

SAFETY PRECAUTIONS

IN

**INTEGRATED
SCIENCE
EXPERIMENTS**



**PHYSICAL SCIENCES SECTION
ADVISORY INSPECTORATE
EDUCATION DEPARTMENT
1999**

PREFACE

This pamphlet is a revised edition of the one published in 1995. There are some changes and additions. Aiming at promoting laboratory safety in the teaching of Integrated Science, the pamphlet highlights the safety precautions to be taken in experiments and activities as suggested by the CDC Syllabus for Science (Secondary 1-3). For easy reference, the experiments and activities listed in part III of the pamphlet are in the order as they appear in the CDC Syllabus.

Teachers are also advised to make reference to the pamphlet *Safety in Science Laboratories* published by the Education Department for more information on laboratory safety.

It must, however, be emphasized that the advice and information offered in this pamphlet are inevitably not exhaustive and do not preclude the need for exercising care and good judgement at all times in safeguarding against laboratory accidents.

Comments and suggestions are welcome and should be directed to the Principal Inspector, Physical Sciences Section, Advisory Inspectorate, Education Department, Room 1208, Wu Chung House, 213 Queen's Road East, Wan Chai, Hong Kong or the e-mail address *physci@hknet.com*.

Physical Sciences Section
Advisory Inspectorate
Education Department
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I. PROPER USE OF PROTECTIVE EQUIPMENT

(i) Safety spectacles/ Face shield/ Safety screen

Teachers, pupils and laboratory staff, when working in the laboratory, should wear safety spectacles in all circumstances wherever there is any potential risk of eye injury. Safety spectacles should always be put on when heating chemicals, handling acids, alkalis and other corrosive chemicals, working with glass apparatus under pressure, or carrying out potentially violent or exothermic reactions. Scratched or defective safety spectacles should be replaced without delay because they may affect visibility and cause strain to the eyes or fail to serve their protective function. Dirty safety spectacles should be cleaned with a detergent or disinfectant (e.g. diluted Savlon) as appropriate.

If a teacher intends to demonstrate potentially dangerous experiments in front of a class of pupils, the safety screen should be used to isolate the apparatus from the pupils. The teacher should also put on proper protective equipment, such as a pair of safety spectacles or a face shield, for his/her own protection.

(ii) Protective gloves

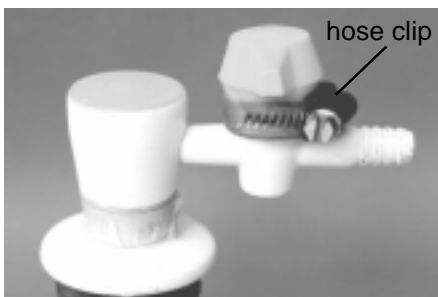
Teachers and laboratory staff, when handling animals and killing animals for dissection e.g. rats, should wear leather gloves so as to avoid being bitten or scratched. Students should also put on surgical gloves during dissection. When working with wormery/snail house or handling microbiological experiments, disposable gloves should be worn in order to prevent infection. Furthermore, chemical resistant gloves should be put on when handling acids, alkalis and organic solvents if necessary, whereas heat/cold resistant gloves should also be used when dealing with furnace or hot plate in the laboratory for protection.

II. SAFE USE OF GAS TAPS

Schools should take safety precautions to prevent accidents due to inappropriate use of gas taps. The main gas supply valve of the laboratory should only be turned on when gas supply is required, and all downstream gas taps inside the laboratory must be in the OFF position before the main valve is turned on. Teachers and laboratory technicians must ensure that Bunsen burners are properly connected to the gas taps before experiments. Schools should also properly secure all unused gas taps in order to prevent them from being mistakenly turned on by pupils. The ways to secure the common types of gas taps are given below for teachers' and laboratory technicians' reference.

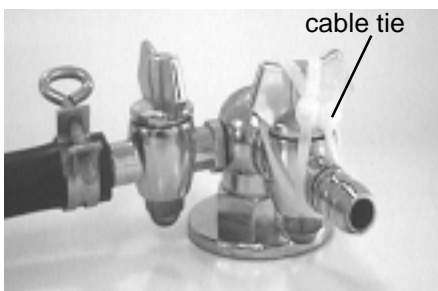
(1) Pressdown type gas tap

The unused gas tap can be secured by fixing a hose clip under the gas tap knob to prevent it from being turned on mistakenly.



(2) Gas tap with automatic shut-off facility and a safety valve

The unused gas tap can be tied up, such as by using a nylon cable tie, to prevent it from being turned on mistakenly.



III. SAFETY PRECAUTIONS IN EXPERIMENTS/ACTIVITIES

Unit 1 Introducing Science

Experiments/Activities

Safety Precautions

C.1 Mixing solutions

Mix solutions of chemicals and make observations.

Label the containers of chemicals with hazard warning labels. Provide pupils with short blunt-end droppers. Pupils should wash their hands after performing experiments in which chemicals have been used.

Explain to pupils the meanings of the hazard warning labels. (*See Appendix A for details.*)

Teach pupils the proper way to hold a reagent bottle and to get solution from it. Remind pupils not to return excessive chemicals back to reagent bottles.

C.2 Measuring temperature, weighing and volume

Blindfold a pupil. Place one of his hands in hot water and the other in ice water.

Do not use hot water above 50°C.

Experiments/Activities

Measure the temperature of air, tap water, icy water, hot water and molten wax, etc.



Safety Precautions

As it is probably pupils' first time to use a thermometer, to play safe, provide them with the alcohol type to start with. Help pupils to develop the good habit of returning the thermometer back to its casing immediately after experiment and putting it in a safe place.

Teach pupils the correct way of using a Bunsen burner, including that the hand should be lower than the top of the chimney when lighting a burner.

If a sharper melting temperature is desired, octadecan-1-ol may be used to replace wax.

Do not use naphthalene to replace wax as the former produces harmful vapour. (See Appendix B for details.)



C.3 Dissolving, evaporation, filtration

Evaporate salt solution to dryness.

Pupils should wear safety spectacles in this experiment.



Heat gently towards the end of evaporation to avoid splashing out of the hot salt solution. If salt begins to 'spit' from the solution, turn off the Bunsen flame.

Heating over a beaker of boiling water can be a better alternative to direct heating.

Never invite pupils to taste the salt formed.

C.4 Using a stop-watch to measure small time intervals

Count the pulse rate/heartbeat for one minute.

If the effect of physical exercise on pulse rate/heartbeat is to be measured, teacher should note that pupils who are exempted from Physical Education lessons for medical reasons should not be allowed to perform this experiment.

C.5 Making observations and recording results

Pull two rubber suckers apart.

The experiment should be conducted in a more spacious part of the laboratory. Ensure no glassware is nearby.

Remind pupils not to apply a sudden force to pull the rubber suckers apart.

Blow air into a stoppered bottle containing water and make observations.

Ask pupils to handle glass tubings carefully. Use clean rubber tubings for blowing. Warn pupils not to over-exert themselves in blowing.

Teacher should note that pupils who are exempted from Physical Education lessons for medical reasons should not be allowed to perform this experiment.

C.6 Looking at differences within one kind of organism

Measure the volume of one's lungs by blowing air to displace water in a plastic bottle.

Use clean rubber tubings for blowing.

As this experiment may exert excessive physical stress on some pupils, teachers should note that pupils who are exempted from Physical Education lessons for medical reasons should not be allowed to perform this experiment.

Do not replace the plastic bottle by a glass one as the latter is quite heavy and may be broken easily.

Unit 2 Looking at Living Things

Experiments/Activities

Safety Precautions

C.1 Looking at snail/earthworm

Activities involving the handling of earthworms or snails.

Wear disposable gloves to prevent the transmission of germs/parasites from the animals to pupils.

After the experiments, all bench tops should be washed with disinfectant solution and all pupils involved should have their hands thoroughly washed.

Keep wormery or snail house in hygienic conditions. (*See Appendix C for details.*)

Unit 3 Energy

Experiments/Activities

Safety Precautions

C.2 Simple energy changes

Burn a magnesium ribbon and observe.

Pupils should wear safety spectacles in this experiment. Warn pupils not to look directly at the bright flame which may cause harm to the eyes.



Hang a weight with an elastic band and then allow it to oscillate.

Use a light weight for the experiment, say 20 g.

Heat the lower opening of a tube with wire gauze in it to produce sound.

Ensure that the long tube is firmly clamped and the stand is stable enough by putting enough weights on the base of the stand.

Take care that the tube may become very hot.

C.3 More examples of energy changes

Demonstrate charging and discharging of lead-acid cell.

Ensure that the two lead plates will not touch each other, otherwise short-circuiting results causing damage to the low voltage power supply unit.


C.5 Energy converters and daily applications


Use a steam engine and a dynamo to convert energy stored in fuel to electrical energy.

Before experiment, ensure proper functioning of the valve of the boiler. Excessive building up of pressure in the boiler may lead to an explosion.

Experiments/Activities


Safety Precautions

Some solid fuels accompanying the steam engine may be harmful. Read instructions and take necessary precautions. 

If alcohol is used as the fuel, do not add alcohol to the fuel-containing vessel while the vessel is still hot. 

C.6 Energy in food

Burn food samples over a Bunsen burner.

Pupils should wear safety spectacles in this experiment. 

Do not burn fats, as hot oil droplets may jet out and cause burns.

Clean the Bunsen burners after the experiment as spillage of food tends to block the chimney of the burners.

Unit 4 Matter as Particles

Experiments/Activities

Safety Precautions

C.1 State of matter

Arrange materials provided into solids, liquids and gases.

If nitrogen(IV) oxide is selected as an example of gas, remind pupils of the toxicity of the gas. Cover the container properly and place it inside a fume cupboard.



Do not use bromine as it is more hazardous than nitrogen(IV) oxide.



Heat some substances (e.g. ammonium carbonate or copper(II) nitrate) in a test tube and note the gas produced.

Pupils should wear safety spectacles in this experiment.



Use only a small amount of the substances.

Ask pupils not to inhale the gas directly. Show pupils the correct way of detecting the odour of a gas by using a hand to fan the gas towards the nose.

Iodine vapour is harmful. If experiment on heating iodine is to be done, it should be performed as a teacher's demonstration in a well-ventilated laboratory or in a fume cupboard.



C.2 Particle size

Make a solution with a single potassium manganate(VII) crystal.

Remind pupils not to touch the potassium manganate(VII) crystals with their bare hands. The crystal will turn the skin brown due to oxidation.



C.3 More about particles

Demonstrate diffusion using nitrogen(IV) oxide.

Take care not to allow the toxic gas to escape out of the gas jars.



Ensure good ventilation or perform the experiment inside a fume cupboard.

Do not replace nitrogen(IV) oxide by bromine as bromine is more hazardous.



S.4 Particles - more to do

Perform dilution experiment and taste orange juice at different dilutions.

Pupils must not normally be allowed to eat or drink in the laboratory. When these activities are essential to their studies, clean domestic containers and drinking water should be used.

C.5 A particle model

Demonstrate with a kinetic motion model.

Polystyrene beads fallen on the floor can be dangerous as they are very slippery. Avoid dropping the beads onto the floor.

C.6 Gas pressure

Compress gas inside a syringe.

Do not provide needles for the syringes.

Experiments/Activities

Demonstration: Remove air directly with a vacuum pump from a metal can until it collapses.

Demonstration: Remove air from the Magdeburg hemispheres using a vacuum pump. Then try to separate them.

Measure lung pressure by blowing strongly into a Bourdon gauge.

C.7 Density

Demonstration: Add solids to a jar containing layers of immiscible liquids (e.g. oil, water and mercury).

Safety Precautions

Never allow pupils to stand too close to the vacuum pump while it is turned on.

Check the apparatus before the experiment to ensure that it will not break apart very easily upon pulling. To avoid accidents, remind pupils that the apparatus will suddenly break apart upon pulling.

The experiment should be conducted in a more spacious part of the laboratory. Ensure no glassware is nearby.

Ask pupils not to over-exert themselves in blowing.

Teacher should note that pupils who are exempted from Physical Education lessons for medical reasons should not be allowed to perform this experiment.

Take care not to spill mercury or expose pupils to mercury vapour, which is hazardous to health.

The jar should not be made of glass which is easily broken when heavy solids are dropped into the jar .

In case of spillage or leakage, collect



Experiments/Activities

Safety Precautions

Demonstration: Raise a plastic bag by hot air from burning alcohol.

large drops of mercury immediately with a dropper. Cover remnants of mercury with zinc dust (or a paste of sulphur and lime), and leave for a few hours, then collect them as chemical wastes.

Beware of the potential fire hazard of the experiment. Have fire fighting equipment ready.

Hold the cotton pad soaked in alcohol in a metal dish but not in a watch glass.

Never use a Bunsen burner in place of burning alcohol to lift up the plastic bag.

C.8 Heating substances

Heat the bar or the bi-metallic strip in thermal expansion experiment.

Remind pupils to handle the hot apparatus with care.

E.8 More applications of thermal expansion

Examine an aquarium heater with a thermostat and see how it works.

The heater should be operated in water to avoid danger resulting from over-heating of the heating wire.

Demonstrate working of fire alarm using bimetallic strip.

Remind pupils to handle the hot bimetallic strip with care.

C.9 Joining and separating particles

Demonstration: Heat metal (e.g. copper turnings, iron filings) with sulphur in test tubes.

Make use of safety spectacles/safety screen.



Toxic sulphur dioxide gas will be produced. Use small amount of the chemicals. Ensure good ventilation in the laboratory or perform the demonstration in a fume cupboard.



Reaction between sulphur and iron filings may be vigorous. Stop heating once glowing starts to spread through the tube.

Demonstration: Drop a piece of Dutch metal into a jar of chlorine.

Carry out the experiment in a fume cupboard as fumes and heat are evolved, and chlorine is poisonous.



Electrolyze copper(II) chloride solution.

Use minimum amount of copper(II) chloride to avoid large quantity of poisonous chlorine gas being evolved. Ensure adequate ventilation.



Unit 5 Solvents and Solutions

Experiments/Activities

Safety Precautions

C.1 Finding out about water

Effect of adding salt on the boiling point of water.

Pupils should wear safety spectacles in this experiment.



Never stir water with the thermometer. Alert pupils not to let the bulb of thermometer touch the bottom of the flask/beaker.

C.3 Water purification

Filter muddy pond water and evaporate the filtrate to dryness.

Pupils should wear safety spectacles in this experiment.



Heat gently towards the end of evaporation to avoid splashing out of the hot liquid. Heating over a beaker of boiling water can be a better alternative to direct heating.

Distil the filtrate and evaporate the distillate to dryness.

In distilling the filtrate, add anti-bumping stones (pumice stones or broken porcelain) to the filtrate to avoid uneven heating which may result in shooting out of hot liquid.

C. 4 Dissolving

Dissolve substances (e.g. sodium hydroxide) into water and measure the temperature change.

Pupils should wear safety spectacles in this experiment.



Warn pupils of the corrosive nature of sodium hydroxide and ask them to handle it with care.



C.6 Solvents other than water

Test the solubility of iodine in different liquids.

Warn pupils of the harmful nature of iodine. Use minimal amount of the chemical and handle it with care.



Test the solubility of sulphur in water and methylbenzene (toluene).

Toluene is flammable and harmful. Use minimal amount of the solvent and ensure good ventilation.



Find a suitable solvent for nail varnish and lacquer.

Propanone, ethyl ethanoate and 'thinner' are flammable. Use minimal amount of the solvents and ensure good ventilation.



Unit 6 Cells and Reproduction

Experiments/Activities

Safety Precautions

C.2 Animal and plant cells

Observe animal cells under a microscope.

Do not use human cheek cells as there is a potential danger of transmitting blood-borne diseases.

Use other sources of animal cells or commercially prepared slides. (*See Appendix D for details.*)

C.4 Reproduction in plants

Examine different parts of a flower and pollen grain.

Some pupils may be allergic to pollen grains, remind them not to handle flowers or pollen grains.

Avoid using plants known to be poisonous. (*See Appendix E for details.*)

C.6 Mammal development

Look at dissection or prepared specimens of a pregnant rat/rabbit.

If dissection is intended, ensure that the animal is healthy and clean.

Dissection should be done by teacher or laboratory technician. (*See Appendix F for details.*)

If specimen preserved in formalin (methanal solution) is to be used, ensure that the specimen jar is well covered, as methanal vapour irritates the respiratory system, skin and eyes.



Unit 7 Living Things and Air

Experiments/Activities

Safety Precautions

C.3 Breathed and unbreathed air

Collect breathed air and compare its composition with that of unbreathed air.

Excessive rebreathing of the same sample of air is dangerous.

Pupils exempted from Physical Education lessons should not be allowed to breathe in and out of the plastic bag.

C.4 Breathing system in man

Examine a pig's lung.

Use clean and fresh lungs.

Specimens provided by abattoirs may carry germs. Pupils should cover any wounds on their hands with waterproof dressings and wear surgical gloves to prevent infection when handling the specimen.

After the experiment, all bench tops and instruments used should be washed with disinfectant solution, whereas pupils involved should have their hands thoroughly washed.

C.6 Formation of starch in green plants

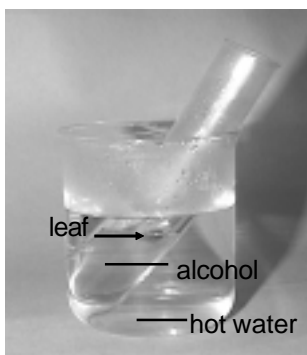
Test for the presence of starch in leaves.

Alcohol is flammable. When alcohol is used, ensure that there is no flame nearby.



Small and thin leaves should be used for the experiment. When using hot ethanol to remove chlorophyll from

Experiments/Activities



Safety Precautions

the leaves, heat the alcohol by using a beaker of very hot water. Remind pupils to handle the hot water with care.

C.8 Respiration

Place germination seeds and sterilized boiled seeds in vacuum flasks and observe the temperature changes.

The commonly used sterilized agent - mercury (II) chloride is poisonous. Handle it with care or use safer substitutes. *(See Appendix G for details)*



Unit 8 Making Use of Electricity

Experiments/Activities

Safety Precautions

C.1-5

Experiments involving the use of low voltage d.c. power supply.

Warn pupils of the danger of short-circuiting as this may produce heat and cause burns.

To avoid any mishap in electricity experiments, it is important for pupils to acquire the habit of wiring a circuit according to a circuit diagram. Always start from the positive pole of the cell, and wire up the apparatus one after the other until the negative pole is reached. It is always good to include a circuit key. Before pressing on the key, the circuit should be checked by teacher.

E.5 More about electromagnet

Making an electromagnet with insulated wire.

Ensure insulated wire is used to avoid short-circuiting.

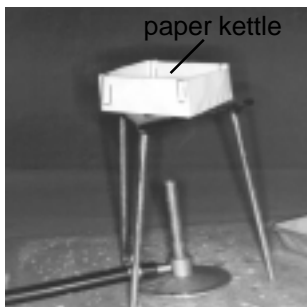
Unit 9 Making Heat Flow

Experiments/Activities

Safety Precautions

C.2 Convection in liquids

Heat a paper kettle containing water.



Make a kettle just large enough to be supported on the tripod used.

Ask pupils to use a small flame, otherwise the paper kettle may catch fire.

Remind pupils that the paper kettle may collapse and cause hot water spillage.

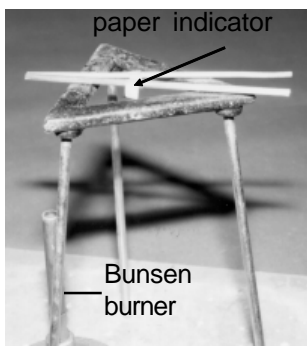
C.3 Conduction in solids

Heat rods of different materials.

Rods do not give any visible sign when they are hot. Remind pupils to handle the hot rods with care.

Heat rods of different metals.

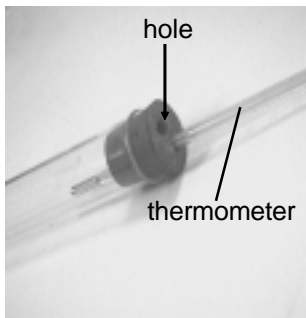
Remind pupils to handle the hot rods with care.



If paper indicators are placed at the end of the rods, it will take a longer time for them to change colour. The glass/aluminium rod may melt or soften due to over-heating. Placing the paper indicators midway between the two ends of the rods and at equal distance from the heat source can also achieve the aim of the experiment.

C.4 Air and water are poor conductors

Show that air is a poor conductor of heat.



Ensure that there is a hole in the rubber bung for hot air to escape.

Ensure that the glass of the tube is strong enough to stand high temperature and the thermometer bulb does not touch the glass wall.

Show that water is a poor conductor of heat by heating water containing ice in a boiling tube.

Pupils should wear safety spectacles in this experiment.



Point the mouth of the boiling tube away from anybody. Do not heat with a stationary flame.

C.6 Applications of heat transfer

Study how a vacuum flask works to prevent heat transfer.

Handle the vacuum flask with care to avoid accidental breakage of the flask.

It is always safe to prepare a wooden stand to hold the vacuum flask.

Study factors affecting the rate of heat loss of hot water.

Remind pupils to handle hot water carefully to avoid heat burns.

Unit 10 Hydrogen, Acids and Alkalis

Experiments/Activities

Safety Precautions

C.1 Electrolysis of water

Electrolyze water and test for the gases produced.

Warn pupils of the potential hazards of hydrogen gas and ask them to collect only small samples of the gas for the 'pop' sound test.



Pupils should wear safety spectacles during the test for hydrogen.



C.2 Action of metals on water

Demonstration: Add sodium metal to water in a trough.

Sodium is a highly reactive metal and should be handled with care.



Demonstrate the experiment behind a safety screen and ask pupils to wear safety spectacles if necessary.



Use only a small piece of sodium metal. Cut the metal with care. It should be noted that old stock of sodium which may appear yellow due to the formation of superoxide, is liable to explode upon friction or shock. It should not be used for practical work.

Never attempt to collect the hydrogen gas evolved.

Avoid using potassium metal as it is more hazardous.

Experiments/Activities

Add calcium granules to water.

Safety Precautions

Ask pupils to handle calcium with forceps, and avoid skin contact which may result in burns.



C.3 Action of metals on acids

Add samples of metals to dilute acids.

Never add highly reactive metals such as potassium and sodium into acids as the reactions are extremely vigorous.

Do not use magnesium powder as its reaction will be very vigorous resulted from its large surface area. Use only the ribbon form. For the same reason, use aluminium foils and zinc granules instead of their powder.

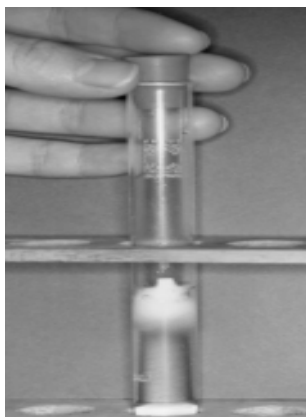
Do not use an excessive amount of dilute acids.



Pupils should wear safety spectacles during the test for hydrogen.



When collecting the hydrogen gas, remind pupils to fit the tube loosely with a stopper to avoid splashing out of acid and shooting out of the stopper due to excessive pressure.



C.4 Degree of acidity & alkalinity

Find the pH value of some given chemicals and household substances.

If lemon juice, 7-up, coke etc. are used, remind pupils that the materials are intended for experimental use and the rule that eating and drinking are not allowed in laboratory should be strictly followed.


C.5 Neutralization

Add dilute hydrochloric acid to neutralize sodium hydroxide solution.

Pupils should wear safety spectacles in this experiment. 

When disposable syringes are used for measuring the volume of solutions, do not provide needles for the syringes.

Evaporate the neutralized solution to dryness and obtain the salt produced.

Pupils should wear safety spectacles in this experiment. 


Remind pupils to heat gently towards the end of evaporation to avoid splashing out of the hot liquid. Heating over a beaker of boiling water can be a better alternative to direct heating.

Never invite pupils to taste the salt produced.

E.5 Concentration and neutralization

Dissolve solid sodium hydroxide in water and neutralize the solution by acid.

Pupils should wear safety spectacles in this experiment. 

Warn pupils of the corrosive nature of sodium hydroxide and ask them to handle it with care. 

Unit 11 Detecting the Environment

Experiments/Activities

Safety Precautions

C.2 The eye

Dissect an ox eye and identify the main parts of the eye.

Use clean and fresh ox eyes.

Specimens provided by abattoirs may carry germs. Pupils should cover any wounds on their hands with waterproof dressings and wear surgical gloves to prevent infection when handling the specimen.

Before allowing pupils to carry out the dissection, teachers should demonstrate the proper dissection skills first and remind pupils to handle the dissecting instruments with care.

After the experiment, all bench tops and instruments used should be washed with disinfectant solution, whereas pupils involved should have their hands thoroughly washed.

E.3 Long and short sight

Use the model eye kit to demonstrate long and short sight and their correction.

Do not leave the model eye kit under sunlight, as the attached lenses may converge the sunlight to start a fire.

C.5 Sources of sound

Produce sound with a tuning fork, a taut string and the end of a ruler.

Choose suitable type of ruler for the experiment. Preferably the ruler can be made to vibrate freely with a slight

Experiments/Activities

Tap a tuning fork and place it lightly on water surface.

C.6 Transmission of sound

Demonstrate the ‘electric bell in bell jar’ experiment.

C.8 Pitch

Study how the notes produced by plucking a guitar wire change when the wire is tightened or loosened.

C.9 Taste and smell

Investigate the sense of taste by tasting different food substances.

Safety Precautions

force. Use G-clamp if deemed necessary.

Do not use metre rule. Long ruler may give rise to accident if the ceiling fans are low.

Strike the tuning forks on a rubber bung, not on any hard object like the bench top.

Never allow pupils to stand too close to the vacuum pump while the pump is turned on.

Take care not to over-tighten the wire as the wire may break and cause injuries.

Start with the tightened position. Unscrew in the direction that only results in decreasing the tension of the wire.

Pupils should not normally be allowed to eat or drink in the laboratory. When the activities are essential to their studies, remind pupils of the necessary precautions.

Use clean domestic containers and

Experiments/Activities

Safety Precautions

drinking water. Use drinking straws to transfer solutions for tasting.

C.10 Touch

Study the sense of touch by touching different parts of the skin of a blindfolded pupil.

Avoid using pointed objects such as pins.

Study the sense of touch by putting fingers in hot and cold water.

Do not use hot water above 50°C.

Unit 12 Forces and Movement

Experiments/Activities

Safety Precautions

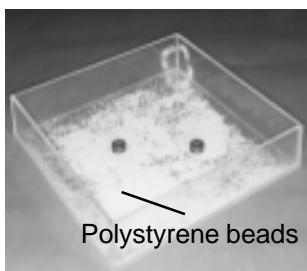
C.1 What is a force?

Pull a spring in opposite directions.

Never allow pupils to over-extend the spring.

Study the effect of force by placing two ring magnets on some polystyrene beads in a tray.

Polystyrene beads fallen on the floor can be dangerous as they are very slippery. Use a deeper tray to avoid spillage.



C.2 Friction

Drop simultaneously two identical steel balls into two measuring cylinders, containing two different liquids.

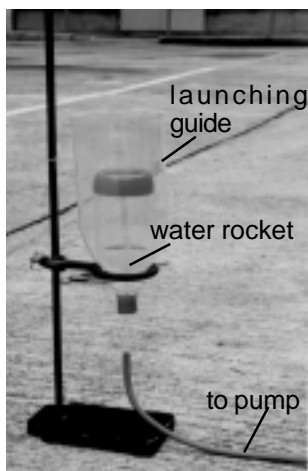
Do not use large steel balls, as they may be heavy enough to produce an impact to break the cylinder on reaching the bottom of the cylinder.

Use transparent plastic cylinders as far as possible.

C.8 Action and reaction

Study action and reaction by pushing or pulling while sitting on a cart.

Demonstration: Fire a 'water rocket' vertically and observe the motion.



Do not allow pupils to stand or squat on the cart as they may easily lose their balance and fall.

Remind pupils not to push or pull too hard.

The rocket may fly off at high speed and this may become a potential hazard to the observers.

Teachers should launch the water rocket vertically upward in an open space outside the laboratory. Ask pupils to keep a distance away from the rocket.

To ensure vertical launching, a launching guide can be used. It can be constructed easily by cutting off the bottom of a large plastic soft drink bottle (1-1.25 L capacity), and securing it to a rigid stand as shown in the diagram.

Unit 13 Food and Transport

Experiments/Activities

Safety Precautions

C.3 Storing food

Study food decay caused by activities of micro-organisms.

Keep any culture of microbes in covered containers and follow the safety precautions in handling micro-organisms. (*See Appendix I for details.*)

C.6 Tooth and tooth decay

Identify human teeth on the jaw.

For hygienic purpose, ask pupils to clean their mouths with antiseptic mouthwash first if they are allowed to observe each other's teeth. Instead, pupils may use a mirror to observe their own teeth.

Bite a small piece of carrot and chew it. Note the teeth used. Bite and tear off a small piece of toffee from a toffee bar and note which teeth are most effective for this purpose.

Pupils should not normally be allowed to eat or drink in the laboratory. When the activity is essential to their studies, remind pupils of the necessary precautions.

Cover a pig's tooth with wax. Scratch away wax at one point and immerse the tooth into dilute acid to study tooth decay.

For hygienic purpose, use a clean pig's tooth.

Pupils should wear safety spectacles in this experiment.



Use forceps and never fingers to hold the tooth for dipping into hot molten wax and to pick up the tooth from the dilute acid.



Experiments/Activities

Study acid formation by the action of bacteria in saliva on glucose solution.

C.7 Digestion and absorption

Observe a dissected rat/ rabbit showing the digestive system.

Study digestion of starch by saliva.

Observe the inner wall of a piece of preserved specimen of pig's intestine.

Safety Precautions

Rinse the tooth with water before observation.

Pupils should only handle their own saliva, including its disposal and rinsing of equipment after use. (*See Appendix D for details.*)

If dissection is intended, use healthy and clean animals.

If specimen preserved in formalin (methanal solution) is used, ensure that the specimen jar is well covered, as methanal vapour irritates the respiratory system, skin and eyes. (*See Appendix F for details.*)

Pupils should only handle their own saliva, including its disposal and rinsing of equipment after use. (*See Appendix D for details.*)

It is desirable to replace saliva by chemically prepared 5% diastase solution to reduce the chance of transmitting diseases through saliva.

If specimen preserved in formalin (methanal solution) is used, ensure that the specimen jar is well covered, as methanal vapour irritates the respiratory system, skin and eyes.



E.7 Enzymes

Study digestion of starch by saliva.

Pupils should only handle their own saliva, including its disposal and rinsing of equipment after use. (*See Appendix D for details.*)

It is desirable to replace saliva by chemically prepared 5% diastase solution to reduce the chance of transmitting diseases through saliva.

C.8 Transport in mammals

Take the pulse rate when the body is at rest and immediately after exercise.

Do not ask pupils who are exempted from Physical Education lessons for medical reasons to perform the experiment.

Remind pupils to stop doing the experiment immediately if they feel uncomfortable.

C.10 Kidney and its functions

Examine a dissected fresh pig's kidney.

Use clean and fresh pig's kidneys.

Specimens provided by abattoirs may carry germs. Pupils should cover any wounds on their hands with waterproof dressings and wear surgical gloves to prevent infection when handling the specimen.

Before allowing pupils to carry out the dissection, teachers should demonstrate the proper dissection skills

Experiments/Activities

Safety Precautions

first and remind pupils to handle the dissecting instruments with care.

After the experiment, all bench tops and instruments used should be washed with disinfectant solution, whereas pupils involved should have their hands thoroughly washed.

C.12 Absorption and transport of water in plants

Demonstration of absorption of water by the roots of a potted woody plant.

Periwinkle is a poisonous plant. Use other safer alternatives such as Chinese Hibiscus.

Study water transport in plants (e.g. Chinese white cabbage seedling).

Ask pupils to take care when cutting the seedling with a razor blade to expose the tissues for water transport. It is desirable to use single-edged blades.


Unit 14 Materials from the Earth

Experiments/Activities

Safety Precautions


C.1 Rock and soil

Illustrate the weathering of rocks by dropping heated granite into cold water.

Use safety screen and wear safety spectacles. 

The cold water should be contained in a large metal container.

Filter some soil water and evaporate the filtrate to dryness to show the presence of minerals in soil.

Pupils should wear safety spectacles in the experiment. 

Remind pupils to heat gently towards the end of evaporation to avoid splashing out of the hot liquid. Heating over a beaker of boiling water can be a better alternative to direct heating.

Study the growth of bacterial colony/fungi on agar plate contaminated by soil.

Keep any culture of microbes in covered containers and take the safety precautions in handling microorganisms. (*See Appendix H for details.*)

C.2 Building materials

Make mortar and concrete.

Pupils should wear disposable gloves while handling cement as it may cause irritation upon prolonged skin contact.

Test the tensile strength of concrete bar by adding weights to the bar until breakage.

Beware of dropping fragments/weights. This activity should be performed as a teacher's demonstration.

C.3 Getting materials from the earth's crust

Examine mineral specimens.

Asbestos is carcinogenic. Do not use asbestos specimen.



Extract a metal from its ores (sulphides and oxides) by carbon reduction.

Pupils should wear safety spectacles in the experiment.



Sulphur dioxide produced from the roasting of sulphide ores is toxic. Use small quantities of ores. Ensure good ventilation or use the fume cupboard.



If soft drink bottle cap is used as container for the reduction, remove the plastic disc inside first as it will produce toxic fumes when burnt.

Demonstration: Use a copper wire and weights to illustrate the ductility of metals.

Avoid applying excessive tension to the wire as the wire may break and cause injuries.

C.4 Coal

Perform destructive distillation of coal.

Pupils should wear safety spectacles in the experiment.



Owing to the pungent smell and harmful nature of the products, carry out the experiment in a well-ventilated laboratory.



Ensure secure clamping of the apparatus.

C.5 Crude oil

Perform fractional distillation of crude oil.

Avoid skin contact with crude oil and its fractions as they may contain harmful substances. If possible, use artificial crude oil which may be available from some scientific suppliers.



This experiment should be carried out in a well-ventilated laboratory.

Pupils should wear safety spectacles in the experiment.



Soak a piece of cotton wool in the crude oil to avoid bumping. Avoid heating the soaked cotton wool with a stationary hot flame and be careful of burns.

Ensure secure clamping of the apparatus.

Avoid collecting fractions with boiling temperature over 300°C as harmful decomposition products may be produced.



Study burning behaviour of the fractions.

Pupils should wear safety spectacles in the experiment.



Use small amount of the fractions only.

Remind pupils not to add fuel to a burning fraction.

Ensure good ventilation as sooty fumes are produced.

C.6 Materials from the sea

Evaporate sea water to dryness.

Pupils should wear safety spectacles in this experiment.



Remind pupils to heat gently towards the end of evaporation to avoid splashing of the hot liquid. Heating over a beaker of boiling water can be a better alternative to direct heating.

Carry out flame test on some salts and the residue from evaporation of sea water.

Pupils should wear safety spectacles during the flame test.



Concentrated hydrochloric acid is highly corrosive. Pupils should handle it with care.



E.6 More materials from the sea

Carry out flame test on shell/coral.

Pupils should wear safety spectacles during the flame test.



Concentrated hydrochloric acid is highly corrosive. Pupils should handle it with care.



Heat shell/coral strongly with a Bunsen flame.

Pupils should wear safety spectacles.



If soft drink bottle cap is used as container for heating, remove the plastic disc inside the cap first as it will produce toxic fumes when burnt.

Add water to the product obtained from heating shell/coral.

Make sure that the product is cooled down sufficiently before adding water.

Avoid direct contact with the product which is corrosive.



Unit 15 Electricity and Electronics

Experiments/Activities

Safety Precautions

C.1 Electrostatics

Charge a strip of different materials.

Teachers may like to charge two metal-coated plastic strips by the EHT power supply. Note that the two strips will stick together if oppositely charged. Switch off the EHT power supply as soon as possible when the strips stick together, as prolonged short-circuiting will damage the supply unit.

Experiments involving Van de Graaff generator.

The Van de Graaff generator can produce extremely high voltage (above 3×10^4 V). Generally the equipment is reasonably safe as the current is at the microampere (μ A) level, but some people (e.g. those with weak hearts) are susceptible to health risk. The generator should be discharged before making any alteration. The chassis of the generator should be properly earthed.

C.2 Pushing charges

Measure the voltages of various unknown sources with a voltmeter.

Warn pupils not to measure the mains voltage.

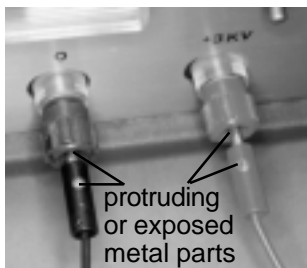
E.3 Transmitting electrical energy

Experiment involving the power transmission line model.

Demonstrate with the power transmission line model, which uses low voltage.

C.5 Discharge through gas

Experiments involving the Extra High Tension (E.H.T.) power supply.



Check carefully that the two electrodes inside the discharge tube are not in contact before the experiment.

Ensure that there are no protruding or exposed metal parts, such as those shown in the diagram, on the plugs when connecting to the E.H.T. power supply.

Ensure that there is a large current-limiting-resistor in series with the positive terminal.

Always connect the negative terminal to the earth terminal unless otherwise instructed. (*See Appendix I for details.*)

C.6 Current through a vacuum

Experiments involving the use of Extra High Tension (E.H.T.) power supply.

Ensure that there is a large current-limiting-resistor in series with the positive terminal.

Always connect the negative terminal to the earth terminal unless otherwise instructed. (*See Appendix I for details.*)

Experiments involving the use of cathode ray oscilloscope (C.R.O.).

Do not use the C.R.O. to measure the mains voltage.

IV. EXPERIMENTS/ACTIVITIES NOT RECOMMENDED

The following experiments which are sometimes suggested in some science publications, are considered unsafe. Teachers are advised not to demonstrate these experiments or arrange pupils to perform them on safety ground.

Unit

Experiments/Activities

Unit 3 Energy

C.3 More examples of energy change

Wrap a match head in aluminum foil and heat the wrapped head in a Bunsen flame.

C.6 Energy in food

Heat food powder in an enclosed can.

Unit 7 Living things and air

C.2 Gases in the air

Find out the percentage volume of oxygen in air by burning phosphorus.

Unit 8 Making use of electricity

C.3 Heating effect

Wind an electric wire round the thermometer bulb and measure the temperature rise when electricity passing through the wire.

Unit

Experiments/Activities

Unit 10 Hydrogen, acids and alkalis

C.2 Action of metals on
water

Put the sodium metal on a filter paper
and let the latter float on water.

Blow a soap bubble using hydrogen
and put a burning splint close to it.

Unit 15 Electricity and electronics

C.1 Electrostatics

Touch the dome of the Van de Graaff
generator after it has been charged.

Hazard warning labels

Containers of hazardous chemicals, such as reagent bottles, should bear appropriate hazard warning labels which convey information on the hazardous nature of the substances. Examples of some common hazard warning labels are shown below:



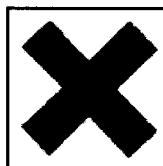
FLAMMABLE 易燃



EXPLOSIVE 爆炸性



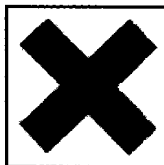
CARCINOGEN 致癌物



HARMFUL 有害



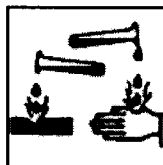
TOXIC 有毒



IRRITANT 刺激性



OXIDIZING 氧化性



CORROSIVE 腐蚀性

Hazards in the use of naphthalene in science experiments

1. Naphthalene (mothball) had sometimes been used in science experiments in melting point determination in Secondary 1 Integrated Science. However, it is known that some 4.5% of local born male babies suffer from G6PD (glucose-6-phosphate dehydrogenase) deficiency which would last for life and that people with such deficiency when exposed to naphthalene may suffer from haemolysis (destruction of blood cells). In addition, naphthalene is harmful by inhalation, ingestion and skin contact. Science teachers are advised to note the hazardous nature of naphthalene and not to use it in any science experiments.
2. Wax, octadecan-1-ol or stearic acid should be used in melting point determination.
3. Schools are advised to request parents to report G6PD deficiency and any acute diseases suffered by their children so that precautions can be taken where appropriate.

Wormery for earthworm/snail house

1. Wear disposable gloves when working with the wormery/snail house.
2. Keep wormery/snail house in hygienic condition. Clean the wormery /snail house regularly with disinfectants. The types of disinfectants recommended for cleaning include:

<u>Disinfectant</u>	<u>Working Strength</u>	<u>Toxicity</u>
(a) Iodophores ‘Wescodyne’ ‘Mikroklene’	Solution containing 150 ppm available iodine	Non-irritant
(b) Ampholytes ‘Tego MHG’ ‘Miranol’	1% solution	Virtually none

Note:

Phenolic solutions and their derivatives such as ‘Lysol’ and ‘Sudol’ are not recommended as they are toxic and irritating.

Reference:

Precautions Against Biological Hazards (pp.50-51), Imperial College of Science and Technology, London, 1974

Experiments involving animal blood, cells and human saliva

1. Teachers are reminded that taking human blood and cell samples (such as cheek cells) for practical work should not be performed, as this may carry a risk of transmitting blood borne diseases such as AIDS (Acquired Immune Deficiency Syndrome) and Viral Hepatitis B.
2. Experiments on observation of animal cells have high educational value. The animal cells required for such activities could be obtained from sources OTHER THAN HUMAN BODY, e.g. bull's eye corneal cells.

Preparation:

Slides of bull's eye corneal cells can be prepared by pressing a microscope slide gently against the cornea of a bull's eye (fresh or refrigerated). The cells can be stained with a drop of methylene blue and covered with a cover slip in the normal way. At least 10 preparations can be made from one eyeball.

(For details, please see: Lewis, JCE & Chester, MF, 'Bullocks Corneal Cells: An Alternative to Human Cheek Cells', *School Science Review*, Mar 1989, Vol 70, No 252.)

Alternatively, by using a scalpel (beware of cuts), the cells can be scraped off from the surface of the cornea of a bull's eye which has been soaked in water over-night. The tissue can be mounted in a drop of water or dye such as methylene blue for observation under a microscope.

3. For hygienic purpose, it is highly recommended for schools to use chemicals (e.g. diastase) to replace human saliva during experiments, wherever possible. For experiments that involve human saliva, teachers should instruct pupils to work only with their own body fluids.

4. When performing the experiments related to animal blood, cells and human saliva, teachers should instruct pupils to wear disposable plastic/vinyl gloves for protection and hygienic reasons.

References:

- (1) *Guidelines on the Prevention of Blood-borne Diseases in Schools*, Department of Health and Education Department, 1994.
- (2) *Prevention of Hepatitis B Virus Infection in Newborn Babies*, Hepatitis B Vaccination Clinic and Central Health Education Unit, 1997.

Some common plants known to be poisonous

The following plants known to be poisonous should be kept inaccessible to pupils:

<i>Alocasia odora</i> (Alocasia)	海芋
<i>Colocasia esculenta</i> (Taro)	芋
<i>Euphorbia milii</i> (Crown of Thorns)	鐵海棠
<i>Euphorbia pulcherrima</i> (Poinsettia)	一品紅 (聖誕花)
<i>Euphorbia tirucalli</i> (Milk Rush)	綠玉樹
<i>Exoecaria agallocha</i> (Milk Mangrove)	土沉香 (海漆)
<i>Nerium indicum</i> (Oleander)	夾竹桃
<i>Rhus chinensis</i> (Sumac)	鹽膚木
<i>Rhus hypoleuca</i> (Sumac, Lacquer Tree)	野漆樹
<i>Rhus succedanea</i> (Wax Tree)	白背漆 (鹽霜柏)
<i>Thevetia peruviana</i> (Thevetia)	黃花夾竹桃
<i>Vinca rosea</i> (Periwinkle)	長春花

Reference:

Hong Kong Poisonous Plants, Urban Council, 1988.

Handling and killing of rats for dissection

1. Living rats may bite or scratch people handling them. Leather gloves for handling of animals should therefore be worn when working with them.
2. All living rats for dissection must be obtained from a licensed dealer (Please refer to *School Science Newsletter* Issue No.45 published by the Education Department for a list of licensed rat traders in Hong Kong.) and wild rats should not be used.
3. Under no circumstances should pupils be allowed to handle living rats. Killing of rats should only be carried out by teachers or laboratory technicians. It should be done in a swift and humane way with carbon dioxide or chloroform (trichloromethane) in the absence of pupils. As chloroform is harmful, the killing chamber should be exposed after use either in fume cupboard or in the open air.
4. After killing, check that the animals are dead and immerse them in dilute disinfectant before handling them over to pupils for dissection.
5. It should be noted that rats should not be reared in schools for use in dissections.
6. If a pupil is bitten by a rat, the case should be reported to the teacher-in-charge at once. Basic first-aid treatment should be given to the wounded pupil, who should then be sent immediately to hospital/clinic for medical treatment. The animal in question should be isolated for subsequent diagnosis purpose.

Sterilization of boiled seeds for experiments on respiration

Mercury(II) chloride is a commonly used reagent for the sterilization of boiled seeds for respiration experiments. Since it is corrosive to the mucous membrane and poisonous to human bodies, teachers are advised to replace it with safer alternatives, such as 1-2% formalin solution or dilute sodium hypochlorite solution (commercial bleach).

(a) Sterilization with 1-2% formalin (methanal solution)

Prepare a 1-2% solution of formalin by diluting one part of 40% formalin with 39 parts of water. Soak the boiled seeds in the solution for 5 minutes. Rinse the seeds twice with cold water before use.

Note: Methanal vapour is irritating to the respiratory tract, eyes and nose. Skin contact may give rise to dermatitis. Handle it inside a fume cupboard and wear rubber gloves.

(b) Sterilization with dilute sodium hypochlorite solution

Dilute commercial bleach (containing sodium hypochlorite) with 4 times its own volume of water. Soak the boiled seeds in the solution for 15 minutes. Rinse 2-3 times with water before use.

Note: Although being the least hazardous of the 3 sterilizing agents, prolonged skin contact with dilute sodium hypochlorite solution causes irritation. Avoid inhalation of its vapour as this may produce bronchial irritation.

Reference:

- (1) *MERCK Index*
- (2) *Experimental Work in Biology* (p.252), Combined edition, Teacher's book, D.G.Mackean.
- (3) *Modern Certificate Biology Experimental Workbook* (pp. 87-88), Mary Soltay, Longman.
- (4) *Class Experiments in Biology* (p.39), Teacher's book, C. J. Worsley, P.C.G. Worsley, D.G. Mackean.

Safety precautions in handling micro-organisms

1. Cultures of micro-organisms may be contaminated by pathogens which may arise from mutation or from wild sources. All micro-organisms should therefore be treated as potentially hazardous and be handled with care.
2. Pathogenic micro-organisms may gain access into the human body if fingers with wound touch the culture or the aerosols above the culture are inhaled or contaminated food is ingested.
3. Students who are unable to appreciate the importance of safety precautions in microbiological experiments should never be allowed to perform them. If class discipline cannot be relied on, the teacher should abandon individual experiments in favour of teacher demonstrations.
4. All hand-to-mouth operations should be strictly forbidden during microbiological experiment. Pipette fillers should be used to transfer liquid cultures. Teachers, technicians and students should wash hands thoroughly with soap and warm water after practical microbiological work. Paper towels are to be preferred to roller or other communal towels, which themselves may harbour large populations of micro-organisms.
5. All cuts on body surface should be covered with waterproof dressings before starting microbiological experiments.
6. Avoid production of aerosols during sterilization of inoculating loop by flame-heating. Always immerse the loop in 70% alcohol before flaming.
7. Never isolate micro-organisms from potentially dangerous sources such as polluted water, human mucus, pus and faeces.
8. Do not incubate culture of micro-organisms at 37°C because this practice tends to select organisms adapted to human body temperature. Most of the saprophytic micro-organisms used in school microbiology grow well at normal room temperature.

9. Cultures of micro-organisms for class inspections should be kept in sealed containers to prevent contamination and infection. Self-adhesive tapes should be used to seal petri-dishes containing micro-organisms.

10. If the petri-dishes containing cultures of micro-organisms must be opened for inspection, the teacher or laboratory technician should kill the micro-organisms by adding a few drops of methanal solution (formalin) to a piece of filter paper and leave it in the lid for at least one hour prior to class inspection.

11. Unwanted cultures should be destroyed by autoclaving or immersing in disinfectant solutions (e.g. hypochlorite/‘Chlorox’, or formalin) for several hours before disposal.

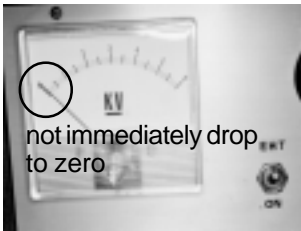
12. All apparatus contaminated with micro-organisms should be autoclaved or immersed in disinfectant solutions for several hours before cleaning or disposal.

13. The bench and floor should be washed with disinfectant solutions immediately after each practical microbiology class. Areas contaminated with bacteria due to spillage or accidental breakage of the container should be covered with ‘Chlorox’ and left for 15 minutes before cleaning.

Safety precautions in using extra high tension (E.H.T.) power supply

1. As the E.H.T. power supply is plugged into the mains, it is possible to produce a current higher than that usually produced by the Van de Graaff generator. It is therefore essential to ensure that there is a large current-limiting-resistor in series with the positive terminal, fitted into the power supply. Always connect the negative terminal to the earth terminal unless otherwise instructed.

2. Users should always switch off the E.H.T. power supply before making adjustments to the circuit. A 5000 V shock is unpleasant though it is unlikely to be fatal as the large internal resistance of the power supply



limits the current to a very small value. The power supply, however, will not be safe even after being switched off; there is likely to be a large smoothing capacitor inside it, which will remain charged for a short time. The capacitor will discharge through the voltmeter in the power supply, so watch the reading as it falls to a safe value before making adjustments to the circuit.

3. Any experimentation requiring the use of high voltage would be safer if the floor is covered with effective insulating materials. Nobody should be allowed to work alone in a room when using high voltage. Terminals should be protected and naked wire should never be used. Suitable screen or barrier for protection against electric shock should be provided whenever necessary. All high voltage equipment should always be kept clean.