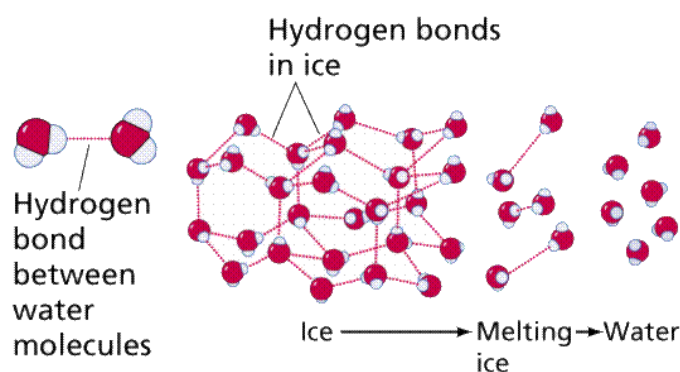
Water is polar covalently bonded within the molecule. This unequal sharing of the electrons results in a slightly positive and a slightly negative side of the molecule. Other molecules, such as Ethane, are nonpolar, having neither a positive nor a negative side, as shown in following Figure.

The difference between a polar (water) and nonpolar (ethane) molecule is due to the unequal sharing of electrons within the polar molecule. Nonpolar molecules have electrons equally shared within their covalent bonds.



These link up by the hydrogen bond discussed earlier. Consequently, water has a great interconnectivity of individual molecules, which is caused by the individually weak hydrogen bonds, shown in Figure below, that can be quite strong when taken by the billions.

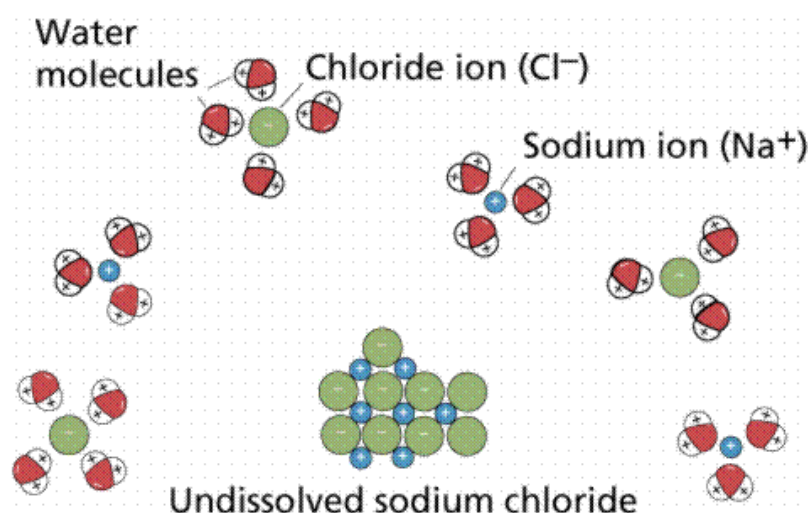
Figure 3. Formation of a hydrogen bond between the hydrogen side of one water molecule and the oxygen side of another water molecule.



Water has been referred to as the universal solvent. Living things are composed of atoms and molecules within aqueous solutions (solutions that have materials dissolved in water). Solutions are uniform mixtures of the molecules of two or more substances. The solvent is usually the substance present in the greatest amount (and is usually also a liquid). The substances of lesser amounts are the solutes.

The solubility of many molecules is determined by their molecular structure. You are familiar with the phrase "mixing like oil and water." The biochemical basis for this phrase is that the organic macromolecules known as lipids (of which fats are an important, although often troublesome, group) have areas that lack polar covalent bonds. The polar covalently bonded water molecules act to exclude nonpolar molecules, causing the fats to clump together. The structure of many molecules can greatly influence their solubility. Sugars, such as glucose, have many hydroxyl (OH) groups, which tend to increase the solubility of the molecule. This aspect of water is illustrated in Figure 4.

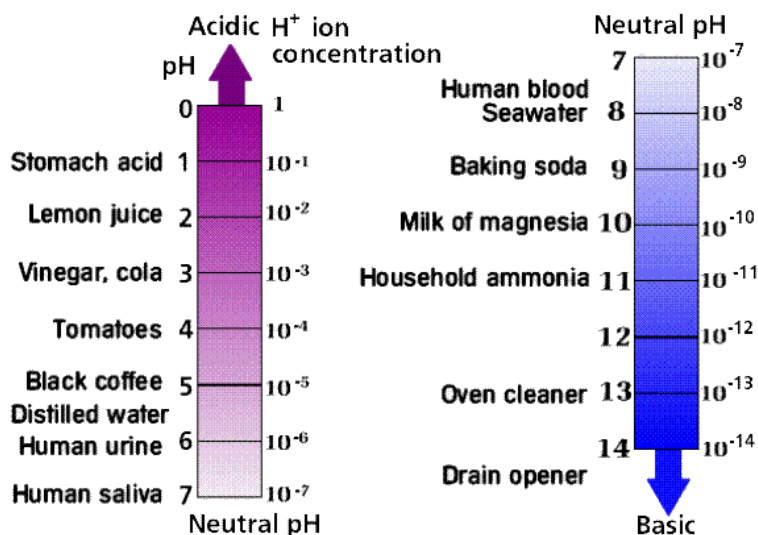
Dissolution of an ionically bonded compound, sodium chloride, by water molecules.



Water tends to disassociate into H^+ and OH^- ions. In this disassociation, the oxygen retains the electrons and only one of the hydrogens, becoming a negatively charged ion known as hydroxide. Pure water has the same number (or concentration) of H^+ as OH^- ions. Acidic solutions have more H^+ ions than

OH⁻ ions. Basic solutions have the opposite. The pH of several common solutions is shown in Figure 5. An acid causes an increase in the numbers of H⁺ ions and a base causes an increase in the numbers of OH⁻ ions.

pH of some common items.



The pH scale is a logarithmic scale representing the concentration of H⁺ ions in a solution. Remember that as the H⁺ concentration increases the OH⁻ concentration decreases and *vice versa*. If we have a solution with one in every ten molecules being H⁺, we refer to the concentration of H⁺ ions as 1/10. Remember from algebra that we can write a fraction as a negative exponent, thus 1/10 becomes 10⁻¹. Conversely 1/100 becomes 10⁻², 1/1000 becomes 10⁻³, etc. Logarithms are exponents to which a number (usually 10) has been raised. For example, log 10 (pronounced "the log of 10") = 1 (since 10 may be written as 10¹). The log 1/10 (or 10⁻¹) = -1. pH, a measure of the concentration of H⁺ ions, is the negative log of the H⁺ ion concentration. If the pH of water is 7, then the concentration of H⁺ ions is 10⁻⁷, or 1/10,000,000. In the case of strong acids, such as hydrochloric acid (HCl), an acid secreted by the lining of your stomach, [H⁺] (the concentration of H⁺ ions, written in a chemical shorthand) is 10⁻¹; therefore, the pH is 1.

Perform simple tests to determine change of chemical structure

Copper(II) sulfate test for water



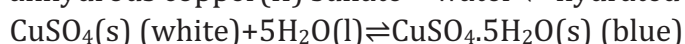
Copper sulfate experiment

Pure copper(II) sulfate is white. It is also known as **anhydrous copper(II) sulfate** because it has no water in it.

When water is present in a sample of copper(II) sulfate it turns blue. It is still a dry solid, because the individual water molecules are trapped within the ionic lattice surrounding the copper(II) ions. Solutions of copper(II) sulfate are also blue.

This colour change can be used to detect the presence of water (or water vapour).

anhydrous copper(II) sulfate + water \rightleftharpoons hydrated copper(II) sulfate



Cobalt(II) chloride test for water

Water can also be detected using blue anhydrous cobalt(II) chloride. This turns pink in the presence of water.

Interpret water standards from international organizations, especially WHO.

WHO drinking water quality guidelines:

Regulatory standards should include mandatory monitoring to verify whether the water quality meets the standard. If it does not meet the standard, some kind of countermeasures must be taken so that the standard can be achieved. On the other hand, unlike these regulatory standards, there is a guideline, which serves just as a reference when the goal or the standard for the desired water quality is provided. The WHO Drinking Water Quality Guidelines (DWQG) is a typical example of such a guideline. The WHO DWQG is used as a reference in development of national drinking water quality standards in many countries.

Type of water	Organisms	Guideline value
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All water directly intended for drinking	E. coli or thermotolerant coliform bacteria	Must not be detectable in any 100 ml sample
Treated water entering the distribution system	E. coli or thermotolerant coliform bacteria	Must not be detectable in any 100 ml sample
Treated water in the distribution system	E. coli or thermotolerant coliform bacteria	Must not be detectable in any 100 ml sample

COMPILE AND PRESENT DOCUMENTATION

Assignments and reports compiled submitted by the students

Logs of the activities and other documents are compiled

UNIT 08

APPLY MATHEMATICS IN WATER TESTING

This unit of competency describes the outcomes required to perform calculations for water industry related operations. This unit includes producing and interpreting charts and graphs

IDENTIFY AND INTERPRET FORMULAE FOR PROCESS CALCULATIONS

Required calculation method is identified to suit the application, including selection of relevant arithmetic operations and/or formulae.

Fractions, Decimals, and Percent

The number 10 divided by 2 gives an exact quotient of 5. This may be written as $10/2 = 5$. However, if we attempt to divide 7 by 9, we are unable to calculate an exact quotient. This division may be written $7/9$ (read “seven ninths”). The number $7/9$ represents a number, but not a whole number, and is called a *fraction*. Simply put, fractions are used to express a portion of a whole.

The water/waterworks operator is often faced with routine situations that require thinking in fractions and, on occasion, actually working with fractions. One of the common rules governing the use of fractions in a math problem deals with units of the problem. Units such as gpm are actually fractions — (gallons per minute or gal/min). Another example is — cubic feet per second (cfs), which is actually ft^3/sec . As can be seen, understanding fractions helps in solving other problems.

A fraction is composed of three items: two numbers and a line. The number on the top is called the *numerator*, the number on the bottom is called the *denominator*, and the line in between them means divided.

$$\text{Divide } \frac{3 \leftarrow \text{Numerator}}{4 \leftarrow \text{Denominator}}$$

The denominator indicates the number of equal-sized pieces into which the entire entity has been cut, and the numerator indicates how many pieces we have.

Fractions

In solving fractions, the following key points are important:

- ✓ Fractions are used to express a portion of a whole
- ✓ A fraction consists of two numbers separated by a horizontal line or a diagonal line — for example, $1/6$
- ✓ The bottom number, called the *denominator*, indicates the number of equal-sized pieces into which the entire entity has been cut
- ✓ The top number, called the *numerator*, indicates the number of pieces
- ✓ Like all other math functions, dealing with fractions is governed by rules or principles

Principles associated with using fractions include:

- ✓ *Same numerator and denominator:* When the numerator and denominator of a fraction are the same, the fraction can be reduced to 1; for example, $5/5 = 1$, $33/33 = 1$, $69/69 = 1$, $34.5/34.5 = 1$, $12/12 = 1$.
- ✓ *Whole numbers to fractions:* Any whole number can be expressed as a fraction by placing a 1 in the denominator; for example, 3 is the same as $3/1$ and 69 is the same as $69/1$.
- ✓ *Adding fractions:* Only fractions with the same denominator can be added, and only the numerators are added; the denominator stays the same — for example, $1/9 + 3/9 = 4/9$ and $6/18 + 8/18 = 14/18$.
- ✓ *Subtracting fractions:* Only fractions with the same denominator can be subtracted, and only the numerators are subtracted; the denominator remains the same — for example, $7/9 - 4/9 = 3/9$ (reduced = $1/3$) and $16/30 - 12/30 = 4/30$.
- ✓ *Mixed numbers:* A fraction combined with a whole number is called a mixed number — for example, $4\frac{1}{3}$, $14\frac{2}{3}$, $6\frac{5}{7}$, $43\frac{1}{2}$, and $23\frac{12}{35}$. The numbers are read “four and one third”, “fourteen and two thirds”, “six and five sevenths”, “forty three and one half”, and “twenty three and twelve thirty fifths”.
- ✓ *Changing a fraction:* Multiplying the numerator and the denominator by the same number does not change the value of the fraction. For example, $1/3$ is the same as $(1 \times 3)/(3 \times 3)$ which is $3/9$.
- ✓ *Simplest terms:* Fractions should be reduced to their simplest terms. This is accomplished by dividing the numerator and denominator by the same number. The result of this division must leave both the numerator and the denominator as whole numbers. For example, $2/6$ is not in its simplest terms; by dividing both by 2 we obtain $1/3$. The number $2/3$ cannot be reduced any further as no number can be divided evenly into both the 2 and the 3.

Problems

Reduce the following to their simplest terms:

$$2/4 = \underline{\hspace{2cm}}$$

$$14/18 = \underline{\hspace{2cm}}$$

$$3/4 = \underline{\hspace{2cm}}$$

$$6/10 = \underline{\hspace{2cm}}$$

$$9/18 = \underline{\hspace{2cm}}$$

$$17/29 = \underline{\hspace{2cm}}$$

$$24/32 = \underline{\hspace{2cm}}$$

- ✓ *Reducing even numbers:* When the starting point is not obvious, do the following: If the numerator and denominator are both even numbers (2, 4, 6, 8, 10, etc.), divide them both by 2, continue dividing by 2 until a division will no longer yield a whole-number numerator and denominator.
- ✓ *Different denominators:* To add and/or subtract fractions with different denominators, the denominators must be changed to a common

denominator (the denominators must be the same). Each fraction must then be converted to a fraction expressing the new denominator. For example, to add $1/8$ and $2/5$:

- Begin by multiplying the denominators: $8 \times 5 = 40$.
 - Change $1/8$ to a fraction with 40 as the denominator: $40/8 = 5$, $5 \times 1 = 5$ (the numerator); new fraction is $5/40$. Notice that this is the same as $1/8$ except that $5/40$ is not reduced to its simplest terms.
 - Change $2/5$ to a fraction with 40 as the denominator: $40 \div 5 = 8$, $8 \times 2 = 16$ (the numerator); new fraction is $16/40$.
 - Complete the addition: $5/40 + 16/40 = 21/40$.
- ✓ *Numerator larger:* Any time the numerator is larger than the denominator, the fraction should be turned into a mixed number. This is accomplished by doing the following:
- Determine the number of times the denominator can be divided evenly into the numerator. This will be the whole number portion of the mixed number.
 - Multiply the whole number times the denominator and subtract from the numerator; this value (the remainder) becomes the numerator of the fraction portion of the mixed number. For example, for $28/12$, 28 is divisible by 12 twice, so 2 is the whole number. Then, $2 \times 12 = 24$, and $28/12 - 24/12 = 4/12$. Dividing the top and bottom by 4 gives us $1/3$. The new mixed number is $2\frac{1}{3}$.
- ✓ *Multiplying fractions:* In order to multiply fractions, simply multiply the denominators together, and reduce to the simplest terms. For instance, to find the result of multiplying $1/8 \times 2/3$:

$$\frac{1}{8} \times \frac{2}{3} = \frac{1 \times 2 = 2}{8 \times 3 = 24} = \frac{2}{24} = \frac{1}{12}$$

- ✓ *Dividing fractions:* In order to divide fractions, simply invert the denominator (turn it upside down), multiply, and reduce to simplest terms. For example, to divide $1/9$ by $2/3$:

$$\frac{1}{9} \div \frac{2}{3} = \frac{1}{9} \times \frac{3}{2} = \frac{1 \times 3 = 3}{9 \times 2 = 18} = \frac{3}{18}, \text{ reduced} = \frac{1}{6}$$

- ✓ *Fractions to decimals:* In order to convert a fraction to a decimal, simply divide the numerator by the denominator; for example:

$$1/2 = 0.5, 5/8 = 0.625, 7/16 = 0.4375, 1/4 = 0.25$$

- ✓ *Change inches to feet:* To change inches to feet, divide the number of inches by 12; for example, to change 5 inches to feet:

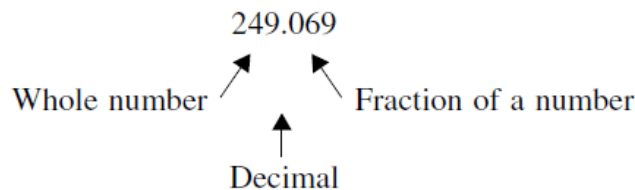
$$5/12 = 0.42 \text{ feet}$$

Problem

Change the following to feet: 2 inches, 3 inches, 4 inches, 8 inches.

Decimals

While we often use fractions when using measurements, dealing with decimals is often easier when we do calculations, especially when working with pocket calculators. A decimal is composed of two sets of numbers. The numbers to the left of the decimal are whole numbers, and the numbers to the right of the decimal are parts of the whole number (fraction of a number), as shown below:



In order to solve decimal problems, the following key points are important:

- ✓ As mentioned, we often use fractions when dealing with measurements, but it is often easier to deal with decimals when we do the calculations, especially when we are working with pocket calculators and computers.
- ✓ We convert a fraction to a decimal by dividing.
- ✓ The horizontal line or diagonal line of the fraction indicates that we divide the bottom number into the top number. For example, to convert $4/5$ to a decimal, we divide 4 by 5. Using a pocket calculator, enter the following keystrokes:

$$\boxed{4} \boxed{\div} \boxed{5} \boxed{=}$$

The display will show the answer: 0.8.

- ✓ Relative values of place:
 - 0.1 — tenths
 - 0.01 — hundredths
 - 0.001 — thousandths
 - 0.0001 — ten thousandths
 - 0.00001 — hundred thousandths

When we use a calculator, we can convert a fraction to a decimal by dividing. The horizontal line or diagonal line of the fraction indicates that we divide the bottom number into the top number.

For example, to convert $4/5$ to a decimal, divide 4 by 5. Using a pocket calculator, enter the following keystrokes:

$$4 \div 5 =$$

- ✓ Reading numbers: 23,676 is read as “twenty-three thousand six hundred seventy-six.”
- ✓ When *subtracting* decimals, simply line up the numbers at the decimal and subtract. For example,

$$\begin{array}{r} 24.66 \\ -13.64 \\ \hline 11.02 \end{array}$$

- ✓ To *add* decimal numbers, use the same rule as subtraction, line up the numbers on the decimal and add. For example,

$$\begin{array}{r} 24.66 \\ +13.64 \\ \hline 38.30 \end{array}$$

- ✓ To *multiply* two or more decimal numbers follow these basic steps:
 - Multiply the numbers as whole numbers; do not worry about the decimals.
 - Write down the answer.
 - Count the total number of digits (numbers) to the right of the decimal in all of the numbers being multiplied; for example, $3.66 \times 8.8 = 32.208$. Three digits are to the right of the decimal point (2 for the number 3.66 plus 1 for the number 8.8); therefore, the decimal point would be placed three places to the left from the right of the decimal place, which results in 32.208.
- ✓ To *divide* a number by a number containing a decimal, the divisor must be made into a whole number by moving the decimal point to the right until a whole number is obtained:
 - Count the number of places the decimal must be moved.
 - Move the decimal in the dividend by the same number of places.

Percent

The words *percent* mean “by the hundred”. Percentage is usually designated by the symbol %;

thus, 15% means 15 percent or 15/100 or 0.15. These equivalents may be written in the reverse

order: $0.15 = 15/100 = 15\%$. In water/wastewater treatment, percent is frequently used to express plant performance and control of biosolids treatment processes. When working with percent, the following key points are important:

- ✓ Percents are another way of expressing a part of a whole.
- ✓ As mentioned, the term *percent* means “by the hundred”, so a percentage is the number out of 100. To determine percent, divide the quantity we wish to express as a percent by the total quantity then multiply by 100:

$$\text{Percent}(\%) = \frac{\text{Part}}{\text{Whole}}$$

- ✓ For example, 22 percent (or 22%) means 22 out of 100, or 22/100. Dividing 22 by 100 results in the decimal 0.22:

$$22\% = \frac{22}{100} = 0.22$$

- ✓ When operators use percentages in calculations (such as when used to calculate hypochlorite dosages and when the percent available chlorine must be considered), the percentage must be converted to an equivalent decimal number. This is accomplished by dividing the percentage by 100. For example, calcium hypochlorite (HTH) contains 65% available chlorine. What is the decimal equivalent of 65%? Because 65% means 65 per hundred, divide 65 by 100 (65/100), which is equal to 0.65.

- ✓ Decimals and fractions can be converted to percentages. The fraction is first converted to a decimal, then the decimal is multiplied by 100 to get the percentage. For example, if a 50-foot-high water tank has 26 feet of water in it, how full is the tank in terms of the percentage of its capacity?

$$\frac{25 \text{ ft}}{50 \text{ ft}} = 0.52 (\text{decimal equivalent})$$

$$0.52 \times 100 = 52, \text{ so the tank is } 52\% \text{ full}$$

Problem

- ✓ The plant operator removes 6500 gallons (gal) of biosolids from the settling tank. The biosolids contain 325 gal of solids. What is the percent solids in the biosolids?
- ✓ Biosolids drawn from the settling tank contain 5% solids. If 2800 gallons of biosolids are withdrawn, how many gallons of solids are removed?

Averages (Arithmetic Mean) and Median

Whether we speak of harmonic mean, geometric mean, or arithmetic mean, each figure is designed to find the center (or middle) of a set of numbers. These terms capture the intuitive notion of a *central tendency* that may be present in the data. In statistical analysis, an *average of data* is a number that indicates the middle of the distribution of data values. The three most important measures of the center used in statistics are the *mean*, *median*, and the *mode*.

Averages

An *average* represents several different measurements as a single number. Although averages can be useful by telling approximately how much or how many, they can also be misleading, as we demonstrate below. You will encounter two kinds of averages in waterworks/wastewater treatment calculations: the *arithmetic mean* (or simply *mean*) and the *median*.

The *mean* (what we usually refer to as an *average*) is the total of a set of observations divided by the number of observations. We simply add up all of the individual measurements and divide by the total number of measurements taken.

Problem

The operator of a waterworks or wastewater treatment plant takes a chlorine residual measurement every day and part of the operating log is shown in [Table 6.1](#). Find the mean.

Solution

Add up the seven chlorine residual readings: $0.9 + 1.0 + 0.9 + 1.3 + 1.1 + 1.4 + 1.2 = 7.8$. Next, divide by the number of measurements (in this case, seven): $7.8 \div 7 = 1.11$. The mean chlorine residual for the week was 1.11 mg/L.

Median

The *median* is simply defined as the value of the central item when the data are arrayed by size. First, arrange all of the readings in either ascending or descending order, then find the middle value.

Problem

In our chlorine residual example, what is the median?

TABLE 6.1
Daily Chlorine Residual Results

Day	Chlorine Residual (mg/L)
Monday	0.9
Tuesday	1.0
Wednesday	0.9
Thursday	1.3
Friday	1.1
Saturday	1.4
Sunday	1.2

Solution

Arrange the values in ascending order:

0.9 0.9 1.0 1.1 1.2 1.3 1.4

The middle number is the fourth one (1.1), so, the median chlorine residual is 1.1 mg/L.

Problem

A water system has four wells with the following capacities: 115 gpm, 100 gpm, 125 gpm, and 90 gpm. What are the mean and median pumping capacities?

$$\frac{115 \text{ gpm} + 100 \text{ gpm} + 125 \text{ gpm} + 90 \text{ gpm}}{4} = \frac{430}{4} = 107.5 \text{ gpm}$$

To find the median, arrange the values in order:

90 gpm 100 gpm 115 gpm 125 gpm

With four values, we have no single middle value, so we must take the mean of the middle values:

$$\frac{100 \text{ gpm} + 115 \text{ gpm}}{2} = 107.5 \text{ gpm}$$

At times, determining what the original numbers were like (e.g., range) is difficult (if not impossible) when dealing only with averages.

Units of measurement are identified and used correctly.

Units of Measurement

A basic knowledge of units of measurement and how to use them and convert them is essential. Water/wastewater operators should be familiar with the U.S. Customary System (USCS), as well as the English System and the International System of Units (SI). Some of the important units are summarized in following

Table, which gives some basic SI and USCS units of measurement that will be encountered. In the study of water/wastewater treatment plant math operations (and in actual practice), it is quite common to encounter both extremely large quantities and extremely small ones.

Commonly Used Units

Quantity	SI Units	USCS Units
Length	Meter (m)	Feet (ft)
Mass	Kilogram (kg)	Pound (lb)
Temperature	Celsius (C)	Fahrenheit (F)
Area	Square meter (m ²)	Square foot (ft ²)
Volume	Cubic meter (m ³)	Cubic foot (ft ³)
Energy	Kilojoule (kJ)	British thermal unit (Btu)
Power	Watt (W)	Btu/hr
Velocity	Meters/second (m/sec)	Miles/hour (mi/hr)

For example, the concentrations of some toxic substance may be measured in parts per million (ppm) or parts per billion (ppb). To describe quantities that may take on such large or small values, it is useful to have a system of prefixes to accompany the units. Some of the more important prefixes are presented in Table below

Quantity	Prefix	Symbol
10 ⁻¹²	Pico-	p
10 ⁻⁹	Nano-	n
10 ⁻⁶	Micro-	μ
10 ⁻³	Milli-	m
10 ⁻²	Centi-	c
10 ⁻¹	Deci-	d
10	Deca-	Da
10 ²	Hecto-	H
10 ³	Kilo-	K
10 ⁶	Mega-	M

Conversion Factors

Sometimes we have to convert between different units. Suppose that a 60-inch piece of wood is attached to a 6-foot piece of wood. How long are they combined? Obviously, we cannot find the answer to this question by adding 60 to 6 because the two figures are given in different units. Before we can add the two numbers, we have to convert one of them to the units of the other, then, when we have two numbers in the same units, we can add them. In order to perform this conversion, we need a *conversion factor*. In this case, we have to know how many inches make up a foot. Knowing that 12 inches is 1 foot, we can perform the calculation in two steps as follows:

$$60 \text{ inches} = 60/12 = 5 \text{ feet}$$

$$5 \text{ feet} + 6 \text{ feet} = 11 \text{ feet}$$

From this example, it can be seen that a conversion factor changes known quantities in one unit of measure to an equivalent quantity in another unit of measure. To make the conversion from one unit to another, we must know two things:

- The exact number that relates the two units
- Whether to multiply or divide by that number

When making conversions, confusion over whether to multiply or divide is common; on the other hand, the number that relates the two units is usually known and thus is not a problem. Understanding the proper methodology — the mechanics — for various operations requires practice and common sense.

Along with using the proper mechanics (and practice and common sense) in making conversions, probably the easiest and fastest method of converting units is to use a conversion table. The simplest conversion requires that the measurement be multiplied or divided by a constant value.

For instance, in wastewater treatment, if the depth of biosolids on a drying bed is 0.85 feet, we would multiply by 12 inches per foot to convert the measured depth to inches (10.2 inches). Likewise, if the depth of the solids blanket in the secondary clarifier is measured as 16 inches, dividing by 12 inches per foot converts the depth measurement to feet (1.33 feet).

INTERPRET AND PRESENT GRAPHICAL REPRESENTATIONS OF MATHEMATICAL INFORMATION

Information is presented clearly using mathematical symbols, graphs and charts

Graphs and Charts

Although tables are useful for summarizing a lot of data concisely, clearly, and accurately, sometimes you want to get an overall message across quickly. You can do this using a graph or a chart. Graphs can also be used to explore relationships between sets of data, such as the way in which a sunflower grows over a season.

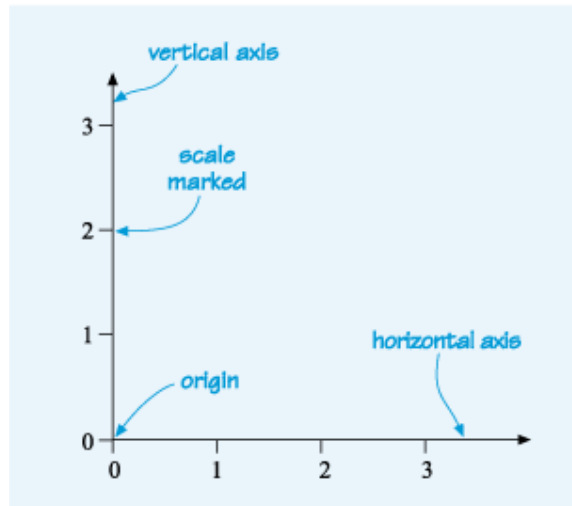
Activity: Graphs and Charts

You have probably seen different types of graphs and charts in your day to day life, when watching the TV, reading a newspaper or on the Internet. Spend a few moments now writing down all the different types that you have seen—don't worry if you don't know the math language for these at the moment!

Plotting Points

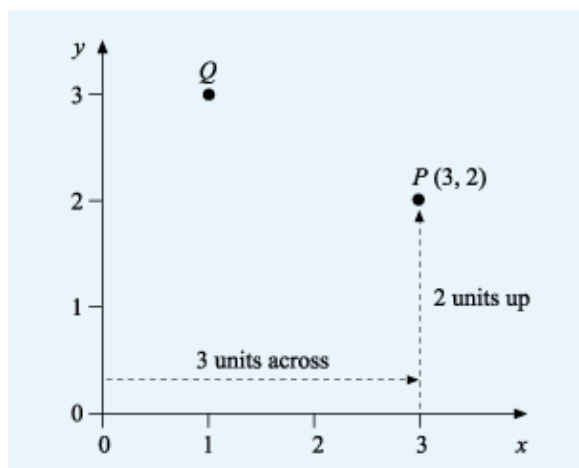
Many graphs and charts are constructed by plotting points on a grid.

The graph below shows two perpendicular lines: the horizontal axis and the vertical axis, which set up a grid. Each axis is marked with a scale, in this case from 0 to 3. The point where the two axes meet and where the value on both scales is zero is known as the origin. (Axes is the plural form of axis.)



Long description

We can describe the location of any point on the grid by its horizontal and vertical distance from the origin. In the graph below, the horizontal axis has been labeled with an "x" and the vertical axis with a "y." This is because the horizontal axis is usually known as the x-axis and the vertical axis as the y-axis.



Long description

Look at the point P in the above graph. To get to the point P from the origin, move 3 units across and 2 units up. (Alternatively, the point P is opposite 3 on the x-axis and 2 on the y-axis.) We say that P has the coordinates (3, 2).

The horizontal distance of P from the origin is known as the x-coordinate

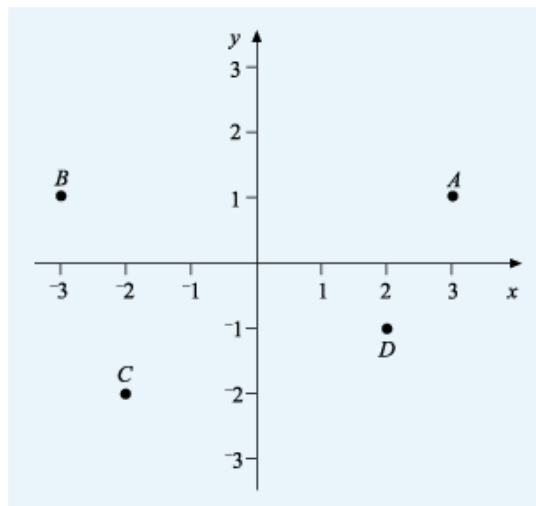
of P and the vertical distance from the origin is known as the y-coordinate of P. So for point P, 3 is the x-coordinate and 2 is the y-coordinate.

Notice that the x-coordinate is the first coordinate in the pair and the y-coordinate is the second coordinate in the pair. So the general form for the coordinates of a point is (x, y) . This is important to remember to avoid plotting points the wrong way round!

In the same way, Q is 1 unit across and 3 units up, so Q has coordinates $(1, 3)$.

Negative Coordinates

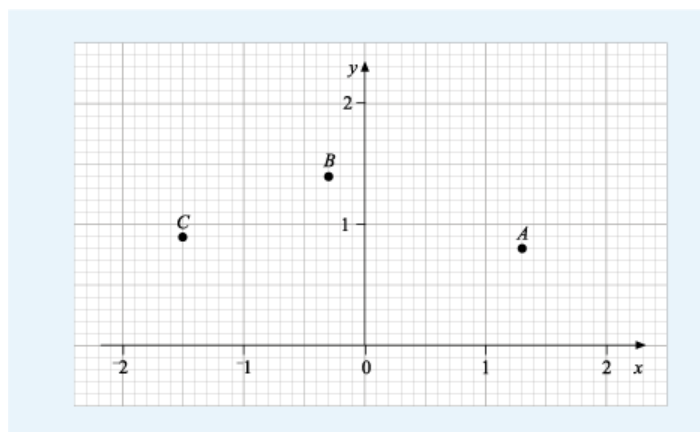
The axes can be extended downward and to the left to include negative values as shown here. In the graph below, B is 3 units to the left of the origin so its x-coordinate is -3 . It is 1 unit up, so its y coordinate is 1. So B has coordinates $(-3, 1)$.



Decimal Coordinates

In the examples so far, all the coordinates were whole numbers and the scales were also marked at whole unit intervals. It is possible to plot points that have decimal coordinates such as $(1.8, -2.1)$.

In the graph below, each unit along the axes has been divided into ten, so each gray line represents a tenth of a whole unit, or 0.1, just like on the number lines we saw in Unit 2. The point A has coordinates $(1.3, 0.8)$ and is plotted 1.3 units across to the right of the origin and 0.8 units up.



Displaying Data on a Graph or Chart

You have seen that, provided you have both an x- and a y-coordinate, you can plot a point on a chart. So if a set of data consists of pairs of data values, then the data can be plotted on a graph.

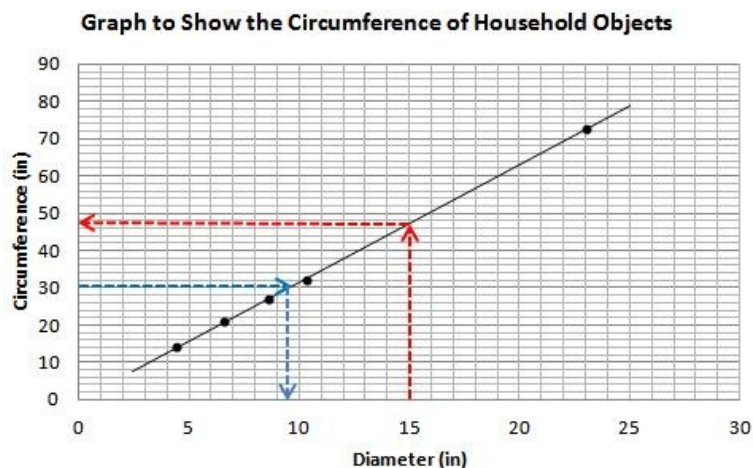
Drawing a Graph

The following data values were collected on the circumferences and diameters of various circular objects. All of the measurements are in inches.

Diameter (in.)	Circumference (in.)
4.4	14.1
6.6	20.9
8.6	27
10.3	32.3
23.0	72.8

(a) On some graph paper or in your notebook, plot these points on a graph with the diameter on the horizontal (x) axis and the circumference on the vertical (y) axis. Draw a straight line through the points.

Note the title and labeling of the axes. You may have used a different scale from us if you had different graph paper. This is fine as long as it makes best use of the paper and is easy to read from.



(b) Use your graph from part (a) to estimate the circumference of a circle of diameter 15 inches.

Answer: To find the circumference of a circle of diameter 15 inches, find 15 on the horizontal axis. From this point, draw a vertical line to meet the graph. Then draw a horizontal line across to the vertical axis and read off the value. The circumference of a circle of diameter 15 in. is about 47 inches.

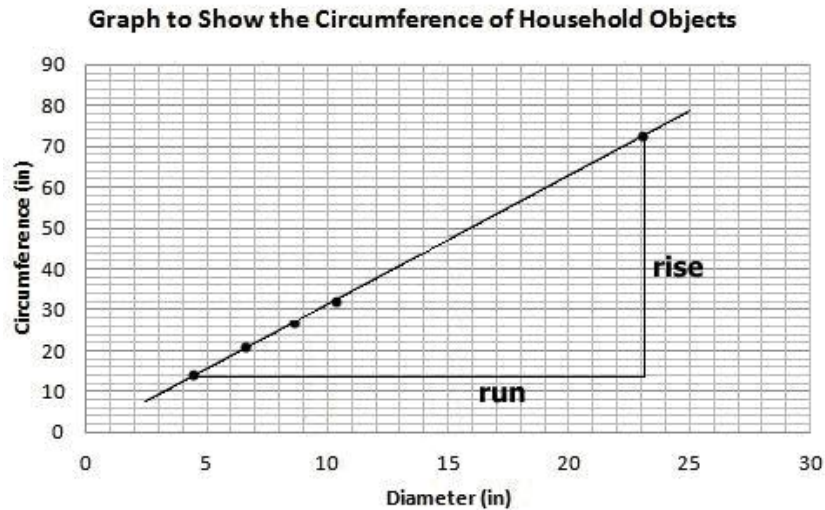
(c) Use your graph from part (a) to estimate the radius of a circle of circumference 30 inches.

Answer: The circumference is 30 in., so find 30 on the vertical axis. From this point, draw a line horizontally across to the graph, then vertically down to the horizontal axis. The point where this line crosses the horizontal axis gives the diameter of a circle whose circumference is 30 inches. It is about 9.5 inches, so the radius of the circle will be half of this, about 4.7 to 4.8 inches.

Optional Brain Stretcher

This is an interesting graph as you can make an estimate for π (pi) from it. π is the ratio of the circumference to the diameter of any circle and is a constant.

By measuring the slope (gradient) of the graph that you have drawn you will obtain an estimate for π . This is calculated by dividing the rise of the line by corresponding run of the line as shown below.



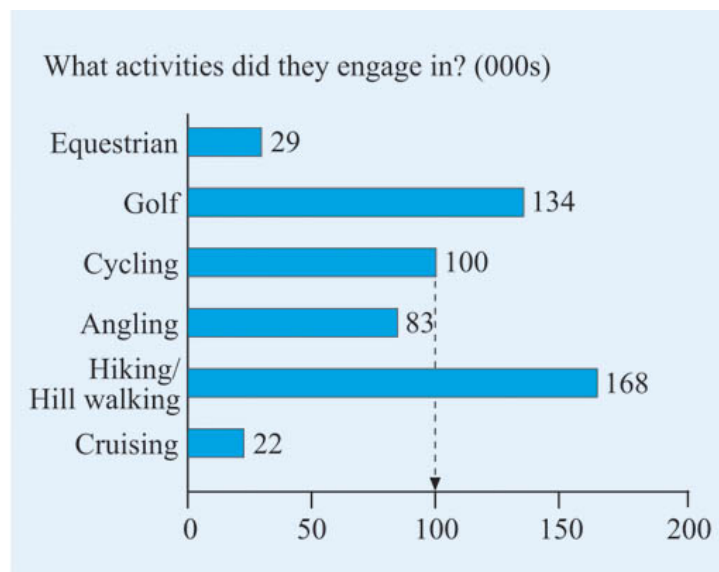
Have a go and see if you get a value close to 3.141.

Gradient = $\frac{\text{rise}}{\text{run}} = \frac{72.8 \text{ in} - 14.1 \text{ in}}{23.0 \text{ in} - 4.4 \text{ in}} = \frac{58.7 \text{ in}}{18.6 \text{ in}} = 3.156$ (to 3 d.p.)

This is not a bad estimate for pi!

Bar Charts

Earlier, you saw data from the Irish Tourism Fact Card presented in tables. Information can also be illustrated in bar charts. The chart below is also from the Tourism Fact Card and shows the numbers of visitors participating in different activities. The data were based on estimates from the Irish Central Statistical Office "Purpose of Visit" survey.



In a bar chart, the length of each bar represents the number in that category. On this chart, you can see that the longest bar is for hiking/hill walking, so this was the most popular activity. The shortest bar is for cruising, indicating that this was

the least popular activity of those listed.

From the title, we know that the numbers of visitors are measured in thousands. On this bar chart, the values represented by the bars have been marked directly on the chart. For example, the number of visitors who played golf was 134,000 and the number of visitors who went hiking/hill walking was 168,000.

If the values had not been marked on the bars, they could have been estimated by drawing a line from the end of the bar and seeing where it intersected the horizontal axis. For example, the end of the cycling bar is level with the 100 marked on the horizontal scale (as shown by the dashed line), so approximately 100,000 visitors went cycling.

Because the bars on this chart are horizontal, the chart is known as a horizontal bar chart. Bar charts can also be drawn with the bars vertical. Note that in a bar chart, each bar has the same width, and since the bars represent different and unrelated categories, the bars do not touch each other and are separated by gaps. Can you see anything that is missing from this bar chart?

There is no label on the horizontal axis, which you would normally expect to complete a bar chart.

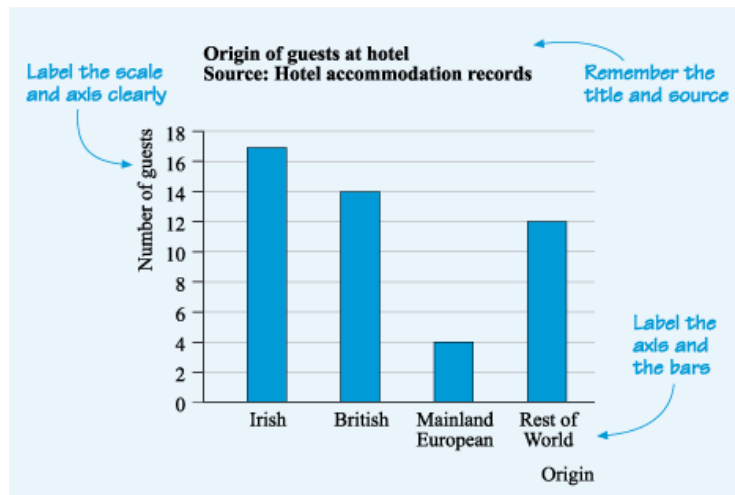
Drawing a Bar Chart

The same basic guidelines apply to drawing a bar chart as they do to drawing a graph, so bear these in mind when completing this activity.

In an earlier activity, you created the following table showing information about hotel guests. Use the table to draw a vertical bar chart to show the total number of guests in each of the nationality categories. Mark the nationality categories on the horizontal axis and the number of guests on the vertical axis.

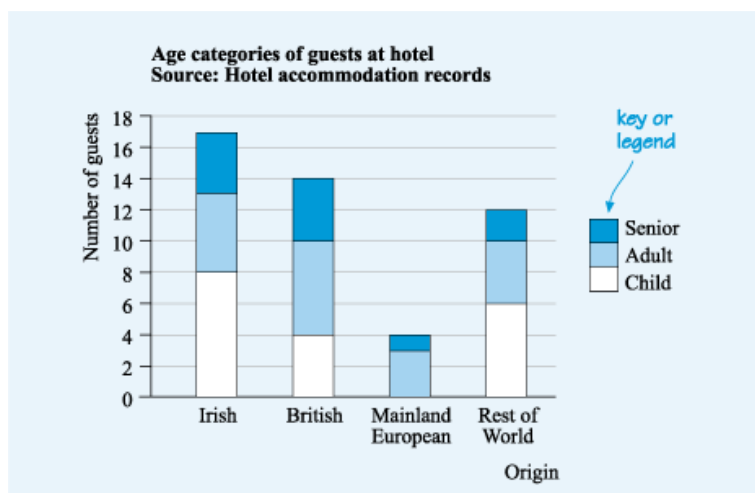
Origin and Age Categories of Hotel Guests

	Child	Adult	Senior	Total
Irish	8	5	4	17
British	4	6	4	14
Mainland European	0	3	1	4
Rest of the world	6	4	2	12
Total	18	18	11	47



Component Bar Charts

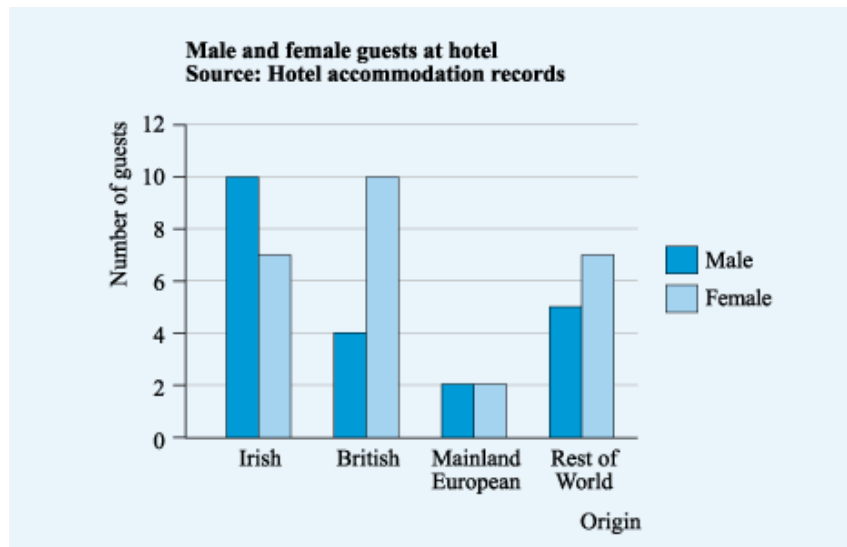
If you wished to show how the totals were broken down into the different age groups, you could split each bar into three different sections where the length of each section represented the number of guests in that age group. The resulting component bar chart is shown below. Notice that a key or legend has been added to the graph to explain the shading for the different categories.



When you read a component bar chart, you need to find the height of the relevant section. For instance, the top of the section representing British adults is opposite the 10 on the vertical scale. The bottom of that section is opposite the 4. So the number of British adults is $10 - 4 = 6$.

Comparative Bar Charts

Another way of displaying the totals would be to split each bar into two, one representing the number of males and the other the number of females in each category. To enable these numbers to be compared directly, the bars representing males and females can be placed next to each other as shown below. This is an example of a **comparative bar chart**.



Using the bar chart above, answer the following questions.

(a) How many female guests from Britain were there?

Answer: There were ten female guests from Britain.

(b) How many male guests in total stayed at the hotel?

Answer: The total number of male guests was 21.

Notice how all these charts followed the same format with the title and source clearly labeled and the axes and scales clearly marked, but they emphasized different aspects of the data. When you are displaying data in a graphical form, it is important to choose a chart or graph that stresses the main points as simply as possible, so that your reader can understand your chart quickly and easily.

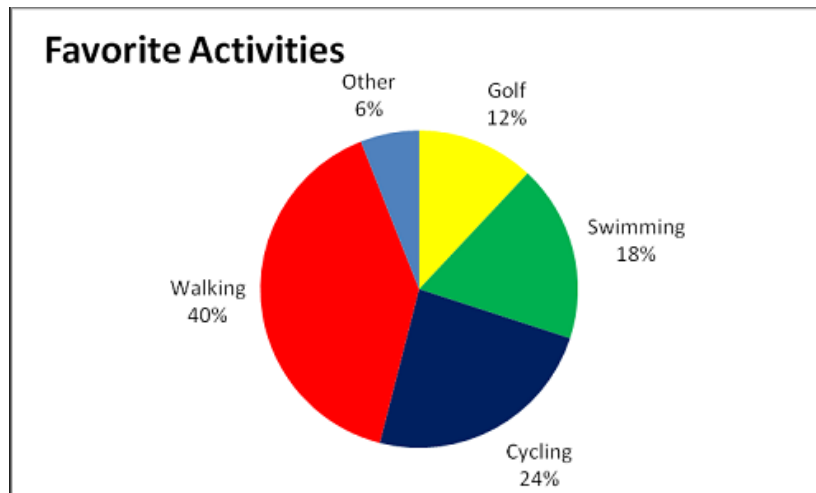
The tourist market bar charts display how many items (in this case, guests) there are in each category. How many times an item occurs is known as the **frequency**. Charts that display frequencies are also known as **frequency diagrams**.

For more practice interpreting bar charts, try the following lesson:

Pie Charts

Although bar charts are useful to display numbers and percentages, sometimes you may wish to stress how different components contribute to the whole. Pie charts are often used where you want to compare different proportions in the data set. The area of each slice (or sector) of the pie represents the proportion in that particular category.

For example, the pie chart below illustrates the favourite type of exercise for a group of people.

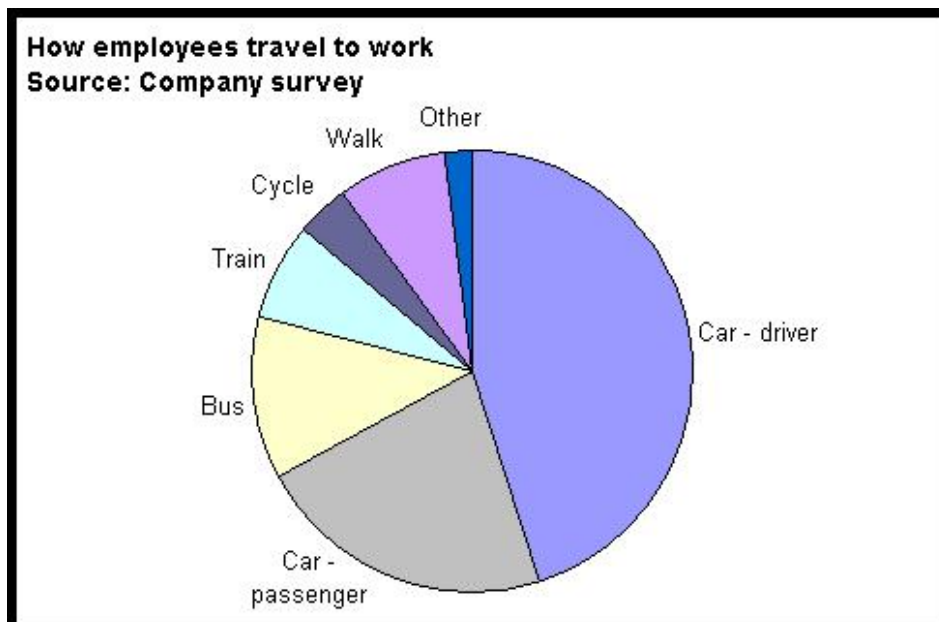


This pie chart shows the percentages for each category, so you can read these off directly. The most popular activity was walking (40%), followed by cycling (24%) and swimming (18%).

Notice, however, that the source of the data has not been stated, so you do not know where it came from or how many people were interviewed. It is important to consider both these points. If, for example, it was a small sample, you may not wish to rely on the results to generalize to a larger group.

Sometimes the percentages are not marked on the chart. So, the proportions can then be roughly estimated by eye. For example, the pie chart below illustrates how employees in a particular company travel to work.

Activity: How Employees Travel to Work



Use the pie chart above to answer the following questions.

(a) Do more people travel to work by bus or by train?

Answer: The slice of the pie representing bus travel is larger than the slice representing train travel, so yes, more people travel by bus than by train.

(b) Would it be correct to say that the number of employees who travel to work as car drivers is about twice the number who travel as car passengers?

Answer: The slice of the pie representing car drivers is about twice the size of the slice representing car passengers, so it is correct to say that the number of employees who travel to work as car drivers is about twice the number who travel as car passengers.

(c) Estimate the proportion of employees who travel to work by car, either as the driver or as a passenger.

Answer: The two slices for car drivers and passengers cover about two-thirds of the circle, so about two-thirds of employees travel to work by car, either as the driver or as a passenger.

It is important to remember that pie charts are useful only for comparing proportions, looking at parts of a whole. If you are interested in other aspects such as trends or frequencies, then other graphs or charts may be more appropriate.

If necessary—provided the pie chart has been drawn accurately—you can also work out the percentages by measuring the angle at the center of the pie for each sector, using a protractor. For example, the angle at the center of the circle for the “Car Passenger” category is about 80° .

Because a complete circle measures 360° , the fraction that this sector represents is $\frac{80}{360}$, or 22%.

So about 22% of the employees travel to work as car passengers.

Pie charts are often used to give an overall impression rather than detailed information, so on many occasions a rough estimate will suffice.

Reading a Chart or Graph

- ✓ Read the title of the chart and check the source of the data.
- ✓ Check the axes. What is being measured? What units have been used?
- ✓ Examine the scales. How should these be interpreted? What does each interval represent?
- ✓ Check the key or legend. What does the shading or line represent?
- ✓ Finally, examine the chart or graph itself, reading off the information that you need. Are you looking for a specific value or a trend or some other information?

You have also created graphs by hand. You may prefer to use a computer to draw your graphs and charts. There are many exciting ways to present data, but the important points listed below still apply whether you are drawing graphs by hand or by using software.

Drawing Graphs and Charts

- ✓ Include a clear title—so that your reader can see at a glance whether this chart is the one they are interested in.
- ✓ Include the source of the data—so that your reader can make further checks on how the data was collected if they wish.
- ✓ Choose the simplest graph or chart that illustrates the point you wish to emphasize.
- ✓ Label axes with both words and units.
- ✓ Mark scales clearly, choosing a scale that is easy to interpret.
- ✓ Include a legend if you have used more than one type of shading or line.

Look out for real-life graphs and charts in newspapers, magazines, on television, or on the Internet. Do these graphs follow the guidelines? Can you understand what the graphs are illustrating?

PERFORM CALCULATIONS

Formulae are used correctly to perform calculations.

Water storage facilities for water distribution systems are required primarily to provide for fluctuating demands of water usage (to provide a sufficient amount of water to average or equalize daily demands on the water supply system). In addition, other functions of water storage facilities include increasing operating convenience, leveling pumping requirements (to keep pumps from running 24 hours a day), decreasing power costs, providing water during power source or pump failure, providing large quantities of water to meet fire demands, providing surge relief (to reduce the surge associated with stopping and starting pumps), increasing detention time (to provide chlorine contact time and satisfy the desired contact time [CT] value requirements), and blending water sources.

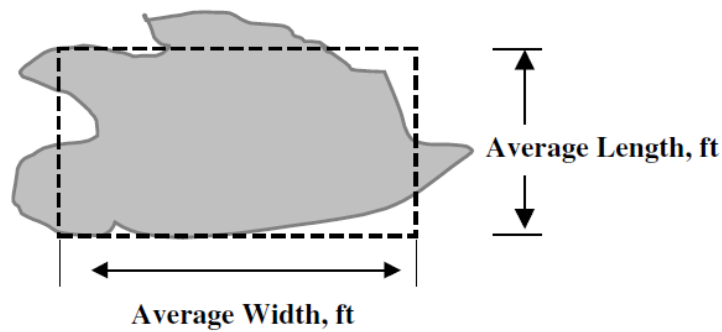
Water Storage Calculations

The storage capacity (in gallons) of a reservoir, pond, or small lake can be estimated using following Equation

$$\text{Reservoir, pond or lake capacity (gal)} = \text{ave. length (ft)} \times \text{ave. width (ft)} \times \text{ave. depth (ft)} \times 7.48 \text{ gal/cu ft}$$

Problem: A pond has an average length of 250 ft, an average width of 110 ft, and an estimated average depth of 15 ft. What is the estimated volume of the pond in gallons?

(Top view of a pond)



$$\begin{aligned}\text{Volume (gal)} &= 250 \text{ ft} \times 110 \text{ ft} \times 15 \text{ ft} \times 7.48 \text{ gal/cu ft} \\ &= 3,085,500 \text{ gal}\end{aligned}$$

Problem

A small lake has an average length of 300 ft and an average width of 95 ft. If the maximum depth of the lake is 22 ft, what is the estimated gallons volume of the lake?

Note:For small ponds and lakes, the average depth is generally about 0.4 times the greatest depth; therefore, to estimate the average depth, measure the greatest depth and multiply that number by 0.4.

Solution:

First, the average depth of the lake must be estimated:

$$\begin{aligned}\text{Estimated average depth (ft)} &= \text{greatest depth (ft)} \times 0.4 \text{ depth (ft)} \\ &= 22 \text{ ft} \times 0.4 \text{ ft} \\ &= 8.8 \text{ ft}\end{aligned}$$

The lake volume can then be determined using Equation 15.16:

$$\begin{aligned}\text{Volume (gal)} &= 300 \text{ ft} \times 95 \text{ ft} \times 8.8 \text{ ft} \times 7.48 \text{ cu ft} \\ &= 1,875,984 \text{ gal}\end{aligned}$$

Copper Sulfate Dosing

Algal control, perhaps the most common in situ treatment of lakes, ponds, and reservoirs, is achieved by application of copper sulfate; the copper ions in the

water kill the algae. Copper sulfate application methods and dosages will vary depending on the specific surface water body being treated. The desired copper sulfate dosage may be expressed in mg/L copper, lb copper sulfate/ac-ft, or lb copper sulfate/ac.

For a dose expressed as mg/L copper, the following equation is used to calculate lb copper sulfate required:

$$\text{Copper sulfate (lb)} = \frac{\text{copper (mg/L)} \times \text{volume (MG)} \times 8.34 \text{ lb/gal}}{\frac{\% \text{ available copper}}{100}}$$

Problem

For algae control in a small pond, a dosage of 0.5 mg/L copper is desired. The pond has a volume of 15 MG. How many pounds of copper sulfate will be required? (Copper sulfate contains 25% available copper.)

Solution

$$\begin{aligned}\text{Copper sulfate (lb)} &= \frac{0.5 \text{ mg/L} \times 15 \text{ MG} \times 8.34 \text{ lb/gal}}{\frac{25}{100}} \\ &= 250 \text{ lb copper sulfate}\end{aligned}$$

For calculating pounds copper sulfate/acre-ft, use the following equation (assume the desired copper sulfate dosage is 0.9 lb/ac-ft):

$$\text{Copper sulfate (lb)} = \frac{0.9 \text{ lb copper sulfate} \times \text{ac-ft}}{1 \text{ ac-ft}}$$

Problem

A small lake has a surface area of 6.0 acres. If the desired copper sulfate dose is 5.2 lb/ac, how many pounds of copper sulfate are required?

Solution

$$\begin{aligned}\text{Copper sulfate (lb)} &= \frac{5.2 \text{ lb copper sulfate} \times 6.0 \text{ ac}}{1 \text{ ac}} \\ &= 31.2 \text{ lb copper sulfate}\end{aligned}$$

UNIT 09

HANDLE DANGEROUS GOODS/HAZARDOUS SUBSTANCES

This unit involves the skills and knowledge required to handle dangerous goods and hazardous substances in accordance with relevant work health safety(WHS)/occupational health and safety (OHS) regulations concerning the safe handling of dangerous goods and hazardous substances, within the transport and logistics industry

IDENTIFY REQUIREMENTS FOR WORKING WITH DANGEROUS GOODS AND/OR HAZARDOUS SUBSTANCES

Dangerous goods/hazardous substances are identified from information including class labels, manifests and other documentation

Hazardous Chemicals versus Dangerous Goods

Hazardous chemicals are any substance, mixture or article that satisfies the criteria for a hazard class in the Globally Harmonised System of Classification and Labelling of Chemicals (GHS) that are used in the workplace. These can be classified according to their health and physicochemical hazards.

Dangerous goods are substances, mixtures or articles that, because of their physical, chemical (physicochemical) or acute toxicity properties, present an immediate hazard to people, property or the environment.

Globally Harmonised System of Classification and Labelling of Chemicals (GHS)

The WHS Regulation 2011 covers workplace hazardous chemicals and dangerous goods under a single framework for hazardous chemicals and introduces a new hazard classification and hazard communication system based on the United Nations' Globally Harmonised System of Classification and Labelling of Chemicals (GHS).


The GHS (known as "The Purple Book") is a single internationally agreed system of chemical classification and hazard communication through labelling and SDSs which includes harmonised criteria for the classification of physical, health and environmental hazards. This will replace the Approved Criteria for Classifying Hazardous Substances [NOHSC:1008(2004)] (NOHSC). While the GHS was introduced in the WHS Regulation 2011, transitional arrangements apply in Australia until 1st January 2017 to allow manufacturers and suppliers to apply the new requirements. The GHS has already been adopted by Japan, China, Korea, Malaysia, Taiwan, New Zealand, the EU, Canada and the USA (or currently transitioning).

Upon full implementation of the GHS for use and minor storage, the ADG Code will still apply to the transport and storage of placard quantities of hazardous chemicals in the workplace.

The Hazardous Chemical Information System (HCIS) is a database of information on chemicals that have been classified in accordance with the GHS. HCIS contains GHS classifications and labelling information for over 4,500 chemicals and a searchable database of workplace exposure standards (HCIS replaces the previous Hazardous Substance Information System (HSIS) which was a database of information on substances classified in accordance with NOHSC).

Classification

If a chemical meets the criteria of the GHS, for one or more class, it is a hazardous chemical. Each hazard class is split into categories, divisions and types which are explained through the new pictograms, signal words and hazard statements (see Classification and Labelling for Workplace Hazardous Chemicals Poster for full table).

Classification		Labelling			
Hazard		Pictogram, code*	Signal word	Hazard Statement	
Class	Category			Code*	Text
Explosives	Unstable explosive		Danger	H200	Unstable explosive
	Division 1.1			H201	Explosive; mass explosion hazard
	Division 1.2			H202	Explosive; severe projection hazard
	Division 1.3			H203	Explosive; fire, blast or projection hazard
	Division 1.4	GHS01	Warning	H204	Fire or projection hazard
	Division 1.5	No GHS Pictogram ⁽¹⁾	Danger	H205	May mass explode in fire
	Division 1.6	No GHS Pictogram ⁽¹⁾	No Signal Word	N/A	No Hazard Statement

⁽¹⁾ Divisions 1.5 and 1.6 need to be labelled with their respective Dangerous Goods class label in accordance with the relevant regulations.

Hazard Pictograms

These provide a graphical representation of the chemical's hazardous properties. There has been a change from displaying Dangerous Goods Diamonds to Hazard Pictograms



Note: the WHS Regulation allows manufacturers and importers to continue to use dangerous goods class labels on containers for workplace hazardous chemicals for transport purposes.

Signal words

Introduction of Signal Words that provide an indication of the relative severity of the hazard:

- DANGER - Severe or significant hazard
- WARNING - Less severe hazard.

Hazard statements

- Describes the nature and severity of chemical hazard.
- Categorised in relation to physical/health/environmental hazards.
- Change from Risk Phrases.
- Examples:
 - Highly flammable liquid and vapour
 - May cause respiratory irritation
 - May cause cancer
 - Contains gas under pressure
 - Causes severe skin burns and eye damage.

Precautionary statements

- Recommended measures to prevent or minimise risks during storage, handling, use or disposal.
- Categorised into prevention, response, storage and disposal.
- Change from Safety Phrases.
- Examples:
 - Keep away from heat/sparks/open flames/hot surfaces – No smoking
 - Dispose of contents in accordance with local Regulations
 - Do not breathe dust/fume/gas/mist/vapours/spray
 - Get immediate medical advice/attention.

Labelling

Labels are required to be affixed on containers or pipe-work that contain hazardous chemicals.

Additionally, non-hazardous chemicals should also be labelled to distinguish them from those that are hazardous.

Labels display information on any hazards associated with the hazardous chemical, plus instructions and information on the safe storage, handling, use and disposal of the chemical. Like an SDS, a label is an important source of information that can be used to control risks during use

Job hazards are identified and required action is taken to minimise, control or eliminate identified hazards

Manifest and Placarding Requirements assist emergency services to respond to any incidents by notifying them of the type, quantity, and locations of hazardous chemicals on site.

Incidents including hazardous chemicals and dangerous goods should be managed according to the Campus Emergency Response Procedures and the Incident Management and Reporting Guidelines.

The need for fire protection and the appropriate fire protection system should be determined by a risk assessment. The “fire protection system” includes fire detection, fire suppression and firefighting equipment, which may be fixed or portable. The risk assessment should take into

account the types and quantities of hazardous chemicals and other material and substances and how they are stored and handled. Additionally, the risk assessment should consider the types and quantities of hazardous chemicals and other materials and substances in the area and the types of incidents these could potentially cause. The fire protection system should be installed, tested and maintained in accordance with legislative requirements.

Spill containment should be provided to hold the spill of the largest package. This may be in the form of secondary packaging, temporary or permanent bunding, or draining into an underground sump or tank. Any area or receptacle intended to contain spills or leaks must not be shared with any other substances, including other hazardous chemicals that are not compatible with the hazardous chemicals to be contained.

Ensure spillage controls are in place to prevent or limit environmental contamination, and that ventilation is adequate for storage, handling and draining. This may require a ventilation survey.

Storage requirements for dangerous goods/hazardous substances are identified and applied

Each unit is responsible for the safe storage of all hazardous chemicals and dangerous goods in their workplace in line with regulatory requirements, requirements listed on the SDS and country’s Standards. This applies to all storage locations including laboratories, chemical stores, shared storage areas and workshops.

Hazardous chemicals in bulk must be stored appropriately so that the container, associated pipe work and transfer systems are in good condition. Where the need is identified this may include inspection and maintenance to occur on items that may include but not limited to:

- ✓ stable foundations and supports
- ✓ installation is free from excessive stress and forces
- ✓ protected from deterioration.

Hazardous chemicals stored in packages must be:

- ✓ closed when not in use
- ✓ stored on surfaces which will not deteriorate if the package is damaged resulting in a spill
- ✓ stored in such a way to minimise the risk of falling, and

- ✓ positioned in such a way so that leakage will not affect other hazardous chemicals.

Containers, pipe work and attachments holding DG are to be protected from physical damage which may include impacts, imposed loads and mechanical stress.

AS/NZS 3833 The Storage and Handling of Mixed Classes of Dangerous Goods in Packages and

Intermediate Bulk Containers outlines requirements for the separation of, and segregation within, stores containing more than one class of dangerous goods, in quantities exceeding those given for minor storage.

Generally, explosives (Class 1) and radioactive substances (Class 7) are incompatible with

everything and substances within the same class SHOULD be compatible (check for 5.1 oxidising






agents and 8 corrosives). ChemAlert's Dangerous Goods Storage Compatibility Guide provides

information on separation and segregation requirements

Inspection of storage areas should be undertaken and documented in line with the Workplace Safety Inspection Guidelines and related Checklists.

Storage Cabinets

Storage cabinets for dangerous goods must comply with the relevant Australian Standard. A brief summary of standards for some types of cabinets is listed on the next page. The full standard should be consulted.

DG Class		Doors	Lock	Clearance	Inner-Base Bunding
Class 3 Flammable liquids (AS 1940)		Self-closing & close-fitting	Held shut automatically by catches at 2 or more points	Minimum 3m laterally & 1m vertically (ignition)	Liquid-tight compound, at least 150mm deep, designed to prevent the compound from being used as a storage space
Class 5.1 Oxidising agents (AS 4326)		Self-closing & close-fitting	Held shut by catches that release in the event of a build-up of pressure within the cabinet	Minimum 3m (heat)	Liquid-tight compound, at least 150mm deep, capable of containing at least 25% of the total storage capacity
Class 5.2 Organic peroxides (AS 2714)		Self-closing & close-fitting with non-plastic hinges	Held shut by non-plastic catches that release in the event of a build-up of pressure within the cabinet	Minimum 3m (ignition)	Liquid-tight compound, at least 150mm deep, designed to prevent the compound from being used as a storage space
Class 6.1 Toxic substances (AS 4452)		Self-closing & close-fitting	Lockable	N/A	Liquid-tight compound, at least 150mm deep, capable of containing at least 25% of the total storage capacity
Class 8 Corrosive substances (AS 3780)		Self-closing & close-fitting	Held shut by catches at no fewer than two points	N/A	Liquid-tight compound, at least 150mm deep, capable of containing at least 25% of the total storage capacity

Secondary Containment

Areas where hazardous chemicals are used and stored should include secondary containment to capture the maximum possible spill. This can be in the form of permanent or temporary bunding, spill trays, secondary containers, etc.

Legislative requirements for dangerous goods/hazardous substances are used to plan work activities

Hazardous substances are covered by the OHS Regulations, and Dangerous Goods are covered by the Dangerous Goods Act and Regulations:

- ✓ the regulations have been recast to the Globally Harmonised System of Classification and Labelling of Chemicals (GHS) requirements and terminology.
- ✓ All references to the Approved Criteria for Classifying Hazardous Substances, Hazardous Substances Information System (HSIS) and associated terminology have been removed
- ✓ The AgVet labelling requirements have been amended to align with the Model WHS approach which is to allow for APVMA labels but require GHS hazard and precautionary statements
- ✓ the definition of 'container' has been amended to capture containers exceeding 500lts or 500kg

A hazardous substance means a substance that satisfies the criteria for hazard classification set out in Part 3 (Health Hazards) of the GHS, but does not include a substance that satisfies the criteria solely for one of the following hazard classes:

1. acute toxicity - oral - category 5;
2. acute toxicity - dermal - category 5;
3. acute toxicity - inhalation - category 5;
4. skin corrosion/irritation - category 3;
5. serious eye damage/eye irritation - category 2B;
6. aspiration hazard - category 2

A hazard pictogram means a graphical composition, including a symbol combined with other graphical elements, that is assigned in the GHS to a hazard class or hazard category

A hazard statement means a statement assigned in the GHS to a hazard class or hazard category describing the nature of the hazards of a hazardous substance including, if appropriate, the degree of hazard

Handling procedures for different classes and characteristics of goods are observed

Dangerous Goods are substances that present an immediate risk to people, property and the environment. These substances can be explosive, flammable, oxidising, toxic, radioactive or corrosive.

As dangerous goods present a number of risks to people, property and the environment, it is very important that you handle them in a safe and compliant manner to minimise the risks that they may have upon your workplace.

The requirements for the storage and handling of dangerous goods can be found in the Australian Standards. The Australian Standards are documents that outline the best practices for the storage and handling of dangerous goods in the workplace. Each dangerous goods class poses different risks upon the workplace and therefore Standards Australia have developed a different standard for each dangerous goods class. Below we will outline some important factors that must be considered when handling dangerous goods in the workplace.

Handling large packages of dangerous goods

With the increased use of dangerous goods in the last century, chemical manufacturers now package their dangerous goods in much larger packages. In this day and age, it is not uncommon to see dangerous goods such as acids and flammable liquids in packages as large as 205L drums and 1000L Intermediate Bulk Containers. Failure to handle these large packages with the right equipment can result in severe damage to people and property.

If your organisation procures their dangerous goods in 1000L intermediate bulk containers (IBC's), a forklift must be used to lift these IBC's in and out of chemical

storage containers. 205L drums have a rounded shape and they are a lot harder to handle. When these drums are lifted in and out of chemical storage containers, forklift attachments must be used. If your organisation does not have a forklift attachment for lifting 205L drums, these drums can be safely lifted in and out of chemical storage containers on a pallet.

Dispense dangerous goods away from other incompatible chemicals

When dangerous goods are dispensed from their containers, there is an increased risk that they will mix with other incompatible classes of dangerous goods. When incompatible classes of dangerous goods mix, it can result in violent chemical reactions that can easily harm people and property. To avoid harm to people and property, dangerous goods must be dispensed in an area that is isolated from other incompatible classes of dangerous goods. If you have separate dangerous goods storage facilities for each dangerous goods class, a safe location for dispensing dangerous goods would be inside the facility where the specific dangerous goods class is being stored. This location will be away from ignition sources and other incompatible chemicals.

When dangerous goods are being dispensed, it is important to do so in a bunded area to ensure that any spills are safely contained. It is also essential to have a spill response kit available in the area where the dangerous goods are being dispensed. This will allow any spills that may occur to be safely cleaned up.

Personal Protective Equipment

Personal protective equipment is another control measure that can be used to protect people and property from the risks associated with dangerous goods. It is particularly important to use personal protective equipment when dispensing and handling toxic and corrosive substances.

Toxic substances are substances that will cause harm to human health if they enter the body. The means by which toxic substances enter your body are called the routes of exposure. There are 3 main routes of exposure. These include:

- ✓ Ingestion
- ✓ Skin contact
- ✓ Inhalation

Of the three routes of exposure, inhalation is the most common form. To reduce the risk of exposure to toxic substances, it is important to use the correct personal protective equipment such as respiratory equipment and gloves while handling and dispensing toxic substance. Many substances such as flammable liquids, organic peroxides and oxidising agents are also toxic and the correct PPE must be used while handling these substances as well.

Another dangerous substance that often requires the use of personal protective equipment is corrosive substances. Corrosive substances are substances that will dissolve other materials such as stone, metal and human flesh. To reduce the risk of acid burns, corrosive resistant gloves must always be worn when handling corrosive substances.

To ensure that everyone in the workplace has access to the correct personal protective equipment, all the relevant PPE must be kept in a hi-visibility PPE cabinet that is close to the dangerous goods storage location.

Safety Data Sheets

To ensure that everyone in the workplace is aware of the specific risks associated with the dangerous substances that they are handling, it is very important to have a copy of the safety data sheets for each dangerous substance. Safety data sheets are documents that outline the specific reactivity, fire, health and environmental hazards associated with a particular substance. The safety data sheet will also outline the basic storage and handling requirements for the particular substance. Before a dangerous substance is dispensed or used, the safety data sheet for the substance must be consulted to ensure that the dangerous substance is handled in the safest manner. The safety data sheets for each substance must be kept in a secure document storage box, close to the area where the dangerous goods are being stored. This allows the safety data sheets to be easily accessed in the event of an emergency.

Next Steps

As dangerous substances pose many risks upon the people and property of your organisation, it is very important to ensure that you handle them in a safe manner. This includes using the correct handling equipment and PPE, and having safety data sheets close to the area where the dangerous goods are being stored. If you fail to handle dangerous goods in a safe and compliant manner, it could result in costly harm to the people and property of your organisation. Before dangerous goods are handled, it is very important to be aware of the specific chemical and physical properties associated with the dangerous goods that you are handling.

CONFIRM SITE INCIDENT PROCEDURES

Incident reporting processes are identified

In the event an incident occurs at the University or in the course of undertaking university business, the following steps shall be followed by the person or persons involved, the person nominated to investigate (responsible supervisor or other delegated person) and others rendering assistance.

Immediate Incident Response

- a) If no danger to yourself, render immediate action to ensure own safety and that of others
- b) Where there is a foreseeable risk to yourself and others in rendering immediate action, seek
- c) assistance from FM Assist.
- d) Provide or seek first aid treatment and where necessary, emergency assistance where medical
- e) assessment is identified for any injuries sustained
- f) Isolate the site where there remains risk of further injury
- g) Where an incident is immediately notifiable to SafeWork SA (results in serious injury or a dangerous occurrence) and notification has been made by the Safety & Wellbeing team, so far as is reasonably practicable, the site where the incident occurred must not be disturbed until an inspector arrives at the site or directs otherwise (whichever is earlier).

Reporting Incidents

- a) Immediately notify your supervisor/manager of the incident that has occurred
- b) The responsible supervisor/manager or delegated person shall:
 - 1. immediately notify Safety and Wellbeing on 0407 181 594 or 8302 2459 of any serious incidents that meet the criteria for statutory reporting outlined above
 - 2. immediately advise the responsible senior manager of the Research Institute, Academic or Central Unit and Campus Senior WHS Consultant where a serious injury/illness or death has occurred or where there is potential for serious harm to a person or persons, significant damage to property or serious impact on the environment (dangerous occurrence)
 - 3. assist in facilitating prompt injury management processes for the injured/ill employee. Note: Injury/Illness reports submitted to the online system will inform the University Injury Management team and initiate the Injury Management Early Intervention Program
 - 4. arrange for debriefing where an incident has resulted in serious injury/illness, death to a person or persons and/or has impacted on other people or caused concern within an area. Employee counselling should be offered to any personnel affected by the incident using the University's Employee Assistance Program provider by calling: 1300 277 924. For critical incidents such as a fire, bomb threat or flood.

- c) The person involved or a person on their behalf shall:
1. log details of the incident using the online Hazard & Incident Reporting & Investigation System as soon as practicable after the incident and within 48 hours
 2. Note: An employee or other authorised person shall log details of an incident in the online reporting system on behalf of a student, contractor, volunteer or others (i.e. member of public, visitor)
 3. nominate the supervisor/manager responsible for the person injured or involved to investigate the circumstances of the incident. For example:
 - supervisor/manager directly responsible for an injured/involved employee
 - contract supervisor responsible for a project where an external contractor is injured/involved
 - program services manager responsible for an injured/involved student

Note: For incidents that occur in remote localities (e.g. on fieldtrips, placements etc), where computer facilities are limited and/or non-existent, details must be communicated to a nominated contact person who shall report the occurrence on their behalf.

Incident Investigation

The responsible supervisor/manager or other delegated person nominated to investigate an incident shall:

- a) ensure an investigation commences as soon as possible after an incident occurs and in consultation with:
 - the injured/involved person (where practical)
 - the HSR (where applicable)
 - the campus WHS Consultant
 - any other personnel relevant to the matter
- b) establish that the incident site is safe prior to investigating to prevent further injury. Refer to above to ensure an incident site is not entered into where a serious notifiable incident has occurred.
- c) gather factual information to describe the circumstances, for example what happened, what occurred leading up to the incident, other contributing factors, who else was involved etc.
- d) analyse the factual information gathered to identify contributing factors and underlying causes relating to potential deficiencies in the following:
 - System – a method, a set of independent and interrelated elements that function as a whole i.e. workplace procedures or processes that specify the way in which something is implemented

- Design – design of plant/machinery/equipment, design of work task/processes
- Environment – the surroundings in which work is performed i.e. work environment / work conditions / naturally occurring environmental conditions
- Behaviour – human factors including inexperience / complacency / work pressure / fatigue, medical illness etc.

Note: the investigation should identify causes other than just ‘human error’ or ‘complacency’ where factual information relates to potential deficiencies in any of the four categories mentioned above.

- e) make conclusions about why the incident occurred based on the investigation findings
- f) recommend appropriate corrective action/s in consultation with all personnel involved in the investigation to prevent a recurrence
- g) ensure identified corrective action is implemented prior to work re-commencing i.e. building development/refurbishment projects, building services infrastructure, laboratory/workshop processes
- h) complete the online investigation form, corresponding with the online logged report (same occurrence number) within the online Hazard & Incident Reporting & Investigation System, including details of corrective action taken or expected to be taken and submit as soon as practicable following investigation. Corrective actions recorded on the online incident investigation form shall be followed up by the Safety & Wellbeing Team where necessary to ensure appropriate action is implemented and completed to prevent a recurrence
- i) include any planned corrective action in the WHS Local Action Plan following the outcome of the investigation to ensure action is implemented, particularly where an ongoing scheduled activity is required
- j) monitor and evaluate corrective action/s implemented to ensure the controls selected have been effective to mitigate risk and have not presented any new hazards.

Reporting Identified Hazards

- a) Fix the hazard immediately and safely if competent to do so and there is no danger to yourself or others
- b) Where the hazard cannot be fixed immediately, promptly notify your supervisor/ manager, the local HSR (where applicable) and isolate the site where there is immediate risk of injury
- c) Immediately notify FM Assist of any campus related matters (i.e. hazards relating to building /infrastructure) and raise a Customer Service Request (CSR) for assistance where corrective action is required
- d) Log details of the hazard (attach photos where possible) using the online hazard report within the Hazard & Incident Reporting & Investigation System to ensure appropriate action is taken to eliminate the hazard or mitigate the risk

Note: Nominate the supervisor/manager responsible for the area where the hazard was identified, to investigate the reasons for the hazard being present. For example:

- supervisor/manager responsible for a hazard present within the context of work performed within an Academic or Central Unit, or Research Institute.
 - contract supervisor responsible for a project involving work undertaken by an external contractor
 - program services manager responsible for a hazard relating to a course undertaken by a student
- e) Supervisors/managers are required to proactively identify reasonably foreseeable hazards within the context of work being performed in a local area (i.e. hazards associated with working with chemical substances, plant and equipment, fieldtrips, working remotely, workloads etc.) and advise employees and students of the requirement to report such a hazard to them immediately when identified. For example, a laboratory manager shall instruct people working in their laboratory to report any malfunction of a fume cupboard. Alternatively, a person observed performing an unsafe task, activity and/or in unsafe conditions should also be reported. Hazards identified through periodic workplace inspections that cannot be fixed immediately and require specialist advice/assistance, should be reported using the online system to ensure appropriate corrective action is implemented to prevent injury.

Emergency equipment is located and checked in accordance with workplace procedures and statutory regulations

All employers are obligated to ensure staff are trained in workplace emergency procedures. This may include what to do in case of a fire, earthquake, or other emergency; identifying locations of emergency exits; and processes to follow to evacuate the building in the case of an emergency. These procedures are site specific and should be a part of the training for all new employees. In addition, regular drills or reviews of procedures are important to ensure that if an actual emergency occurs, everyone is able to react accordingly and safely.

Orientation to any new job site, even if temporary, should always include the following information:

- Location of emergency exits
- Location of first aid supplies or the procedures to call for an attendant
- Location of fire extinguishers
- Evacuation procedures and muster stations
- Any hazards present on the site

First Aid Procedures

Providing access to first aid supplies or attendants is a requirement of employers under the OHS Regulation, but the required vary according to the size of the employer and many other factors. For example, in some cases it is required that a designated first aid attendant be on duty, while in others it is enough to provide a first aid kit stocked with a prescribed list of supplies. Many industrial settings and B.C. training institutions are equipped with a first aid station with a trained attendant. The person who staffs that station is able to perform a wide variety of services from bandaging minor cuts to stopping major bleeding and splinting broken bones.

All workers should know where the first aid station is, who staffs it, and what services are available. If you sustain an injury, no matter how minor, ensure that the incident is reported in the first aid station log. Minor irritations often develop into major problems, so report all injuries promptly.

Emergency Wash Station or Shower Locations

There may be times when you are working with acids or hazardous substances such as cleaning solutions which may burn your flesh or splash into your eyes. If you accidentally splash or spill a corrosive substance on your skin, you will want to wash the affected area very quickly with large amounts of water to dilute the acid and minimize burning. It is therefore necessary that you be aware of the location of your emergency eyewash stations, sinks, or showers throughout your work site.

Fire Safety Procedures and Regulations

Components that produce fire

Before a fire can occur, these three components must be present:

- Fuel (a combustible material such as wood, gasoline, paper, or cloth)
- Heat (sufficient to raise the fuel to its ignition temperature)
- Oxygen, usually in the form of air (to sustain combustion)



Fire triangle

When these three components combine, as shown in the fire triangle (Figure), the result is rapid combustion (fire). Keeping these three components separated will prevent a fire from occurring. An existing fire can be extinguished by removing any one of the three components:

- ✓ Remove the fuel (combustible material) from the vicinity of the fire. For example, if you shut off the valve of a gas main, the result will be starvation.
- ✓ Remove the heat. For example, by applying water, the result will be cooling.
- ✓ Remove the oxygen. For example, if you cover the fire with a lid, a wet blanket, or some sand, or you use a carbon dioxide, foam, or dry chemical extinguisher, the result is smothering.

Remember, keeping these three components separated will prevent a fire from occurring. Likewise, an existing fire can be extinguished by removing any one of the three components.

Combustion speed

Fire, or combustion, is a form of oxidation (the union of a substance with oxygen). During the process of oxidation, energy is released in the form of heat — sometimes accompanied by light. Oxidation takes place at varying rates of speed. Table 1 shows examples of oxidation occurring at differing rates of speed.

Combustion speeds	
Speed	Example
Very slow	The rusting of iron
Slow	The spontaneous heating of materials such as oil soaked rags
Fast	The burning of paper or wood

Extremely fast	The exploding of gunpowder upon ignition
----------------	--

First aid firefighting

First aid firefighting is best described as extinguishing a fire in its initial stages (before the fire can become too large) by using whatever is readily at hand. First aid extinguishers are designed to deal with fires in their infancy. These traditional fire extinguishers are still required on all work sites, even in areas protected by sprinkler systems.

Emergency procedures are identified and confirmed

As noted above, fire is only possible where there is a supply of combustible materials, oxygen, and heat. However, lack of caution, equipment failure, or simple human error can cause ignition. Here are some fire safety precautions for working near, handling, or storing flammable materials.

Flammable liquids and related equipment

The nature of flammable liquids makes them very vulnerable to ignition. Consequently, the following storage precautions are necessary:

- ✓ All containers of flammable liquids must be of an approved type and clearly marked.
- ✓ All containers must have secure capping devices.
- ✓ Open flames or lit cigarettes must be prohibited within or near any liquid-gas storage area.
- ✓ Where drums are used as containers, they must have taps and a drip tray.
- ✓ Transportation must only take place while containers are sealed.
- ✓ All empty containers must be stored on end.
- ✓ Spills must be cleaned up or covered with sand.

Any equipment that requires a flammable liquid needs the same basic precautionary measures as stored liquids. All tank or equipment leaks must be reported and then repaired immediately.

All waste liquids that are flammable must be placed in approved containers for disposal and taken to the appropriate location for disposal according to municipal waste disposal regulations.

Paper and wood products

Dry paper and wood are susceptible to ignition quite easily. When damp or wet, they do not ignite quickly. Keep all paper and wood products away from open flames such as burners and pilot lights.

Oily cloths

All oily cloths must be placed in metal bins with sealed lids and sent to be laundered professionally.

Oils and fats

All oils and fats have a predetermined flash point at which they will ignite. This is considerably higher than the smoke point where the oil gives off large amounts of smoke, which is a good indicator that the heat should be removed or turned down. For safety considerations, allow oil to cool down before removing or recycling.

Garbage and clutter

Garbage and clutter present a problem in fire prevention for two reasons. Garbage may contain substances that are toxic when burned, and clutter in high traffic areas may present an obstruction for fire fighters or for those trying to evacuate a building. Always ensure that exit corridors are kept clear and that garbage is disposed of regularly.

SELECT HANDLING TECHNIQUES

Load handling and shifting procedures are selected in accordance with identified requirements for particular goods

A risk assessment must be performed when hazardous chemicals and dangerous goods are to be transported. Dangerous goods during transport are subject to the ADG Code. Dangerous goods transported by air must be packaged by a licenced dangerous goods handler. Minor transport of hazardous chemicals and dangerous goods for purposes such as fieldwork, must comply with the relevant guidelines and SDS including segregation from food stuffs, and as appropriate labelling and signage. Hazardous chemicals and dangerous goods should not be transported within the cabin of the vehicle.

It is necessary to identify those hazardous chemicals and hazardous chemicals at the workplace together with any foreseeable hazards arising from the use, storage and handling of the product.

This can occur through risk management processes as per the WHS Risk Management Guidelines.

This identification may include a stocktake to establish:

- ✓ what items are stored
- ✓ the method of storage
- ✓ transport
- ✓ how it is handled and used
- ✓ who is in control

- ✓ substance compatibility and separation
- ✓ hazardous areas that is within, or arises from storage or handling.

Transfer

When transferring hazardous chemicals:

- an appropriate area should be set aside for the purposes of transfer or decanting of hazardous chemicals products
- vapour or dust generation during transfer should be minimised
- where static electricity is generated, appropriate controls measures should be adopted to minimise the charge build up eg earthing, bonding or relaxation
- ensure the suitability of pipe work, attachments and associated safety systems in areas where the risk elimination or control measures have been proposed.

Consideration should be given to minimising the generation of static electricity and for sources of heat or ignition.

Handling equipment is checked for conformity with workplace requirements and manufacturer guidelines

The use of mechanical equipment to move and store materials can increase the risk of injury to employees. Before operating mechanical equipment to handle materials, a risk assessment should be completed in accordance with the WHS Risk Management Guidelines. In particular, thought should be given to:

- ✓ the most appropriate mechanical equipment to assist with materials handling
- ✓ the load rated capacity (maximum weight) of the selected mechanical equipment to avoid overloading
- ✓ traffic management and the need to ensure provisions are made to guarantee pedestrian safety for a traffic management plan.

If the mechanical handling is assessed as medium or high level of risk, risk controls including isolation or development of safe work procedures may be required to be developed for the task consisting of an action plan to manage traffic and ensure pedestrian safety. If traffic management is required this should be completed by a qualified person in accordance with the WHS Training Guidelines.

Hand Truck (2-Wheel Trolley)

The following principles should be applied for the safe use of hand trucks:

- ✓ load weight should be within the Rated Load (RL) of the particular trolley

- ✓ load should be stable and have a centre of gravity not higher than handle height
- ✓ keep the centre of gravity low by placing heavier items below the lighter ones
- ✓ load height should be such that the operator has clear visibility in the direction of travel
- ✓ place the load so that it will not slip, shift or fall, and secure it with straps if they are provided
- ✓ always wear enclosed footwear when using this equipment to move items
- ✓ distance to be travelled should not be greater than 35m without a break
- ✓ path should be free of obstacles and be at least 1m wide
- ✓ load weight of one-person handling should not exceed 100kg
- ✓ push the load so that the weight will be carried by the axle and not the handle
- ✓ tip the load slightly forward so that the tongue of the hand truck goes under the load and then push the tongue of the hand truck all the way under the load
- ✓ do not walk backward with a hand truck unless going up stairs or ramps
- ✓ when going down an incline, keep the hand truck in front of you so it can be controlled at all time
- ✓ move hand trucks at a walking pace
- ✓ hand truck should not be used by an employee more than 200 times per day
- ✓ store hand trucks with the tongue under a pallet, shelf or table.

Hand Trolley (3-, 4-, 5-, 6- Wheel Trolley)

The following principles should be applied for the safe use of hand trolleys:

- ✓ load weight should be within the RL of the particular trolley
- ✓ use a trolley that is designed in accordance with ergonomic guidelines
- ✓ for 3-wheel trolleys, the load should be stable and have a centre of gravity not higher than handle height
- ✓ place the load so that it will not slip, shift or fall, and secure it with straps if they are provided
- ✓ always wear enclosed footwear when using this equipment to move items
- ✓ load height should be such that the operator has clear visibility in the direction of travel—if the view is obstructed, get a second person to assist
- ✓ load length should be such that the trolley and load are easily manoeuvrable, and can be readily stopped
- ✓ consider the use of two persons to handle trolley loads longer than 4m to minimise the risk of injury from the high force required to stop the load suddenly and maintain its stability should it come into contact with other persons, or fixtures or items
- ✓ total distance travelled with a load should not exceed 400m
- ✓ path should be free of obstacles and have good clearance for the trolley

- ✓ do not walk backward with a hand trolley unless going up ramps
- ✓ when going down an incline, keep the trolley in front of you so it can be controlled at all times
- ✓ use a trolley fitted with brakes if required to stop on a ramp or regularly use a ramp;
- ✓ move hand trolleys at a walking pace
- ✓ hand trolleys should not be used by an employee more than 200 times per day
- ✓ if trolleys are pushed up a slope, the load should be reduced so that the recommended rolling force limit is not exceeded.

Hand Pallet Jack

The following principles should be applied for the safe use of hand pallet (electrical and manual) jacks:

- ✓ load weight should be within the RL of the particular hand pallet jack
- ✓ load height should be such that the operator has clear visibility in the direction of travel. If the view is obstructed, get a second person to assist
- ✓ secure the load on a pallet or place it in a stillage so that it will not slip, shift or fall
- ✓ distance to be travelled should not be greater than 35m
- ✓ path should be free of obstacles and be at least 1.3m wide
- ✓ if a T-handle is used, it should be long enough to protect the employee's feet from being struck by the pallet during pulling activities
- ✓ if hand pallet jacks are pushed up a slope, the load should be reduced so that the recommended rolling force limit is not exceeded
- ✓ do not walk backward with a hand pallet jack unless going up ramps
- ✓ when going down an incline, keep the pallet jack in front of you so it can be controlled at all times
- ✓ use a hand pallet jack fitted with brakes if required to stop on a ramp or regularly use a ramp
- ✓ move hand pallet jacks at a walking pace
- ✓ start and stop the pallet jack gradually to prevent the load from slipping
- ✓ hand pallet jack should not be used by an employee more than 200 times per day
- ✓ due to the wheel design, do not use hand pallet jack on gravel, damaged, or uneven surfaces
- ✓ always wear enclosed footwear when using this equipment to move these items
- ✓ never ride on hand pallet jacks.

Pedestrian Traffic Safety

Use of mechanical aids to move materials should not place pedestrians at risk. Where appropriate:

- ✓ clear walkways for pedestrians should be marked and identified to isolate pedestrian areas from traffic areas and minimise pedestrian/vehicle interaction
- ✓ loading and unloading docks/areas should be clearly marked and identified
- ✓ designated storage areas should be marked and identified.

Suitable signage or placards are checked for compliance with workplace procedures, as required

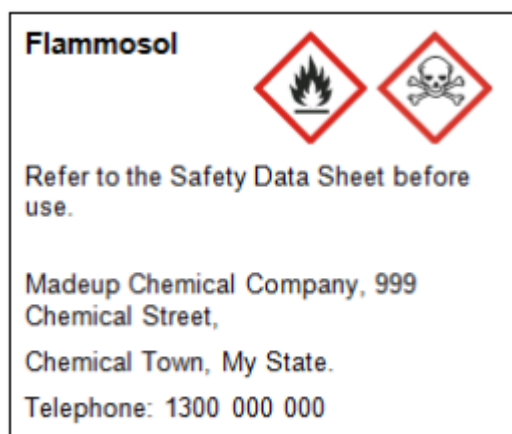
Special labelling requirements may be applied in some circumstances. The Labelling of Workplace Hazardous Chemicals Code of Practice outlines specific guidance for:

- ✓ Small containers
- ✓ Research chemicals or samples for analysis
- ✓ Decanted or transferred chemicals
- ✓ Hazardous waste products
- ✓ “Internal use” chemicals with known hazards
- ✓ Dangerous goods packaged for transport
- ✓ Consumer products
- ✓ Agricultural or veterinary chemical products
- ✓ Products containing nanomaterials

Small containers

Where a hazardous chemical is packaged in a container that is too small to attach a label with information that is required of hazardous chemical labels in general, then the label must include the minimum requirements of:

- ✓ Written in English (legibly)
- ✓ The product identifier
- ✓ Name, address and business telephone number of manufacturer or importer
- ✓ Hazard statement OR pictogram
- ✓ Any other element that is reasonably practicable to include (priority should be given to elements relating to the most significant hazards)



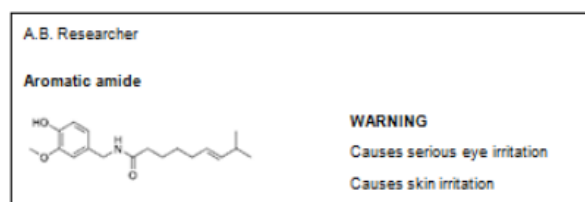
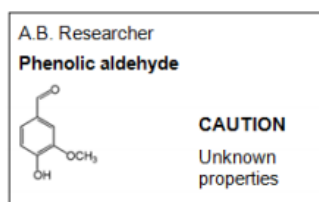
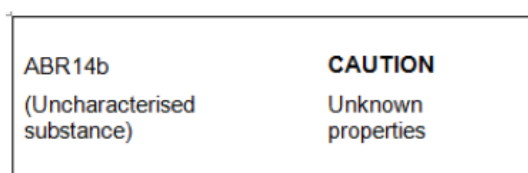
Research chemicals or samples for analysis

If a hazardous chemical is used for research purposes only or is a sample for analysis, the label must include the minimum requirements of:

- ✓ Written in English (legibly)
- ✓ The product identifier, which may be the:
 - Actual name of chemical
 - Recognised abbreviation or acronym
 - Chemical formula, structure, or reaction components
- ✓ Hazard statement OR pictogram
- ✓ The identity of the substance or mixture must be determined

Where research chemical or sample for analysis cannot be identified this should be indicated

clearly on the label.



Decanted or transferred chemicals

If a hazardous chemical has been decanted or transferred from the container in which it was packed and will not be used immediately or it is supplied to someone else, the label must include the minimum requirements of:

- ✓ Written in English (legibly)

- ✓ The product identifier
- ✓ Hazard statement OR pictogram

Where the entire decanted amount will be used immediately, labelling of its container is not required.

Where a container is repeatedly used for decanting the same substance, a permanent label (including ALL Labelling of Containers requirements) must be attached to that container.

Hazardous waste products

If it is reasonably likely that a waste product is a hazardous chemical, then the label on the container of the hazardous waste must include the minimum requirements of:

- ✓ Written in English (legibly)
- ✓ The product identifier, which should reflect the nature of the waste as closely as possible, eg:
 - Chlorinated solvent waste
 - Flammable waste
 - Heavy metal waste
- ✓ Name, address and business telephone number of manufacturer or importer
- ✓ Hazard statement OR pictogram

UOW has labels for hazardous, biological, radiological, cytotoxic, toxic, halogenated, nonhalogenated, aqueous acidic and aqueous alkaline waste

Wollongong Campus
Northfields Avenue
Wollongong NSW 2522
Phone: (02) 4221 3555

**UNIVERSITY OF
WOLLONGONG**
AUSTRALIA





HAZARDOUS WASTE DISPOSAL IDENTIFICATION LABEL

Name: _____

Signature: _____ **Phone:** _____

Unit: _____ **Date:** ____/____/____

Item/s Disposed (Chemical name):

Waste Type: ☐ Other

<input type="checkbox"/> Halogenated <input type="checkbox"/> Non-Halogenated <input type="checkbox"/> Acetone (Class 3) <input type="checkbox"/> Silica gel <input type="checkbox"/> Ethidium bromide (Class 6.1)	<input type="checkbox"/> Flammable (Class 3) <input type="checkbox"/> Corrosive (Class 8) <input type="checkbox"/> Aqueous - acidic (Class 9) <input type="checkbox"/> Aqueous - alkaline <input type="checkbox"/> Metal
--	--

UN Number/s: _____

Package Size: _____ **Quantity (Approx volume):** _____

If Applicable:

Dangerous Goods Class _____ **Packaging Group:** I / II / III
(Circle)

HRD-WHS-FRM-372.4

DISPOSE OF DANGEROUS WASTES

Identify different types of dangerous wastes

You might think that toxic waste is somebody else's trouble. But if whatever you do for fun or profit produces a waste that can cause harm by its being absorbed through the skin, inhaled, or swallowed.

Odds are that you're generating what the EPA considers a toxic waste if you're in the business of manufacturing, farming, construction, automotive servicing, laboratory work, or medicine. All of these activities can yield heavy metals, radiation, dangerous pathogens, or other poisons that can pollute the air, water, or soil.

Truth be told, just living your life can yield toxic waste. Common household products such as batteries, pesticides, paint, and automobile lubricants are considered toxic when improperly disposed of. Computers, televisions, and cell phones contain toxic chemicals. The roster of things you can simply toss into the garbage is getting smaller and smaller.



The United Nations Environment Program (UNEP) has published a rogues' gallery of chemical bad-actors that pose a risk to human health and are therefore considered toxic waste. Among them:

Arsenic—a ubiquitous carcinogen indispensable in the manufacture electrical circuits, wood preservatives, pesticides, and poisoning political rivals

Asbestos—prized for its insulating quality until it was learned that inhaling stray fibers is carcinogenic, although it's still used to make automobile brakes and roofing materials (N.B. Never lick automobile brakes or roofing materials)

Cadmium—a malleable, ductile metal that's an excellent electrical conductor and thus indispensable for batteries and electroplating—but breathing the stuff can cause lung damage, irritation of the digestive tract, and/or kidney disease

Chromium—used to line industrial furnaces, to strengthen steel, in the manufacture of dyes and pigments, in wood preserving, for leather tanning, and making shiny car bumpers—it's also associated with cancer, chronic bronchitis, and lung damage

Clinical wastes—such as contaminated "sharps;" human blood and blood products; pathological, microbiological, or "isolation" wastes; cultures and

stocks of infectious agents; and other stuff you don't even want to think about—let alone touch

Lead—found in batteries, paints, and ammunition—it can damage nerve, reproductive, and/or renal function if ingested or inhaled

Mercury—a liquid metal and electrical conductor used in specialty switches and found in thermometers, barometers, and other scientific instruments—not to mention your dental fillings. Exposure can lead to birth defects and kidney and brain damage

PCBs—these are mostly banned but pose a risk when legacy equipment is incinerated or otherwise improperly disposed of, as exposure can damage human nervous, reproductive, and immune systems, as well as your liver

Persistent Organic Pollutants (POPs)—substances in chemicals and pesticides that cause nervous and reproductive system defects and that can accumulate in the environment or food chain

Strong acids and alkalis—used in manufacturing and industrial production, they can cause destruction of human skin at the site of contact within a specified period of time

Select proper disposal procedures

Hazardous Material Disposal

Hazardous waste is waste that is dangerous or potentially harmful to our health or the environment. Under the United States Environmental Protection Agency (USEPA), waste can be a listed hazardous waste, or characteristically hazardous. Listed hazardous wastes, by definition, have been determined by USEPA as being hazardous.

Waste that has not been specifically listed can still be characteristically hazardous if it exhibits any one of the following characteristics:

- ✓ Ignitability;
- ✓ Corrosivity;
- ✓ Reactivity; or
- ✓ Toxicity.

Ignitability

- ✓ Flammable Liquids – Flashpoint <140°F (e.g., alcohols, acetone, ethyl acetate, mineral spirits, gasoline)

- ✓ Oxidizers (e.g., nitrates, perchlorates, bromates, permanganates, peroxides, iodates)
- ✓ Organic Peroxides (e.g., benzoyl peroxide, cumene hydroperoxide, methyl ethyl ketone peroxide)

Corrosivity

Aqueous liquids with a pH < 2 or > 12.5 or other liquids capable of corroding steel at a rate of > 6.35 mm (0.250 inches) per year at a test temperature of 55°F.

- ✓ Inorganic Acids (e.g., hydrochloric acid, sulfuric acid, nitric acid, perchloric acid, phosphoric acid)
- ✓ Organic Acids – (e.g., formic acid, lactic acid)
- ✓ Bases – (e.g., hydroxide solutions, amines)
- ✓

Reactivity

Materials which can react violently or create toxic fumes:

- ✓ Sulfides and cyanides
- ✓ Peroxide formers (e.g., ethers, potassium amide, sodium amide, vinyl acetate, tetrahydrofuran)
- ✓ Water Reactive Materials (e.g., sodium, potassium, lithium, calcium carbide)
- ✓ Multi-nitrated Compounds (e.g., picric acid, nitrosoguanidine, trinitroaniline)
- ✓ Perchlorate crystal formers (e.g., perchloric acids)
- ✓ Compounds that may undergo vigorous polymerization (e.g., acrylic acid, vinyl acetate, methyl acrylate)

Toxicity

A waste which, when using the toxicity characteristic leaching procedure (TCLP), leaches any number of metallic, organic, or pesticide constituents in concentrations greater than specified in the regulation. Examples for these constituents include arsenic, barium, cadmium, chloroform, chromium, m-cresol, mercury, selenium, and silver.

Disposal of hazardous materials into sinks, drains, commodes, or other sewage disposal channels is **STRICTLY PROHIBITED**.

Storage

All chemical wastes shall be stored using proper chemical segregation practices to avoid intermixing of incompatible materials. (See the Chemical Segregation and Storage Chart for guidance on how to properly store chemical waste containers).

All chemicals shall be stored in a satellite accumulation area near where the waste was generated. Moving/relocating hazardous wastes away from where they were generated is prohibited.

Additionally, no more than 55 gallons of hazardous waste (cumulative total off all wastes in an area) and only one quart of an acutely hazardous waste can be present within a single point of generation (laboratory or maintenance shop). Please note, single used oil containers or petroleum based products equal to or exceeding 55 gallons are subject to additional requirements found within the Spill Prevention, Control, and Countermeasures (SPCC) Policy.

Labeling

All hazardous waste containers shall be properly labeled with the words "Hazardous Waste", a description of the waste contained in the container, the hazards associated with the waste, and the location where the material was generated. If bottles are reused, remove the old chemical name and hazards completely and indicate the type of chemical waste on the container without abbreviations. Hazardous waste containers not labeled in accordance with this policy shall not be removed from the area until such label is affixed to the container (see "Labeling-Hazardous Waste Containers"). If the contents of the container are unknown, please indicate this on the label and in the waste pick up request. Containers of unidentified wastes may need to be evaluated in person by waste vendor before they are removed for disposal.

In an effort to make container labeling easier for users EHS has created multiple labeling options. Please see the links below for links to Adobe forms for printed and handwritten label formats. Additionally, waste labels may also be printed from within the EHS Assistant program once a waste request has been entered.

Packaging

All hazardous waste shall be packaged in accordance with the following instructions:

- ✓ Use a leak-proof container that will safely contain the contents. Open chemical containers, plastic bags or culture dishes will not be accepted.
- ✓ Containers must be closable.
- ✓ The container shall not be overfilled with liquid waste.
 - Empty space of at least five percent of the container volume shall be left to allow for thermal expansion.
 - Be suspicious of any pressure build-up inside the container (e.g. pirahna waste)

- If this is a concern when closing the container, use a cap designed to allow venting of over-pressure or do not secure the cap tightly and if appropriate, place the container inside a fume hood or other well-ventilated area until the chemical reaction has reached equilibrium and is removed by the waste collector.
- ✓ Old cans of dry picric acid or other shock sensitive compounds and all known or suspected peroxide forming chemicals (PFC) shall be left in place and not moved until the waste collector has evaluated the condition of the container. (Note: Friction, heat, and exposure to air can cause aging PFCs to explode).
- ✓ PFCs that MUST be disposed of within three (3) months of opening:
 - Divinyl acetylene
 - Divinyl ether
 - Isopropyl ether
 - Potassium amide
 - Potassium metal
 - Sodium amide
 - Vinylidene chloride
- ✓ PFCs that must be monitored for peroxides or discarded 12 months after opening. (This list is not exhaustive. Please check the SDS and dispose of the material per the manufacturer's expiration date.)
 - Acetal (1,1-diethoxyethane)
 - Acetaldehyde
 - Benzyl alcohol
 - 2-Butanol
 - Cumene
 - Cyclohexanol
 - 2-Cyclohexen-1-ol
 - Cyclohexene
 - Decahydronaphthalene
 - Diacetylene
 - Dicyclopentadiene
 - Diethyl ether
 - 4-Heptanol
 - 2-Hexanol
 - Methylacetylene
 - 3-Methyl-1-butanol
 - Methylcyclopentane
 - Methyl isobutyl ketone
 - 4-Methyl-2-pentanol
 - 2-Pentanol
 - 4-Penten-1-ol
 - 1-Phenylethanol
 - 2-Phenylethanol

➤ 2-Propanol

Refrigerators and Freezers

Equipment containing refrigerants must be disposed of in a manner which is compliant with the EPA's Clean Air Act. For more information regarding the disposal of refrigerators, freezers or other small appliances containing <5 Gallons of refrigerant please see the Disposal of Refrigerators and Freezers guidance document.

Empty Chemical Containers

Chemical containers that have been emptied of their contents by normal methods are not regulated as hazardous waste. The container shall be triple rinsed with water or other suitable solvent and air-dried to ensure that it is free of liquid or other visible chemical residue before disposal.

For volatile organic solvents (e.g., acetone, ethanol, ethyl acetate, ethyl ether, hexane, methanol, methylene chloride, petroleum ether, toluene, xylene) not on the EPA Acutely Hazardous Waste "P" List, the emptied container can be air-dried in a ventilated area (e.g., a chemical fume hood) without triple rinsing.

If the chemical is on the EPA Acutely Hazardous Waste "P" List, or if the material is known to have high acute toxicity, the washings shall be collected and disposed of as hazardous waste by contacting Environmental Health and Safety and requesting a chemical pick-up. In many circumstances it may be advisable to dispose of the empty chemical container as waste rather than triple rinsing the container, which may only increase the volume of waste material needing to be disposed. Additionally containers with residual reactive materials (pyrophoric, water-reactive, or strong oxidizers) should not be treated as empty and should be disposed of as hazardous waste.

Empty reagent bottles may be used for the disposal of laboratory chemical wastes. However, it is important to verify that the chemical wastes are compatible with the empty reagent containers.

Note: It is improper to dispose of volatile liquids by evaporating.

Glass Containers

Empty, intact, unbroken glass chemical containers that meet the above requirements for empty containers may be disposed of as regular laboratory waste in the general waste stream. Completely remove or deface chemical labels using a permanent black marker before disposal. Remove any caps from the bottles.

Broken laboratory glassware free from any biohazardous, radioactive, and

chemical contamination shall be disposed of by packing in a designated broken glass receptacle, cardboard box, or other rigid container. This includes the disposal of the following uncontaminated items:

- ✓ Broken glass
- ✓ Glass vials
- ✓

To minimize various potential hazards when discarding broken or un-serviceable glassware, the guidelines below shall be followed:

- ✓ Dispose of broken laboratory glassware in designated broken glass containers only. These shall be puncture proof, double-lined cardboard boxes or other containers specifically designed for the disposal of glassware not weighing more than 20 pounds when full. They can be obtained from various laboratory equipment distributors;
- ✓ When the box is full, securely seal with tape to prevent any leaks;
- ✓ Label the container as "TRASH";
- ✓ Never use broken glassware boxes for the disposal of sharps, medical/biohazardous materials or liquid wastes;

The following items contaminated with medical/biohazardous material shall be placed in a designated sharps container (for more information see the Potentially Infectious Waste Policy):

- ✓ Broken glassware
- ✓ Glassware with sharp edges or point
- ✓ Pasteur pipettes
- ✓ Glass slides

Contact the appropriate Facility Manager to make arrangements for pick-up

All personnel handling broken glass containers should:

- ✓ Check the weight and integrity of the container prior to lifting;
- ✓ Wear safety glasses and work gloves when handling the container;
- ✓ Do not remove the box if you see a red or orange liner;
- ✓ Do not remove the box if open, compromised, wet or suspected of containing chemicals; and
- ✓ Immediately contact your supervisor with any issues.
- ✓

Metal Containers

Metal containers must be triple-rinsed with water or other suitable solvent and air-dried. If the container is free of hazardous chemical residues, remove or deface any hazard markings or labels, it may then be placed in the regular laboratory trash or recycling receptacles.

Secondary Containers

Containers that were used as overpack for the primary chemical container may be placed in regular trash or recyclable trash. Any packing materials, such as vermiculite, perlite, clay, Styrofoam, etc., may be placed in the regular trash unless it was contaminated with the chemical as a result of container breakage or leak. Packing materials contaminated with hazardous materials shall be disposed of as hazardous waste.

Dispose the wastes accordingly

There are several basic steps and regulations that all individuals must follow to properly and safely handle, store and dispose of hazardous materials generated in their work area:

- ✓ First investigate whether or not processes using hazardous materials can be eliminated; or determine if alternative methods exist for processes that do not use hazardous materials.
- ✓ Attempt to reduce the quantity, toxicity or other hazardous characteristic of materials being generated from processes that cannot be eliminated or substituted for by an environmentally safe process.
- ✓ Evaluate hazardous materials characteristics to ensure that incompatible materials are not combined or stored near one another.
- ✓ Do NOT dispose hazardous materials to the sanitary sewer system, atmosphere (i.e., evaporation), or solid trash receptacles (please see Part 400.05 - Unacceptable Hazardous Materials Management Practices).
- ✓ Insure that proper containers are available to accumulate each waste stream in advance of actually conducting research, analyzing samples or starting a chemical process.
- ✓ Properly label containers with words that accurately identify each container's contents.
- ✓ Keep track of accumulations to the container (all constituents and their concentrations). A log book with entries referenced to unique container numbers is helpful.
- ✓ Containers must ALWAYS be kept closed between accumulations.
- ✓ Minimize the accumulation of hazardous materials in your area by submitting materials and full containers promptly to EHS for disposal. Never accumulate more than 55 gallons of hazardous materials or one (1) liter of acute hazardous waste in a given area.
- ✓ Submit all chemicals and hazardous materials to EHS for final characterization, collection and proper disposal.

UNIT 10

WORK SAFELY WITH INSTRUMENTS

This unit of competency covers the ability to safely store, transport and operate laboratory instruments following established safe work practices and in accordance with laboratory procedures and licensing requirements

STORE INSTRUMENTS SAFELY AND SECURELY

Identify requirements for storage facilities and associated document processes

Working safely with hazardous chemicals requires proper use of laboratory equipment. Maintenance and regular inspection of laboratory equipment are essential parts of this activity. Many of the accidents that occur in the laboratory can be attributed to improper use or maintenance of laboratory equipment.

The most common equipment-related hazards in laboratories come from devices powered by electricity devices for work with compressed gases, and devices for high or low pressures and temperatures. Other physical hazards include electromagnetic radiation from lasers and radio-frequency generating devices. Seemingly ordinary hazards such as floods from water-cooled equipment, accidents with rotating equipment and machines or tools for cutting and drilling, noise extremes, slips, trips, falls, lifting, and poor ergonomics account for the greatest frequency of laboratory accidents and injuries. Understandably, injuries to the hands are very common in the laboratory. Care should be taken to use appropriate gloves when handling laboratory equipment to protect against electrical, thermal, and chemical burns, cuts, and punctures.

Store instruments in accordance with requirements and documented procedures

Make an Equipment Register and check proper functioning of equipment

Making an overview of which equipment is present in the laboratory is the first step in implementing a quality management system for equipment. The equipment register contains specific details about each piece of equipment (such as maintenance and calibration dates, maintenance frequency, who is responsible for the equipment, etc.). Hence, the equipment register is the most important element in managing the quality of equipment.

When the equipment register is made directly check the functioning of each piece of equipment and record this in the equipment register so that it is clear which pieces of equipment have priority in planning for maintenance (which is part of phase 2 of this tool).

Create an Equipment Register.

This is an overview of all equipment present in the laboratory including the most important details. A file will be made for each piece of equipment that will contain more elaborate information.

Record the following details of each piece of equipment:

- ✓ Identity: The name of the piece of equipment, including its type/model where applicable
- ✓ Label: Make this yourself use a logical label that includes the abbreviated name of the laboratory (to indicate that the equipment is owned by the laboratory) and a unique code for the piece of equipment
- ✓ Serial number: This is a number provided by the manufacturer
- ✓ Manufacturer name
- ✓ Manufacturer's contact person and contact details
- ✓ Date of purchasing
- ✓ Date of putting into service
- ✓ Location: E.g. room number and, if applicable the building number
- ✓ Condition: E.g. "Functioning properly"/ "In need of calibration"/ "In need of maintenance"/ "Defect"
- ✓ Service provider name
- ✓ Service provider's contact person and contact details
- ✓ Frequency of maintenance: How often per year is maintenance and calibration needed?
- ✓ Date of previous maintenance
- ✓ Date of next scheduled maintenance
- ✓ Remarks: Additional information, if needed.

Role of Equipment Officer:

Make an inventory of equipment present in the laboratory. You can do this on paper or digitally if possible. It is more convenient to make a digital register as this poses less work when adaptations need to be made. Be sure to include all the details listed above. In the right-hand column a template Equipment Register is provided that includes the above listed details.

Be sure to include all equipment. Think of computers, autoclaves, incubators, centrifuges, laminar flow cabinets, pipettes, timer clocks, etc.

Determine for each piece of equipment if it is functioning properly for the examinations performed. Also ask the staff members using the piece of equipment frequently whether it functions properly.

If you have identified a nonfunctional piece of equipment and this piece of equipment has a direct critical effect on laboratory testing, put it out of service, determine which repair must be performed, and explain this to the laboratory manager. Critical means that the absence of a properly functioning piece of equipment makes specific routine laboratory examinations impossible to be performed.

Determine if there is a critical need for a specific piece of equipment that is not present in the laboratory at this moment.

If this is the case, list the characteristics of the piece of equipment needed and submit this to the Laboratory Manager.

Laboratory Manager:

1. When the Equipment Officer indicates that specific pieces of equipment need repair, identify funding and arrange repair. If extensive repairs are needed to a certain piece of equipment, determine whether it is more cost efficient to purchase a new piece of equipment or to go on with repairing the old piece of equipment.
2. The Equipment Officer also drafts a list with new equipment needed to enable correct performance of laboratory examinations. Investigate the procurement options for each piece of equipment and determine the amount of funding needed. In choosing the equipment take into account:
 - ✓ That reagents are available and easily deliverable.
 - ✓ That specific technical maintenance must be possible (e.g. a maintenance company is available that is capable of performing specified technical maintenance on the equipment, or that training can be given in the laboratory by the company that installs the piece of equipment, in order to learn how to perform maintenance on the equipment).
3. Identify the funding and purchase the required equipment.

Secure instruments to prevent unauthorized access

Install a system to prevent access of unauthorized persons to the laboratory

The laboratory is a potentially dangerous place if you are not aware of the risks. The laboratory houses dangerous reagents (e.g. corrosive liquids, inflammable liquids, pathogens, etc.), sensitive equipment that, if handled incorrectly, may break and cost a lot of money to repair, and privacy-sensitive patient data. Therefore, unauthorized persons should not be able to enter the laboratory building.

Access to the laboratory by unauthorized persons must be prevented by displaying signs that indicate that access is forbidden for unauthorized personnel (passive preventive measure). Locks should be put on entry doors (active preventive measure) and laboratory staff should be constantly aware to check for unauthorized persons. Staff should be encouraged to challenge and question unfamiliar persons to determine if they have appropriate authority to be present in the laboratory, and to call for security to assist them in the event that they find an unauthorized person in the laboratory.



IMPORTANT is that, with installation of these locks, rapid evacuation of the building should remain possible. E.g. in case of a fire the laboratory staff should not have to look for keys to open the door to evacuate. Several solutions are

possible, for example (from cheap to more expensive):

- ✓ A lock on the entrance door(s) and only a door handle on the inside of the door. This way somebody needs a key to open the door from the outside but just has to turn the handle to open the door from the inside.
- ✓ A badge reading system on the outside of the entrance door(s). All laboratory staff will have a badge to open the door to enter the building. From the inside it must be possible to open the door just by turning the door handle (see figure).
- ✓ A fingerprint reading system on the outside of the entrance door(s). This way somebody needs to put his/her finger on the fingerprint system to enter the building. From the inside it must be possible to open the door just by turning the door handle.



In this figure you see an electronic badge reading system. The inside of the door can be opened by turning the handle, from outside a badge is needed. Also note the automatic door closers above the doors that ensure that the doors are always closed. NOTE that, when an electrical system is installed (badge or fingerprint reading system), it should be possible at all times to open the door during a power failure.

An additional possibility is to introduce the use of visitor badges. These badges should present the name of the person and the period in which he/she visits the laboratory. The visitors should wear these badges so that they are easily identifiable as authorized visitor.

Print the "Authorized Personnel Only" sign as many times as needed and install these at visible locations near entry doors (make sure that they are water proof).

Record instruments' movements and usage in accordance with documented procedures

Prepare Stock Cards and set up the inventory management system

To know which supplies and how much of each supply is available in the laboratory stock, an inventory register needs to be made. This is a database with records containing details of all the available supplies. The first step in making the system inventory register is the design and use of Stock Cards (on paper or electronically).

Design the layout of a Stock Card:

The Stock Card should leave room to fill out the following details:

- ✓ Name of the item in stock
- ✓ Date and amount ordered
- ✓ Date of receipt of item
- ✓ Amount received
- ✓ Lot-number
- ✓ Expiry date
- ✓ Date the material was placed in service
- ✓ Amount of items used
- ✓ Balance of items in stock (number still in stock)

The Stock Cards can either be maintained in an electronic database (Excel or a dedicated program) or in a paper database. A template stock card in MS. Word (for a paper system) is provided in the right-hand column. [TB] In the same column you will find a tool and an example more specific to TB laboratories.

Stock Officer:

1. Design the Stock Card. The Template Stock Card provided in the right-hand column could be used as a start.
2. If on paper: Print a sufficient number of Stock Cards (of each item in the stock a Stock Card should be filled-out).
3. Take a new folder and title this "Stock Inventory Register". Place two tabs in this folder, one named "Orders" and one named "Stock Inventory". Order forms of orders that have not yet been received by the laboratory are placed behind the "Orders"-tab and the Stock Cards with details of all items already in stock are placed behind the "Stock Inventory"-tab. If an electronic register is used: create a similar system that helps you to keep track of which items are ordered and which are already in stock (and in which quantity).
4. Fill-out a Stock Card for each item in stock.
5. If necessary, make a good system for orderly division of items in stock. E.g. place items in alphabetical order of names and place the oldest item in the front and the newer items in the back so that the older items are used first, decreasing the risk of using expired products.

6. Present to all staff members in a weekly staff meeting how the stock inventory system works and what a Stock Card is. The laboratory manager will explain that nobody is authorized any longer to take items from stock and that they have to ask you if they need something. This way you can keep the Stock Cards up to date and prevent differences between the quantities in the stock register and the actual stock as much as possible. Note that you always have to help colleagues who need something from the stock directly.
7. Perform a stock balance once per quarter: count of each item how many there are in stock, and see if this is in accordance with the amount indicated on the Stock Card. If not, update the Stock Card. Also check expiration dates and discard items that are expired. [TB] On the right you will find an example how to calculate monthly consumption together with a sample of a quarterly control stock card.

Laboratory Manager:

1. Stress during the weekly staff meeting in which the Stock Officer presents how the stock inventory system works that the Stock Officer is now the only person that is allowed to take items from the stock. This way the Stock Officer can update the Stock Cards directly and it is prevented that quantities in stock start to differ from quantities in the register. Explain also that each newly arrived order must be inspected and unpacked by the Stock Officer. Nobody is allowed to place items in the stock him/herself as the laboratory must segregate uninspected/unaccepted supplies from inspected/accepted supplies.
2. Adapt the Authorization Matrix to specify that nobody is authorized to take items from stock except for the Stock Officer.

TRANSPORT INSTRUMENTS SAFELY AND SECURELY

A general move contractor with a qualified chemical lab-packing contractor (LPC) will package and transport all hazardous and non-hazardous chemical reagents. Radioactive materials will be moved by the EH&S Radiation Safety group. Biological materials will be transported inside freezers under certain conditions and following procedures that will be outlined later in this document.

The proper procedures for moving chemical, radioactive, and biological materials will be outlined below. Moving hazardous materials without following the stringent regulatory requirements is both dangerous and illegal, and will not be permitted. Individual researchers will not move any hazardous materials on their own (with the exception of controlled substances as applicable).

In laboratories where chemical, infectious, or radioactive materials have been

used, the departing laboratory staff is responsible for ensuring that all laboratory surfaces and equipment have been properly disinfected or decontaminated. Laboratory staff that share space with other laboratory groups should carefully survey any shared spaces and areas in order to locate and appropriately handle and/or dispose of their hazardous materials

Select vehicle suitable for the purpose

Moving Hours: Package and move Hazardous Chemicals only during normal business hours so support staff will be available to help if there is a spill or accident.

Transportation Routes: Never move open containers of hazardous materials in elevators. Do not leave hazardous materials or other items in the corridors during moving. This is a violation of the fire code.

Transportation Equipment: If the move is within a building or to a connected adjacent building, use a good hand-truck, dolly or a cart designed for this purpose whenever possible. OCRS has some equipment available on a first-come, first-served basis. Contact your Lab Compliance Coordinator to check on availability of this equipment. For longer moves contact OCRS at 322-2057 for assistance.

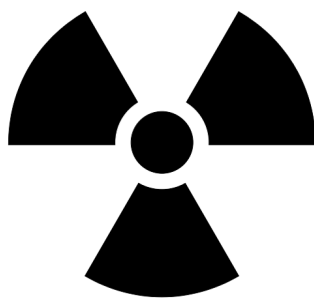
Transportation Vehicle: You may not transport hazardous materials in private vehicles.

Personal Protective Equipment: Wear appropriate personal protection for the materials being handled (safety glasses or goggles, lab coat, gloves, closed-toe shoes, etc.) (*NOTE: There is an extra danger in sloshing and breakage during the move of hazardous chemicals.)

Accident Prevention: Have boxes, plastic bags, and containers for broken glass, ready and available before you begin.

Spill Response: Ensure that you have immediate access to adequate and proper materials for cleanup of a spill at any point during the move. The spill guidelines should always be observed.

Attach regulation signage in accordance with state or territory requirements to indicate that radioactive sources are being carried



For transportation purposes, radioactive material is defined as any material which has a specific activity greater than 0.002 microcuries per gram. This definition does not specify a quantity, only a concentration. As an example, pure cobalt-60 has a specific activity of 1,000 curies per gram, which is about 500 billion times greater than the definition. However, uranium-238 has a specific activity of only 0.3 microcuries per gram, which is only 150 times greater than the definition.

Although both exceed the definition of radioactive material in their pure form, either of these materials could be uniformly mixed with enough substance, such as dirt, which would cause the concentration to fall below the definition. In the case of uranium-238, if one gram were mixed with about 150 grams of dirt (about 1/3 of a pound), the concentration could be classified as non-radioactive.

Remember, however, that the definition of radioactive material above only applies for transportation.

Markings



Markings are designed to provide an explanation of the contents of a package by using standard terms and codes.

Labelling



Labels are used to visually indicate the type of hazard and the level of hazard contained in a package.

Labels rely principally on symbols to indicate the hazard.

Although the package required for transporting radioactive material is based on the activity INSIDE the package, the label required on the package is based on the radiation hazard OUTSIDE the package. Radioactive material is the only hazardous material which has three possible labels, depending on the relative radiation levels external to the package. Also, labels for radioactive material are the only ones which require the shipper to write some information on the label. The information is a number called the Transport Index (TI), which, in reality, is the highest radiation level at 1 meter from the surface of the package.

The three labels are commonly called, White 1, Yellow 2, and Yellow 3, referring to the color of the label and the roman numeral prominently displayed. A specific label is required if the surface radiation limit and the limit at 1 meter satisfy the following requirements:

<u>Label</u>	<u>Surface Radiation Level</u>		<u>Radiation Level at 1 Meter</u>
White 1	Does not exceed 0.5 millirem/hour		Not applicable
Yellow 2	Does not exceed 50 millirems/hour	AND	Does not exceed 1 millirem/hour
Yellow 3	Exceeds 50 millirems/hour	OR	Exceeds 1 millirem/hour

Since the TI is the radiation level at 1 meter, it is clear that a White 1 label has no TI. A Yellow 2 must have a TI no greater than 1, and a Yellow 3 may have a TI greater than 1.

Referring to the radiation limits on page 11-19 for vehicles, it can be seen that the maximum TI for nonexclusive use vehicles (common carriers) and for exclusive use (contract carriers) open vehicles is 10. The radiation level at 1 meter from the surface of a package can exceed 10 mrem/hour only if the

package is transported in an exclusive use (contract carrier), closed vehicle.

Ensure that instruments are properly located and fixed securely in place

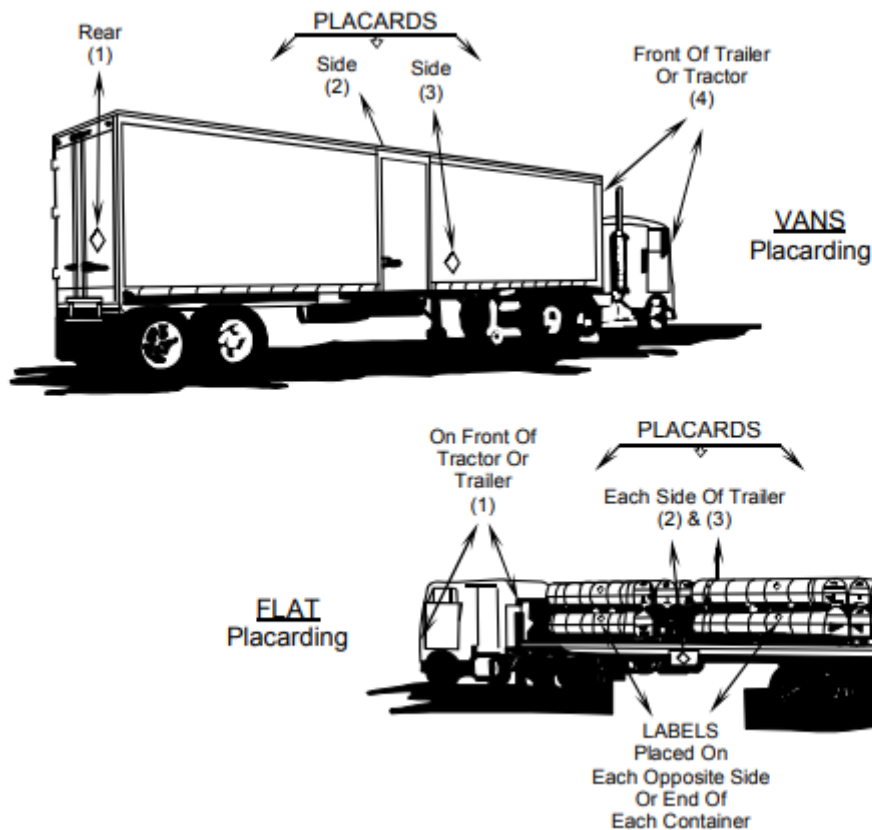
Equipment management is one of the essential elements of a quality management system. Proper management of the equipment in the laboratory is necessary to ensure accurate, reliable and timely testing.

The benefits of a good equipment management are many:

- ✓ helps to maintain a high level of laboratory performance;
- ✓ reduces variation in test results, and improves the technologist's confidence in the accuracy of testing results;
- ✓ lowers repair costs, as fewer repairs will be needed for a well-maintained instrument;
- ✓ lengthens instrument life;
- ✓ reduces interruption of services due to breakdowns and failures;
- ✓ increases safety for workers;
- ✓ produces greater customer satisfaction.

Placarding

Placards are just bigger labels which are placed on the outside of the vehicle. Unlike labels, there is only one placard and no information needs to be written on it (i.e., no TI). In fact, a placard on a vehicle is only required if the vehicle is carrying a package bearing a Yellow 3 label or low specific activity material. If the amount of material being transported constitutes a highway route controlled quantity, the diamond-shaped placard has a black square border surrounding it.



Ensure security of instruments when the vehicle is unattended

There are essentially three classes of carriers:

- ✓ Common,
- ✓ Contract, and
- ✓ Private.

Common and contract carriers provide a service to others. They carry other peoples' materials.

Common carriers have published rates for hauling material, while contract carriers negotiate a specific contract with the shipper. Common and contract carriers are not licensed by the NRC. The responsibility for safety rests with the shipper.

Private carriers own the radioactive material which they carry. The transport of material is accomplished in direct support of the radioactive material user's business. These carriers are licensed by the NRC.

Some examples of private carriers who transport their sources from one job site

to another are:

- ✓ Industrial radiographers,
- ✓ Portable gauge users, and
- ✓ Well loggers.
- ✓

In addition to the above, radiopharmacies deliver their own radiopharmaceuticals to nuclear medicine clinics.

Radiation Limits

<u>Type of Transport</u>	<u>Maximum Radiation Limit</u>
Common carrier non-exclusive use:	
<i>Open or closed transport</i>	200 millirems/hour on the surface of the package and 10 millirems/hour at 1 meter from any surface of the package
Contract carrier exclusive use:	
<i>Closed transport</i>	1000 millirems/hour on the surface of the package, 200 millirems/hour at the surface of the vehicle, 10 millirems/hour at 2 meters from any surface of the vehicle, and 2 millirems/hour in the vehicle cab
<i>Open transport</i>	200 millirems/hour on the surface of the package, 200 millirems/hour on any imaginary surface of the vehicle, 10 millirems/hour at 2 meters from any imaginary surface of the vehicle, and 2 millirems/hour in the cab of the vehicle

For non-exclusive use vehicles, that is, vehicles which may be carrying other non-radioactive material as well (common carriers), the radiation limit is imposed on the package.

For exclusive use vehicles, that is, the vehicle is only carrying radioactive material for one shipper (contract or private carrier), the package limits are higher, but there are also limits on the outside of the vehicle.

USE INSTRUMENTS SAFELY AND MAINTAIN SECURITY

Follow safe working practices

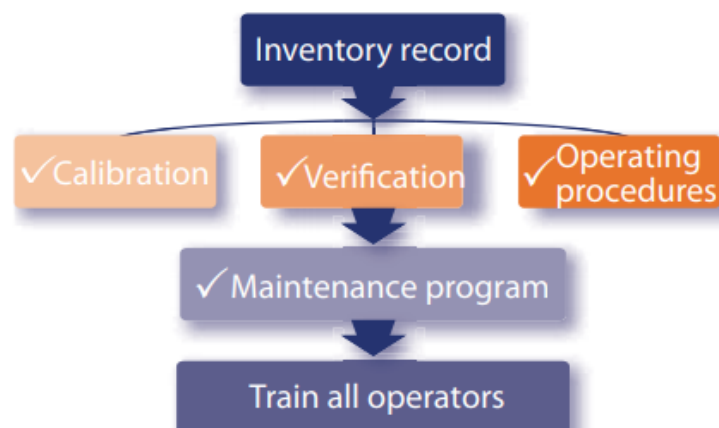
Getting equipment ready for service

After equipment has been installed, the following details need to be addressed before putting the equipment into service.

- ✓ Assign responsibility for performing the maintenance and operation programmes.

- ✓ Develop a system for recording the use of parts and supplies.
- ✓ Implement a written plan for calibration, performance verification, and proper operation of the equipment.
- ✓ Establish a scheduled maintenance programme that includes daily, weekly and monthly maintenance tasks.
- ✓ Provide training for all operators; only personnel who have been trained specifically to properly use the equipment should be authorized as operators.

Designate those authorized to use the equipment and when it is to be used.



Equipment calibration

Follow the manufacturer's directions carefully when performing the initial calibration of the instrument. It is a good idea to calibrate the instrument with each test run, when first putting it into service. Determine how often the instrument will need to be recalibrated, based on its stability and the manufacturer's recommendation. It may be advantageous to use calibrators provided by or purchased from the manufacturer.

Prior to testing patient specimens, it is important to evaluate the performance of new equipment to ensure it is working correctly with respect to accuracy and precision.

In addition, test methods using kits or laboratory instruments need to be evaluated for the ability to detect disease (sensitivity, specificity, positive and negative predictive value) and to determine normal and reportable ranges.

Verification of manufacturers' performance claims—Manufacturers provide performance evaluations for testing methods using their kits or instruments, and include the information in the package inserts or operator's manuals. However, laboratories need to verify the manufacturer's performance claims, and demonstrate they can get the same results using the kits or equipment in their

laboratory, with their personnel.

Some of the steps that should be followed to verify performance include:

- ✓ testing samples with known values and comparing the results to the expected or certified value;
- ✓ if equipment is temperature controlled, establishing the stability and uniformity of the temperature.

Validation of new equipment and associated techniques—If the equipment and associated techniques are new, validation processes will be important. Validation can be carried out by running samples in parallel using both old and new equipment and methods for a period of time to determine that the expected results can be obtained. These validation procedures should be completely recorded.

Maintain instrument security

Implementing an inventory management programme

In establishing an inventory control programme there are a number of factors to consider. A system should be designed so that the laboratory can closely monitor the condition of all supplies and reagents, know what quantities are available and be alerted when there is a need to reorder.

The following are important steps for implementation.

- ✓ Assign responsibility—without this, nothing may get done.
- ✓ Analyze the needs of the laboratory.
- ✓ Establish the minimum stock needed for an appropriate time period.
- ✓ Develop needed forms and logs.
- ✓ Establish a system for receiving, inspecting and storing supplies.
- ✓ Maintain an inventory system in all storage areas, and for all reagents and supplies used in the laboratory

Analyze needs

A laboratory needs a process for analyzing its needs for materials and for determining how many kits for a particular test should be on hand.

The laboratory should make a list of all the tests it performs and identify all the supplies and reagents that are needed for each test. It is wise to use all available information to help estimate the usage of supplies and reagents for the period of time between ordering new materials. The information necessary for analysing needs includes:

- ✓ a complete description of each item used;
- ✓ the package count or number of units in which the item is supplied (e.g. a kit can include 12 tests or 100 tests, and pipette tips can be packaged as 100 per box or 1000 per box);
- ✓ approximate usage per month (quantification, e.g. 6 boxes used per month);
- ✓ the priority or importance level the item has in doing the work of the laboratory
- ✓ (e.g. used every day or only once a month?); length of time required to receive a delivery (will the order take a day, week or month to arrive?);
- ✓ storage space and conditions (will a bulk order use too much storage space? Does the item require storage in a refrigerator?).

MAINTAIN RECORDS

Record observations, data and results in accordance with workplace procedures

Forms and logs

Developing an appropriate record-keeping system is an important step for inventory management. Good tools for managing the stock include:

- ✓ standardized forms
- ✓ card systems
- ✓ log books.

For any system that is used, the following information should be recorded:

- ✓ date reagent or set of supplies are received;
- ✓ lot numbers for all supplies, reagents and kits;
- ✓ pass or fail acceptance criteria;
- ✓ date the lot number or box of supplies was put into service or, if not usable, the date and method of disposition.

Logbook

The stock logbook or card system will provide a way to keep track of all supplies and reagents that are on hand at any given time. In addition to information mentioned above, it is a good idea to record:

- ✓ name and signature of the person receiving the materials
- ✓ date of receipt
- ✓ expiration date
- ✓ quantity of the material received
- ✓ minimum stock that should be on hand
- ✓ current stock balance.

Additional information to record could include:

- ✓ shelf number or name
- ✓ destination (e.g. to -20°C freezer to media room).

It is a good idea to keep the stock logbook in the storage area.

Maintain confidentiality of workplace information

Confidentiality is the protection of personal information. Confidentiality means keeping a client's information between you and the client, and not telling others including co-workers, friends, family, etc.

Examples of maintaining confidentiality include:

- ✓ individual files are locked and secured
- ✓ support workers do not tell other people what is in a client's file unless they have permission from the client
- ✓ information about clients is not told to people who do not need to know
- ✓ clients' medical details are not discussed without their consent
- ✓ adult clients have the right to keep any information about themselves confidential, which includes that information being kept from family and friends.

The types of information that is considered confidential can include:

- ✓ name, date of birth, age, sex and address
- ✓ current contact details of family, guardian etc
- ✓ bank details
- ✓ medical history or records
- ✓ personal care issues
- ✓ service records and file progress notes
- ✓ individual personal plans
- ✓ assessments or reports
- ✓ guardianship orders
- ✓ incoming or outgoing personal correspondence.

Other information relating to ethnic or racial origin, political opinions, religious or philosophical beliefs, health or sexual lifestyle should also be considered confidential.

Adult clients have the right to determine what information they consider personal and confidential.

There is, however, no such thing as absolute confidentiality in the community services industry. Workers are required to keep notes on all interactions with clients and often to keep statistics about who is seen and what issues are addressed. As a worker, there will be times when you could be faced with some personal difficulties regarding confidentiality. You need to give your client an assurance that what is said will be in confidence (that it will stay secret between you and the client) because, unless you are able to do that, the client is unlikely to be open with you. However, you also need to be aware of the limits to the

confidentiality that you are offering. There are several instances where total confidentiality is either impossible, undesirable or illegal. These include:

- ✓ cases where the law requires disclosure of information which will be
 - if the health and/or welfare of a child or young person is at risk. You are required to contact Department of Community Services and notify them of your concerns.
 - if your client tells you he/she has committed a serious crime. You are required to notify your supervisor or the police directly.
 - if a worker is subpoenaed to present information in a court of law
- ✓ when the client needs to be protected from harming themselves (eg if suicidal)
- ✓ where others may need to be protected (if the client has threatened to harm others or will do so inadvertently)
- ✓ the need to keep records
- ✓ when working in conjunction with other professionals in caring for a client
- ✓ the requirements of professional supervision, training, workshops or seminars.
- ✓ For more details go to the sections on *Legislation governing confidentiality* and *Exceptions to the general rule of confidentiality*.

It is always good practice to tell clients at the beginning of your contact with them that whatever they tell you is confidential except in the above circumstances.

When writing up case notes you need to be careful about what you include and how you write this information up. Always remember that clients have the right to see files and read anything that has been written about them.

When working with other professionals it is good practice to obtain the written consent of the client before exchanging information.

If you are going to be discussing a client and their situation in supervision, in a training session or at a workshop, you can always change the name and any information that may identify the client. Other workers in these situations are also bound by the same ethical and legal requirements relating to confidentiality that you are.

Confidentiality also extends to things like:

- ✓ names and addresses of clients
- ✓ phone numbers and addresses of staff and volunteers
- ✓ names and personal details of people who donate money or time
- ✓ details of funding agreements
- ✓ information about strategic planning.

Importance of confidentiality

Confidentiality is important for several reasons. One of the most important elements of confidentiality is that it helps to build and develop trust. It potentially allows for the free flow of information between the client and worker

and acknowledges that a client's personal life and all the issues and problems that they have belong to them.

One of the major purposes for obtaining a client's consent before speaking to a third party (such as another agency or a family member/carer) is to protect the confidentiality and privacy of the client. Informed consent (obtaining personal information with the formal permission of the client or a person who has the legal authority to provide permission on behalf of the client) is considered essential in maintaining the privacy of the client.

It is important to keep your clients' business as just that – their business. You should only discuss matters relating to your clients' business with co-workers, and then only what needs to be discussed. Discussions should take place in the workplace and not be audible to other members of staff or the general public. You should never discuss clients' business with family or friends.

Respect for client confidentiality and staff personal information should be a high priority for all community services to comply with legislation that governs disclosure of information. In this regard all organisations need to have policies and procedures that provide guidelines for workers. Appropriate worker behaviour can also be incorporated in a code of conduct.

To ensure confidentiality, workers should only access confidential information for work that is covered by their job description and the policies and procedures of the organisation. They should only disclose information to other parties where a client (or co-worker in relation to their personal information) has consented to the release of the information or where disclosure is required or mandated by legislation due to indications of risk of harm. Further workers need to ensure that any information that is collected is securely stored and disposed of.

PERFORM EMERGENCY PROCEDURES

Identify potential emergency situations

In order to be better prepared in situations of emergency the laboratory should perform a hazard analysis and implement the necessary arrangements and procedures for personnel on how to act in such situations. This helps in minimizing the severity of consequences of emergency situations.

To optimize emergency preparedness first all the hazards that could take place at the laboratory must be identified. This enables the development of procedures for personnel on how to act in such cases and it helps to identify which arrangements must be put in place in the laboratory facility. Some examples of hazards:

- ✓ Fire
- ✓ Flooding
- ✓ Earth quakes
- ✓ Biological or chemical emergencies

The second step is to formulate which procedures and arrangements are necessary to increase emergency preparedness for identified hazards. Think of the following actions:

- ✓ First aid kits and people trained to provide first aid
- ✓ Evacuation plan
- ✓ Indication of evacuation routes
- ✓ Installation of firefighting equipment
- ✓ Plans to maintain the laboratory in operation following an emergency/disaster (such as an earth quake)
- ✓ Response plans for biological, chemical and radiological incidents taking place within the laboratory, including a clear division of roles and responsibilities for all staff members during such an emergency
- ✓ Response plans for bioterrorism, chemical terrorism and emergency evacuation of high-containment laboratories, including a clear division of roles and responsibilities for all staff members during such an emergency
- ✓ Periodic evacuation and disaster drills

The third step is the actual formulation of the identified procedures and the implementation of the arrangements in the laboratory facilities.

Laboratory Manager and Biosafety Officer:

1. Make a list of emergencies that could take place in the laboratory. Consider emergencies related to the work of the laboratory but also external emergencies that require preparedness and full capacity of the laboratory.
2. Determine per identified emergency what could be done to increase preparedness. Focus on both procedures and equipment that could be needed in such situations. Also think about organizational arrangements that may be needed in specific emergency situations, such as a specific division or roles and responsibilities.
3. Make an action plan to write and implement the identified procedures, purchase the identified emergency equipment and implement the identified organizational emergency arrangements.
4. Monitor timely and adequate implementation of the action plan.
5. Evaluate the emergency arrangements on a regular basis with a biosafety audit to ensure that all the procedures and organizational emergency arrangements stay up to date and that the emergency equipment stays functional.

Respond to emergencies in accordance with documented procedures

When there is a hazard within a building such as a fire or chemical spill, occupants within the building should be evacuated or relocated to safety. Other incidents such as a bomb threat or receipt of a suspicious package may also require evacuation. If a tornado warning is broadcast, everyone should be moved

to the strongest part of the building and away from exterior glass. If a transportation accident on a nearby highway results in the release of a chemical cloud, the fire department may warn to “shelter-in-place.” To protect employees from an act of violence, “lockdown” should be broadcast and everyone should hide or barricade themselves from the perpetrator.

Protective actions for life safety include:

- ✓ Evacuation
- ✓ Sheltering
- ✓ Shelter-In-Place
- ✓ Lockdown

Your emergency plan should include these protective actions. If you are a tenant in multi-tenanted building, coordinate planning with the building manager.

Evacuation

Prompt evacuation of employees requires a warning system that can be heard throughout the building. Test your fire alarm system to determine if it can be heard by all employees. If there is no fire alarm system, use a public address system, air horns or other means to warn everyone to evacuate. Sound the evacuation signal during planned drills so employees are familiar with the sound.

Make sure that there are sufficient exits available at all times.

- ✓ Check to see that there are at least two exits from hazardous areas on every floor of every building. Building or fire codes may require more exits for larger buildings.
- ✓ Walk around the building and verify that exits are marked with exit signs and there is sufficient lighting so people can safely travel to an exit. If you find anything that blocks an exit, have it removed.
- ✓ Enter every stairwell, walk down the stairs, and open the exit door to the outside. Continue walking until you reach a safe place away from the building. Consider using this safe area as an assembly area for evacuees.

Appoint an evacuation team leader and assign employees to direct evacuation of the building. Assign at least one person to each floor to act as a “floor warden” to direct employees to the nearest safe exit. Assign a backup in case the floor warden is not available or if the size of the floor is very large. Ask employees if they would need any special assistance evacuating or moving to shelter. Assign a “buddy” or aide to assist persons with disabilities during an emergency. Contact the fire department to develop a plan to evacuate persons with disabilities.

Have a list of employees and maintain a visitor log at the front desk, reception area or main office area. Assign someone to take the lists to the assembly area when the building is evacuated. Use the lists to account for everyone and inform the fire department whether everyone has been accounted for. When employees are evacuated from a building, OSHA regulations require an accounting to ensure

that everyone has gotten out safely. A fire, chemical spill or other hazard may block an exit, so make sure the evacuation team can direct employees to an alternate safe exit.

Sheltering

If a tornado warning is broadcast, a distinct warning signal should be sounded and everyone should move to shelter in the strongest part of the building. Shelters may include basements or interior rooms with reinforced masonry construction. Evaluate potential shelters and conduct a drill to see whether shelter space can hold all employees. Since there may be little time to shelter when a tornado is approaching, early warning is important. If there is a severe thunderstorm, monitor news sources in case a tornado warning is broadcast. Consider purchasing an Emergency Alert System radio - available at many electronic stores. Tune in to weather warnings broadcast by local radio and television stations. Subscribe to free text and email warnings, which are available from multiple news and weather resources on the Internet.

Shelter-In-Place

A tanker truck crashes on a nearby highway releasing a chemical cloud. A large column of black smoke billows into the air from a fire in a nearby manufacturing plant. If, as part of this event, an explosion, or act of terrorism has occurred, public emergency officials may order people in the vicinity to “shelter-in-place.” You should develop a shelter-in-place plan. The plan should include a means to warn everyone to move away from windows and move to the core of the building. Warn anyone working outside to enter the building immediately. Move everyone to the second and higher floors in a multistory building. Avoid occupying the basement. Close exterior doors and windows and shut down the building’s air handling system. Have everyone remain sheltered until public officials broadcast that it is safe to evacuate the building.

Lockdown

An act of violence in the workplace could occur without warning. If loud “pops” are heard and gunfire is suspected, every employee should know to hide and remain silent. They should seek refuge in a room, close and lock the door, and barricade the door if it can be done quickly. They should be trained to hide under a desk, in the corner of a room and away from the door or windows. Multiple people should be trained to broadcast a lockdown warning from a safe location.

Report emergency situations to appropriate personnel

Accident Reporting

If you have received a cut, a burn, or an exposure to a hazardous material, please REPORT IT. Let a management and the Director of Safety and Security know.

Reasons to report:

1. Accident investigation of a minor injury can help to uncover and correct a problem. Left unreported, it could happen again to someone else.
2. An injury may not require treatment now, but it could become a problem at a later time.
3. The Director of Safety and Security will investigate and determine what can be done to prevent a recurrence.
4. Accident reports should be submitted to the Director of Human Resources:

UNIT 11

RECORD AND PRESENT DATA

This unit of competency covers the ability to record and store data, perform simple calculations of scientific quantities and present information in tables and graphs

RECORD AND CHECK DATA

Enter data into laboratory information system or record sheets as directed

The International Organization for Standardization (ISO) and Clinical and Laboratory Standards Institute (CLSI) define a sample as “one or more parts taken from a system and intended to provide information on the system” (ISO 15189:2007). The term “specimen” is very commonly used in the laboratory to indicate a sample taken from the human body, but the terminology used throughout ISO documents is “primary sample”, or just “sample”. In this handbook, the terms “sample” and “specimen” should be considered interchangeable. It is useful to note that in some of the existing transport regulations, the term “specimen” continues to be used.

Importance of good management

Proper management of samples is critical to the accuracy and reliability of testing, and therefore to the confidence in laboratory diagnosis. Laboratory results influence therapeutic decisions and can have significant impacts on patient care and outcomes. It is important to provide accurate laboratory results in order to ensure good treatment.

Inaccuracies in testing can impact length of hospital stays, as well as hospital and laboratory costs. Inaccuracies can also affect laboratory efficiency, leading to repeat testing with resultant waste of personnel time, supplies and reagents.

Sample management components

Written policies for sample management must be established and reflected in the laboratory handbook. Components to be addressed include:

- ✓ information needed on requisitions or forms;
- ✓ handling urgent requests;
- ✓ collection, labelling, preservation and transport;
- ✓ safety practices (leaking or broken containers, contaminated forms, other biohazards);
- ✓ evaluating, processing and tracking samples;
- ✓ storage, retention and disposal.

Content

Important information that should be included in the laboratory handbook:

- ✓ contact names and telephone numbers;
- ✓ name and address of the laboratory;
- ✓ hours of operation of the laboratory;
- ✓ list of tests that can be ordered;

- ✓ detailed information on sample collection requirements;
- ✓ sample transport requirements, if any;
- ✓ expected turnaround times;
- ✓ description of how urgent requests are handled—this should include a list of what kinds of tests are done on an urgent basis, what are the expected turnaround times, and how to order these tests

Check data to identify transcription errors or atypical entries

Transcription Errors

Every time data is manually entered into the system, there's a possibility that an error will be committed.

Human errors do occur, and there are a variety of different reasons as to why they happen. One could be that the person misunderstood what was written or what was said. Another reason for an error was that the person was rushing, and didn't pay enough attention to detail.

Long codes that have no significant meaning to the encoder are susceptible to error.

Transposition Errors

Transposition errors happen when the encoder accidentally mixed up the order of numbers or letters.

For example, 78 might be entered as 87, or 'faith' might be entered as 'faiht'.

Verification

Validation procedures cannot make sure that the data entered is correct—it can only check that it is rational, logical, and acceptable. It is obviously ideal to have as much accurate information as possible in your database.

Verification can be done to ensure that the data in the database has as few errors as possible. Another way to phrase this is by saying that verification is done to make sure that the data entered is equal to the data from the original source.

Verification means to check that the data from the original source document is exactly the same as the data that you have entered into the system.

Rectify errors in data using enterprise procedures

Double entry – This refers to inputting the data twice and comparing the two entries.

- ✓ A classic example would be when creating a new password. You are often asked to enter the password twice. This lets the computer verify that data entry is exactly the same for both instances, and that no error has been committed. The first entry is verified against the second entry by matching them.
- ✓ While this may be useful in identifying many errors, it is not practical for large amounts of data. Here are some disadvantages of double entry:
- ✓ It would take an encoder a lot of time to input the data twice. It doubles the workload as well as the cost.
- ✓ An encoder could input the same error twice, and it wouldn't be noted as an error.
- ✓ The possibility of having two (correct) versions of the same data exists, and double entry can't account for this eventuality.

Proofreading data – This process requires another person checking the data entry against the original document. This is tedious as well as costly.

Checking the data on the screen against the original paper document – This can help identify transcription and transposition errors. It also saves time, in comparison with the double entry technique. However, it is difficult to keep shifting your eyes back and forth from the monitor to the hard copy, and this difficulty can exacerbate human factors such as tiredness and blurry eyes, resulting in missed errors.

Printing out a copy of the data and comparing the printout to the original paper document – This is probably the simplest method of verification because you can put both copies side by side and scan both for errors. However, it can be tedious if there is a large amount of data to check. Also, if scanned too quickly, errors could well be overlooked.

Getting a helping hand – If you verify data with a team member, then one good way of identifying errors is for the coworker to read the input data while you check it against the original document. This can consume a lot of time and it utilises two people, so whether or not it's a good solution for any given situation depends on how crucial the data is versus time spent, and other resources (e.g. money). It is recommended that the second person reads the input data instead of yourself, because there is a high possibility that you will commit the same mistake twice; for example while transposing a number.

CALCULATE SIMPLE SCIENTIFIC QUANTITIES

Calculate simple scientific quantities using given formulae and data

Chemical Use Calculations

In a typical plant operation, the chemical use (in lb/day or gpd) is recorded each day. Such data provide a record of daily use from which the average daily use of the chemical or solution can be calculated.

To calculate average use in lb/day, we use.

$$\text{Average use (lb/day)} = \frac{\text{total chemical used (lb)}}{\text{number of days}}$$

To calculate average use in gallons per day (gpd), we use:

$$\text{Average use (gpd)} = \frac{\text{total chemical used (gal)}}{\text{number of days}}$$

To calculate the supply in inventory,

$$\text{Inventory supply (days)} = \frac{\text{total chemical in inventory (lb)}}{\text{average use (lb/day)}}$$

$$\text{Inventory supply (days)} = \frac{\text{total chemical in inventory (gal)}}{\text{average use (gpd)}}$$

Problem

The pounds (lb) of calcium hypochlorite used each day for a week are given below. Based on the data, what was the average lb/day hypochlorite chemical use during the week?

Monday, 50 lb/day	Friday, 56 lb/day
Tuesday, 55 lb/day	Saturday, 51lb/day
Wednesday, 51 lb/day	Sunday, 48 lb/day
Thursday, 46 lb/day	

Solution

$$\begin{aligned}\text{Average use (lb/day)} &= \frac{357}{7} \\ &= 51 \text{ lb/day}\end{aligned}$$

Problem

The average calcium hypochlorite use at a plant is 40 lb/day. If the chemical inventory in stock is 1100 lb, how many days of supply is this?

Solution

$$\begin{aligned}\text{Inventory supply (days)} &= \frac{1100 \text{ lb in inventory}}{40 \text{ lb/day average use}} \\ &= 27.5 \text{ days}\end{aligned}$$

**Determining chlorine
Dosage (feed rate)**

The units of milligrams per liter (mg/L) and pounds per day (lb/day) are most often used to describe the amount of chlorine added or required. Equation 19.1 can be used to calculate either mg/L or lb/d chlorine dosage:

$$\text{Chlorine feed rate (lb/day)} = \text{chlorine (mg/L)} \times \text{flow (MGD)} \times 8.34 \text{ lb/gal}$$

Problem

Determine the chlorinator setting (lb/day) required to treat a flow of 4 MGD with a chlorine dose of 5 mg/L.

Solution

$$\begin{aligned}\text{Chlorine (lb/day)} &= 5 \text{ mg/L} \times 4 \text{ MGD} \times 8.34 \text{ lb/gal} \\ &= 167 \text{ lb/day}\end{aligned}$$

Problem

A pipeline that is 12 inches in diameter and 1400 ft long is to be treated with a chlorine dose of 48 mg/L. How many lb of chlorine will this require?

Solution

Determine the gallon volume of the pipeline:

$$\begin{aligned}\text{Volume (gal)} &= 0.785 \times D^2 \times \text{length (ft)} \times 7.48 \text{ gal/cu ft} \\ &= 0.785 \times 1 \text{ ft} \times 1 \text{ ft} \times 1400 \text{ ft} \times 7.48 \text{ gal/cu ft} \\ &= 8221 \text{ gal}\end{aligned}$$

$$\begin{aligned}\text{Chlorine (lb)} &= 48 \text{ mg/L} \times 0.008221 \text{ MG} \times 8.34 \text{ lb/gal} \\ &= 3.3 \text{ lb}\end{aligned}$$

Problem

A chlorinator setting is 30 lb per 24 hr. If the flow being chlorinated is 1.25 MGD, what is the chlorine dosage (expressed as mg/L)?

Solution

$$30 \text{ lb/day} = x \text{ mg/L} \times 1.25 \text{ (MGD)} \times 8.34 \text{ lb/gal}$$

$$x = \frac{30}{1.25 \times 8.34}$$

$$x = 2.9 \text{ mg/L}$$

Problem

A flow of 1600 gpm is to be chlorinated. At a chlorinator setting of 48 lb per 24 hr, what would be the chlorine dosage (in mg/L)?

Solution

Convert the gpm flow rate to MGD flow rate:

$$\begin{aligned} 1600 \text{ gpm} \times 1440 \text{ min/day} &= 2,304,000 \text{ gpd} \\ &= 2.304 \text{ MGD} \end{aligned}$$

Now calculate the chlorine dosage in mg/L using Equation 19.1:

$$\text{Chlorine (lb/day)} = x \text{ mg/L} \times 2.304 \text{ MGD} \times 8.34 \text{ lb/gal} = 48 \text{ lb/day}$$

$$x = \frac{48}{2.304 \times 8.34}$$

$$= 2.5 \text{ mg/L}$$

Ensure calculated quantities are consistent with estimations and expectations

In following Table, there are two ranges reported. The acceptable range for the Level I (Normal Control) is 3.7 – 4.3 mmol/L. The range for Level II (Abnormal Control) is 6.7 – 7.3 mmol/L. When the daily QC result obtained for the normal control is compared to the range calculated for the normal control, it becomes apparent that each result lies somewhere within the expected range. This indicates that the analytical process is “in control” at the normal level on that day of testing.

When the daily QC result for the abnormal control (high potassium) is compared to the defined range for the abnormal control, the analytical process is shown to be “in control” for each day of testing except for the last day (11/7). On November 1 through November 6, both controls were “in control” and patient values could be reliably reported. However, the laboratory was “out of control” for abnormal high potassiums on November 7 because the value obtained for the QC material (8.0 mmol/L) was outside the acceptable range (6.7 – 7.3 mmol/L).

This means that some error occurred which may have made some patient results unreliable. The laboratory should not report any patient samples with an abnormally high potassium result until the error is resolved and the abnormally high sample(s) are re-tested.⁶

Perhaps it is now apparent that the range defined for each level of control is fundamental to the quality control system. The next section describes how to calculate the basic statistics required to develop an acceptable control range.

Table : Example of a QC Log with Results			
Test: Potassium	Instrument: Instrument No. 1		Unit of Measure: mmol/L
Range ▶	Level I Normal Control 3.7 – 4.3 mmol/L	Level II Abnormal Control 6.7 – 7.3 mmol/L	Results
1 November	4.0	7.0	4.2, 4.0, 3.8, 5.0, 5.8, 4.2
2 November	4.1	7.0	3.8, 4.4, 4.6, 3.9, 4.8, 4.4, 3.9
3 November	4.0	6.9	4.4, 3.9, 3.7, 4.7
4 November	4.2	7.1	4.7, 5.6, 4.2, 3.7, 4.3
5 November	4.1	7.0	4.2, 4.3, 4.1, 4.3
6 November	4.1	7.0	4.6, 4.4, 5.5, 3.8, 3.2
7 November	4.2	8.0	2.8, 4.6, 4.2, 3.2, 3.9, 4.1, 6.0, 4.3

Report all calculated quantities with appropriate precision and units

PRESENT DATA IN TABLES, CHARTS AND GRAPHS

Present data accurately in tables and charts using given formats and scales

Tables are often used to display data clearly, particularly when it is important that the data are displayed accurately, such as on a food label, or when a lot of data needs to be displayed in a concise form, such as on a bus or train schedule. The table shown below is from the Irish Tourism Fact Card for 2003. There’s a lot of information here to sort out, but imagine how confusing it would be if it was a list!

Employment in the Irish Tourist Industry (Numbers Employed by Sector)

Sector/Year	1999	2001	2002	2003	% +/- ('01-'03)
Hotels	53,906	54,275	54,656	54,164	-0.2%
Guesthouses	3,115	2,943	2,914	2,879	-2.2%
Self-catering accommodation	4,580	3,830	n/a	3,878	1.3%
Restaurants	40,283	41,827	41,409	41,085	-1.8%
Non-licensed restaurants	15,221	13,849	n/a	15,642	12.9%
Licensed premises	78,300	78,225	80,121	79,319	1.4%
Tourism services and attractions	33,910	34,568	34,852	34,749	0.5%
Total	229,315	229,517		231,716	0.96%

So how do we start to understand what is shown in a table?

The first thing to do is to look at **the title**. This should explain clearly what the table contains. This table contains the number of people employed in the Irish tourist industry, divided into sectors.

["Fáilte", pronounced fall-sha, is an Irish word meaning "welcome".] Next, check the source of the data. Have the data been collected by a reputable organization? Can you check how the data have been collected? This is an important step: if, for example, the data are only based on a few results or have not been collected properly, then you may not wish to rely on the values given in the table. The source of these data is given below the table, a survey conducted in 2004 by Fáilte Ireland, the Tourist Board for Ireland. This is an official organization, so the data are likely to be reliable.

The next step is to examine the column and row headings. What information is being given? Raw numbers, or percentages? What units are being used? Do you understand any abbreviations used and how the table is constructed?

The column headings are the years 1999, 2001, 2002, and 2003. Note that the year 2000 is missing; this could affect your interpretation of the figures.

The final column has a confusing heading. Can you work out what it means? Look carefully at the symbols used. It is the percentage change between 2001 and 2003, given as either a positive or a negative number. Between 2001 and 2003, for instance, the number of people employed in hotels in Ireland fell by 0.2%.

The rows give types of tourist facilities, such as hotels and restaurants, with the total for all types given in the bottom row.

Finally, you can look at **the main body of the table** to find the information you need.

For example, to find the number of people employed in restaurants in 2001, move along the row labeled restaurants, and down the column labeled 2001. Where this row and column meet, the value is 41,827.

This means that, in 2001, 41,827 people were employed in restaurants.

Reading a Table

Before you go on to use the information in the table, here is a summary of the steps in reading a table.

- ✓ Read the title.
- ✓ Check the source of the data.
- ✓ Examine the column and row headings, particularly the units used.
- ✓ Check that you understand the meaning of any symbols or abbreviations.
- ✓ Extract the information you need from the main body of the table.

Graphs and Charts

Although tables are useful for summarizing a lot of data concisely, clearly, and accurately, sometimes you want to get an overall message across quickly. You can do this using a graph or a chart. Graphs can also be used to explore relationships between sets of data, such as the way in which a sunflower grows over a season.

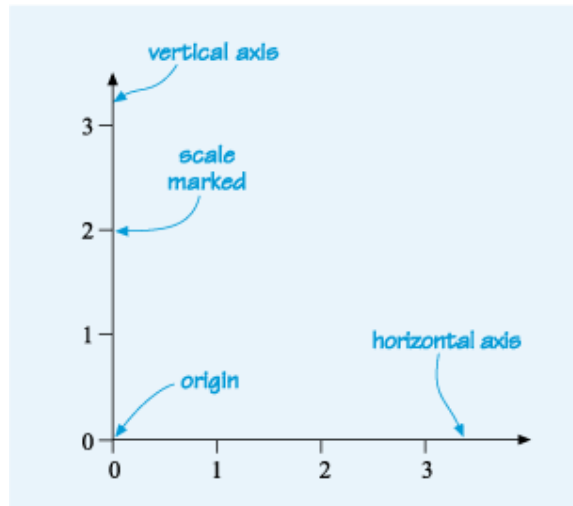
Activity: Graphs and Charts

You have probably seen different types of graphs and charts in your day to day life, when watching the TV, reading a newspaper or on the Internet. Spend a few moments now writing down all the different types that you have seen—don't worry if you don't know the math language for these at the moment!

Plotting Points

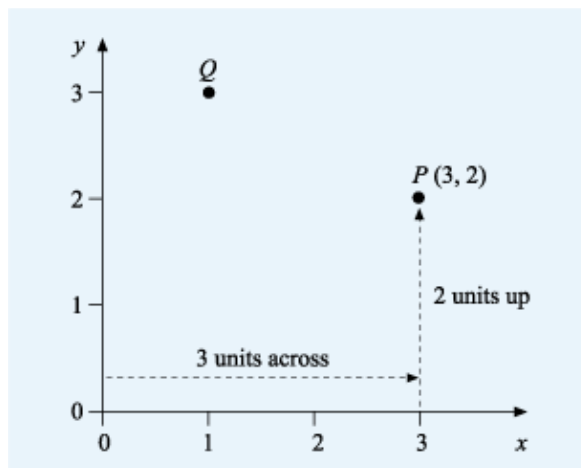
Many graphs and charts are constructed by plotting points on a grid.

The graph below shows two perpendicular lines: the horizontal axis and the vertical axis, which set up a grid. Each axis is marked with a scale, in this case from 0 to 3. The point where the two axes meet and where the value on both scales is zero is known as the origin. (Axes is the plural form of axis.)



Long description

We can describe the location of any point on the grid by its horizontal and vertical distance from the origin. In the graph below, the horizontal axis has been labeled with an “x” and the vertical axis with a “y.” This is because the horizontal axis is usually known as the x-axis and the vertical axis as the y-axis.



Long description

Look at the point P in the above graph. To get to the point P from the origin, move 3 units across and 2 units up. (Alternatively, the point P is opposite 3 on the x-axis and 2 on the y-axis.) We say that P has the coordinates (3, 2).

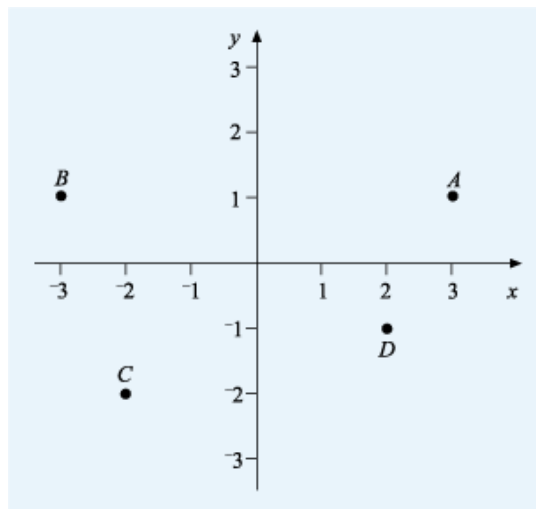
The horizontal distance of P from the origin is known as the x-coordinate of P and the vertical distance from the origin is known as the y-coordinate of P. So for point P, 3 is the x-coordinate and 2 is the y-coordinate.

Notice that the x-coordinate is the first coordinate in the pair and the y-coordinate is the second coordinate in the pair. So the general form for the coordinates of a point is (x, y). This is important to remember to avoid plotting points the wrong way round!

In the same way, Q is 1 unit across and 3 units up, so Q has coordinates (1, 3).

Negative Coordinates

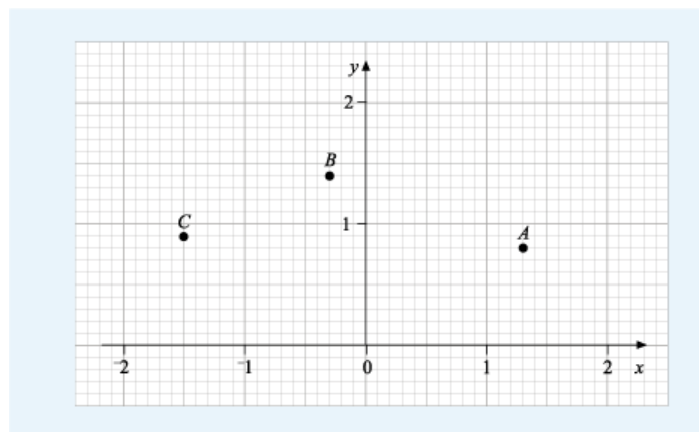
The axes can be extended downward and to the left to include negative values as shown here. In the graph below, B is 3 units to the left of the origin so its x-coordinate is -3 . It is 1 unit up, so its y-coordinate is 1. So B has coordinates $(-3, 1)$.



Decimal Coordinates

In the examples so far, all the coordinates were whole numbers and the scales were also marked at whole unit intervals. It is possible to plot points that have decimal coordinates such as $(1.8, -2.1)$.

In the graph below, each unit along the axes has been divided into ten, so each gray line represents a tenth of a whole unit, or 0.1, just like on the number lines we saw in Unit 2. The point A has coordinates $(1.3, 0.8)$ and is plotted 1.3 units across to the right of the origin and 0.8 units up.



Displaying Data on a Graph or Chart

You have seen that, provided you have both an x- and a y-coordinate, you can plot a point on a chart. So if a set of data consists of pairs of data values, then the data can be plotted on a graph.

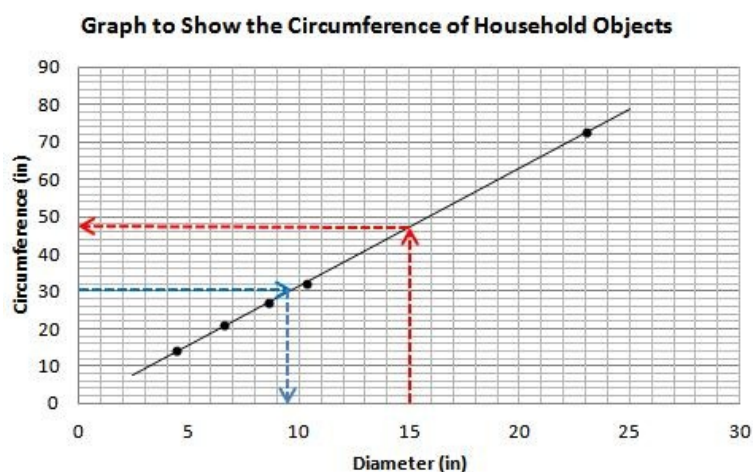
Drawing a Graph

The following data values were collected on the circumferences and diameters of various circular objects. All of the measurements are in inches.

Diameter (in.)	Circumference (in.)
4.4	14.1
6.6	20.9
8.6	27
10.3	32.3
23.0	72.8

(a) On some graph paper or in your notebook, plot these points on a graph with the diameter on the horizontal (x) axis and the circumference on the vertical (y) axis. Draw a straight line through the points.

Note the title and labeling of the axes. You may have used a different scale from us if you had different graph paper. This is fine as long as it makes best use of the paper and is easy to read from.



(b) Use your graph from part (a) to estimate the circumference of a circle of diameter 15 inches.

Answer: To find the circumference of a circle of diameter 15 inches, find 15 on

the horizontal axis. From this point, draw a vertical line to meet the graph. Then draw a horizontal line across to the vertical axis and read off the value. The circumference of a circle of diameter 15 in. is about 47 inches.

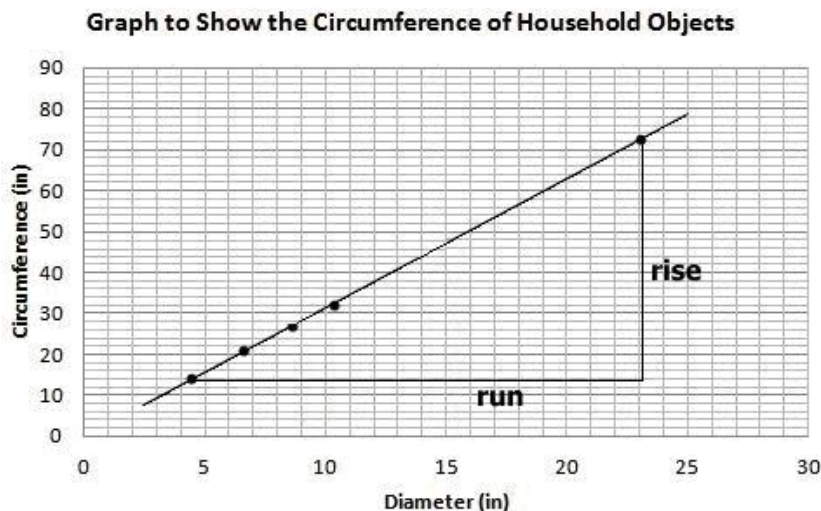
(c) Use your graph from part (a) to estimate the radius of a circle of circumference 30 inches.

Answer: The circumference is 30 in., so find 30 on the vertical axis. From this point, draw a line horizontally across to the graph, then vertically down to the horizontal axis. The point where this line crosses the horizontal axis gives the diameter of a circle whose circumference is 30 inches. It is about 9.5 inches, so the radius of the circle will be half of this, about 4.7 to 4.8 inches.

Optional Brain Stretcher

This is an interesting graph as you can make an estimate for π (pi) from it. π is the ratio of the circumference to the diameter of any circle and is a constant.

By measuring the slope (gradient) of the graph that you have drawn you will obtain an estimate for π . This is calculated by dividing the rise of the line by corresponding run of the line as shown below.



Have a go and see if you get a value close to 3.141.

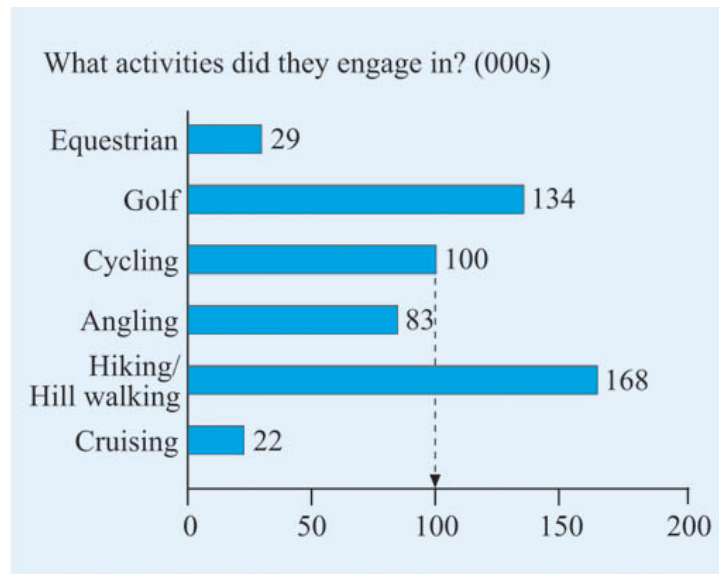
Gradient = $\frac{\text{rise}}{\text{run}} = \frac{72.8 \text{ in} - 14.1 \text{ in}}{23.0 \text{ in} - 4.4 \text{ in}} = \frac{58.7 \text{ in}}{18.6 \text{ in}} = 3.156 \text{ (to 3 d.p.)}$

This is not a bad estimate for π !

Bar Charts

Earlier, you saw data from the Irish Tourism Fact Card presented in tables. Information can also be illustrated in bar charts. The chart below is also from the Tourism Fact Card and shows the numbers of visitors participating in different

activities. The data were based on estimates from the Irish Central Statistical Office “Purpose of Visit” survey.



In a bar chart, the length of each bar represents the number in that category. On this chart, you can see that the longest bar is for hiking/hill walking, so this was the most popular activity. The shortest bar is for cruising, indicating that this was the least popular activity of those listed.

From the title, we know that the numbers of visitors are measured in thousands. On this bar chart, the values represented by the bars have been marked directly on the chart. For example, the number of visitors who played golf was 134,000 and the number of visitors who went hiking/hill walking was 168,000.

If the values had not been marked on the bars, they could have been estimated by drawing a line from the end of the bar and seeing where it intersected the horizontal axis. For example, the end of the cycling bar is level with the 100 marked on the horizontal scale (as shown by the dashed line), so approximately 100,000 visitors went cycling.

Because the bars on this chart are horizontal, the chart is known as a horizontal bar chart. Bar charts can also be drawn with the bars vertical. Note that in a bar chart, each bar has the same width, and since the bars represent different and unrelated categories, the bars do not touch each other and are separated by gaps. Can you see anything that is missing from this bar chart?

There is no label on the horizontal axis, which you would normally expect to complete a bar chart.

Drawing a Bar Chart

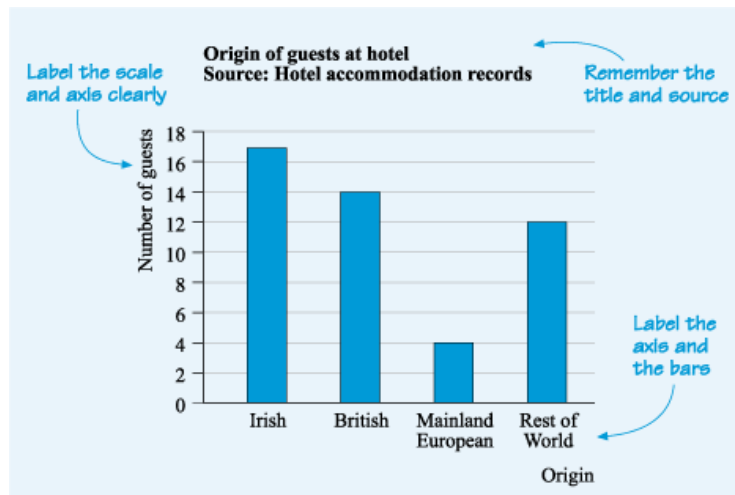
The same basic guidelines apply to drawing a bar chart as they do to drawing a graph, so bear these in mind when completing this activity.

In an earlier activity, you created the following table showing information about hotel guests. Use the table to draw a vertical bar chart to show the total number of guests in each of the nationality categories. Mark the nationality categories on

the horizontal axis and the number of guests on the vertical axis.

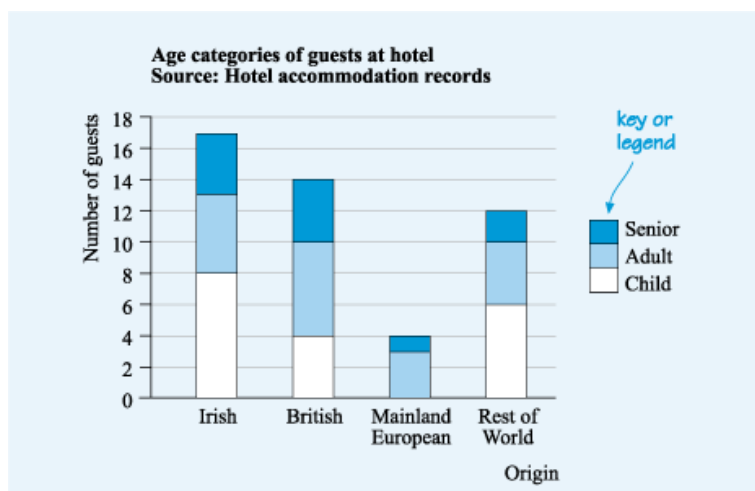
Origin and Age Categories of Hotel Guests

	Child	Adult	Senior	Total
Irish	8	5	4	17
British	4	6	4	14
Mainland European	0	3	1	4
Rest of the world	6	4	2	12
Total	18	18	11	47



Component Bar Charts

If you wished to show how the totals were broken down into the different age groups, you could split each bar into three different sections where the length of each section represented the number of guests in that age group. The resulting component bar chart is shown below. Notice that a key or legend has been added to the graph to explain the shading for the different categories.

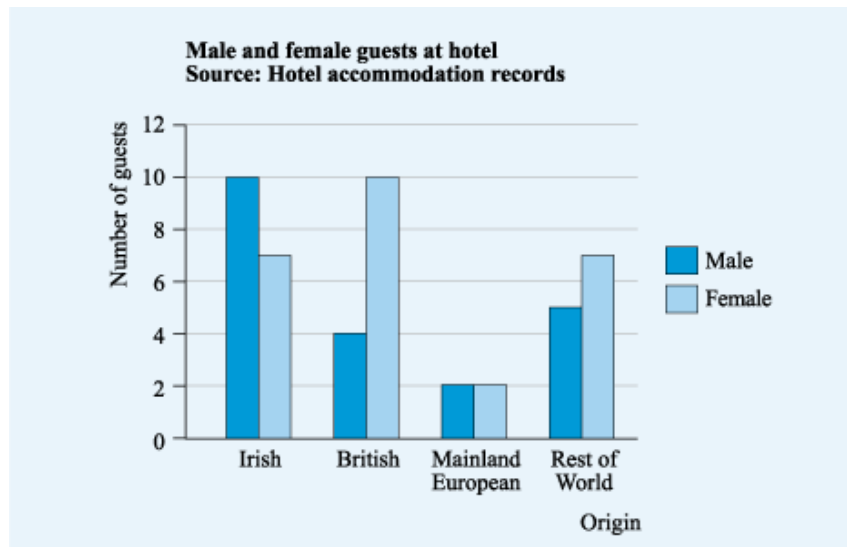


When you read a component bar chart, you need to find the height of the relevant section. For instance, the top of the section representing British adults is opposite the 10 on the vertical scale. The bottom of that section is opposite the

4. So the number of British adults is $140 \div 5$.

Comparative Bar Charts

Another way of displaying the totals would be to split each bar into two, one representing the number of males and the other the number of females in each category. To enable these numbers to be compared directly, the bars representing males and females can be placed next to each other as shown below. This is an example of a **comparative bar chart**.



Using the bar chart above, answer the following questions.

(a) How many female guests from Britain were there?

Answer: There were ten female guests from Britain.

(b) How many male guests in total stayed at the hotel?

Answer: The total number of male guests was 21.

Notice how all these charts followed the same format with the title and source clearly labeled and the axes and scales clearly marked, but they emphasized different aspects of the data. When you are displaying data in a graphical form, it is important to choose a chart or graph that stresses the main points as simply as possible, so that your reader can understand your chart quickly and easily.

The tourist market bar charts display how many items (in this case, guests) there are in each category. How many times an item occurs is known as the **frequency**. Charts that display frequencies are also known as **frequency diagrams**.

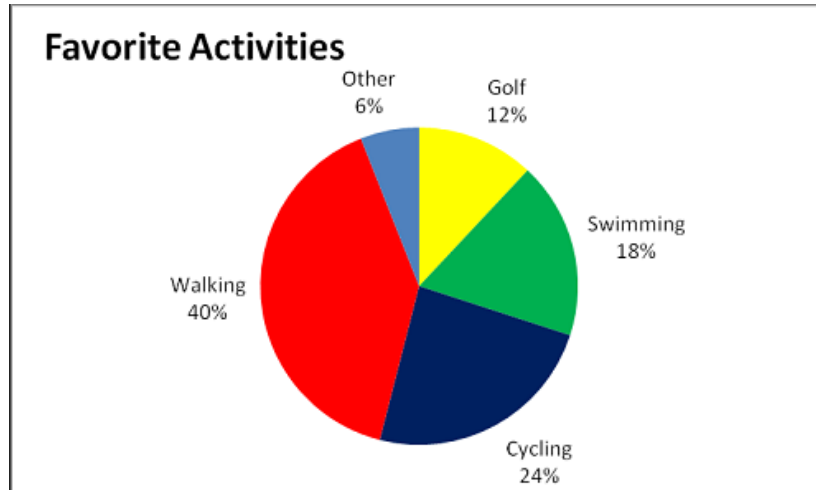
For more practice interpreting bar charts, try the following lesson:

Pie Charts

Although bar charts are useful to display numbers and percentages, sometimes you may wish to stress how different components contribute to the whole. Pie

charts are often used where you want to compare different proportions in the data set. The area of each slice (or sector) of the pie represents the proportion in that particular category.

For example, the pie chart below illustrates the favourite type of exercise for a group of people.

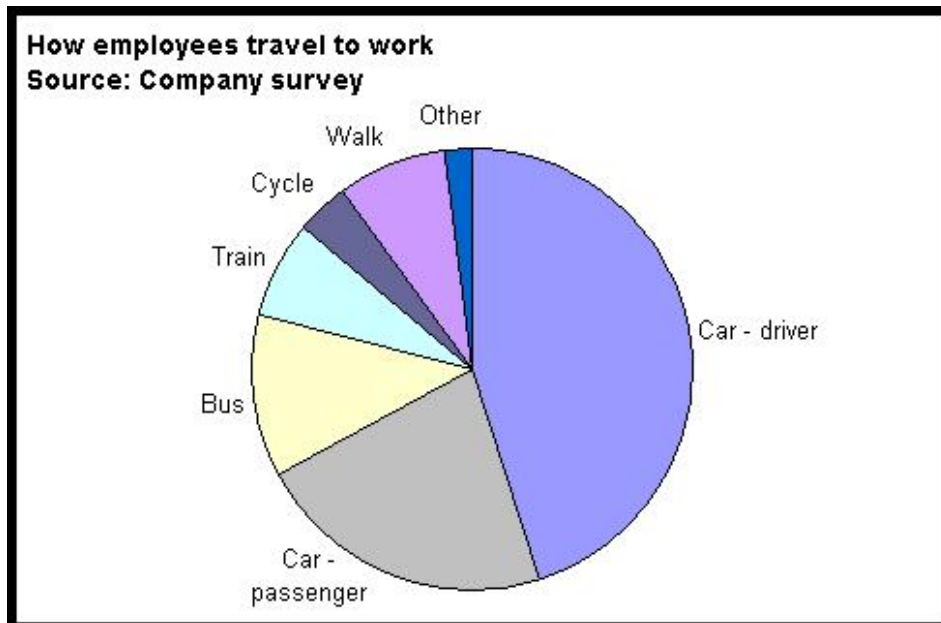


This pie chart shows the percentages for each category, so you can read these off directly. The most popular activity was walking (40%), followed by cycling (24%) and swimming (18%).

Notice, however, that the source of the data has not been stated, so you do not know where it came from or how many people were interviewed. It is important to consider both these points. If, for example, it was a small sample, you may not wish to rely on the results to generalize to a larger group.

Sometimes the percentages are not marked on the chart. So, the proportions can then be roughly estimated by eye. For example, the pie chart below illustrates how employees in a particular company travel to work.

Activity: How Employees Travel to Work



Use the pie chart above to answer the following questions.

- (a) Do more people travel to work by bus or by train?

Answer: The slice of the pie representing bus travel is larger than the slice representing train travel, so yes, more people travel by bus than by train.

- (b) Would it be correct to say that the number of employees who travel to work as car drivers is about twice the number who travel as car passengers?

Answer: The slice of the pie representing car drivers is about twice the size of the slice representing car passengers, so it is correct to say that the number of employees who travel to work as car drivers is about twice the number who travel as car passengers.

- (c) Estimate the proportion of employees who travel to work by car, either as the driver or as a passenger.

Answer: The two slices for car drivers and passengers cover about two-thirds of the circle, so about two-thirds of employees travel to work by car, either as the driver or as a passenger.

It is important to remember that pie charts are useful only for comparing proportions, looking at parts of a whole. If you are interested in other aspects such as trends or frequencies, then other graphs or charts may be more appropriate.

If necessary—provided the pie chart has been drawn accurately—you can also work out the percentages by measuring the angle at the center of the pie for each sector, using a protractor. For example, the angle at the center of the circle for the “Car Passenger” category is about 80° .

Because a complete circle measures 360° , the fraction that this sector represents

is $2 + 4$, or 22%.

So about 22% of the employees travel to work as car passengers.

Pie charts are often used to give an overall impression rather than detailed information, so on many occasions a rough estimate will suffice.

Reading a Chart or Graph

- ✓ Read the title of the chart and check the source of the data.
- ✓ Check the axes. What is being measured? What units have been used?
- ✓ Examine the scales. How should these be interpreted? What does each interval represent?
- ✓ Check the key or legend. What does the shading or line represent?
- ✓ Finally, examine the chart or graph itself, reading off the information that you need. Are you looking for a specific value or a trend or some other information?

You have also created graphs by hand. You may prefer to use a computer to draw your graphs and charts. There are many exciting ways to present data, but the important points listed below still apply whether you are drawing graphs by hand or by using software.

Drawing Graphs and Charts

- ✓ Include a clear title—so that your reader can see at a glance whether this chart is the one they are interested in.
- ✓ Include the source of the data—so that your reader can make further checks on how the data was collected if they wish.
- ✓ Choose the simplest graph or chart that illustrates the point you wish to emphasize.
- ✓ Label axes with both words and units.
- ✓ Mark scales clearly, choosing a scale that is easy to interpret.
- ✓ Include a legend if you have used more than one type of shading or line.

Look out for real-life graphs and charts in newspapers, magazines, on television, or on the Internet. Do these graphs follow the guidelines? Can you understand what the graphs are illustrating?

STORE AND RETRIEVE DATA

File and store data in accordance with enterprise procedures

Information management is a system that incorporates all the processes needed for effectively managing data—both incoming and outgoing test information. The information management system may be entirely paper-based, computer-based, or a combination of both. Whatever technology is employed, information management is another of the essentials of a quality system, and is closely related to documents and records

When planning and developing an information management system, whether it is a manual, paper-based system, or an electronic system, there are some important elements to consider:

- ✓ unique identifiers for samples
- ✓ standardized test request forms (requisitions)
- ✓ logs and worksheets
- ✓ checking processes to assure accuracy of data recording and transmission
- ✓ protection against loss of data
- ✓ protection of patient confidentiality and privacy
- ✓ effective reporting systems
- ✓ effective and timely communication.

Maintain enterprise confidentiality standards

It is important to establish a means to protect against loss of data. For paperbased systems, this will involve using safe materials for recording and storing the records properly. For computerized systems, scheduled or regular backup processes become very important.

It is of utmost importance to safeguard a privacy and, in this regard, security measures must be taken to protect the confidentiality of laboratory data. Laboratory directors are responsible for putting policies and procedures in place to ensure confidentiality of information is protected.

UNIT 12

PERFORM CALIBRATION AND MAINTAENANCE OF LABORATORY EQUIPMENT

This unit of competency covers the ability to perform setup, pre-use and in-house calibration checks on equipment and assist with its maintenance. Moreover, maintaining of record keeping of the faulty equipment

PERFORM SETUP AND PRE-USE CHECKS OF LABORATORY EQUIPMENT

Perform laboratory equipment setup and pre-use checks in accordance with enterprise procedures

Selecting equipment

Selecting the best instrument for the laboratory is a very important part of equipment management. Some criteria to consider when selecting laboratory equipment are listed below.

- ✓ Why and how will the equipment be used? The instrument should be matched against the service the laboratory provides.
- ✓ What are the performance characteristics of the instrument? Is it sufficiently accurate and reproducible to suit the needs of the testing to be done?
- ✓ What are the facility requirements, including the requirements for physical space?
- ✓ Will the cost of the equipment be within the laboratory's budget?
- ✓ Will reagents be readily available?
- ✓ Will reagents be provided free of charge for a limited period of time? If so, for how long?
- ✓ How easy will it be for staff to operate?
- ✓ Will instructions be available in a language that is understood?
- ✓ Is there a retailer for the equipment in the country, with available services?
- ✓ Does the equipment have a warranty?
- ✓ Are there any safety issues to consider?

If the decisions about purchasing are made outside the laboratory, for example by a central purchasing body, the laboratory manager should provide information that will support selecting equipment that will best serve the needs of the laboratory. In areas where there are national programs for purchasing standard equipment, the laboratories of the country should have some input to decisions. In addition, in areas where donors are likely to provide some of the equipment that is used, laboratory management should have input into choice of equipment. If this is not possible, management should consider declining equipment, if inappropriate for laboratory needs.

Acquiring equipment

Is it better to purchase, rent or lease equipment? When making this decision, it is a good idea to factor in repair costs. The initial cost of an instrument may seem reasonable, but it may be expensive to repair. Also consider savings that could be negotiated if the laboratory needs more than one piece of equipment.

The manufacturer should provide all of the necessary information to operate and

maintain equipment.

Before purchasing ask if:

- ✓ wiring diagrams, computer software information, a list of parts needed, and an operator's manual are provided;
- ✓ the manufacturer will install the equipment and train staff (covering travel expenses as necessary) as part of the purchase price;
- ✓ the warranty includes a trial period to verify that the instrument performs as expected;
- ✓ the manufacturer's maintenance can be included in the contract and if so,
- ✓ whether maintenance is provided on a regular basis.

Determine if the laboratory can provide all the necessary physical requirements, such as electricity, water, and space. There must be adequate room to move the equipment into the laboratory; consider door openings and elevator access.

Perform safety checks in accordance with relevant enterprise and instrumental procedures

Installing equipment

Before equipment is installed, verify that all physical requirements (electrical, space, doors, ventilation, and water supply) have been met. Other things to consider are:

- ✓ The vendor's responsibilities for installation should be confirmed in writing prior to beginning the installation process.
- ✓ A checklist of the expected performance specifications should be developed, so that performance can be quickly verified as soon as the equipment is installed.

Whenever possible, it is best to have the manufacturer install laboratory equipment; this will likely improve the conditions of the warranty, and also may ensure that the installation is done properly and quickly.

If equipment is installed by the laboratory:

- ✓ check that the package contents contain all of the parts;
- ✓ make a copy of any software that is part of the system;
- ✓ do not allow the equipment to be used before it is completely installed, performance is verified, and testing personnel are trained.

Identify faulty or unsafe components and equipment and report to appropriate personnel

If you have concerns about a product due to its design, construction or the manner of supply, you should report the matter to the appropriate market surveillance authority (MSA). The manufacture and supply of most equipment used at work

However, before you report a defective product, it will help in processing and investigating your concerns if you can also provide the following information:

- ✓ reasons you consider the product to be defective
- ✓ details of any injuries or harm resulting from the defect
- ✓ a description of the defect with, where relevant, measurements (such as gaps in safeguards and the distance through such gaps to parts giving rise to danger)
- ✓ photographs of the product and the defect, if available
- ✓ details of the markings / information on the product or accompanying documentation (eg type, serial number, date of manufacture, CE or other conformity markings)
- ✓ full contact details of the manufacturer, any supplier(s) and date of supply
- ✓ a copy of the Declaration of Conformity (or Declaration of Incorporation)
- ✓ extracts from the user instructions which deal with health and safety
- ✓ details of the markings / information on the product or accompanying documentation

Complete instrument log books/records to meet enterprise requirements

Record the following details of each piece of equipment:

- ✓ Identity
The name of the piece of equipment, including its type/model where applicable
- ✓ Label
Make this yourself: use a logical label that includes the abbreviated name of the laboratory (to indicate that the equipment is owned by the laboratory) and a unique code for the piece of equipment
- ✓ Serial number
This is a number provided by the manufacturer
- ✓ Manufacturer name
- ✓ Manufacturer's contact person and contact details
- ✓ Date of purchasing
- ✓ Date of putting into service
- ✓ Location
E.g. room number and, if applicable the building number

- ✓ Condition
E.g. "Functioning properly"/ "In need of calibration"/ "In need of maintenance"/ "Defect"
- ✓ Service provider name
- ✓ Service provider's contact person and contact details
- ✓ Frequency of maintenance
How often per year is maintenance and calibration needed?
- ✓ Date of previous maintenance
- ✓ Date of next scheduled maintenance
- ✓ Remarks
Additional information, if needed.

PERFORM CALIBRATION CHECKS

Startup equipment according to operating procedures

After equipment has been installed, the following details need to be addressed before putting the equipment into service:

- ✓ assign responsibility for performing the maintenance and operation programs;
- ✓ develop a system for recording the use of parts and supplies;
- ✓ implement a written plan for calibration, performance verification, and proper operation of the equipment;
- ✓ establish a scheduled maintenance program that includes daily, weekly, and monthly maintenance tasks;
- ✓ provide training for all operators; only personnel who have been trained specifically to properly use the equipment should be authorized as operators.

Designate those authorized to use the equipment and when it is to be used.

Use specified standards for calibration check

Follow the manufacturer's directions carefully when performing the initial calibration of the instrument. It is a good idea to calibrate the instrument with each test run, when first putting it into service. Determine how often the instrument will need to be recalibrated, based on its stability and on manufacturer's recommendation. It may be advantageous to use calibrators provided by or purchased from the manufacturer.

Check equipment as per calibration procedures and schedules

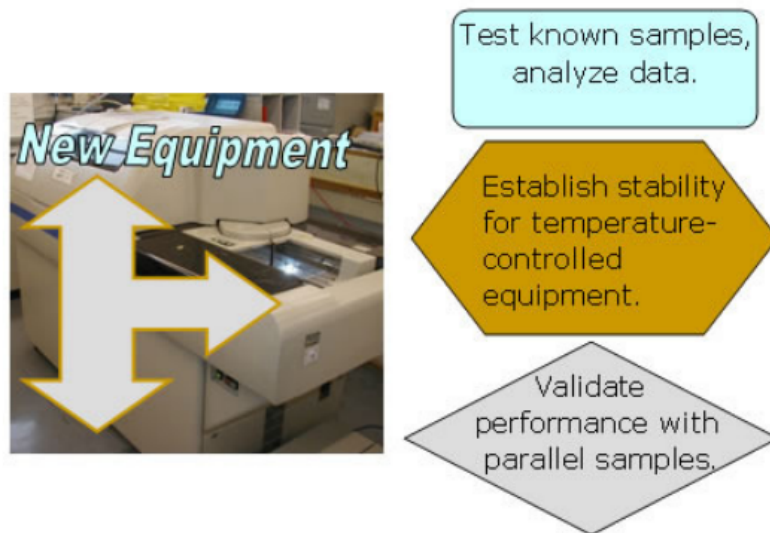
Prior to testing specimens, it is important to evaluate the performance of new equipment to ensure it is working correctly with respect to accuracy and precision. In addition, test methods using kits or laboratory instruments need to be evaluated for the ability to detect disease (sensitivity, specificity, positive and negative predictive value), and to determine normal and reportable ranges.

Record all calibration data accurately and legibly

Verification of manufacturers' performance claims—Manufacturers provide performance evaluations for testing methods using their kits or instruments, and include the information in the package inserts or operators' manuals. However, laboratories need to verify the manufacturers' performance claims, and demonstrate they can get the same results using the kits or equipment in their laboratory, with their personnel.

Some of the steps that should be followed to verify performance include:

- ✓ testing samples with known values and comparing the results to the expected or certified value;
- ✓ if equipment is temperature controlled, establishing the stability and uniformity of the temperature.



Compare data with specifications and/or previous records to identify non-compliant equipment

Validation of new equipment and associated techniques— If the equipment and/or associated techniques are new, validation processes will be important. This can be carried out by running samples in parallel on both previous and new equipment/methods for a period of time to determine that the expected results can be obtained. These validation procedures should be completely recorded.

Function checks

In order to verify that equipment is working according to the manufacturer's specifications, it is necessary to monitor instrument parameters by performing periodic function checks. This should be done before using the instrument initially, then with the frequency recommended by the manufacturer. These function checks should also be done following any instrument repairs. Some examples of function checks are daily monitoring of temperatures and checking

the accuracy of wavelength calibration.

ASSIST WITH EQUIPMENT MAINTENANCE

Perform basic maintenance in accordance with enterprise procedures

Preventive maintenance

Preventive maintenance includes measures such as systematic and routine cleaning, adjustment, and replacement of equipment parts at scheduled intervals. Manufacturers generally recommend a set of equipment maintenance tasks that should be performed at regular intervals: daily, weekly, monthly, or yearly. Following these recommendations will ensure that the equipment performs at maximum efficiency and will increase the lifespan of the equipment. This will also help to prevent:

- ✓ inaccurate test results due to equipment failure
- ✓ delays in reporting results
- ✓ lower productivity
- ✓ large repair costs.

Maintenance plan

A maintenance plan will include preventive maintenance procedures as well as provision for inventory, troubleshooting, and repair of equipment. When implementing an equipment maintenance program, some of the initial steps will include what follows.

- ✓ Assign responsibility for providing oversight.
- ✓ Develop written policies and procedures for maintaining equipment, including routine maintenance plans for each piece of equipment. The plan should specify the frequency with which all maintenance tasks should be performed.
- ✓ Develop the format for records, create logs and forms, and establish the processes to maintain records.
- ✓ Train staff on the use and maintenance of the equipment, and assure that all staff understand their specific responsibilities.

It is recommended that a label be attached to the instrument indicating when the next maintenance or service should be performed.

The laboratory should keep an inventory log of all equipment in the laboratory. The log should be updated with information on new equipment, as it is added, and include documentation of when old equipment is retired.

For each piece of equipment, the equipment inventory log should have a record of:

- ✓ instrument type, make and model number, and serial number of the instrument, so that any problems can be discussed with the manufacturer;
- ✓ date the equipment was purchased, and whether it was purchased new, used, or reconditioned;
- ✓ manufacturer/vendor contact information;
- ✓ presence or absence of documentation, spare parts, and maintenance contract;
- ✓ warranty's expiration date;
- ✓ specific inventory number indicating the year of acquisition; this is especially useful for larger laboratories. For example, use the style "YY-number" (04- 001, 04-002, etc.) where "YY-number" equals the last two numbers of the year followed by a number attributed in the year.

An inventory process must be conducted if the laboratory does not have an existing inventory system for equipment.

- ✓ This could be conveniently organized following a model grid room by room, for example, reception, sampling, serology, and parasitology.
- ✓ During the inventory, the condition of the equipment should be documented as:
 - functional
 - partially functional, or
 - non-functional. Equipment that is not functioning needs to be evaluated as to whether or not it can be repaired. Non-repairable equipment should be retired, and work should be scheduled for equipment needing repair.

Inventory of spare parts

To ensure that the laboratory does not run out of spare parts, an inventory record of those used most frequently should be kept for each piece of equipment. The record should include:

- ✓ part name and number;
- ✓ average use of the part, and the minimum to keep on hand;
- ✓ cost;
- ✓ date when the part is placed into storage, and when it is used (in and out stock log);
- ✓ quantity of each part remaining in inventory.

Identify and replace, repair or dispose of damaged/worn equipment as appropriate

What is the source of the problem?

Problems with equipment may present in many ways. The operator may notice subtle changes such as drift in quality control or calibrator values or obvious flaws in equipment function. Sometimes, the equipment fails to operate. It is important to teach operators to troubleshoot equipment problems in order to quickly get the equipment functioning and resume testing as rapidly as possible. When an operator observes instrument drift, it is important to repeat the preventive maintenance procedures as a first step to resolve the problem. If this does not work, proceed with troubleshooting processes.

Troubleshooting

Manufacturers frequently provide a flowchart that can help determine the source of problems. Some of the questions to consider are listed below.

- ✓ Is the problem related to a poor sample? Has the sample been collected and stored properly? Are factors such as turbidity or coagulation affecting instrument performance?
- ✓ Is there a problem with the reagents? Have they been stored properly, and are they still in date? Have new lot numbers been introduced without updating instrument calibration?
- ✓ Is there a problem with the water or electrical supply?
- ✓ Is there a problem with the equipment?

Make one change at a time based on symptoms. If equipment is the problem, review the manufacturer's instructions to verify that all procedures are being followed correctly.

When problems cannot be corrected

If problems cannot be identified and corrected in-house, attempt to find a way to continue testing until the equipment can be repaired. Some ways to achieve this are as follows.

- ✓ Arrange to have access to back-up instruments. It is often too costly for the laboratory to have its own back-up instruments, but sometimes a central stores agency can maintain back-up instruments to be shared throughout the local area or country.
- ✓ Ask the manufacturer to provide a replacement instrument during repairs.
- ✓ Send the samples to a nearby laboratory for testing.

Be sure to notify the appropriate providers that there are problems and that there will probably be delays in completing the testing.

Do NOT use faulty equipment! Seek help from the manufacturer or other

technical expert. Place a note on the equipment so all staff are aware that it is not in use.



Service and repair

Manufacturers may provide service and repair of equipment that is purchased from them. Be sure to set up a procedure for scheduling service that must be periodically performed by the manufacturer. When instruments need repair, remember that some warranties require that repairs be handled only by the manufacturer.

Large facilities sometimes have biomedical service technicians in-house who perform equipment maintenance and repair.

Routine service should be scheduled so as not to interrupt the flow of work.

Retiring and disposing of equipment

It is very important to have a policy and procedures for retiring older laboratory equipment. This will usually occur when it is clear that the instrument is not functioning and is not repairable, or when it is outmoded and should be replaced with new equipment.

Once a piece of equipment is fully retired and it has been determined that it has no further usefulness, it should be disposed of in an appropriate manner. This last step is often neglected in laboratories, and old equipment accumulates, taking up valuable space and sometimes creating a hazard.

When disposing of equipment, salvage any useable parts, particularly if the equipment is being replaced with another similar one. Then consider any potential biohazards, and follow all safety disposal procedures.



MAINTAIN RECORDS

Record and report information on unsafe or faulty equipment according to enterprise procedures

Developing documents and policies for recordkeeping

Equipment documents and records are an essential part of the quality system. The policies and procedures for maintenance should be defined in appropriate documents, and keeping good equipment records will allow for thorough evaluation of any problems that arise. (Module 16: Documents and Records)

Each major piece of equipment will have its own equipment maintenance document. Smaller, commonly used equipment such as centrifuges and pipettes may be managed with an equipment maintenance document or manual that deals with all such equipment in the laboratory.

An equipment maintenance document should include:

- ✓ step-by-step instructions for routine maintenance, including frequency of performance, and how to keep records of performance;
- ✓ instructions for carrying out function checks, frequency of performance, and how to record the results;
- ✓ directions for calibrating the instrument;
- ✓ guide for troubleshooting;
- ✓ any required manufacturer's service and repair;
- ✓ list of any specific items needed for use and maintenance, such as spare parts.

For major equipment, include identification of the specific instrument, and perhaps information on its performance.

Recording maintenance information

Each piece of equipment should have a dedicated logbook documenting all characteristics and maintenance elements:



- ✓ preventive maintenance activities and schedule;
- ✓ recording of function checks and calibration;
- ✓ any maintenance performed by the manufacturer;
- ✓ full information on any problem that the instrument develops, the subsequent troubleshooting activity, and follow-up information regarding resolution of the problem. In recording problems, be sure to record:
 - date problem occurred, and when equipment was removed from service;
 - reason for breakdown or failure;
 - corrective action taken; including a note about any service provided by the manufacturer;
 - date returned to use;
 - any changes to procedure for maintenance or function checks as a result of the problem.

Some of the tools that are helpful for keeping records on equipment management are:

- charts
- logs
- checklists
- graphs
- service reports.

UNIT 13

SAMPLING AND PREPARE SAMPLES FOR TESTING

This unit of competency covers the ability to log samples, check sample documentation, schedule and prepare samples for testing in accordance with enterprise procedures

SAMPLING

Ideally, a laboratory infrastructure should be established which will enable all samples to be returned to a central or regional laboratory within a few hours of being taken. However, this depends on the availability of a good transportation system and of reliable motorized transport for all sampling officers, and these are not available in many countries. Thus, although it may be possible to establish well-equipped central and even regional laboratories for water analysis, at the provincial and district levels it may be necessary to rely on a relatively small number of simple tests. This approach is sometimes called critical-parameter water testing.

The most important factor to take into account is that, in most communities, the principal risk to human health derives from faecal contamination. In some countries there may also be hazards associated with specific chemical contaminants such as fluoride or arsenic, but the levels of these substances are unlikely to change significantly with time. Thus, if a full range of chemical analyses is undertaken on new water sources and repeated thereafter at fairly long intervals, chemical contaminants are unlikely to present an unrecognized hazard. In contrast, the potential for faecal contamination in untreated or inadequately treated community supplies is always present. The minimum level of analysis should therefore include testing for indicators of faecal pollution (thermotolerant (faecal) coliforms), turbidity, and chlorine residual and pH (if the water is disinfected with chlorine).

Even in developing countries poorly served by roads and transportation, it is usually possible to devise a rational sampling and analytical strategy. This should incorporate carefully selected critical-parameter tests in remote (usually rural) locations using simple methods and portable water-testing equipment where appropriate. Wherever possible the community should be involved in the sampling process. Where water is disinfected, primary health workers, schoolteachers, and sometimes community members can be trained to carry out simple chlorine residual testing. The same people could also collect samples for physicochemical analysis and arrange for their delivery to the regional laboratory. The use of community members in this way has significant implications for training and supervision but would be one way of ensuring more complete surveillance coverage.

Locate sampling points

One objective of surveillance is to assess the quality of the water supplied by the supply agency and of that at the point of use, so that samples of both should be taken. Any significant difference between the two has important implications for remedial strategies.

Samples must be taken from locations that are representative of the water source, treatment plant, storage facilities, distribution network, points at which water is delivered to the consumer, and points of use. In selecting sampling points, each locality should be considered individually; however, the following general criteria are usually applicable:

- ✓ Sampling points should be selected such that the samples taken are representative of the different sources from which water is obtained by the public or enters the system.
- ✓ These points should include those that yield samples representative of the conditions at the most unfavourable sources or places in the supply system, particularly points of possible contamination such as unprotected sources, loops, reservoirs, low-pressure zones, ends of the system, etc.
- ✓ Sampling points should be uniformly distributed throughout a piped distribution system, taking population distribution into account; the number of sampling points should be proportional to the number of links or branches.
- ✓ The points chosen should generally yield samples that are representative of the system as a whole and of its main components.
- ✓ Sampling points should be located in such a way that water can be sampled from reserve tanks and reservoirs, etc.
- ✓ In systems with more than one water source, the locations of the sampling points should take account of the number of inhabitants served by each source.
- ✓ There should be at least one sampling point directly after the clean-water outlet from each treatment plant.

Sampling sites in a piped distribution network may be classified as:

- ✓ fixed and agreed with the supply agency;
- ✓ fixed, but not agreed with the supply agency; or
- ✓ random or variable.

Each type of sampling site has certain advantages and disadvantages. Fixed sites agreed with the supplier are essential when legal action is to be used as a means of ensuring improvement; otherwise, the supply agency may object to a sample result on the grounds that water quality may have deteriorated in the household, beyond the area of responsibility of the supplier. Nevertheless, fixed sample points are rare or unknown in some countries.

Fixed sites that are not necessarily recognized by the supply agency are used frequently in investigations, including surveillance. They are especially useful when results have to be compared over time, but they limit the possibility of identifying local problems such as cross-connections and contamination from leaking distribution networks.

Sampling regimes using variable or random sites have the advantage of being more likely to detect local problems but are less useful for analysing changes over time.

Sampling frequency and Sampling methods

The most important tests used in water-quality surveillance or quality control in small communities are those for microbiological quality (by the measurement of indicator bacteria) and turbidity, and for free chlorine residual and pH where chlorination is used. These tests should be carried out whenever a sample is taken, regardless of how many other physical or chemical variables are to be measured.

The recommended minimum frequencies for these critical measurements in unpiped water supplies are summarized in Table below and minimum sample numbers for piped drinking-water in the distribution system are shown in following Table.

Table: Minimum frequency of sampling and analysis of unpiped water supplies

Source and mode of supply	Minimum frequency of sampling and analysis		Remarks
	Bacteriological	Physical/chemical	
Open wells for community supply	Sanitary protection measures; bacteriological testing only if situation demands	Once initially, for community wells	Pollution usually expected to occur
Covered dug wells and shallow tubewells with hand-pumps	Sanitary protection measures; bacteriological testing only if situation demands	Once initially, thereafter as situation demands	Situations requiring testing: change in environmental conditions, outbreak of waterborne disease, or increase in incidence of waterborne diseases
Deep tubewells with hand-pumps	Once initially, thereafter as situation demands	Once initially, thereafter as situation demands	Situations requiring testing: change in environmental conditions, outbreak of waterborne disease, or increase in incidence of waterborne diseases
Protected springs	Once initially, thereafter as situation demands	Periodically for residual chlorine if water is chlorinated	Situations requiring testing: change in environmental conditions, outbreak of waterborne disease, or increase

			in incidence of waterborne diseases
Community rainwater collection systems	Sanitary protection measures; bacteriological testing only if situation demands	Not needed	

Table Minimum sample numbers for piped drinking-water in the distribution system

<i>Population served</i>	<i>No. of monthly samples</i>
>5000	1
5000–100000	1 per 5000 population
>100000	1 per 10000 population, plus 10 additional samples

Make sampling procedure

Sampling Method

1. Detach sand strainer or water filter from tap with appropriate tools;
2. Check for the correct sample bottle and label;
3. Turn on cold water tap at maximum flow and start timing;
4. Let water flow for 2 to 5 minutes depending on how often the tap is used (If the internal laboratory system has not been used for a long period of time, flush the system thoroughly before sampling);
5. After flushing, open cap of the sample bottle;
6. Keep holding the sample bottle cap in one hand while sample is being collected to ensure it does not come into contact with anything to avoid contamination;
7. Fill the sample bottle carefully to prevent overflow;

Fill the sampling bottle carefully to prevent overflow.



8. Carefully put the cap back on the sample bottle;
9. The following should be noted during sampling:
 - i. Never rinse the bottle; the sampling bottle shall be so held that the water does not come in contact with the hand before entering into the bottle;
 - ii. Make sure that all samples are correctly labeled (sampling point, date and flushing time)



- iv. Reinstall tap sand strainer or water filter with tools;
- v. Store water samples in ice-boxes with freezer packs and deliver to
- vi. laboratory on the same day.

Cleaning Procedure for Sampling Bottles

Please follow the procedure below for cleaning polyethylene bottles (250 ml) and caps:

1. Rinse bottles and caps once with tap water.

2. Fill bottles to just overflowing with diluted 'Decon 90 (5%)' and put caps on bottles.
3. Shake bottles slightly and let them stand for at least 2 hours.
4. Remove caps and empty bottles.
5. Rinse bottles and caps in flowing tap water until no foam is observed.
6. Rinse bottles and caps once with deionised water.
7. Fill up bottles with 1:1 nitric acid (HNO₃) and put caps on bottles.
8. Shake bottles slightly and let them stand for at least 2 hours.
9. Remove caps and empty bottles.
10. Rinse bottles and caps 3 times with deionised water.
11. Dry bottles and caps in oven at 50°C.

LOG SAMPLES

Record date (and time of arrival, if required) of samples at enterprise

It is good practice for a member of the laboratory staff to sign for the receipt of samples and to make the following checks at the same time:

- ✓ All of the necessary details are recorded on the labels of sample bottles.
- ✓ The samples are contained in appropriate bottles.
- ✓ Samples have arrived in time for subsequent analysis to provide a reliable picture of water quality at the time of sampling.
- ✓ Samples have been treated with any necessary preservatives.
- ✓ Samples have been stored at appropriate temperatures, maintained throughout transport.

Samples should be logged into the laboratory system as soon as they arrive and (generally) transferred to a refrigerator at about 4 °C. If someone other than laboratory staff is to receive the samples, they should be instructed to transfer them directly to a refrigerator, noting the time and the condition of the samples, and then inform laboratory staff accordingly.

Where sample storage times and/or conditions have been such as to make it unlikely that analyses will yield reliable results, laboratory staff should decline to accept the affected samples. Supervisory staff should lend their support to the decision to reject samples on this basis.

Check and match samples with request forms before they are accepted

In general, the shorter the time that elapses between collection of a sample and its analysis, the more reliable will be the analytical results. For certain constituents and physical values, immediate analysis in the field is required in order to obtain dependable results, because the composition of the sample may change before the sample arrives at the laboratory.

Some determinations are more likely to be affected than others by storage of samples prior to analysis. Certain cations are subject to loss by adsorption or ion exchange upon the walls of glass containers. These include iron, copper, aluminum, manganese, trivalent chromium, and zinc. Temperature changes very quickly; pH may change significantly in a matter of minutes; dissolved gases may be lost (O_2 , CO_2 , H_2S , C_{12} , CEU) or gained (O_2 , CO_2). Determinations of temperature, pH, and dissolved gases should always be carried out in the field, because changes are almost inevitable by the time the samples reach the laboratory. With changes in the pH-alkalinity-carbon dioxide balance, calcium carbonate may precipitate and cause a decrease in the values for calcium and for total hardness. Iron and manganese form readily soluble compounds in their lower (reduced) valence states, and relatively insoluble compounds in their higher (oxidized) valence states; therefore these cations may precipitate out, or may dissolve out of a sediment, depending upon the redox potential of the sample. Microbiological activity may be responsible for changes in the nitrate-nitrite-ammonia balance, for decreases in phenols and in BOD, or for the reduction of sulfate to sulfide. Any residual chlorine is converted to chloride. Sulfide, sulfite, ferrous iron, iodide, and cyanide may be lost through oxidation. Color, odor, and turbidity may increase, decrease, or change in quality. Sodium, silica, and boron may be leached out of the glass container. Hexavalent chromium may be reduced to the trivalent state. This list is by no means all-inclusive. It is clearly impossible to prescribe absolute rules for the prevention of all possible changes ... to a large degree the dependability of water analyses must rest upon the experience and good judgment of the analyst.

Enter samples into the laboratory information management system (LIMS)

LIMS

From spreadsheets to record books, traditional methods of data recording are often insufficient to keep up with the demands of a modern lab. Recording, processing and analysing samples is a complicated and time-consuming process without the right tools and the large amounts of data storage required means any organisational methods must be well-maintained and adequately planned. Thankfully, that's where a Laboratory Information Management System could help. A LIMS will make it easier to track data and reduce the amount of time it takes to record it. The software can make the process of storing and analysing complex data samples simple and easy.



LIMS allows scientists and technicians to enter detailed essential information relating to the samples they're working with. Potential info to store includes:

- ✓ Inspection number
- ✓ Batch material
- ✓ Time and date
- ✓ Where the test was conducted
- ✓ Additional data

As a sample makes its way through the testing process, all of this information is held safely, securely and in one easy-to-access place. Many LIM systems will generate a barcode when the initial sample data is entered so that it can simply be scanned again by various staff members as additional information is obtained. Each user can scan the same code to ensure that the data is up-to-date, and the process is on track. As well as keeping all data safely contained, it can also track tests, schedule updates and even pass test results on to other systems in the chain. A LIMS means the need for manual recording of data (which obviously leaves room for human error) is no longer necessary as the system will automatically capture data. This reduces the time spent on admin and also lowers the possibility for inaccuracy.

Types of LIMS

Due to the nature of lab work, there are many different types of LIMS in operation. In fact, ask around and you may even get a different definition of a laboratory information management system depending on who you talk to, that's how dynamic and fast-paced the system can be.

Different types of LIMS have different functionalities, and these are dependent on the requirements of the individual lab. You could choose a system that focusses on data capture, system info and the storage options. Each LIMS operates a little differently but there are a range of functions that the software is designed to perform.

Sample Management

Sample management is one of the key functions of an LIMS. As a lab manager or technician, you'll no doubt be looking for ways to streamline processes and reduce error. An LIMS provides detailed and accurate records of each sample and stores it securely, thus reducing the chances that data could get lost or mixed up as it moves between workers and departments. As you record the initial sample, the system will make a detailed record that outlines:

- ✓ Who recorded the sample
- ✓ Who or what the sample was taken from
- ✓ Which researchers are working on the project?
- ✓ What part of the process it's currently at
- ✓ Where it needs to go next
- ✓ How it should be stored
- ✓ Relevant dates and when it needs to move to the next stage of the process

On the whole, the system is fully automated, making the process simple and straightforward for lab workers.

Workflow management

An LIMS can play the pivotal role of streamlining decision making within the lab. In a busy lab with large-scale research and numerous technicians, this can come in incredibly useful.

Consider that an LIMS can

- ✓ Automatically assign work to team members
- ✓ Suggest which instruments should be used
- ✓ Outline current rules system to researchers
- ✓ Let staff know exactly where samples should go to next.

In a traditional laboratory, it's generally assumed that 75% of the total outgoings in a lab go on manpower. Reducing the amount of admin involved gives staff more time and money to dedicate to research.

Reporting, maintenance, and inventory management

And last but by no means least, the LIMS can be used to assist with reporting, maintenance and inventories. The right system will:

- ✓ Identify how long your backlog is
- ✓ Outline how long it generally takes your lab to process a sample
- ✓ Highlight which instruments are used most in your lab

Another invaluable use is maintenance recording, it can provide detailed and up-to-date information regarding the upkeep of your equipment and notify you when any equipment is due for upgrade or maintenance work. For instruments such as centrifuges that are used extensively and come under a lot of wear and tear, accurate readings are key. An LIMS will ensure that you're never working

with substandard equipment. Not only will this information come in useful on a day-to-day basis but will also prove useful for auditing purposes.

Apply required document tracking mechanisms

Storage must be given careful consideration, as the main goal of documentation is finding the information when it is needed.

Using a paper system:

It is important to consider the following when using a paper system for records.

- **Permanence**—paper records must last for as long as needed. This should be ensured by binding pages together, or using a bound book (log register). Pages should be numbered for easy access, and permanent ink used.
- **Accessibility**—paper systems should be designed so that information can be easily retrieved whenever needed.
- **Security**—documents and records must be kept in a secure place. Security considerations include maintaining patient confidentiality. Care should be taken to keep documents safe from any environmental hazards such as spills. Consider how records can be protected in the event of fires, floods, or other possibilities.
- **Traceability**—it should be possible to trace a sample throughout all processes in the laboratory, and later to be able to see who collected the sample, who ran the test, and what the quality control results were for the test run including issuing of the report.

This is important in the event there are questions or problems about any reported laboratory result. All records should be signed, dated, and reviewed to ensure that this traceability throughout the laboratory has been maintained.

Using an electronic system:

Electronic systems have essentially the same requirements as paper systems. However, the methods for meeting these requirements will be different when using computers. The following are factors to consider.

- **Permanence**—backup systems in case the main system fails are essential. Additionally, regular maintenance of the computer system will help to reduce system failures and loss of data.
- **Security**—it is sometimes more difficult to assure confidentiality with a computer system, as many people may have access to the data.
- **Traceability**—electronic record systems should be designed in a way that allows for tracing the specimen throughout the entire process in the laboratory. Six months after performing an examination, it should be possible to look at the records and determine who collected the

specimen and who ran the test.

Record retention Retention times for records should be determined in each laboratory, based on a number of factors:

- the length of time the laboratory will need to have access to its records;
- government requirements or standards that dictate record retention times;
- whether the laboratory is engaged in ongoing research requiring many years of data;
- the time interval between the laboratory's assessments or audits.

Process 'urgent' test requests according to enterprise requirements

- Request shall be made via phone by authorized personnel.
- Request form must be stamped URGENT where applicable.
- Samples must be sent immediately to the laboratory.

Acceptance Criteria for Verbal Requests (Repeat / *Additional Test)

- Request must be made on the same day sample is sent to the laboratory.
- Request can only be accepted if sample is sufficient.
- Requested test is suitable to sample collected.
- Request must be made by an authorized clinician

Ensure security and traceability of all information, laboratory data and records

As critical to the smooth running of laboratories as equipment safety and security, data and information security is hugely beneficial to any lab's day-to-day activities. Without it, you run the risk of data loss, viruses, inadequate storage and a whole host of other problems which can be particularly damaging to your laboratory.

Here, we'll guide you through how you can optimise your lab's information and data security, ensuring only the right people can access its most important files and information.

Quick Navigation

- ✓ Cybersecurity
- ✓ Digital Encryption
- ✓ Appropriate Record Keeping

Cybersecurity

Don't leave your information vulnerable to attacks from outside interference. Safeguarding your most important files and data with the correct cybersecurity measures or policy is a bit of a no-brainer.

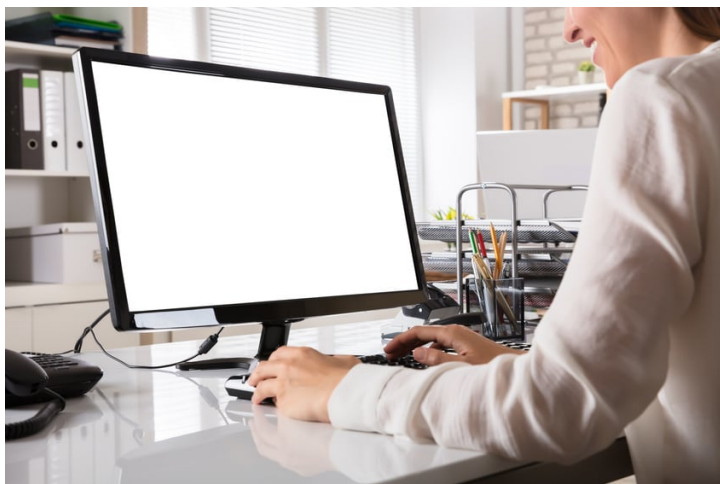
Getting started with a policy, no matter how small, is hugely beneficial. Take a look at the minimum regulations other labs use and see how you can employ these tools to help improve security. In your policy, outline the systems that need to be in place, how they will protect the company's data and who will be responsible for them.

You should be looking at things such as antivirus software, firewalls, automated backups to encrypted servers, and regular updates/patches to improve the vulnerabilities of certain applications.

After documenting your policy and implementing the applications, informing your employees about your lab's security is integral to preserving its safeguarding. This is because employees can unknowingly compromise your lab's networks through phishing scams, posting secure info on social media, and general human error. Your policy should include best practices for reducing damage, and what happens if they do not comply with the rules and regulations.

When optimising your lab's security, consider who requires access to computers and workstations. Employ the use of ID cards to identify registered users, and record the presence of any guest users. Whenever a user logs in, their use of a workstation should be logged; lab employees should be able to identify who used a workstation at any particular time, as well as any other workstations used by the same person.

If computers or workstations are not in use, make sure they're locked. More controlled access to your lab means less chance of damaging or compromising the information contained within.



Digital encryption

Encryption is a versatile, endlessly important security system that no lab should be without. Data that is encrypted is locked, therefore the only way to read it is to open it with a specific decryption key. Encryption-protected data secures sensitive data from malware and unauthorised access from third parties.

Files, passwords, emails and data backups should be encrypted, protecting you from hackers and third parties safely and easily, so consider making your most valuable files and information iron clad by encrypting them.



Appropriate record keeping

Record keeping is integral to any lab's day-to-day research. It's important for reasons of accountability and integrity, but it's also necessary in plenty of other ways. It keeps important data to hand which you'll need for analysis, collaboration, peer review and presenting your findings. If you find yourself embroiled in allegations of research misconduct, proper record keeping is invaluable in refuting these claims too.

Your records should make note of the person storing the information, what you did, the date of the research (including year), why the research was carried out, the methodology, what materials you used, your findings and interpretations, as well as what you'll do next.

A regular notebook will work just fine, but you'll have to make your own copies by hand and things can be hard to track if they aren't organised properly. Electronic notebooks are more conducive to research purposes because they're searchable, legible, can easily be backed up to avoid loss or damage, and can easily use images, videos and other files to back up your findings. If you're using an electronic notebook to make records, then the appropriate security measures must be taken to avoid loss of files and information.

ADDRESS CUSTOMER SERVICE ISSUES

Report to referring client/supervisor when samples and request forms do not comply with workplace requirements

The laboratory informs the customer when the method proposed by the customer is considered to be the incorrect choice or the incorrect revision for the intended purpose.

Statements of Conformity

When the customer requests a statement of conformity to a specification or standard for the test, the specification or standard and the decision rule are clearly defined in the compliance programs or standard. Otherwise, the laboratory communicates the decision rule selected to the customer and obtains their agreement.

Differences and Deviations

The authorities review the annual workplan to ensure that each laboratory has the capability and resources to provide the requested services. Any differences between the workplan and the laboratory capability are resolved prior to commencing work and in accordance with GUIDE. A Guide to Understanding the Program-based Forecast for Work planning, or through consultation with management.

Communicating with the customer

Requests for deviations from work assignments or compliance programs are processed by the Regulatory authority. RA interacts with the customer to determine whether the requested changes are acceptable and do not impact the integrity of the laboratory or the validity of the results. Records of contract changes are maintained.

Maintain confidentiality of all client/workplace data and information

Confidentiality

Confidentiality is the protection of personal information. Confidentiality means keeping a client's information between you and the client, and not telling others including co-workers, friends, family, etc.

Examples of maintaining confidentiality include:

- ✓ individual files are locked and secured
- ✓ support workers do not tell other people what is in a client's file unless they have permission from the client
- ✓ information about clients is not told to people who do not need to know

- ✓ clients' medical details are not discussed without their consent
- ✓ adult clients have the right to keep any information about themselves confidential, which includes that information being kept from family and friends.

The types of information that is considered confidential can include:

- ✓ name, date of birth, age, sex and address
- ✓ current contact details of family, guardian etc
- ✓ bank details
- ✓ medical history or records
- ✓ personal care issues
- ✓ service records and file progress notes
- ✓ individual personal plans
- ✓ assessments or reports
- ✓ guardianship orders
- ✓ incoming or outgoing personal correspondence.

Other information relating to ethnic or racial origin, political opinions, religious or philosophical beliefs, health or sexual lifestyle should also be considered confidential.

Adult clients have the right to determine what information they consider personal and confidential.

There is, however, no such thing as absolute confidentiality in the community services industry. Workers are required to keep notes on all interactions with clients and often to keep statistics about who is seen and what issues are addressed. As a worker, there will be times when you could be faced with some personal difficulties regarding confidentiality. You need to give your client an assurance that what is said will be in confidence (that it will stay secret between you and the client) because, unless you are able to do that, the client is unlikely to be open with you. However, you also need to be aware of the limits to the confidentiality that you are offering. There are several instances where total confidentiality is either impossible, undesirable or illegal. These include:

- ✓ cases where the law requires disclosure of information which will be
 - if the health and/or welfare of a child or young person is at risk. You are required to contact Department of Community Services and notify them of your concerns.
 - if your client tells you he/she has committed a serious crime. You are required to notify your supervisor or the police directly.
 - if a worker is subpoenaed to present information in a court of law
- ✓ when the client needs to be protected from harming themselves (eg if suicidal)
- ✓ where others may need to be protected (if the client has threatened to harm others or will do so inadvertently)
- ✓ the need to keep records
- ✓ when working in conjunction with other professionals in caring for a client

- ✓ the requirements of professional supervision, training, workshops or seminars.
- ✓ For more details go to the sections on *Legislation governing confidentiality* and *Exceptions to the general rule of confidentiality*.

It is always good practice to tell clients at the beginning of your contact with them that whatever they tell you is confidential except in the above circumstances.

When writing up case notes you need to be careful about what you include and how you write this information up. Always remember that clients have the right to see files and read anything that has been written about them.

When working with other professionals it is good practice to obtain the written consent of the client before exchanging information.

If you are going to be discussing a client and their situation in supervision, in a training session or at a workshop, you can always change the name and any information that may identify the client. Other workers in these situations are also bound by the same ethical and legal requirements relating to confidentiality that you are.

Confidentiality also extends to things like:

- ✓ names and addresses of clients
- ✓ phone numbers and addresses of staff and volunteers
- ✓ names and personal details of people who donate money or time
- ✓ details of funding agreements
- ✓ information about strategic planning.

Importance of confidentiality

Confidentiality is important for several reasons. One of the most important elements of confidentiality is that it helps to build and develop trust. It potentially allows for the free flow of information between the client and worker and acknowledges that a client's personal life and all the issues and problems that they have belong to them.

One of the major purposes for obtaining a client's consent before speaking to a third party (such as another agency or a family member/carer) is to protect the confidentiality and privacy of the client. Informed consent (obtaining personal information with the formal permission of the client or a person who has the legal authority to provide permission on behalf of the client) is considered essential in maintaining the privacy of the client.

It is important to keep your clients' business as just that – their business. You should only discuss matters relating to your clients' business with co-workers, and then only what needs to be discussed. Discussions should take place in the workplace and not be audible to other members of staff or the general public. You should never discuss clients' business with family or friends.

Respect for client confidentiality and staff personal information should be a high priority for all community services to comply with legislation that governs disclosure of information. In this regard all organisations need to have policies and procedures that provide guidelines for workers. Appropriate worker

behaviour can also be incorporated in a code of conduct.

To ensure confidentiality, workers should only access confidential information for work that is covered by their job description and the policies and procedures of the organisation. They should only disclose information to other parties where a client (or co-worker in relation to their personal information) has consented to the release of the information or where disclosure is required or mandated by legislation due to indications of risk of harm. Further workers need to ensure that any information that is collected is securely stored and disposed of.

Ensure that information provided to customers is accurate, relevant and authorized for release

Accuracy, or a lack of it, will greatly influence the customer experience. When accuracy is maintained, the result is a happy customer that will be a long-time advocate of the brand—that's our customers!

Laboratory quality can be defined as accuracy, reliability and timeliness of reported test results. The laboratory results must be as accurate as possible, all aspects of the laboratory operations must be reliable, and reporting must be timely in order to be useful in a public health setting.

When making measurements, there is always some level of inaccuracy. The challenge is to reduce the level of inaccuracy as much as possible, given the limitations of our testing systems. An accuracy level of 99% may at first glance appear acceptable, but the resulting 1% error can become quite large in a system where many events occur, such as laboratory testing.

Minimizing laboratory error

In order to achieve the highest level of accuracy and reliability, it is essential to perform all processes and procedures in the laboratory in the best possible way. The laboratory is a complex system, involving many steps of activity and many people. The complexity of the system requires that many processes and procedures be performed properly. Therefore, the quality management system model, which looks at the entire system, is very important for achieving good laboratory performance.

Deal with customers politely and efficiently and in accordance with workplace procedures

By handling customers effectively and efficiently you're delivering excellent customer service, which will have massive benefits for your company, such as powerful word of mouth marketing. This cannot be underestimated. Traditional advertising can be effective, but nothing is as likely to lead to a sale than a recommendation from a trusted friend.

Be available on many channels

One of the key points to consider is availability; it's really frustrating for customers who struggle to find ways to get in touch. Some websites hide their telephone number, their email address, and don't have any presence on alternative channels, such as social media. Failure to provide points of contact really is an opportunity missed. The more frequently we engage our customers, the more we build our brand and the loyalty associated with it.

Regardless of whether feedback is positive or negative, it's always important to understand customers' thoughts. If you are unapproachable then you could be missing out on information that can help shape your business and develop it further.

A simple call from a customer can help to get straight to the point, and the customer receives an instant response, or is given a time frame in which someone will get back to them. If your company does not display a phone number, it could have negative implications for your customer service. Similarly if you don't have a contact email address, or you have one and fail to respond in an adequate time frame, it can create a bad customer experience.

With developments in technology you can now get a professional Internet phone service at an affordable price, so there is no excuse not to provide a number.

Increased use of social media means news travels fast – especially bad news! Therefore it's important to be active and deal with any customer complaints or issues as they arise. Failing to stay on top of things and deal with negative word of mouth could dent your company's reputation. Spending a small time responding to queries could have massive benefits for your customer service reputation.

Choose a suitable support ticket system

If you provide an online service, in order to manage customer service effectively you need a good ticketing system. This allows your team to receive emails and create phone cases for customer queries, and delegate them to the relevant individual or team.

This helps keep things in order, and allows you to track any updates that may have happened on the ticket. It stops multiple responses to the same person and also shows which cases need working on.

Offer quick response times

Customers also get frustrated with long response times, as it seems you are too small to handle the demand, or too busy doing other things rather than helping them. Try to offer excellent response times, as customers will waste less of their time waiting for a solution, especially if your company is responsible for the issue.

Aim to answer calls as soon as possible and try to reduce overall wait times.

Measure email response times, and the time it takes to close cases.

Respond to good and bad feedback

It's important to keep on top of feedback, whether good or bad, and respond accordingly. If someone's taken the time out to praise your product or service then it would be nice to show your appreciation and build on that relationship with the customer.

Negative feedback can be harmful for your business. Try to get to the bottom of it and find a resolution that will send the customer away happy. Trying to get to the root of the problem, and making an effort to resolve the issue, often diffuses the situation, and shows any spectators on social media that you take your customers satisfaction seriously.

A happy client that receives excellent customer service is more likely to talk about their fantastic experiences and promote your company for free. They will also remain loyal to the brand and continue to support your business.

PREPARE SAMPLES FOR TESTING

Perform physical separation of the samples, as required

When two or more substances, that do not react chemically, are blended together, the result is a mixture in which each component retains its individual identity and properties.

The separation of the components of a mixture is a problem frequently encountered in chemistry. The basis of the separation is the fact that each component has a different set of physical and chemical properties. The components are pure substances which are either elements or compounds. Under the same conditions of pressure and temperature, the properties of every sample of a pure substance are identical. Each sample melts at the same temperature, boils at the same temperature, has the same solubility in a given solvent, etc.

Although these and other characteristics can be used to identify a particular substance, we will be concerned, in this experiment, with the separation of a mixture into its components, not with the identification of the substances. Techniques used to separate mixtures rely on differences in the physical properties of the components. Techniques useful for the separation of mixtures include the following:

Distillation is the purification of a liquid by heating it to its boiling point, causing vaporization, and then condensing the vapors into the liquid state and collecting the liquid. Separation of two or more liquids requires that they have different boiling temperatures. All boiling temperatures can be reduced by decreasing the

pressure on the liquid.

Extraction is the removal of one substance from a mixture because of its greater solubility in a given solvent.

Filtration is the process of removing or "straining" a solid (the chemical term is precipitate) from a liquid by the use of filter paper or other porous material.

Decanting is the pouring of a liquid from a solid-liquid mixture, leaving the solid behind.

Centrifuging is the process of separating a suspended solid from a liquid by whirling the mixture at high speed.

Sublimation is the physical property of some substances to pass directly from the solid state to the gaseous state without the appearance of the liquid state. Not all substances possess this characteristic. If one component of a mixture sublimates, this property may be used to separate it from the other components of the mixture. Iodine (I_2), naphthalene ($C_{10}H_8$, mothballs), ammonium chloride (NH_4Cl) and dry ice (solid CO_2) are some substances which sublime.

Chromatography is the process of separating a mixture by the distribution of its components between two phases, one phase being stationary and the other phase moving. Some examples of chromatography are gas chromatography, paper chromatography, and thin-layer chromatography.

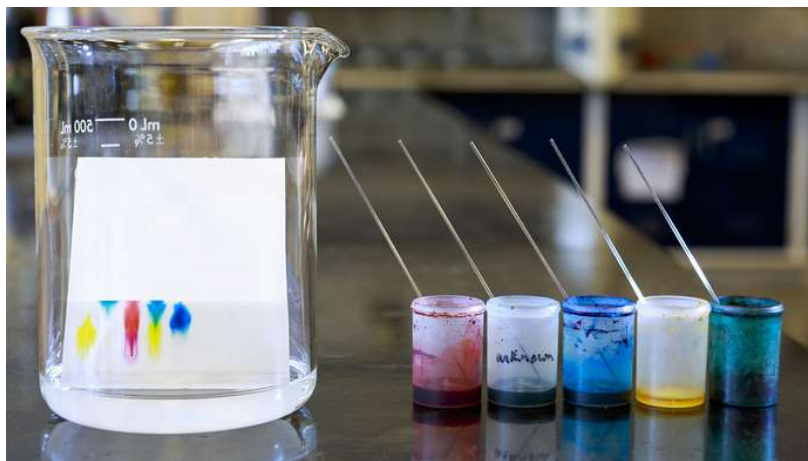
Prepare the required number of sub-samples

Split replicates are samples obtained by dividing one sample that is designated for a specific laboratory analysis into two or more subsamples (replicates), each of which is submitted to one or more laboratories for identical analysis. Split replicates can be collected for different purposes, depending on the procedures employed and whether the purpose is to determine variability from field plus laboratory processes (the field-replicate split sample) or from laboratory procedures (the lab-replicate split sample).

Lab-replicate split sample. A sample collected in a single bottle that is split into two or more replicates after having been processed and preserved is used to answer the question: "What is the variability associated with laboratory handling and analysis of the sample?" This type of split replicate sample typically is prepared from filtered samples; it is not appropriate, generally, for whole-water samples containing noticeable concentrations of suspended material.

Perform chemical separation of the samples, as required

Paper chromatography, in analytical chemistry, technique for separating dissolved chemical substances by taking advantage of their different rates of migration across sheets of paper. It is an inexpensive but powerful analytical tool that requires very small quantities of material.



Simple paper chromatography with various inks.

The method consists of applying the test solution or sample as a spot near one corner of a sheet of filter paper. The paper is initially impregnated with some suitable solvent to create a stationary liquid phase. An edge of the paper close to the test spot is then immersed in another solvent in which the components of the mixture are soluble in varying degrees. The solvent penetrates the paper by capillary action and, in passing over the sample spot, carries along with it the various components of the sample. The components move with the flowing solvent at velocities that are dependent on their solubilities in the stationary and flowing solvents. Separation of the components is brought about if there are differences in their relative solubilities in the two solvents. Before the flowing solvent reaches the farther edge of the paper, both solvents are evaporated, and the location of the separated components is identified, usually by application of reagents that form coloured compounds with the separated substances. The separated components appear as individual spots on the path of the solvent. If the solvent flowing in one direction is not able to separate all the components satisfactorily, the paper may be turned 90° and the process repeated using another solvent.

Paper chromatography has become standard practice for the separation of complex mixtures of amino acids, peptides, carbohydrates, steroids, purines, and a long list of simple organic compounds. Inorganic ions can also readily be separated on paper. Compare thin-layer chromatography.

Place samples in appropriate transport media, as required

Samples should be delivered to the relevant laboratory for analysis as soon as practicable after collection. Where samples are to be transported to a laboratory by post or courier service, the sample collector should liaise with the receiving laboratory regarding delivery arrangements.

DISTRIBUTE SAMPLES

Group samples requiring similar testing requirements

group testing is any procedure that breaks up the task of identifying certain objects into tests on groups of items, rather than on individual ones.

Example: Multiplex assay design for COVID19 testing

During a pandemic such as the COVID-19 outbreak in 2020, virus detection assays are sometimes run using nonadaptive group testing designs. One example was provided by the Origami Assays project which released open source group testing designs to run on a laboratory standard 96 well plate.



Origami Assay paper template for group testing design

In a laboratory setting, one challenge of group testing is the construction of the mixtures can be time-consuming and difficult to do accurately by hand. Origami assays provided a workaround for this construction problem by providing paper templates to guide the technician on how to allocate patient samples across the test wells.

Using the largest group testing designs (XL3) it was possible to test 1120 patient samples in 94 assay wells. If the true positive rate was low enough, then no additional testing was required

Distribute samples to workstations maintaining sample integrity

The laboratory needs a system to allow for tracking a sample throughout the laboratory from the time it is received until results are reported.

This can be done manually by careful keeping of records.

- ✓ confirm receipt of samples, include date and time;
- ✓ label samples appropriately; keep with the test requisition until laboratory ID is assigned;
- ✓ track aliquots–traceable to the original sample.

If computers are available, maintain a database for tracking. The following information about each sample should be entered into the database:

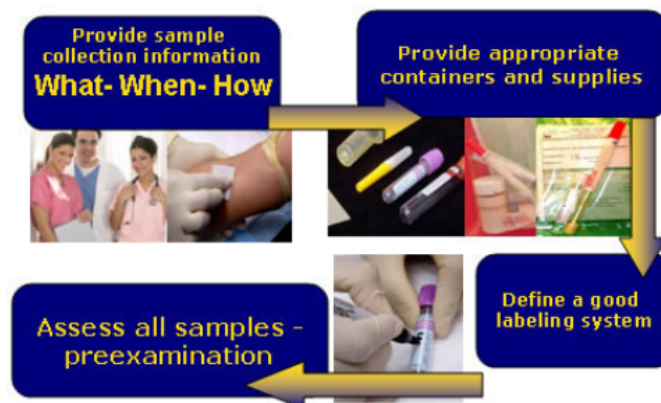
- ✓ identification number;
- ✓ patient information;
- ✓ collection date and time;
- ✓ type of sample: for example, urine, throat, cerebrospinal fluid for culture;
- ✓ tests to be performed;
- ✓ name of ordering physician (or other health care provider);
- ✓ location of patient, such as ward, clinic, outpatient;
- ✓ diagnostic test results;
- ✓ time and date results are reported.

Handle all samples as if infectious



Check that samples and relevant request forms have been received by laboratory personnel

The collection of appropriate and optimum samples is the responsibility of the laboratory, even though the actual collection process is often carried out by persons who are not part of the laboratory staff. The sample may be collected at the bedside by a nurse if the patient is being managed in a hospital. The health care provider may collect a sample in a clinic setting.



The laboratory can help to assure good samples by providing collection information to health care personnel at the collection site, making sure that

appropriate containers and collection supplies are available, defining a good labeling system, and checking all samples carefully when they arrive in the laboratory

Test requisition

The first step in the process of obtaining the sample is the request for testing. The laboratory must make available a test request form that specifies all the information that will be needed for proper handling and reporting.

Essential information for the test request form includes:

- ✓ patient identification;
- ✓ tests requested;
- ✓ time and date of the sample collection;
- ✓ source of the sample, when appropriate;
- ✓ clinical data, when indicated;
- ✓ contact information for the health care provider requesting the test.

Collection of samples in the field for epidemiological studies should be accompanied by a form that includes the patient's name, a unique identification number, demographic information, and the patient's health status. The additional information is necessary to assist in identifying the source of an infection, and finding potential contacts.

MAINTAIN A SAFE WORK AREA AND ENVIRONMENT

Apply safe work practices to ensure personal safety and that of other laboratory personnel

The most common injuries in labs are needle sticks, strains because of improper lifting techniques and cuts from broken glassware. The following safe working practices will reduce the possibility of laboratory accidents.

- ✓ Appropriate attire shall be worn in all laboratories. Closed-toed shoes with leather uppers will be worn. Shorts will not be worn, not even if worn under lab coats. Appropriate, personal protection apparel including lab coats, safety glasses/goggles, filter masks and/or gloves will be made available and shall be worn. Laboratory supervisors and course directors are responsible for implementation of proper laboratory attire and personal protection apparel. UNTHSC personnel who are inappropriately dressed will be denied access to all laboratories and animal care facilities.
- ✓ Hands shall be washed after an operation is completed, after removal of gloves and before leaving the laboratory area. Gloves used in the laboratory shall be removed before leaving the laboratory.

- ✓ Protective equipment provided shall be used when performing any task that may result in injury, illness or exposure to biohazards. Any defects in this protective equipment must be reported immediately to management. Use of this defective equipment must be suspended until repairs or replacements are made.
- ✓ Work areas shall be kept clean and free from clutter.
- ✓ Laboratory passageways and aisles must remain unobstructed and must be wide enough for free movement while handling standard materials and supplies.
- ✓ Work areas must be adequately ventilated. The air ducts of the laboratory shall not be blocked or diverted. Likewise, the air flow of flow hoods must be adequate for the work performed in them and they must be vented properly.
- ✓ Laboratory doors shall be kept closed. Laboratories are designed to contain a fire thereby giving the occupants of the building time to escape. Open doors defeat this design and allow the rapid spread of flames and smoke in the building. Open doors also disturb the ventilation balance throughout the building allowing possible buildup of airborne toxins in other areas.
- ✓ All human body fluids, tissue and contaminated articles will be handled as potential sources of HIV, HBV and HCV infection. Specific procedures are referenced in Part 3, Chapter 1 of the UNTHSC Safety Manual.
- ✓ Mechanical pipetting devices shall be used. Never pipette by mouth.
- ✓ All laboratory personnel that are required to come in contact with animals shall be trained in the proper handling techniques and shall be immunized for diseases as required by the health science center occupational health program for animal handlers.
- ✓ Hazardous materials, including flammable liquids, chemicals, biohazardous materials and radioactive materials, must be stored, handled and disposed of properly. Specific procedures are listed in the health science center Radiation Safety Manual, the Chemical Hygiene Program and to bloodborne pathogens referenced in Part 3, Chapter 1 of the UNTHSC Safety Manual.
- ✓ Accidental spills or exposure of radioactive, hazardous or biohazardous materials must be reported immediately to management. Spill residues must be disposed of properly.
- ✓ Non-hazardous chemicals spills (including water), and broken glassware must be cleaned up immediately and disposed of properly.
- ✓ "Sharps" including syringe needles, scalpel blades, glass transfer pipettes and broken glass shall be handled carefully and disposed of in puncture-proof containers NOT in the regular trash.
- ✓ Syringes shall not be placed in the common wastebasket with their needle tips still intact. Current Centers for Disease Control (CDC) guidelines recommend that syringes not be recapped, rather a disposal unit should be used that will accept the entire syringe unit. The one exception to this guideline is that syringes contaminated with radioactive materials from in

vitro research should be carefully recapped and disposed of as radioactive waste.

- ✓ Necessary emergency equipment will be readily available within the laboratory or just outside the room. The emergency equipment will be readily accessible and easily identifiable.
- ✓ All gas cylinders must be individually secured to a wall or table using approved brackets or floor mounts. Cylinders not in use or cylinders being transported shall have their regulators removed and safety cap in place.

Use appropriate personal protective equipment (PPE) to ensure personal safety when sampling, processing, transferring or disposing of samples

Personal Protective Equipment (PPE) is widely recognised as a means of protection for individuals working in an environment where all other methods of hazard control are in place and there is still a risk of injury. You must remember that PPE is the last barrier or line of defence between you and the hazardous material you are working with.

The minimum PPE you are required to wear when working in University Laboratories are:

- ✓ Enclosed Shoes (no bare feet, thongs, or sandals and
- ✓ Lab Coat (must be individually issued, worn at all times when working in the lab, removed before

leaving the lab and laundered regularly and when contamination is suspected).

AQIS Note: If you have been working with Quarantine materials, your lab coat must be autoclaved prior to being removed from the lab and laundered

The following additional PPE is provided and should be used where required / instructed / determined by a risk assessment:

- ✓ Safety Glasses / Goggles
- ✓ Gloves
- ✓ Dust Mask / Respirator
- ✓ Face Shield
- ✓ PVC Apron
- ✓ Hearing protection

Eye Protection

The type of eye protection required for a worker or student at the University will depend on the hazards that they work with or which they encounter in the specific work activity, and should be determined by undertaking a risk assessment. The risk assessment should take account of the hazards that are present in the laboratory for most of the time, and consider the work of the group as a whole, not just that of an individual.

Safety Glasses must be worn when:

- ✓ There is a risk of objects striking or causing damage to your eyes.
- ✓ When instructed to do so by your Supervisor or the Lab Manager.
- ✓ If required by the Risk Assessments or Chemical MSDS.

** Safety Glasses may limit, but will not prevent chemicals from splashing into your eyes. Safety Glasses are only suitable when the chemicals you are working with would not harm your eyes in the event of an accident.

Safety Goggles must be worn:

- ✓ When working with hazardous chemical solutions where there is a risk of splash to your eyes.

Face Shield must be worn when:

- ✓ Working with volatile hazardous chemical solutions (eg. concentrated acids).
- ✓ Working with dangerous substances that could strike/splash the face/eyes.
- ✓ There is a risk of solution explosion or instability causing a splash to the face/eyes.
- ✓ There is a risk of dangerous objects striking the face/eyes, such as particles, glass or metal shards.

Standard Prescription Glasses are not sufficient as protective eyewear if:

- ✓ You are working with hazardous chemical solutions and there is a risk of splash to the eye.
- ✓ You are working with toxic, corrosive, pathogenic or radioactive substances.
- ✓ You are undertaking activities where there is a risk of objects striking the eye, such as particles,
- ✓ glass or metal shards.

** In these instances, ordinary prescription glasses will not provide adequate protection from injury to the eyes and could even be hazardous to the wearer. Please see the Laboratory Manager if you require Prescription Safety Glasses.

Gloves

Different gloves are available for different tasks. Please ensure that you are using the right type of glove for the task you are undertaking. For chemicals, this information can be found in the MSDS.

Gloves available in this laboratory include:

- ✓ Latex disposable examination gloves – powder free
 - Protects your cultures / samples from you.
 - Helps stop the spread of some contaminants around the laboratory.
 - Not to be used with hazardous chemicals.
- ✓ Nitrile disposable gloves (blue)
 - Resistant to many solvents and chemicals.
 - Abrasion and puncture resistance.
 - Helps protect you from exposure to some hazardous chemicals.
- ✓ Rubber gloves
 - Good resistance to detergents and diluted chemicals.
- ✓ Cotton gloves
 - For use under other gloves – absorbs perspiration and helps with heat resistance (for eg, against hot dishwashing water).
- ✓ Leather gloves
 - Some protection when handling broken glass – extreme care must still be taken. Heat resistant gloves
 - Enables you to handle hot items – extreme care must still be taken.
 - Used to remove items from the Drying Ovens and/or Autoclave.

Report all accidents and spillages to supervisor

Work-related incidents are tracked and investigated so that preventative measures can be implemented. The information contained in the reports is essential to maintain successful safety programs. The facts are necessary to develop procedures that can control both the conditions and acts that contribute to incidents.

Supervisor's Responsibility

The supervisor is responsible for ensuring that the workplace is safe and safety hazards and unsafe practices are identified and corrected. The responsibility includes telling others of safety problems that require the other's action to correct. The supervisor must train employees to recognize and protect against hazards in the workplace. Supervisors must also inform employees who use hazardous substances of their safe use and ensure employee access to Material Safety Data Sheets. If a supervisor observes an employee engaging in an unsafe practice, she/he must instruct the employee to follow the safety procedures and enforce compliance, if necessary.

Employee's Responsibility

Each employee has the responsibility to:

- ✓ Read, understand and obey written and verbal safety instructions.
- ✓ Operate only that equipment which she/he has been authorized to use and trained to use safely.
- ✓ Read the Material Safety Data Sheet before using any hazardous material.
- ✓ Use the safety gear provided for his/her job.
- ✓ Keep work areas clean and orderly.
- ✓ Avoid behavior which could lead to injury.
- ✓ Report unsafe conditions to his/her supervisor.

Procedures for Reporting Accidents

Supervisors and employees shall follow established procedures for reporting accidents. In the absence of specific unit procedures, the following apply.


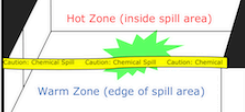
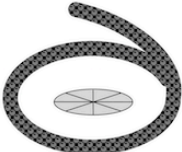
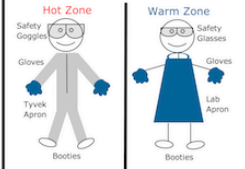

- ✓ An accident or personal injury emergency should be reported to supervisor. Call 911 for emergency response to spills of hazardous materials that are inhalation hazards or immediate threats to the environment.
- ✓ Employees must report all accidents to the work unit supervisor, whether or not the employee has been injured. If an injury occurs, the employee must complete the Employee's Work Injury and Illness Report and the supervisor must complete the Employer's First Report of Injury or Disease and the Supervisor's Accident Analysis and Prevention Report, within the specified time.
- ✓ Persons who are not employees should report an accident and/or injury to the nearest department office or Building Manager, who shall take responsibility for following procedures.
- ✓ Concerns about unsafe building conditions should be reported to the Building Manager.
- ✓ Report any spill or release of hazardous materials to the Safety Department.
- ✓ NOTE: If the spill is an inhalation hazard or an immediate threat to the sewer system or exterior environment, notify the fire department unit.

Clean up splashes and spillages immediately using appropriate techniques and precautions

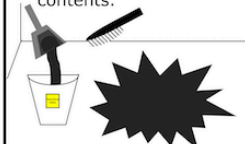
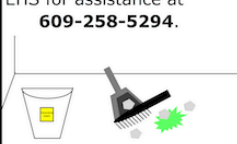
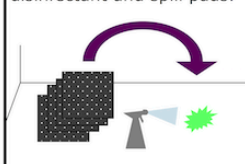
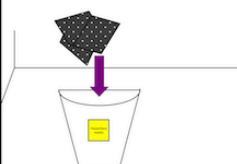
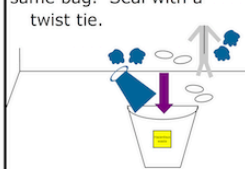
In the event of a chemical spill, the individual(s) who caused the spill is responsible for prompt and proper clean-up. It is also their responsibility to have spill control and personal protective equipment appropriate for the chemicals being handled readily available.

Cleaning up Chemical Spills

EHS: 609-258-5294 PUBLIC SAFETY: 609-258-3333

<p>1. Call Public Safety at 609-258-3333 if...</p> <ul style="list-style-type: none"> • anyone is hurt, • the spill is greater than one gallon • there is a release to the environment • there is a violent reaction or fire 	<p>2. For spills less than one gallon, use this spill kit.</p> 
<p>3. Put up "Caution: Chemical Spill" tape. Notify people in the surrounding area.</p> 	<p>4. Protect nearby floor drains with a spill sock.</p> 
<p>5. Put on the appropriate PPE.</p> 	<p>6. Pour absorbent from the outside of the spill to the center.</p> 



<p>7. Collect absorbent in a bag. Label the bag as hazardous waste and the contents.</p> 	<p>8. Take extra caution with regard to shards of glass and chemical vapors. Call EHS for assistance at 609-258-5294.</p> 
<p>9. Decontaminate area with compatible disinfectant and spill pads.</p> 	<p>10. Collect contaminated spill pads in the same bag.</p> 
<p>11. Remove PPE and collect disposables in the same bag. Seal with a twist tie.</p> 	<p>12. Contact EHS at 609-258-5294 or ehs@princeton.edu to refill the spill kit. Report spills to your supervisor.</p>

The following are general guidelines to be followed for a chemical spill.

Emergency Actions

- ✓ Immediately alert area occupants and supervisor, and evacuate the area, if necessary.
- ✓ If there is a fire or medical attention is needed, contact Public Safety.
- ✓ Attend to any people who may be contaminated. Contaminated clothing must be removed immediately and the skin flushed with water for no less than fifteen minutes. Clothing must be laundered before reuse. See First Aid for Chemical Exposures for more information.
- ✓ If a volatile, flammable material is spilled, immediately warn everyone, control sources of ignition and ventilate the area.

Immediate Spill Response

- ✓ Personal protective equipment, as appropriate to the hazards. Refer to the Material Safety Data Sheet or other references for information.
- ✓ Consider the need for respiratory protection.(link is external) The use of a respirator or self-contained breathing apparatus requires specialized training and medical surveillance. Never enter a contaminated

atmosphere without protection or use a respirator without training. If respiratory protection is needed and no trained personnel are available, Public Safety at 911. If respiratory protection is used, be sure there is another person outside the spill area in communication, in case of an emergency. If no one is available, contact Public Safety.

- ✓ Using the chart below, determine the extent and type of spill. If the spill is large, if there has been a release to the environment or if there is no one knowledgeable about spill clean-up available Public Safety.

✓

Category	Size	Response	Treatment Materials
Small	up to 300mL	chemical treatment or absorption	neutralization or absorption spill kit
Medium	300mL to 5L	absorption	absorption spill kit
Large	more than 5L	call Public Safety (609-258-3333)	outside help

- ✓ Protect floor drains or other means for environmental release. Spill socks and absorbents may be placed around drains, as needed.
- ✓ Contain and clean-up the spill according to the table above.
- ✓ Loose spill control materials should be distributed over the entire spill area, working from the outside, circling to the inside. This reduces the chance of splash or spread of the spilled chemical. Bulk absorbents and many spill pillows do not work with hydrofluoric acid. POWERSORB® (by 3M) products and their equivalent will handle hydrofluoric acid. Specialized hydrofluoric acid kits also are available for purchase from lab safety suppliers. Many neutralizers for acids or bases have a color change indicator to show when the spill is neutralized.
- ✓ When spilled materials have been absorbed, use brush and scoop to place materials in an appropriate container. Polyethylene bags may be used for small spills. Five gallon pails or 20 gallon drums with polyethylene liners may be appropriate for larger quantities.
- ✓ Complete a hazardous waste sticker, identifying the material as Spill Debris involving XYZ Chemical, and affix onto the container. Spill control materials will probably need to be disposed of as hazardous waste. Contact EHS for advice on storage and packaging for disposal.
- ✓ Decontaminate the surface where the spill occurred using a mild detergent and water, when appropriate.
- ✓ Report all spills to your supervisor.

Minimise the generation of wastes and environmental impacts

Engage and motivate your coworkers to buy green products and help reduce waste. Learn more about how your office can go green.

- ✓ Instead of printing hard copies of your documents, save them to your hard drive or email them to yourself to save paper.
- ✓ Make your printer environmentally friendly. Change your printer settings to make double-sided pages. Use small point fonts when possible and use the "fast draft" setting when possible to save ink.
- ✓ Pay your bills via e-billing programs when possible to save paper.
- ✓ Use paperclips (over staples) when possible.
- ✓ Reuse envelopes with metal clasps and reuse file folders by sticking a new label over the previous one.

Green Purchasing at Work

- ✓ Purchase recycled paper and keep a recycling bin nearby your desk.
- ✓ For information on how to buy more recycled-content products for your office, see EPA's Comprehensive Procurement Guidelines.
- ✓ Buy energy efficient items with the ENERGY STAR ® logo or items that are EPEAT registered for the office.

Ensure the safe disposal of hazardous materials and other laboratory wastes

Disposal Procedures

It is the clear responsibility of all research workers to ensure the safe and correct disposal of all wastes produced in the course of their work. Improper and irresponsible disposal of chemical wastes down drains, to the Local Authority, refuse collection, or into the atmosphere is forbidden by law. The Aldrich Handbook provides a useful summary of the correct disposal procedure for most chemicals. Due to new legislation, increasingly strict environmental controls and the escalating costs of disposal, it is essential that the appropriate disposal procedures given below are strictly adhered to:

Wash down drains with excess water

Concentrated and dilute acids and alkalis

- ✓ Harmless soluble inorganic salts (including all drying agents such as CaCl_2 , MgSO_4 , Na_2SO_4 , P_2O_5)
- ✓ Alcohols containing salts (e.g. from destroying sodium)
- ✓ Hypochlorite solutions from destroying cyanides, phosphines, etc.
- ✓ Fine (tlc grade) silica and alumina

It should be noted in particular that no material on the "Red List" should ever be

washed down a drain. This list is as follows:

compounds of the following elements:- antimony, arsenic, barium, beryllium, boron, cadmium, chromium, cobalt, copper, lead, mercury, molybdenum, nickel, selenium, silver, tellurium, thallium, tin, titanium, uranium, vanadium and zinc.

- ✓ organohalogen, organophosphorus or organonitrogen pesticides, triazine herbicides, any other biocides.
- ✓ cyanides
- ✓ mineral oils and hydrocarbons
- ✓ poisonous organosilicon compounds, metal phosphides and phosphorus element
- ✓ fluorides and nitrites

Incineration (Solvent Waste collection)

- ✓ all organic solvents including water-miscible ones
- ✓ soluble organic waste including most organic solids
- ✓ paraffin and mineral oil (from oil baths and pumps)

Laboratory waste bins and controlled waste

All waste suitable for the Local Authority refuse collection, except recyclable paper and glass, is termed 'controlled waste'. Items in this category which includes dirty paper, plastic, rubber and wood, should generally be placed in the waste bins available in each laboratory and will be collected by the cleaners. However, each laboratory must also have a container for certain items which are not allowed to be put in the normal waste bins. In this special controlled waste container should be put:- all broken laboratory glassware, any sharp objects of metal or glass, all fine powders (preferably inside a bottle or jar) and dirty sample tubes or other items lightly contaminated with chemicals (but not any syringes or needles). Laboratory controlled waste containers must be emptied regularly and never allowed to overflow. Under no circumstances must any item of glass, sharp metal or fine powder ever be put in a normal laboratory waste bin. The tops must be removed from all bottles put out for disposal and there should be no detectable smell of chemicals from any bottle put for disposal.

Waste for special disposal

This is a troublesome and expensive method of disposal and the quantity of special waste must be kept to an absolute minimum. Only the following items should be disposed of in this way:

1. Schedule 1 poisons (but not cyanides) and other highly toxic chemicals
2. Materials heavily contaminated with substances in (i)
3. Materials contaminated with mercury
4. Carcinogenic solids including asbestos.

Special waste must be collected in a separate labelled bottle or jar for disposal. On no account must different types of waste be mixed. Advice should be sought from the School Safety Co-ordinator before beginning any work which will produce waste requiring special disposal in order to ensure that:

- ✓ the waste can be disposed of
- ✓ it is collected in the most suitable form so as to minimise the cost involved and
- ✓ it will be stored under suitable conditions.

The importance of handling waste for special disposal to the School Safety Co-ordinator immediately the container is full or the work is finished is emphasised. The hoarding up of hazardous waste in laboratories is strictly forbidden. Environmental Health and Safety Services should be notified of all 'Special Waste' on the appropriate form.

Glass recycling

For environmental reasons the recycling of glass is encouraged, but only certain items of waste glass produced within laboratories are acceptable for recycling. Each laboratory should have a bin for recyclable glass. Only clean glass bottles such as those in which chemicals are received, and broken or waste plate glass are allowed. All broken laboratory glassware, items significantly contaminated by chemicals, sample tubes, droppers and glass wool must be disposed of as controlled waste. The recycling service will refuse to empty a recycling container if any of these prohibited items are discovered in it.

Bottles for bulk solvents

The importance of returning the specially labelled winchesters for solvents which are bought in bulk to the Store ready for direct refilling is emphasised. They must not be contaminated in any way and should not normally be washed out. Bottles containing sodium must not, under any circumstances, be returned directly to the Store. When sodium is first added to a bottle of solvent a label indicating this (available from the Store) should be attached. When the bottle is empty the sodium must be safely destroyed by adding ethanol or methylated spirit and the label removed. The bottle must then be washed out, dried and returned to the Store ready for direct refilling.

Empty winchester bottles may be re-used e.g. for the disposal of waste solvents. They must first be washed out with water if they have contained a corrosive or harmful chemical e.g. concentrated acid or ammonia.

Biohazard/Sharps Disposal - Syringes and Needles

"Sharps" contaminated with biologically hazardous materials must be collected in special containers to be sent for incineration. It is also required, at the request of Fife Council, that all syringes and needles of any type should be disposed of by the same route. No syringes or needles must ever be put in a laboratory waste bin or controlled waste container.

UNIT 14

PREPARE WORKING SOLUTIONS

This unit of competency covers the ability to prepare working solutions and to check that existing stocks of solutions are suitable for use. Working solutions include those required to perform laboratory tests. Personnel are required to calculate quantities and make dilutions

MAKE UP WORKING SOLUTIONS

Identify the relevant standard methods for solution preparation

The best way to reduce the risk of drinking unsafe water is to use the multi-barrier approach.

The five steps of the multi-barrier approach to safe drinking water are:

1. Protect your source water
2. Sediment your water
3. Filter your water
4. Disinfect your water
5. Store your water safely

Each step in the process, from source protection to water treatment and safe storage, helps reduce health risks. The emphasis should be placed on protecting our water sources first.

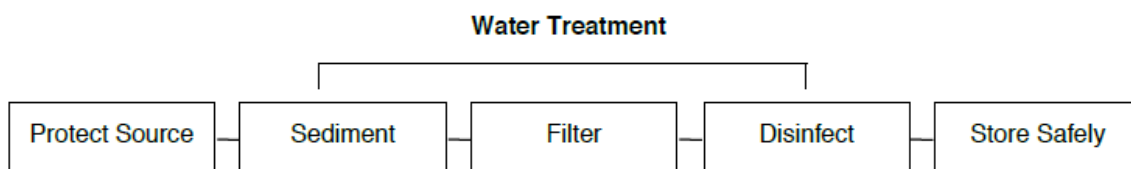
The concept of the multi-barrier approach is also addressed by the WHO as part of the Guidelines for Drinking Water Quality and water safety plans, the principles of which can be applied at both community and household levels. The WHO provides additional information about water safety plans on their website at: www.wspportal.org/ibis/water-safety-portal/eng/home.

Water can be treated at a central location, in large volumes, and then supplied to households

through a network of pipes. This is often called centralized or community water treatment.

Smaller volumes of water can also be treated at the point of use (POU), such as in institutions (e.g., schools, clinics, religious institutions), and in the home. This is also commonly called household water treatment and safe storage (HWTS) since the family members gather the water, and then treat and store it in their home.

Both conventional (community) and household systems follow the same basic water treatment process, which is the middle three steps of the multi-barrier approach: sedimentation, filtration and disinfection. The main difference between conventional and household systems is the scale of the technologies used



- ✓ Sedimenting water removes larger particles and often more than 50% of pathogens
- ✓ Filtering water removes smaller particles and often more than 90% of pathogens
- ✓ Disinfecting water deactivates or kills any remaining pathogens

Assemble specified laboratory equipment

Using Portable Test Kits

Water quality testing can be a challenge where resources are limited. The lack of testing available in developing countries highlighted the need for rapid, simple, and inexpensive test methods. This need is especially great for rural and small community and household water supplies that are located far away and who cannot afford commercial laboratory testing. On-site testing using portable kits with simplified test methods have allowed water quality testing to be a possibility in developing countries.

Testing for many physical, chemical and microbiological parameters can be carried out in the field using specifically designed products that are portable and relatively easy to use. In rural and remote communities, it is more convenient to carry out water testing on-site. Another advantage of using portable kits is that tests are carried out on new water samples where the quality has not changed as a result of being stored and transported over long distances.

User's manual with simple step-by-step instructions on how to conduct the water quality tests. This makes it easy for people to use and does not require a high level of training. However, some level of training is required to ensure correct use of the equipment and ability to understand and report the results.

Example Portable Test Kits



Potatest® Kit (Credit: Palintest)



Delagua Kit (Credit: Delagua)

Portable test kits can also be a useful tool to raise awareness about water quality. Community health promoters or field staff can use water quality testing to help bring about positive changes in hygiene and sanitation behaviours. Many tests show visual results, which help people to improve their understanding of their water quality.

Portable water quality test kits should have the following characteristics:

- ✓ Easy to use with simple instructions
- ✓ Small and easy to transport
- ✓ Fast results
- ✓ Limited need for distilled or deionized water

- ✓ Robust (e.g., limited effects from UV light, shock, humidity, temperature)
- ✓ Can test several parameters
- ✓ Limited consumables or consumables are easy to obtain
- ✓ Reasonable cost of equipment and consumables

Setting Up a Project Laboratory

Some larger organizations have set up their own water quality testing laboratories to support their projects. This is usually the case where there are a large number of samples to be taken over a long time frame, and commercial laboratories are not available or are too expensive.

The feasibility to establish a project laboratory depends upon the availability of financial resources, physical facilities, skilled technicians, and testing equipment.

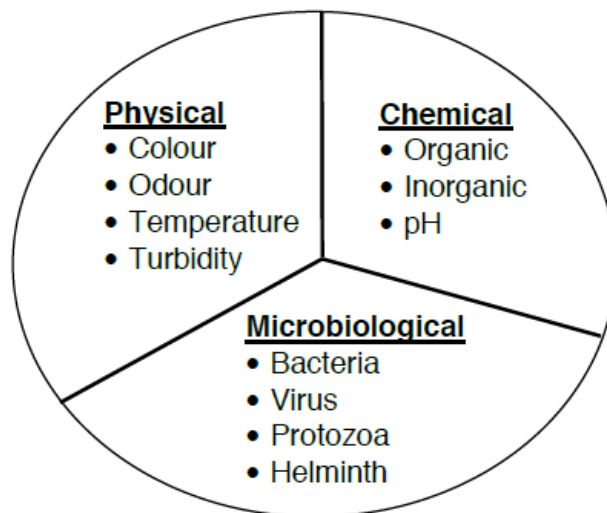
Select and prepare materials and solvent of specified purity

The following are some examples of objectives for water quality testing:

- ✓ Identify an appropriate drinking water source
- ✓ Identify the source of an outbreak of a drinking water related disease
- ✓ Investigate seasonal changes in drinking water quality
- ✓ Increase user awareness on water quality issues
- ✓ Assess the effectiveness of household water treatment and safe storage (HWTS) in reducing turbidity and pathogens
- ✓ Assess the concentration of arsenic and fluoride in drinking water
- ✓ Provide troubleshooting as part of an ongoing monitoring program
- ✓ Monitor compliance with standards or guidelines
- ✓ Evaluate the effectiveness of a safe water project

Test Parameters

Physical, chemical, and microbiological parameters can be measured through water quality testing. The parameters to be tested depend on your project needs, objectives and available resources. However, above all, the parameters for water quality testing should be based on prioritizing those that will have the greatest impact on public health.



The first step in deciding whether or not a particular parameter should be included in your testing program is to make a judgement on the following questions:

- ✓ Is the contaminant known to be present or absent in the waters of the region or country? If known to be present or if no information is available, then the indicator/parameter may be included. If it is known to be absent, then it should be excluded.
- ✓ If known to be present, at what concentration does the contaminant exist? Does the concentration exceed national standards or the World Health Organization (WHO) Guidelines?
- ✓ What is the extent of the presence of the contaminants? Do they only occur in one region or only during the rainy season?
- ✓ Are there any current or planned activities in the area that may cause the contaminant to be present in water or levels to increase? For example, is there an industry located nearby the water source? Do local farmers use fertilizers on their fields?

You can also take the following sources of information into consideration:

- ✓ **Health Care Data**
Community health centres or hospitals usually collect some level of information about the numbers of patients and types of illnesses that are treated. This information can indicate how illnesses are spreading throughout the area. For example, if a large number of patients suffering from diarrhea are treated, this would show that poor quality drinking water and hygiene may be the major causes of illness. Local leaders, traditional healers and religious leaders can also be good sources of information about health issues that are occurring within a community.

✓ Household and Community Requests

End users may show interest in their drinking water quality and the effectiveness and reliability of community or household water treatment technology. Sometimes they want to be able to see the pathogens to better understand the process. In this situation, it can be beneficial to do microbiological testing to demonstrate the presence or absence of pathogens in the water.

✓ Natural Disasters

Natural disasters such as flooding, earthquakes and landslides often contaminate water sources. Depending on the type and intensity of the natural disaster, you may need to conduct water quality testing for microbiological contamination.

✓ Geographic Location

Due to natural geological formations, some regions may be prone to arsenic, fluoride or other chemical contamination. Also, you may want to do testing near industrial or agricultural operations where there may be by-products that may cause water contamination.

✓ Secondary Information

Government agencies, research centres or international organizations may carry out a national or regional survey and report on the surface and groundwater quality. This type of information provides a general idea of the local situation, which can help you to determine the water quality parameters required for the area.

Measure appropriate quantities of reagents for solution preparation and record data

Preparing a solution of known concentration is perhaps the most common activity in any analytical lab. The method for measuring out the solute and the solvent depend on the desired concentration and how exact the solution's concentration needs to be known. Pipets and volumetric flasks are used when we need to know a solution's exact concentration; graduated cylinders, beakers, and/or reagent bottles suffice when a concentrations need only be approximate. Two methods for preparing solutions are described in this section.

Preparing Stock Solutions

A stock solution is prepared by weighing out an appropriate portion of a pure solid or by measuring out an appropriate volume of a pure liquid, placing it in a suitable flask, and diluting to a known volume. Exactly how one measure's the reagent depends on the desired concentration unit. For example, to prepare a

solution with a known molarity you weigh out an appropriate mass of the reagent, dissolve it in a portion of solvent, and bring it to the desired volume. To prepare a solution where the solute's concentration is a volume percent, you measure out an appropriate volume of solute and add sufficient solvent to obtain the desired total volume.

Preparing Solutions by Dilution

Solutions are often prepared by diluting a more concentrated stock solution. A known volume of the stock solution is transferred to a new container and brought to a new volume. Since the total amount of solute is the same before and after dilution, we know that

$$C_o \times V_o = C_d \times V_d$$

Where, C_o is the stock solution's concentration, V_o is the volume of stock solution being diluted, C_d is the dilute solution's concentration, and V_d is the volume of the dilute solution. Again, the type of glassware used to measure V_o and V_d depends on how precisely we need to know the solution's concentration

Prepare labels and log solution details in laboratory register

The laboratory should keep a register (log) of all incoming samples. A master register may be kept, or each specialty laboratory may keep its own sample register.

Assign the sample a laboratory identification number – write the number on the sample and the requisition form. If computers are used for reports, enter the information into the computer.

The register should include:

- ✓ date and time of collection;
- ✓ date and time the sample was received in laboratory;
- ✓ sample type;
- ✓ Sample name and demographics, as required;
- ✓ laboratory assigned identification (e.g., number 276_01_06_2009);
- ✓ tests to be performed.

Transfer solutions to appropriately labelled containers



All specimens **MUST** be clearly and unequivocally identified with a minimum of four key identifiers (see tables in the [specimen acceptance policy](#)) which must be correct and if a request form is required, the information on the sample **MUST** match the information given on the request form. It is best practice to use more than the minimum key identifiers.

Sample containers must be labelled at the time of collection, with cross-checking to positively identify the patient and ensure patient safety. Pre-labelling of blood collection tubes/sample tubes and pots is poor practice, increases risks of misidentification and is not acceptable.

It is also important to clearly identify the investigations required with relevant supporting information.

If you have any doubts regarding this policy please ring the relevant department for further information.

Specimens will not be accepted for analysis if:

- ✓ There is no unique identification of the patient i.e. they do not meet the minimum data set for identification
- ✓ There is an incorrect sample type or tube
- ✓ Incorrect transportation conditions
- ✓ Sample is received in a hazardous condition e.g. leaking or sharps attached.
- ✓ Sample or request form is unlabelled or incorrectly labeled with less than the minimum data sets for patient identification
- ✓ Mismatch of details between the form and sample(s)
- ✓ The information provided is illegible

CHECK EXISTING STOCK OF SOLUTIONS

Shelf life

Most laboratory reagents have a limited shelf life. In general, solutions should not be kept for more than one year. In a great many cases, solutions will deteriorate in less than a year.

Some solutions are chemically unstable. Over time the concentration of such

solutions will change as the unstable reagents break down, or react, to form other chemicals. Sodium hydroxide solutions have a limited shelf life, because sodium hydroxide reacts with atmospheric carbon dioxide to form carbonates. Therefore, the concentration of a sodium hydroxide solution cannot be known with certainty, unless it has been freshly standardised.

There may be some evaporation of solutions kept in bottles. The moisture that condenses in the upper portion of the bottle will dilute the dispensed solution as it is poured out. In all cases, solutions should be mixed thoroughly before use.



Solutions should be routinely checked prior to use for signs of turbidity or deposits that may indicate microbial contamination or chemical degradation. Crystals around the neck of a storage bottle may indicate a change in concentration. When this occurs decisions need to be made to discard, treat or re-check the solutions.

Solutions must not be left uncovered for any longer than necessary, and should be returned to storage, with the lid firmly secured, as soon as the required volume of solution has been measured out. Solutions without a lid could be contaminated by external contaminants, or some of the water in the bottle could evaporate, thereby changing the concentration of the solution.

Guidelines for storing laboratory solutions

Improper storage of laboratory solutions can reduce their shelf life. The following principles should be followed when storing laboratory solutions.

- ✓ Solutions should be kept in a cool place, preferably in the dark and certainly out of direct sunlight.
- ✓ Solutions should be returned to storage, with the lid firmly secured, as soon as the required volume of solution has been measured out.
- ✓ Solutions should be regularly checked, and any that have been kept beyond their shelf life; have deteriorated; have questionable labels; are leaking; have corroded caps; have precipitated out or have developed any other problem, need to be properly disposed of
- ✓ Solutions should be kept well sealed to avoid vaporisation and spills.
- ✓ Solutions should be stored away from heat sources such as heaters and hot water pipes, and sources of ignition such as flames.
- ✓ Handling full bottles of solution can be difficult when reaching overhead. Therefore, to reduce the risk that the bottles are dropped, solutions should preferably not be stored on shelves above eye level.
- ✓ Solutions should not be stored in aisles, stairways, hallways, or on floors, desks or bench tops.

- ✓ Solutions should preferably be stored on sturdy shelving, which has a raised lip edging and has been secured to the wall or ceiling, or in a suitable alternative that provides secondary containment, in case the containers spill or leak

MAINTAIN A SAFE WORK ENVIRONMENT

Use appropriate personal protective equipment (PPE) to ensure personal safety when sampling, processing, transferring or disposing of samples

Personal Protective Equipment (PPE) is widely recognised as a means of protection for individuals working in an environment where all other methods of hazard control are in place and there is still a risk of injury. You must remember that PPE is the last barrier or line of defence between you and the hazardous material you are working with.

The minimum PPE you are required to wear when working in University Laboratories are:

- ✓ Enclosed Shoes (no bare feet, thongs, or sandals and
- ✓ Lab Coat (must be individually issued, worn at all times when working in the lab, removed before

leaving the lab and laundered regularly and when contamination is suspected).

AQIS Note: If you have been working with Quarantine materials, your lab coat must be autoclaved prior to being removed from the lab and laundered

The following additional PPE is provided and should be used where required / instructed / determined by a risk assessment:

- ✓ Safety Glasses / Goggles
- ✓ Gloves
- ✓ Dust Mask / Respirator
- ✓ Face Shield
- ✓ PVC Apron
- ✓ Hearing protection

Eye Protection

The type of eye protection required for a worker or student at the University will depend on the hazards that they work with or which they encounter in the specific work activity, and should be determined by undertaking a risk assessment. The risk assessment should take account of the hazards that are present in the laboratory for most of the time, and consider the work of the group as a whole, not just that of an individual.

Safety Glasses must be worn when:

- ✓ There is a risk of objects striking or causing damage to your eyes.
- ✓ When instructed to do so by your Supervisor or the Lab Manager.
- ✓ If required by the Risk Assessments or Chemical MSDS.

** Safety Glasses may limit, but will not prevent chemicals from splashing into your eyes. Safety Glasses are only suitable when the chemicals you are working with would not harm your eyes in the event of an accident.

Safety Goggles must be worn:

- ✓ When working with hazardous chemical solutions where there is a risk of splash to your eyes.

Face Shield must be worn when:

- ✓ Working with volatile hazardous chemical solutions (eg. concentrated acids).
- ✓ Working with dangerous substances that could strike/splash the face/eyes.
- ✓ There is a risk of solution explosion or instability causing a splash to the face/eyes.
- ✓ There is a risk of dangerous objects striking the face/eyes, such as particles, glass or metal shards.

Standard Prescription Glasses are not sufficient as protective eyewear if:

- ✓ You are working with hazardous chemical solutions and there is a risk of splash to the eye.
- ✓ You are working with toxic, corrosive, pathogenic or radioactive substances.
- ✓ You are undertaking activities where there is a risk of objects striking the eye, such as particles,
- ✓ glass or metal shards.

** In these instances, ordinary prescription glasses will not provide adequate protection from injury to the eyes and could even be hazardous to the wearer. Please see the Laboratory Manager if you require Prescription Safety Glasses.

Gloves

Different gloves are available for different tasks. Please ensure that you are using the right type of glove for the task you are undertaking. For chemicals, this information can be found in the MSDS.

Gloves available in this laboratory include:

- ✓ Latex disposable examination gloves – powder free
 - Protects your cultures / samples from you.
 - Helps stop the spread of some contaminants around the laboratory.
 - Not to be used with hazardous chemicals.
- ✓ Nitrile disposable gloves (blue)
 - Resistant to many solvents and chemicals.
 - Abrasion and puncture resistance.
 - Helps protect you from exposure to some hazardous chemicals.
- ✓ Rubber gloves
 - Good resistance to detergents and diluted chemicals.
- ✓ Cotton gloves
 - For use under other gloves – absorbs perspiration and helps with heat resistance (for eg, against hot dishwashing water).
- ✓ Leather gloves
 - Some protection when handling broken glass – extreme care must still be taken. Heat resistant gloves
 - Enables you to handle hot items – extreme care must still be taken.
 - Used to remove items from the Drying Ovens and/or Autoclave.

Minimise generation of waste and environmental impacts

Engage and motivate your co-workers to buy green products and help reduce waste. Learn more about how your office can go green.

- ✓ Instead of printing hard copies of your documents, save them to your hard drive or email them to yourself to save paper.
- ✓ Make your printer environmentally friendly. Change your printer settings to make double-sided pages. Use small point fonts when possible and use the “fast draft” setting when possible to save ink.
- ✓ Pay your bills via e-billing programs when possible to save paper.
- ✓ Use paperclips (over staples) when possible.
- ✓ Reuse envelopes with metal clasps and reuse file folders by sticking a new label over the previous one.

Green Purchasing at Work

- ✓ Purchase recycled paper and keep a recycling bin nearby your desk.


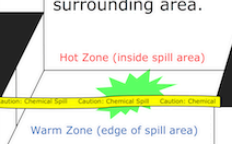
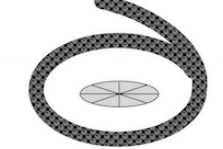
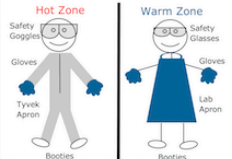

- ✓ For information on how to buy more recycled-content products for your office, see EPA's Comprehensive Procurement Guidelines.
- ✓ Buy energy efficient items with the ENERGY STAR ® logo or items that are EPEAT registered for the office.

Clean up spills using appropriate techniques



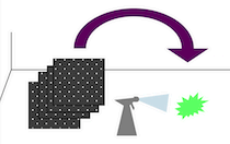
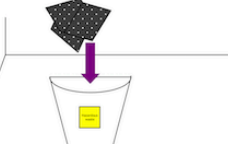
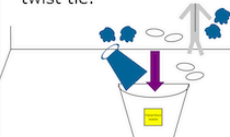
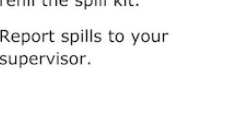
In the event of a chemical spill, the individual(s) who caused the spill is responsible for prompt and proper clean-up. It is also their responsibility to have spill control and personal protective equipment appropriate for the chemicals being handled readily available.

Cleaning up Chemical Spills

EHS: 609-258-5294 PUBLIC SAFETY: 609-258-3333

1. Call Public Safety at 609-258-3333 if... <ul style="list-style-type: none"> anyone is hurt, the spill is greater than one gallon there is a release to the environment there is a violent reaction or fire 	2. For spills less than one gallon, use this spill kit. 
3. Put up "Caution: Chemical Spill" tape. Notify people in the surrounding area. 	4. Protect nearby floor drains with a spill sock. 
5. Put on the appropriate PPE. 	6. Pour absorbent from the outside of the spill to the center. 



7. Collect absorbent in a bag. Label the bag as hazardous waste and the contents. 	8. Take extra caution with regard to shards of glass and chemical vapors. Call EHS for assistance at 609-258-5294. 
9. Decontaminate area with compatible disinfectant and spill pads. 	10. Collect contaminated spill pads in the same bag. 
11. Remove PPE and collect disposables in the same bag. Seal with a twist tie. 	12. Contact EHS at 609-258-5294 or ehs@princeton.edu to refill the spill kit. Report spills to your supervisor. 

The following are general guidelines to be followed for a chemical spill.

Emergency Actions

- ✓ Immediately alert area occupants and supervisor, and evacuate the area, if necessary.
- ✓ If there is a fire or medical attention is needed, contact Public Safety.
- ✓ Attend to any people who may be contaminated. Contaminated clothing must be removed immediately and the skin flushed with water for no less

than fifteen minutes. Clothing must be laundered before reuse. See First Aid for Chemical Exposures for more information.

- ✓ If a volatile, flammable material is spilled, immediately warn everyone, control sources of ignition and ventilate the area.

Immediate Spill Response

- ✓ Personal protective equipment, as appropriate to the hazards. Refer to the Material Safety Data Sheet or other references for information.
- ✓ Consider the need for respiratory protection.(link is external) The use of a respirator or self-contained breathing apparatus requires specialized training and medical surveillance. Never enter a contaminated atmosphere without protection or use a respirator without training. If respiratory protection is needed and no trained personnel are available, Public Safety at 911. If respiratory protection is used, be sure there is another person outside the spill area in communication, in case of an emergency. If no one is available, contact Public Safety.
- ✓ Using the chart below, determine the extent and type of spill. If the spill is large, if there has been a release to the environment or if there is no one knowledgeable about spill clean-up available Public Safety.

Category	Size	Response	Treatment Materials
Small	up to 300mL	chemical treatment or absorption	neutralization or absorption spill kit
Medium	300mL to 5L	absorption	absorption spill kit
Large	more than 5L	call Public Safety (609-258-3333)	outside help

- ✓ Protect floor drains or other means for environmental release. Spill socks and absorbents may be placed around drains, as needed.
- ✓ Contain and clean-up the spill according to the table above.
- ✓ Loose spill control materials should be distributed over the entire spill area, working from the outside, circling to the inside. This reduces the chance of splash or spread of the spilled chemical. Bulk absorbents and many spill pillows do not work with hydrofluoric acid. POWERSORB® (by 3M) products and their equivalent will handle hydrofluoric acid. Specialized hydrofluoric acid kits also are available for purchase from lab safety suppliers. Many neutralizers for acids or bases have a color change indicator to show when the spill is neutralized.

- ✓ When spilled materials have been absorbed, use brush and scoop to place materials in an appropriate container. Polyethylene bags may be used for small spills. Five gallon pails or 20 gallon drums with polyethylene liners may be appropriate for larger quantities.
- ✓ Complete a hazardous waste sticker, identifying the material as Spill Debris involving XYZ Chemical, and affix onto the container. Spill control materials will probably need to be disposed of as hazardous waste. Contact EHS for advice on storage and packaging for disposal.
- ✓ Decontaminate the surface where the spill occurred using a mild detergent and water, when appropriate.
- ✓ Report all spills to your supervisor.

Ensure the safe collection of laboratory and hazardous waste for subsequent disposal

It is the clear responsibility of all research workers to ensure the safe and correct disposal of all wastes produced in the course of their work. Improper and irresponsible disposal of chemical wastes down drains, to the Local Authority, refuse collection, or into the atmosphere is forbidden by law. The Aldrich Handbook provides a useful summary of the correct disposal procedure for most chemicals. Due to new legislation, increasingly strict environmental controls and the escalating costs of disposal, it is essential that the appropriate disposal procedures given below are strictly adhered to:

Wash down drains with excess water

Concentrated and dilute acids and alkalis

- ✓ Harmless soluble inorganic salts (including all drying agents such as CaCl_2 , MgSO_4 , Na_2SO_4 , P_2O_5)
- ✓ Alcohols containing salts (e.g. from destroying sodium)
- ✓ Hypochlorite solutions from destroying cyanides, phosphines, etc.
- ✓ Fine (tlc grade) silica and alumina

It should be noted in particular that no material on the "Red List" should ever be washed down a drain. This list is as follows:

compounds of the following elements:- antimony, arsenic, barium, beryllium, boron, cadmium, chromium, cobalt, copper, lead, mercury, molybdenum, nickel, selenium, silver, tellurium, thallium, tin, titanium, uranium, vanadium and zinc.

- ✓ organohalogen, organophosphorus or organonitrogen pesticides, triazine herbicides, any other biocides.
- ✓ cyanides
- ✓ mineral oils and hydrocarbons
- ✓ poisonous organosilicon compounds, metal phosphides and phosphorus element

- ✓ fluorides and nitrites

Incineration (Solvent Waste collection)

- ✓ all organic solvents including water-miscible ones
- ✓ soluble organic waste including most organic solids
- ✓ paraffin and mineral oil (from oil baths and pumps)

Laboratory waste bins and controlled waste

All waste suitable for the Local Authority refuse collection, except recyclable paper and glass, is termed 'controlled waste'. Items in this category which includes dirty paper, plastic, rubber and wood, should generally be placed in the waste bins available in each laboratory and will be collected by the cleaners. However, each laboratory must also have a container for certain items which are not allowed to be put in the normal waste bins. In this special controlled waste container should be put:- all broken laboratory glassware, any sharp objects of metal or glass, all fine powders (preferably inside a bottle or jar) and dirty sample tubes or other items lightly contaminated with chemicals (but not any syringes or needles). Laboratory controlled waste containers must be emptied regularly and never allowed to overflow. Under no circumstances must any item of glass, sharp metal or fine powder ever be put in a normal laboratory waste bin. The tops must be removed from all bottles put out for disposal and there should be no detectable smell of chemicals from any bottle put for disposal.

Waste for special disposal

This is a troublesome and expensive method of disposal and the quantity of special waste must be kept to an absolute minimum. Only the following items should be disposed of in this way:

1. Schedule 1 poisons (but not cyanides) and other highly toxic chemicals
2. Materials heavily contaminated with substances in (i)
3. Materials contaminated with mercury
4. Carcinogenic solids including asbestos.

Special waste must be collected in a separate labelled bottle or jar for disposal. On no account must different types of waste be mixed. Advice should be sought from the School Safety Co-ordinator before beginning any work which will produce waste requiring special disposal in order to ensure that:

- ✓ the waste can be disposed of
- ✓ it is collected in the most suitable form so as to minimise the cost involved and
- ✓ it will be stored under suitable conditions.

The importance of handling waste for special disposal to the School Safety Coordinator immediately the container is full or the work is finished is emphasised. The hoarding up of hazardous waste in laboratories is strictly forbidden. Environmental Health and Safety Services should be notified of all 'Special Waste' on the appropriate form.

Glass recycling

For environmental reasons the recycling of glass is encouraged, but only certain items of waste glass produced within laboratories are acceptable for recycling. Each laboratory should have a bin for recyclable glass. Only clean glass bottles such as those in which chemicals are received, and broken or waste plate glass are allowed. All broken laboratory glassware, items significantly contaminated by chemicals, sample tubes, droppers and glass wool must be disposed of as controlled waste. The recycling service will refuse to empty a recycling container if any of these prohibited items are discovered in it.

Bottles for bulk solvents

The importance of returning the specially labelled winchesters for solvents which are bought in bulk to the Store ready for direct refilling is emphasised. They must not be contaminated in any way and should not normally be washed out. Bottles containing sodium must not, under any circumstances, be returned directly to the Store. When sodium is first added to a bottle of solvent a label indicating this (available from the Store) should be attached. When the bottle is empty the sodium must be safely destroyed by adding ethanol or methylated spirit and the label removed. The bottle must then be washed out, dried and returned to the Store ready for direct refilling.

Empty winchester bottles may be re-used e.g. for the disposal of waste solvents. They must first be washed out with water if they have contained a corrosive or harmful chemical e.g. concentrated acid or ammonia.

Biohazard/Sharps Disposal - Syringes and Needles

"Sharps" contaminated with biologically hazardous materials must be collected in special containers to be sent for incineration. It is also required, at the request of Fife Council, that all syringes and needles of any type should be disposed of by the same route. No syringes or needles must ever be put in a laboratory waste bin or controlled waste container.

UNIT 15

PERFORM BASIC TESTS

This unit of competency covers the ability to prepare samples and perform tests and measurements using standard methods with access to readily available advice from supervisors

INTERPRET TEST REQUIREMENTS

Review test request to identify samples to be tested, test method and equipment involved

All laboratory testing depends upon proper sampling technique. Sampling must be designed to obtain accurate data for identifying treatment process changes and varying water qualities. The objective is to remove a small portion that is representative of the entire flow and adequately reflects actual conditions in the water.

Sample Location

The test requirements usually determine sample location. Obtain the sample where mixing is best and the water is of uniform quality. The sampling location must be accessible. Avoid slippery surfaces. Do not climb on or under guardrails.

Composite Samples

This type of sample is taken to determine average conditions in a large volume of water whose chemical properties vary significantly over the course of a day. Small aliquots are taken at regular intervals and pooled into one large sample over a 24-h period. If composite samples are to be taken manually, the frequency of sampling should depend on the number of changes in water quality. Most often, grabs are taken hourly, and the volume of each is flow proportioned. Samples are then combined into a composite for testing.

Identify hazards and workplace controls associated with the sample, preparation methods, reagents and/or equipment

Grab Samples

A grab sample is taken all at once, at a specific time and place. Insert container upside down into the water. Rotate open end toward direction of flow and allow to fill under the surface. Sample about 12 in. underwater, or at center of the channel, about medium depth from the bottom. Avoid surface scum and bottom sediment. Be careful not to collect deposits from tank sidewalls. Eliminate any large, uncharacteristic particles that enter the sample. Fill sample bottle completely to exclude air space if sample is to be analyzed for DO, pH, chlorine residual, alkalinity, or VOCs.

If preservative or dechlorinating agent has been added to empty sample bottle, adjust sampling technique so that the bottle does not overfill, or the chemical will be washed out. Be careful to handle sterile bottles for bacteriological testing aseptically. Collect enough sample to allow duplicate and spiked analysis. If both influent and effluent samples are desired from a process unit with a detention time of 2 h, consider the timing. Take the influent sample now, and the effluent sample in 2 h. There will be a good chance of getting the same water.

The Sample Bottle

For chemical testing, the sample bottle must be clean. For bacteriological testing, the sample bottle must be clean and sterile. Bottles may be glass or plastic for most analyses; labels must be firmly attached to the sample bottle, not to the lid. Use labels that will not come off when damp. Use a water-insoluble ink pen. The label on a sample bottle should include sample ID number, date and time of collection, type of sample, location, adverse weather conditions, collector's initials, analysis to be performed, and sample preservation, if any.

Preservation and Transport

Dissolved oxygen, pH, and temperature should be analyzed on site, at the sampling location. Bacteriological tests must be performed within 24 h of sampling. All samples should be analyzed as soon as possible after collection.

Preservation of Samples

Test Preservation	Max.	Time
Acidity	Refrigerate	24 h
Alkalinity	Refrigerate	24 h
Chloride	None required	No max.
Chlorine Residual	Analyze immediately	15 min
Color	Refrigerate	48 h
Specific Conductance	Refrigerate	28 days
Fluoride	None required	28 days
Hardness	Add HNO ₃ to pH2	6 months
Metals	Add HNO ₃ to pH2	No max.
Ammonia	Add H ₂ SO ₄ to pH2	7 days
Nitrate	Refrigerate	48 h
Nitrite	Refrigerate	Do immediately
Organic Nitrogen	Refrigerate, add H ₂ SO ₄ to pH2	7 days
Odor	Refrigerate	6 h
Dissolved Oxygen	Analyze immediately	8 h
pH	Analyze immediately	15 min
Phosphate	Refrigerate	48 h
Total Phosphorus	Add H ₂ SO ₄ to pH2, refrigerate	28 days
Solids	Refrigerate	7 days
Sulfate	Refrigerate	28 days

Temperature	Analyze immediately	15 min
Turbidity	Refrigerate	2 4 h

PREPARE SAMPLE

Record sample description, compare with specification, record and report discrepancies

Chain of Custody

This is a legal requirement that refers to the recorded handling of a sample from collection to analysis. It allows for tracing individual samples in case of a problem.

The sample is in custody if it is in hand or in sight, if it is locked away, or if it is placed in a secure area nobody can enter without the possessor's knowledge. When the sample changes hands, a change of possession form is signed by both parties; the date and time are recorded.

The chain of custody records include:

- ✓ Sample labels — For sample identification
- ✓ Sample seals — For shipped samples, to ensure no tampering
- ✓ Field logbook — Includes all information on label, container type, sample size, field analysis, number of samples taken
- ✓ Chain of custody record — Includes label information and change of possession forms

Online Sampling and Analysis

There is increasing, and for some parameters mandatory, use of automatic online sampling and monitoring. It has the advantage of yielding constant and immediate results. Time is saved, and problems due to carriage to laboratory are eliminated. Meters are installed directly into the process flow, and the water is monitored as it flows by. Typical tests that are performed this way are pH, DO, temperature, turbidity, and chlorine residual. The signal may be read on site, or transmitted to the lab or control room for remote readout. Frequent cleaning and calibration of the monitoring instruments are essential.

Laboratory Records

Process control and regulatory compliance depend upon the proper recording of laboratory analysis data. Analysis reports (bench sheets) should include:

- ✓ Name, time, and date of analysis
- ✓ Analyst name
- ✓ Sample preparation

- ✓ Analysis method
- ✓ Test conditions (standards, reagents, instrument settings, temperature, and reaction time)
- ✓ Results of analysis
- ✓ Observations — comments

Prepare sample in accordance with appropriate standard methods

The most important aspect in collecting water samples is to develop a sampling plan, consistently implement the plan and describe why that sampling plan was selected. In addition, documenting what happened when you implemented the plan and how replacement samples or surveys were made if households could not be contacted will assist in understanding the sample selection

First, you will need to determine how many households or water locations to sample. The sample size that you select will depend on:

- ✓ Your resources for water quality testing and analyzing data
- ✓ The total number of sampling points involved
- ✓ The logistics in reaching the sampling points, especially those in rural, remote areas
- ✓ How much data is needed to make a good decision
- ✓ Your best judgment

Statistical calculations of sample size for more rigorous research are outside the scope of this Manual. However, CAWST can provide you with additional resources for calculating sample size.

Sample Size for Small Projects (<100 households or locations)

If resources are available, it would be good to test 100% of the households or locations in a small project. As a minimum, 30% of households or locations should be used as the sample size.

Sample Size for Large Projects (>100 households or locations)

It is recommended to use the sample size that corresponds to the project size in the following table. It shows that smaller project needs to select relatively a relatively large number of samples. For example, a project with 1,000 households, should test between 43 and 91 of the households to get an adequate representation of the water quality.

Project and Sample Sizes

Project Size	Sample Size
500	41-83
1,000	43-91
2,000	43-95
3,000	44-97
4,000-6,000	44-98
7,000-15,000	44-99
>20,000	44-100

Geographical location and socioeconomic status can also be considered during the sample selection. Before determining the sample size, the project can be divided into different geographical areas, such as high land, low land, or coastal areas, to get an accurate representation. Households can also be classified based on socioeconomic status such as high, medium, and low income. Then, 10-20% of the households can be taken as a sample from each geographical area and each socioeconomic group.

Deciding What Locations to Sample

There are different methods to choose who or where you are going to sample. It is best to use a random sample (without a particular pattern) so that there is no bias in your results, but this might not always be possible.

Simple Random Sampling

In this method, every household who took part in the project has an equal chance of being selected in the sample. You can use different methods to randomly select the households, such as drawing names or numbers from a hat, or using an online random number generator

Systematic Random Sampling

In this method, households are selected at particular intervals. The interval can be calculated by dividing the total number of households who took part in the project by the number of households to be selected (sample size).

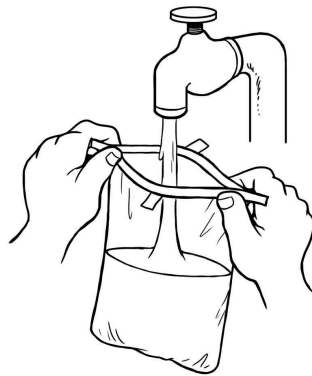
Cluster Random Sampling

In this method, the population is divided into clusters or groups, and some of these are then

chosen by simple random sampling. It is a good method to use for large projects. Samples taken from households of the same street or households within the same tribe are an example of cluster sampling.

Convenience Sampling

Convenience sampling does not give you a random sample of the population because households are only selected if they can be accessed easily and conveniently. Many projects often use convenience sampling instead of random sampling due to limited time and resources.



Cleaning and Sterilizing Sample Containers

You can reuse glass or heat resistant plastic sample containers. To prepare the containers, they should be washed with soap and rinsed at least three times (five is better) with distilled water to remove any residue. If distilled water is not available, clean chlorine-free water may be used (e.g., filtered and then boiled).

After washing, sample containers for microbiological testing need to be sterilized. Sample containers for physical and chemical tests need to be clean, but not sterilized. However, often the same water sample is used for physical, chemical and microbiological testing, so then the container must be sterilized using one of the following methods:

- ✓ Conventional oven: Heat at 180°C for 30 minutes
- ✓ Boiling: Boil for 10 minutes
- ✓ Autoclave: Heat at 121°C for 20 minutes
- ✓ Pressure cooker: Heat for at least 30 minutes

Never use bleach, chlorine or disinfectants that may leave a residue without properly rinsing (with distilled water) or boiling the containers afterwards. The residue may affect your results by inhibiting or killing the bacteria you are trying to test for.

Using Additives or Preservatives

Whenever chlorine is used for disinfection, chlorine residual may be present in the water after sampling and will continue to act on any microorganisms in the sample. Therefore, the results of any microbiological test may not show the true contamination of the water. If you suspect or know that the water sample has been chlorinated, then you need to add sodium thiosulphate to the sample. The sodium thiosulphate immediately inactivates any residual chlorine but does not affect the microorganisms that may be present. Sodium thiosulphate should be added to the sample container, after it has been sterilized. For 200 mL samples.

Preservatives may also be required for testing other chemicals, such as ammonia or cyanide. The manufacturer of portable test kits or a commercial laboratory will usually include the preservative along with instructions on how to use it properly.

Sampling Surface Water

Lakes and reservoirs can be subject to several influences that cause water quality to vary from place to place and from time to time. Where feeder streams or effluents enter lakes or reservoirs there may be local areas where the incoming water is concentrated, because it has not yet mixed with the main water body. Isolated bays and narrow inlets of lakes are frequently poorly mixed and may contain water of a different quality from that of the rest of the lake (UNEP/WHO, 1996). For rivers or other moving water, you should try to obtain samples from a point where the water is well mixed and representative of the drinking water supply. Do not take samples that are too near the bank, too far from the point of where the drinking water is taken, or at a depth above/below the point of where the drinking water is taken. Surface water quality can also change depending on the time of day or season. It is important to sample at the same time of the day and record the weather conditions when you are taking your sample.

It may be possible to take the sample by hand if it is easy to get to the water. In many cases it may be inconvenient or dangerous to enter the water. In these cases, you may need to tie your container to a piece of wire or rope and throw it into the water. A bridge is an excellent place at which to take a sample, but only if it is close to where people get their drinking water.

Sampling Surface Water

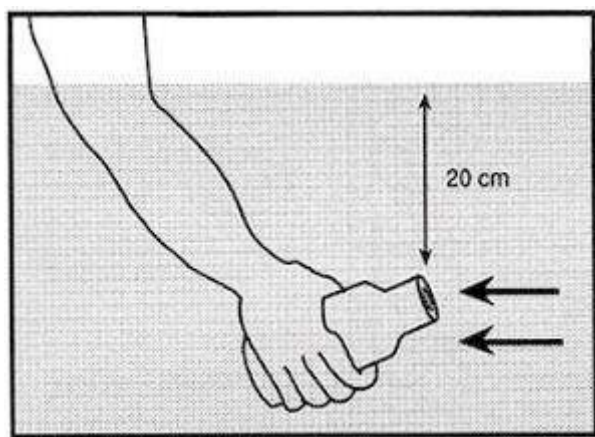
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To sample a surface water source:

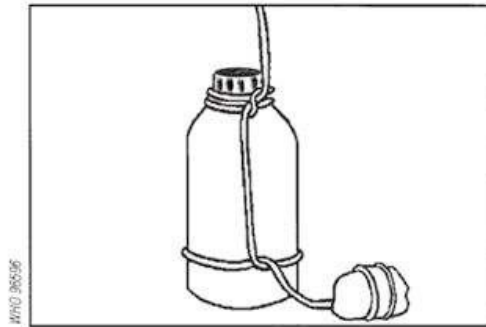


1. Carefully remove the cap from the container and put it facing up in a clean place or ask somebody to hold it. Take care to prevent dust from entering the container or anything else that may contaminate the sample.
2. Hold the sample container firmly and dip the open mouth of the container into the water.
3. Lower the container about 20 cm below the surface of the water and scoop up the water sample. This scooping action ensures that no external contamination enters the sample container. In areas where the water is moving (e.g., rivers), the sample should be taken against the direction of the flow of water.
4. Lift the sample container carefully and place on a clean surface where it cannot be knocked over. If the container is completely full, pour out a little

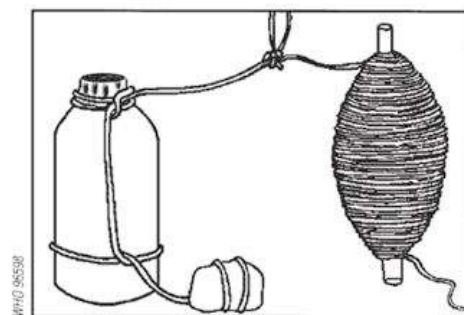
water to leave an air space in the container. This allows space for mixing the water sample before analysis. Put the cap back on the container.

Sampling an Open Well or Tank

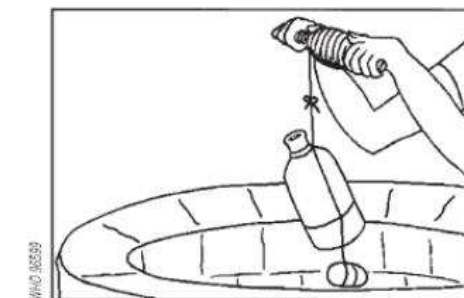
1. Prepare the sample container. Use string, rope or cable to attach a weight (e.g., small rock) to the container.



2. Take a 20 m length of string, rolled around a stick, and tie it to the container. Open the container as described above.



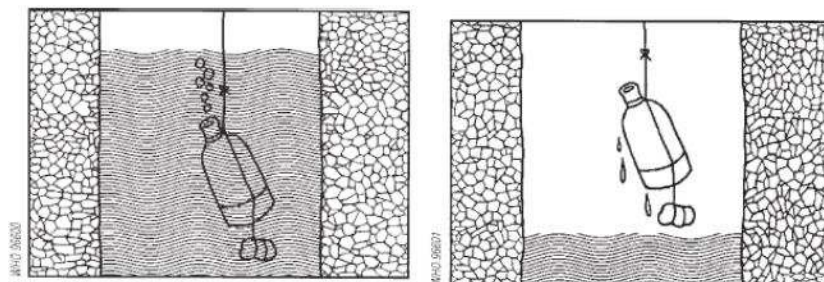
3. Carefully remove the cap from the container and put it facing up in a clean place or ask somebody to hold it. Take care to prevent dust from entering the container or anything else that may contaminate the sample.
4. Lower the weighted sample container into the well or tank, unwinding the string slowly. Do not allow the container to touch the sides of the well or tank because it may pick up dirt and contaminate the sample.



5. Immerse the container completely in the water and continue to lower it below the surface of the water (about 20 cm although this can be difficult

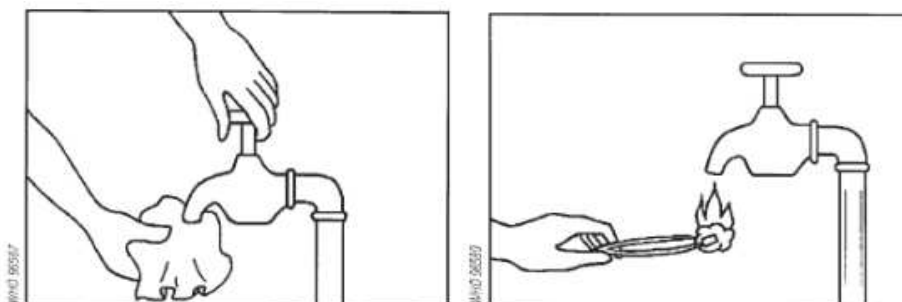
to judge). Do not allow the container to touch the bottom of the well or disturb any sediment.

6. Once the container is full, bring it up by rewinding the string around the stick. Lift the container carefully and place on a clean surface where it cannot be knocked over. If the container is completely full, pour out a little water to leave an air space in the container. This allows space for mixing the water sample before analysis. Put the cap back on the container.



Sampling a Tap

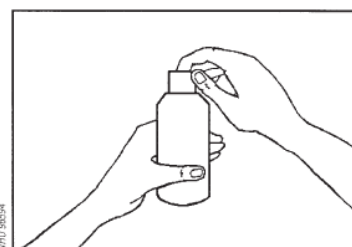
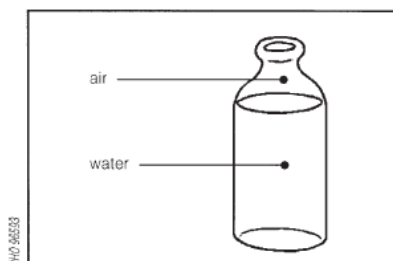
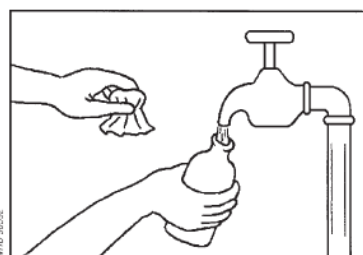
1. Remove any attachments (e.g., nozzles, pipes, screens) from the tap. These attachments are a frequent source of contamination.
2. Optional - Use a clean cloth to wipe the tap and to remove any dirt. Sterilize the inside and outside of the tap for 1 minute. Pour alcohol on the outlet and flame it with a lighter or use tweezers to hold an alcohol-soaked cotton swab that is lit on fire. If the tap is made of plastic, then use an alcohol-soaked cotton swab that is NOT lit on fire, or else the plastic will melt! Sterilizing the tap will tell you the actual water quality. Not sterilizing the tap will tell you the water quality that people are drinking.



3. Open the tap before sampling. Carefully turn on the tap and allow water to flow at a moderate rate for 2-3 minutes to clear out any deposits in the pipes.



4. Carefully remove the cap from the container and put it facing up in a clean place or ask somebody to hold it. Take care to prevent dust from entering the container or anything else that may contaminate the sample. Hold the sample container under the water flow to fill it. Leave an air space in the container. This allows space for mixing the water sample before analysis. Put the cap back on the container.



CHECK EQUIPMENT BEFORE USE

Set up test equipment in accordance with test method

Laboratory Test Methods

The following methods, in order of complexity, are generally used to test chemical contaminants in the laboratory. A full review of laboratory methods for measuring the various parameters important to drinking water quality is beyond the scope of this Manual. The WHO Guidelines for Drinking Water Quality provides a comprehensive list of laboratory methods for specific chemicals that have guideline values (WHO, 2011).

1. Colorimetric Method

Chemical reagents are added to the water sample which react with the particular chemical parameter of interest. The product that is formed absorbs light at a particular wavelength. The water sample is then analyzed in a colorimeter or spectrophotometer and compared to known standards.

2. *Electrode methods*

Ion-selective electrodes can measure the concentration of certain ions in the water sample. pH is easily measured with an electrode and meter.

3. *Chromatography*

Samples are passed through a column containing a specific packing or coating that selectively retains certain types of chemicals. Different compounds pass through the column at different speeds, depending on their affinity to the packing or coating. A detector at the exit of the column quantifies the concentration of the chemical. There are many types of chromatography: ion chromatography, liquid chromatography and gas chromatography.

4. *Atomic Absorption Spectrometer (AAS)*

AAS is used to analyze the presence of metals. Samples are heated either in a flame or electrically in a graphite furnace, and the concentration is determined by the metal atom's absorption of light at a particular wavelength.

5. *Inductively Coupled Plasma (ICP)*

ICP is also used to analyze the presence of metals. Samples are broken down to the atomic level and metals are detected either through atomic emission spectroscopy or mass spectroscopy.

Colorimetric and electrode methods can be implemented in basic laboratories with relative ease. Chromatography and AAS are considerably more expensive and complex, and are more appropriate for central or reference laboratories. ICP methods are very costly and difficult, and are uncommon in developing countries (UNICEF, 2008).

Portable Test Methods

Many types of portable test kits are available to measure various chemical parameters in drinking water. These are generally used for checking compliance as well as for operational monitoring of drinking water quality.

Although portable test kits have the advantage of being simple to use in non-laboratory environments and are often available at relatively low prices, their analytical accuracy is generally less than that of the laboratory methods listed above. However, when properly used, portable test kits provide valuable tools for rapidly assessing numerous chemical parameters when commercial laboratories are not available or are too expensive (WHO, 2011).

The most popular portable test methods are test strips, colour comparators, colorimeters and photometers and digital meters. It is necessary to check the validity of the test method before using it.

Test (Reagent) Strips

There are many different types of test strips available to measure different chemical contaminants. They are generally convenient and easy to use, provide quick results, and are the cheapest way to do field testing. Test strips are also available in individual packaging. This can be useful as the strips can deteriorate with humidity, heat, dust and light. The main limitation of test strips is that they are less accurate since they require a visual interpretation of the results.

Test strips typically have a plastic handle with a reagent area at one end. Typically, you dip the reagent area into a water sample, remove it and compare the colour of the reagent area with a colour chart. Some test strips work by presence/absence of a colour change at a maximum concentration.

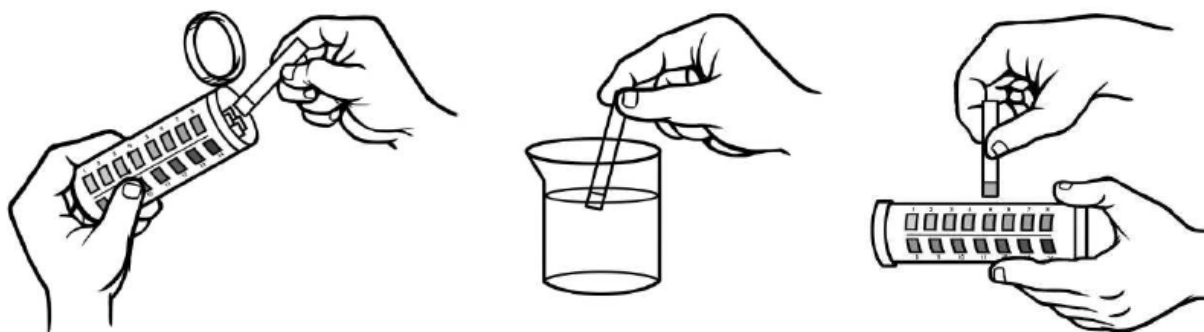
It is important to use the required activation method for the test strip you are using. Different products require different activation methods, such as:

- ✓ Dipping the strip in the sample
- ✓ Swishing the strip back and forth in the sample
- ✓ Holding the reagent area in a stream of the sample

Also, different test strips require different times that you must wait before you compare the strip to the colour chart. Using the wrong activation method or reading your results too early or late for that test strip may lead to incorrect results.

Selecting Equipment and Products

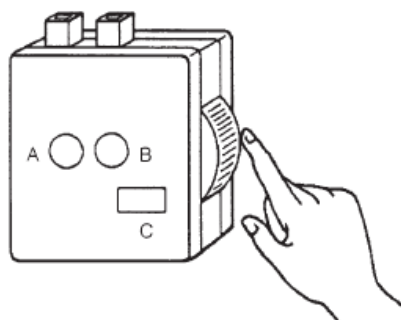
There are several different types of equipment and products available in the commercial market for water quality testing. All have their own advantages and limitations. Some are easy to operate, but may lack in precision. Others are accurate, but may be difficult to read. Similarly some are unable to measure a small quantity of your water sample. Therefore, selecting the appropriate equipment and products is important to meet your testing objectives. Test strips are available to measure pH and a variety of chemicals, such as chlorine and manganese.



Using a test strip by dipping it into a water sample and checking the colour against a scale to measure the value

Colour Disc Comparator

There are different types of colour disc comparators that are available. The comparator is used with a range of interchangeable colour discs. These colour discs compare the colour produced for the test against the standard test colours provided on the disc. Colour discs are available for a range of chemical parameters such as chlorine, fluoride, nitrate, iron and manganese. Colour comparators can sometimes be more accurate than test strips and they are easy to use, but they are more expensive, require more materials and still require a visual determination of the chemical concentration.



Colour disc comparator

Colorimeter and Photometer

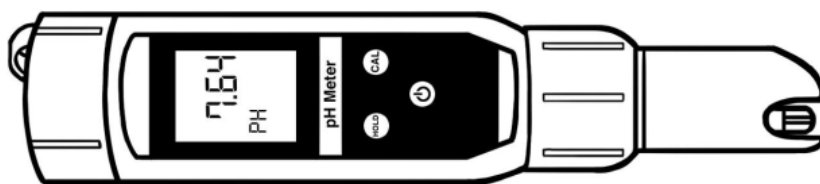
Colorimeters and photometers are digital instruments that use a light source to measure the chemical concentration in a water sample. Compared to test strips, they offer more accurate and repeatable results since the concentration is given as a digital reading. As well, colorimeters and photometers can read a large variety of chemicals in a water sample, as well as a wider numerical range within each parameter. However, they are more expensive, need a power source and require training to ensure they are being used properly.



Photometer used to measure chemicals in water

Digital Meters

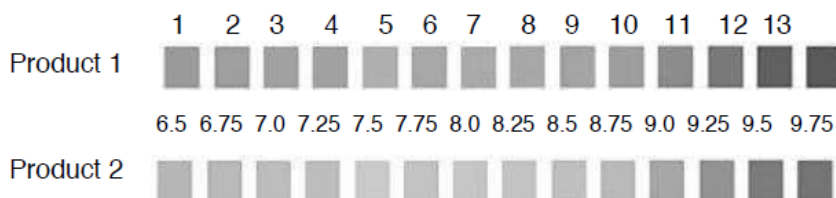
Some portable test kits include various digital meters to measure parameters like pH and electrical conductivity (EC). They are relatively easy to use and can provide more accurate measurements than other methods, such as test strips. The main disadvantages are the need to calibrate the meters and replace batteries as required, and the general fragility of electronic equipment.



Digital pH meter



Example: A company produces test strips for measuring pH. Two products are available. One with a range between pH 1 to pH 14 and another with a range of pH 6.5 to pH 10.0. As drinking water usually lies between pH 6.5 and pH 8.5, the second test strip is more suited to our work and provides better precision and accuracy.



Perform pre-use and safety checks in accordance with workplace procedures and manufacturer instructions

pH meters are calibrated (set to a correct reading) with purchased solutions that

have specific pH values. They are called buffers, and are composed of phosphates, acetates, etc., depending upon the pH of the buffer. These are the standards with which the meter is set to work correctly. The pH is listed on each buffer bottle, and it is dependable, but shelf life is limited. Buffers can also be purchased in dry capsule form (long shelf life) and prepared as solutions when needed. Follow the instructions carefully on the meter for calibration. Instructions are somewhat different for each meter. Use the buffers indicated for calibration with that meter.

Always calibrate a pH meter with two buffers. A pH meter, near the end of calibration, will usually give a reading of “slope.” This has to do with the efficiency of the electrode. It is the change in millivolts per decade of concentration. In pH terms, a decade of concentration is the difference between pH units, since the concentration multiplies by 10 from 1 pH unit to another. The instrument divides this change in mv/decade concentration by the ideal change in mv/decade concentration and obtains a percentage (of probe efficiency). The reading should be over 90% slope; some meters will adjust for the slight amount off 100% accuracy. If the slope reading is under 90%, repeat the calibration. If it is still off, recondition or change the electrode.

If you are using an older meter and there are no directions for calibration, choose two buffers that straddle the expected pH of the sample. Immerse the electrode in one of them and set the calibration knob to read that pH. Do the same with the other buffer, then set the meter to “read pH” and read the sample.

The buffer solution is really a “buffer.” It neutralizes any possible acid or alkaline influences present in the water in which it is dissolved, and the pH should reside very stably at its designated value. When the pH electrode is immersed in the buffer, the reading should not drift. If it does, recondition or change the probe. A pH meter operates in millivolts, and it will give millivolt readings all the way through calibration, making the conversion to pH units at the end.

Identify faulty or unsafe equipment and report to appropriate personnel

pH Troubleshooting Tips

1. Open air port when using. Close when done.
2. Rinse between samples with distilled water.
3. Do not be concerned with odd readings obtained while the electrode is rinsing in distilled water. Although distilled water should have a pH of 7 at 25°C, the electrode has difficulty reading anything at all in distilled water, which does not conduct electricity.
4. Handle the pH electrode carefully. Glass membranes break easily.

5. Wait for the sample reading to settle down before recording it. Wait 5 to 6 min before taking a reading with any electrode method (cleaner waters often have low ionic strength and a slow response time).
6. If an automatic temperature adjustment probe is included with the meter, this must be immersed in the solution with the pH electrode in order to sense the temperature and read the correct pH.
7. Needle drift is frequently caused by the sample changing. Check for drift when immersed in pH 7 buffer. If there is drift when in the buffer, change the filling solution. Recondition or replace the electrode.
8. Don't stir the solution with the pH electrode. It may cause the needle to swing. However, if the sample is not stirred at all, a polarity may build up around the electrode. It is best to stir the sample very slowly with a stir bar.
9. Don't immerse the electrode in very high or low pH solutions. This shocks the electrode and it may have difficulty recovering.
10. Don't immerse the electrode in sample deeper than level of the electrolyte. Sample will flow in rather than electrolyte flowing out.
11. Electrode contamination from electrolyte crystallization can be rinsed off with distilled water. See conditioning instructions in manufacturer's pamphlet.
12. If readings are poor, it is more likely the electrode than the meter that is at fault.
13. Troubleshoot the obvious first:
 - a. Is it plugged in?
 - b. Is there electrolyte in the electrode?
 - c. Is the meter switched to "pH"?
 - d. Is the glass membrane broken?
 - e. Is the sleeve on the filling port open?
14. After use, store electrode immersed in pH 7 buffer. Never let a pH electrode dry out.
15. Keep electrode clean between uses. pH 7 buffer is phosphate and it stimulates algae and bacterial growth. Change it frequently.

Check calibration status of equipment and report any out-of-calibration items to appropriate personnel

It is important to calibrate equipment according to the manufacturer's specifications to get results. Most electronic equipment will require some sort of calibration. Commonly used water quality testing equipment that requires calibration include incubators, pH meters, turbidimeters, colorimeters and photometers. Manufacturers should give the instructions for calibration when you buy a piece of equipment.

PERFORM TESTS ON SAMPLES

Identify, prepare and weigh or measure sample and standards to be tested

Priority Chemical Parameters

Unlike microbiological contamination, most chemicals in drinking water pose a health concern only after years of exposure. Often chemical contamination goes unnoticed until disease occurs due to chronic exposure. The severity of health effects depends upon the chemical and its concentration, as well as the length of exposure. There are only a few chemicals that can lead to health problems after short-term exposure, such as nitrate, unless there is a massive contamination of a drinking water supply (WHO, 2011).

It is not possible to test water for all of the chemicals that could cause health problems, nor is it necessary. Most chemicals occur rarely, and many result from human contamination of a small area, affecting only a few water sources.

However, three chemicals have the potential to cause serious health problems and occur over widespread areas. These are arsenic and fluoride, which can occur naturally, and nitrate, which is commonly used in fertilizer for agriculture. These three contaminants are more often found in groundwater, though surface water can also be impacted. When planning new water supply projects, especially using groundwater resources, these three contaminants should be prioritized for testing (UNICEF, 2008).

A second priority for water quality testing should be for chemical parameters that commonly cause water to be rejected for aesthetic purposes, such as metals (mainly iron and manganese) and total dissolved solids (salinity) (UNICEF, 2008).

When water is disinfected with chlorine, it is also important to monitor the drinking water quality for pH and free residual chlorine (FRC) as indicators of appropriate and effective treatment. As well, it may be important to test for chemicals that are known to be present locally, such as mercury or lead from industrial pollution.

Conduct tests in accordance with workplace procedures

There are several factors to be taken into consideration when choosing an appropriate microbiological test method, including:

- ✓ Available resources
- ✓ Required level of accuracy and precision
- ✓ Technical skills of staff
- ✓ Geographical location

- ✓ Objective of the results

There are three main test methods to determine the presence of indicator bacteria in drinking water:

- ✓ Presence/absence (P-A)
- ✓ Most probable number (MPN)
- ✓ Membrane filtration

Traditionally, membrane filtration using international standard methods was recommended to test for indicator bacteria in drinking water. This method requires trained technicians, equipment and other supporting materials that were historically only available in a conventional laboratory. The relatively high cost of membrane filtration made it difficult, impractical or impossible to perform these tests in many parts of the world.

These constraints highlighted the great need for rapid, simple and inexpensive test methods. This need is especially great for small community and household water supplies that lack access to and cannot afford conventional laboratory testing. On-site testing using portable test kits and the development of alternative and simplified testing methods, such as P-A or MPN tests, have contributed to overcoming these constraints (WHO, 2002).

Different equipment and products for these test methods are now widespread and commercially available. The following sections discuss the different test methods, how they are conducted, and their advantages and limitations.

Presumptive Test Method

Presumptive tests are the traditional method that was used for identifying indicator bacteria in drinking water. As coliform bacteria grow, they ferment lactose and produce gas, changing the colour of the culture media and making bubbles. Since some noncoliform bacteria can also ferment lactose, this first test is called a “presumptive” test. Bacteria from a positive test can then be grown with a culture media that tests more specifically for coliforms, leading to “confirmed” results. Finally, the test can be completed by taking positive samples from the confirmed test through additional identification steps. Each of the three steps (presumptive, confirmed and completed) needs 1-2 days of incubation. Typically only the first two steps are performed in coliform and thermotolerant coliform tests, while all three phases are done for periodic quality control or for positive identification of *E. coli*.

Enzyme Substrate Test Methods

In recent years, tests have been developed that chemically identify specific enzymes produced by particular indicator bacteria. These enzymes react with

specific substrates in the culture media and generally produce a strong colour change that is easy to identify. These tests are more rapid than the presumptive test method: some can produce results in 24 hours or less. Furthermore, they are more specific than presumptive tests; so confirmatory tests are generally not necessary. The main disadvantage is the higher cost to purchase enzyme substrate tests. As well, the culture media doesn't exist in powder form. It is most often in liquid or agar form which needs to be refrigerated. Two of the most relevant enzyme tests for drinking water are described briefly below.

Beta-galactosidase (Beta-gal): Coliform bacteria produce the beta-gal enzyme. A number of specific substrates have been developed which react with this enzyme to produce a strong colour, usually yellow or deep red.

Beta-glucuronidase (Beta-gluc): Over 95% of *E. coli* produce the beta-gluc enzyme. This enzyme reacts with the substrate 4-methylumbelliferyl-beta-D-glucoside (MUG) to produce a chemical that glows blue when exposed to ultraviolet light. Other substrates can produce a visible colour, typically blue (e.g., 4-chloro-3-indolyl-beta-D-glucuronide, also known as X-gluc). Many commercially available P-A, MPN and membrane filtration tests use enzyme substrate methods. These tests are recommended by CAWST for their simplicity and specificity and are the basis of the discussion for culture media in this Manual. See Appendix 5 for a summary of different culture media for membrane filtration.

Presence-Absence

Presence-absence (P-A) is a qualitative test that depends on a colour change to indicate the presence of contamination. If the test turns out to be positive, meaning that the indicator bacteria is present, the water sample will change to a specific colour. P-A tests will not tell you the quantity of indicator bacteria in the water sample.

P-A tests are generally only appropriate in circumstances where thermotolerant coliforms are rarely found and when contamination occurs only at low levels (e.g., in deep wells). Quantitative test methods, like MPN and membrane filtration, are preferred where there is known or likely fecal contamination in the drinking water. For example, quantitative test methods are better when testing a surface water source or unprotected well. If positive results are found using P-A testing, the water sample should be re-tested using either MPN or membrane filtration to confirm the level of contamination.

P-A testing is not appropriate for testing the treatment effectiveness of household water treatment (HWT) technologies. We already know that many of these technologies may not be 100% effective for bacteria removal, so there is a chance that P-A tests will turn positive when testing the treated water. The P-A

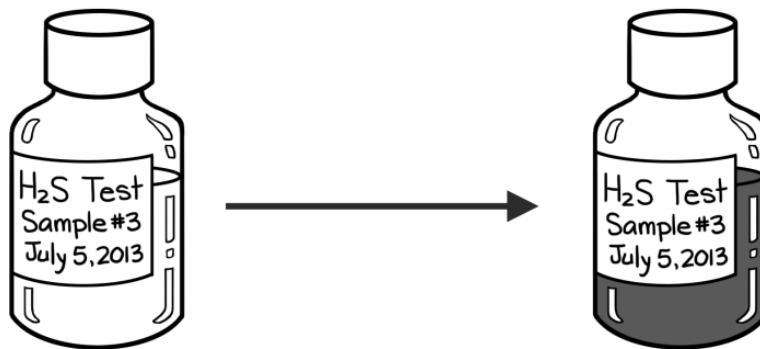
test will not indicate the level of contamination, despite the fact that the treated water quality is improved compared to the original water source, or help to determine the removal effectiveness of HWT technologies.

The advantages of P-A tests are that they are relatively inexpensive, quick and easy to use. The main limitation is that it will only measure positive or negative; the results do not tell you the actual number of indicator bacteria in the sample. There are a number of commercially available P-A tests which use enzyme substrate methods.

Different P-A products can test for three types of indicator bacteria:

1. H₂S producing bacteria
2. Total coliform bacteria
3. Total coliform bacteria and *E. coli*

There are different P-A tests using H₂S bacteria that are produced by different manufacturers. For example, in the P-A test manufactured by ENPHO in Nepal, a strip of test paper is added to a water sample. If the test paper turns black within 24 hours, it means that H₂S was produced, which means that bacteria coming from feces are likely present in the water sample.



Black water indicates a positive result for H₂S bacteria and likely fecal contamination

There are also different P-A tests that use total coliform and/or *E. coli* as the indicators. The general process for these tests is:

1. A powdered reagent is added to the water sample
2. The sample is incubated for 24-48 hours at 35°C
3. The results are read: Colourless = negative, Colour = total coliforms present, Fluorescent = *E. coli* present (seen using a UV lamp)



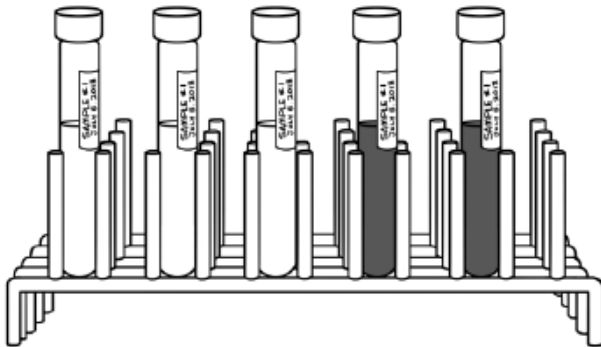
Clear water indicates a negative result for total coliforms, coloured water indicates total coliforms are present,

*fluorescent water indicates *E. coli* is present (seen using a UV lamp)*

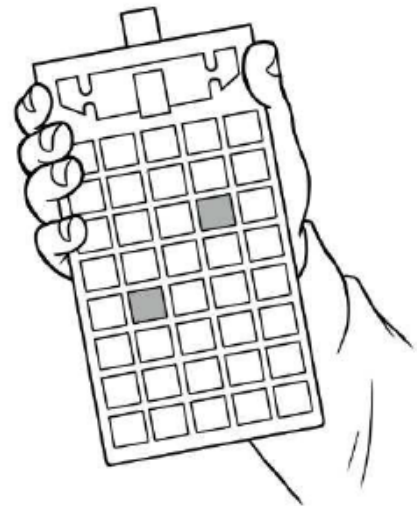
Most Probable Number

The most probable number (MPN) test method estimates the number of indicator bacteria that is most likely to be present in the water sample.

Multiple samples (1-10 mL) of the same water to be tested are added to a culture media in sterile tubes and incubated at a particular temperature for a fixed time (usually 24 hours). Three or five tubes are commonly used, though ten tubes may be used for greater sensitivity. It is becoming more popular to use a disposable tray with multiple small wells instead of multiple tubes since it simplifies the procedure. By counting the number of tubes or wells showing a positive result and comparing with a standard table, a statistical estimate of the most probable number of bacteria can be made. The results are reported as MPN per 100 mL (UNICEF, 2008).



Multiple tubes (10 mL each)



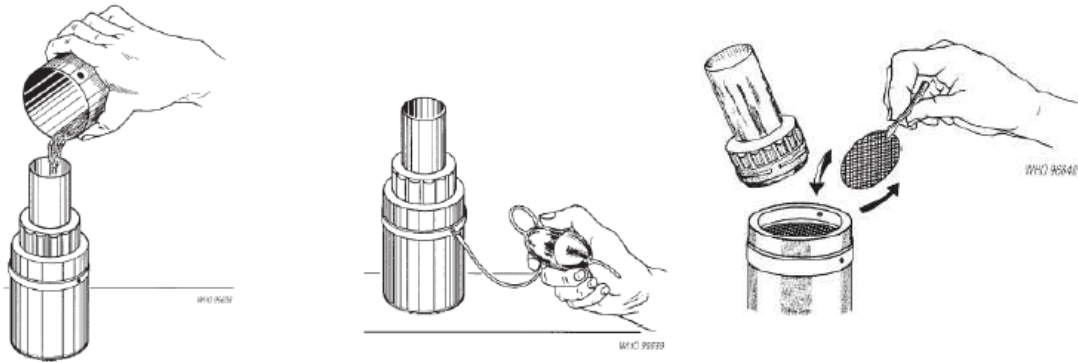
Multiple wells in a disposable tray

Membrane Filtration

Membrane filtration (MF) is the most accurate method to determine the number of indicator bacteria in a water sample and is internationally recognized as a standard method for water quality testing.

Membrane filtration can be done in a laboratory or by using a portable test kit. In general, a 100 mL water sample is vacuumed through filter paper using a small hand pump. After filtration, the bacteria remain on the filter paper which is then placed in a Petri dish with a nutrient solution (also known as culture media). The Petri dishes are placed in an incubator at a specific temperature and time which can vary according the type of indicator bacteria and culture media.

After incubation, the bacteria colonies can be seen with the naked eye or using a magnifying glass. The size and colour of the colonies depends on the type of bacteria and culture media used. The bacteria colonies are counted to determine the number of colony forming units (CFU) per 100 mL.

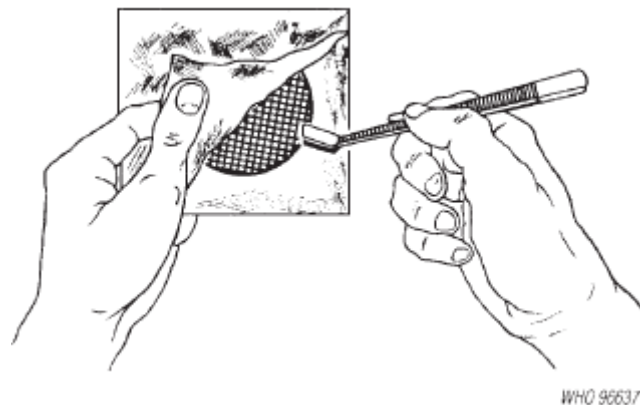


1- Pouring the water sample into a portable membrane filter setup, 2- vacuuming the water through filter paper using a small hand pump, 3- removing the filter paper with the bacteria from the water sample (Credit: WHO, 1997)

Membrane filtration is highly reproducible and can be used to test relatively large volumes of water samples. However, it also has limitations, particularly when testing waters with high turbidity or large numbers of noncoliform (background) bacteria. Turbidity caused by the presence of algae or suspended particles can clog the membrane or prevent the growth of indicator bacteria on the filter paper. Low coliform estimates may be caused by the presence of high numbers of noncoliform bacteria, toxic metals or toxic organic chemicals (e.g., phenols).

Filter Paper

Filter paper, also called a membrane filter, is used to trap the bacteria from the water sample. A pore size of $0.45\ \mu\text{m}$ is most commonly used since it filters out all coliform bacteria. The filter paper usually has a grid printed on it so that you can more easily count the bacteria colonies. There are various types of filter papers with different grid colours available from manufacturers.



Removing a filter paper from its sterile package

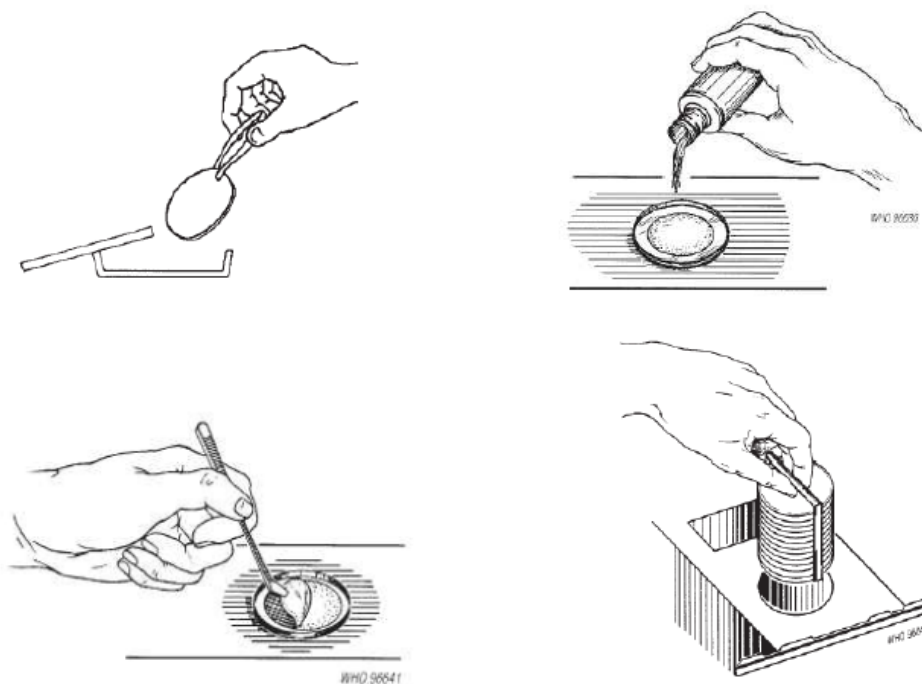
Culture Media

Bacteria cannot be seen with the human eye. In order to observe them, they are grown under controlled conditions to a size that we can actually see and count them. Culture media are substances which contain nutrients to help the bacteria

grow. Culture media in liquid form is called a broth and the semi-solid form (gel) is called an agar. Different culture media are used to grow different indicator bacteria.

In most cases, the culture media is poured onto an absorbent pad in a Petri dish. The filter paper with the bacteria is then put on top and soaks up the culture media. The Petri dish with the culture media and filter paper is incubated so that the bacteria will replicate hundreds of thousands of times and eventually appear on the Petri dish as small dots called colonies. The number of colonies formed on the media is reported as colony forming units (CFU) per unit of volume of the water sample (i.e., 100 mL), hence CFU/100 mL.

Different culture media products have different storage requirements and expiration dates. Once opened the media is exposed to contamination and should be stored securely. Be sure to follow the manufacturer's instructions on how to properly use and store the culture media.



1- An absorbent pad is put into the Petri dish, 2- the culture media is poured on top, 3- the filter paper with the bacteria is added, and 4- the Petri dish is put into the incubator (Credit: WHO, 1997)

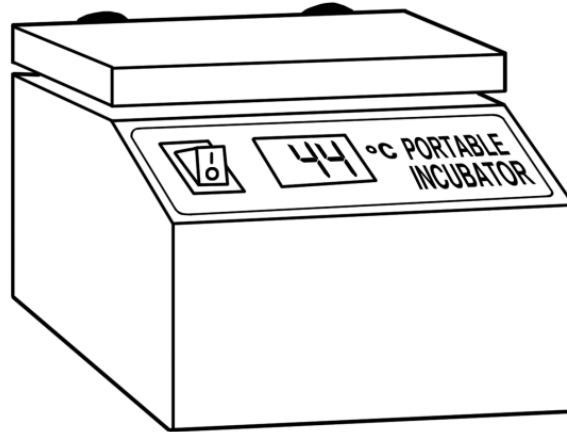
Resuscitation

Bacteria are alive and are stressed after the filtration process. Stressed bacteria do not grow well and may die if they are further stressed by heat. Therefore, you should wait 1-4 hours at room temperature before incubating samples to allow bacteria time to recover and ensure that they survive and grow.

Incubator

The incubator is another important piece of equipment needed for membrane filtration, and sometimes for P-A and MPN tests. There are different types of incubators made by different manufacturers. Some incubators are portable and use a battery for power supply, while others need to stay in one location and use the main power supply.

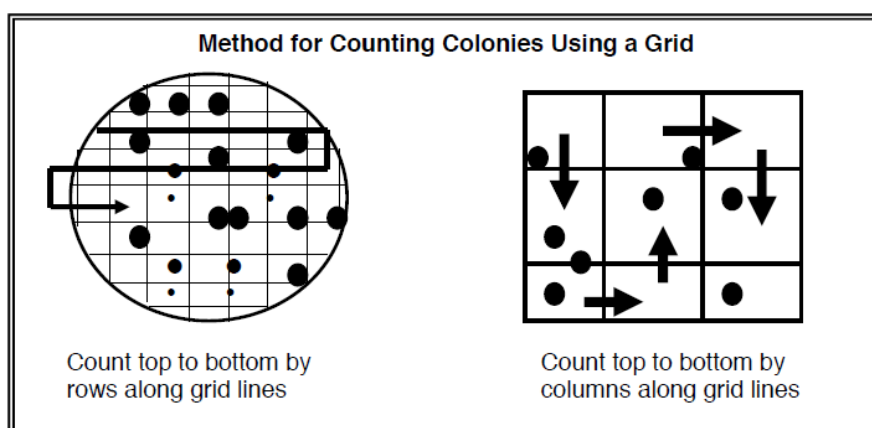
The incubation temperature is critical to ensure that microbiological test results are accurate. Different culture media require different temperatures to grow the specific indicator bacteria. For example, thermotolerant coliforms grow at 44°C. The manufacturer of the culture media will give instructions on the temperature needed for incubation.



Incubators need to be calibrated on a regular basis to make sure that the temperature is accurate. Manufacturers will give instruction on how often to calibrate the incubator and the process to do so.

Colony Counting Techniques

After incubation, you remove the Petri dishes and count the bacteria colonies. You will count all colonies of a certain colour, depending on the indicator bacteria and the culture media used. Colonies may vary considerably in size. Generally, where there are a large number of colonies, they are smaller in diameter. Where colonies are fewer, they tend to be larger. This is because the colonies compete for nutrients in the culture media and will grow larger when there is no competition. Use the grid lines on the filter paper to help count large numbers of colonies. Examine and count all colonies with the particular colour you are looking for. Colonies shown in every grid square are counted. Go from top to bottom and left to right until all grid squares are covered.

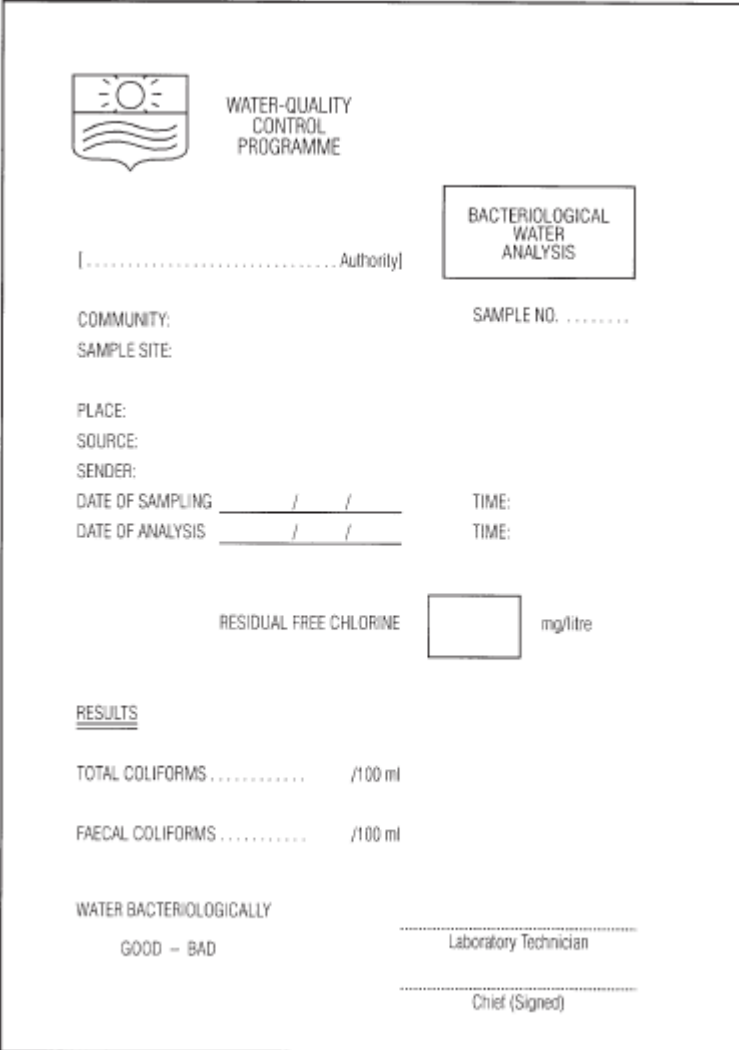


You will report the number of colony forming units (CFU) per 100 mL of water sample. It is difficult to count more than 100 colonies. Petri dishes with more than 200 colonies can be reported as “too numerous to count” (TNTC). Some colonies may overlap which can cause counting errors. Dilutions can be made to reduce the number of colonies and make it easier to count. See Section 4: Water Sampling and Quality Control for instructions on how to dilute your water sample.

Most culture media manufacturers provide an information sheet or troubleshooting guide which can help you to identify and count the colonies.

Record **data in accordance with workplace procedures**

The analysis of a given sample will provide several results. The form drawn up for recording these results, although it should not be complicated, must be completed. The completed form should contain the data on the sampling, which will also serve to identify the samples, those entered on the sample dispatch form, and data on the bacteriological analysis itself. A suggested comprehensive form is shown in Fig. Once the analysis is completed, the laboratory carrying out the work should record the results obtained in a standardized form (protocol); this should follow the recommendations. The protocol can be a very simple report, which records the sample identification information together with the result of the analysis and the appropriate classification of the water.



The form is titled 'WATER-QUALITY CONTROL PROGRAMME' and 'BACTERIOLOGICAL WATER ANALYSIS'. It includes fields for 'Authority', 'Community', 'Sample Site', 'Place', 'Source', 'Sender', 'Date of Sampling', 'Date of Analysis', 'Sample No.', 'Time', and 'Residual Free Chlorine' (mg/litre). There is a section for 'RESULTS' with fields for 'Total Coliforms' and 'Faecal Coliforms' per 100 ml. At the bottom, there is a section for 'Water Bacteriologically' with 'Good - Bad' and a signature line for the 'Laboratory Technician' and 'Chief (Signed)'.

WATER-QUALITY CONTROL PROGRAMME

BACTERIOLOGICAL WATER ANALYSIS

[..... Authority]

COMMUNITY:

SAMPLE SITE:

PLACE:

SOURCE:

SENDER:

DATE OF SAMPLING:

DATE OF ANALYSIS:

SAMPLE NO.

TIME:

TIME:

RESIDUAL FREE CHLORINE: mg/litre

RESULTS

TOTAL COLIFORMS: /100 ml

FAECAL COLIFORMS: /100 ml

WATER BACTERIOLOGICALLY

GOOD - BAD

Laboratory Technician

Chief (Signed)

MAINTAIN A SAFE WORK ENVIRONMENT

Use established safe work practices and personal protective equipment (PPE) to ensure personal safety and that of other laboratory personnel

Personal Protective Equipment (PPE) is widely recognised as a means of protection for individuals working in an environment where all other methods of hazard control are in place and there is still a risk of injury. You must remember that PPE is the last barrier or line of defence between you and the hazardous material you are working with.

The minimum PPE you are required to wear when working in University Laboratories are:

- ✓ Enclosed Shoes (no bare feet, thongs, or sandals and
- ✓ Lab Coat (must be individually issued, worn at all times when working in the lab, removed before leaving the lab and laundered regularly and when contamination is suspected).

AQIS Note: If you have been working with Quarantine materials, your lab coat

must be autoclaved prior to being removed from the lab and laundered

The following additional PPE is provided and should be used where required / instructed / determined by a risk assessment:

- ✓ Safety Glasses / Goggles
- ✓ Gloves
- ✓ Dust Mask / Respirator
- ✓ Face Shield
- ✓ PVC Apron
- ✓ Hearing protection

Eye Protection

The type of eye protection required for a worker or student at the University will depend on the hazards that they work with or which they encounter in the specific work activity, and should be determined by undertaking a risk assessment. The risk assessment should take account of the hazards that are present in the laboratory for most of the time, and consider the work of the group as a whole, not just that of an individual.

Safety Glasses must be worn when:

- ✓ There is a risk of objects striking or causing damage to your eyes.
- ✓ When instructed to do so by your Supervisor or the Lab Manager.
- ✓ If required by the Risk Assessments or Chemical MSDS.

** Safety Glasses may limit, but will not prevent chemicals from splashing into your eyes. Safety Glasses are only suitable when the chemicals you are working with would not harm your eyes in the event of an accident.

Safety Goggles must be worn:

- ✓ When working with hazardous chemical solutions where there is a risk of splash to your eyes.

Face Shield must be worn when:

- ✓ Working with volatile hazardous chemical solutions (eg. concentrated acids).
- ✓ Working with dangerous substances that could strike/splash the face/eyes.
- ✓ There is a risk of solution explosion or instability causing a splash to the face/eyes.
- ✓ There is a risk of dangerous objects striking the face/eyes, such as particles, glass or metal shards.

Standard Prescription Glasses are not sufficient as protective eyewear if:

- ✓ You are working with hazardous chemical solutions and there is a risk of splash to the eye.
- ✓ You are working with toxic, corrosive, pathogenic or radioactive substances.
- ✓ You are undertaking activities where there is a risk of objects striking the eye, such as particles,
- ✓ glass or metal shards.

****** In these instances, ordinary prescription glasses will not provide adequate protection from injury to the eyes and could even be hazardous to the wearer. Please see the Laboratory Manager if you require Prescription Safety Glasses.

Gloves

Different gloves are available for different tasks. Please ensure that you are using the right type of glove for the task you are undertaking. For chemicals, this information can be found in the MSDS.

Gloves available in this laboratory include:

- ✓ Latex disposable examination gloves – powder free
 - Protects your cultures / samples from you.
 - Helps stop the spread of some contaminants around the laboratory.
 - Not to be used with hazardous chemicals.
- ✓ Nitrile disposable gloves (blue)
 - Resistant to many solvents and chemicals.
 - Abrasion and puncture resistance.
 - Helps protect you from exposure to some hazardous chemicals.
- ✓ Rubber gloves
 - Good resistance to detergents and diluted chemicals.
- ✓ Cotton gloves
 - For use under other gloves – absorbs perspiration and helps with heat resistance (for eg, against hot dishwashing water).
- ✓ Leather gloves
 - Some protection when handling broken glass – extreme care must still be taken. Heat resistant gloves
 - Enables you to handle hot items – extreme care must still be taken.
 - Used to remove items from the Drying Ovens and/or Autoclave.

Minimise generation of waste and environmental impacts

Engage and motivate your co-workers to buy green products and help reduce waste. Learn more about how your office can go green.

- ✓ Instead of printing hard copies of your documents, save them to your hard drive or email them to yourself to save paper.
- ✓ Make your printer environmentally friendly. Change your printer settings to make double-sided pages. Use small point fonts when possible and use the "fast draft" setting when possible to save ink.
- ✓ Pay your bills via e-billing programs when possible to save paper.
- ✓ Use paperclips (over staples) when possible.
- ✓ Reuse envelopes with metal clasps and reuse file folders by sticking a new label over the previous one.

Green Purchasing at Work

- ✓ Purchase recycled paper and keep a recycling bin nearby your desk.
- ✓ For information on how to buy more recycled-content products for your office, see EPA's Comprehensive Procurement Guidelines.
- ✓ Buy energy efficient items with the ENERGY STAR ® logo or items that are EPEAT registered for the office.

The safety of staff undertaking analytical procedures, both in the field and in the laboratory, is of the greatest importance. All staff should be trained in safety procedures relevant to their work. In the laboratory, individual staff members should be authorized to undertake procedures involving risk of any type only after appropriate training; unauthorized staff should not be allowed to undertake analyses.

All laboratories should formulate and implement a safety policy that should cover cleaning, disinfection, and the containment of hazardous substances. Safety equipment such as fire extinguishers, safety glasses, and first-aid kits should be suitably located, and readily available; they should be routinely checked and all staff should be trained in their use.

Ensure safe disposal of laboratory and hazardous wastes

It is the clear responsibility of all research workers to ensure the safe and correct disposal of all wastes produced in the course of their work. Improper and irresponsible disposal of chemical wastes down drains, to the Local Authority, refuse collection, or into the atmosphere is forbidden by law. The Aldrich Handbook provides a useful summary of the correct disposal procedure for most chemicals. Due to new legislation, increasingly strict environmental controls and the escalating costs of disposal, it is essential that the appropriate disposal procedures given below are strictly adhered to:

Wash down drains with excess water

Concentrated and dilute acids and alkalis

- ✓ Harmless soluble inorganic salts (including all drying agents such as CaCl_2 , MgSO_4 , Na_2SO_4 , P_2O_5)
- ✓ Alcohols containing salts (e.g. from destroying sodium)
- ✓ Hypochlorite solutions from destroying cyanides, phosphines, etc.
- ✓ Fine (tlc grade) silica and alumina

It should be noted in particular that no material on the "Red List" should ever be washed down a drain. This list is as follows:

Compounds of the following elements: antimony, arsenic, barium, beryllium, boron, cadmium, chromium, cobalt, copper, lead, mercury, molybdenum, nickel, selenium, silver, tellurium, thallium, tin, titanium, uranium, vanadium and zinc.

- ✓ organohalogen, organophosphorus or organonitrogen pesticides, triazine herbicides, any other biocides.
- ✓ cyanides
- ✓ mineral oils and hydrocarbons
- ✓ poisonous organosilicon compounds, metal phosphides and phosphorus element
- ✓ fluorides and nitrites

Clean, care for and store equipment and reagents as required

Incineration (Solvent Waste collection)

- ✓ all organic solvents including water-miscible ones
- ✓ soluble organic waste including most organic solids
- ✓ paraffin and mineral oil (from oil baths and pumps)

Laboratory waste bins and controlled waste

All waste suitable for the Local Authority refuses collection, except recyclable paper and glass, is termed 'controlled waste'. Items in this category which includes dirty paper, plastic, rubber and wood, should generally be placed in the waste bins available in each laboratory and will be collected by the cleaners. However, each laboratory must also have a container for certain items which are not allowed to be put in the normal waste bins. In this special controlled waste container should be put: all broken laboratory glassware, any sharp objects of metal or glass, all fine powders (preferably inside a bottle or jar) and dirty sample tubes or other items lightly contaminated with chemicals (but not any syringes or needles). Laboratory controlled waste containers must be emptied regularly and never allowed to overflow. Under no circumstances must any item of glass, sharp metal or fine powder ever be put in a normal laboratory waste bin. The tops must be removed from all bottles put out for disposal and there should be no detectable smell of chemicals from any bottle put for disposal.

Waste for special disposal

This is a troublesome and expensive method of disposal and the quantity of special waste must be kept to an absolute minimum. Only the following items should be disposed of in this way:

1. Schedule 1 poisons (but not cyanides) and other highly toxic chemicals
2. Materials heavily contaminated with substances in (i)
3. Materials contaminated with mercury
4. Carcinogenic solids including asbestos.

Special waste must be collected in a separate labelled bottle or jar for disposal. On no account must different types of waste be mixed. Advice should be sought from the School Safety Co-ordinator before beginning any work which will produce waste requiring special disposal in order to ensure that:

- ✓ the waste can be disposed of
- ✓ it is collected in the most suitable form so as to minimise the cost involved and
- ✓ it will be stored under suitable conditions.

The importance of handling waste for special disposal to the School Safety Co-ordinator immediately the container is full or the work is finished is emphasised. The hoarding up of hazardous waste in laboratories is strictly forbidden. Environmental Health and Safety Services should be notified of all 'Special Waste' on the appropriate form.

Glass recycling

For environmental reasons the recycling of glass is encouraged, but only certain items of waste glass produced within laboratories are acceptable for recycling. Each laboratory should have a bin for recyclable glass. Only clean glass bottles such as those in which chemicals are received, and broken or waste plate glass are allowed. All broken laboratory glassware, items significantly contaminated by chemicals, sample tubes, droppers and glass wool must be disposed of as controlled waste. The recycling service will refuse to empty a recycling container if any of these prohibited items are discovered in it.

Bottles for bulk solvents

The importance of returning the specially labelled winchesters for solvents which are bought in bulk to the Store ready for direct refilling is emphasised. They must not be contaminated in any way and should not normally be washed out. Bottles containing sodium must not, under any circumstances, be returned directly to the Store. When sodium is first added to a bottle of solvent a label indicating this (available from the Store) should be attached. When the bottle is empty the sodium must be safely destroyed by adding ethanol or methylated spirit and the label removed. The bottle must then be washed out, dried and

returned to the Store ready for direct refilling.

Empty winchester bottles may be re-used e.g. for the disposal of waste solvents. They must first be washed out with water if they have contained a corrosive or harmful chemical e.g. concentrated acid or ammonia.

Biohazard/Sharps Disposal - Syringes and Needles

"Sharps" contaminated with biologically hazardous materials must be collected in special containers to be sent for incineration. It is also required, at the request of Fife Council, that all syringes and needles of any type should be disposed of by the same route. No syringes or needles must ever be put in a laboratory waste bin or controlled waste container.

16.REFERENCES

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- <https://www.open.edu/openlearncreate/mod/oucontent/view.php?id=569&printable=1>
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