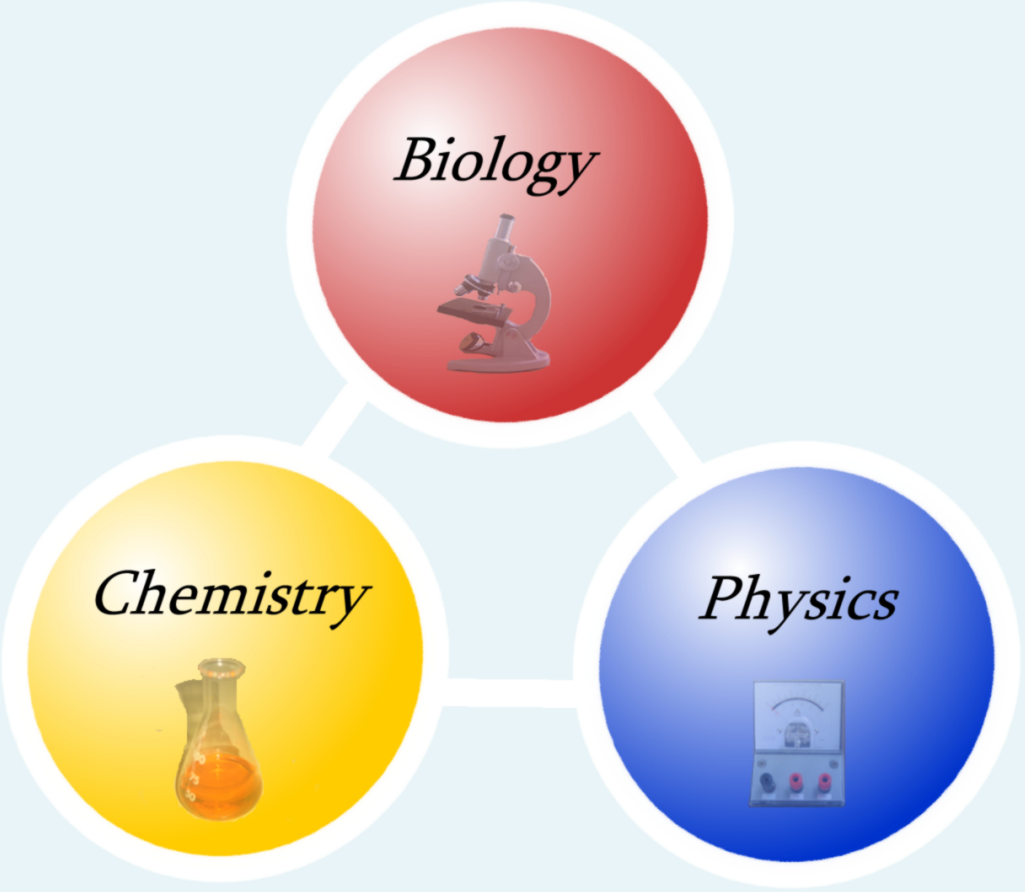
Mauritius Research Council

Ministry of Education
and Human Resources

Training Manual for Secondary School Laboratory Attendants



Foreword by the Honourable Minister of Education and Human Resources

Training manual for secondary school laboratory attendants

It gives me great pleasure to be associated with this training manual for secondary school laboratory attendants, which has been produced jointly by the Mauritius Research Council (MRC) and my Ministry.

Indeed, my Ministry is very much concerned with the teaching and learning of science in schools. The Mauritius Research Council, in its capacity as the adviser to Government on matters pertaining to science and technology, has undertaken a number of studies with a view to assessing the status of science and technology in Mauritius.

In line with the recommendations made, the New Curriculum makes provision for compulsory science for all students up to Form V. However, in order to enhance the quality of teaching and learning of science for all in our schools, it is also imperative to provide adequate training and tools to all those who will have the responsibility of leading us to the attainment of our objectives. This also demands that the teaching of science has to be both more interactive and anchored *in realia*. In this respect, this approach will bring the learning of science in line with our vision for a quality education for all.

This is the first training manual that has been developed for laboratory attendants working in Mauritius and Rodrigues. Developed by a Task Force composed of experienced teachers from State and Private secondary schools, this manual aims at strengthening the competencies in a critical area of the national human resources involved in science and technology education.

It covers the theoretical background and addresses, in a concise manner, the various basic skills and techniques required by laboratory attendants, both experienced and new, to help them provide effective support in biology, chemistry and physics practical classes. Essential referential information has been provided regarding the organisation and management of the laboratory, hazards and precautions, and the adoption of good laboratory practice to ensure the safety of students, teachers and laboratory attendants. In line with the growing use of computers in science teaching, the manual also introduces basic information technology (IT) skills.

Importantly, this manual has equally a potentially wider audience since it may also be used as a resource material in other countries that follow similar secondary school science curricula.

I wish to acknowledge the effort and dedication of the members of the Task Force who, in spite of their ongoing teaching commitments, have successfully collaborated to produce this unique training resource.

Hon. Dharambeer Gokhool

Acknowledgements

The Mauritius Research Council (MRC) wishes to acknowledge the excellent contribution of all the members of the Task Force, who worked as a team over a period of several months to produce this training manual.

The Council is grateful to the secondary schools and laboratory attendants who took part in the Awareness Workshop for Laboratory Attendants held in September 2004 and the half-day workshop held in December 2005, as well as the schools which kindly accepted to take part in the preliminary evaluation of the manual and whose staff provided useful comments and suggestions on improving the material.

The MRC also wishes to thank the Ministry of Education and Human Resources and the Private Secondary Schools Authority for their collaboration in providing information pertaining to the equipment required for science laboratories, and for granting permission to reproduce this information for reference purposes in the training manual.

NOTE ON THE USE OF THIS MANUAL

Laboratory attendants in secondary schools play a crucial role in the preparation and smooth running of science practical lessons and demonstrations.

The purpose of this manual is to provide guidance to laboratory attendants in biology, chemistry and physics, to enable them contribute more effectively to the teaching of practical science at lower and higher secondary level.

The manual is designed in a user-friendly format and makes use of numerous illustrations to cover the key areas that are essential for developing the required laboratory-based skills and techniques. Emphasis is made throughout the manual on adopting good laboratory practice, especially concerning safety. In this context, the manual can serve as the basis for a structured training course for laboratory attendants. Teachers or instructors who wish to use this manual for training laboratory attendants are encouraged to refer to examples in their own laboratory, to demonstrate how the approach developed in the manual can be transferred to the day-to-day activities of the laboratory attendant.

The MRC has, as far as possible, ensured that the contents of this manual are accurate. Kindly advise us of any errors or omissions at the address below, so that we can rectify these when updating. We also welcome your comments and suggestions on how to enhance the manual.

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UNIT 1 – LABORATORY ORGANISATION AND MANAGEMENT

1. INTRODUCTION

Practical Work is an integral part of science teaching and learning. The laboratory attendant is indispensable for the proper running of practical work. As such s/he has important responsibilities in the management of the laboratory. It is advisable that attendants have some knowledge of what a good laboratory design is, to ensure that they can optimize the use of sometimes limited resources in the laboratory. Laboratory equipment, apparatus and materials should be properly managed and be easily accessible for the efficient running of practical classes.

1.1 OPENING AND CLEANING

Laboratory attendants should perform the following duties daily:

(i) Arrive half an hour prior to the beginning of classes in the morning.
(ii) Open doors and windows for aeration.
(iii) Check the gas taps for any leakages.
(iv) Turn lights on, if necessary.
(v) Clean all benches and stools and wash sinks, whenever the need arises.
(vi) Wipe glass panes, sweep and mop the floor.

1.2 DAILY PLANNING OF PRACTICAL WORK / DEMONSTRATION

Make sure that the teachers' instructions for practical work or demonstrations are entered in a record book.

Read the instructions carefully so that you can organise properly and have everything at hand when required.

The following information will be essential:

- Number of pupils or groups of pupils in the class.
- Time/period of practical lesson/s planned for the day.
- List of equipment/materials/apparatus and the number required.
- Equipment/materials that need to be prepared in advance.

- Apparatus to be checked to ensure that they are in proper working condition. If there is a need for borrowing or loaning of equipment from other laboratories, then make the necessary arrangements as early as possible.

1.3 RUNNING OF PRACTICAL CLASSES

- Remember to open main gas supply when using the Bunsen burner. Close after use.
- Placing the equipment/apparatus/materials needed for the day on a tray (or trolley), makes it easier to move from the preparation room to the laboratory and back.
- Materials, which are likely to be re-used in near future, can be kept in appropriately labelled containers and stored for subsequent use in other practical classes.
- Glassware should be handled carefully.
- Make sure you are aware of:
  - ✓ the hazardous nature of certain materials, e.g., radioactive materials, corrosive and oxidizing agents, and
  - ✓ how to handle, store and/or dispose of them safely.
- When preparing solutions use distilled water, unless specified otherwise.
- Perform trial experiments and report to the teacher/s concerned.
- Record the amount of chemicals and solutions used in your notebook.
- Organise the safe disposal of used chemicals and other waste materials (discuss with the teacher if you need advice on safe disposal procedures).
- Clean the laboratory after each practical session to promote safe and clean practices (this ensures that you follow good laboratory practice).
- Ensure that dangerous chemicals, concentrated acids and alkalis are securely stored.
- Keep an eye on all electrical apparatus and inspect all electrical fittings and connecting wires.
- Cover all equipment with dust covers when they are not in use. Note that routine cleaning and dusting of equipment help in their maintenance.
- Avoid prolonged exposure of equipment and chemicals to excessive heat or direct sunlight. In most cases, these conditions can contribute to damage.
- Note that it is best to follow instructions given in the manufacturer's manual for good maintenance of equipment.

- At any time, if you happen to detect a gas leakage, immediately open all doors and windows and close the main gas supply tap. Do not turn on or off any electrical switch. After sufficient aeration, proceed to investigate the cause of the leakage.
- Make sure that you know the location of emergency electrical cut-outs, stopcocks and main switches in the laboratory. These should be labelled properly. This will allow prompt intervention when dealing with an emergency.

1.4 STERILISATION (BIOLOGY)

For experiments which involve micro-organisms or tissue culture, it is necessary to sterilise instruments and culture media.

Instruments can be quickly sterilised by heating in the flame of a Bunsen burner or by dipping in absolute (almost 100%) ethanol.

Bench tops are best washed with a mild antiseptic solution.

The skin surface can be swabbed with cotton wool soaked in absolute ethanol. Note that cultures must be sterilised before disposal.

1.5 CLEANING AND DISPOSAL AREA (BIOLOGY)

One of the main problems of waste disposal concerns solid materials. These can be collected in wire baskets or plastic containers. Plastic bags can be suspended on the sides of sinks, which can then be emptied into dustbins. Ensure that a supply of disinfectant is always handy.

Dirty glassware and apparatus need to be collected carefully and cleaned promptly. Animal tissue or other biological materials must always be safely disposed of.

A drying rack for glassware is essential. It is also important that a specific area be allocated for this purpose.

1.6 STOCK KEEPING AND CONTROL

It is necessary to organise the store in an orderly and systematic manner.

(i) Arranging Stock

Items should be placed in known positions so that they can be located easily.

Racks, shelves and cupboards should be available in the laboratory.

- Allocate a number (e.g., 1, 2, 3, etc.) to each cupboard.
- Allocate a letter (e.g., A, B, C, etc.) to each shelf.
- Sub-divide each shelf in sub sections (e.g., (i), (ii), etc.)

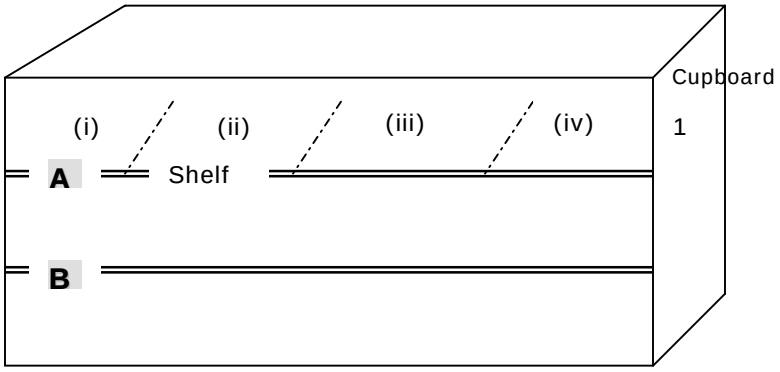

Figure 1: Organisation of storage of laboratory material in a cupboard

Once the above procedure has been carried out, you can stock the equipment and material as indicated below.

(a) For Chemistry or Biology

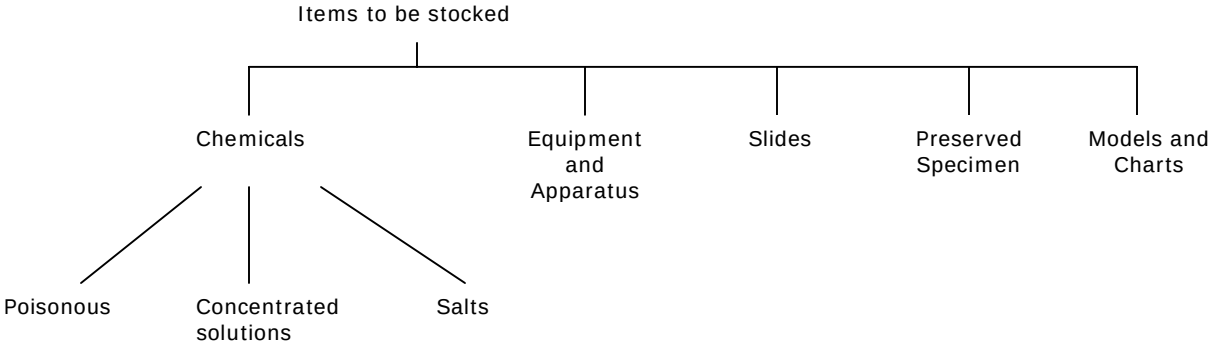

Figure 2: General classification of laboratory material

(b) Physics

Classify the items as follows:
- Electricity
- Magnetism
- Mechanics
- Light
- Heat
- Modern physics

Arrange the chemicals/equipments in ALPHABETICAL order as per above classification.

Finally, display the list of items stocked in each cupboard on an A4 sheet. This can be placed in a transparent folder and attached to the cupboard door, so that the information is easily accessible to everyone using the laboratory.

(ii) Stock Control – Record Keeping

(a) A Stock Book (Hard Cover)

	Item	Cupboard No.	Qty Reqd by Authority	Qty in stock as at 30.06.05	Qty used or damaged	Qty Bought	Stock as at 01.07.2006
1.	Alphabetical order						
2.							
3.							

To keep track of the movement of stocks, a regular inspection of the store and checking of stocks is needed. The frequency of checking could be on a specific day of the month, e.g., the last Friday of every month.

The laboratory attendant has to keep a weekly record of the use of chemicals and breakages in a special 'Note Book'. He/she should make sure that the various items and chemicals required are always available in sufficient quantity, so as to cater for the scheduled sessions of practicals.

Computerised stock control systems can represent a suitable way to keep track of stock movements. Appropriate software (e.g., Microsoft Excel) is required and the laboratory attendant should be aware of how to input and retrieve data (see section on Basic IT skills for more information).

(iii) Ordering Equipments/Chemicals

Ordering often requires experience in the laboratory, sound judgement of what is required and some common sense. Whereas multiple small orders are not appropriate on a cost basis, it is also unwise to leave too long intervals between consecutive orders due to the limited shelf-life of some chemicals/reagents. Safety issues also need to be considered.

Examples:
Conical flasks: can be ordered for a year's supply.
Hydrogen peroxide: order sufficient stock to last for 2 months (beyond this period, the reagent will decompose and over time can lead to an accumulation of potentially explosive peroxides).

To keep a progress of purchase orders, an 'Order Book' is quite useful.

Date	Supplier	Item/Qty	Estimate (Rs)	Remarks

(iv) Record Keeping

Keep records of:

(i) practical and demonstration work,
(ii) stock:
- chemicals
- glassware
- instrument and apparatus,

(iii) reference books,
(iv) chemicals and reagents used, and
(v) breakages.

This will enable you to plan, monitor and do your work properly. Records can be kept in files, record books and computer files. For example, records of chemicals used and breakages should state the date, the name of the person responsible, the class and description of the item, etc.

Example showing record of chemicals used

Date	Chemical	Amount used	Amount left
6.10.05	Calcium carbonate	10.0 g	
2.10.05	Concentrated hydrochloric acid	100 cm^3	

Example showing record of breakages

Date	Name	Form	Unit	Item and description
5.09.05	Suraj	UVI	1	Burette
6.09.05	Jean	LVI	1	Conial flask 250 cm^3

The record of chemicals used and breakages occurring during the year will be very useful for inventory, stock control and for purchasing new equipment, glassware and chemicals.

Note: Another useful file to keep

(i) List of equipment and chemicals already purchased, e.g., invoices.
(ii) Recent price list and catalogue of suppliers (note that with growing access to the Internet, a lot of this information can now be viewed on the websites of the suppliers).
(iii) Requisition list, equipment and chemicals to be purchased.

The stock book must be updated every year by including equipment and chemicals received and by removing breakages and chemicals used, as well as any apparatus which are still in proper working condition.

For further information on Storage and Stock Control, please refer to Appendix 1 (On CD on back cover)

1.7 CLOSING THE LABORATORY

At the end of the day, ensure that all gas taps, electricity, and water supplies in the laboratory are closed.

Return the keys to the office/usher after closing the laboratory.

For further information on Day to Day Laboratory Management, please refer to Appendix 2 (On CD on back cover)

UNIT 2 - HAZARDS AND PRECAUTIONS IN THE LABORATORY

A laboratory can be a hazardous place. Your duty as laboratory attendant is to see to it that all potential hazards are minimised in the interest of all those have access and use the laboratory.

Accidents in the laboratory often happen due to unsafe work practices. Prevention is always better than cure, and therefore every possible precaution should be taken to avoid any kind of accident in the laboratory. Use of personal protective devices and caution during the handling of materials and equipment can minimise the risk of accidents. Always observe elementary safety rules in the laboratory.

The essential ingredients of prevention of hazardous situations are:

(i) good 'housekeeping',

(ii) awareness,

(iii) good storage habits, and

(iv) safe working procedures.

The following are examples of some potential sources of hazards in the laboratory (this list is not exhaustive and you may wish to prepare your own list to use as reference in your laboratory):

(1) Limitations in the laboratory working space.

(2) Glassware.

(3) Fire.

(4) Chemicals.

(5) Gas cylinders and burners.

(6) Electricals.

(7) Radioactive material.

(8) Tools.

(9) Preserved material.

(10) Toxic plants.

(11) Microbiological material.

(12) Field work.

(13) Aeration.

(14) Practical work.

2.1 LABORATORY WORKING SPACE

- The students' working areas should be adequate. This can prevent accidents due to students jostling or bumping into one another.
- Fittings on the floor and wall must not protrude. You should be cautious whenever there are slabs of drains or pipes over the floor surface or when the floor is slippery.
- Always move carefully in a laboratory.

In general, the laboratory layout must be such that all normal activities like opening windows and pulling down blackout blinds can be done without any risk of damaging material or equipment found on the benches. Accidents may occur due to poor laboratory organisation.

2.2 GLASSWARE

- Breakage can be due to incorrect heating procedure and/or poor quality of glassware.
- Glass objects may roll off the bench or get knocked onto the floor.
- Hot glassware can cause serious burns.
- Broken, chipped or cracked glassware (e.g., glass tubing with sharp and rough edges) can cause cuts.
- Broken thermometers (while these can cause cuts, the material inside the thermometer, e.g., mercury, is itself hazardous).

2.3 FIRE

- Volatile substances.
- Flammable substances.
- Electric short-circuits or sparking caused by defective switches, or by overloading on multi-plugs.

2.4 CHEMICALS

- Unlabelled reagent bottles.
- Corrosive chemicals.
- Inappropriate storage methods.

- Bottles containing concentrated ammonia.
- Diluting of concentrated acids.
- Organic chemicals (which can be both volatile and toxic).

2.5 GAS CYLINDERS AND BURNERS

- Wrong handling procedures.
- Old, worn or damaged rubber tubing.
- Regulator in poor working condition.
- Leakage (cylinders, regulators, connections and tubing).

2.6 ELECTRICALS

- Damaged insulation, plugs, sockets and outlets.
- Damp conditions.
- Loose connections.
- Overloading (including multi-plugs).
- Improper or damaged earth connections.
- Short circuits.
- Improper fuse rating.
- Absence of circuit breakers and differential switch (e.g., Residual Current Device, RCD).
- Improper/faulty wiring.
- Mobile phones operating close to sensitive equipment.

2.7 RADIOACTIVE MATERIAL

- Unnecessary exposure.
- Improper handling.
- Improper storage.

2.8 TOOLS

- Dissecting instruments (scalpels, forceps, needles, scissors and cutters).
- Syringes with needles.
- Screw drivers, cork borers, soldering iron, etc.

2.9 PRESERVED MATERIAL

- Improper preservation of animal tissues and organs in formalin.
- Improper preservation of plant materials in alcohol.

2.10 TOXIC PLANTS

- Plants with variegated leaves.
- Plants with latex (milky fluid).

2.11 MICROBIOLOGICAL MATERIAL

- Bacterial cultures.

2.12 FIELD WORK

- Collection of specimens.
- Accompanying students in outdoor activities.

2.13 AERATION

- Improper ventilation.
- Fume hoods in poor working condition.

2.14 PRACTICAL WORK

- Lack of observing basic precautions.
- Distraction of students.
- Snapping of wires, boiling of alcohol or volatile liquids, use of pipettes.
- Improper use of microscopes.
- Use of apparatus that has not been properly secured on the bench.

For further information on Hazards and Safety Symbols, please refer to Appendix 3. (On CD on back cover)

UNIT 3 - SAFETY AND FIRST AID PROCEDURES IN THE LABORATORY

Security and safety are important in the laboratory. Although the immediate responsibility for ensuring laboratory safety is closely linked with the teachers and laboratory attendants using the laboratory daily, ultimately the whole school, including the rector/principal, ushers, and students, has an interest in seeing to it that the science laboratory remains safe environment. In this unit, the measures to avoid accidents and reasonable steps to be taken in the event of accidents will be discussed.

3.1 PERSONAL HYGIENE

- Wash promptly whenever a chemical has come into contact with the skin. Before you start, know what you are working with.
- Wear closed shoes in the laboratory.
- Wear a laboratory coat to protect from accidental splashes, spills, etc.
- Wear gloves and goggles when handling corrosive reagents.
- Laboratory coats should be laundered regularly.
- Avoid wearing your laboratory coat outside the laboratory.
- Do not drink, eat or smoke in the laboratory.
- Do not use ice from the laboratory for beverages. The refrigerator or oven in the laboratory should not be used to store food.

3.2 HOUSEKEEPING

Good housekeeping is a necessity for a safe laboratory.

- Always maintain the laboratory clean.
- Inspect the storage area regularly to locate, correct or draw attention to potentially dangerous situations, e.g., gas fixtures, electrical fittings and connections.
- Inspect electrical appliances and gas fixtures on a regular basis.
- Report any hazard to the teacher/head of department.
- Do not allow students to carry dangerous reagents.
- Experiments which produce toxic or irritant gases, e.g., chlorine, should be carried out in the fume chamber or under a hood, with adequate ventilation.
- Return reagents and equipment items to their proper place after use.
- Chemicals, especially liquids, should never be stored on the floor. Large bottles (2.5 litres, or bigger) should not be stored above bench level.

- Unlabelled, contaminated or undesirable reagents should be discarded in a safe manner.
- Store items such that they do not protrude out of shelves or benches.
- Store items and equipment so that they do not block access to emergency equipment.
- Keep aisles and passageways clear so that movement is free.
- Do not store combustible material close to aisles or passageways.
- Clean all working surfaces and floors regularly.
- Do not allow spills on floors. Mop up immediately to avoid slipping.
- Label all containers, indicating clearly the name of the contents and the hazards, if any.
- Do not leave the laboratory unattended.
- At least two exit doors must be easily accessible at all times.
- Ask students to leave their bags and other bulky items on shelves which are specifically designated for this.

3.3 FIRST AID KIT AND FIRST AID PROCEDURES

- A First Aid kit should contain the following items: band aids, sterile gauze, bandages, scissors, antiseptic creams or ointments and eyewash (*please refer to Appendix 4 for more details*).
- Make sure that the First Aid kit is located in an easily accessible part of the laboratory. The location of the First Aid kit should be clearly visible from any place in the laboratory.
- Regularly check that the kit is stocked and verify the expiry dates. Substances whose expiry dates have passed should be discarded and replaced immediately.
- Although it can be helpful to administer First Aid before an injured person is able to receive professional medical care, you should be aware that in some circumstances this may not apply. For advice, check with a person who has followed formal First Aid training.
- Do not give the injured person anything to drink unless you are absolutely sure there is no risk of causing further complications.
- Wash cuts with plenty of water and apply sterile dressing. You can also apply a thin layer of antiseptic cream.
- In cases of minor heat burns on the skin, you may use running water to alleviate the pain. Apply a paste of sodium bicarbonate (sodium hydrogen carbonate) and water.

- Sodium bicarbonate (sodium hydrogen carbonate) can also be used in cases of acid and alkali burns.
- In case of eye burns, wash the eye with plenty of running water for 5-10 minutes, then seek medical assistance.
- In case of bleeding, hold the injured area tightly for some time to stop the blood flow. If severe bleeding continues seek immediate medical assistance or call the ambulance.
- In case of electrocution, do not touch the person as you may yourself run the risk of being electrocuted. Immediately switch off the electricity mains supply and get the person to lie down. Seek medical assistance.

3.4 LABORATORY WORKING SPACE

- Accidents can occur in situations where students have insufficient working space, due to overcrowding of chemicals/equipment on the workbench.
- Too many stools around the workbench and in the aisles or passageways may be a potential hazard because movement is restricted in case of accident.

3.5 GLASSWARE

- Handle broken glass with care, as it can be a cause of injury in laboratories.
- Inspect all glassware before use.
- Do not use cracked or chipped glassware. Keep aside broken glass for audit purposes.
- After audit, discard all broken, chipped or badly scratched glassware. Before disposal, wash all empty glassware containing chemicals with plenty of water.
- All broken glass requires special handling disposal procedures to prevent injury of those collecting waste. Dispose of broken glass pieces carefully.
- Do not store glassware near the edge of shelves.
- Do not store glass bottles or containers in direct sunlight. They may act as a lens and cause fire.
- Glass tubing must be handled with special care. When you have finished cutting the glass tube, polish the ends. You can (i) rotate the tips on a Bunsen flame, or (ii) use emery paper.

- Carry long glass tubing vertically, **never** horizontally.
- Follow the right procedure when you cut glass tubing. Use a glass file or knife to make a mark on the glass. Apply pressure close to the mark to break the tubing. Use a piece of strong tissue or cloth to avoid the risk of being cut by the sharp edges, and to contain any glass fragments. Never use bare hands.
- When you need to insert a thermometer or tubing into a rubber bung, first use a cork-borer lubricated with glycerol (propan1-2-3-triol) with a slightly greater diameter than the thermometer/tubing. Then insert the thermometer or the tubing in the borer. Withdraw the cork borer. Use the same procedure to remove tube/thermometer from the bung.
- Always use pipette fillers to pipette solutions, e.g., volatile liquids, aqueous ammonia, oxalic acid (ethanedioic acid), toxic liquids and bacterial broths, etc. (As a general rule for your own safety, avoid pipetting by mouth).
- If glass stoppers become jammed, loosen by tapping gently with a wooden block wrapped in a piece of cloth. You may also use warm water, depending on the substance that is inside the container.
- Since use of glass involves more risk, you may use plastic whenever possible. For example, you can use plastic measuring cylinders to measure volumes of water, dilute acid, dilute alkali etc. For some chemicals, plastic cannot be used – ask for advice from the teacher if you are not sure.
- Use heat resistant glass apparatus whenever heating is required.
- Handling damaged thermometers can be a hazard due to both broken glass and mercury spillage.

3.6 FIRE

- Light Bunsen burners using preferably a gas lighter. Caution students with long and loose hair, or loose clothing.
- Check fire extinguishers regularly to see if they are in proper working conditions.
- Get fire extinguishers serviced and recharged regularly.
- Keep the following at hand:
  - ✓ carbon dioxide extinguishers,
  - ✓ fire blanket, and
  - ✓ sand bucket.
- If someone's clothing catches fire, smother (*etouffe'*) the flames with the fire blanket and place the person horizontally on the floor.
- In case of fire in the laboratory assist any person in immediate danger to safety, if this can be done without risk.
- Evacuate the laboratory in an orderly manner.

- Switch off the main gas supply.
- If there is still no immediate danger to yourself, use a fire extinguisher to control and put out the fire.
- If this is not possible, use the fire alarm and notify the fire brigade.
- If possible, close doors and windows, making sure that no one is left behind.

For further information on List of Materials for First Aid Kit and Fire Fighting, please refer to Appendices 4 & 5. (On CD on back cover)

3.7 CHEMICALS

- You should never taste chemicals or drink from a beaker, even if there is no apparent smell or colour. Many chemicals are toxic. They can cause poisoning, e.g., lead or mercury compounds.
- Wash hands thoroughly after handling chemicals.
- Wash sinks with water to remove traces of chemicals.
- Pour chemicals from bottles by using the correct techniques.
- When pouring chemicals from beakers, use a stirring rod to direct the flow and avoid splashes.
- Handle organic solvents with care, as many are highly flammable.
- Some reactions can be dangerous. Never mix chemicals or solutions unless clearly instructed to do so.
- Keep flammable chemicals in a cool place away from the laboratory. Keep a limited amount for use in the laboratory.
- Store dangerous chemicals such as corrosive acids close to the floor, never on high shelves.
- Any chemicals stored at floor level should be away from the walking areas.
- Sodium metal must always be stored in kerosene/paraffin oil. Do not handle sodium metal with bare hands. This metal is very reactive and contact with air and moisture can be dangerous.
- Label reagent bottles clearly and prominently.
- Bottles should never be completely filled with liquids. Leave adequate space for the lid.
- When dissolving substances such as sodium hydroxide always use a heat resistant vessel (preferably glass), since a lot of heat is liberated during this process.
- When preparing dilute acid from concentrated acid, **always add a small volume of concentrated acid to a large volume of water, never water to acid.** Use heat resistant glass or plastic vessel during the preparation.
- Do not allow unauthorized persons in the store room.

- Store chemicals in single rows and in alphabetical order on strongly constructed shelves.
- Chemicals which deteriorate on exposure to light, should be stored in brown bottles or in the dark, e.g., hydrogen peroxide, silver nitrate, bromine, potassium permanganate.

3.8 GAS CYLINDERS AND BURNERS

Gas Cylinders

- Open gas cylinder controls slowly and carefully.
- Handle the gas cylinders with care.
- Keep gas cylinders at ground level in a safe place (preferably outside the laboratory).
- Cylinders must be firmly secured at all times – chained, or clamped to the wall or bench.
- Always check the gas detector before switching on the gas tap.
- Always switch off the main gas tap when burners are not in use.
- Know how to operate the emergency switch for gas.
- Stiff valves should be treated with carbon, **NEVER** use wrenches or hammers. If unable to open, return unused to the supplier indicating the fault.
- Cylinders must not be used without pressure regulators.
- Do not store cylinders close to flammable solvents.
- 50% of accidents involving gas cylinders are caused by oxygen. Oxygen-enriched atmospheres increase fire hazards.
- Valve gear must never be greased or oiled.

Bunsen burners

- Check the rubber tubing regularly. It can be damaged by heat, especially during summer.
- Never use worn out rubber tubing as it can cause gas leakage.
- Clean burners regularly to remove deposits.
- Check gas taps before, during and after each practical session.
- Adjust the air hole of burners so as to get a blue flame.
- Never keep volatile liquids near a Bunsen flame.

- Use a water bath for heating an inflammable liquid. Direct heating involves the serious risk of the liquid igniting and burning explosively.
- Check for gas leakages using soapy water on rubber tubing.
- Use rubber tubing of appropriate length (about 50 cm), to avoid entangling with nearby objects.

Refrigerators

Foodstuff for staff should never be placed in a biological refrigerator designated for microbiological cultures or dissection material.

Domestic refrigerators have a micro-switch for the internal light, which is usually not spark proof. About 3 – 5 cm^3 of ether, propanone or petroleum ether evaporated inside a refrigerator 1m^3 capacity will produce an explosive mixture. (**Note**: spark proof refrigerators will have a manufacturer label on the door to indicate this).

3.9 Damaged Insulation, Plugs and Sockets

Usually electrical cables consist of three wires – **LIVE**, **NEUTRAL** and **EARTH** wires. The **LIVE** wire is the one which is at a high voltage (usually 240 volts a.c.) and is therefore dangerous to touch. Any contact with the **LIVE** wire may result in electric shock or electrocution.

- Be sure that adequate electrical insulation covers all electrical conductors and connectors before you switch on any equipment. Examine equipment regularly for the possible presence of faulty/ bare wires. Insulation may suffer from wear and tear after prolonged use of wires. Do not use old and worn out leads that have bare connecting wires inside exposed.
- Regularly examine electrical plugs to make sure the wiring is secure and the fuse is properly rated and in working condition.
- Do not pull on cords to remove plugs from sockets. Pull out the plug gently from the socket.
- Avoid bending or twisting electrical cables as this will eventually cause the insulation to crack or break.
- Ensure that all electrical wirings are insulated to minimise any risk of contact with the **LIVE** wire. Damaged insulation can lead to short circuit, overheating and eventually fire.
- In case a fault is detected, switch **OFF** the mains supply. It is dangerous to carry out repair of any equipment, which is not completely disconnected from the mains.

- It is a good practice to remove the plug from the socket before repair. Sometimes the socket may be faulty and the appliance may still be 'live' when you think it is off. (**Note**: Whenever possible, use 3-pin sockets which have their own switch – this brings an added level of safety.)
- Electrical sockets may present shock and electrical fire hazards. Never insert metal objects such as hairpins, paperclips, pens, keys or normal screwdrivers into the sockets, especially those which do not have their own switch.

3.10 DAMP CONDITIONS

Water provides a good path for electricity. Electrical accidents often occur when a person comes into contact with both a **LIVE** power line and ground. A person standing in water provides an excellent electric contact with ground. The resistance of the human body to current flow decreases drastically when the skin is wet, compared to that of dry skin. If the person touches a defective electrical appliance, current will easily flow through his body and this may cause serious injuries and even death.

- Never touch electrical appliances, plugs or switches with wet hands.
- Do not let appliances or cables come into contact with water. Take special precaution when working with water in electrical equipment, e.g., when filling an electric kettle with water, avoid getting the socket wet.
- Avoid using equipment near water, e.g., near laboratory sinks or on wet floor etc. If the equipment is not properly insulated and earthed, there is a potential danger of electric shock.

3.11 LOOSE CONNECTIONS

Loose connections can cause short circuits. If a bare wire becomes loose and is in contact with some part of the equipment (e.g., the metal casing of an electrical kettle which is not earthed), any person touching it will get an electric shock or will be electrocuted.

Loose connections can also lead to overheating of the wires or the electrical device. The heat produced may be enough to melt the insulation and cause a fire.

- Check regularly for loose connections, bare wires coming out of the terminals in plugs or in sockets.
- Never use any apparatus that produces a "tingle" or a buzzing sound. Check its connections or send for repair if necessary.

- Check that plugs fit in tightly in sockets. Otherwise, insertion or removal of the plugs can cause sparking with the possible risk of fire.
- In the interest of safety, always use appropriately matched plugs and sockets. E.g., Interfacing a French model plug (2 round pins and one round recess) with a UK model socket (designed to receive plugs with 3 rectangular pins) will allow electricity to flow. However, because the **EARTH** terminals are never connected, there is no protection at all from electric shock/electrocution in case a fault occurs.

3.12 OVERLOADING

Plugging in too many appliances in one socket will overload the circuit. This will cause overheating as an unusually large current will flow in the wires. If the wires are not designed to carry this current, the large amount of heat produced can melt the insulation, cause a short circuit and possibly start a fire.

- Avoid overloading circuits.
- Use extensions which have the proper rating and are equipped with a fuse.
- For added safety, when using an extension that ends with several electrical sockets, ensure that each socket can be switched individually.
- Avoid using long extension cords.
- Avoid joining one extension to another.

3.13 IMPROPER OR DAMAGED EARTH CONNECTIONS

Earth wires are connected to the metal casings of appliances, which are the parts that you may have to touch while using them. If a live wire is accidentally detached from its connection inside the appliance and touches the metal casing, a current immediately flows to earth through the earth wire and blows the fuse. This prevents the current from flowing through the person who is touching the casing at that moment. Earthing a device is therefore essential for protecting the user.

However, if the earth connections of the laboratory electricity supply are improper or damaged, then the user is still at risk when a fault occurs, even though the equipment itself is properly wired.

To have a properly connected earth wire:

- Fix the earth wire to a copper rod/plate.
- Bury the rod/plate about one metre deep in a damp soil containing charcoal and kitchen salt.

- Ensure that all sockets in the laboratory that have an earth terminal are connected to the main earth wire that links the laboratory to the copper rod/plate. It is advisable to get the assistance of a qualified electrician to verify this.

3.14 SHORT CIRCUIT

Short circuits occur when an extra conducting path of much lower resistance comes into contact with the usual circuit and allows more current to flow in the circuit. Such a situation can arise when the live wire comes into contact with the neutral wire. As a result, a large amount of current flows in the connecting wires. The excessive heating of the insulators can cause melting and can start a fire.

3.15 IMPROPER FUSE RATING

A fuse is a safety device that breaks the circuit whenever a current which exceeds the rated value flows in it. It is connected in an electric circuit to protect the equipment and the wiring against any excessive current flow in case of short circuit or overloading. Without a fuse, the wiring becomes hot and can cause a fire.

- Always use fuses of the correct rating. If a fuse of higher rating than the required one is used, it will allow a larger amount of current than usual to flow. This may result in overheating of the cables and electrical wires and cause damage to the electrical appliance.
- Switch off the mains before changing any fuse.
- Always replace a blown out fuse by one of the same rating as recommended by the manufacturer.
- If the replaced fuse blows again, this may indicate another problem in the equipment. Have the equipment checked before you attempt to switch it on again.

3.16 ABSENCE OF CIRCUIT BREAKERS AND DIFFERENTIAL SWITCH (RESIDUAL CURRENT DEVICE, RCD)

Circuit breakers, differential switches and residual current devices (RCDs) are all safety devices which will interrupt the circuit to protect against major shock and electrical fires.

- Make sure you know the location of such a device in your laboratory and how to reset it.
- Before resetting the device, first find out and correct the problem which caused the device to be activated.

3.17 IMPROPER / FAULTY WIRING

One example of improper/faulty wiring is connection of a wire to an inappropriate terminal, e.g., **EARTH** wire connected to the **LIVE** terminal in a 3-pin plug. In this case, the metal casing of the equipment becomes 'live' and any one touching the metal case will get electrocuted.

- Always make sure to connect each wire to its appropriate terminal using the colour code. (**LIVE** wire: brown, **NEUTRAL** wire: blue, **EARTH** wire: green and yellow stripes).
- In general, when wiring an electric circuit, make the **LIVE** connection the last step in assembling and the first step in disassembling.
- Disconnect the power source before making any circuit changes. Avoid touching the 'live' sections of the circuit.
- Never test a circuit using an ordinary screwdriver. A **LIVE** wire indicator (tester) is a specially-made screwdriver used to distinguish a **LIVE** wire from a **NEUTRAL** wire.

The following are signs of trouble in wiring systems:

- face plates on outlets or switches that are warm to the touch,
- circuits that do not work,
- smell of burning plastic/rubber at sockets or switches,
- flickering lights, and
- small buzzing sound.

3.18 MOBILE PHONES

- Avoid using mobile phones in the laboratory. The electromagnetic radiation it emits or receives has sufficient energy capable of igniting inflammable gas/ vapour products.
- Always switch off mobile phones in the laboratory.

3.19 RADIO-ACTIVE MATERIAL

Exposure

The risk from exposure to radiation depends upon the amount of radioactivity, the distance from the source, duration of exposure to radiation and absence of shielding.

Exposure to high levels of radiation from radioactive material can be extremely harmful to the human body. Lower doses of exposure can cause immediate effects like pain and burns. Overexposure can lead to serious long-term effects, such as cancer. Certain organs, e.g., the eyes, are more vulnerable to these radiations.

Handling

The following are a few safety measures to be taken when handling radioactive material:

- Always handle radioactive sources carefully with long tongs or tweezers/forceps. Never handle them with bare hands. The source must never be allowed to come into contact with the skin.
- Do not hold the radioactive source near the eyes.
- Carry the container with care to avoid risk of accidents, which might cause the box to open and expose the source.
- Never direct the source towards people.

Storage

- Radioactive sources must always be kept in their boxes when not in use.
- Store radioactive materials in lead containers and inside wooden boxes. Keep these wooden boxes in specially designed metal containers on a tiled surface or in a cupboard in a remote corner of the store room.

3.20 Tools

Science laboratories are equipped with a wide range of tools: awls and pins, cork borers, cutters, dissecting instruments, glass cutters, guillotines, knives, knife sharpeners, pliers, screw drivers, syringes, etc. All of them can be potentially hazardous if you are not trained to handle and use them properly.

All dissecting instruments like sharp forceps, scalpels, scissors, and pointers can cause cuts through negligence. They can be more dangerous if they are rusty.

- Handle dissecting instruments with caution. Keep them in waxed trays, to prevent rusting and store in drawers with locks.
- Provide the exact number of dissecting instruments to students for a practical class.
- Collect and check all instruments at the end of the class.
- Syringes are sometimes used with needles. Store needles in their sheath. Sterilise after use in a pressure cooker or by boiling them in water for 5 – 15 minutes, or by dipping them in 70% ethanol.
- Screwdrivers and pliers are often used during the preparation of practicals involving electricity. Keep them dry and rust free. Make sure the handles are properly insulated.
- Cork borers are used to remove cylindrical pieces of tissue from plant material like potato or beetroot, and to insert or remove thermometers and glass tubings. Do not use rusty borers as they maybreak in your hand when pressure is applied.

3.21 PRESERVED MATERIALS

- A number of preserved specimens are found in the biology laboratory. Whole animals like worms, reptiles or small mammals, or animal organs such as the heart of sheep, bull's eye, kidneys, etc., are kept in jars filled with a solution of formaldehyde.
- Plant materials are preserved in jars containing alcohol.
- Check these jars regularly. Add preservatives like formaldehyde or ethanol, if necessary, and seal again using sealers or seal tape to prevent evaporation of the liquid and possible escape of toxic vapours.
- Replace old and damaged labels.

3.22 TOXIC PLANTS

- Plants or plant parts such as leaves, flowers and fruits which are used for experiments and demonstrations in biology, need to be carefully selected for the purposes of teaching.
- Many plants are unsuitable as they are potentially toxic.
- Avoid plants with milky latex.
- Bring plant materials as specified in your instructions. Edible plants can be used safely.

3.23 MICRO-ORGANISMS

- In microbiology, you will have to work with bacterial cultures. Some of them, if handled without certain basic precautions, can be harmful and can cause disease.
- Work with extra caution.
- Sterilise Petri-dishes, test tubes, glass slides, syringes, etc., before and after use. You can sterilise them by any one of the following methods:
  - Place them in boiling water for 15 minutes.
  - Dip them in 70 % ethanol.
  - Boil them in a pressure cooker.
- Do not store bacterial cultures in a refrigerator for too long. Throw them away after use.
- As a basic precaution and for your safety, use gloves.
- Wash your hands with soap and wipe with cotton wool soaked in 70% alcohol (ethanol).

3.24 FIELD WORK

- Laboratory attendants may have to fetch plant materials from waste lands. Wild flowers, specific plants or animals may be needed for some practicals or demonstrations. You may have to accompany students on ecological studies.
- Wear the appropriate clothing such as raincoat, boots and gloves, if available.
- Do not take unnecessary risks. Avoid marshy lands, cliffs and sea-side locations with dangerous tides.
- Use tools provided to obtain materials in nature, for example, nets and traps, containers and bags.
- Carry a First Aid kit with cotton wool, plasters and bandage, etc.

3.25 AERATION

- A laboratory, which is closed overnight, is often stuffy.
- Put on the fans and the extractors as you enter the laboratory.
- Whenever possible, keep doors and windows open during a practical class.
- Check if the store is properly ventilated.
- Use a fume chamber, if available, to work with chemicals that emit toxic fumes, e.g., chlorine.

3.26 PRACTICAL WORK

To avoid accidents during a practical:

- Work strictly according to instructions for practical work given in examination papers or teachers' instructions.
- Get apparatus, glassware/materials and tools ready before the practical lesson.
- Make sure that you have all the necessary materials; you may have to prepare materials for biology practical work in advance, for example, germinating seeds, flowers, etc.
- Label containers to avoid confusion.
- Keep an account of apparatus, materials and tools given to students.
- Do not overcrowd the working space with unnecessary reagent bottles and apparatus.
- Use appropriate containers for hazardous chemicals and carry them in trays or racks, or use a trolley if necessary.
- Light burners only when required, and turn off when not in use.
- Follow safety rules and procedures when boiling a leaf in alcohol (ethanol), or making an electrical connection or working with a microscope.
- Use a water bath to boil a leaf in alcohol (ethanol).
- Heat glass tubes using test tube holders.
- Never point the mouth of the glass tube towards you or other people.
- Avoid smelling chemicals, flowers and other specimens, etc.
- Never cut plant or animal tissues directly on the table; use a white tile.
- Never use a microscope in direct sunlight.
- Connect the positive of power supply (red terminal), to positive terminal (red terminal) of meters, e.g., ammeter or voltmeter.
- Avoid loose connections.
- Set rheostat to maximum value before switching on (for electrical circuit).
- Do not perform unauthorized experiments or use equipment without reading instructions.
- Take extra precaution so as not to interchange cork or stoppers of reagent bottles.
- Do not keep apparatus and equipment unsecured on the bench (e.g., use appropriate clamps, stands, or supports).

UNIT 4 - BASIC LABORATORY TECHNIQUES AND SKILLS

Note: Information provided in Units 4 and 5 cover the use of scientific equipment that is available in both State and Private Secondary Schools. For a complete list of equipment for science laboratories, please refer to Appendix 6.

4.1 CHEMISTRY

For the smooth running of the chemistry laboratory, it is important for the laboratory attendants to acquire certain basic techniques and skills such as:

(1) using and manipulating different apparatus and equipment,

(2) setting up apparatus for demonstrations, and

(3) preparing solutions and reagents.

While some of these techniques and skills can be acquired with experience, it is preferable that the laboratory attendants follow a structured training course, which will enable them to perform their duties efficiently and in a safe manner.

4.1.1 USING AND MANIPULATING DIFFERENT TYPES OF APPARATUS AND EQUIPMENT

Some apparatus are very sensitive – take care while using them. Glassware has to be handled very carefully for safety purposes.

(a) Cleaning of Test Tubes

Insert a test tube brush carefully into the test tube and twist it slowly (do not shove the brush in, as the base of the test tube may break). Then, rinse with water.

(b) Putting Solids in a Test Tube

Use a clean and dry spatula to put solid chemicals in a test tube.

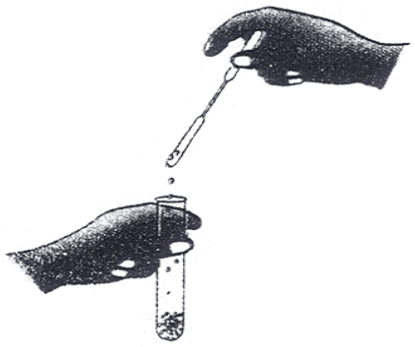

Figure 3: Transferring solid material into a test tube

(c) Pouring Solution From A Reagent Bottle Into A Test Tube

Hold the stopper between the last two fingers and the palm of the hand. Twist the stopper off.

Figure 4: Opening a reagent bottle safely

Hold the bottle over the label to prevent any spillage over the label and pour the solution into the test tube until one-third full.

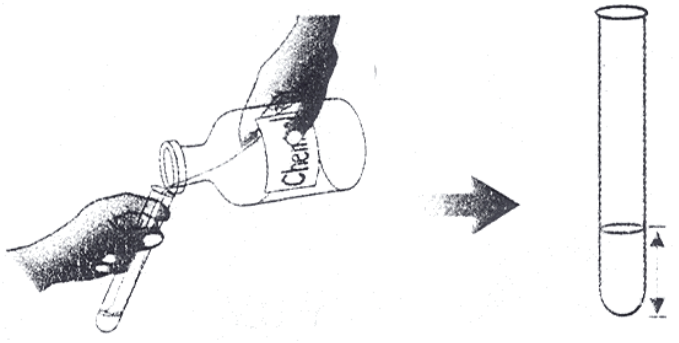

Figure 5: Transferring liquid into a test tube

Place the stopper back immediately after pouring.

(d) Transferring A Solution From One Container To Another

Stir the contents smoothly using a glass rod. Pour the solution against the glass rod to avoid spillage.

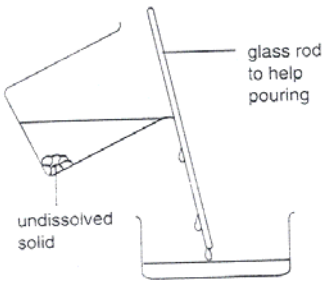

Figure 6: Transferring a liquid without spillage

(e) Heating A Liquid In A Test Tube

Use a test tube holder to hold a test tube while heating a liquid.

Never point the test tube towards yourself or anyone else while heating.

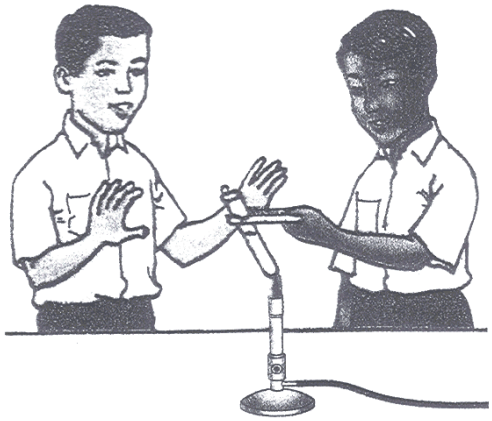

Figure 7: Unsafe method of heating a liquid

(f) Measuring Volume of Liquids

When a liquid is placed in a glass vessel, for example a measuring cylinder or burette, it forms a curved surface at the top called a meniscus.

To determine the volume of a liquid accurately, position yourself so that your eyes are at the same level as the bottom of the meniscus and read the scale.

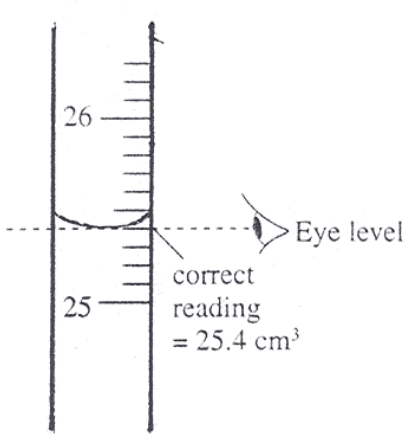

Figure 8: Correct technique to read volume in a measuring cylinder

(g) Using a Bunsen burner

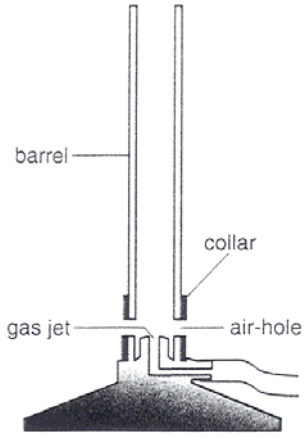

Figure 9: Section through a Bunsen burner

A Bunsen burner is a very important piece of equipment in the laboratory and it is used to heat various materials.

If the air hole is closed, a yellow luminous flame is obtained. This flame produces a lot of soot and is not suitable for heating.

When the air hole is opened, a blue flame is obtained. This flame is very hot and it is this type of flame that is suitable for heating.

To light a Bunsen burner, turn the collar to close the air hole. Light a match stick or click on the trigger of a flame starter and hold it over the barrel. Turn the gas tap on gently with the other hand. Once the burner is lit (it will appear as a yellow flame, because the air hole has been closed), slowly open the air hole until a blue flame is obtained.

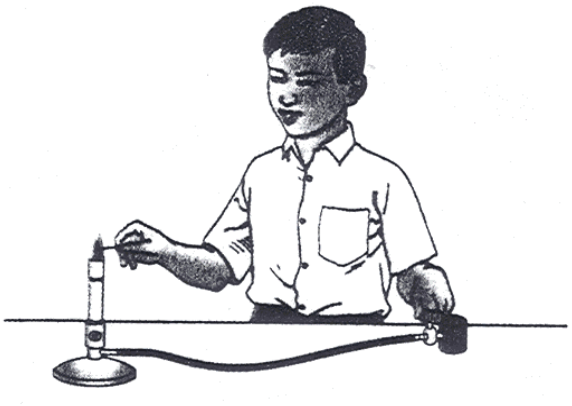

Figure 10: Lighting a Bunsen burner

4.1.2 Setting Up Apparatus For Demonstrations

Very often, different parts of the apparatus used for demonstrations are scattered throughout the laboratory and are not properly stored. Assemble these parts and keep them in one place, so that they are always easily accessible.

(a) Distillation

Set up the apparatus as shown in the diagram.

Check the apparatus and make sure it is in proper working condition before being used for any demonstration.

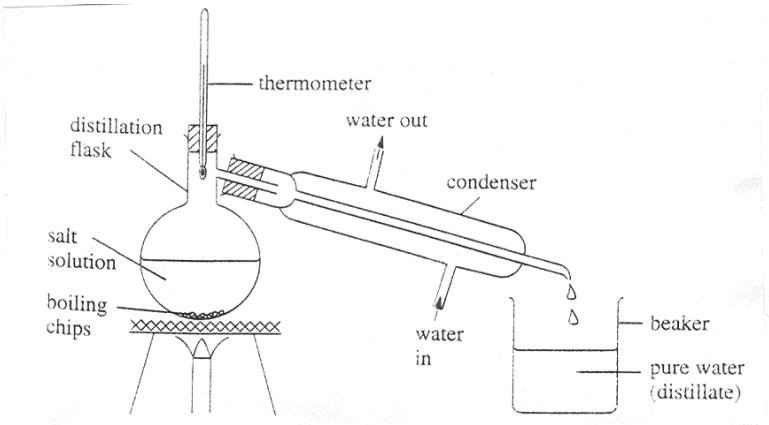

Figure 11: Setup of apparatus for distillation

(b) Preparation Of Gases

For preparing and collecting gases, different methods can be used.

The methods will depend on the physical properties of the gas, namely:

- ✓ the solubility of the gas in water, and
- ✓ the density of the gas compared to the density of air.

Ask the teacher concerned before setting up the apparatus.

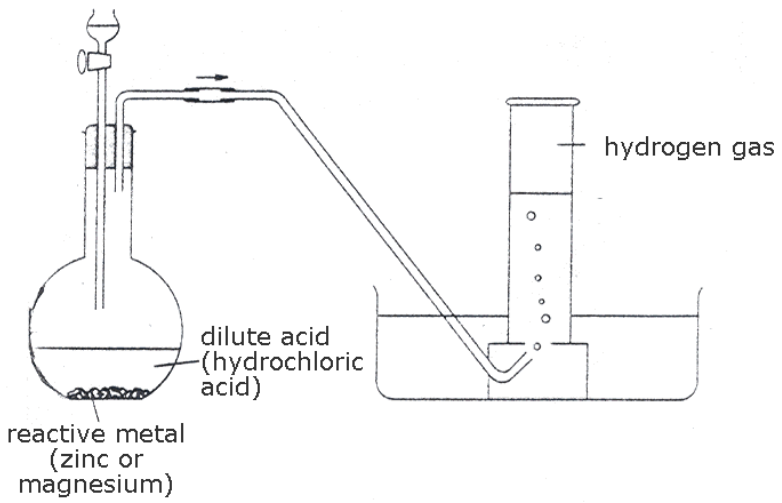

Figure 12: Setup of apparatus to collect hydrogen gas

(c) Preparation of Standard Solutions

Procedure

Calculate the exact volume of solution required and the exact mass of solid needed.

Weigh the solid accurately in a weighing container and transfer it carefully to a volumetric flask fitted with a funnel. Wash the container at least twice with distilled water. Transfer all the washings into the volumetric flask. Swirl the flask until all the solid has dissolved. Using a wash bottle, rinse the funnel and transfer the washings into the flask. Make up to the mark with distilled water and mix properly before use. The same procedure can be adopted for preparing larger volumes, where large measuring cylinders may be used.

4.1.3 PREPARATION OF SOLUTIONS AND REAGENTS

To obtain accurate results during practical work, it is important that the solutions are prepared using clean apparatus. Proper planning and other techniques of solution preparation need to be followed. Before preparing solutions, take the following steps:

- Rinse the glassware with plenty of tap water.
- Rinse with distilled water if necessary.
- Calculate the exact volume of solution required to avoid wastage.
- Calculate the mass of chemicals for the required volume of solution. Have the calculations checked by the teacher concerned.
- Weigh with great care, as it is important for accuracy and will determine the success of the experiment.
- Always weigh solids in a weighing bottle or dry beaker covered with a watch glass (ensure that the weighing area is protected from draughts that may be caused by open windows/doors).

(a) Acids

Diluting concentrated acids is a dangerous process as it produces a large amount of heat.

Concentrated acids produce poisonous and irritant gases. Use a fume cupboard for dilution, and in addition to a laboratory coat, wear gloves and goggles. **When diluting a concentrated acid, always add a small volume of the concentrated acid to a large volume of water, never the reverse.**

Use a large container for diluting concentrated acid, preferably cooled with ice or cold water on the outside. Use a measuring cylinder to measure the volume of concentrated acid required for dilution. Put cold water in the large container and slowly add the required volume of concentrated acid from the measuring cylinder to the cold water with constant stirring. If the mixture becomes hot, stop and allow to cool, before proceeding.

Rinse the measuring cylinder used for the concentrated acid with water. Use the washing and add more water to make up to the required volume.

Stir the mixture thoroughly.

- **Acetic acid (Ethanoic acid), CH_3COOH (1 M)**
  Dilute 58 cm^3 of glacial ethanoic in distilled water and make up to 1 dm^3.

- **Ethanedioic acid (Oxalic acid), (0.5 M)**
  (i) Dissolve 45 g of anhydrous oxalic acid, $H_2C_2O_4$ in 1 dm^3 of solution.
  (ii) Dissolve 63 g of hydrated oxalic acid, $H_2C_2O_4.2H_2O$ in 1dm^3 of solution.

- **Hydrochloric acid, HCl**
  Concentrated hydrochloric acid has a density of 11.9 g cm^{-3} and contains 36.0 % (w/w) or 425 g dm^3. It is 11.6M.

  (i) Hydrochloric acid (2M)
  Add 180 cm^3 of concentrated acid to about 750 cm^3 of water with constant stirring. Make up to 1 dm^3 with distilled water.
  (ii) Hydrochloric acid (0.1M)
  Dilute 9.0 cm^3 of concentrated acid to 1 dm^3 of solution with distilled water.

- **Nitric acid, HNO_3**
  Concentrated nitric acid has a density of 1.42 g dm^{-3}. It contains 69.5% (w/w) or 990 g HNO_3 per dm^3 (15.7M). It should be handled with great care as it is corrosive and oxidising.

  (i) Nitric acid (2M)
  Add 128 cm^3 of concentrated nitric acid to about 750 cm^3 of water with constant stirring. Make up to 1dm^3 with distilled water.

  (ii) Nitric acid (0.1M)
  Dilute 6.4 cm^3 of concentrated nitric acid to 1 dm^3 of solution with distilled water.

- **Sulphuric acid, H_2SO_4**
  Sulphuric acid is a very strong acid. It is dibasic and has a density of 1.76 g cm^{-3}.

  (i) Sulphuric acid (1M)
  Add 56 cm^3 of concentrated sulphuric acid to about 750 cm^3 of water with constant stirring. Make up to 1 dm^3 with distilled water.

  (ii) Sulphuric acid (0.1 M)
  Dilute 5.6 cm^3 of concentrated sulphuric acid to 1 dm^3 of solution with distilled water.

(b) Alkalis

Alkalis, especially sodium hydroxide and potassium hydroxide are corrosive. Contact with the skin causes burns. They should not be handled with bare hands.

The solids are deliquescent, that is they absorb water vapour from the atmosphere.

For accuracy, weighing should be carried out in a container that can be tightly closed afterwards.

When an alkali is dissolved in water a large amount of heat is generated.

Weigh the right amount of solid alkali in a sealed container. Dissolved the solid little by little in water, if solution becomes too hot, stop and allow to cool before proceeding. Rinse the weighing container with water and make up to the total volume.

Concentrated ammonia solution produces a very poisonous and pungent smelling gas. Open the bottle in a fume cupboard. It is advisable to cool the bottle before opening.

- **Ammonia, NH_3 (2M)**
  Add between 133.4 to 140 cm^3 of concentrated ammonia in about 750 cm^3 of water and make up to 1 dm^3 with distilled water.

- **Limewater (calcium hydroxide), $Ca(OH)_2$**
  Add 5 g of calcium hydroxide in 1 dm^3 of water. Shake and allow to stand overnight. Filter and use the clear filtrate as limewater. More water can be added to the lime and allow to stand. This can be kept as stock solution.

- **Potassium hydroxide, KOH (2M)**
  Add 112 g of solid potassium hydroxide a little at a time, to a plastic container containing about 200 cm^3 of water. Stir to dissolve and make up to 1 dm^3 with distilled water.

- **Sodium hydroxide, NaOH (2M)**
  Add 80 g of solid sodium hydroxide a little at a time, to a plastic container containing about 200 cm^3 of water. Stir to dissolve and make up to 1 dm^3 with distilled water.

(c) Indicators

Indicators are substances that have different colours in acidic and alkaline conditions.

Table 1: List of commonly used indicators

Indicator	Colour in acidic solution	Colour in alkaline solution
Bromothymol Blue	Yellow	Blue
Litmus solution	Red / Pink	Blue
Methyl Orange	Red / Pink	Yellow
Phenolphthalein	Colourless	Red / Pink
Screened Methyl Orange	Magenta (Red/Pink)	Green

Universal indicator is used to measure the pH of a solution. It gives different colours at different pH numbers.

- **Bromothymol Blue**
  Dissolve 400 mg in 1 dm^3 of ethanol.

- **Litmus Solution**
  Boil 5 g of litmus powder in 250 cm^3 of water. Allow to stand, then filter. Add little amount of dilute of nitric acid to the filtrate until the colour is just purple.

- **Methyl Orange**
  Dissolve 2 g in 1 dm^3 of distilled water.

- **Phenolphthalein**
  Dissolve 5 g in 500 cm^3 of ethanol and dilute to 1 dm^3 with distilled water.

- **Screened Methyl Orange**
  Dissolve 1 g of methyl Orange and 1.4 g of xylene cyanol in 500 cm^3 of ethanol and dilute to 1 dm^3 with distilled water.

- **Starch Solution (40% w/v)**
  Mix 10 g of starch into a paste in a small quantity of cold water. Pour the paste in 250 cm^3 of boiling water and stir properly.

(d) Bench Solutions

Always use distilled water for preparing bench solutions.

Use a volumetric flask to make up when preparing standard solutions.

- **Ammonium ethanedioate (Ammonium oxalate), $(NH_4)_2C_2O_4.H_2O$ (0.5M)**
  Dissolve 72 g of ammonium oxalate in 1 dm^3 of distilled of water.

- **Barium Chloride, $BaCl_2.2H_2O$ (0.25M)**
  Dissolve 61 g of barium chloride in 1 dm^3 of distilled water.

- **Barium nitrate, $Ba(NO_3)_2$ (0.25M)**
  Dissolve 65.25 g of barium nitrate in 1 dm^3 of distilled water.

- **Bromine water, Br2 (aq).**
  Dilute 25 cm^3 of bromine to 500 cm^3 with distilled water.

- **Copper (II) sulphate, $CuSO_4.5H_2O$ (0.5 M)**
  Dissolve 125 g of copper(II) sulphate in water containing 10 cm^3 of dilute sulphuric acid and make up to 1 dm^3 with distilled water.

- **Fehling's solution A.**
  Dissolve 17.3 g of copper(II) sulphate in 250 cm^3 of distilled water and add little concentrated sulphuric acid.

- **Fehling's solution B**.
  Dissolve 38.5 g of sodium hydroxide and 88 g of potassium tartrate in 250 cm^3 of distilled water.

- **Ferrous Ammonium Sulphate (Ammonium Iron(II) Sulphate) $FeSO_4.(NH_4)_2SO_4.6H_2O$ (0.1M)**
  Dissolve 39.2 g of Ferrous Ammonium Sulphate in 1 dm^3 of distilled water.

- **Hydrogen Peroxide, H_2O_2**
  Concentrated hydrogen peroxide (100%) 8.8M is dangerous and highly oxidising. Handle with great care.

  (i) Hydrogen Peroxide, H_2O_2 (10%)
  Dilute 100 cm^3 to 1 dm^3 with distilled water.

  (ii) Hydrogen Peroxide (1.0M)
  Dilute 114 cm^3 of hydrogen peroxide (100% volume) to 1 dm^3 with distilled water.

***Note**: If the original solution has been kept for a long time, its concentration will change. Make necessary adjustments with the teacher's help. Be aware that peroxide crystals may form and deposit at the base of the bottle – these may form explosive mixtures. In case you see crystals in an old bottle, the teacher should be consulted before you attempt to open the bottle.*

- **Iodine (0.05 M)**
  Dissolve 12.7 g of iodine and 25 g of potassium iodide in water and make up to 1 dm^3 with distilled water. Use only glass weighing bottle and spatula to handle iodine.

- **Iron (II) sulphate, $FeSO_4.7H_2O$ (0.1M)**
  Dissolve 27.8 g of iron (II) sulphate in water containing 50 cm^3 of 1M sulphuric acid and make up to 1 dm^3 with distilled water.

- **Iron (III) chloride, $FeCl_3.6H_2O$ (0.5M)**
  Dissolve 135 g of iron (III) chloride in distilled water containing 20 cm^3 of concentrated sulphuric acid and make up to 1 dm^3 with distilled water.

- **Lead (II) ethanoate (lead acetate), $(CH_3COO)_2Pb.3H_2O$ (0.25M)**
  Dissolve 95 g of lead(II) ethanoate in 500 cm^3 of water containing 10 cm^3 of glacial ethanoic acid and make up to 1 dm^3 with distilled water.

- **Lead (II) Nitrate, $Pb(NO_3)_2$ (0.25M)**
  Dissolve 83 g of lead (II) nitrate in 1 dm^3 of distilled water.

- **Potassium Chromate (VI), K_2CrO_4 (0.25M)**
  Dissolve 48.5 g of potassium chromate (VI) in 1 dm^3 of distilled water.

- **Potassium Dichromate (VI), $K_2Cr_2O_7$ (0.1M)**
  Dissolve 29.4 g of potassium dichromate (VI) in 1 dm^3 of distilled water.

- **Potassium Iodate(V), KIO_3 (0.1M)**
  Dissolve 21.4 g of potassium iodate in 500 cm^3 of hot water and make up to 1 dm^3 with distilled water.

- **Potassium Iodide, KI (10%)**
  Dissolve 100 g of potassium iodide in 1 dm^3 of distilled water.

- **Potassium Manganate (VII), $KMnO_4$ (0.02M)**
  Dissolve 3.16 g of potassium manganate (VII) in a little hot water and make up to 1 dm^3 with distilled water.

- **Potassium Thiocyanate, KSCN (0.1M)**
  Dissolve 9.7 g of potassium thiocyanate in 1 dm^3 of distilled water.

- **Silver Nitrate, $AgNO_3$ (0.1M)**
  Dissolve 17 g of silver nitrate in 1 dm^3 of distilled water. Keep in dark bottles and away from direct intense sources of light.

- **Sodium Carbonate (0.5M)**

  (i) Anhydrous sodium carbonate Na_2CO_3
  Dissolve 53 g of anhydrous sodium carbonate in 1 dm^3 of distilled water.

  (ii) Hydrated sodium carbonate $Na_2CO_3.10H_2O$
  Dissolve 107 g of hydrated sodium carbonate in 1 dm^3 of distilled water.

- **Sodium Thiosulphate, $Na_2S_2O_3.5H_2O$ (0.1M)**
  Dissolve 24.8 g of sodium thiosulphate in 1 dm^3 of distilled water.

Table 2: Preparation of Dilute Acids

ACID	Concentration in Mol dm^{-3}	Volume of concentrated acid for 1 dm^3 of solution
Ethanoic acid (Acetic acid)	1	58 cm^3 of glacial acetic acid
Ethanedioic acid (Oxalic acid)	0.5 M	45g of anhydrous $H_2C_2O_4$ or 63g of hydrated oxalic acid $H_2C_2O_4.2H_2O$
Hydrochloric acid, HCl	2M 0.1 M	180 cm^3 9.0 cm^3
Nitric acid, HNO_3	2M 0.1M	128 cm^3 6.4 cm^3
Sulphuric acid H_2SO_4	1.0 M 0.1 M	56 cm^3 5.6 cm^3

NOTE: The volumes indicated for preparing dilute acids are for guidance only. This is because the exact density of the original concentrated acid may vary slightly from batch to batch, and you will need to take this into consideration when making your calculations.

Table 3: Preparation of Alkalis

ALKALI	Concentration in mol dm^{-3}	Volume or mass to be used for 1 dm^3 of solution
Ammonia, NH_3	2 M	133.4 cm^3
Lime water (Calcium hydroxide)	saturated	5g
Potassium hydroxide	2 M	112g

Table 4: Preparation of Bench Solutions

	REAGENT SOLUTION	**Concentration in mol dm^{-3}**	**Volume or mass to be used for 1 dm^3 of solution**
1	Ammonium ethanedioate (Ammonium oxalate),$(NH_4)_2C_2O_4.H_2O$	0.5 M	72g
2	Ammonium Perodisulphate,$(NH_4)_2S_2O_8$	0.1M	22.8g
3	Barium Chloride, $BaCl_2.2H_2O$	0.25M	61g
4	Barium Nitrate,$Ba(NO_3)_2$	0.25M	65.25g
5	Bromine water, $Br_2(aq)$		50 cm^3
6	Copper(II) Sulphate, $CuSO_4.5H_2O$	0.5M	125g +10cm^3 of dilute sulphuric acid
7	Fehling's solution A		69.2g $CuSO_4.5H_2O$
8	Fehling's solution B		154g of sodium hydroxide +352g of potassium tartrate
9	Hydrogen peroxide, H_2O_2	(i)10% (ii) 1.0M	100cm^3 of 100 volume 114 cm^3 of 100 volume
10	Iodine, I_2	0.05 M	12.7g of iodine + 25g of potassium iodide
11	Iron (II) sulphate,$FeSO_4.7H_2O$	0.1M	27.8g + 50 cm^3 of dilute sulphuric acid
12	Iron(III) chloride,$FeCl_3.6H_2O$	0.5M	135g
13	Lead (II) ethanoate (lead acetate), $(CH_3COO)_2Pb.3H_2O$	0.25M	95g + 10cm^3 of glacial acetic acid
14	Lead (II) nitrate,$Pb(NO_3)_2$	0.25M	83g
15	Potassium chromate,K_2CrO_4(VI)	0.25M	48.5g
16	Potassium dichromate(VI) $K_2Cr_2O_7$	0.1M	29.4g
17	Potassium iodate,KIO_3	0.1M	21.4g
18	Potassium iodide	10%	100g

Table 4: Preparation of Bench Solutions

19	Potassium ferricyanide, $K_3[Fe(CN)_6].3H_2O$	0.25M	105.5
20	Potassium manganate(VII), $KMnO_4$	0.02M	3.16g
21	Potassium peroxodisulphate,$K_2S_2O_8$	0.1M	27g
22	Potassium thiocyanate, KSCN	0.1M	9.7g
23	Silver nitrate, $AgNO_3$	0.1M	17g
24	Sodium carbonate,Na_2CO_3	0.5M	53g Anhydrous Na_2CO_3
25	Tin(II) Chloride $SnCl_2.2H_2O$	0.25M	56g in 100 cm^3 of conc HCl

(e) Preparation of Salt Solutions for Analysis:

(IDENTIFICATION OF CATIONS AND ANIONS)

To prepare aqueous solutions for salt analysis, read the Relative Molecular Mass (M_r) of the salt on the label of the container.

Prepare a salt solution of concentration 0.25 mole or 0.5 mole per dm^3.

Use the table below to calculate the mass of salt required to prepare salt solutions for analysis.

Table 5: Preparation of Salt Solutions for Analysis

Volume of salt solution in cm^3	Mass of salt in grams	
	0.25 M	**0.5 M**
1000 cm^3	M_r x 0.25	M_r x 0.5
750 cm^3	M_r x 0.25 x ¾	M_r x 0.5 x ¾
500 cm^3	M_r x 0.25 x ½	M_r x 0.5 x ½
250 cm^3	M_r x 0.25 x ¼	M_r x 0.5 x ¼
200 cm^3	M_r x 0.25 x 1/5	M_r x 0.5 x 1/5
125 cm^3	M_r x 0.25 x 1/8	M_r x 0.5 x 1/8
100 cm^3	M_r x 0.25 x 1/10	M_r x 0.5 x 1/10
50 cm^3	M_r x 0.25 x 1/20	M_r x 0.5 x 1/20

4.2 PHYSICS

BASIC LABORATORY TECHNIQUES AND SKILLS

The contribution of the laboratory attendant in the preparation of science practical lessons and demonstrations is a very important factor in the teaching-learning process. This unit is designed to equip laboratory attendants with certain basic laboratory skills needed to perform their tasks and duties, and to give assistance to the science teacher for effective learning to take place.

The laboratory attendant should be able to:

- use instruments correctly to make accurate measurement of physical quantities,
- assemble apparatus for demonstrations and practicals,
- follow the correct procedures for handling materials and equipment, and
- keep apparatus used for demonstrations and practicals in working order.

4.2.1 MEASUREMENT OF PHYSICAL QUANTITIES USING LABORATORY INSTRUMENTS

MEASUREMENT OF LENGTH

Commonly used instruments of length:

Length to be measured	**Suitable Instruments**
several metres	measuring tape
several centimetres	metre rule or half-metre rule
1 cm - 10 cm	vernier calipers
less than 2 cm	micrometer screw gauge

The metre rule

The simplest length-measuring instrument to be found in the laboratory is a metre (or half-metre) rule. It has the great advantage of being cheap, convenient and simple to use. But you should be aware of three possible sources of error.

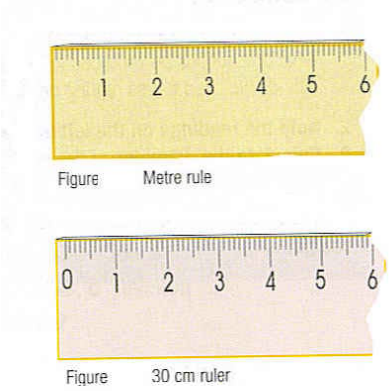

Figure 13: Graduations on a metre rule

End or zero error

As a result of wear and tear, the zero mark at the end of most wooden rules can no longer be seen. For this reason, it is a bad practice to place the zero end of the rule against one end of the object to be measured and to take the reading at the other end (most 30 cm rulers have end errors, i.e. the zero mark starts at a distance from the end of the ruler). It is more appropriate

- to measure from another mark, e.g., at 1 cm mark,
- then subtract 1 cm at the other end.

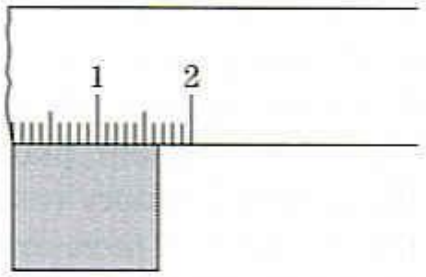

Figure 14: Zero error with a metre rule

The calibration

The calibration of the metre rule may give rise to another source of error because the markings are incorrect. The calibration may be checked by laying the rule alongside a more accurate rule (e.g., an engineer's steel rule) and note any discrepancy.

Parallax error

If the object to be measured is not on the same level as the graduated surface of the rule, the angle at which the scale is viewed will affect the result as illustrated below.

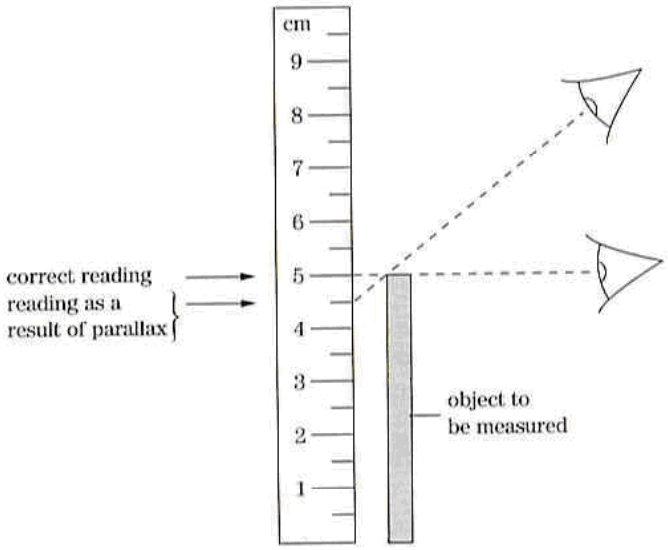

Figure 15: Measurement with and without parallax error

A rather sophisticated way of eliminating parallax error is to place a mirror alongside the scale on the metre rule. When the needle and scale are viewed directly, the needle and its image in the mirror coincide. This ensures that the scale reading is always at the same viewing angle.

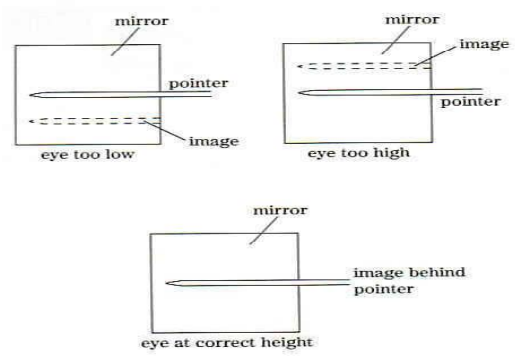

Figure 16 (i): Use of a plane mirror

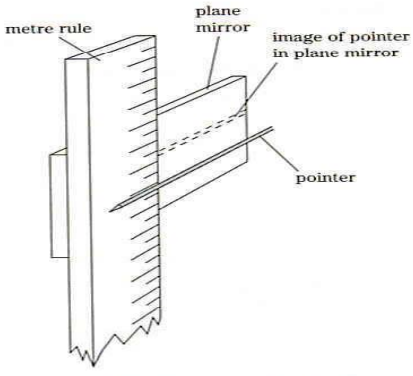

Figure 16 (ii): Using a plane mirror with a metre rule

A simple way of eliminating parallax error is to place the eye in a position which is directly opposite the mark and always perpendicular to the scale.

The vernier calipers

The vernier caliper is a versatile instrument for measuring the dimensions of an object, the internal and external diameters of a test tube, the diameter of a hole, or the depth of a hole.

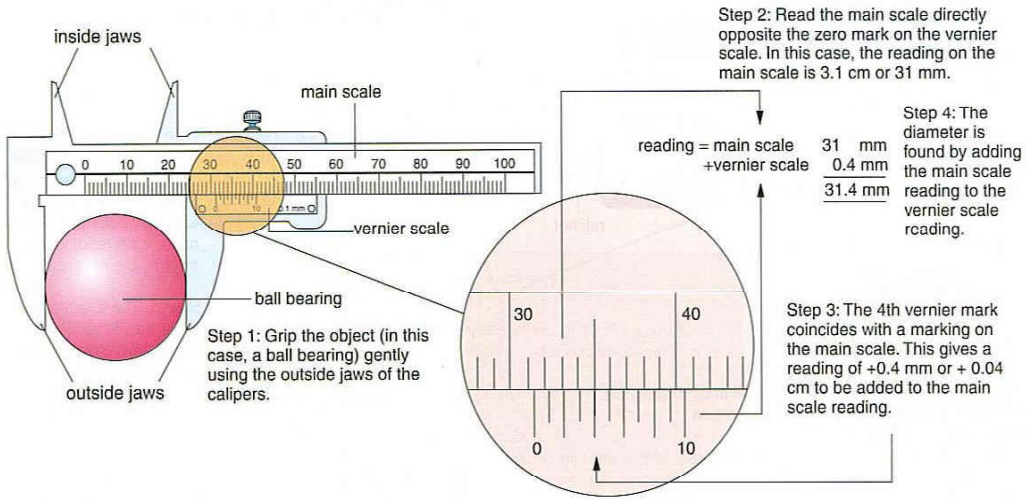

Figure 17: Using the vernier calipers

The reading is taken as follows:

- Place the object (ball bearing) securely between the jaws of the calipers.
- Read the main scale mark (3.1 cm in this example) directly opposite the zero mark on the vernier scale.
- Now look for the vernier mark (4 in this example) on the vernier scale that coincides with a mark on the main scale. This number is the reading for the hundredths of a cm, i.e. 0.04 cm.
- The final reading is found by adding this vernier reading to the main scale reading obtained.

Final reading = (3.1 + 0.04) cm

= 3.14 cm

The second set of jaws (the inside jaws) has the straight parts on the outside. These can be used to measure the internal diameter of a test-tube or the diameter of a hole. The jaws are placed inside the test-tube/hole and are moved apart until they are in contact with the sides of the test-tube/hole. The readings are then taken.

A pin/tail at the end of the sliding part of the caliper can be used to measure the depth of a hole (e.g., a hole that has been drilled in but not right through, a wooden board). The end of the main scale is placed on the board, across the hole, and the pin moved into the hole until it reaches the bottom. The readings are then taken to get the depth of the hole.

The micrometer screw gauge

This instrument is used to measure length to an accuracy of 0.001 cm or 0.01 mm and is very useful for measuring diameters of wires.

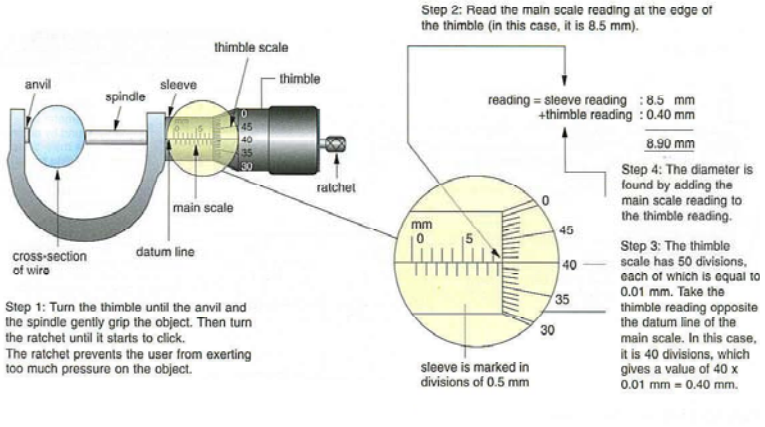

Figure 18: Using a micrometer screw gauge

The reading is taken as follows:

- Grip the object, e.g., a copper wire, between the thimble and the anvil.
- Turn the ratchet until a click sound is heard. Do not go on turning after the click sound is heard as over tightening will cause undue pressure on the object.
- Take the reading (8.5 mm, in this case) on the main scale at the edge of the thimble.
- Take the reading (40 divisions giving a value of 0.40 mm) on the thimble scale that coincides with the datum line of the main scale.
- Obtain the final reading by adding the main scale reading to the sleeve reading.

  Final reading = (8.5 + 0.40) mm = 8.90 mm

Additional requirement when measuring the diameter of a wire

- Check the micrometer for any zero error and make necessary adjustment.
- Measure the diameter at several positions along the length of the wire (to allow for tapering, i.e. the diameter is not uniform along the whole length of the wire).
- Measurements along the length of the wire should be taken spirally (to check for circular cross section), see figure below.

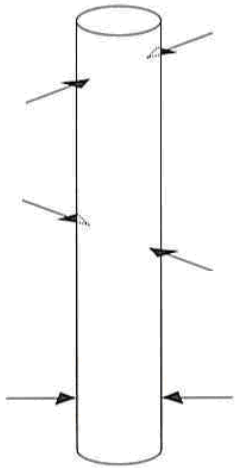

Figure 19: Measuring the diameter of a wire

Precautions to be taken when using the micrometer before any measurement:

- Clean the ends of the anvil and the spindle as any dirt on either of these leads to inaccurate reading.
- Always check for zero error. Before placing any object between the anvil and the spindle, turn the thimble until the anvil and the spindle meet. The zero on the thimble scale should lie opposite the datum line of the main scale. If not, then there is a zero error and adjustment should be made (as shown below).

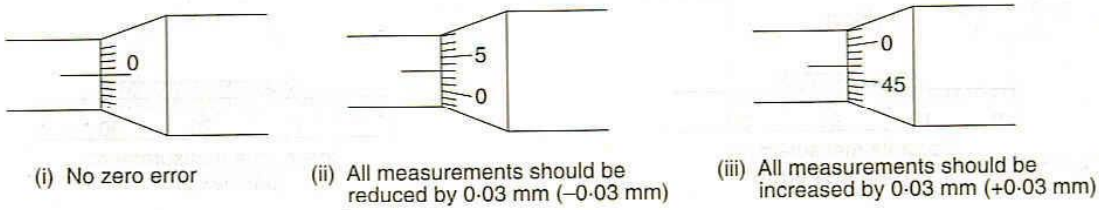

Figure 20: Zero error in micrometer

Measuring volume of a liquid

The volume of a liquid can be measured with a beaker, a pipette, a burette or a measuring (graduated) cylinder.

- Read the capacity of each to use the appropriate instrument according to the volume that needs to be measured.
- Measuring cylinders and beakers should be placed on flat horizontal surface (level table).
- Avoid parallax error when reading the volume of the liquid. Position your eye at the same horizontal level as the lower meniscus of the liquid (see diagram below).

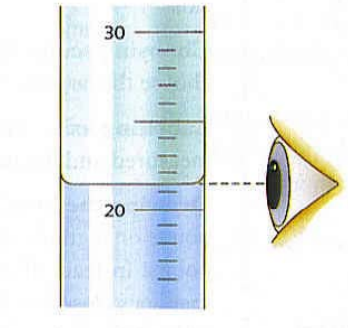

Figure 21: Reading the volume of a liquid

Measuring mass

Mass is usually measured with a lever balance (horizontal or circular) or an electronic balance.

Lever balance

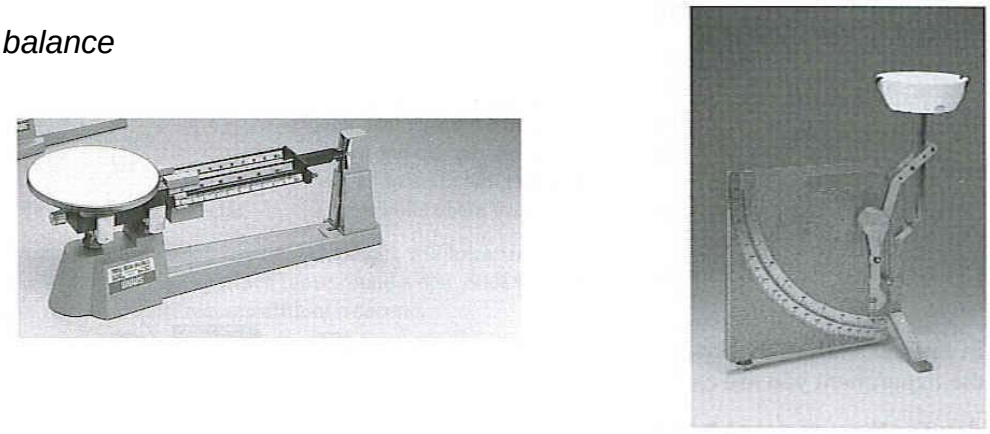

Figure 22: Horizontal and circular models of a level balance

- Place the object of unknown mass on the pan.
- Obtain the mass by moving the slider on the beam until the beam is balanced or level.
- Make sure objects are dry before placing on the scale pan.
- Do not place chemicals or granular solids directly on the pan. Always put these in a container, e.g., a watch glass placed on the pan.
- Always place the balance on a smooth horizontal surface and check for zero error before taking a reading.

Electronic balance

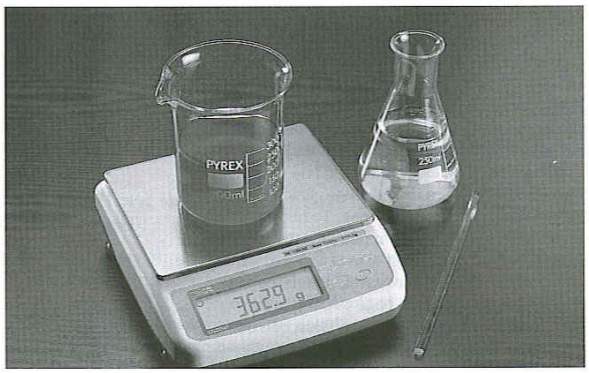

Figure 23: Electronic balance

This is a more accurate and sensitive balance.

- Connect to the mains supply and switch on the balance.
- Make sure the screen displays ‘0 g’ before putting any object on the pan.
- The object of unknown mass is placed gently on the top of the pan.
- Read the mass directly from the screen. The value is displayed on the screen.

Precautions when using electronic balance:

- Do not place wet objects on the pan.
- Make sure there is no dust on the pan before weighing.
- Press buttons gently as the instrument is very sensitive.
- Always place the balance on a smooth horizontal level.
- Avoid any unnecessary vibrations (e.g., while leaning against the bench) near the balance.
- Use balance in a draught-free environment.
- Do not use balance beyond its maximum capacity.

Measuring weight

Figure 24: Measuring weight

Weight is measured using a spring balance (e.g., Newton meter/force meter).

- Always check for zero error. The pointer must be at the zero mark when no object is suspended to the hook of the balance.
- Make sure the spring has not been deformed permanently. The pointer must return to the zero mark when stretched and released.
- Use spring balance of suitable range for any measurement.

Measuring time

Instruments commonly used in the laboratory to measure time are: stopwatch, stop clock and the millisecond timer.

Figure 25: Analogue stopwatch

Stopwatches can be of analogue or of digital type.

- Always check for zero error in the analogue stopwatch. The pointer must be at the zero mark before switching on.
- Check whether analogue stopwatch is working properly by standardizing with an accurate one.

Where timings have to be made manually, it has to be accepted that there will be a delay between the experimenter observing an event and starting a stopwatch. This delay is known as reaction time. The effects of reaction time may be reduced by making the time interval between starting and stopping the watch as large as possible (e.g., count sufficient oscillations in a simple pendulum experiment so that the time is greater than about twenty seconds), repeat the timings and calculate the average.

In some experiment (e.g., determination of 'g' using a free-fall apparatus), electronic switching for timing is essential in order to reduce the potentially very large error caused by the reaction time of the experimenter. Here timing to one-thousandth of a second is essential (using a millisecond timer).

Other small intervals of time can also be measured using a Cathode Ray Oscilloscope (CRO) with a calibrated timebase. Measurements from the screen of the CRO can be used to give values of time intervals.

For example, if the trace below is obtained on the screen of a CRO with a timebase setting of 10ms/cm (10 millisecond per centimetre), then time period of input signal to CRO = (2cm x 10ms/cm) = 20ms = 0.020s.

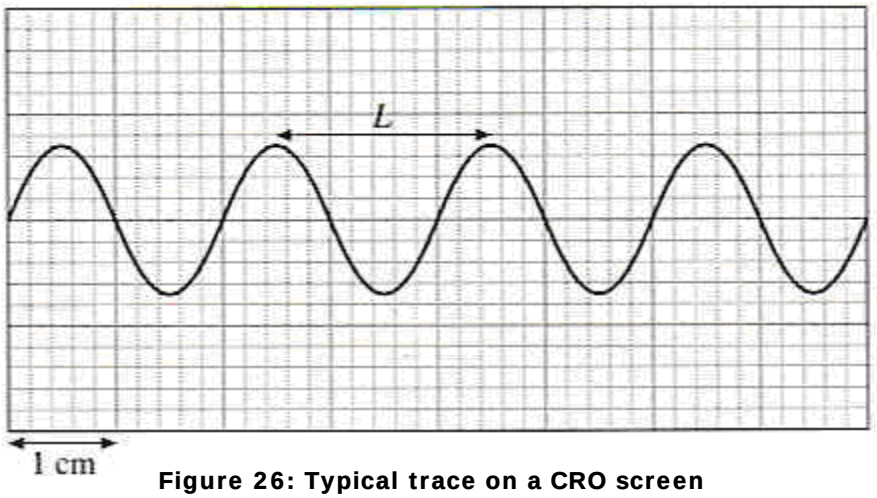

Figure 26: Typical trace on a CRO screen

Measuring temperature

The most common instrument used in the laboratory is the mercury-in-glass thermometer with a Celsius scale (ºC). It has a range of -10^0 C to 110^0C.

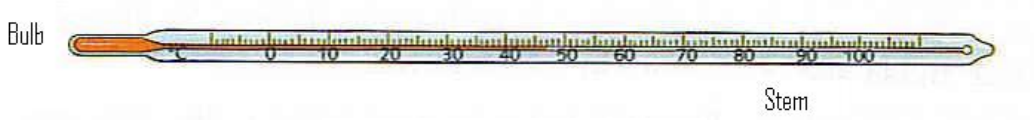

Figure 27: Thermometer

- Read the scale to know the sensitivity of the thermometer (the number of degrees represented by one division on the scale). If 100 divisions represent 100ºC, then 1 division represents 1ºC. If there are 200 divisions between the 0ºC mark and the 100ºC mark, then 1 division represents 0.5ºC or 2 divisions represent 1ºC.

Precautions while using a thermometer

- Avoid using a thermometer as a stirrer.
- Be careful when you handle thermometers. Never hold a thermometer by its bulb. Always hold it by the stem.
- When measuring the temperature of liquid in a beaker which is being heated, the liquid must be thoroughly stirred before taking the reading.
- The thermometer is calibrated for use at a standard depth of immersion; this may be stated on the stem (which is usually one-third the length of the thermometer). Do not immerse the thermometer deeper than the stated value.
- Before inserting a thermometer through a rubber bung:
  - make sure the hole of the bung is of appropriate size,
  - lubricate the hole thoroughly with detergent,
  - wear gloves and grip the thermometer (if it breaks you will not be cut).

4.2.2 ELECTRICAL CIRCUITS

SYMBOLS IN CIRCUIT DIAGRAMS

In electrical experiments, the set up of the apparatus is shown in circuit diagrams. To prepare the apparatus for electrical experiments you should identify all the components used. The diagram below shows the symbols for the most commonly used electrical devices.

Symbol	Device	Symbol	Device	Symbol	Device
	switch	or	lamp	or	galvanometer
	cell		fixed resistor	A	ammeter
	battery	or	variable resistor (or rheostat)	V	voltmeter
	power supply	or	fuse		2-way switch
	wires joined		coil of wire		earth connector
	wires crossed		transformer		capacitor

Figure 28: Symbols of commonly used electrical devices

Measuring current and potential difference (voltage)

Physics laboratories have a selection of instruments for measuring current and voltage. The two main types are analogue meters (in which a pointer moves over a scale) and digital meters (in which the value is displayed on a screen). Analogue meters can be of single or dual range type.

Current is measured with an ammeter. Potential difference is measured with a voltmeter. In an analogue ammeter/voltmeter, the pointer must be on the 0 mark on the scale when not in use. If not, the zero error can be corrected by turning the screw found on the face of the ammeter/ voltmeter with a screw driver.

- Identify the a.c (alternating current) and the d.c (direct current) terminals, the positive (red) terminal and the negative (black) terminal.
- Always connect ammeters in series with other components in the circuit.
- Always connect voltmeters in parallel with the component of which the voltage is to be measured.
- Always connect positive of power supply (red terminal) to positive of meters (ammeters and voltmeters) – see diagram.

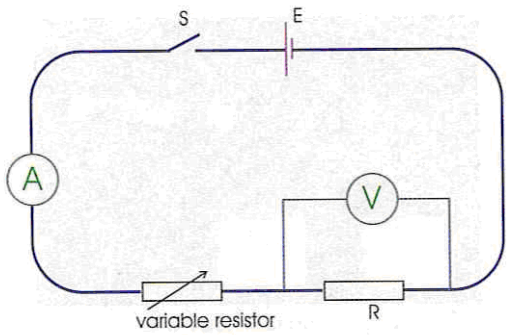

Figure 29: Electric circuit

Multimeters

Multimeters, or multifunction instruments, are available in both analogue and digital forms. Such meters may include switched options for the measurement of direct and alternating currents and voltages, and of resistance, with several ranges for each quantity being measured. If you use a multimeter, make sure that you are familiar with the controls, so that you can set the instrument to measure the quantity you require.

Figure 30: Digital multimeter

Measurement of voltage using a Cathode Ray Oscilloscope (CRO)

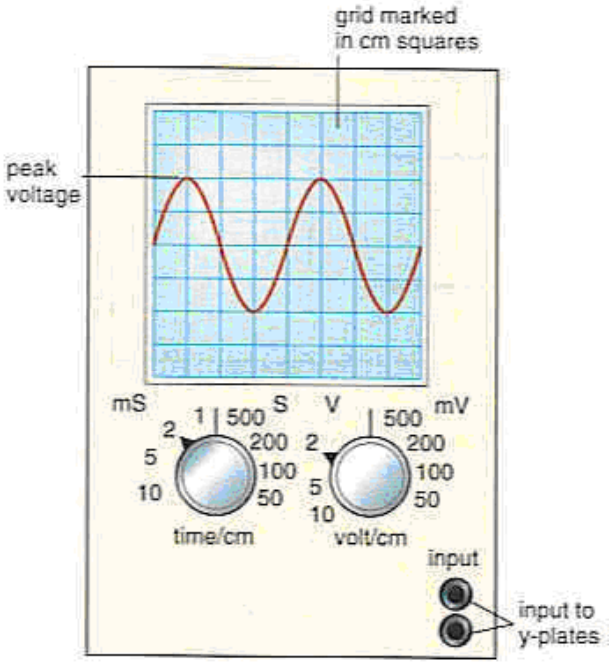

Figure 31: CRO signal

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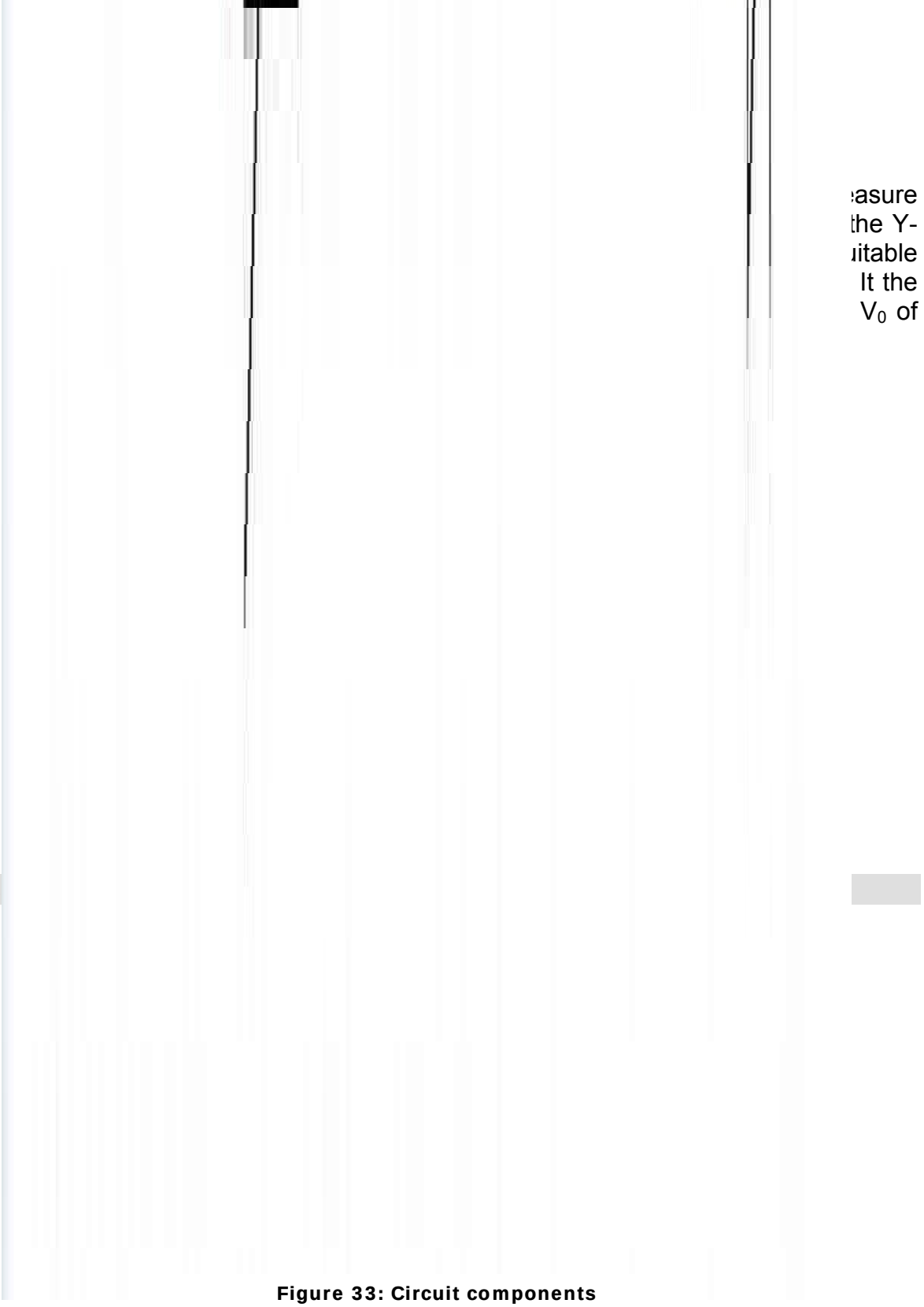


Figure 33: Circuit components

(1) Resistors

The resistor is a device used to control the amount of current flowing through the circuit.

A variable resistor is used to vary the resistance in a circuit.

Fixed standard resistors have their values written on them (see figure).

The value and tolerance of the resistor is given by the four coloured bands on the resistor. A resistor has resistance measured in ohms (Ω).

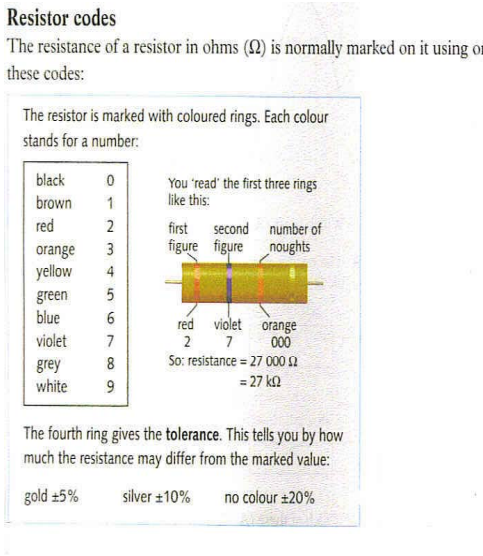


Figure 34: Colour coding of a resistor

A Variable Resistor

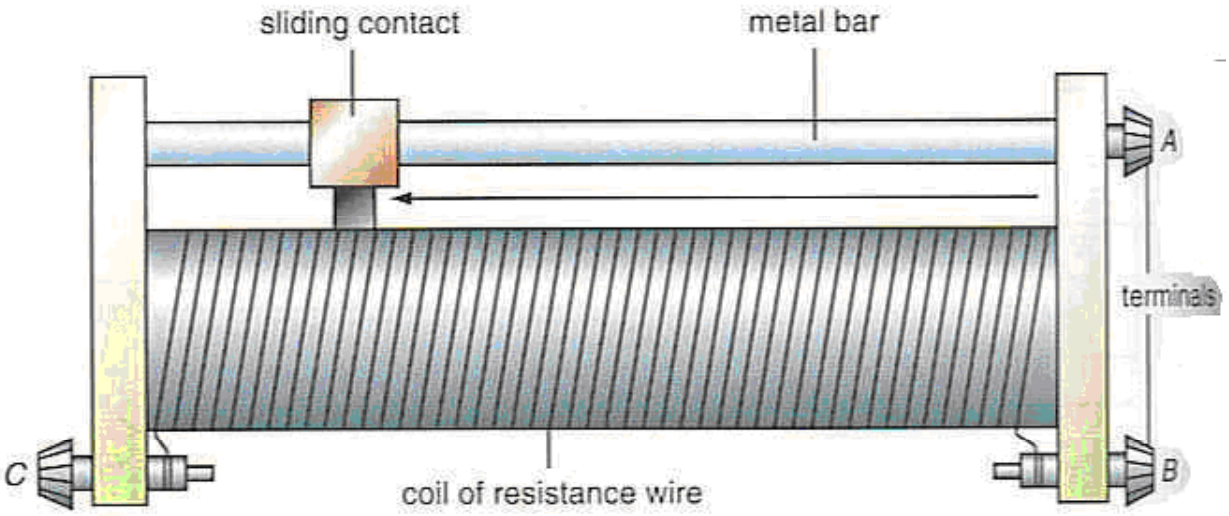
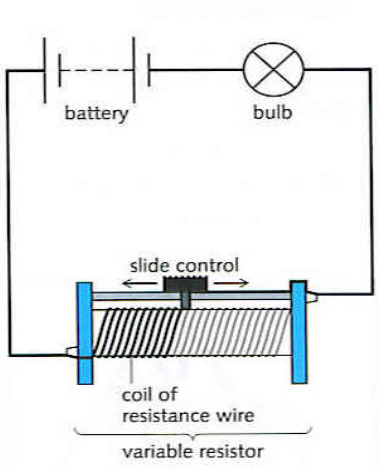


Figure 35: A variable resistor

A rheostat can be used as a variable resistor. It then varies the current in a circuit.

Rheostat as variable resistor



Moving the slide control of the variable resistor to the right increases the length of resistance wire in the circuit. This reduces the current and dims the bulb.

Figure 36: Rheostat used as a variable resistor

A rheostat can also be used as a potential divider. It then varies the voltage in a circuit.

Rheostat as potential divider

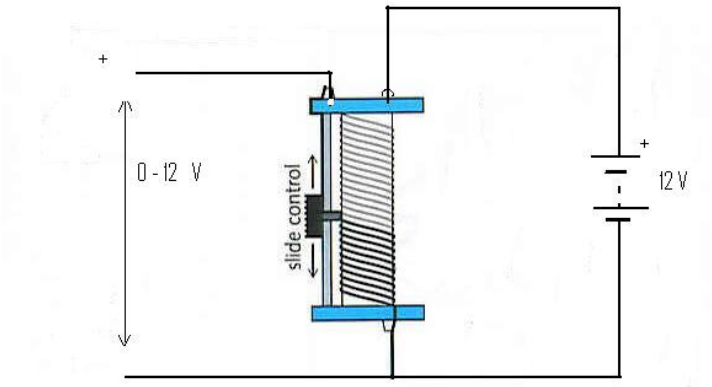


Figure 37: Rheostat used as a potential divider

Another important consideration when using resistors is the power rating. The power rating of a resistor is the maximum rate of dissipation of electrical energy as heat before the resistor get damaged.

(2) Thermistor

The thermistor is a device whose resistance is affected by temperature. The resistance of most thermistors decreases with increasing temperature. Thermistors are used in applications such as temperature control, temperature measurement and fire alarms.

(3) Light dependent resistor (LDR)

The LDR is a device whose resistance varies with the amount of light incident on it. The resistance decreases as the amount of light falling on the LDR increases. Under bright lighting, the LDR has very low resistance and in the dark it has a very high resistance.

(4) Capacitors

A capacitor is a device that can store electric charge. It consists of a pair of metal plates separated by air or an insulator (e.g., paper, mica or oil).

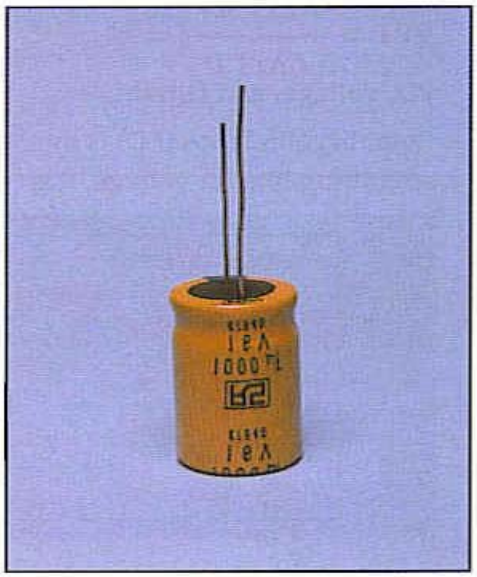


Figure 38: Capacitor

A capacitor has capacitance measured in farad (F). Microfarad (μF) and picofarad (pF) are common units of capacitors.

1 μF = 10^{-6} farad = 1 / 1000000 farad

1 pF = 10^{-12} F = 1 / 1000000000000 F

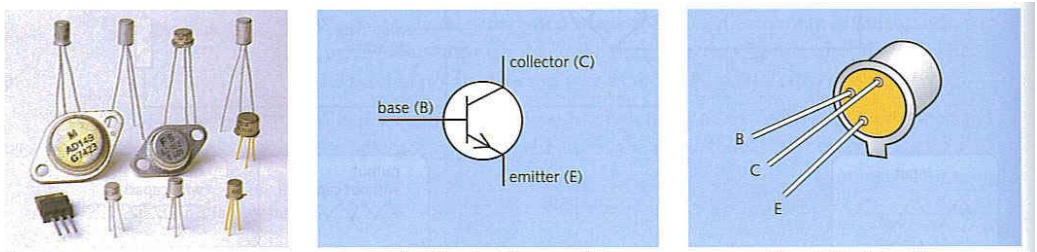
A capacitor and a resistor can be used together to form a time-delay circuit or a time-switch.

(5) Diodes

A diode is a device that allows current to flow in one direction only. A diode is also called a valve. A bridge rectifier consisting of four diodes is used to convert an alternating current into a direct current.

(6) Transistors

They are used for amplifying signals and for switching. Most are made from specially treated crystals of silicon.

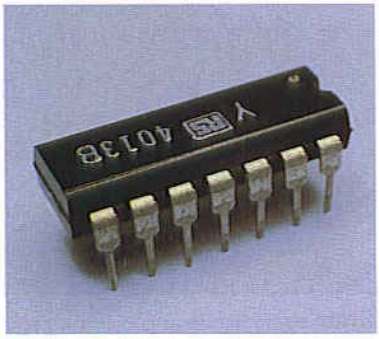


Transistors | npn junction transistor: symbol | Type BC108 transistor

Figure 39: Transistors

(7) Integrated circuits (ICs)

They are also known as 'microchips'. They contain many complete circuits with resistors, transistors, gates and connections all formed on a tiny chip of silicon only a few millimetres square.



▲ A logic IC package. Twelve of the 'pins' make connections to the gates on the chip. The other two are for the power supply.

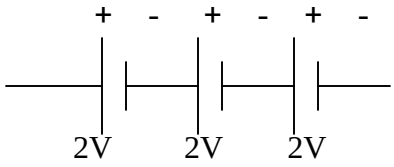
Figure 40: A logic IC package

(8) Series and parallel connections

Series connection

(a) Cells

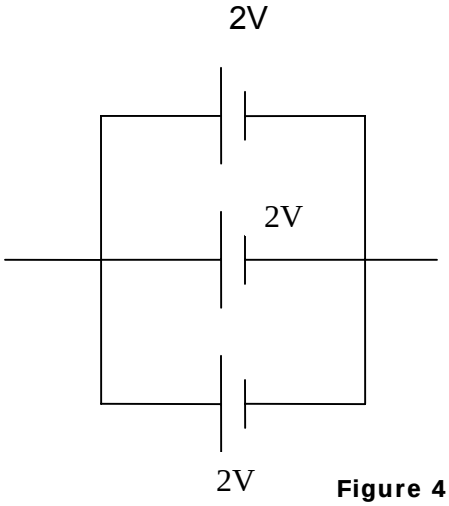
In series connection, the **positive** terminal (+) of one cell is connected to the **negative** terminal (-) of the other cell.



Series combination of 3 cells.
Combined voltage = (2+2+2) V
= 6V

Figure 41: Series Connection

In parallel connection, the **positive** terminal (+) of one cell is connected to the **positive** terminal (+) of the other cell. Then the negative terminal (-) is connected to the negative terminal (-) of the other cell.



Parallel combination of 3 cells.
Combined voltage = 2V

Figure 42: Parallel connection

(b) Resistors can be connected in series.
In series connection, same current passes through each resistor

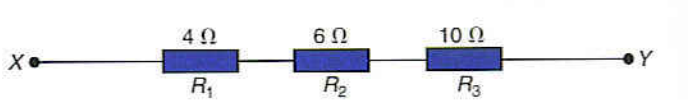


Figure 43: Resistors connected in series

The equivalent resistance $R_{equivalent} = R_1 + R_2 + R_3$

For example, if $R_1 = 4\ \Omega$, $R_2 = 6\ \Omega$, $R_3 = 10\ \Omega$, then the equivalent resistance of the 3 resistors = (4 + 6 + 10) = 20 Ω

In parallel connection, there is same potential difference (voltage) across each resistor.

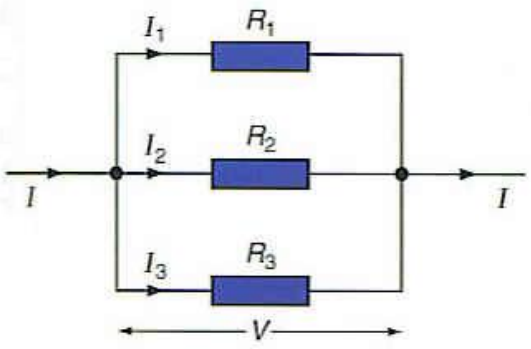


Figure 44: Resistors connected in parallel

The equivalent resistance, $R_{equivalent}$ is calculated as follows:

$$^1/_{Req} = {}^1/_{R1} + {}^1/_{R2} + {}^1/_{R3}$$

4.2.4 Simple Skills required by the Laboratory Attendant

Wiring a plug

A 3-pin plug has three wires: the LIVE wire (brown), the NEUTRAL wire (blue) and the EARTH wire (green with yellow stripes). Inside the plug, there are three terminals marked L for live, N for neutral and E for earth. It is important that the three wires are correctly connected to the appropriate terminals.

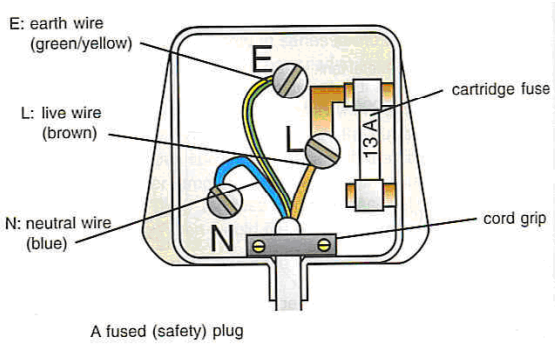


Figure 45: A fused safety plug

The following are the various steps to follow to wire a 3-pin plug:

- Open the plug with a screwdriver.
- Take out the fuse and keep aside to fit in the plug after wiring is complete.
- Using a cutter or wire stripper, carefully remove sufficient plastic insulator from each of the three wires. Each wire should be of the correct length to reach the respective pins. The insulation should extend right to the terminal.
- Be careful not to cut the wire strands (inner wires) or allow them to break off. If the strands are cut accidentally, cut off all strands and start again.

  The earth pin is longer than the live and the neutral pins. So this is the first wire to be connected and the last to be disconnected.
- Twist the wire strands (the bare ends) neatly into a clockwise loop so that there are no whiskers coming out.
- Fix the flex firmly with the cord grip. Care should be taken not to break the outer insulation from the wires when tightening the screws of the cord grip.
- Wrap the trimmed wires round the appropriate terminals and screw firmly so that each wire is secured to the terminal.
- Check that the wires are firmly gripped. If there are loose strands of wires, these can cause short circuit within the plug by touching other conducting parts inside.
- Replace the fuse back into position. Check that it is of the appropriate rating for the appliance.
- Check that the wires cannot be pulled out of the pins easily.
- Replace the plug top and screw to close the plug securely.

Lenses

Lenses commonly used in the laboratory are of the converging and the diverging types.

To find an approximate value of the focal length of a lens

- Place a screen a few cm behind the lens.
- Place the lens near the window and direct it towards a far away object to obtain a sharp image on the screen.
- Measure the distance between the lens and the screen. This distance is approximately equal to the focal length of the lens.

  Always keep the lens clear of dust.

In general, for the good running of a practical or demonstration session, the laboratory attendant must possess the following skills. He/she should:

- Be able to use measuring devices such as micrometer, screw gauge, vernier calipers, etc.
- Make sure that no damage is done to expensive equipment by keeping an eye on its manipulation or use by the students.
- Not give apparatus/equipment that could be used beyond limit, thus causing damage to the apparatus/equipment. For example, a simple spring must be supplied with loads sufficient to stretch it over a limited range or an electric meter with a limited power supply that do not go beyond the range of the meters during the experiment.
- Make sure that all the electric meters, power supply and magnets have clearly marked polarities on them.
- Be able to set up simple electrical circuits (series and parallel, connecting rheostat as a variable resistor and as a potential divider).
- Know how to charge an accumulator.
- Replace fuse in power packs, multimeters, 3 pin plugs with the correct fuse rating.
- Know how to use colour code for resistors/electric wires.
- Be able to identify circuit components such as capacitors, LDR, LED, thermistors, diode, etc.
- Use A.C./D.C. power supply.
- Use multimeters (digital and analogue).
- Check taps and tubing of gas supply and burners.
- Check drains waste pipe and water supply.
- Replace batteries in stop watches, digital meters, electronic balance, etc.
- Know how to use a soldering iron.
- Store magnets and compasses using keepers.
- Set up and adjust overhead projectors, slide projectors.
- Set up the ripple tank for wave demonstration.
- Switch on the CRO and set the time-base circuit and voltage gain at suitable setting so as to demonstrate sine wave/square wave patterns with a signal generator.
- Make correction for zero errors in electronic meters and micrometer screw gauge.

- Check the fire extinguisher and First Aid kit.
- Take care of all sensitive and electronic devices such as:
  - Electronic balance
  - Electronic millisecond timer
  - Digital meters
  - G.M. counter
  - CRO
  - Signal generator, and
  - Power packs

These devices must be switched on very often even when not required for practical or demonstration session.

Always seek advice of the physics teacher in case of doubt.

Setting up a ripple tank

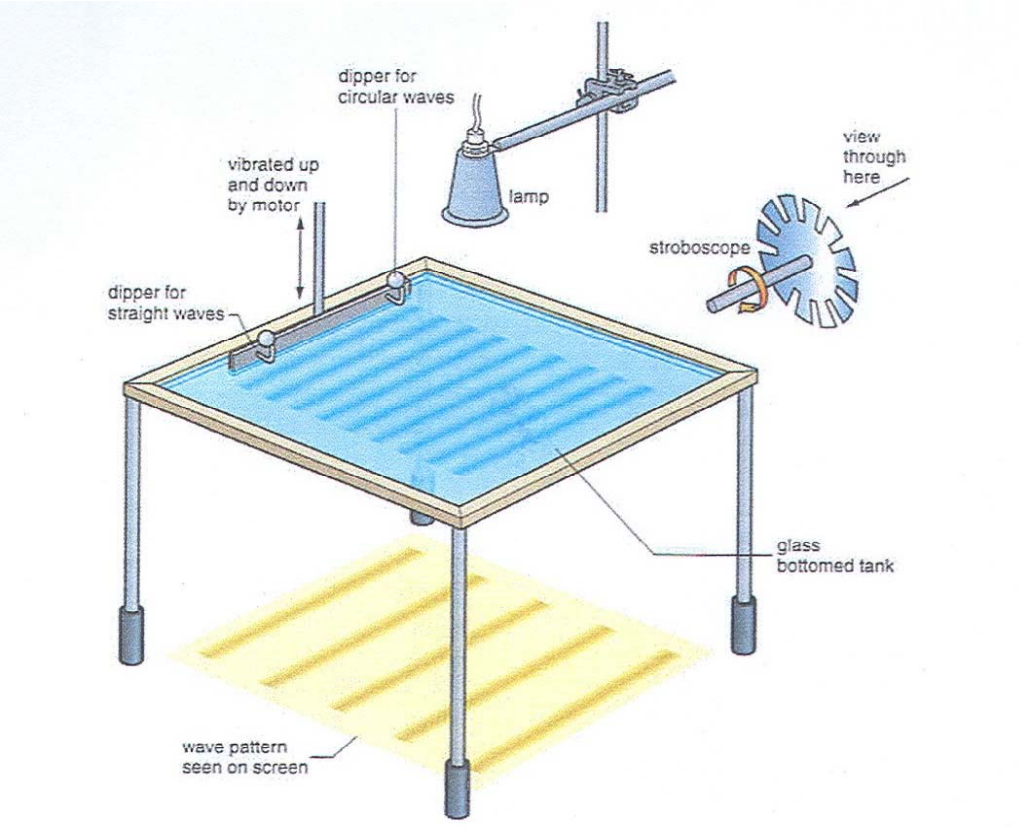


Figure 46: Setup of apparatus for a ripple tank experiment

- Place the ripple tank on level ground/floor.
- Put some water in the tank/tray.
- Lower the dipper (straight or circular) such that it just touches the surface of water. Note that elastic bands are used to hold the dipper in position.
- Place a white screen (e.g. Bristol paper) on the floor under the glass bottomed tank/tray.
- Adjust the position of the lamp just above the tank/tray of water.
- The small electric motor is connected to a d.c. supply via a rheostat. The latter can be used to change the current to the motor and thus to vary the frequency of vibration of the dipper.
- A stroboscope (spinning disc) can be used to 'freeze' the wave motion.

4.3 BIOLOGY

4.3.1 BIOTECHNIQUES

MICROSCOPES

Microscopes are very sensitive optical instruments. They are the most important assets of the biology laboratory. Laboratory attendants should be familiar with the components of a microscope and be able to check and adjust a microscope.

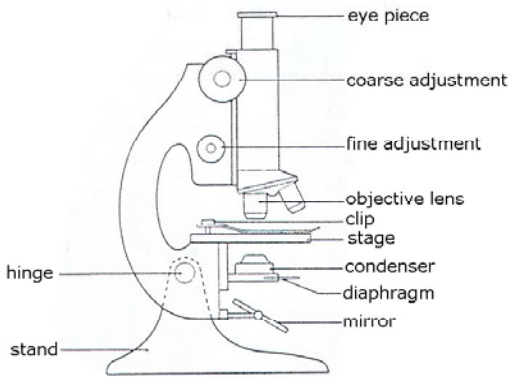


Figure 47: The structure of a microscope

Checking the microscope:

1. Turn the microscope towards a diffused source of light (the window or a tube light).
2. Rotate the nose piece to align the eyepiece lens with one of the objectives.
3. Place a slide on the stage.
4. Lower the barrel until the objective lens is 0.5 cm to the slide.
5. Look through the eyepiece, using the adjustment knob to focus.

If the field of vision is not clear, it could be due to dust or grease. Remove dust or grease with the help of a lens tissue. Do not touch the lenses with your fingers.

Examination of cells and tissues with the microscope:

Materials are mounted on glass slides. These are rectangular pieces of plane glass, 7.5 x 2.5 cm.

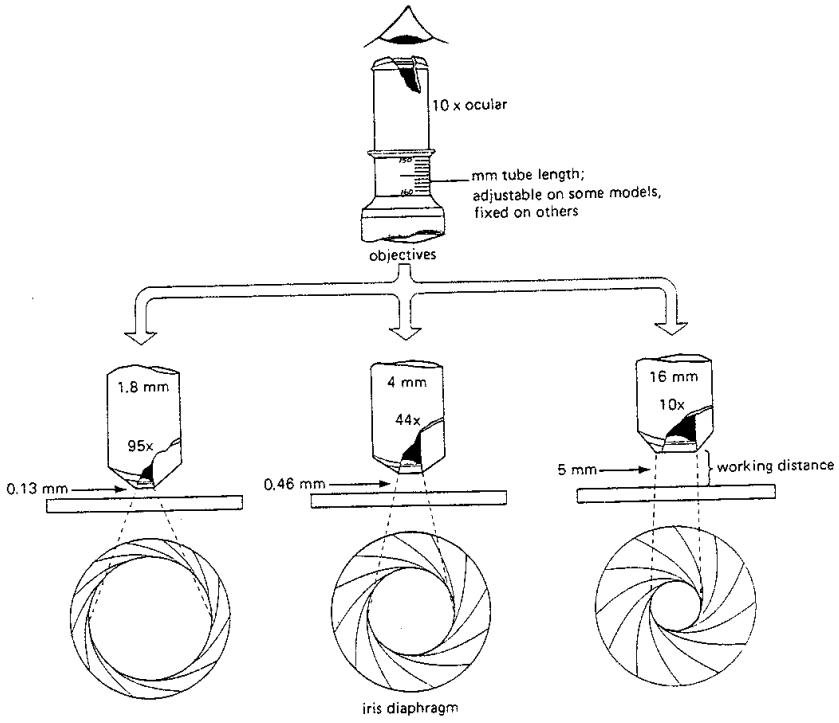


Figure 48: Working distance of the objective lens and adjustment of the diaphragm

Temporary mounting:
Fresh plant or animal tissues are mounted on plain microscope slides in a suitable medium and covered with a cover slip.

The mounting media are stains like Iodine or Methylene blue. Some plant tissues are examined without any stain. The tissue is examined using a drop of water, e.g., epidermis of leaf.

To examine cells from the epidermis of onion:

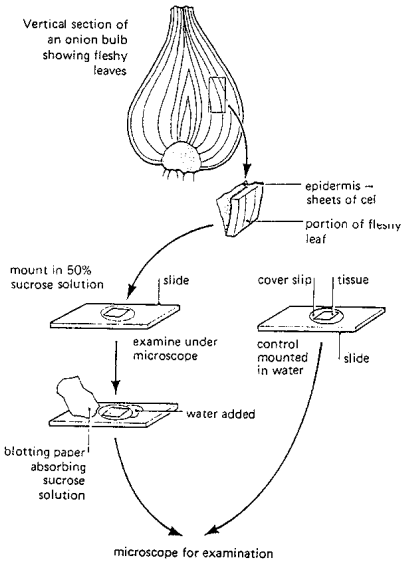


Figure 49: Examination of onion epidermal cells

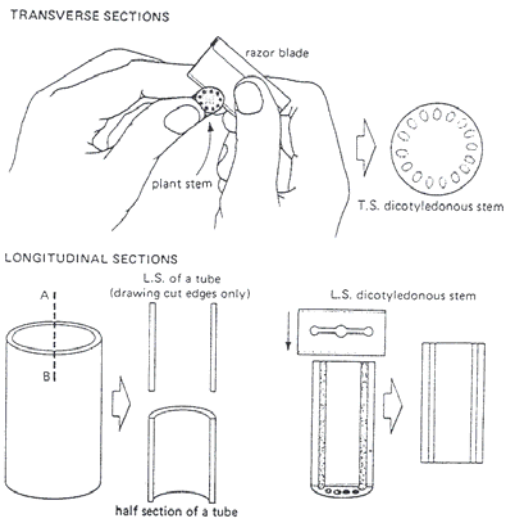


Figure 50: Preparation of plant sections for microscopy

To obtain plant sections for examination with a microscope:

Laboratory attendants may be called to assist students in temporary mounting procedure:

(1) Place a drop of the mounting medium on the glass slide.
(2) Place the specimen in the mounting medium.
(3) Place the edge of a clean cover slip on the slide as shown in the diagram.
(4) Lower the cover slip gently with the help of a needle
(5) Blot excess stain with a tissue paper or blotting paper.

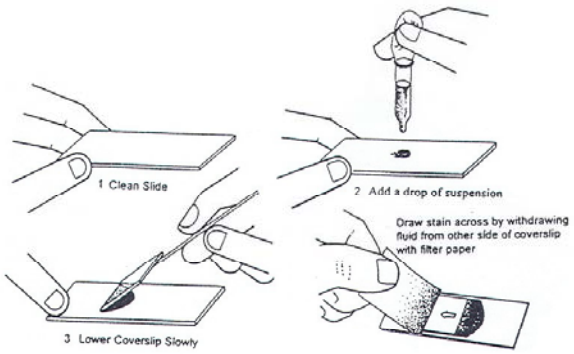


Figure 51: Procedure for the preparation of slides

Micrometry

Micrometer scales, also called graticules, are small plastic rulers used to carry out measurements of objects viewed with a microscope. There are two types of scales: the stage micrometer and the eyepiece micrometer.

To insert the eyepiece graticule, open the eyepiece and drop the scale in the open space. Close the eyepiece.

Figure 52: An eyepiece graticule

Clean graticules after use. Keep them in a dry place.

Bioviewers are light instruments used to view slides on filmstrips.

Stains

A number of stains are used in the biology laboratory:

- Acetic orcein
- Borax carmine
- Eosin
- Haematoxylin
- Iodine
- Light green
- Methylene blue
- Phoroglucinol
- Safranin

Figure 53: Bioviewers

(Source: Biology an Integrated Approach, R Soper & STyrell Smith)

Most of these stains are available commercially in powder form.

Prepare stains strictly according to instructions.

- Eosin: Dissolve 1 g of eosin in 100 ml of 90% ethanol. This is used as a dye to show transpiration in a balsam plant.

- Iodine: Dissolve 1 g of iodine crystals and 2 g of potassium iodide in 300 ml of distilled water.

- Methylene blue: Mix 1 g of methylene blue with 0.6 g of sodium chloride. Dissolve mixture in 100 ml of distilled water in a conical flask, shaking gently. Dilute stain if necessary (e.g., 0.25 g in 100 ml of distilled water).

- Acetic orcein: Dissolve 3 g of orcein in 100 ml of glacial acetic acid. Boil for three hours in a beaker. Allow the solution to cool. Dilute it with 100 ml of distilled water.

- Phloroglucinol: Dissolve 2 g of phloroglucin in 100 ml of 90% ethanol. Add few drops of concentrated hydrochloric acid before use.

Indicators

- Bicarbonate indicators
- Bromothymol blue
- Cobalt chloride
- Catechol
- DCPIP
- pH papers
- TIC
- Others that are provided according to instructions

Reagents

(1) *Benedict's solution*:

- Dissolve 173 g of sodium citrate and 100 g of sodium carbonate in 800 ml of distilled water. Filter the solution and keep it aside. Call it 'Solution A'.
- Dissolve 17.3 g of copper sulphate in 100 ml of distilled water. Call it 'Solution B'.
- Mix Solution A and Solution B. Add distilled water to make it up to 1000 ml.

Note: Nowadays, Benedict's solution is obtained ready made.

(2) *Biuret reagent*:

This reagent is made up of two solutions: dilute potassium hydroxide and copper sulphate solution.

The two solutions are mixed half an hour before a practical class in the ratio of 1:9 (i.e., 1 ml of copper sulphate to 9ml of potassium hydroxide).

Note: The solutions can be dispensed separately.

(3) *Iodine solution*: used as a test reagent for starch (refer to Iodine as stain above)

(4) *Copper sulphate solution*: dissolve 25 g in 100 ml of distilled water.

(5) *Hydrochloric acid*: used as table reagent for food test; the concentration is is 1M.

(6) *Hydrogen Peroxide*: This reagent is used often. It is commercially available in bottles labeled 30% v/v. To get a roughly 1M solution, mix 10 ml with 90 ml of distilled water. Dilute to get 0.1M, 0.2M, etc.

Note: An exact 1M solution is not required. However, if necessary, dilute the H_20_2 as follows: 113 ml of H_20_2 with 887 ml of distilled water to make 1000 ml.

Materials frequently used

- Agar
- Albumen
- Alginate
- Amylase
- Gelatine
- Glucose
- Sucrose
- Starch
- Yeast

Agar

(1) Boil water in a kettle.

(2) Weigh 8 g of agar powder.

(3) Pour 100 ml of boiling water in a 250 ml beaker.

(4) Add the powder and stir until it thickens.

(5) Allow it to cool.

Note: The hot mixture can be poured into Petri-dishes and allowed to cool.

Albumen

Dissolve 2 g of egg albumen powder in 100 ml of distilled water.

Alginate

Dissolve 5 g of sodium alginate powder in 100 ml of distilled water. This gives a 5% sodium alginate solution. It is used together with 0.1 % yeast to form a yeast/alginate mixture.

Amylase

(1) Weigh 1 g of Amylase powder on a piece of paper.

(2) Place 100 ml of distilled water in a beaker.

(3) Add the amylase powder to the water slowly and stir until it dissolves completely.

To prepare a 1M solution of glucose

(1) Find the molecular weight of the sugar you will use, e.g., the molecular weight of glucose is 180.

(2) Weigh 180 g of glucose in a dry beaker.

(3) Pour 1000 ml of distilled water in a large container.

(4) Add the glucose to the distilled water.

(5) Note that if only 100 ml of glucose is required, you only need to dissolve 18 g in 100 ml of distilled water.

(6) To prepare solutions of different concentrations, e.g., 0.1M, 0.5M, proceed as follows:

- for 0.1M glucose, mix 10 ml of 1M glucose to 90 ml of distilled water.
- for 0.5M glucose, mix 50 ml of 1M glucose to 50 ml of distilled water.

Note: Glucose is a reducing sugar.

Sucrose is prepared in the same way as glucose. Remember, the molecular weight of sucrose is 342. Here, 342 g of sucrose are dissolved in 1000 ml of distilled water to get a 1M sucrose solution.

Very often, the concentration is expressed in percentage. For example, students may need to be provided with a 1% glucose solution.

In this case, weigh 1 g of glucose and dissolve it in 90 ml of distilled water. Add water to make it up to 100 ml.

If you are asked to provide a 2% glucose solution, dissolve 2 g of glucose in 100 ml of distilled water.

Note: Sucrose is a non-reducing sugar.

To prepare a 1% starch solution

(1) Boil water in a kettle.

(2) Weigh 1 g of starch.

(3) Make a paste with the starch with 10 ml of water in a beaker.

(4) Add 90 ml of hot water.

(5) Stir it to obtain a uniform suspension.

(6) Allow it to cool before dispensing.

(7) Always prepare starch well in advance to have sufficient time for cooling. The starch suspension can be stored overnight.

To prepare a yeast suspension (1%)

(1) Weigh 1 g of yeast.

(2) Place the yeast powder in a 250 ml beaker.

(3) Add 100 ml of distilled water slowly and stir.

(4) Prepare the suspension half an hour before use. Store in a cool place.

4.3.2 COMMON EXPERIMENTS

Various experiments are carried out for demonstrations in biology. Laboratory attendants should be familiar with the apparatus used for the experiments.

As laboratory attendants, you may have to assist teachers/students in the setting up of the apparatus for some experiments. Follow the instructions precisely.

Osmosis using a potato

(1) Cut a potato in two halves.

(2) Peel off the skin at the cut end.

(3) Bore a hole at the other end.

(4) Put a cube of sugar in the hole.

(5) Place the potato in a Petri-dish or small beaker containing water.

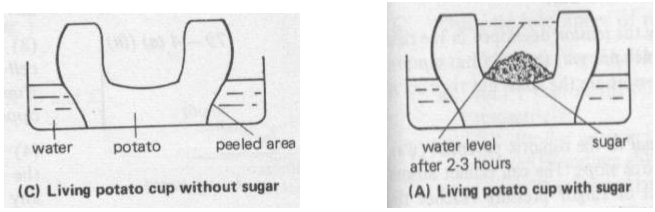


Figure 54: Using a potato to demonstrate osmosis

Osmosis using a visking tubing

(1) Cut a piece of visking tubing about 12 cm.

(2) Soak it in water until it becomes soft.

(3) Tie one end of the visking tube.

(4) Fill it with a 1M sucrose solution.

(5) Tie the other end of the visking tube around a glass tubing as shown.

(6) Dip the visking tubing in a boiling tube or beaker containing water.

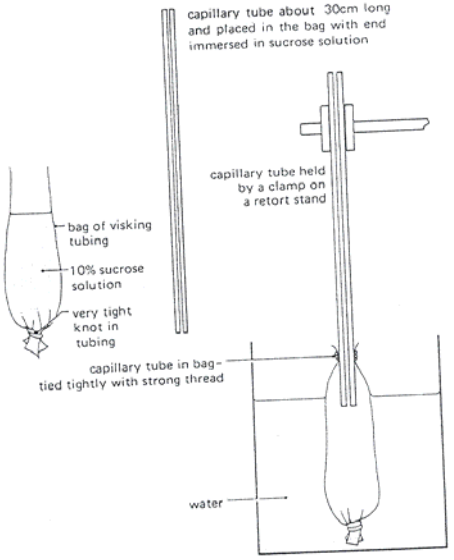


Figure 55: Demonstration of osmosis using a visking tube

Using a cork borer to obtain potato cylinders for experiments on osmosis

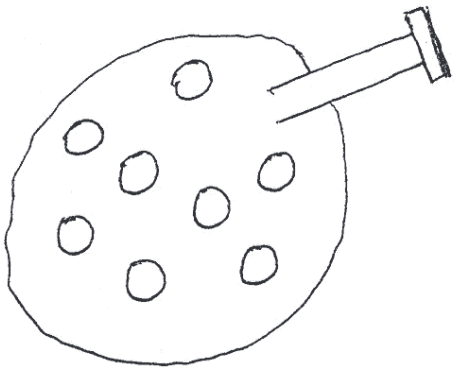


Figure 56: Cork borer used to extract potato cylinders

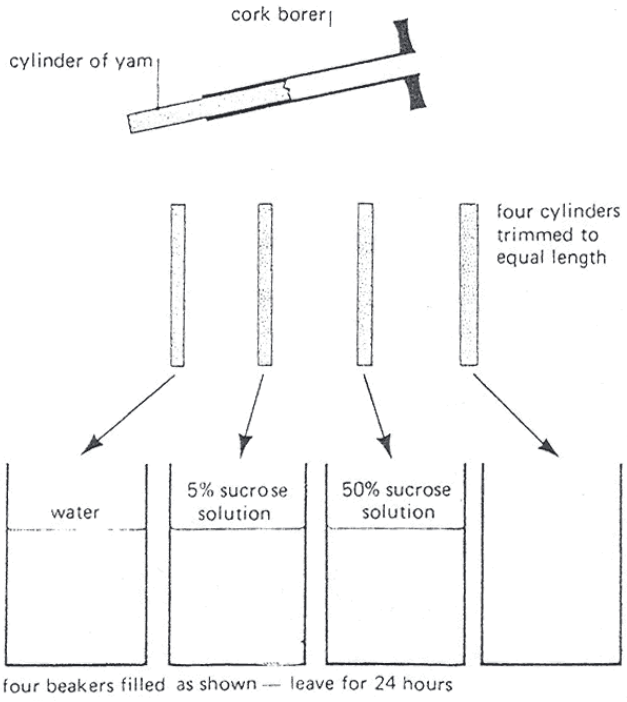


Figure 57: Use of potato cylinders to demonstrate osmosis

Diffusion experiments: Set up the apparatus as shown.

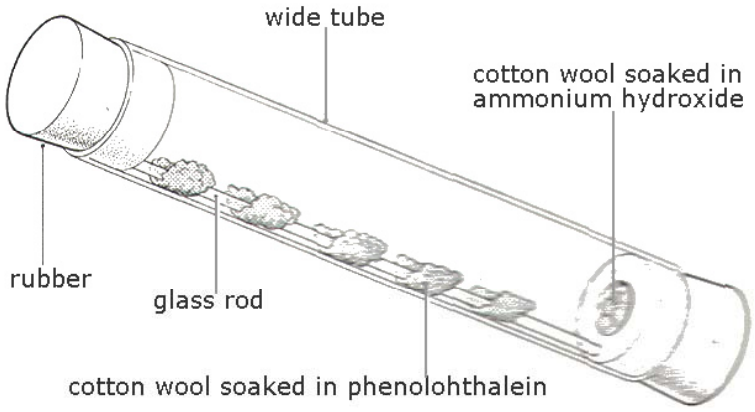


Figure 58: Experimental setup to demonstrate diffusion

Experiments on Transpiration

To set up a photometer

(1) Take a knife and some water in a jug.
(2) Look for an appropriate plant in the school yard.
(3) Cut a shoot with about ten leaves.
(4) Place the cut end immediately in the jug of water.
(5) Bring it to the laboratory to set up the photometer.

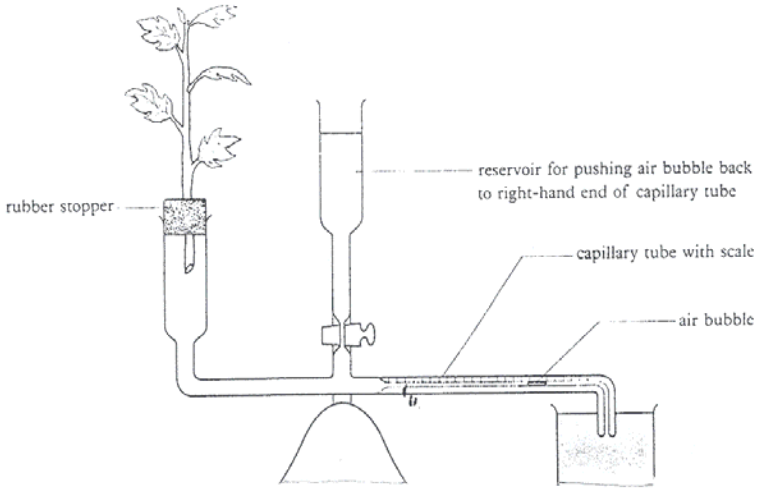


Figure 59: Setup of a photometer to demonstrate transpiration

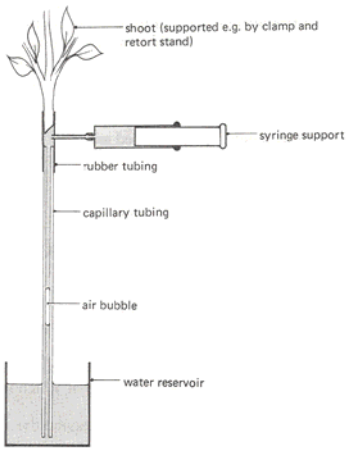


Figure 60: The bubble photometer

To obtain germinating seeds

(1) Obtain seeds (bean, maize, pea, lentil) from the market.
(2) Place the seeds on wet cotton wool in a tray.
(3) Keep the tray in a warm cupboard for 3 – 4 days.

Note: Mung bean seeds are used for experiments in respiration. They germinate overnight.

For experiments on germination, bean and pea seeds are used.

(1) Add water to a jar up to a depth of one centimeter.
(2) Roll a piece of blotting paper and insert it in the jar.
(3) Place a few seeds in between the paper and the wall of the jar as shown.
(4) Allow the seeds to germinate over 3 – 4 days.

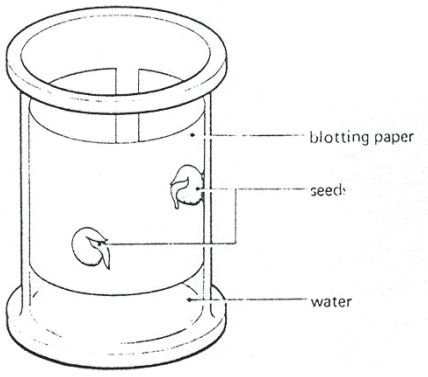


Figure 61: Germinating peas in a gas jar

Using Bell jars

(1) To demonstrate transpiration

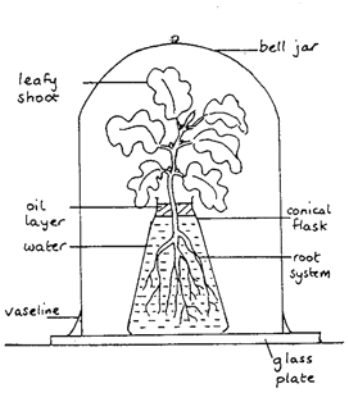


Figure 62: Setup to demonstrate transpiration

(2) To produce a culture of bread mould (*Mucor*)

Figure 63: Setup for producing *Mucor*

Apparatus for Respiration Experiments

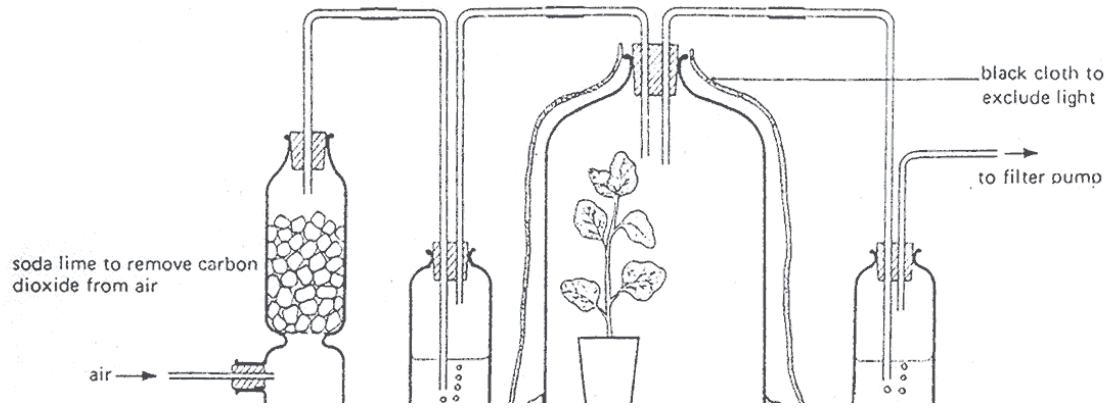


Figure 64: Setup to show evolution of CO_2 by a plant in the dark

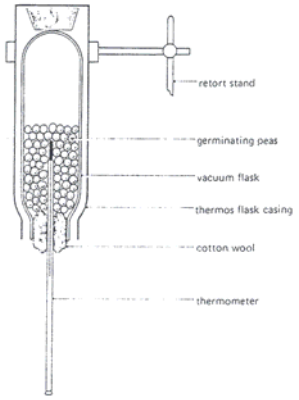


Figure 65: The production of heat by germinating seeds

Respiration

Apparatus used in the investigation of oxygen uptake in small terrestrial invertebrates

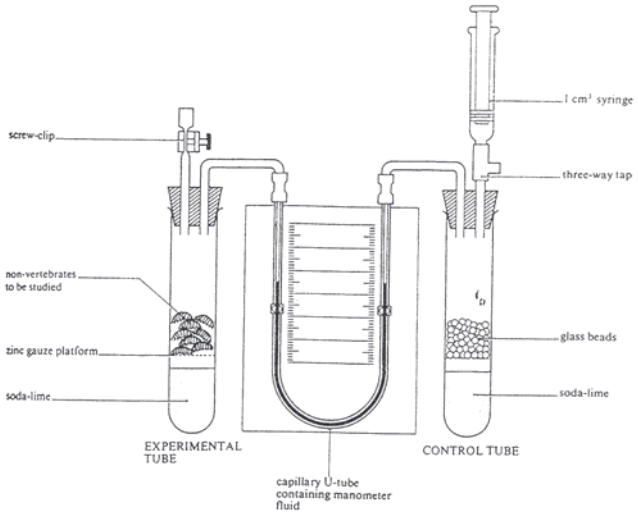


Figure 66: Setup to demonstrate oxygen uptake

Experiments in photosynthesis: using stencils

(1) Attach stencil to a fresh green leaf of a potted plant as shown.

(2) The plant is then exposed to sunlight for 48 hours.

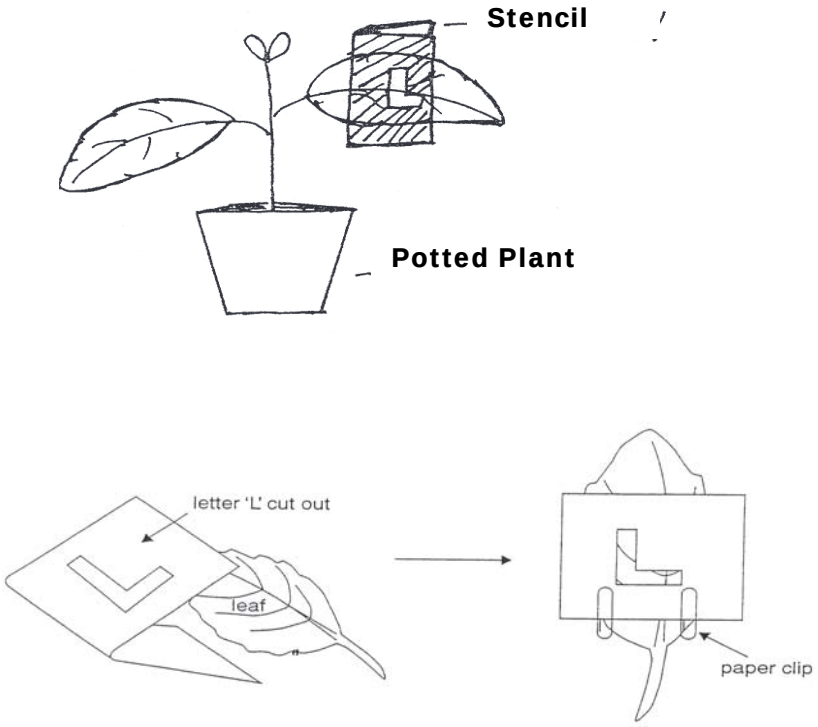
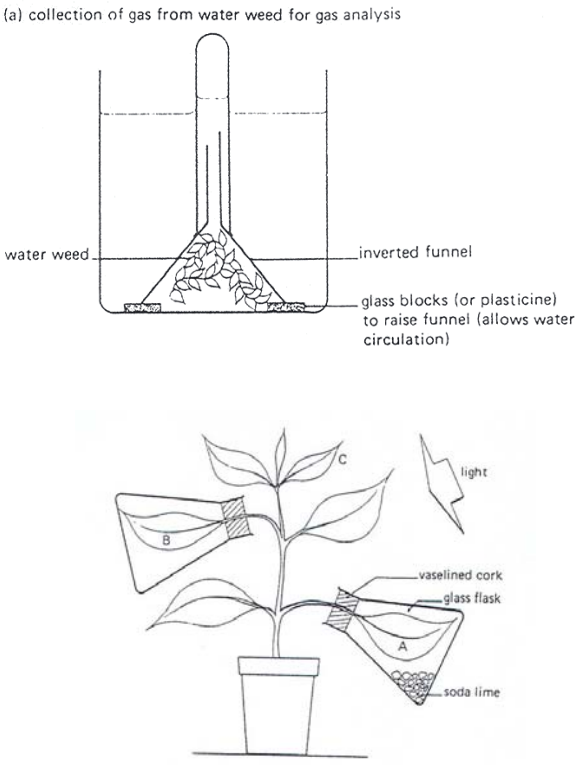
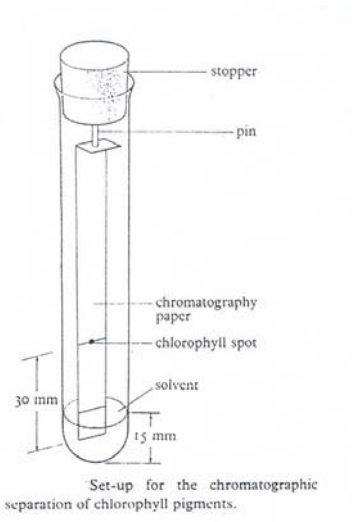


Figure 67: Using a stencil

Note: The plant should previously have been destarched, by keeping it in a dark cupboard for around 2 days.

Experiments in photosynthesis





Set-up for the chromatographic separation of chlorophyll pigments.

Figure 68: Photosynthesis

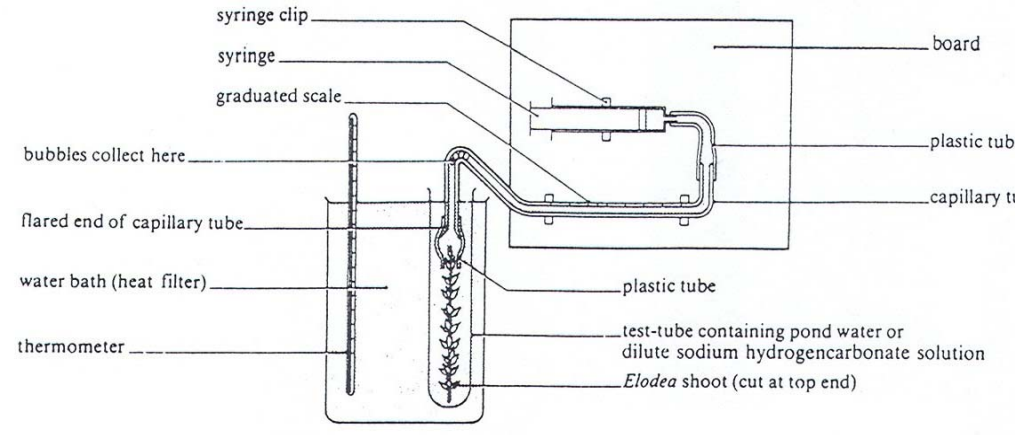


Figure 69: Apparatus for measuring the rate of oxygen evolution by a water plant during photosynthesis

To obtain a chlorophyll extract

A chlorophyll extract can be obtained from fresh leaves or dry leaves.

Requirements:

- Pestle and mortar.
- Acetone.
- Fresh leaves (spinach, cabbage) or dry leaves.
- Sand.
- Filter paper or muslin cloth.

Procedure:

- Put some sand in the mortar together with a few leaves.
- Chop the leaves if necessary.
- Add acetone and grind the leaves (to avoid exposure to acetone, this can be carried out in a fume cupboard).
- Filter using preferably muslin cloth.
- Keep in corked specimen tube, away from light.

Testing a green leaf for starch

(1) Pluck a leaf which has been exposed to light for at least two hours.
(2) Dip the leaf in boiling water.
(3) Place the leaf in a boiling tube containing ethanol.
(4) Boil the leaf in ethanol in a water bath (see Fig 72).
(5) Remove the leaf from the boiling tube.
(6) Wash in cold water to remove the ethanol.
(7) Apply Iodine solution over the leaf, on a tile or in a watch glass.

Procedures for food tests

Look at the flow sequences below, which illustrate different experimental setups for conducting food tests.

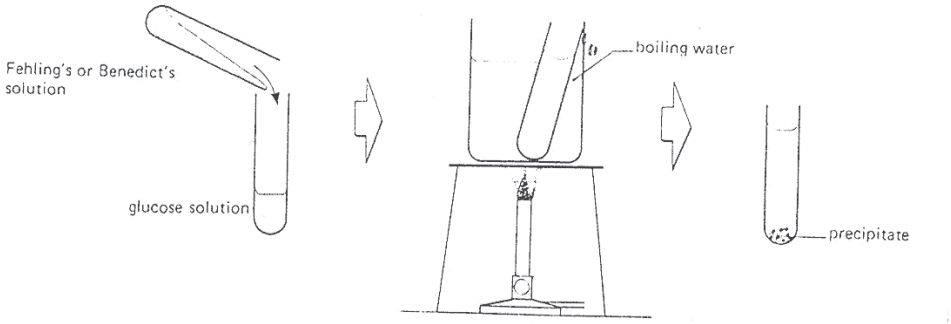


Figure 70: Flow sequence for the glucose (reducing sugar) test

Starch + Amylase rate of reaction using a spotting tile

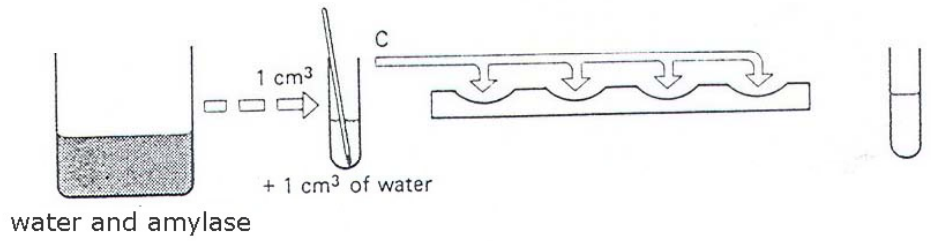


Figure 71: Flow sequence to demonstrate the enzyme-catalysed hydrolysis of starch

This method is used to detect the presence of starch remaining in solution at different time intervals, following the action of amylase (amylase catalyses the breakdown of starch into maltose, which is a disaccharide).

There are several wells on a spot tile. First, you need to add a drop of iodine solution into each well. A blank should also be prepared (usually, the blank is a drop of distilled water). Following addition of amylase to the test tube containing a starch solution, a fixed volume of sample is drawn at timed intervals and added to a well. The contents of the well are mixed and the colour compared to that of the blank. When the dark blue colour disappears or the colour of the mixture in the well is similar to that of the blank, the end point is reached, and the reaction time can be recorded.

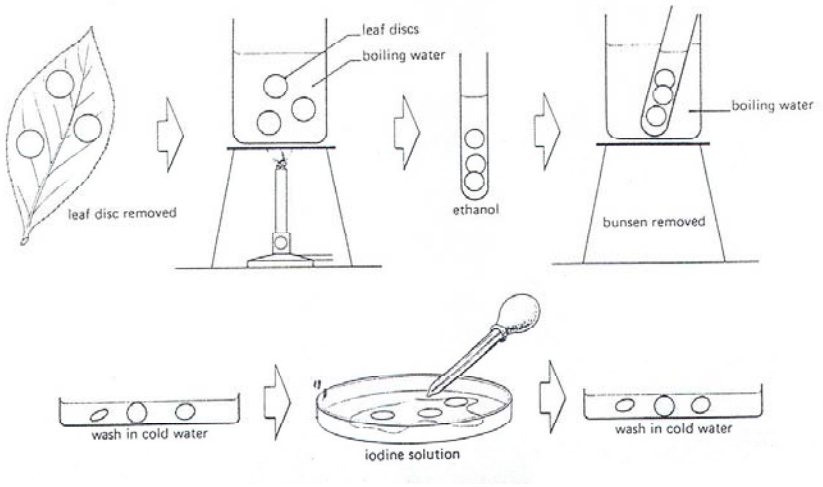


Figure 72: Flow sequence for decolourising a leaf followed by the starch test

The following two figures illustrate the setup used to demonstrate the influence of varying mineral nutrition on plant growth

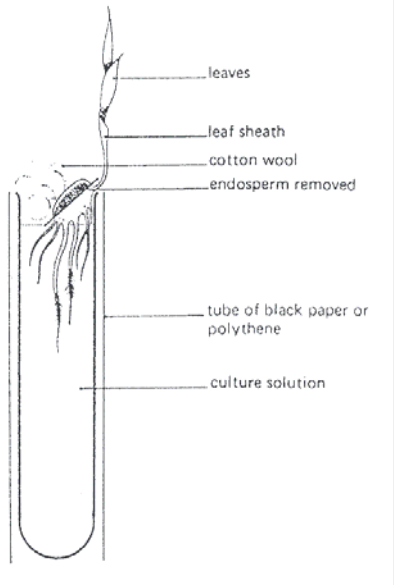


Figure 73: Single plant experiment to demonstrate the influence of culture solution on growth

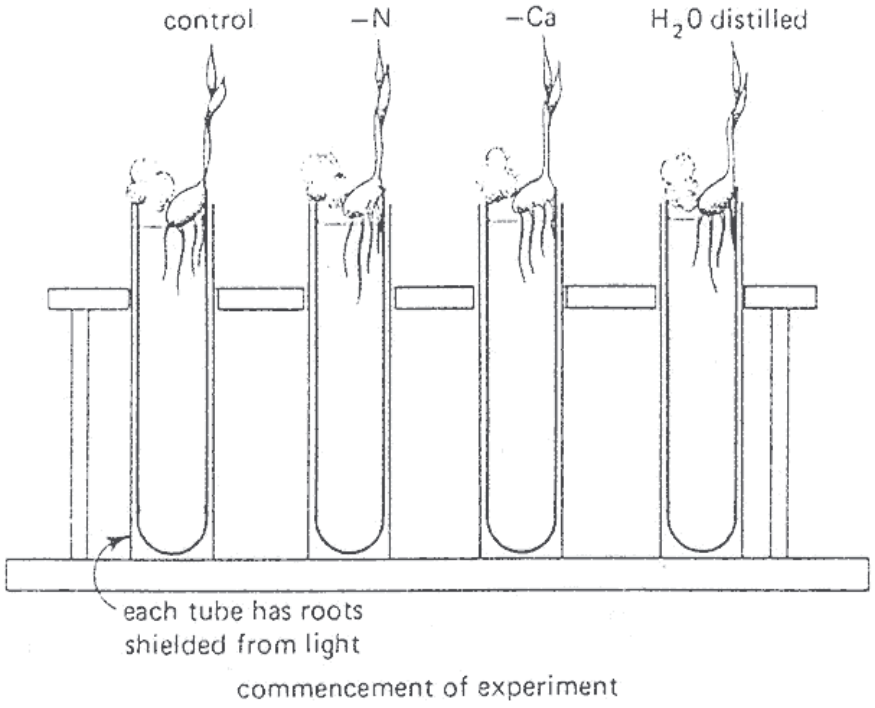


Figure 74: Multiple plant experiment to demonstrate the influence of culture solution on growth

Apparatus for experiments on Tropism

Clinostat

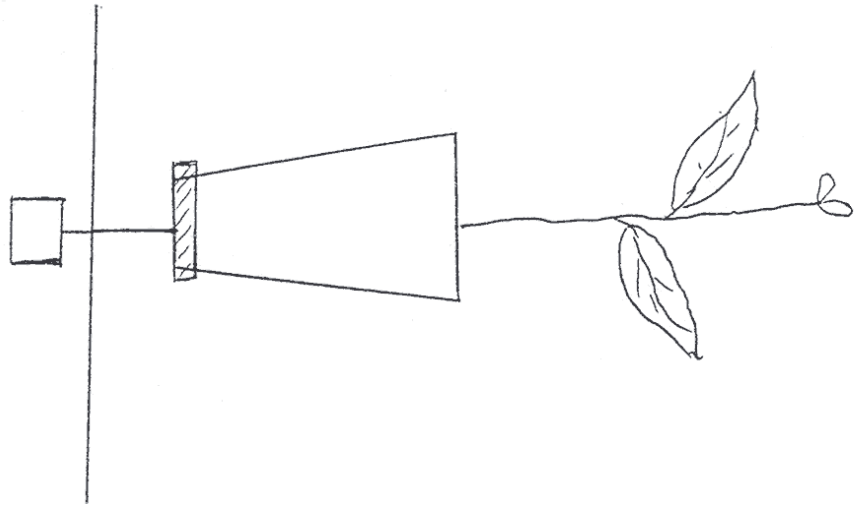


Figure 75: Clinostat

Apparatus for measurement of growth:

Auxanometer

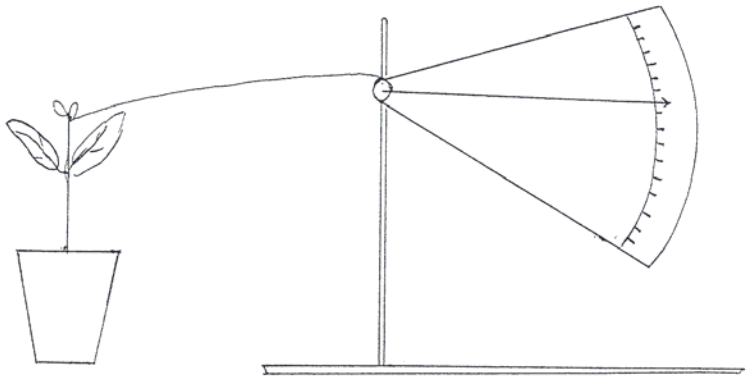


Figure 76: Auxanometer

4.3.3 COLLECTION AND PRESERVATION OF PLANTS AND ANIMALS

While collecting and preserving specimens, consider the following rules:

(1) Some plant and animal species are under legal protection. It is an offence to uproot any wild plant without permission of the landowner or relevant authority.

(2) Do not bring poisonous plants or live animals in the laboratory, except for small insects, woodlice, larvae or worms needed for some experiments.

(3) Collect specimens to satisfy the particular needs of the time. For example, if you need two plants, do not uproot more than what you require.

(4) Preserve specimens as soon as you can, e.g., within 24 hours.

(5) Preserve plant specimens in alcohol and animals specimens in formalin. Some plants can be dried and preserved in a herbarium. Insects can be pinned and displayed on boards.

(6) Collect fresh animals like woodlice and insect larvae in vessels with provision for aeration. They are used in experiments like respiration.

(7) Sterilise dry fruits and seeds to prevent them gathering fungus and rotting.

(8) Sterilise bones and teeth to prevent infection.

For further information on plant materials frequently used in biology classes, please refer to Appendix 7. (On CD on back cover)

Procedure

- Use sterile glass Petri-dishes or plastic Petri-dishes which have been pre-sterilised. Pour into five dishes nutrient broth, which is a jelly made from agar.

- Micro-organisms grow well in the incubator at 37°C and experiments have shown that they are present in a number of places in the laboratory and on the body. They can thus be spread easily by air currents.

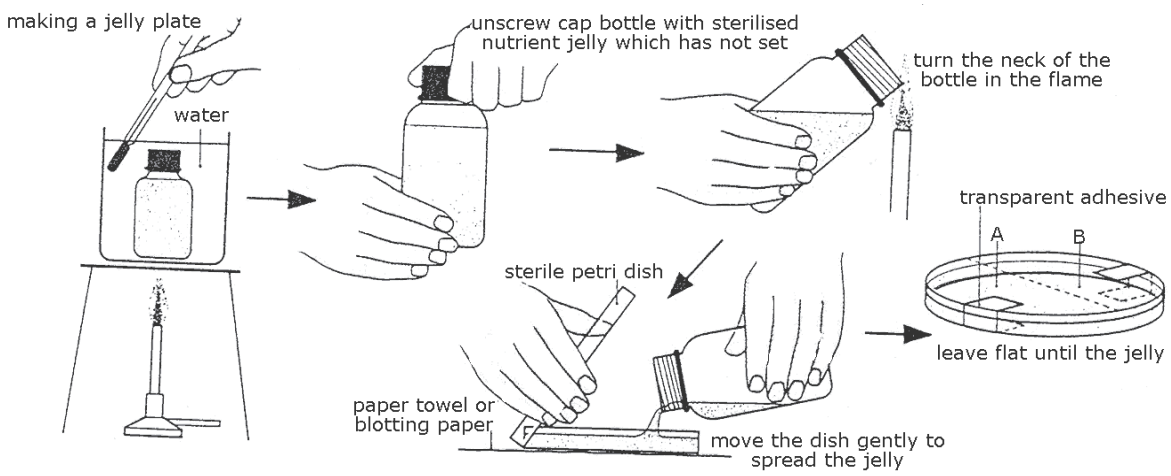


Figure 77: Preparation of culture plates

Experiments on soil

To show the different components of soil:

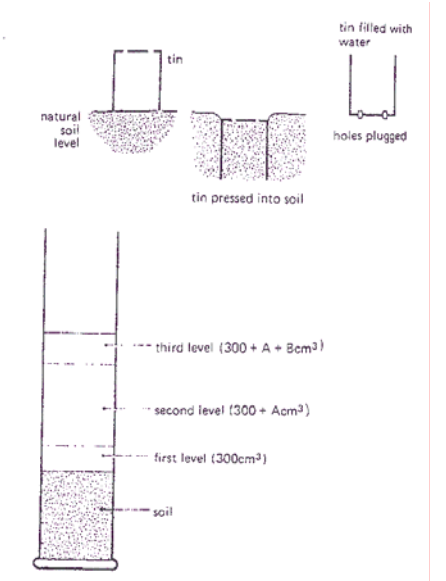


Figure 78: Layering of soil

To show the presence of micro- organisms in soil:

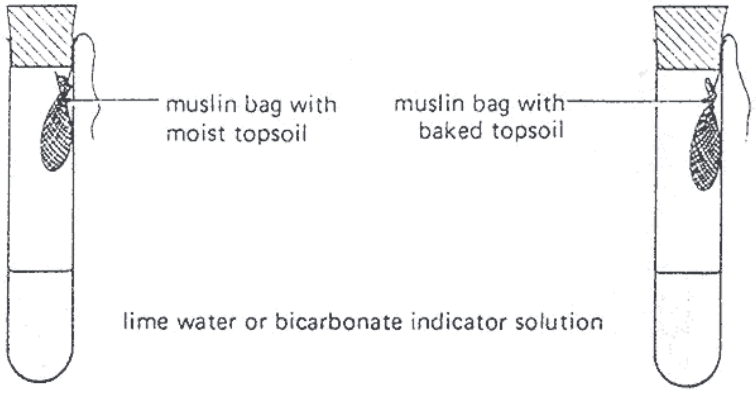
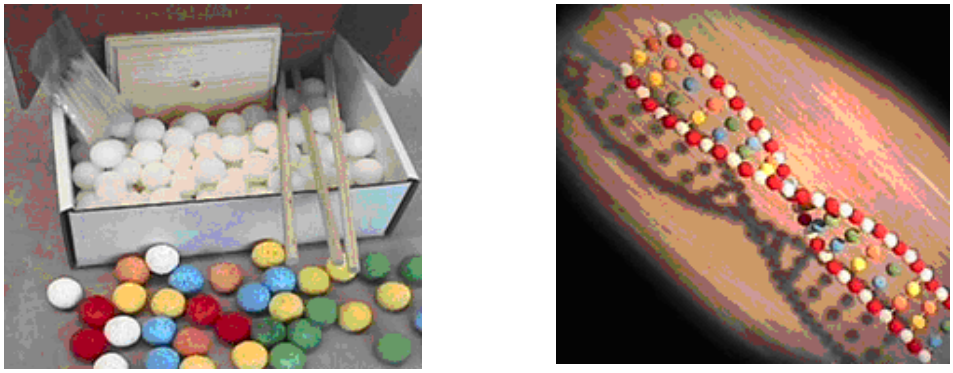


Figure 79: Demonstrating the production of CO_2 by soil micro-organisms

Using a Gene Kit for the construction of nucleic acid models



A **B**

Figure 80: (A) Example of a Gene Kit, (B) DNA model constructed using a Gene Kit

(Source: Biology an Integrated Approach, R Soper & STyrell Smith)

UNIT 5 - BASIC MAINTENANCE OF LABORATORY EQUIPMENT

Regular maintenance of apparatus/instruments is a necessary exercise in any laboratory.

Maintenance includes proper cleaning, regular servicing, repairing and proper storing in order to keep the apparatus/instruments in proper working condition. You may have to refer to instruction manuals for certain specific apparatus.

5.1 PROTECTION OF EQUIPMENT FROM DUST

- Regular cleaning and dusting of equipment is necessary.
- Keep apparatus/instruments inside cupboards as far as possible to prevent them from gathering dust.
- Use a doormat and mop the floor to reduce accumulation of dust.
- Keep sensitive equipment such as spectrometer, travelling microscope, cathode ray oscilloscope (CRO), electronic balance, timers, etc, covered with dust covers when not in use.

5.2 WATER TAPS AND DRAINAGE SYSTEM

- Water leakage from taps, water pipes, joints and drainage system may affect electrical sockets and connections. This may lead to short circuits and eventually cause electrocution or fire break out.
- Close the main supply and report to the head of department as soon as possible.

5.3 GAS SUPPLY AND BUNSEN BURNER

- The gas taps of all Bunsen burners should operate smoothly.
- Check the condition of the rubber tubing. Look out for cracks and replace the tubing if necessary.
- Make sure the Bunsen burner's flame is blue. If a yellow and luminous flame is obtained, check whether the air hole is properly opened. If a yellow flame continues, turn off the burner. Invert it and tap it on a hard surface to remove any unburnt materials. You can also remove the barrel and clean the jet with a fine wire.

5.4 PREVENTION OF CORROSION AND RUST

- All equipment made of metal or having metal components can get damaged because of corrosion and rust, due to spillage of liquid on them or humidity.
- Wipe the equipment after use to remove any droplets of liquid.
- Lubricate the equipment with silicon grease or wax it to prevent rusting.

5.5 USE OF INSTRUCTION MANUAL

For equipment such as cathode ray oscilloscope (CRO), signal generator, 'g' by free fall apparatus, electronic balance, microscopes, etc., keep a copy of the operational instructions with the equipment to assist the user. This will prevent unnecessary damage due to wrong handling of equipment.

5.6 SIMPLE SERVICING OF EQUIPMENT

All equipment in the laboratory needs simple servicing to keep them in good condition.

Barometers

- Clean the glass casing, the scales and the thermometer attached to it.
- Check the mercury level in the pouch.
- Always keep in a vertical position even when moving it.

Boyle's law and Charles law apparatus

- Clean the glass tube and the rubber tubing with soap solution.
- Clean the scale with a piece of soft cloth.

Bunsen burners (refer to 'Gas supply and Bunsen burners')

Calipers (Vernier calipers)

- Clean the scale and lubricate with silicon grease or wax.
- Maintain vernier scales of a travelling microscope in the same way.

Circuit components (fixed resistors, lamps/bulbs, thermistors, diodes, etc.)

Check with the help of the teachers if necessary that all the components are in good working condition. Discard all components that cannot be used.

Compression balance

- Clean scale, keep it dust free.
- Check for zero error and adjust if necessary.

Digital meters

- Check that they are in good working condition.
- Check the batteries and replace if necessary.
- Switch on all digital meters frequently, even when not in use.

Deflection magnetometer / Tangent galvanometer

To prevent the demagnetization of the magnet attached to the pointer, place a soft iron washer at the centre of the magnetometer.

Discharge tubes

Clean all discharge tubes, e.g., sodium vapour lamp, mercury vapour lamp, with a soft cloth and keep them in their boxes.

Dissection sets

- Keep all dissecting instruments away from moisture.
- Wipe scissors, forceps and scalpels with a cloth and keep them in separate boxes.
- Change scalpel blades if they are blunt or start getting rusty.

Electric motor / Dynamo / Generator

Lubricate the bearings with oil spray.

Electric meters (analogue)

- Check for zero error, and adjust if necessary.
- Check that they are in good working condition, send for repairs if necessary.

Electronic balance

- Keep the balance in a cabinet and avoid moving it from one place to another, as it is very sensitive.
- Before weighing an object, make sure that the reading indicates 0.00g.
- Do not place wet or hot objects on the balance. Allow a hot object to cool down before weighing.
- Use a dry cloth to clean the pan.
- In case of fault, report to head of department. Never try to repair or calibrate the electronic balance.
- Fix a label in bold character to indicate the maximum mass that can be weighed.

Glassware

- Wash all glassware: (beakers, burettes, pipettes, measuring cylinders, test tubes, boiling tubes, flasks, Petri-dishes, etc.) after a practical session, with detergent and water, using a brush if necessary.
- Soak stained glassware in a mixture of dilute sulphuric and potassium dichromate solution. Use gloves, as this solution is corrosive.
- Place glassware on racks or in trays for drying.

  Burettes: Clamp washed burettes upside down for drying.
  Service tap of burettes regularly by applying a thin film of vaseline to ensure smoothness of glass tap.

- Check clip burettes regularly; change rubber tubing whenever necessary.

Glass blocks/ Prisms, lenses

- Keep all types of glass blocks, prisms, and lenses clean and free of dust at all times.
- Check for cracks and discard if necessary.
- Keep all optical pins clean and shiny.
- Keep all metal adjustable stands for lenses clean and lubricate adjusting screws.

Hypsometer

- Remove the thermometer and the manometer from the apparatus after use.
- Remove the rubber corks, clean and keep dry.

Micrometer screw gauge

- Clean the thimble, scales, anvil, and spindle.
- Lubricate the moving parts.
- Check for zero error and adjust if necessary.

Metre rule

- Always remove any plasticine / cellotape / masking tape from the ruler after use.
- Wipe and clean before storing.

Microscopes (Refer to section on 'Microscopes')

Optical bench

Clean the scale.

Plane mirrors

Clean with soft cloth. Cover sharp edges with masking tape.

Potentiometer/Wheatstone Bridge

- Clean and lubricate all terminals.
- Clean and polish scales.
- Change wire as and when required.

Plugs

- Keep all plugs and switches, resistance boxes, banana plugs fixed to wires clean and dust free.
- Screws of the banana plug fixed to wires must be tight.
- Check fuses in plugs

Resistance thermometer

- Handle with care.
- Clean and lubricate all four terminals to prevent rusting.
- Always keep in its box.

Resonance tube

Clean and dry.

Sonometer

- Check the wire for kinks.
- Clean the scale and lubricate the pulley.

Spectrometer

- Clean the lenses of the collimator, the eyepiece and the objective of the telescope with a lens tissue paper.
- Clean and lubricate the screw of the adjustable slit, the revolving table and the scale, the adjusting screws of the collimator and the telescope.
- Always keep the spectrometer under a dust cover.

Stopwatch

- Check that all watches are in good working condition.
- Change battery if necessary.
- Check for calibration errors.
- Send the analogue watches for servicing every six months.

Telescope

- Clean lenses of the piece and objective with a soft cloth or lens tissue.
- Lubricate the focus adjusting screw.
- Keep the stand clean and free from dust (use a dust cover).

Travelling microscopes

- Clean the lenses of the eyepiece and objectives with a soft cloth or lens tissue.
- Check the cross wire; repair if necessary.
- For the scales, see vernier calipers.

Thermometers

- Wash and wipe thermometers after use.
- For experiments involving substances like camphor or naphthalene or wax, clean thermometers by dipping them in hot water and wipe them to ensure that no substances stick to the glass.
- Keep thermometers in horizontal position.
- If mercury thread is broken, cool thermometer to rejoin the broken mercury thread.
- Check for cracks, and faded scales and discard if necessary.

Tuning fork

- Clean thoroughly.
- Dry and cover with a thin layer of wax to prevent rusting.

Young's modulus apparatus

- Clean and lubricate the scales.
- Check the wires for kinks.
- Lubricate all screws and check the spirit level.

5.7 CHEMICALS AND REAGENTS

- Fill reagent bottles regularly.
- Fill reagent bottles with freshly prepared solutions at the beginning of every academic year, where applicable.
- Empty and clean all reagent bottles at the end of the year or during school holidays.
- Do not throw away standard solutions like Benedicts' reagent.
- Keep a record of the amount of chemicals used and the amount left after every practical session. It becomes easier to renew stock.
- Keep enzymes in the refrigerator.
- Prepare the exact amount of enzyme solution for a practical to avoid wastage, as enzymes are expensive.

5.8 APPARATUS FOR PRACTICAL AND DEMONSTRATIONS

- In the laboratory, apparatus such as the ripple tank and those used for distillation and preparation of gases must be assembled beforehand and kept for easy access.
- In many cases, students have to set up certain apparatus, e.g., potometers, respirometers.
- Check each component after a practical session.
- Clean and keep them together in boxes.

5.9 MICROSCOPES

A light microscope is a delicate and expensive optical instrument.

- Handle it with great care.
- Always carry a microscope with both hands. Hold the limb with one hand and place your other hand under the base.
- Do not hold the microscope like a handbag. The mirror is not screwed in. It will fall off.
- Keep the microscope in a dry and cool place inside a cupboard.
- Do not allow acids or alkalis, or other corrosive material, to get in contact with it.

- Wipe the microscope with a soft cloth after it has been used.
- Clean the lenses with lens cleaning tissue.
- Use xylene to remove spots.

Refer to instruction manuals for other components of the microscope like the condenser and objective lenses.

Checking the microscope:

- Turn the mirror towards a source of light (diffused, not direct).
- Remove the eyepiece lens.
- Rotate the nosepiece so that the low power objective lens clicks in place.
- Look through the tube.
- Adjust the amount of light by opening or closing the diaphragm.
- If the microscope has a condenser instead of a diaphragm, lower or raise the condenser until you get maximum light.
- Rotate the nosepiece again to check for medium and high power objectives.
- Any cloudiness or spot can be due to dust or grease on the lenses.
- Remove lenses and clean them.
- Place a permanent slide on the stage and try to view it.
- If it is clear, the microscope is good.
- Mark it with a tick and keep it along with other good microscopes.

5.10 CHARTS

- Make a list of all the charts you have in the laboratory.
- Label the chart at the back, for example:
  (1) Digestive tract
  (2) Respiration
  (3) Photosynthesis
  (4) Periodic Table
  (5) Energy
- Roll the charts so that the numbers are clearly visible.
- Place them in a cupboard.

5.11 MODELS

- Keep large models like the human torso and the human skeleton in the preparation room or the store, covered with a hood to avoid dust.
- Small models such as the heart, the eye, the kidney, atomic structure, motor generator, leaf structure, etc., can be displayed in show cupboards inside the laboratory.
- Some models are dismantled during a class for explanation.
- Reassemble all the parts immediately after use.
- Keep models away from heat.

5.12 PERMANENT SLIDES

- Permanent slides are expensive and very important.
- They can break easily since they are made of glass.
- Handle them with care.
- Make a list of all the slides.
- Classify them, for example, plants, animals, microorganisms and keep them in separate trays in the slide cabinet.
- Clean slides with a soft tissue after a practical session.

For further information on Duties specific to the Biology Laboratory, please refer to Appendix 8. (On CD on back cover)

Note: Examples of practical examinations and instructions for laboratory attendants, where the skills and techniques developed in Units 4 & 5 are used, are given in Appendix 9.

UNIT 6 - BASIC INFORMATION TECHNOLOGY (IT) SKILLS

Today, computers are being made available in schools, libraries, and a growing percentage of households.

Experts in education are actively involved in developing ways for students to use technology to improve education. Students use computers for simple word processing, and also for information gathering and research. Encyclopaedias and other reference works are available on the Internet and on CD-ROMs, which can be searched by the student using the computer in his or her classroom or the school library. With increased usage of computers, many students are learning to access information at an earlier age.

Computers are also used for Computer-Aided Instruction (CAI). Interactive programs provide practice in such basic skills as spelling, mathematical computation, and word recognition. Other programs capitalise on the student's curiosity and motivation to teach physics, chemistry and biology, amongst others.

The present module aims to enable the laboratory attendant to use the computer in his/her day-to-day activity. The module is made up of three parts, namely, **Word Processing** with Microsoft Word, **Spreadsheet Processing** with Microsoft Excel and **Internet** with Microsoft Explorer. These software packages are usually bundled/pre-installed in a new computer system.

After completing this module, the laboratory attendants will be able to:

(i) create standard documents,

(ii) perform effective stock control of chemicals and equipment, and,

(iii) search for information using the Internet.

6.1 MICROSOFT WORD

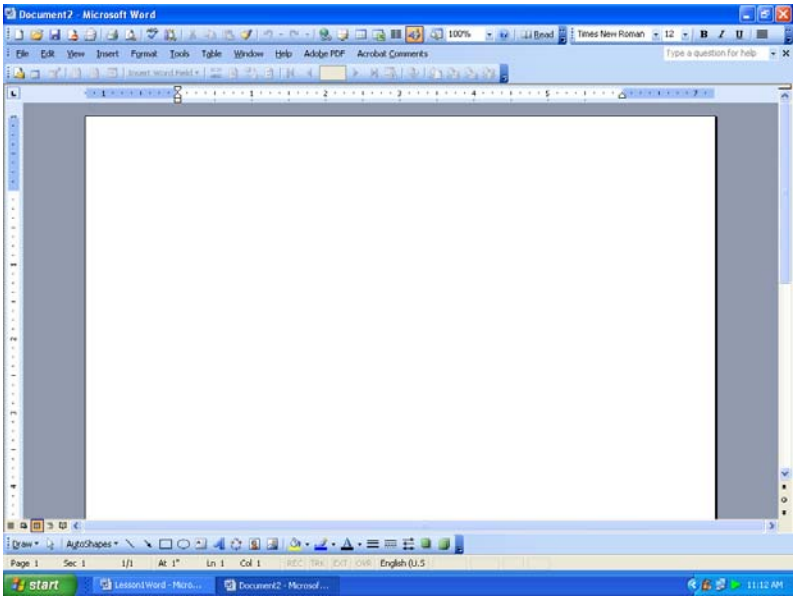
There are quite a few ways to start an application in **WINDOWS**.

Starting Word

(1) Click or double-click the Desktop icon  , or,

(2) Press the ***START*** button, slide up to ***PROGRAMS,*** locate **Word** and click

Your screen will look like the one shown here.



To close the document, click the  (cross) in the upper right corner of the New Document panel or choose ***File > Close.***

The Title Bar

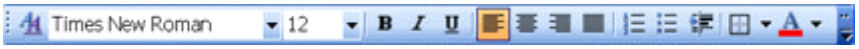
The Title bar displays the name of the document on which you are currently working. At the top of your screen, you should see "Microsoft Word - Document1" or a similar name.

The Menu Bar

The Menu bar is generally found directly below the Title bar. The Menu bar displays the menu. The Menu bar begins with the word File and continues with edit, View, Insert, Format, Tools, Table, Window, and Help. You use the menus to give instructions to the software.

Toolbars

The Standard Toolbar



The Formatting Toolbar

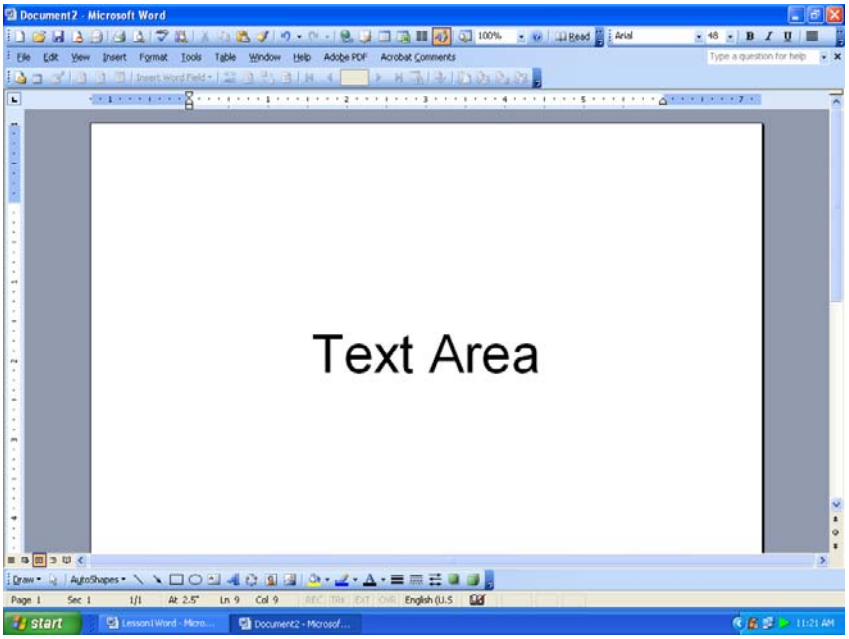
Toolbars provide shortcuts to menu commands. Toolbars are generally located just below the Menu bar.

The Ruler

The ruler is generally found below the main toolbars. The ruler is used to change

Note: You can display any of these (and other) facilities by clicking on ***View*** → ***Tools***

Text Area



The ‘text area” is the space where you type your document.

The blinking vertical line in the upper left corner of the text area is the ***cursor***. It marks the insertion point. The cursor shows where the next character will appear.

Exiting Word

To exit Word:

1. Click File.
2. Click Exit. If you want to save your work click ***Yes*** at the prompt:

   "Do you want to save changes to Document1?"

   Otherwise, click ***No***.

Basic Features

We are now going to use a few of the most used keys and actions. These are:

Typing keys, the Backspace key, the Delete key, inserting text, bolding, underlining, and italicizing.

Open Microsoft Word.

Selecting text (Highlighting)

A series of characters (text) can be selected by one of the following methods:

(i) Place the pointer at the character. Press the left button of the mouse and drag (slide) to the right/left/up/down until you reach the end of the text you wish to select. As you do this, the text will be "**highlighted**" (reverse video) as shown below:

Release the button.

(ii) Place the pointer to the left of the line you wish to select. Press left button and drag down or up to select.

(iii) Place pointer at the character. Press SHIFT and use arrow keys (UP/DOWN/LEFT/RIGHT) to select text. Release SHIFT key.

Typing and Using the Backspace Key

The exercises that follow will teach you how to enter and delete text. To enter text, simply type just as you would if you were using a typewriter.

However, if you wish to have a nice text layout, you must be wary of the following **rules of punctuation**:

(1) Do **NOT** leave any space ***before*** a punctuation.

(2) Leave **ONE** blank space (space bar) ***after*** a punctuation that is within a sentence, [comma (**,**), semi-column (**;**), etc…)

(3) Leave **ONE** blank space between two words.

(4) Leave **TWO** blank spaces after a punctuation which ends a sentence, [period(**.**), question mark(**?**), exclamation mark(**!**)]

Now, type the following text bearing in mind the above rules:

The computer as we know it today is the product of several major eras of human's technology. Technology is the application of tools and techniques such as to improve the likelihood of human survival. In addition to the survival aspect, the use of tools and techniques to solve non-essential, but still needed or interesting problems, has given rise to many great inventions. These include things like the automobile, bicycle, radio, etc.

Capitalize:

(i) Hold down the Shift key while typing the letter, or,

(ii) Press the “Caps Lock” key once. Press this key again if you want to continue typing in small letters. “Caps Lock” is known as a ‘toggle’ (ON/OFF) key

Delete

(i) Use the Backspace key to delete text. This key deletes one character to the left of the cursor

(ii) Use “Delete” (Del) key if you want to delete one character to the right of the cursor.

(iii) You can also delete a series of characters at a time by using the following method:

a. Highlight the characters or lines you wish to delete
b. Press the “Delete” key.

Word wrapping

You do not need to press Enter to start a new line. Microsoft Word automatically wraps at the end of the line.

Press ***Enter*** twice to leave a blank line and to start a new paragraph. (There are other more sophisticated ways of formatting paragraphs).

Inserting Text

You need to be in the Insert mode. Look at the right side of the Status bar. If the letters "**OVR**" are gray, you are in the Insert mode. If the letters "**OVR**" are black, you are in the Overtype mode. In the overtype mode characters to the right of the cursor will be replaced by new characters that you type.

To change to the Insert mode:

(1) Double-click the letters "**OVR**."

(2) The letters "**OVR**" are now gray.

(3) Make sure the letters "**OVR**" are gray before proceeding.

Bold, Underline, and Italicize

You can embolden, underline, or italicise text when using **Word**. These features can be used one at a time or can combined.

Text can be formatted before typing them or after they have been typed.

Some of the different methods for bolding, italicizing, or underlining are

(i) an icon,

Highlight text, and click the appropriate icon on the TOOLBAR, i.e;

 = bold,  = Italic  = Underline

Formatting can be removed from text by highlighted it and then clicking the appropriate icon/s.

(ii) or the keys.

Press the CONTROL (Ctrl) key and hit letter "B" for bold, "I" for italic or "U" for underline. Release the Ctrl key. The same combination of keys can be used to remove them.

Perform these formatting methods on the text you have typed above.

Save File

You must save your files if you wish to recall them later. Before you can save, you must give your file a name. To save your file and close Word, follow the instructions given here:

1. Choose ***File > Save As*** from the menu.
2. Specify the correct folder in the ***Look In*** box.
3. Name your file by typing in the ***File Name*** box.
4. Click ***Save***.

Folders

It is good practice to create folders with suitable filenames in order to save your files. Related files are grouped into a folder. In this way, we are sure to be able to retrieve very quickly the files that are needed.

There are quite a few ways of creating folders. Here we shall do it from within Word. At the moment you wish to save your document into a folder that does not exist yet. Follow these steps:

1. Click ***File > Save As…***
2. Click on a blank area in the ***Save As***… window

3. Right click and choose ***New > Folder.***
4. Type a name that best describes the file/s that will be saved.

Saving in a Folder

1. Click or double-click the folder where you wish to save a file.
2. Type a filename and click ***Save***.

A word or two of caution:

1. You must choose filenames that are meaningful to you and to the work you are doing. Such names as **x12, arg4,** etc.. are meaningless and will create confusion . Appropriate names would be **StockMay2006** (stock taken on May 2006), **ChemicalRequestJune2006** (Letter written in June 2006 to request for replenishment of stock in the Chemistry laboratory)

2. Make it a habit of saving your work very often. You may have to face the misfortune of losing your valuable work should there be a load shedding. Saving file 'on the go' is quite simple. Just press ***Cntrl and*** hit ***S (****save).*

Basic Features

We shall now use **cut, copy, paste, AutoText, spell check, find, replace, and fonts** in order to automate some procedures and also, to improve the appearance of our document.

Open File

You may wish to type a fresh paragraph or, alternatively, open an existing file.
To continue working on a file you previously saved, you must open the file. Follow the steps in order to open a file.

1. Choose ***File > Open*** from the menu.
2. Locate the file in the ***Look In field.*** You may have to look for the file in the appropriate folder.
3. Click Open. The file appears.

Cut and Paste, Copy and Paste

You can ***cut (delete)*** text from one area of a document and save it so it can be ***paste***d elsewhere in the document. Text that is ***cut*** (or ***copied***) is stored on the Clipboard (memory of the computer). This text is available for use (***paste)*** at a later stage. You can paste Clipboard information as often as you like.

(a) ***Cut***ting ***text***

When you cut (or copy) text, it is stored in a part of the computer's memory called the '***Clipboard'***. You can also copy text. When you copy text, it is also stored on the Clipboard. Information stored on the Clipboard stays there until new information is either cut or copied. Each time you execute Cut or Copy, you replace the old information on the Clipboard with whatever you just cut or copied...

Place the cursor at the beginning of the text you want to ***cut*** or ***copy***. ***Highlight*** until the end of the portion of text you wish to ***cut*** or ***copy***. Either,

(i) Press ***Ctrl*** followed by ***X*** ***(Ctrl + C,*** if you want to copy onto Clipboard, or

(ii) Position the pointer anywhere on the highlighted area and press the right button (right click). Choose the appropriate option from the dropdown menu.

(b) ***Past***ing text

A text that has been ***cut*** or ***copied*** can be ***pasted*** at any insertion point. Place the insertion point at the location you wish to copy the text to. Then, either,

(i) Press ***Ctrl + V***, or

(ii) Right click the mouse and choose option ***Paste*** from the dropdown menu. Click the ***Paste*** icon  . From the Toolbar.

Spell Check

Spell check is a facility that helps you to check your spelling and grammar as you type. Spelling errors display with a red wavy line under the word. Grammar errors display with a green wavy line under the error. Spell checking your entire document can be effected by one of the following:

(i) Press F7, or

(ii) Click the spelling icon  , or

(iii) Choose ***Tools > Spelling and Grammar*** from the menu.

If you want to spell check part of your document, highlight the area you want to spell check and then resort to one of the above actions

Note:

1. If the word is misspelt in several places in the document, click ***Change All*** to correct all misspellings.

2. Some words (especially names of people or places) may not be in the internal dictionary of Word. If you frequently use a word not found in the dictionary, you should add that word to the dictionary by pressing the Add to Dictionary button. Word will then recognize the word the next time it encounters it. Click ***Add to Dictionary***. Click ***Ignore*** if you want to leave the word unchanged.

A word of caution:

You must always proof read your document after spell checking it. Word only helps you to remove certain spelling mistakes. For example, it will not stop at the word '*see*' in the sentence "*I went to the see'*.

Find and Replace

If you need to find a particular word or piece of text, you can use the ***Find*** command. If you want to search the entire document, simply execute the ***Find*** command. If you want to limit your search to a selected area, highlight that area and then execute the ***Find*** command.

After you have found the word or piece of text you are searching for, you can replace it with new text by executing the ***Replace*** command.

Effecting ***Find*** and ***Replace***

Choose ***Edit > Find*** from the menu. Type the word/s you wish to locate. If you want to replace it by another word/s, click on ***Replace*** and type the word/s in the empty textbox.

Alternatively you may choose ***Edit > Replace*** if you know that some word/s need to be replaced.

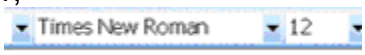
Fonts, Font Size and other formatting Tools

Font is the "family" of typefaces you use for your text. Word has many fonts preinstalled. Some of these are **Arial, Courier, Times New Roman**.
Font size is the size (height and weight) of the font.

Fonts and font sizes can be changed before or after text is/has been typed.

Changing Font/Font size

Highlight text which needs to be thus formatted.

1. Click ***Format > Font***. Select the font and font size you wish the text to have, or,
2. Click 

from the toolbar and click the 'down' arrow. Choose the correct font and adjust the font size by clicking the other 'down' arrow.

Formatting Formulae

Laboratory attendants are sometimes called upon to write formulae. This can be implemented effectively if one uses a few basic skills. Some formulae of chemicals have small numbers written at the bottom (subscript) or at the top (superscript) of the set of characters.

Examples: H_2SO_4, (2 and 4 are subscripts)
SO_4^{2-} (4 is subscript and 2- is superscript)

To write formulas follow the following steps:

1. Type the characters which make up the formula, e.g., SO42- (sulphate ion)
2. Highlight 4
3. Click ***Format > Font*** from the Toolbar
4. Check the ***subscript*** checkbox
5. Highlight 2-
6. Click ***Format > Font*** and check the ***superscript*** checkbox

The formula should now appear as SO_4^{2-}. **Note:** The checkboxes must be cleared after you have done these formatting otherwise, you will continue typing in 'subscripted' or 'superscripted' form. The same set of actions as above is used.

Do not forget to save your file.

Working with Paragraphs

Formatting a paragraph can be effected by either,

(i) highlighting the text and choosing the appropriate paragraph format, or,
(ii) Just placing the cursor anywhere in the paragraph. After you set a paragraph format, subsequent paragraphs will have the same format unless you change their format.

You choose the option that best suits your purpose.

In order to end a paragraph, press ***Enter*** once. It is better to press ***Enter*** twice so as to leave a blank line and thus, increase visibility. (**Note:** There are other ways of formatting paragraphs.

Line Spacing

Line Spacing sets the amount of space between lines within a paragraph. You may choose any one of the methods mentioned above so as to format a paragraph. Single spacing is the default. At ***1.5 lines***, the ***Line Spacing*** is set to one-and-a-half times the single-space amount. For ***double-spaced lines***, the line spacing is set to two times the single-space amount. You need to format the paragraphs so as to have a document that impresses the reader.

After having highlighted the lines you wish to format, do the following:

1. Choose ***Format > Paragraph*** from the menu
2. Click to open the drop-down menu on the ***Line Spacing*** field
3. Choose the option that applies and click ***OK.***

Indentation

Indentation allows you to indent your paragraph from the left or right margin. The following examples show different types of indentation.

Procedure:

1. Highlight a paragraph (preferably NOT the first or last one).
2. Choose ***Format > Paragraph*** from the menu.
3. Type **1"** in the Left field.
4. Type **1"** in the Right field.
5. Click OK. Your paragraph is now indented one inch from both the left and right margins.

Alignment

You can flush your text either to the left (***left-justified/aligned***) or to the right (***right justified/aligned***). You can also ***fully justify*** the text (both left and right aligned) or ***centre*** it.

Left-Justified, Right-Justified, Fully-Justified, Centered

Highlight text

1. Choose ***Format > Paragraph*** from the menu.
2. Choose ***the Indents and Spacing tab***.
3. Click to open the ***Alignment*** pull-down menu.
4. Click ***Left/Right/Justified/Centered***
5. Click ***OK***...

The paragraph is aligned as required.

Save File and Exit Microsoft Word

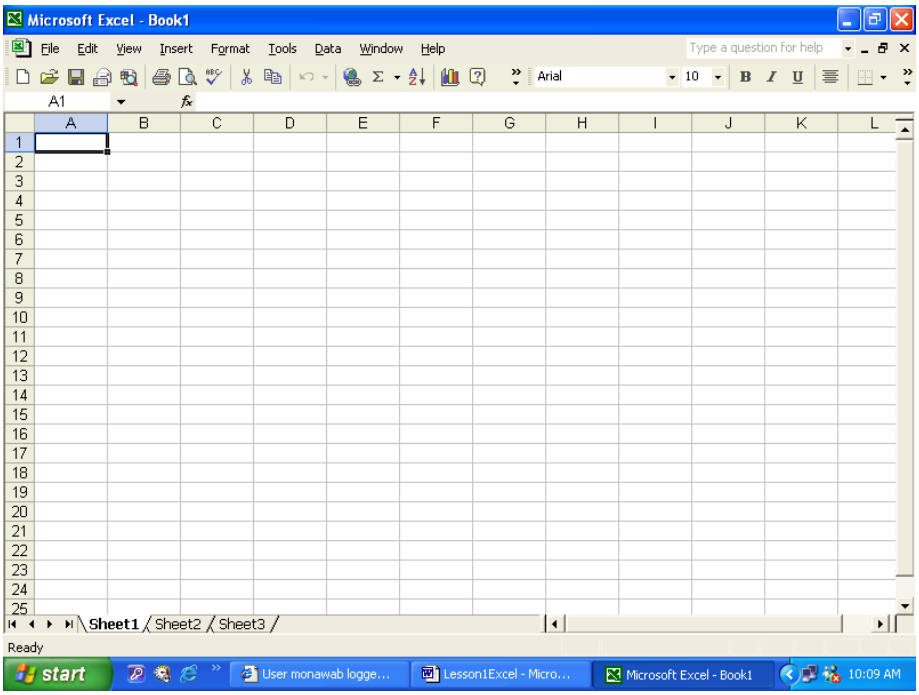
6.2 THE MICROSOFT EXCEL WINDOW

Open Microsoft Excel using one of the following methods:

(i) From the Desktop click or double-click the icon for Excel

(ii) Press ***START > PROGRAMS,*** slide to the right and locate Excel. Click once.

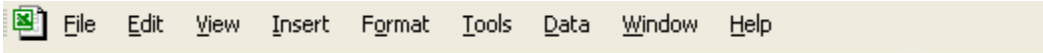
The task pane may appear at the right hand corner. This takes up some display space. Close it by clicking the ✕ in the upper right corner.
You will have a similar screen display to the one shown below.



The Title Bar

The ***Title bar*** is located at the very top of the screen. This displays the name of the workbook you are currently using. The top of your screen shows "Microsoft Excel - Book1" or a similar name.

The Menu Bar



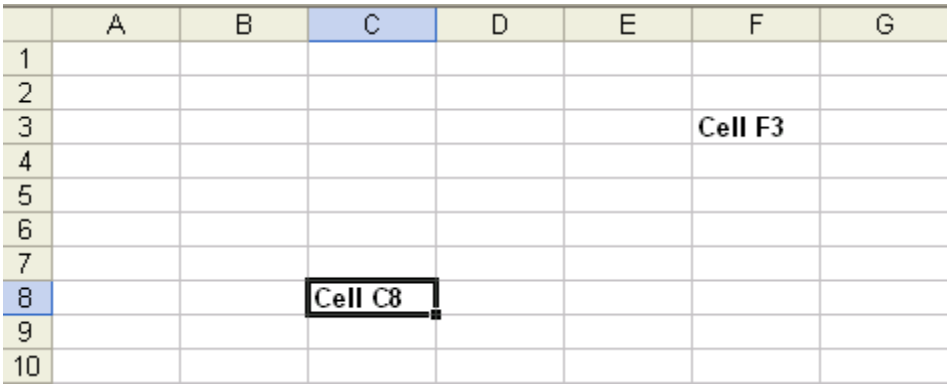
As in **Microsoft Word** and many applications for **Windows**, the ***Menu bar*** is directly below the Title bar. It contains the following: ***File, Edit, View, Insert, Format, Tools, Data, Window, and Help.*** If you point with your mouse to a menu option and click the left mouse button, a drop-down menu opens. Use the left and right arrow keys on your keyboard to move left and right across the Menu bar. Up and down arrow keys may also be used to move up and down the drop-down menu. To choose an option, highlight the item on the drop-down menu and press Enter. An ellipse (…) after a menu item signifies additional options; if you choose that option, a dialog box opens.

Toolbars

Toolbars provide shortcuts to menu commands. A tool can be 'activated' by the following steps:

View > Toolbars and then checking the appropriate tool.

Worksheets

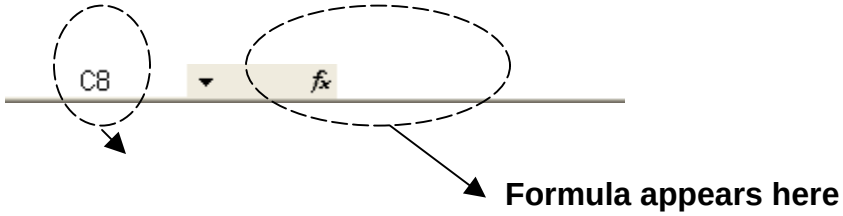


A worksheet is the area where you 'work'. It consists of columns and rows. The columns are lettered **A** to **IV**; the rows are numbered **1** to **65536**. This is quite a huge worksheet (maybe the size of a football stadium!). You will seldom use the entire worksheet.

We refer to a cell address by a combination of the column coordinate and the row coordinate. Cell **A1** is located at the top left hand corner (i.e. column **A** and row **1)**. The screenshot above shows cells C8 and F3.

The Formula Bar

Set the Formula bar by clicking on ***View*** and checking the ***Formula bar*** checkbox (if it is empty).



1. This bar displays the cell address. The ***Name box*** is on the left side and the formula shows next to the ***fx***.

The Status Bar

Turn the ***Status bar*** on by checking it in the ***View*** menu. This bar appears at the bottom of screen.

The word "**Ready**" indicates that Excel is in the Ready mode and is waiting for you to type in your next command. As you work through you will see other indicators that appear on the lower right corner of the screen.

Experience it by pressing each of the following toggle keys a few times:

Num Lock, Caps Lock, Scroll Lock, End

Navigating across the worksheet

Arrow Keys

You can use the up/down/left/right arrow keys to 'navigate' through the worksheet, one cell at a time.

The Tab Key makes you move across the page to the right, one cell at a time
Use ***Shift+Tab Keys*** to move to the left, one cell at a time.

Use ***Page Up and Page Down*** keys move the cursor up and down one page at a time.

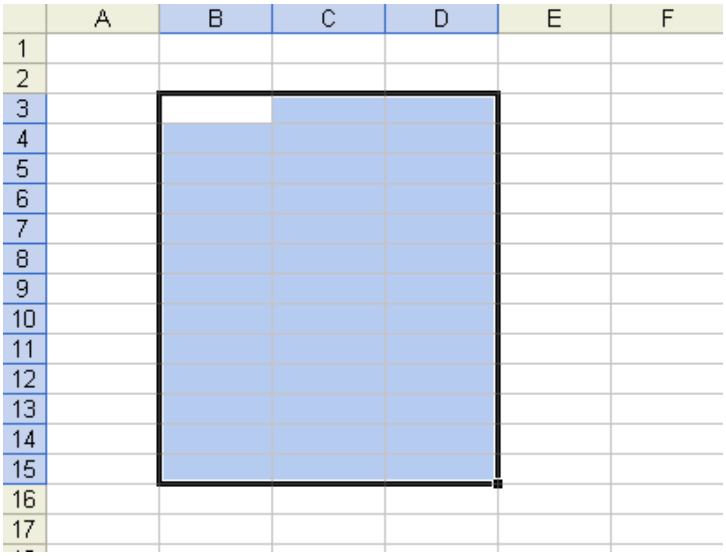
End Key + an arrow key cause the cursor to move to the far end of the spreadsheet in the direction of the arrow. The End key moves you to the end of the data area.

A combination of ***Home Key + Cntrl Key will take you*** to cell A1, or to the beginning of the data area if you have entered data.

Note: There are other shortcuts that will enable you to moving quickly around the Worksheet

However, you can type the address of the cell in the ***Name Box*** and press ***Enter***. This will take you to that specific cell.

Selecting Cells



A group of cells is selected by highlighting them in the following way:

Place cursor at the cell you wish to start the highlighting to begin with (e.g., Cell B3). Then either,

(i) Click the left button of the mouse and drag sideways and/or down until you reach the last cell you wish to include. Release the button, Or,

(ii) Press ***SHIFT*** and use one of the arrow keys to move in the direction you wish. Release the ***SHIFT*** button, or,

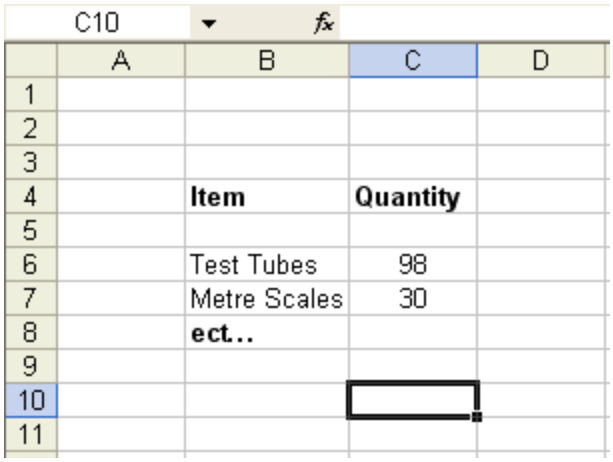
(iii) Press ***F8*** key in order to anchor (position) the cursor. (Note that "EXT" appears on the Status bar in the lower right corner of the screen. You are in the *Extend mode*). Click in the last cell (e.g., D15) you wish to include. All cells between B3 and D15 will be highlighted. To 'deactivate' highlighting, press ***F8*** again.

There are other methods of highlighting/selecting cells. These are beyond our scope.

Entering Data

Entering data into cells is quite simple. Simply place the cursor in the cell in which you would like to enter data. Then you type the data and press ***Enter.***

Note: The position of the cell is displayed in the ***Name box***. You may go to a particular cell by typing the cell reference in the ***Name box*** and then pressing ***Enter***.



In the above example, the cursor is presently at C10. Can you read the cell references of the entries?

Editing a Cell

You may use one of the following ways to edit data in a cell. Move cursor to the cell you wish to edit, then,

(i) Press ***F2,*** Edit data. Press ***Enter.***

(ii) Click on the ***Formula bar,*** Edit data. Press ***Enter.***

(iii) Double-click in the cell. Edit data. Press ***Enter.***

Note: Typing in a cell while you are in the ***Ready*** mode replaces the old cell entry with the new information you type

Wrapping Text

Some texts are too long to fit in a cell. You can fix it by choosing

(i) ***Format > Cells*** from the menu, the

(ii) ***Word wrap*** from the ***Alignment tab.***

using the following procedure:

Deleting a Cell Entry

Highlight cell or group of cells press ***Delete***.

Entering Numbers as Labels or Values

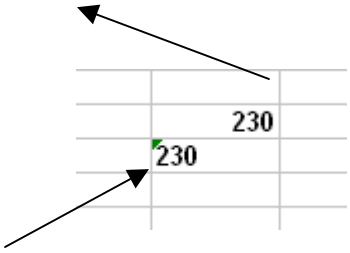
Labels are alphabetic, alphanumeric, or numeric text *on which you do not perform mathematical calculations*.

Values are numeric text on which you perform mathematical calculations. If you have a numeric entry, such as an employee number, on which you do not perform mathematical calculations, enter it as a label by mark first.

By default, any number that is typed into a cell is a '*numeric value*'. That is, you can perform mathematical calculations with it.

However, if you do not wish to perform any calculation with it, enter it as a ***label.*** This can be done by simply typing a single quotation just ***before*** the number.

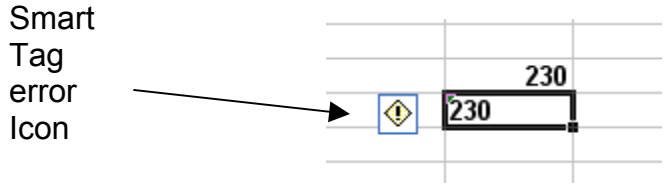
E.g: (i) 230 (**numeric**). Number is right-aligned (by default)



(ii) **'**230 (**label)** is left-aligned and a green triangle appears in the upper left corner of the cell

Smart Tags

If you want to convert a number entered as ***label,*** use ***Smart Tags.*** Cells with smart tags in them appear with a green triangle in the upper left corner.



When you place the cursor in the cell, the ***Trace Error icon*** appears. Click the ***Trace Error icon***. Options appear. Choose the option that fits the purpose.

Saving a File

Choose ***File > Save*** from the menu. Type an appropriate filename and click ***Save***.

Closing Microsoft Excel

Choose ***File > Close*** from the menu.

Choosing a typeface for your spreadsheet.

You may choose a default font in the following way:

To set your font to Arial, Regular, and Size 10:

1. Choose ***Format > Cells*** from the menu.
2. Click the Font tab and choose the *Font*, *Font Style* and *Font Size*
3. Check ***Normal Font*** box so as to make this your default typeface.
4. Click ***OK***.

Adjusting the Standard Column Width

By default, the width of each cell is set a standard column width. Follow the steps below to change column width if you wish to change it.

Choose ***Format > Column > Standard Width*** from the menu. In the **Standard Width** dialog box type a figure, (e,g., 15) and press ***Enter***. See the effect.

Cell Alignment

Type a name in one of the cells and align it accordingly using the following procedure:

(i) ***Format > Cells*****.** Choose **Alignment** tab. Choose ***Left/Right/Center,*** or,

(ii) Click one of the icons ***Left/Right/Center.*** 

Adding Bold, Underline, and Italic

You can bold, underline, or italicize text by clicking a cell or highlighting a series of cells. Two methods of doing this are:

(i) Click on one of the icons form the **Toolbar**  **,** or,
(ii) Choose ***Format > Cells > Font Tab >Bold/Italic (from Font Type)*** and ***Single/Double*** associated with the ***Underline box***.
(iii) Press and hold **Cntrl** button and hit the letter **B/I/U.** Release **Cntrl** button.

Note: You can bold, underline, *and* italicize a single piece of text using all three icons one after the other.

Removing Formatting (Left/Right/Center) Bold, Italic, Underline) from text.

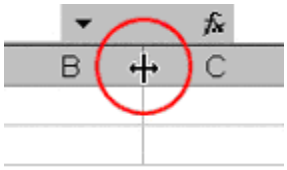
Highlight the cell/s and click on the appropriate icon from the **Toolbar** again in order to remove formatting from text. Alternatively, press and hold **Cntrl** button and hit the letter **B/I/U.** Release **Cntrl** button.

Adding Colour

Sometimes, we need to format text in such a way that they 'stand out'. One of the ways that this can be done is by displaying such text in colour. This can be done by ***Format > Cells > Color*** and selecting an appropriate colour from the drop down window.

Working with Long Text

A long text entry spills over the adjoining cell such that the entry in that cell appears 'cut'. Place the cursor on the line between the column headings (e.g., between B and C. The cursor should look like the one displayed here, with two arrows pointing left and right



Then,

(i) Move your mouse to the right while holding down the left mouse button. The width indicator appears on the screen. Release the mouse button, or,

(ii) Double click the left button. The column will adjust itself and will take the size of the longest word in any one cell.

Making Numeric Entries

In Microsoft Excel, numbers are right-aligned. You can perform mathematical calculations such as addition, subtraction, multiplication, and division.

Important: ***When entering a mathematical formula, precede the formula with an equal sign (=).***

Performing Mathematical Calculations

It is here that the power of a spreadsheet is really understood. Spreadsheets are used to perform a multitude of mathematical and scientific calculations. It is mainly used in modelling "**what-If"** situations. The following exercises demonstrate how to perform mathematical calculations.

Create the following spreadsheet:

	A	B	C	D
1				
2		**Class**	**No. Of Students**	
3				
4		**1 Red**	**32**	
5		**1 Blue**	**35**	
6		**1 Yellow**	**37**	
7		**1 Green**	**30**	
8				
9		**Total**		
10				

There are a few ways of doing ***Addition.*** Some of them are:

(i) Click in cell C9 (on the right of the "**Total"** label), type **= C4 + C5 + C6 + C7** and Hit **Enter.**

(ii) Click in Cell C9, type **=**, type **Sum(** (open bracket). Click in cell **C4**, type **:** (column) and click in cell **C7. Type)** (Close bracket). The formula becomes **=Sum(C4:C7).** Hit **Enter.**

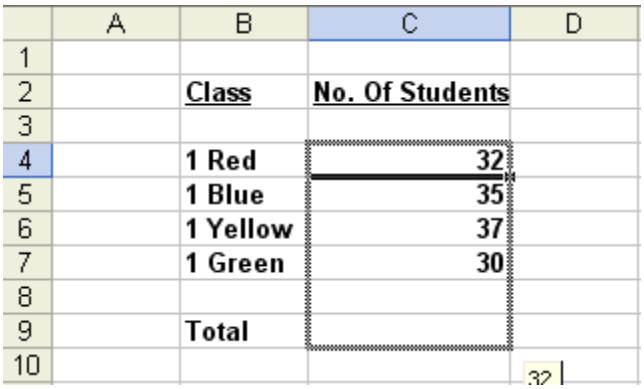
(iii) Click in cell C9 and press the **AutoSum** icon Σ. All numbers above C9 will be summed.

(iv) Click in cell C4. Press the **handle** (small square at the bottom right-hand corner) with the left button.

	A	B	C	D
1				
2		**Class**	**No. Of Students**	
3				
4		**1 Red**	**32**	
5		**1 Blue**		
6		**1 Yellow**		
7		**1 Green**	**30**	
8				
9		**Total**		
10				

handle

Drag vertically down and release the button when you reach cell C9 (for **Total**). See below:



	A	B	C	D
1				
2		**Class**	**No. Of Students**	
3				
4		**1 Red**	**32**	
5		**1 Blue**	**35**	
6		**1 Yellow**	**37**	
7		**1 Green**	**30**	
8				
9		**Total**		
10				

Once you release the button (or hit **Enter** as in the previous examples), Excel computes the Total (**Sum**) and displays it in cell C9. The appropriate formula is also displayed in the ***Formula bar***.

Subtraction, Multiplication and Division may be performed in a similar way. However, you must note the following:

(i) Type the **=** (equal to sign) before typing in any expression/formula

(ii) Execution takes place following the concept of precedence used in Mathematics. Calculations are performed from left to right, with multiplication and division performed before addition and subtraction

Note: Do the following if you want to move to a particular cell:

Press **Cntrl + g.** In the ***Reference*** field type the cell address you wish to go to.

Automatic re-calculation takes place whenever figures are changed in cell/s. Perform the following to turn this option on (if it is not selected). Choose ***Tools > Options > Calculation tab.*** Select the ***Automatic*** radio button.

Try this by changing the number of students in each class. You will see the effect in the ***Total.***

Formatting Numbers

You can add commas to separate thousands, specify the number of decimal places or display the number as a percent in addition to several other options. After typing a figure in a cell,

Format > Cell > Number tab. Select any one from the list. If you choose *Number,* then specify the number of decimal places by entering a digit in the ***Decimal places*** dropdown list. If you want to commas (**,**) to be displayed after every three digits starting from the right then check the ***Use 1000Separator(,)***

Click ***Ok*** when you have done the formatting.

You also format numbers by making use of the appropriate icon/s from the ***Toolbar***.

Copying and Pasting

(a) Using the menu

When data is ***copied***, it is placed in a part of the computer's memory, called the ***Clipboard***. This data is available for ***pasting*** at a later stage. You can copy entries from one cell to another cell. To copy the formula or contents of a cell or cells, follow these steps:

(i) Highlight the cell/s containing data you wish to copy.
(ii) Choose ***Edit > Copy***. (or you can click the ***copy*** icon from the ***Toolbar*** ). Moving dotted lines appear around cell/s
(iii) Click in the cell where you wish to ***paste*** data
(iv) Choose ***Edit > Paste***. (or click the ***paste*** icon from the ***Toolbar*** 
(v) Press ***Esc*** to exit the ***Copy*** mode.

Formulas can be copied in a similar way. However, the cell reference changes to take up the reference of the new cell. r.

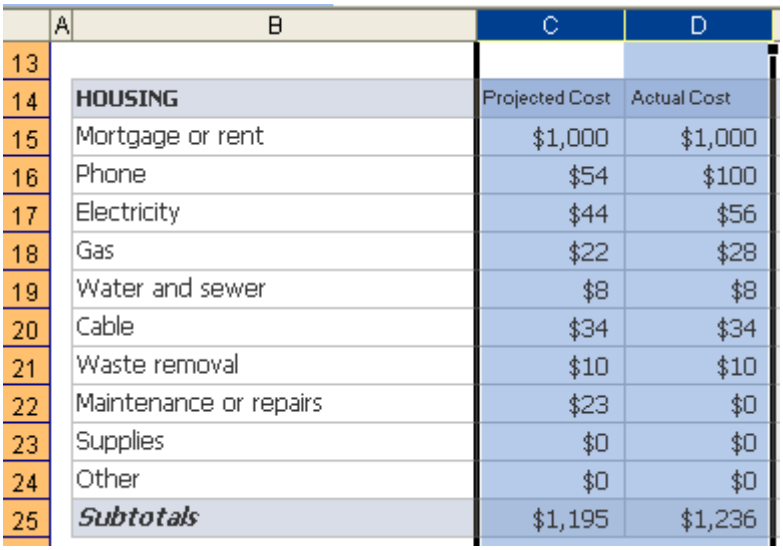
(b) Using the Keyboard Shortcut

(i) After highlighting the cell/s, press ***Cntrl* + C** (copy).
(ii) Move to cell you wish to paste. Press ***Cntrl + V*** (paste). Your cursor should be in cell C10.
(iii) Press ***Esc*** to exit the ***Copy*** mode.

Deleting

(i) Columns

To delete columns C and D:
Click on column C and drag to column D.



	A	B	C	D
13				
14		**HOUSING**	Projected Cost	Actual Cost
15		Mortgage or rent	$1,000	$1,000
16		Phone	$54	$100
17		Electricity	$44	$56
18		Gas	$22	$28
19		Water and sewer	$8	$8
20		Cable	$34	$34
21		Waste removal	$10	$10
22		Maintenance or repairs	$23	$0
23		Supplies	$0	$0
24		Other	$0	$0
25		***Subtotals***	$1,195	$1,236

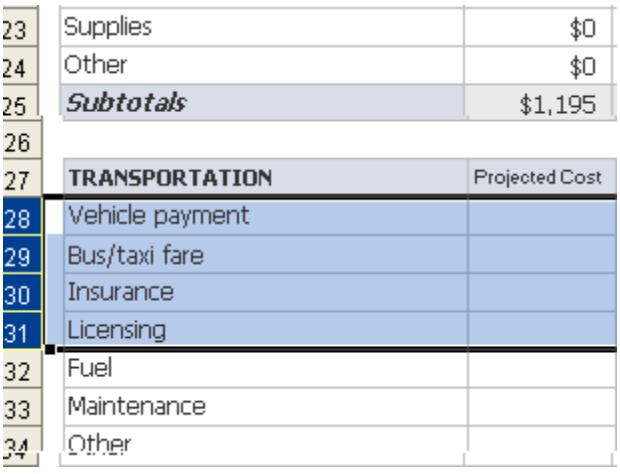
Choose ***Edit > Delete*** from the menu. Column D is deleted. Click anywhere on the spreadsheet to remove your selection.

Note: Excel will re-label the columns

Rows

You can delete rows from your spreadsheet. To delete rows 28 through 31:

Click the row 28 and drag to row 31.



23	Supplies	$0
24	Other	$0
25	***Subtotals***	$1,195
26		
27	**TRANSPORTATION**	Projected Cost
28	Vehicle payment	
29	Bus/taxi fare	
30	Insurance	
31	Licensing	
32	Fuel	
33	Maintenance	
34	Other	

Choose ***Edit > Delete*** from the menu. Rows 28 through 31 are deleted. Click anywhere on the spreadsheet to remove your selection.

Note: Excel will renumber the rows

Inserting

(i) Columns

Click on the column where you wish to add a column. Choose ***Insert > Columns*** from the menu. A column is inserted to the right of the column

(ii) Rows

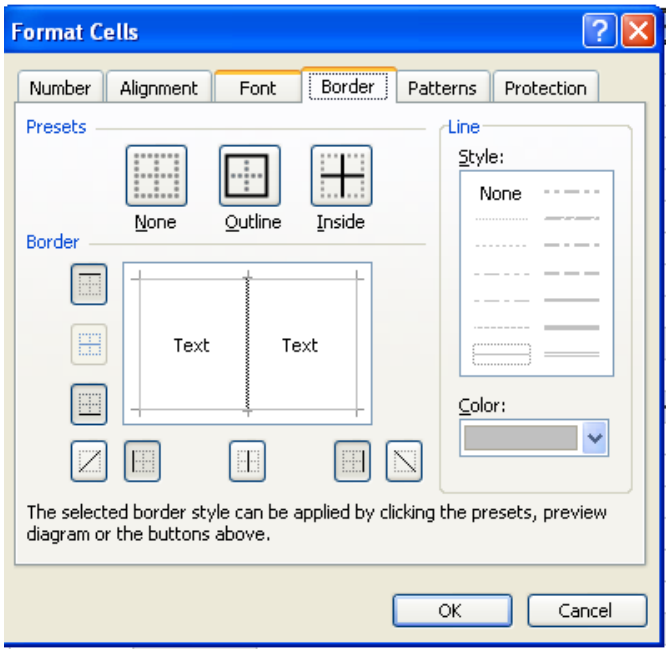
Click on the row number where you want to add a row. Choose ***Insert > Rows*** from the menu. A row is inserted above row.

Creating Borders

You can use borders to make entries on your spreadsheet stand out. Select/highlight the cell/s you wish to add borders to. Choose ***Format > Cells >.***

Border Tab. You may now select any one (or several) from the options shown in the ***Format Cells*** drop down window. You may also choose the ***Line Style***.

If you wish to add background colour to the cell/s then choose the ***Patterns*** tab ***>(your choice from the palette of colours)***



Printing

The simplest way to print is to click the Print icon located on the Standard toolbar. Dotted lines will appear on your screen after you click the print icon. The dotted lines indicate the right, left, top, and bottom edges of your printed pages.

Print Preview

There are many print options. You can select print options in ***Page Setup*** or in ***Print Preview***. In ***Print Preview,*** you can see the results of your selections onscreen. Among the many print options given you may:

- Determine whether to print landscape or portrait.
- Scale (up or down) your document so the data fills the entire page.
- Specify how many pages wide and how many pages long you want your printed document to be.
- Select the paper size and print quality.
- Set the first page number.

The ***Margins tab***, will allow you to:

- Set the size of your margins
- Centre your spreadsheet horizontally and/or vertically on the page.

To preview and print your spreadsheet choose ***File > Preview*** from the menu.

Saving Your File

To save your file:
Choose ***File>Save*** from the menu.

Opening a File

Choose ***File > Open*** from the menu. Go to the directory where the required file is found. Select it by clicking on it. Click ***Open***.

6.3 THE INTERNET

The Internet is a computer network made up of thousands of networks worldwide. No one knows exactly how many computers are connected to the Internet. It is certain, however, that these number in the millions and are growing.

No one is in charge of the Internet. There are organisations which develop technical aspects of this network and set standards for creating applications on it, but no governing body is in control.

The Internet consists primarily of a variety of access procedures (protocols). Many of these protocols feature programs that allow users to search for and retrieve material made available by the protocol.

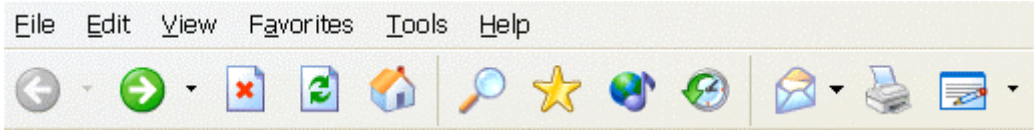
The **World Wide Web** (abbreviated as the ***Web*** or ***WWW***) was developed in 1989 by Sir Tim Berners-Lee, Fellow of the British Computer Society. It is a system of Internet servers that makes it possible to access several Internet protocols. The Web is the fastest-growing component of the Internet. It consists of files, called ***pages*** or ***home pages***, containing **links** to documents and resources throughout the Internet.

The operation of the Web relies primarily on hypertext as its means of information retrieval. ***Hypertext*** is a document containing words that connect to other documents.

HTTP (***Hypertext Transfer Protocol***) transmits hypertext over networks. This is the protocol of the Web.

Words can be ***linked*** to other ***pages***. A single hypertext document can contain links to many documents. In the context of the Web, words or graphics may serve as links to other documents, images, video, and sound. Overall, the Web contains a complex virtual web of connections among a vast number of documents, graphics, videos, and sounds.

THE TOOLBARS



Menu Bar: Contains menu items that open up dropdown lists for related options.

Navigation Toolbar: Contains icons for a variety of features including navigating among Web pages, searching the Web using a selection of search tools, accessing and managing Favorites, viewing a History of visited pages, printing, and accessing email and newsgroups.

ACCESSING RESOURCES ON THE WEB

1. If you have the URL (address) of a Web page

Type the URL (refer to **Anatomy of a URL**) in the **Address** bar at the top of the screen. To accomplish this, click on the **Address** bar to highlight the current URL. Then type in the new URL and press the Enter key.

2. If you are on a Web page

Click on:

- words or images which change the shape of the mouse pointer from an arrow to a hand and display a URL on the bottom of the screen when the mouse pointer is placed over it
- the blue words on the display screen
- the purple words on the display screen (the purple colour indicates that the resource has been recently accessed on your terminal)

NAVIGATING THE WEB

To go back to previous sites:

Click on the small **Back** left arrow  on the navigation bar near the top left corner of your screen. Each time you click on this arrow, you will return to the next previous site that you visited. If you hold your mouse over the **Back** arrow, the title of the upcoming page will briefly appear.

To move forward:

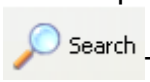
When you have returned to previous sites with the **Back** arrow, you can go forward again by clicking on the small right-pointing arrow next to the **Back** arrow. If you hold your mouse over this arrow, the title of the upcoming page will briefly appear.

To move farther ahead, click on the small black triangle to the right of the Forward arrow  in the menu bar at the top of the screen. This presents a list of several sites you have visited. Click on any of the choices to return to the desired site. This is the equivalent of clicking on the **Forward** arrow several times.

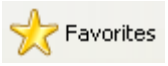
Stop:  This icon will stop a page while it is in the process of loading. This is useful if a page is not successfully or speedily retrieving.

Refresh:  The square containing the two curved arrows re-retrieves the page you are currently viewing. This is useful if the page does not load successfully or completely.

Home:  The home icon takes you back to the page that was on the screen when Internet Explorer was first started

Search: 

The search button opens up a function that uses one or more Web search tools. You can choose the search tool(s) you want as your default.

Favorites: 

Favorites are Web sites you have visited that you would like to store for easy access. You can add, delete and organize your Favorites.

To *add* the current Web page as a favorite, click on **Favorites** and then **Add**. To choose the folder where you want to store this listing, click on **Create in** and choose the folder you want. At this point, you also have the option to create a new folder.

To *delete* a Favorite, simply right click on the item and choose **Delete**. Or, you can choose **Organize Favorites** select the desired item, and click on the **Delete** button.

To *move* a favorite to another folder, click on **Organize Favorites**, select the desired item, and click on **Move to folder**. In the pop-up window, select the folder where you would like to store this listing.

History:  The history function allows you to view and select Web pages you have recently visited. You can sort your items by clicking on the black triangle to the right of the word **View**. You can sort by size, date, the number of times visited, and the order you have visited today.

Mail:  You can read email from this window.

Print:  Allows you to print the current page.

SAVING AND PRINTING YOUR DOCUMENT PRINT

Follow the steps mentioned in the **Word** module in order to ***Save*** or ***Print*** your document.

What are you really searching?
Finding the Web documents, pages or sites you want can be easy or seem impossibly difficult. This is in part due to the sheer size of the WWW, currently estimated to contain 3 billion documents. It is also because the WWW is not indexed in any standard vocabulary.

When you "search the Web," you are NOT searching it directly. It is not possible to search the WWW directly. The Web is the totality of the many web pages which reside on computers called “servers” all over the world. Your computer cannot find or go to them all directly. What you are able to do through your computer is access one or more of many intermediate search tools available now. The search tool provides you with hypertext links with URLs to other pages. You click on these links, and retrieve documents, images, sound, and more from individual servers around the world.

There is no way for anyone to search the entire Web.

The URL

URL stands for **Uniform Resource Locator**. The URL specifies the Internet address of a file stored on a host computer connected to the Internet. Every file on the Internet, no matter what its access protocol, has a unique URL. Web browsers use the URL to retrieve the file from the host computer and the specific directory in which it resides. This file is downloaded to the user's computer and displayed on the monitor connected to the machine.

Anatomy of a URL
This is the format of the URL:
protocol://host/path/filename
For example, this is a URL on the Web site of the Mauritius Research Council:

http://www.mrc.org.mu/ScienceEducation.htm

Structure of this URL:
1. Protocol: **http**
2. Host computer name: **www**
3. Second-level domain name: **mrc**
4. Top-level domain name: **org**
5. Directory name: **mu**
6. File name: **ScienceEducation.htm**

The following are some of the top-level domains (TLDs) that are common:

com	commercial enterprise
edu	educational institution
gov	government entity
net	network access provider
org	usually non-profit organisations

Search Engines

If you want to find information about a specific topic you will need to use an **Internet Search Engine**, a Web site where you can search for information using keywords.

A search engine is a searchable database of Internet files collected by a computer program.

Some of the commonly used search engines are:

1. Google – http://www.google.com
2. YAHOO! – http://www.yahoo.com
3. Ask.com – http://www.ask.com
4. altavista – http://www.altavista.com
5. msn Search – http://search.msn.com

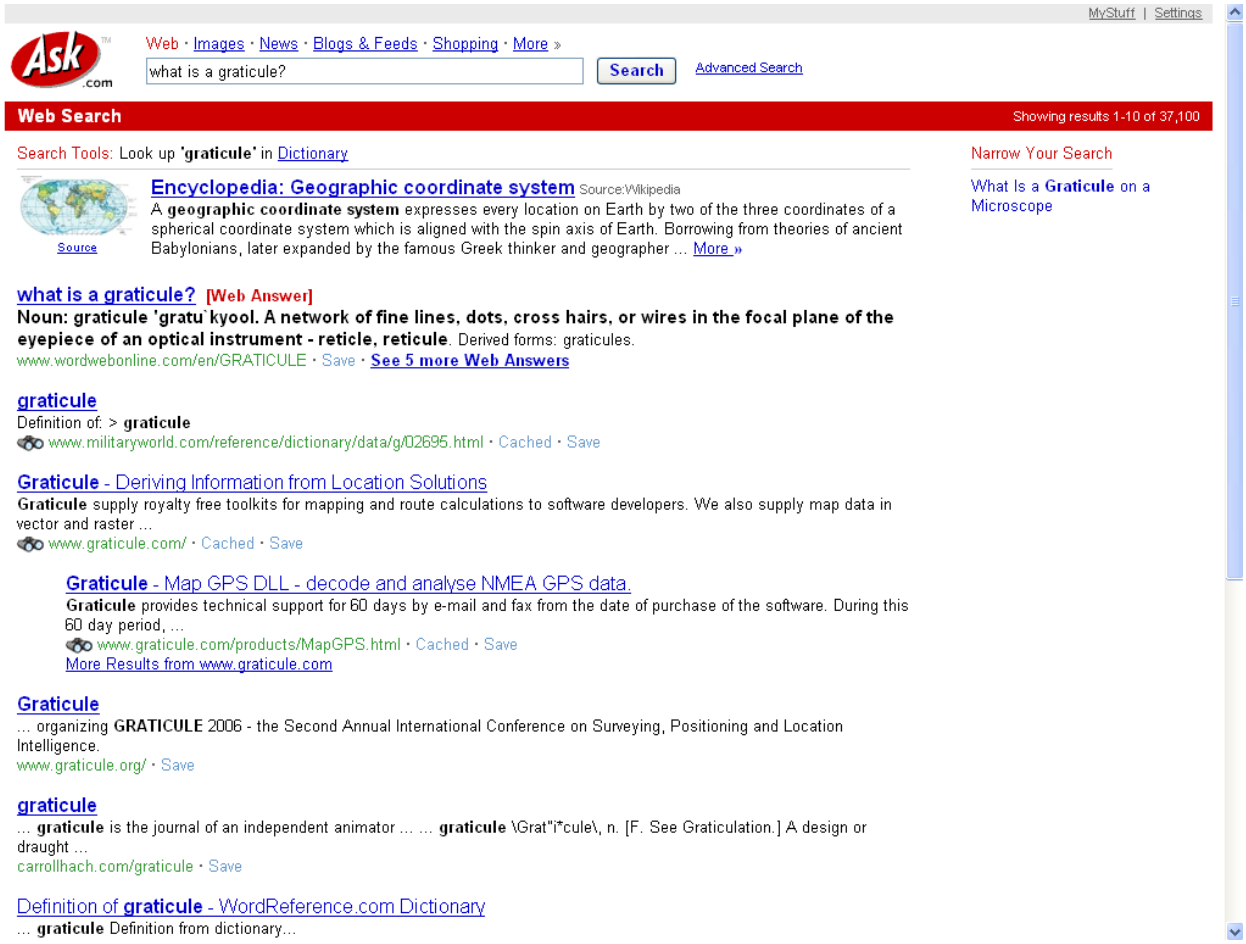
Using a Search Engine

The image above shows **Google**, a typical Internet search engine. Every search engine is somewhat different, but they all have the same basic features.

To begin your search you should click with your mouse in the blank search box. A small flashing black line should appear. Type in words describing what you are looking for. Be as specific as possible. Click the ***Google Search*** button to begin searching the Internet. (Depending on which search engine you use, the Search button may either be next to or below the search box.)

Search Engines index hundreds of thousands of Web sites, so the chances are good that you will get a list of thousands of Web sites that match your keywords. The matching sites will be listed in order of relevance so you are most likely to find what you need by visiting the sites listed in the top 1-10.

Some search engines, such as **Ask Jeeves (http://www.ask.com)**, support natural language searching. This means that you can type in a question about the topic you are interested in. For example, you could type **What is a Graticule?** you will get back a list of web sites relating to your question. An example is given below

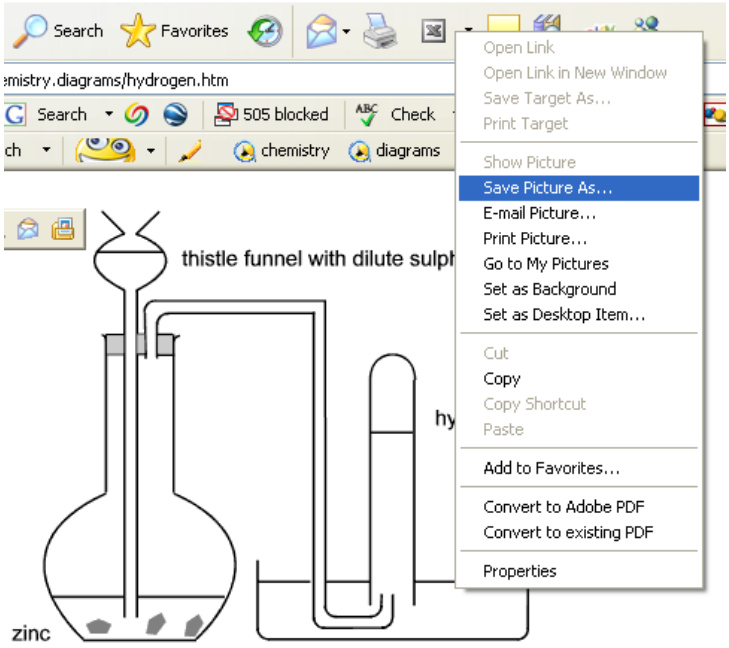


The display above shows some links (underlined) from where you can get more information/material about "**Graticule**". If you run the mouse pointer over those links, a "hand" appears. Clicking will take you to some other links or pages

How to Capture a Graphics (pictures) on the Web to a Diskette/Hard disk

Graphics are files and they may not normally be saved by the ***Save*** procedure as in **Word**. Follow the following procedure in order to save graphic files:

1. Aim your mouse arrow exactly over the graphic.
2. Press down the **RIGHT** mouse button and hold it down. A drop-down menu will appear.
3. Slide down the mouse until you highlight the words, "***Save image as***." Let go of the mouse button.



4. A window will open up. There will be a "Save in" area. Click on the down arrow and navigate to the A drive/Hard drive. Click on the drive you wish to save.

5. Also in this window, you will see "File Name" with a filename specified. This is the name assigned to the graphics file by its author. You can change the name if you like.

   Click on OK. The file will save to your destination drive.

Mauritius Research Council

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