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PREFACE

This safety handbook is a revised edition of the one published in 1994. There have been considerable changes and additions to cater for the latest requirements in laboratory safety in schools and the way forward in curriculum development of science education. The format has been changed to facilitate easier reading and referencing. The aim of this handbook is to enhance the standard of safety in school laboratories by drawing laboratory users' attention to the necessary safety precautions to be taken. It also promotes the awareness of potential hazards to minimise risks and advises on how to effectively deal with any accidents which may occur. We must, however, emphasize that the advice and information offered in this handbook are by no means exhaustive and do not preclude the need for exercising care and good judgement at all times in safeguarding against accidents.

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Agriculture, Fisheries and Conservation Department
Customs and Excise Department
Electrical & Mechanical Services Department
Fire Services Department
Department of Health
Hong Kong Observatory
Labour Department
Leisure and Cultural Services Department
City University of Hong Kong
Hong Kong Institute of Vocational Education
Hong Kong Association for Science and Mathematics Education
Association of Laboratory Assistants and Technicians in Education Department
Hong Kong Laboratory Technicians' Association
Hong Kong St John Ambulance
The Chinese Foundation Secondary School
SKH Tsang Shiu Tim Secondary School

Should schools have any enquiries and suggestions on this handbook, please contact the Science Section, Education Department.

Education Department

1 INTRODUCTION

In recent years, the learning and teaching of science in secondary schools has undergone rapid changes towards a much greater emphasis on open-ended investigation and experimental approach. It is, therefore all the more important for science teachers, laboratory technicians and students to pay attention to safety precautions when working in the laboratories or during a field study.

Schools are held responsible for taking all the necessary safety precautions to maintain a safe learning and working environment in the laboratories. Supervisors/heads of secondary schools should pay particular attention to Regulations 21, 24, 26, 27, 31, 32 and 33 of the *Education Regulations* in connection with safety in school laboratories (for ease of reference, these regulations are reproduced in Appendix I). The Regulations require, among other things, that supervisors/heads of secondary schools should ensure that all necessary safety precautions have been taken in science laboratories. Teachers in charge of science laboratories should assist the school heads to ensure that the safety requirements are complied with, and supervise the work of the laboratory technicians under their charge.

In addition, schools should actively review their safety management systems to ensure that the requirements of the *Occupational Safety and Health Ordinance* are observed so as to ensure occupational safety and health of their employees working in laboratories. Further information about the Ordinance can be found in Appendix II.

Apart from ensuring that students are in compliance with the safety rules in laboratories, science teachers and laboratory staff should set good examples in this regard, and update themselves with the latest development on laboratory safety. The following chapters provide the guidelines and information on various aspects of laboratory safety for reference of science teachers and laboratory staff.

2 SAFETY MANAGEMENT

In order to ensure that safety measures adopted in secondary schools are properly implemented and any emergencies occurring in science laboratories are dealt with in an effective and efficient manner, every school should have an effective safety management system in place (e.g. setting up a standing committee on laboratory safety) to monitor the standard of laboratory safety, to draw up and implement an emergency plan (including emergency measures, evacuation procedures and escape routes) and conduct evacuation drills regularly in school.

2. 1 Standing Committee on Laboratory Safety

The following guidelines on setting up a standing committee on laboratory safety are by no means prescriptive and exhaustive. It is the responsibility of each school to formulate proper emergency measures in the light of its practical situation. In order to have better co-ordination of safety work in school, schools may group the Standing Committee with other related safety management groups, like Safety Management Committee and Fire Drills Group.

The Standing Committee on Laboratory Safety should be headed by a laboratory safety coordinator chosen from among the science teachers. The membership should comprise all science teachers and laboratory technicians.

The duties of the Standing Committee are as follows:

- convene regularly to discuss various issues related to laboratory safety such as the formulation or revision of laboratory safety policies and laboratory rules, the evaluation of laboratory accidents occurred and preventive measures that can be taken;
- plan and conduct laboratory safety training programmes regularly for school staff and students;
- carry out safety inspections regularly on the storage of chemicals, maintenance of fire-fighting equipment, personal protective equipment, first-aid boxes, fume cupboards, laboratory ventilation, etc., and to rectify any irregularities spotted;
- formulate, implement and revise the emergency plan for dealing with emergency cases; and
- conduct evacuation drills regularly.

A deputy laboratory safety coordinator should also be appointed and take charge of the duties of the laboratory safety coordinator in the absence of the latter.

It is important that minutes of meetings of the Standing Committee on Laboratory Safety be properly kept and made available for inspection when required.

2.2 Subject Panel Meetings

Science panel chairpersons should arrange at least one of the panel meetings each school year to discuss matters regarding laboratory safety with their members. The meetings on laboratory safety should be conducted in parallel with the meetings of the Standing Committee on Laboratory Safety mentioned in Section 2.1 above to follow up the resolutions passed and to provide feedback to the Standing Committee when necessary.

The duties of panel members related to laboratory safety should be clearly defined. Effective measures should be adopted to ensure all panel members provide adequate safety instructions and equipment to students so that learning and teaching are conducted in a safe environment. Adequate training should be provided to newly appointed teaching and laboratory staff as well as the student-teachers on teaching practice.

2.3 Laboratory Rules

To enhance laboratory safety, each school should formulate its own laboratory rules for compliance by science teachers, laboratory staff and students. When formulating such rules, school should consider its practical situation and make reference to the guidelines given by the Education Department and other relevant government departments. The rules should be displayed conspicuously in laboratories.

2.4 Lessons on Laboratory Safety

All science teachers should spare at least one lesson on teaching the general aspects of laboratory safety with each class at the beginning of the school year. They should elaborate on the specific aspects of laboratory safety of individual experiments whenever appropriate during the normal delivery of science lessons.

2.5 Safety with Experiments

Teachers should ensure the safety of all practical activities and must be thorough in preparation. Experiments should be arranged in such a way to minimise risks, for example, using the minimum amount and lowest concentration of chemicals, and replacing hazardous chemicals or dangerous procedures with safer alternatives whenever possible. Any demonstrations or student experiments that are newly conducted should be tried out before they are performed in class to avoid any unpredictable mishaps.

Before each experiment, teachers should give clear instructions to students and remind them of the potential hazards, safety precautions to take and proper ways to dispose of chemical wastes, etc. As far as possible, teachers should note the health conditions of students so that precautions can be taken where appropriate. Teachers should also give sufficient supervision and guidance to students during experiments. A reasonably good control of class discipline should always be maintained.

2.6 Safety Inspections

Each laboratory should be regularly inspected to ensure that all safety measures are in place. If irregularities are spotted during inspections, prompt actions should be taken to rectify the situations.

To facilitate regular and thorough safety inspections, it is desirable to compile a checklist detailing items which must be checked on a daily, weekly or monthly basis. A sample safety inspection checklist is provided in Appendix III. Schools may modify the checklist in the light of the practical needs and conditions of their laboratories.

2.7 Using a Science Laboratory for the Purpose of Teaching Non-science Lessons

Schools should, as far as possible, avoid arranging non-science lessons to be conducted in science laboratories, especially the Chemistry laboratory. However, if a science laboratory is to be used as a classroom for teaching non-science lessons due to floating class arrangements, the teacher involved should note the following:

- students are not allowed to enter the laboratory unless the teacher is present; and
- students are not allowed to tamper with or remove any of the articles in the laboratory.

2.8 Safety Information/Resources

Schools should formulate and adopt effective measures for handling information and resources about laboratory safety. All safety information and resources should be circulated among relevant teachers and laboratory technicians so that necessary safety precautions could be taken.

It is advisable to set up a "Safety Corner" for keeping all the safety information and resources, such as minutes of meeting, circulars and publications on laboratory safety issued by the Education Department and Material Safety Data Sheets. These materials should be kept in a specified place for easy access of science teachers and laboratory technicians. The contents should also be regularly updated.

2.9 Emergency Plan

The emergency plan should include a set of emergency measures and evacuation procedures, as well as the detailed escape routes. In drawing up the emergency measures and evacuation procedures, schools should ensure that such measures and procedures can cope with a wide range of emergencies such as fire, explosion, spillage of dangerous chemicals, gas leakage and other serious laboratory accidents.

When drawing up the emergency measures, schools should consider:

- ways to minimise injuries;
- ways to help the injured; and
- ways to cut down loss.

It is important that schools should assign one or more members of their staff to report the accident to relevant government departments (e.g. Fire Services Department, Education Department, etc.), to alert all school staff and students when an accident occurs, and to coordinate the evacuation when necessary.

In formulating evacuation procedures, schools should:

- set out the criteria for applying different evacuation procedures;
- devise steps involved in the evacuation; and
- look into any necessary follow-up actions.

Schools should bear in mind that, in accordance with the nature of the accident, different levels of evacuation may be carried out (e.g. evacuating the staff and the students at the scene only, on the same floor or floors above the scene, or evacuating

the whole school). In any event, evacuation should be carried out in a safe and orderly manner. In formulating evacuation procedures, steps should be taken to ensure that congestion will not occur at the staircases and corridors.

Schools should draw maps showing in detail the escape routes from the science laboratories. Such maps should be conspicuously displayed in the science laboratories, and schools should ensure that all staff and students are familiar with the escape routes.

Schools should also conduct regular evacuation drills in accordance with the evacuation procedures and escape routes.

3 RISK ASSESSMENT

A hazard is anything with the potential to cause harm to a person or damage to property. A risk is the likelihood of a hazard causing harm in practice. Risk assessment is about the identification of the hazards involved in an activity and the preventive measures taken to control these risks. Sometimes, hazards can be identified by common sense and experience. All practical work must be carried out with safety in mind to minimise the risk of harming oneself and others—safety is everyone' s responsibility.

3.1 When is a Risk Assessment Needed

A risk assessment is needed for any activities such as a student experiment or a teacher demonstration, and any tasks taken by laboratory staff in which a hazard may be present. In science laboratories, most risks arise from the use of chemicals, electrical devices, living organisms, biological specimens, hot or sharp objects, etc. (see Section 24.2 for the common laboratory accidents reported in schools). Risk assessment should be carried out in advance by the person involved, and double-checked by a higher level of personnel.

Sometimes novel experiments may be suggested in science publications. Teachers should assess the potential risks associated with the experiments. If the risks cannot be easily controlled, teachers should not demonstrate the experiments or arrange students to perform them for safety sake.

In recent years, there has been a marked increase in adopting open-ended investigation and project-based learning approach by students. Such a development is to be encouraged. However, it is important to include safety considerations in the planning process. A risk assessment should be carried out as part of the plan and have it checked before starting the activities. Students have to know what the hazards are and how to minimise the risks. Appropriate emergency procedures must be made known to teachers, technicians and students.

3.2 Making a Risk Assessment

The procedures of risk assessment involve:

- identifying hazards of the substances being used or made
- assessing how likely the hazard will actually cause harm and how serious that harm could be
- deciding what control measures to adopt to reduce the risk to acceptable level, e.g. using a smaller quantity of substances, a more diluted solution, a less hazardous chemical, a lower voltage, a fume cupboard, personal protective equipment, etc.
- finding how to dispose of hazardous residues from the practical work

Other relevant information such as size of the practical group, age, experience and ability of the students should also be considered. Risk assessments are most conveniently made on a standard form. An example of the assessment form is provided in Appendix IV. The assessment procedures will become simple and straightforward when one realises that the intention is to protect oneself and others from any risks. When carrying out risk assessment, keeping record of findings may also help in future to review the assessment.

4 GENERAL PRECAUTIONS

The following are some general precautions concerning laboratory safety. These may serve as guidelines from which schools can work out a set of laboratory rules to be followed by every laboratory user, as well as to equip laboratories with necessary safety facilities/equipment.

4.1 Students' Discipline in the Laboratory

1. Students should follow strictly the instructions given by the teacher.
2. Students should not enter the laboratory unless a teacher is present.
3. Students should not remove anything from the laboratory without permission.
4. Students should not rush around or play in the laboratory.
5. Experiments under way should not be left unattended.
6. Laboratory reagents and chemicals should be returned to the appropriate places immediately after use, with their labels facing the front.
7. Students should immediately report all accidents and breakages to their teacher.
8. Students should not suck fingers or pencils when in the laboratory since these may be contaminated with chemicals as well as germs.

4.2 Personal Precautions to be Taken by all Laboratory Users

1. Eating, drinking and smoking are strictly forbidden in the laboratory and preparation room.
2. Long hair must be properly tied.
3. Special care is needed when working with chemicals which have known hazards. It is important to foresee the potential hazards in each case and to take the proper precautions.
4. Wash hands after experiments, especially those involving the use of chemicals, living organisms and radioactive substances.
5. To avoid the possibility of allergy, extra care should be taken when handling pollen and fur.
6. Pipette fillers should be used to help transfer liquid chemicals.
7. Needle should not be provided for the syringe. The liquid content may squirt into eyes if excessive pressure is exerted on the plunger of the syringe.
8. Heavy objects should be lifted with correct posture. Ask others for assistance whenever necessary. When carrying heavy objects, especially large bottles containing dangerous substances, appropriate carrier or trolley should be used as far as possible.
9. Appropriate safety facilities and personal protective equipment should be used whenever necessary. Please refer to Sections 4.4 and 4.5 respectively for details.

4.3 Housekeeping

1. The laboratory and the preparation room should at all times be kept clean and tidy. Broken glass and chemical spillages must receive immediate attention.
2. All exits and passages should be kept clear and none of the exit doors should be locked when the laboratory is in use. Maps showing detailed escape routes should be conspicuously displayed in each laboratory.
3. The lighting in the laboratory and preparation room should be good and sufficient. Working under insufficient lighting could be dangerous.
4. Every reagent bottle should be clearly labelled. All old and blurred labels should be replaced without delay.
5. Dangerous chemicals must be securely stored in strong cupboards under lock and away from heat sources. Such chemicals should be inspected regularly. A detailed record of them should be kept.
6. Food or drink should not be kept in the laboratory except for experimental purpose.
7. Posters on laboratory safety and rules should be displayed in prominent position to promote the awareness of laboratory safety.
8. Before leaving the laboratory unattended for a long period of time, all water taps, electrical switches and gas mains should be turned off, and all windows and doors should be locked.

4.4 Safety Facilities

Adequate safety facilities must be provided and kept in a state of instant readiness at all times. Science teachers and laboratory technicians should be familiar with the usage of the safety facilities.

4.4.1 Fire Extinguisher

Every laboratory must be equipped with at least one appropriate fire extinguisher: carbon dioxide type or dry powder type. Both carbon dioxide and dry powder fire extinguishers are suitable for ordinary combustible fires, flammable liquid fires and electrical fires. Dry powder type is also suitable for metal fires.

Fire extinguisher should normally be installed near an exit and be easily accessible, i.e. not more than 900 mm above the floor. The school principal is required to ensure that the fire extinguishers are kept in good condition at all times.

Carbon dioxide
fire extinguisher

4.4.2 Fire Blanket

Every laboratory must be equipped with at least one fire blanket of approved type. The fire blanket is used for smothering clothing which has caught fire. They should be kept in the laboratory solely for fire fighting purpose and be located at readily accessible positions.

Fire blanket

4.4.3 Sand Bucket

There should be two buckets of sand in each laboratory. They are suitable for putting out small fires involving burning metals (sodium, powdered zinc, magnesium, etc.) and phosphorus. It is advisable to equip each sand bucket with a scoop.

Sand bucket

4.4.4 Fume Cupboard

The fume cupboard is constantly required for carrying out laboratory work which may generate unpleasant, toxic or flammable fumes and gases. Its sash door should be installed with tempered glass or wired glass.

The fume cupboard should be properly maintained. Its working area should be clean and cleared for immediate use. It should not be used as a storage space for glassware, apparatus and chemicals. The exhaust ventilation system should be regularly checked to ensure its effectiveness.

4.4.5 Safety Screen

Each laboratory should be equipped with a safety screen. It should be used when demonstrating experiments involving potentially violent or exothermic reactions (e.g. reaction of sodium with water) and working with glass apparatus under pressure, etc.

The safety screen separates the experimental set-up from observers, and guards against splashing of chemicals and broken glass fragments from reaching the students. The safety screen should always be kept clean. Scratched safety screen should be replaced without delay.

Safety screen

4.4.6 Spill Control Kit

Each laboratory should have at least one spill control kit to clean up chemical spillage. Suitable personal protective equipment should be worn when using the kit.

Spill control kit

4.4.7 First-aid Box and Eye Wash Unit

Each laboratory should be equipped with a first-aid box and an eye wash unit. Please refer to Section 23.4 for details.

4.5 Personal Protective Equipment

Students, teachers and laboratory staff, when working in the laboratory, should wear suitable personal protective equipment (PPE) in all circumstances wherever there is any potential risk of bodily injury. All PPE should be kept clean and properly maintained in a serviceable condition. Defective PPE should be replaced immediately.

4.5.1 Safety Spectacles

Each laboratory should be equipped with enough safety spectacles for use by every student. Safety spectacles must be put on when conducting experiment involving heating chemicals, handling acids, alkalis and other corrosive chemicals, working with glass apparatus under pressure, carrying out potentially violent or exothermic reactions, or when there is any potential risk of eye injury. Whenever safety spectacles are required, they should be continually worn by all until everyone has finished the relevant activity.

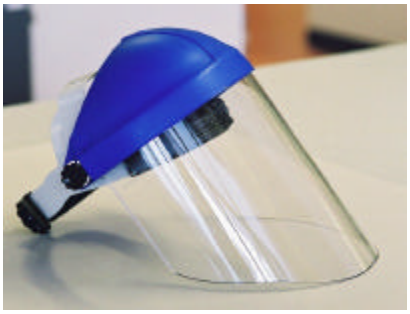
Safety spectacles

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 purpose. Dirty safety spectacles should be cleaned with detergent or disinfectant (e.g. Savlon) as appropriate.

4.5.2 Face Shield

Each laboratory should be equipped with a face shield for use by teachers in demonstrations or by laboratory technicians in preparatory work. It can be used when dispensing large volumes of concentrated acids, alkalis or corrosive chemicals and opening containers which are under pressure. Face shield provides maximum protection for eyes and face, with very wide angle of vision.



Face shield

4.5.3 Protective Gloves and Laboratory Gown

Appropriate protective gloves should be worn for hand protection while handling corrosive chemicals, hot objects, microorganisms, etc. Laboratory gown should be worn for body protection whenever necessary. However, torn or ragged clothing can be dangerous instead of protective.

Protective gloves

4.5.4 Respirator

There should be a respirator with suitable filter cartridge in each laboratory. It should be worn when operations involving hazardous vapours/gases have to be performed outside a fume cupboard e.g. mixing of chemical waste. It should also be used when cleaning up spills of toxic and volatile chemicals. The filter cartridges should be regularly replaced to ensure that they are available for immediate use.

Respirator

4.6 Using Air-conditioners in Laboratories/Laboratory Preparation Rooms

If schools have installed air-conditioners in their science laboratories/laboratory preparation rooms, all users of these special rooms including students, teachers, laboratory staff should take appropriate safety measures to ensure that there is adequate ventilation in the rooms during practical activities.

When Bunsen burners or chemicals are to be used, all air-conditioners should be switched off and exhaust fans switched on. The windows of these laboratories should be left open. Notices to this effect should be conspicuously displayed in these laboratories.

To maintain adequate fresh air supply in laboratory preparation room, the exhaust fan must be switched on whenever the room is in use. To this effect, the air-conditioning system and exhaust fan in the preparation rooms must be electrically interlocked so that switching on of the former will automatically turn on the ventilation fan so as to avoid accumulation of gases within the preparation room, but not vice versa.

Chemicals which generate hazardous vapours should not be handled or stored inside preparation rooms, whether or not air-conditioned. Preparation work which involves unpleasant or hazardous vapours/gases should not be conducted in preparation rooms but in fume cupboards of the laboratories.

Attention should be paid to regular cleansing of the air filter in the maintenance of air-conditioning facilities.

5 FIRE PRECAUTIONS

5.1 Fire-fighting Equipment

Every laboratory must be equipped with at least one appropriate fire extinguisher: carbon dioxide type or dry powder type. Discharged or expired fire extinguishers must be promptly recharged by a registered fire service installations contractor. In addition, there should be an approved type of fire blanket and two buckets of sand in every laboratory. These facilities should be solely used for fire fighting purpose, be easily accessible and not be obstructed.

Fire-fighting equipment should be kept in good condition and in a state of instant readiness at all times. All laboratory staff should be familiar with the operation and handling of all fire-fighting equipment.

5.2 Exits

An illuminated exit sign bearing the word "EXIT" and the characters "出口" should be installed at each exit in accordance with the relevant Code of Practice issued by the Fire Services Department. For safety reasons, all exit doors in the laboratories should never be locked during lessons. School should also ensure that the fire-resisting doors are closed, but not locked. The passage for the laboratory exits should always be kept clear of obstacles.

Illuminated exit sign

5.3 Fire Drills

Schools should conduct fire drills regularly. Maps showing detailed escape routes should be conspicuously displayed in each laboratory. All students, teachers and laboratory staff should be familiar with the escape routes from the laboratories.

5.4 Storing Flammable Substances

Every storeroom, cupboard and container used for storing flammable substances should be clearly and boldly marked "Flammable Substance 易燃物品".

As advised by the Fire Services Department, schools should ensure that ethanol (ethyl alcohol) is not stored together with kerosene or thinner in the laboratory, workshop or in any other rooms, including the dangerous goods store within the school premises.

Storage of dangerous goods in the laboratory should not exceed the exempted quantity as well as the aggregated quantity specified in the *Dangerous Goods (General) Regulations*. If schools have any enquiries or difficulties in complying with the Regulations, please contact the Licensing and Certification Command, Fire Services Department at

2723 8787.

5.5 Evacuation in case of Fire or Explosion

When there is a fire or an explosion occurring in a science laboratory, school should make use of all staff available to evacuate immediately the students from the laboratory, or all the students from the school building if the situation becomes serious. It is essential that any such evacuation should be carried out, without using lift, in an orderly and controlled manner, and that every effort should be made to avoid panic amongst students.

The gas supply and electricity should be turned off at the mains if practicable when it is necessary to evacuate the laboratory. It is essential that all science teachers and laboratory technicians know the positions of mains controls.

Meanwhile, the Fire Services Department should be quickly notified by dialing 999. The Education Department should also be notified of the incident.

6 HAZARDOUS CHEMICALS AND THEIR STORAGE

Hazardous chemicals may be defined as those which may cause injury to persons or damage to property. Chemicals may be hazardous because they are corrosive, flammable, irritant, toxic, harmful, oxidising, explosive or carcinogenic. Many hazardous chemicals may involve more than one hazard.

Good housekeeping, regular inspection as well as clear and exact labelling are essential for minimising accidents resulting from the storage of chemicals.

6.1 General Precautions in Storing Hazardous Chemicals

6.1.1 Storage

1. Hazardous chemicals should be kept in a proper container clearly marked with the names of the chemicals and be stored in a locked room or cupboard except when the chemicals are being used in experiments. The key to the locked room or cupboard must be kept under control of the teacher-in-charge of the laboratory.

2. The bulk of hazardous chemicals should be stored in a chemical storeroom if available. Over-stocking of chemicals should be avoided. Storage of dangerous goods in the laboratory should not exceed the exempted quantity as well as the aggregated quantity specified in the *Dangerous Goods (General) Regulations*.

3. The preparation room and storeroom should not be accessible to students.

4. Where school laboratories have no adjacent preparation room/storeroom, there is an increased obligation on the supervisor, principal, science teachers and laboratory technicians to ensure that dangerous chemicals are properly stored in locked cupboards, to which students have no access.

5. The storage area for chemicals should be provided with sufficient fresh air ventilation.

6. Volatile liquids must be stored in a cool place, away from sunlight or heat sources. Their containers should never be completely filled.

7. It is a good practice to store flammable chemicals in fireproof cabinets. Flammable liquids should never be kept in open shelves, nor should they be readily accessible to students. They should be stored away from any heat source.

8. Chemicals which could combine to produce fumes, a fire or an explosion must not be kept close to each other.

9. In general, chemicals, especially hazardous chemicals, should not be stored on high shelves where there would be a risk of dropping when taking them down for use. Main stock of concentrated sulphuric, nitric and hydrochloric acids, 0.88 ammonia, and flammable liquids should be stored as near to floor level as possible.

6.1.2 Chemical Supplies

In fresh purchase of a chemical, its hazardous nature should be assessed. Safer alternatives of hazardous chemicals, if available, should be acquired for use. All chemicals must be clearly labelled and correctly arranged, preferably date-stamped on date of arrival. A clear and updated record of chemical stocks showing their locations should be kept.

Surplus, expired or old samples of sodium, potassium, phosphorus and other dangerous chemicals should be regarded as chemical wastes and disposed of through the Chemical Waste Treatment Centre (CWTC) as described in Chapter 10 .

6.1.3 Information of Hazardous Chemicals

All containers of hazardous chemicals, including bench reagent bottles, should bear appropriate hazard warning symbols which depict the nature of the chemicals and hence serve to alert the laboratory users. More than one symbol can be used for chemicals with more than one hazard. Some hazard warning symbols in common use are shown in Appendix V.

The Material Safety Data Sheets (MSDSs) for all the hazardous chemicals used should be readily available in each science laboratory. They provide important hazardous information about the chemicals, including their hazard natures, safe handling procedures, first-aid measures and emergency procedures, for reference of laboratory users at any instance.

MSDSs are usually available from suppliers of chemicals or on the Internet. A set of MSDSs covering 450 chemicals commonly used in school laboratories has been prepared by the City University of Hong Kong. It is available on the web pages of the City University of Hong Kong and the Science Section, Education Department.

6.1.4 Reactive Chemicals

Chemicals which have to be kept in suitable immersion liquids (e.g. phosphorus in water, sodium in paraffin oil) should not be kept on the same shelf where they could be confused. An additional label showing the name of the immersion liquid should be stuck on each container. The adequacy of immersion liquid should be regularly inspected.

Water-reactive chemicals like calcium carbide, silicon tetrachloride, disulphur dichloride, phosphorus trichloride and phosphorus pentachloride when in contact with water or moist air, can give out flammable gases (as in the case of calcium carbide) or harmful gases. This may also result in building-up of pressure inside the container and cause cracking of the bottle if the stopper has jammed. These chemicals should be kept dry by storing them in tightly sealed containers or desiccators, away from heat and moisture. It is always advisable to keep the minimum quantity sufficient for current use.

6.1.5 Regular Inspections

The chemicals in the containers should be regularly checked to spot any signs of change, leakage and spillage. Once detected, appropriate corrective actions should be taken. Adequate and suitable equipment (e.g. spill control kit and personal protective equipment, etc.) should be readily available for trained laboratory staff to handle chemical spillages/leakages according to proper emergency procedures. Blurred or detached labels should also be replaced immediately.

6.2 Corrosive Chemicals

Corrosive chemicals refer to those chemicals which may cause serious injuries on prolonged contact with skin. Special care is called for when storing or using the following corrosive substances:

Aluminium chloride, ammonia, bromine, benzoyl chloride, ethanoic acid, ethanoic anhydride, ethanoyl chloride, hydrobromic acid, hydrochloric acid, hydrogen peroxide, methanoic acid, Millon's reagent, nitric acid, phosphorus chlorides, potassium hydroxide, sodium hydroxide and sulphuric acid

Corrosive chemicals should normally be handled with the protective gloves on. Clothing contaminated with corrosive chemicals should be carefully removed. Spillages adhering to skin should be immediately washed with plenty of water. However, it should be noted that some chemicals such as concentrated sulphuric acid have highly exothermic reactions with water. Spillage of these chemicals on skin should be quickly soaked up as far as possible with a dry cloth before drenching the area with a large amount of water.

The following are safety precautions in storing some corrosive chemicals:

Chemicals	**Storage**
Aluminium chloride, anhydrous	Cool and dry, in a well-sealed container.
Ammonia (0.88)	Cool and at floor level. Isolate from halogens and acids. Great care should be taken when opening stock bottles.
Bromine	Store apart from other materials in a cool place. Stopper the bottle tightly after use, and handle only in a fume cupboard. Keep bottle of bromine in a desiccator with soda lime at the bottom. Fresh purchase should be in the form of ampoules which are more convenient to store.
Hydrochloric acid, concentrated	Store at floor level in a well-ventilated room. Isolate from oxidising agents, particularly nitric acid, chlorates and methanal (formalin or formaldehyde).

Chemicals	Storage
Hydrogen peroxide	Keep in brown bottles, away from heat and sunlight. Hydrogen peroxide is fairly stable when pure but may decompose explosively, particularly in contact with dust particles or finely divided metals. It is safe to store when diluted.
Nitric acid, concentrated	Store at floor level in a well-ventilated room. Isolate from reducing agents, metals and strong alkalis.
Phosphorus pentachloride and phosphorus trichloride	Store in well-sealed containers away from moisture and heat.
Potassium hydroxide (solid) and sodium hydroxide (solid)	Store dry in well-sealed containers. Keep away from acids.
Sulphuric acid, concentrated	Store at floor level, away from strong alkalis, chlorates, perchlorates and permanganates.

6.3 Flammable Chemicals

Flammable chemicals may be gases, liquids or solids. The use of such chemicals in science laboratories poses a fire and sometimes an explosive hazard. The following precautions should be taken:

- no smoking, no flames and no electric hot-plates
- fire-fighting equipment must be at hand
- flammable chemicals must not be poured down the drain

6.3.1 Flammable Gases

They include hydrogen, hydrogen sulphide, carbon monoxide, Town gas, LP gas, and hydrocarbon gases. Most of them form explosive mixtures with air or oxygen.

6.3.2 Flammable Liquids

Flammable liquids not only burn in air but their vapours also form explosive mixtures with air. These include benzene, carbon disulphide, dimethylbenzene (xylene), ethoxyethane (diethyl ether), ethanol, ethyl ethanoate, methanol, methylbenzene (toluene), propanone (acetone) and petroleum ether.

In general, all organic liquids should be treated as flammable and appropriate safety measures should be taken when working with them. Volatile flammable liquids must be stored in a cool place (not in a refrigerator) at floor level, away from heat sources and direct sunlight. Their containers should never be completely filled.

Volatile flammable liquids should never be placed in domestic refrigerators. If placed in refrigerators with thermostat controls and door-switch which may spark in operation, these liquids can give out vapours which may be ignited by the sparks, thus causing explosion.

The following are safety precautions in storing some flammable liquids:

Chemicals	Storage
Ethoxyethane (diethyl ether)	Ethoxyethane (diethyl ether) can ignite when the vapour or liquid comes into contact with a hot surface. Ether peroxide can be formed by air oxidation of diethyl ether. Ether peroxide is highly explosive. Explosion may result when "old" samples of diethyl ether are distilled or evaporated to a small volume, due to formation of ether peroxide. If in doubt, test with potassium iodide solution. A yellow or brown colour indicates the presence of the peroxide. Diethyl ether should not be kept for a long time in half-empty bottles.
Ethanol (ethyl alcohol)	Ethanol (ethyl alcohol) should not be stored together with kerosene or thinner in the laboratory, or in any other room within the school premises, including the dangerous goods store.

6.3.3 Flammable Solids

Some solids burn upon exposure to air, water or heat. Some ignite spontaneously when subject to friction, or give off flammable gases upon contact with water and moisture. Flammable solids in this category include aluminium and magnesium powder, phosphorus (yellow or white), potassium, sodium, sulphur and calcium carbide.

The following are safety precautions in storing some flammable solids:

Chemicals	Storage
Alkali metals: potassium, sodium	Cover with paraffin oil in well-sealed glass bottles. Keep bottles in metal containers and store dry. Old stocks of potassium and sodium (especially the former), which appear yellow due to the formation of superoxides, are liable to explode upon friction or shock. It is therefore strictly forbidden to use these old samples for practical work or to cut them into small pieces with a knife as it would entail an explosion. As a general guide, it is advisable ♦ to purchase these metals only in small quantities (i.e. to keep not more than 100 g of each metal in the laboratories); ♦ to date-stamp the samples upon arrival;

Chemicals	Storage
	♦ to check the stock of sodium/potassium in the laboratory regularly, making sure that there is enough immersion liquid; and ♦ that sodium and potassium should never be stored in refrigerators.
Metal powders: aluminium powder and magnesium powder	Keep dry. Isolate from strong oxidising agents.
Phosphorus (yellow or white)	Cover with water in a well-sealed container. Isolate from other chemicals.
Calcium carbide	Calcium carbide reacts with water to generate heat and ethyne which forms an explosive mixture with air. Calcium carbide should be kept dry by storing in a tightly sealed container and away from heat.

6.4 Irritant Chemicals

Irritant chemicals usually refer to those chemicals which can cause by themselves or their vapours inflammation through immediate, prolonged or repeated contact with the eyes, skin or respiratory system. Though some chemicals are not classified as irritant, their vapours may still have certain irritant effects. Protective gloves should be worn and good ventilation should be ensured when handling these chemicals. **Do not allow asthmatics to smell irritating gases.** Containers of these chemicals should be opened with particular care in a fume cupboard.

Irritant chemicals should be stored cool and inside a well-ventilated room.

Students should also be made aware of the hazards associated with the use of the following substances:

1. Halogens are strong irritants to the eyes and skin. Experiments involving halogens should be carried out inside a fume cupboard.
2. The vapour of ethanoic acid irritates the respiratory system, skin and eyes.
3. Methanal (formaldehyde) vapour irritates the respiratory system and eyes. Its solution (formalin) irritates the skin and eyes.
4. Vapours of phenylamine (aniline) and its hydrochloride irritate the eyes.
5. The vapour of trichloromethane (chloroform) irritates the eyes.

6.5 Toxic Chemicals

Toxic chemicals are substances which if inhaled, ingested or penetrated through the skin, may involve serious, acute or chronic health risk and even death. All chemicals should never be tasted. Teachers should impress upon students the dangers of eating food in the laboratory, and using laboratory glassware as drinking utensils. Students should be instructed to wash their hands before leaving the laboratory.

Toxic chemicals must be stored in proper containers (highly toxic chemicals should preferably be stored in double containment) and kept in a locked cupboard.

Students should also be made aware of the hazards associated with the use of the following substances:

1. Cyanides are the most potent of all poisons: a few grains taken into the body may cause death rapidly.
2. Arsenic and arsenic salts are extremely toxic: their absorption can cause death very quickly.
3. Mercury, a cumulative poison, also yields a vapour which is toxic in as low a concentration as one in a hundred million. In this context, the preparation of oxygen by heating mercury(II) oxide is not recommended. Since mercury does produce a vapour, every precaution should be taken to avoid spilling, thereby minimising the risk of mercury poisoning. Any spills should be picked up at once (Please refer to Section 8.1 for details of the treatment of mercury spill). Mercury salts are also highly toxic.
4. Cadmium and its compounds are highly toxic and should be handled with great care. They should neither be inhaled nor ingested.
5. Lead compounds are in general toxic. There is now clear evidence of the many harmful effects resulting from ingestion or inhalation of small quantities. It should be noted that lead poisoning is long term and cumulative. Science students, in common with the rest of the population, are exposed to lead in the atmosphere and from many other sources. Every care should be taken not to add appreciably to the body burden of lead as a result of experimentation in the laboratory.
6. Benzene is toxic by inhalation and in contact with skin. Dangers of very serious irreversible effects.
7. Tetrachloromethane (carbon tetrachloride) is very toxic if swallowed or absorbed through the skin. It is also harmful to the eyes and lungs. It is also a suspected carcinogen. When heated to decomposition, it yields highly toxic fumes of carbonyl chloride (phosgene).
8. Halogens such as chlorine and bromine are highly toxic by ingestion and inhalation. Experiments involving halogens should be performed in a fume cupboard.
9. Phenol is very toxic as a vapour if inhaled and when absorbed through the skin.
10. Millon's reagent is very toxic by inhalation, in contact with the skin and if swallowed. Danger of cumulative effects.

11. Methanal (formaldehyde) is toxic by inhalation, in contact with the skin and if swallowed.

12. Nitrobenzene is toxic by inhalation, in contact with skin and if swallowed. Danger of cumulative effects.

13. Phenylamine (aniline) and its hydrochloride are toxic by inhalation, in contact with skin and if swallowed. Danger of cumulative effects.

14. Common toxic gases, such as ammonia, bromine, carbon monoxide, chlorine, hydrogen sulphide, nitrogen dioxide, and sulphur dioxide, should never be directly smelled in the course of experiments. To smell the contents of a container (e.g. test tube), hold the container about 10 cm away from the nose and gently fan any odour from the hand towards the nose. **Do not allow asthmatics to smell toxic gases.**

6.6 Harmful Chemicals

Harmful chemicals are those substances which if inhaled, ingested or penetrated through the skin, may involve limited health risk. Although the level of harmfulness seems to be lower than that of the toxic chemicals, similar safety precautions for toxic chemicals should also be taken when handling harmful chemicals.

Harmful chemicals should be stored under lock.

Students should also be made aware of the hazards associated with the use of the following substances:

1. Ethanedioic acid (oxalic acid) and ethanedioates (oxalates) are harmful in contact with skin and if swallowed. Pipette filler should be used if aliquots of these are to be used volumetrically.

2. Trichloromethane (chloroform) vapour is a strong anaesthetic which may cause drowsiness, vomiting or unconsciousness. It is a suspected carcinogen. Short-term exposure to high concentrations can cause serious or even fatal poisoning.

3. Naphthalene is harmful by inhalation, ingestion and skin absorption. In addition, it is found that some 4.5 per cent of local born male babies suffer from G6PD (glucose-6-phosphate dehydrogenase) deficiency which is a hereditary disease and would last for life. People with such deficiency when exposed to naphthalene (e.g. in mothball) may suffer from haemolysis (destruction of blood cells). **Teachers are advised not to use naphthalene in any science experiments.** The use of naphthalene in the experiments such as melting point determination and the study of cooling curves should be replaced by wax or octadecan-l-ol, which are safer alternatives. Schools are also advised to request parents to report G6PD deficiency and any acute diseases suffered by their children so that precautions can be taken where appropriate.

6.7 Oxidising Chemicals

Oxidising chemicals are those chemicals which may give rise to highly exothermic reactions when in contact with other substances, particularly flammable substances.

Oxidising chemicals should be stored cool and away from flammable substances.

Students should also be made aware of the hazards associated with the use of the following substances:

1. Concentrated nitric acid will induce violent reaction when in contact with ethanoic acid, ethanol or propanone. It will also ignite when mixed with aluminium, lithium, magnesium, sodium or potassium. This acid should be stored at low level, preferably in a tray to contain spillages, and it should be kept away from metals and combustible materials including organic substances.

2. Potassium manganate(VII) (potassium permanganate) will form vigorously burning mixtures upon mixing with metal powders or combustible materials. This chemical should be kept away from other flammable chemicals in the laboratory.

3. Chlorates(V) (chlorates) and chlorates(VII) (perchlorates) are highly oxidising agents. Wood and clothes impregnated with solutions of these chemicals will ignite easily and burn very vigorously when dry. Chlorates(V) and chlorates(VII) may also decompose explosively on heating. These chemicals should be kept cool, uncontaminated and away from combustibles such as wood, cork, plastic, carbon, sulphur and powdered metals, etc.

6.8 Explosive Chemicals

Explosive chemicals are those chemicals which may start reactions spontaneously upon sudden change in temperature and pressure or under mechanical friction and vibration. The reactions are usually violent and explosion often results.

Explosive chemicals should be stored in a strong locked cupboard, away from heat and moisture and be regularly inspected. Containers of these chemicals should be marked with the date of receipt. It is always advisable to keep the minimum quantity sufficient for current use.

The following substances should not be stored in schools:

- 2,4,6-Trinitrophenol (picric acid) is potentially explosive when subjected to heating, scratching or abrasion.
- Azides may result from prolonged standing of Tollens' reagent, and are liable to explode without any apparent provocation.

6.9 Carcinogenic Substances

Carcinogens are substances capable of causing cancer.

In general, the effects of chemical carcinogens are long-term and insidious, rather than immediate and obvious. These substances can enter the body not only by ingestion, but also by inhalation and skin absorption.

The known cases of carcinoma in humans attributable to the substances have normally been due to prolonged exposure in industrial conditions, either of manufacture or use. It is unlikely that students are at great risk while exposed to these compounds for the much shorter periods involved in educational experimentation. It should be made clear that no threshold dosage has yet been established nor has a safe maximum time of exposure. For as long as this information remains undetermined, it is advisable to take careful precautions. Safer alternatives should be used.

It is recommended that each school should prepare a list of the names and quantities of known or suspected carcinogens held under its control. This list should be kept up-to-date and should be held in the custody of a senior staff.

All carcinogenic substances should be stored in tightly sealed containers, preferably in double containment, labelled "CARCINOGEN", and kept in a locked cupboard.

6.9.1 Carcinogens

The following carcinogens should not be used in schools:

> asbestos, 4-aminobiphenyl, benzene, benzidine and its salts, chloroethene (vinyl chloride), coal tar, cyclophosphamide, 4-nitrobiphenyl, 4,4-dinitrobiphenyl, 1-naphthylamine and its salts, 2-naphthylamine and its salts

The use of asbestos wool and powder, which will create airborne asbestos fibres, is strictly forbidden in school laboratories. Glass wool and mineral wool (e.g. rocksil) are possible alternatives. Wire gauzes with asbestos centres should be replaced by wire gauze with ceramic centres. Asbestos boards should be replaced by suitable non-asbestos substitutes e.g. bench mats made of glass reinforced cement. Schools are strongly advised to replace asbestos fire blankets by fibreglass or other substitutes approved by the Fire Services Department. If schools wish to retain the asbestos specimen in the mineral specimen set used for teaching, they should ensure that the asbestos specimen be securely sealed inside a transparent plastic box.

Bis(chloromethyl) ether (BCME) can be formed spontaneously from the vapours of methanal (formaldehyde) and concentrated hydrochloric acid under normal laboratory conditions. It is a powerful carcinogen at very low concentration if inhaled continuously. Every precaution should be taken to reduce the chances of the two vapours mixing in the laboratory.

A complete list of known human carcinogens and relevant information can be found on the web pages of the International Agency for Research on Cancer (IARC) at *http://www.iarc.fr*.

6.9.2 Suspected Carcinogens

A large number of other substances, listed below, have been shown to cause cancer in animals. It is possible that they could have similar effects on human.

- Polycyclic aromatics and their derivatives
- Aromatic amines, nitro compounds and related compounds
- *N*-nitroso compounds of the general formula RN(NO)R' and the related *N*-nitrosamides, RN(NO)COR'
- Complex mixtures such as crude oil
- Trichloromethane (chloroform) and tetrachloromethane (carbon tetrachloride)
- Other specific substances such as azoxyethane, 1,2-diethylhydrazine, urethane, thiourea, nitrogen mustard, tetramine and â-propiolactone, etc.

The above list is by no means exhaustive. The compounds named serve to indicate the wide range of substances which may have carcinogenic effect.

7 INCOMPATIBLE CHEMICALS

Some chemicals are "incompatible" because they react together to pose corrosive, toxic, fire and explosive hazards. As far as it is practicable, incompatible chemicals should be stored away from each other.

The following is a list of common chemicals and their major incompatible chemical(s):

Chemical	**Incompatible chemical(s)**
Ammonia (0.88)	Aluminium, zinc, galvanized metals, silver, and alloys of these metals, halogens
Ammonium nitrate	Combustible materials, strong acids, organic materials, chemically active metals, powdered metals, nitrates(III) (nitrites), chlorates, sulphur
Bromine	Combustible materials, metals such as iron, copper and their alloys, alkalis
Calcium carbide	Water, aqueous solutions of chemicals
Calcium oxide	Water, strong acids
Carbon, activated	Calcium chlorate(I) (calcium hypochlorite) and other oxidising agents
Copper	Hydrogen peroxide
Chlorates(V), Chlorates(VII) & Chloric(VII) acid	Acids, reducing agents, metal powders, sulphur, finely divided organic compounds or combustibles
Chromic acid	Ethanoic acid (acetic acid), naphthalene, camphor, glycerol, turpentine, alcohols, flammable liquids in general
Ethanedioic acid (oxalic acid)	Silver, mercury
Ethanoic acid (acetic acid)	Chromic acid, nitric acid, hydroxyl compounds, ethane-1,2-diol (ethylene glycol), Chloric(VII) acid (perchloric acid), peroxides, permanganates
Ethanol (ethyl alcohol)	Kerosene, thinner
Hydrogen peroxide	Combustible materials, metals such as copper, chromium, iron and their salts, nitric acid, potassium manganate(VII) (potassium permanganate), phenylamine (aniline)
Hypochlorites	Acids, activated carbon
Iodine	Ammonia (anhydrous or aqueous), ammonium salts, acetaldehyde, combustible materials, aluminium, chemically active metals, powdered metals, carbides

Chemical	Incompatible chemical(s)
Methanal (formaldehyde) and formalin	Strong acids, strong bases, alkali metals, amines, ammonia, phenol  ***When mixed with concentrated hydrochloric acid, BCME (bis(chloromethyl) ether), a strong carcinogen, is formed.***
Nitrates	Sulphuric acid
Nitric acid, concentrated	Metals and organic compounds  ***When mixed, a fire may occur or toxic fumes of oxides of nitrogen may produce.***
Phenylamine (aniline)	Hydrogen peroxide, strong bases, strong acids, zinc, aluminium, solutions containing iron salts
Phosphorus	Caustic alkalis, reducing agents
Phosphorus pentachloride	Water, aqueous solutions of chemicals
Potassium	Water, aqueous solutions of chemicals, acids and halogenated hydrocarbons
Potassium manganate(VII) (potassium permanganate)	Ethane-1,2-diol (ethylene glycol), propane-1,2,3-triol, benzaldehyde, sulphuric acid, hydrogen peroxide
Propanone (acetone)	 Trichloromethane (chloroform) (***When mixed, an explosion may occur.)***, concentrated nitric and sulphuric acid mixtures
Silver	Ethanedioic acid (oxalic acid), 2,3-dihydroxybutanedioic acid (tartaric acid), ammonia and ammonium compounds
Sodium	Water, aqueous solutions of chemicals, acids and halogenated hydrocarbons
Sodium nitrate(III) (sodium nitrite)	Cyanides, strong acids, combustible materials, organic materials, ammonium nitrate and other ammonium salts
Sulphides	Acids, zinc, copper, aluminium, and their alloys
Sulphuric acid	Alkalis, chlorates(V), chlorates(VII) (perchlorates), manganates(VII) (permanganates), ethanoic anhydride (acetic anhydride), combustible materials  ***Concentrated sulphuric acid reacts violently with water.***
Flammable liquids	Ammonium nitrate, chromic acid, hydrogen peroxide, nitric acid, sodium peroxide, halogens

8 CHEMICAL SPILLS

Schools should have effective emergency measures to deal with spillage of chemicals. Laboratory staff should be well prepared to handle small-scale spillages that are likely to occur in school laboratories. Methods of safe handling of chemicals and dealing with spillages are usually provided in Material Safety Data Sheets. Adequate safety equipment (e.g. spill control kits and barrier tape, etc.) and personal protective equipment (e.g. protective gloves, respirator and safety goggles, etc.) should be readily available for use in handling chemical spills.

8.1 Handling Spills

All students and untrained personnel should be kept away from the immediate area of spill. Before attempting cleanup, the degree of hazard should be assessed, proper procedures should be followed and necessary safety precautions should be taken. Appropriate personal protective equipment should be put on when dealing with spillages of hazardous chemicals. Spillage of solid materials that are non-hazardous can be treated with brooms, brushes and shovels. Liquid chemicals that are harmless can be mopped up with paper towels or absorbents.

Guidelines on cleanup of some chemical spills are as follows:

Nature of Spillage	**Cleanup**
Acids and acid halides	Cover with solid sodium carbonate to completely neutralise the acids. Mop up with water.
Alkalis	Cover with solid sodium hydrogensulphate or citric acid to completely neutralise the bases. Mop up with water.
Organic liquids	
♦ Non-flammable	Emulsify with detergent. Mix with water. Mop up.
♦ Flammable	Absorb in sand or mineral absorbent. Shovel into a metal bucket and burn the liquids in a safe place.
Mercury	As far as possible any drops spilt on the floor or the bench should be collected by means of a glass capillary tube attached to a vacuum pump (or water pump) via a suitable trap (e.g. a filter flask). Any remaining small drops (especially those in the crevices) should then be immediately covered with a paste of sulphur and lime. Leave for a few hours, then sweep into receptacles. Wrap in plastic bags and dispose of as chemical wastes.

8.2 Serious Chemical Spills

Teachers and laboratory technicians should not attempt to clean up chemical spills which involve a high degree of hazard. For these serious spills, students should be immediately evacuated from the laboratory. The area should be cordoned off and warning signs should be posted. The principal should be notified immediately to initiate other necessary emergency procedures.

In incidents where the spillage may result in significant contamination of an area or risk of pollution, dial 999 or contact the Fire Services Department for help. Environmental Protection Department should also be informed immediately in case the services from the CWTC Emergency Response Team is required.

9 PROCUREMENT OF CONTROLLED CHEMICALS BY SCHOOLS

To fulfil the international obligation under the *United Nations Convention Against Illicit Traffic in Narcotic Drugs and Psychotropic Substances, 1988,* control was introduced on 25 chemicals which can be used for manufacture of dangerous drugs. The control is prescribed in the *Control of Chemicals Ordinance* (Cap. 145).

9.1 Controlled Chemicals in School Experiments

The following requirements of the Ordinance must be closely observed when procuring controlled chemicals.

9.1.1 **Acetylating Substances** (Schedule 1 chemicals under the Ordinance)

Schools wishing to acquire acetylating substances i.e. ethanoyl chloride (acetyl chloride) and ethanoic anhydride (acetic anhydride) for experimental purposes must apply for a Controlled Chemicals Licence from the Commissioner of Customs and Excise. The application for the licence should be made on Form CED 359 (Rev. 2/98). An inspection to ascertain the suitability of the prospective licensed premises will be arranged.

Schools possessing acetylating substances should store them in a locked cupboard in the laboratory and keep an up-to-date record of usage of these substances.

9.1.2 **Potassium Permanganate** (a Schedule 2 chemical under the Ordinance)

Schools wishing to acquire potassium permanganate for experimental purposes must apply for a Storage Approval from the Commissioner of Customs and Excise. The application for Storage Approval should be made on Form CED 360 (Rev. 2/98).

Schools should keep potassium permanganate in no more quantity than approved in a locked cupboard in the laboratory within the validity of the storage approval. They should also keep in view to renew their storage approval before the expiry date of the approval.

9.2 Submission of Application

Application for a licence or an approval for controlled chemicals should be forwarded to the Controlled Chemicals Group, Customs and Excise Department, Room 631, 6/F, North Point Government Offices, 333 Java Road, North Point, Hong Kong.

As the Ordinance may be reviewed regularly to include more chemicals under its control, schools are advised to contact the Controlled Chemicals Group, Customs and Excise Department at 2541 4383 or refer to their web pages at *http://www.info.gov.hk/customs* for the latest list of controlled chemicals.

10 DISPOSAL OF CHEMICAL WASTES

The *Waste Disposal (Chemical Waste) (General) Regulation* under the *Waste Disposal Ordinance* (Cap. 354) was enacted in May 1992 and has been fully implemented with effect from 3 May 1993. All schools with science laboratories and/or technological subjects workshops are required to comply with the Regulation in respect of the registration with Environmental Protection Department (EPD) as chemical waste producers and the storage and disposal of chemical wastes.

New schools not yet registered with EPD as chemical waste producers should do so as soon as possible by submitting a completed registration form (obtainable from all offices of EPD) to EPD. The general requirements for segregation, packaging, labelling, storage and collection of chemical wastes generated in schools are detailed in Schools Miscellaneous Circular No. 1/1998 on Control of Chemical Wastes in Secondary Schools which is available on the web pages of the Science Section, Education Department at *http://cd.ed.gov.hk/sci*.

10.1 Chemical Wastes

Schools are required to store up, prior to collection for disposal by licensed collectors, the following three main types of chemical wastes which arise as a result of practical work in science laboratories and technological subjects workshops:

- strong acids and alkalis with concentrations as defined in Schedule 1 to the Regulation (an abstract of Schedule 1 is in Appendix VI);
- spent organic solvents; and
- surplus or expired chemicals.

10.2 Storage Facilities

Schools should acquire adequate storage facilities for chemical wastes, viz. steel cupboards, steel and plastic trays according to the specifications given in the latest Chemistry or Integrated Science Standard Equipment and Furniture Lists. The schools registered as chemical waste producers should receive 20 L pails, free of charge, from Enviropace Limited, the contractor of the Chemical Waste Treatment Centre (CWTC).

10.3 Collection Services

CWTC has been carrying out regular collections of the first two types of chemical wastes (i.e. strong acids, strong alkalis and spent organic solvents) from schools since March 1994. Starting from May 1995, the Centre has also provided services to collect the third type of chemical wastes (i.e. surplus or expired chemicals) from schools. For enquiries concerning the collection services, schools should contact CWTC direct (Tel: 2434 6452).

10.4 Disposal Charges

When CWTC initially commenced operation in April 1993, its service was free of charge. But since March 1995, chemical waste producers are required to pay for the collection and disposal services offered by CWTC. Schools which are non-profit making can apply in writing to EPD for reduction or a waiver of charges for disposal of chemical waste by CWTC.

11 GLASSWARE

All glass items should be handled and stored with care. Heat-resistant glassware should be used when liquids are to be heated.

11.1 Handling Glassware

1. Large glass bottles should not be lifted or carried by the neck, nor cradled in the arms. The main body of the bottle should be grasped firmly, and trolleys or special carriers should be used.

2. When a tight glass-stoppered bottle is opened, the bottle should be placed in a trough large enough to hold the contents in case of accidental spillage and the stopper gently tapped. Brief gentle warming of the neck of the bottle can help if appropriate.

3. The fitting of a pipette filler to a pipette should be done gently. During the process, the pipette should be held at the upper stem to avoid accidental breakage.

4. When glass tubing and rods are being cut, hands should be protected with a piece of cloth when "snapping" the cut. The sharp ends of glass tubing should always be polished in a flame.

5. When inserting glass tubing into a cork or rubber bung,

   - the tubing should not be pointed towards the palm of the hand;
   - the size of the hole should be compatible with the size of the tubing and a lubricant should be used; and
   - a cork borer can be used to assist the threading of tubing through the hole of a rubber bung.

   It is always better to sacrifice a cork by cutting it than to struggle to remove stuck glass tubing.

6. Glass tubing should be stored vertically, whenever possible. If a horizontal rack is used, the tubing should not protrude beyond the end of the rack.

11.2 Broken Glassware

1. Glassware showing signs of cracking or those with broken edges should not be used for experiments.

2. Broken pieces of glass should be disposed of properly in a metal or plastic container assigned for such purpose and never into a general rubbish container. If glass is broken in a sink, the pieces should be removed from the sink with tongs.

12 SAFE USE OF GAS

12.1 Gas Supply

Schools should never attempt to carry out installation or repair work on fixed gas pipework or appliances. By law, such work must only be undertaken by registered gas installers (RGIs) employed by contractors registered with the government.

If liquefied petroleum gas (LPG) is used in the laboratory, formal approval must be obtained from the Director of Fire Services and all fire services requirements formulated for such purpose must be observed at all times.

The Gas Authority strongly recommends on safety grounds that LPG cylinders should not be stored inside school science laboratories. For schools in locations where a piped gas supply is not available, LPG cylinders should be housed in an approved chamber external to school premises (i.e. within the entire school boundary but outside the school building) with the gas supply piped into the laboratories. If schools have any enquiries about these recommendations, please contact the Electrical and Mechanical Services Department at 2882 8011.

LPG cylinders must not be used in any locations below ground level where natural ventilation is not possible.

12.2 Ventilation

Make sure that ventilation in the room is adequate when Bunsen burners or gas appliances are to be used.

In laboratories and preparation rooms where air-conditioners are installed, all air-conditioners should be switched off and exhaust fans switched on when doing experiments. All windows of these rooms should also be left open.

12.3 Gas Burners

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.

Gas taps with safety locks are recommended. Older type of gas taps without safety lock tend to loosen with constant use, and should be checked from time to time and replaced when necessary.

The rubber tubings connecting gas taps to Bunsen burners should be of a type suitable for use with the gas being supplied and should be obtained from the gas supplier. Both ends of the tubings should be held in position by hose clips to prevent loosening. They should be regularly inspected for defects and replaced at least every three years.

Both ends of rubber tubings should be held in position by hose clips

All unused gas taps should be properly secured to prevent them from being mistakenly turned on by students. All gas taps should be turned off after experiments have been completed.

12.4 Contingency Measures in case of Gas Leakage

The location of the main gas supply valve to each laboratory (with ON/OFF positions clearly marked) should be made known so that it can be turned off when the laboratory is to be unattended for an extended period of time or in an emergency.

If a gas leak is discovered or suspected,

- all gas supply taps including the main valve to the laboratory should be turned off;
- all windows/doors should be opened wide;
- students should be evacuated from the laboratory area;
- electrical switches must not be operated; and
- all naked flames should be extinguished.

The gas leak should be reported urgently in accordance with the established procedures.

The main gas supply valve must not be turned on again until the gas leak inside the laboratory has been located and repaired by an RGI. However, when gas continues to escape into the laboratory after the main supply has been turned off, or when a smell of gas persists, then the Fire Services Department and the gas supply company must be contacted immediately in accordance with school emergency procedures.

As LPG is heavier than air, leaked LPG tends to accumulate at low level. It will not dissipate easily unless there is plenty of ventilation at low level. In the case of Towngas, it is lighter than air and can be cleared by opening windows wide.

13 COMPRESSED GAS CYLINDERS

The Fire Services Department grants exemption from licensing if the following maximum quantity of cylinders stored in each school is not exceeded:

Type of Compressed Gas Cylinder	Maximum Quantity
Oxygen	2
Nitrogen	1
Carbon dioxide	1
Hydrogen	1

Compressed gas cylinders should be handled with extreme care as a number of possible dangers are associated with the storage and use of compressed gas cylinders.

13.1 Storage

1. Always secure cylinders to a wall or bench in an upright position.
2. Store cylinders in a cool and well-ventilated place, away from direct sunlight, heat or ignition source.
3. Cylinders should be stored well clear of all corrosive substances.
4. Dirt, oil or water should be prevented from entering cylinder valves.
5. When not in use they should not be kept in laboratory and should be removed to a well-ventilated store or preparation room.
6. Keep the storage quantity of gas cylinders to a practical minimum and in compliance with the requirements under the *Dangerous Goods Ordinance*.
7. Empty cylinders should be immediately returned to supplier.

13.2 Use

1. Always handle cylinders with great care and do not throw or bump them heavily. Inform the supplier immediately if the gas cylinder is found to be physically damaged.
2. Before use, the cylinder valve should be inspected. It is most important that the valve can be opened smoothly.
3. In use they should be fixed in stands, wall brackets, or trolleys in an upright position.
4. Stiff valves should be treated cautiously. If possible, try to open the valve slowly by hand pressure using the standard key. Do not use hammers or excessive leverage and do not lubricate any valve or fitting. (This should be strictly observed, especially for oxygen cylinders).
5. Cylinders with stiff valves should be returned to the supplier immediately.
6. Do not handle oxygen cylinders, valves or any fittings with greasy hands, gloves or rags to prevent oxidation of the grease under pressure, otherwise an explosion may result.

14 HANDLING PLANTS

14.1 General

Students should be warned not to ingest any plant materials used in experiments because some of them are poisonous (e.g. castor oil seeds), or contaminated with fungicides, pesticides, pollutants or spoilage microorganisms. The plant materials may also be contaminated during experiment. Thus, remind students to wash hands after handling plants.

Keep plants known to contain irritants inaccessible to students, as the substances may cause allergy. (Refer to Appendix VII for some common plants known to contain irritants.)

Students who are known to be hyper-sensitive to pollen should not be encouraged to handle flowers. Proper precautions should be taken when working with flowers. When dealing with plant specimens which bear spines or thorns, care must be taken. Wear suitable protective gloves when necessary.

14.2 Extraction of Chlorophyll

In the extraction of chlorophyll from leaves with hot alcohol, care must be taken to minimise fire risk. Use alcohol only in the absence of naked flame. To prepare hot alcohol, heat the tube of alcohol by immersing it in a beaker of very hot water. When using other flammable solvents, such as propanone, for extracting chlorophyll for chromatography, the same precautions should be taken.

14.3 Free-hand Sectioning

In free-hand sectioning of plant specimens, care should be taken when holding a razor to prevent cutting the fingers. Do not use rusted or blunt razors. Handle double-bladed razors with special care.

14.4 Macerating, Fixing, Mounting and Staining

Macerating fluids can be harmful, corrosive or flammable. Appropriate care should be taken. The safety considerations should also be taken when handling fixatives, mountants and stains. Some chemicals can only be handled in a fume cupboard but not in open areas. Wear protective gloves when necessary.

15 HANDLING MICROORGANISMS

15.1 General

Cultures of microorganisms should be treated as potentially hazardous due to the possibility of being contaminated by pathogens or becoming virulent as a result of mutation. Pathogenic microorganisms may gain access into the human body if the body surface with wounds or cuts is in direct contact with the culture, if aerosols above the culture are inhaled, or if contaminated food/drink is ingested. All microorganisms and their cultures should therefore be handled with caution.

Hygienic measures should be emphasized when working with microorganisms. Protective gloves and laboratory gowns should be worn if necessary. All wounds and cuts on body surface should be covered with sterile dressings before starting microbiological experiments.

Always employ aseptic technique when working with microbial cultures. Before and after work, clean the bench surface with disinfectant as well as wash hands. All unwanted cultures should be disposed of properly after experiment.

Pipette fillers should be used to help transfer liquid cultures. **Mouth pipetting should be strictly forbidden during microbiological experiments.**

15.2 Microbial Culture

15.2.1 Microbial Source

Never culture microorganisms from potentially dangerous sources such as sewage, human mucus, pus and faeces. Use non-pathogenic microorganisms only.

Microorganisms can be cultured on agar medium or on substances that they grow naturally, for example bread and fruit.

15.2.2 Inoculation of Culture

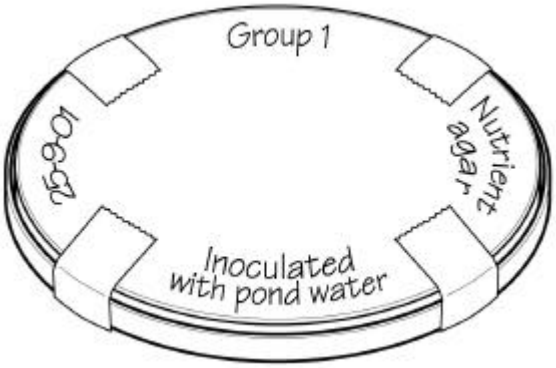
Always practise aseptic technique in inoculation. Immerse an inoculating tool, such as inoculating loop and knife, in 70% alcohol before flaming, but not in reverse order to prevent ignition of fire. Cool down the inoculating tool so as to avoid killing the target microorganism and to reduce the risk of generating aerosols. Sterilise the inoculating tool immediately after use to avoid spread of the microorganisms and contamination of workplace.

15.2.3 Taping and Labelling

Label the base of the petri dishes rather than the lid with permanent felt pen or wax pencil to avoid mixing-up, in case the base gets separated from the lid.

Always hold a whole set of petri dish (the base and the lid together). Seal the dishes with adhesive tape if necessary to avoid contamination or accidental

separation of the base from the lid. Sealing can be made in a manner so as to allow gaseous exchange.



Taped and labelled sample of microorganism

15.2.4 Incubation of Microbial Culture

Cultures of microorganisms should be incubated in an enclosed environment, e.g. incubator. During incubation, the covered dishes should be placed upside down.

Most microorganisms used in school microbiological experiments grow well at room temperature. Raising the temperature to 37°C favours the growth of microorganisms pathogenic to humans and thus is not encouraged.

15.2.5 Examination of Microbial Culture

Transfer of microbial culture by students should not be encouraged.

Examine the specimens in sealed state, e.g. in taped petri dishes or sealed transparent plastic bag. If the petri dishes containing cultures of microorganisms must be opened for inspection, the teacher or laboratory technician should kill the microorganisms by exposing the culture to methanal vapour (a filter paper soaked in 40% methanal solution (formalin) in petri dish for 24 hours) prior to class inspection.

15.3 Handling Microbial Spillage

Microbial spillage should be dealt with by teachers or laboratory technicians. When clearing up the mess, protective gloves and laboratory gowns should be worn. Wear masks when appropriate. It is important not to inhale aerosol cloud formed above the spill.

The spillage should be covered with a towel soaked in disinfectant (e.g. hypochlorite). The towel should be left in place for 15 minutes and then swept into a suitable container. The contaminated area should also be disinfected as appropriate. In case the skin is in contact with the spillage, wash with liquid soap and water immediately and thoroughly. Seek medical help if necessary.

15.4 Disposal of Unwanted Cultures and Contaminated Materials

Unwanted cultures should be destroyed by steam under pressure or immersing in disinfectant for several hours before disposal. All apparatus contaminated with microorganisms or waste materials should also be treated in the same way before disposal.

15.5 Sterilisation after Microbial Work

After each microbiology practical, the bench surface should be wiped with disinfectant immediately.

Wash hands thoroughly with liquid soap and water after microbiological work. For drying purpose, paper towels are preferred and used ones have to be disposed of in a waste container with lid.

16 EXPERIMENTS ON BIOTECHNOLOGY

16.1 General

Precautionary measures should be taken when working with experiments on biotechnology, especially when handling deoxyribonucleic acid (DNA), cells and tissue culture, for the sake of laboratory safety as well as to avoid contamination. Aseptic technique should be employed if appropriate.

All cuts and wounds should be covered with sterile dressings. Protective gloves and laboratory gowns should be worn. Wash hands before and after experiments.

Manipulation of bacterial cells may be involved in experiments on biotechnology. Take the necessary precautions as mentioned in Chapter 15 whenever appropriate.

Before handling those experimental kits and delicate equipment, read the operating manuals first and be familiar with the operation procedures. Handle all pipetting devices with special care to avoid formation of aerosols during transfer. **Mouth pipetting is prohibited.**

16.2 Working with Deoxyribonucleic Acid (DNA) and other Biomolecules

Isolation, analysis and manipulation of both DNA and other biomolecules are always involved in the study of biotechnology/molecular biology. Schools should ensure that all the samples used are biologically safe. The use of those potentially hazardous DNA fragments should be prohibited.

16.2.1 Electrophoresis

Electrophoresis of DNA fragments or other biomolecules should be operated at low voltages. Make sure the wire connection is correct and secure before switching on the power supply. Switch off the power supply before transferring the gel for staining. If home-made electrophoresis equipment is used, make sure it is carefully constructed for safe handling.

16.2.2 Handling Reagents

Toxicity or harmfulness of reagents, such as restriction enzymes and stains, should be checked and proper precautions should be taken.

Care should be taken when staining DNA with dye. A common non-specific dye, methylene blue or silver staining may be used. **Ethidium bromide, which is specific to nucleic acids, is a mutagen and should not be used in schools.**

16.3 Tissue Culture

In tissue culture, plant materials are commonly used. If animal cells are cultured, ensure that they do not harbour any pathogens. Refer to the safety precautions mentioned in Chapter 17 whenever appropriate.

Reagents involved in the preparation of tissue culture may be harmful and should therefore be handled with care.

16.4 Disinfection after Practical Work

All used glassware and plasticware that have been in contact with DNA, biomolecules, bacterial cells and tissue culture should be considered as contaminated. They should be soaked in disinfectant (e.g. hypochlorite) for at least one hour or sterilised using steam under pressure before cleaning or disposal.

After each practical on biotechnology, the bench surface should be wiped with disinfectant immediately. Wash hands thoroughly with liquid soap and water.

17 HANDLING ANIMALS AND ANIMAL PRODUCTS

17.1 General

It is common for schools to use live animals, taxidermic specimens, specimens from abattoirs (e.g. ox's eye and pig's heart), and other animal products for laboratory use. As the animals and animal products may carry germs or parasites, hygienic measures should therefore be emphasized. Protective gloves should be worn if necessary. Any wounds on body surface should be covered with sterile dressings.

After practical work, all bench surface and instruments should be cleaned with disinfectant. Hands should be washed with liquid soap and water thoroughly.

17.2 Live Animals

It is not recommended to rear wild animals and other venomous ones in school laboratories. Animals purchased for laboratory use must be obtained from licensed dealers.

Animals have to be treated humanely. Persons involved in handling animals should note that it is an offence under the *Prevention of Cruelty to Animals Ordinance* (Cap. 169) to treat animals cruelly and cause unnecessary pain and suffering to them.

17.2.1 Protective Measures

Animals may attack, bite or scratch people when under stress or disturbance. They may harbour germs or parasites which can be transmitted to the human body. Suitable protective gloves (e.g. leather gloves for animal handling) and laboratory gowns should therefore be worn when working with live animals.

17.2.2 Animal Cage/Wormery/Aquarium

Animals for laboratory use must be kept in hygienic cages, wormery or aquaria of suitable sizes. The cages/wormery/aquaria should be cleaned with disinfectant regularly. Cages made of galvanised wire or plastic are recommended because they can be easily sterilised.

If an electrical device installed at aquaria (e.g. air pump or heater) is found to have a sign of abnormal operation (e.g. difficult to switch on, much noise produced or overheating), it should not be used and should be checked by registered electrical workers.

17.2.3 Animal Bites

In cases of bites or other injuries, apply first aid immediately. (Wear disposable plastic/vinyl gloves before handling the wounds.) The injuried person should be sent to hospital for medical treatment. The animal in question should be isolated as it may be required for subsequent diagnosis.

17.3 Animal Dissection

Do not allow students to perform dissections outside school laboratories. Before starting the dissection, ensure that students have covered any wounds on exposed parts of their bodies with sterile dressings. Instruct students to wear laboratory gowns and surgical/disposable gloves, and advise them to wear masks. Remind them to wash hands thoroughly with liquid soap and water after performing dissection. Seek medical treatment promptly in case of accidental injury during dissection.

17.3.1 Handling Dissecting Instruments

Teachers should instruct students to handle all dissecting instruments with great care and not to play with them. Do not use rusted or blunt dissecting instruments.

Soak all dissecting instruments and boards in disinfectant after use. Dispose of the unwanted dissecting instruments with great care. A puncture-resistant container can be used for disposal of the instruments to avoid any injuries.

17.3.2 Killing of Animals for Dissection

Rat dissection is commonly carried out at schools. Under no circumstances should students 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 students. As chloroform is harmful, the killing chamber should be exposed after use either in a fume cupboard or in the open air. After killing, check that the animals are dead and immerse them in dilute disinfectant before handling them over to students for dissection.

17.3.3 Disposal of Dissected Animals

Dispose of the dissected animals quickly and properly after dissection. Place the animal carcasses in double sealed plastic bags, label the bags, and dispose of them at a designated refuse collection point.

If it is suspected, during dissection, that the animal is diseased, stop the dissection and dispose of the animal in the proper way.

17.3.4 Measures for Keeping Animals

Do not rear animals in school for use in dissections, and inform students not to do so at home. If necessary, the school may keep the animals for a short period of time. In such circumstances, teachers and laboratory technicians are reminded of the following:

1. Students should not be allowed to handle live animals.
2. Persons who are ill should not contact the animals, as some human infections may also be transmitted to animals.

3. Keep the laboratory in a generally clean and hygienic state. Place animals in a suitable place of the laboratory, which is well-ventilated and where wild rodents and insects cannot gain access.

4. Use cages which are escape-proof, can be cleaned easily, and have adequate facilities for feeding and watering. It is important that animals are separated from their excreta. Clean and sterilise the cages regularly.

5. Provide the animals with sufficient food and fresh drinking water on a regular basis.

6. Use clean and dry sawdust, or absorbent paper (preferably shredded) for bedding materials. Change the bedding materials daily and dispose of them in double sealed plastic bags.

7. Kill any sick animals and dispose of them properly. Isolate other animals that have been in contact with the sick ones, and watch carefully for any possible development of signs of disease. Kill all the kept animals if an epidemic has taken place. Sterilise the cages and dispose of the carcasses properly.

8. Advise the relevant school personnel to be immunised if necessary.

9. Seek medical treatment promptly in case of accidental injury while handling rats, cages, soiled bedding, etc.

17.4 Taxidermic Specimens

When handling taxidermic specimens, carry out protective measures as far as possible. As some students may be allergic to fur or feathers, teachers are advised not to pass those specimens of mammals and birds to these students. Students in doubt should also be refrained from touching the specimens.

17.4.1 Formalin-fixed Specimens

Animal specimens which have been preserved in formalin (methanal solution) may irritate the respiratory system, skin and eyes. Examine these formalin-fixed specimens in sealed containers. Protective gloves should be worn when handling such materials, and examination should be carried out in a well-ventilated area. If these specimens need to be examined in details, the specimens should have been rinsed under water before use.

17.4.2 Specimens Treated with Other Chemicals

Arsenic compounds and mercury(II) chloride, which are commonly added to the fur or feathers of the taxidermic specimens for preservative purpose, are toxic. **Students should be warned not to touch these specimens.**

Ethyl ethanoate (ethyl acetate) is recommended to replace cyanides in the killing bottle used for killing insects. However, it should be noted that ethyl ethanoate is highly flammable and its vapour may irritate the eyes and respiratory system. Practise proper and safe procedure.

17.5 Animal Blood/Cells

For experiments that involve animal blood/cells, such as the preparation of blood smear and examination of animal cells, the following can be used: chicken blood, ox corneal cells or frog skin cells. Whenever appropriate, commercially prepared slides on animal cells can be used for microscopic observation.

17.5.1 Hygienic Measures

Teachers should instruct students to avoid direct contact with animal blood/cells, as many animal pathogens may infect humans. Under no circumstances should these samples be in contact with the wounds or mucosal membrane. Wounds and cuts should be covered with sterile dressings. Laboratory gowns and disposable plastic/vinyl gloves should be worn.

Care should also be taken to prevent spillage. Whenever appropriate, masks and safety spectacles should be worn when splashing of animal blood is anticipated.

17.5.2 Handling Animal Blood Spillage

Any spillage of animal blood should be cleaned up with disposable absorbent materials immediately. The spill site should then be wiped off with cloth or paper towels soaked in disinfectant (e.g. hypochlorite) and then the blood-soiled gloves, cloth and absorbent materials should be placed in double sealed plastic bags for disposal. In case the skin is in contact with the spillage, wash with liquid soap and water immediately and thoroughly.

17.5.3 Disinfection after Practical Work

After practical work, all used plasticware and glassware should be immersed in disinfectant for an appropriate period of time. If they can tolerate heat, they can be boiled for 5 minutes for disinfection, or sterilised by using steam under pressure. The bench surface should be wiped with disinfectant. Persons involved in the experiments should wash hands with liquid soap and water thoroughly.

18 INVOLVING STUDENTS AS THE SUBJECTS IN EXPERIMENTS

18.1 Experiments Involving Human Blood Samples

Schools are reminded that taking human blood 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 types B, C and D.

Teachers should be familiar with the precautionary measures for prevention of blood-borne diseases in schools. Please refer to *Guidelines on the Prevention of Blood-borne Diseases in Schools (2001)* issued by the Department of Health and Education Department for details.

The use of other human body fluids, for example urine and other mucosal secretions, in experiment should be avoided, as they are potentially infectious.

18.2 Use of Human Saliva and Taking Cheek-cell Samples

For hygienic purpose, it is highly desirable to replace saliva by diastase solution when studying the action of human saliva on starch. It is also advisable to use animal cell samples to replace taking human cheek-cells for experiments. (Please refer to Section 17.5 for the types of animal cells used.) If human saliva/cheek-cells are to be used inevitably, teachers should instruct students to work only with their own saliva/cheek-cell samples. Treat the used apparatus as contaminated materials. Practise safe and proper procedure for cleaning or disposal after experiment.

18.2.1 Hygienic Measures

When performing the experiments involving human saliva/cheek-cells, teachers should instruct students to wear disposable plastic/vinyl gloves for protection and hygienic reasons. It is also advisable to wear laboratory gown. Under no circumstances should the samples be in contact with the wounds or mucosal membrane. Wounds and cuts should be covered with sterile dressings.

Care should also be taken not to let the samples spill onto the eyes, nose or mouth, or come into contact with skin or naked wounds. Whenever appropriate, masks and safety spectacles should be worn when splashing of the sample is anticipated.

18.2.2 Handling Spillage of Samples

Any spillage of samples should be cleaned up with disposable absorbent materials immediately. The spill site should then be wiped off with cloth or paper towels soaked in disinfectant (e.g. hypochlorite) and then the cloth or paper towels should be placed in double sealed plastic bags for disposal. In case the skin is in contact with the spillage, wash with liquid soap and water immediately and thoroughly.

18.2.3 Disinfection after Practical Work

After practical work, all instruments should be immersed in disinfectant for an appropriate period of time. If they can tolerate heat, they can be boiled for 5 minutes for disinfection, or sterilised by steam under pressure. The bench surface should also be washed with disinfectant. Wash hands thoroughly with liquid soap and water.

18.3 Experiments that can Cause Physical Stress or Emotional Disturbance

18.3.1 Health Status of Students

When students are asked to serve as the subjects of experiments, teachers should ensure that the students are physically and psychologically fit for the experiments. Students who have health problems should be refrained from participating in the experiments. Teachers may refer to the Schools Miscellaneous Circular on Health Problems of Pupils issued by the Education Department for details.

18.3.2 Experiments that can Cause Physical Stress

Some physiological experiments (such as the estimation of the vital capacity of the lungs and the investigation of the effects of exercise on the pulse rate or breathing rate), in which students may be used as the subjects, may exert excessive physical stress on some of the participating students. There must be no compulsion on the students to perform these experiments. The purpose of the above experiments is to illustrate natural variations among individuals. Finding out who can blow hardest or who can achieve the fastest pulse rate is not the purpose of the experiments and such competition should be discouraged.

Before conducting any experiments involving activities that are outside the range of normal daily experience, teachers should ensure that students understand and comply with the appropriate precautions. Students need to be reminded to stop doing the experiments immediately if they feel uncomfortable or unfit.

Students who are exempted from taking Physical Education lessons for medical reasons should not be allowed to take part in any physiological experiments involving strenuous exercise.

18.3.3 Experiments that can Cause Emotional Disturbance

Teachers are reminded that experiments involving identification of certain hereditary characters, such as colourblindness, among individuals, or pedigree analysis of their families may cause embarrassment and thus be distressing to certain students.

Some students are fear of doing animal dissection or handling animal blood. They may even be shocked upon having a sight of a dissected animal or a blood

sample. Emotional disturbance may also arise from the use of visual materials such as photographs or videos showing dissection and surgical operation. Teachers have to consider the perception of the animal specimens or experimental procedures by these students. There should be no compulsion on the students to involve in the experiments/activities.

18.3.4 Use of Spirometer, Stethoscope and Sphygmomanometer

Measurements obtained by using spirometer, stethoscope and sphygmomanometer from physiological experiments are approximate only and should not be taken as medically relevant.

The mouthpieces/earpieces of spirometer and stethoscope should be disinfected before and after use. Whenever appropriate, disposable mouthpieces or earpieces should be used.

18.4 Smelling and Tasting Substances

In experiments involving smelling of chemicals, students should be reminded of smelling only very small quantities of the chemicals by fanning gently towards the nose. Experiments have to be performed in well-ventilated areas.

Smelling of chemicals

Tasting should not be carried out in laboratories except for experimental purpose. For experiments involving tasting and smelling items other than chemicals, substances known to be harmless and free from contamination should be used. Substances containing irritants or having allergic effect should not be used.

19 OUTDOOR/FIELDWORK ACTIVITES IN SCIENCE

As life-wide learning is being emphasized, arranging science learning and teaching activities outside school settings becomes more popular nowadays. When organising outdoor/fieldwork activities, same as in planning for practical work in laboratories, the concept of risk assessment is also applicable to ensure safety. Risk assessment should be carried out as part of the planning for field activities. All participants have to be conscious of the associated hazards when working outdoors. Necessary precautions need to be taken so as to minimise all possible risks.

The general safety measures as listed in Section 19.1 below aim to provide teachers and other responsible staff with the principles of organising outdoor/fieldwork activities in science as a whole, and the remaining parts of this chapter highlight the relevant safety precautions for working in specific habitats.

19.1 General

Schools should note that outdoor/fieldwork activities must be under the supervision of responsible school staff. Under normal circumstances, a ratio of one staff member to a group of 30 (or below) students is recommended.

The school should inform the police and students' parents/guardians of the route of the trip and the due time of return. Prior written consent from parents/guardians for students taking part in outdoor/fieldwork activities must be obtained. (Please refer to the Circular Memorandum on School Outings in Rural Areas: Safety Precautions issued by the Education Department.)

19.1.1 Considerations in Planning for Outdoor/Fieldwork Activities

When planning the field activities, it is important to note that the activities are appropriate to the age, ability and experience of the students. Students should be adequately trained, prepared and properly equipped for the outdoor/fieldwork activities.

Plan the time required to walk to the field site and return according to the pace of the slowest member, including stopping for rest. Do not make the walk too long. Give consideration to the gradient of the route. Slopes or footpaths steeper than 30° are difficult to walk or work on. Avoid working in gullies. If the route involves walking along the valley, make sure no part is impassable.

Check for the time and height of tides when it is necessary to work at or walk along the coast. Make sure to retreat before high tide.

Check whether a permit is needed if the field site is a Site of Special Scientific Interest (SSSI).

When planning visits to countryside or historic monuments, teachers may refer to the Schools Miscellaneous Circulars on Protecting Hong Kong Countryside from Fire and Litter Damages and on Guidance Notes for the Arrangement of School Visits to Historic Monuments and Archaeological

Sites in Hong Kong issued by the Education Department for information.

19.1.2 Pre-trip

Teachers have to visit the field site before taking any students there. The potential hazards of the field site and possible risks involved in the outdoor/fieldwork activities should be recognised. The location of the nearest telephone to call for assistance and the nearest shelter should also be identified. Mobile phone and first-aid kit should be brought along. For the mobile phone, it is important to note the range of signal coverage and the blind spots.

Details of the field trip with a route map should be worked out before the field trip and left with a responsible person not participating in the field activities. Contingency plan should be arranged in advance.

19.1.3 Briefings on Outdoor/Fieldwork Activities

During briefings on the outdoor investigation/fieldwork, students should be made aware of the terrain and other potential hazards, as well as the necessary safety precautions. All participants including staff must understand their responsibilities and what action to take in the event of an emergency. The need for regard for the safety of oneself and others, as well as the need for calmness and common sense in encountering dangers, should be emphasized.

Students have to be reminded to follow the Country Code. They should also be advised not to collect specimens more than necessary. Any protected or endangered species should not be collected.

Students have to be assigned to work in groups and the group size should be at least three, but room should be allowed for individual work/project. A leader should be appointed to each group and each participant should be made aware of appropriate actions to take in times of emergency. Students should also be reminded not to work alone in the field site.

19.1.4 Exempting Students from Outdoor/Fieldwork Activities

Students who are not physically fit enough or who are exempted from Physical Education lessons could also be exempted from an outdoor investigation or a field trip. Students with heart or respiratory illness should be advised to refrain from participating in the outdoor activities if the "Air Pollution Index" or forecast is within the range of 101 and 200. (Please refer to the Schools Miscellaneous Circular on Air Pollution Index issued by the Education Department.)

19.1.5 Weather Conditions

Teachers should pay attention to weather forecasts before and during the outdoor/fieldwork activities. Weather forecasts are readily available through television, radio, news media, Internet (Hong Kong Observatory's website: *http://www.hko.gov.hk*) or over the telephone (Hong Kong Observatory's Enquiries Hotlines, "Dial-a-Weather": 187 8200 (Cantonese) or 187 8066 (English)). A pocket radio should be carried by the group for the same purpose. In interpreting weather forecasts/conditions, teachers should err on the side of caution.

An outdoor activity must be cancelled if:

- a tropical cyclone warning signal is hoisted.
- there is a/an amber, red or black rainstorm warning.
- a thunderstorm forecast/warning is issued.
- the "Air Pollution Index" or forecast is within the range of 201 and 500.

When the weather condition is considered unfavourable or unstable, apart from the cases mentioned above, teachers should exercise judgement on the suitability of conducting field trips. Cancellation of the outdoor activities is also required, if necessary, for the sake of safety.

Under high ambient temperature, prolonged outdoor work may lead to heat exhaustion or even heatstroke. Avoid prolonged exposure to direct sunlight and do not overwork. Wear light airy clothing and remember to drink lots of water.

Working outdoors under very cold weather may lead to hypothermia. Avoid overstrain so as to conserve energy. Bring spare warm clothing.

19.1.6 Items to Bring Along

The group should carry an updated map of suitable scale showing the area of work and the route leading to the field site. A compass, a whistle, a torch, a mirror for signaling, a pocket radio, a mobile phone and sets of walkie-talkie should be carried for emergency use.

The group must carry a first-aid kit, which should include the following standard items:

- Antiseptics, e.g. Savlon, alcohol
- Sterile cotton wool
- Disposable plastic/vinyl gloves
- Sterile dressings/gauze
- Adhesive plaster
- Bandages (of different sizes)
- Forceps
- Safety pins
- Scissors
- Sterile adhesive dressings (of different sizes)
- Sterile eye pad

- Triangular bandages

The first-aid kit should also include the following additional items:

- Cold pack
- Cotton sticks
- Elastic tensor bandages
- Liniment turpentine
- Thermometer

The first-aid kit should be checked before the field trip. All participants should be made aware of where the first-aid kit is kept. It is highly desirable to have someone with first-aid training accompanying the group.

Plasticware should be used as far as possible. If items of glassware, such as test tubes and beakers, are to be carried, they should be protected from accidental breakage. Care should be taken not to leave them on the ground, otherwise potential hazard could be posed. Take care of all electronic items such as data loggers, digital camera, notebook computer, etc., and they should be kept away from water or dropping into water.

Clothing and footwear should be suitable for the fieldwork and the time of the year. Participants should also bring along windbreakers, raincoats, wide-brim hats and some spare clothing. Bring along protective gloves and suntan lotion if necessary.

Suitable amount of food and drinking water should be carried individually by all participants when on a whole day trip, unless easily available elsewhere.

19.1.7 During Outdoor/Fieldwork Activities

Observe the Country Code when working in countryside. Beware of snakes and venomous insects which may hide among bushes and grasses. Keep to the established footpaths and avoid making new short-cuts.

Vigilant and effective supervision is required at all times at field sites. Teachers should be aware of the whereabouts of all their students at all times. Regular head counts should be carried out before, during and after a field trip, and if necessary, before moving from one site to another.

Irresponsible behaviour can be a threat to safety, and a vigilant approach is required to ensure that responsible and appropriate standards of behaviour are maintained at all times.

Before students proceed to work, teachers have to:

- remind them where the first-aid kit is kept;
- remind them to work in groups; and
- alert them to the potential hazards at the field site.

19.1.8 Other Points to Note

Guard against all risks of fire during fieldwork.

Fieldwork must be finished before sunset.

When fieldwork activities in polluted areas have to be undertaken, the following practical precautions should be taken to prevent infection:

- Rubber gloves should be worn when sampling or measuring.
- Cuts and abrasions should be covered with waterproof dressings.
- It is advisable for individuals with recent cuts and abrasions to take up the duty of recording data instead of collecting samples or taking measurements.
- Wellington boots should be worn in polluted water.
- Never touch food and drinks with contaminated hands.
- Wash hands upon leaving the field when there is clean water supply.

Beware of symptoms of heat exhaustion such as headache, nausea, dizziness and muscle spasm. If allowed to worsen, the patient can develop heatstroke and he/she may become unconscious. To treat heat exhaustion, rest the patient in cool and shady place, loose his/her clothing, and administer water to re-hydrate him/her.

Beware of symptoms of hypothermia, such as fatigue, exhaustion, clammy skin and shivering, due to sudden rainstorm or lack of sufficient clothing in a cold place. To treat hypothermia, seek refuge from the rain and change wet clothing if appropriate. Cover the body with clothing to keep warm and take high calorific food or drinks to maintain body temperature.

If a thunderstorm is imminent, take shelter and wait for conditions to improve. Put on raingear before becoming wet. Lightning usually strikes high projections. Bear this in mind when seeking shelter.

The group should take appropriate measures in dealing with emergency situations. For the measures to be taken in case of getting lost, a hill fire or heavy rain, details are attached in Appendix VIII.

19.2 Precautions for Specific Habitats

19.2.1 Terrestrial Habitats

1. To avoid insect bites or being scratched by spines and thorns of plants, participants should put on long-sleeved shirts and jeans/trousers.

2. Quite a number of plants in the wild are poisonous. Teachers should warn students not to ingest fruits, seeds or leaves of wild plants. Students should be reminded not to touch those plants which are known to contain irritants that induce allergy or dermatitis on skin contact. (Please refer to Appendix VII for some common plants known to contain irritants.)

3. Beware of swarm of wasps/bees, snakes, stray dogs and cattle.

Students should be warned not to irritate hives of wasps/bees or other wild animals, since quite a number of them are venomous or are vectors of diseases.

4. Keep to cleared and way-marked footpaths where possible.

5. Examine the surrounding area carefully before crawling under bushes to observe and collect specimens.

6. Examine rock or logs before sitting on them. Do not lift stones or other objects by bare hands. Always use a stick to turn them over.

7. Dead specimens of vertebrates in the field should not be collected or closely examined due to the risk of transmitting infectious diseases.

8. When collecting animals and plants that bear spines or thorns, one should take extreme care to prevent injuring oneself. Wear protective gloves if necessary.

9. Plants collected from the field should be free from pests or diseases to minimise the chance of infection. Avoid collecting plants known to contain poisonous or irritating sap.

10. When doing experiments on soil analysis, care should be taken to prevent bites from soil organisms such as centipedes or millipedes.

19.2.2 Shore Habitats

1. The teacher should check for the time and level of tides.

2. Each participant should be properly dressed in shoes with adequate tread.

3. Avoid working on exposed shores with strong wave action.

4. On rocky shores, the surface is uneven and often covered with slippery algae. It is safe to try footing before putting one's weight down. Jumping from rock to rock may be dangerous.

5. On mangrove and sandy beaches, the surface may be slippery and the substratum unstable. It is safe to try footing before putting one's weight down. Do not tread on the protruding plant roots/pnematophores and avoid tripping by them.

6. Beware of dangerous plants, the ones that can cause skin allergy, such as *Strophanthus divaricatus* (Goat Horn), *Cerbera manghas* (Cerbera) and *Excoecaria agallocha* (Milky Mangrove), or those plants with prickly leaves such as *Acanthus ilicifolius* (Spiny Bears Breech).

7. Do not turn stones over or scrape any organisms from rocks with bare hands.

8. A throw line must be carried at all times.

9. Never attempt rock climbing, caving, swimming or diving.

19.2.3 Freshwater Habitats

1. Flash flood may occur suddenly during and after heavy rainfall. Leave the stream channel quickly when it rains and never work in streams after heavy rainfall. A sudden rise of water level or an increase in the turbulence and turbidity of the streamflow may be a sign of an approaching flood.

2. Except for very shallow ponds and ditches, working in freshwater habitats should be regarded as potentially dangerous. This is because water current, submerged objects and slippery rock surfaces all pose hazards. Do not jump from rock to rock.

3. Students should work in stream areas where the nature of the substratum is known with certainty and the water is no more than knee-deep.

4. Each participant should be properly dressed in shoes with adequate tread. Rubber boots, slippers or sandals should not be worn.

5. Extreme care should be taken when placing the feet into streams. Always beware of potholes, underwater obstacles, sharp objects such as protruding stones or broken glass, and harmful animals, e.g. snakes and leeches.

6. A throw line must be carried at all times.

7. Never attempt wading, swimming or diving in streams or ponds.

20 USE OF ELECTRICAL EQUIPMENT

It is essential that electrical installations for laboratories should be done in such a manner to comply with the safety requirements as stipulated in the *Electricity Ordinance* (Cap. 406) and its subsidiary Regulations, in particular the *Electricity (Wiring) Regulations*.

20.1 Electrical Installations

All electrical work (including new installation, addition, alteration, inspection, testing and repair) should be carried out by electrical contractors registered with the Electrical and Mechanical Services Department, except for those electrical installations which are installed or maintained by the Government. Name lists of registered electrical contractors/workers are available for reference at the Customer Services Office of Electrical and Mechanical Services Department (EMSD), EMSD web site at *http://www.emsd.gov.hk* or all District Offices.

Electrical installations should have an effective earthing arrangement. To prevent leakage of current, socket outlets should be protected by a residual current device having a rated residual operating current not exceeding 0.03 A.

A main switch which can isolate the supply to all outlets in the laboratory should be installed. Switched socket outlets, preferably with pilot lights, should be installed to facilitate local isolations. They should be placed away from any water tap such that they should not be splashed by water as far as reasonably practicable.

All electrical products and accessories should be obtained from reputable agents/suppliers and the products should be properly marked (e.g. voltage rating, current rating/power consumption).

20.2 Regular Inspection

According to the *Electricity (Wiring) Regulations*, low voltage fixed electrical installations located in schools should be inspected, tested and certified at least once every five years. Schools are advised to pay attention to the fulfilment of this requirement in science laboratories.

If schools have any enquiries or difficulties in complying with the regulations, please contact the Electrical and Mechanical Services Department at 2882 8011.

20.3 Electric Shock

It should be stressed strongly that the passage of even small electric currents through the body may cause death by failure of the heart. It is the amount of current flowing through the body that determines the effect on the body. Any amount of current over 0.01 A or so is capable of producing a severe shock, and current exceeding 0.03 A is lethal.

Since the voltage at the outlets in the laboratory is usually fixed, such as 220 V, the current that passes through the body is basically determined by the resistance of the human body. The actual resistance varies according to circumstances, e.g. the points

of contact, the moisture content of the skin and the voltage of the live parts. When wet, skin resistance can be reduced considerably. This greatly increases the chance for a severe electric shock.

20.4 Safety Measures

The use of electricity in science laboratories is very common and the potential danger for electric shock is always present. It is important that appropriate safety measures be taken.

20.4.1 Plugs/Adaptors/Extension Units

1. Three-pin plugs which comply with the safety standard (BS 546 or BS 1363) should be used. The connections between electrical appliances and three-pin plugs should be made with three-core flexible cables of adequate current rating.
2. Keep the use of adaptors and extension units to a minimum. If necessary, use acceptable three-pin adaptors and extension units (BS 546 or BS 1363) with shutters and pin holes which are either round or rectangular in shape. Do not use more than one adaptor or extension unit at one socket outlet as this may cause overloading.
3. Do not use plugs, adaptors and extension units with cracks, signs of loosen parts or signs of overheating (e.g. discolouration, charring or deformation).

20.4.2 Electrical Appliances

1. Students must be made aware of the great danger resulting from bodily contact with a "live" electrical outlet. **They should not handle electrical appliances when their hands, feet or bodies are wet or when they are standing on a wet floor.**
2. Electrical appliances should not be used in wet places such as area in close proximity to sinks.
3. Ensure that the voltage rating of an electrical appliance matches with the voltage of power supply before use.
4. Switch off the appliance and/or the power supply before the plug is withdrawn/inserted.
5. An electrical appliance which gives even the slightest shock should be repaired immediately. A piece of faulty appliance should never be used until the fault is satisfactorily rectified.
6. In general, electrical appliances should not be left switched on unattended for prolonged periods.
7. Flammable liquids should not be stored near electrical equipment because their vapours can be ignited by an electric arc or a spark.
8. Charging of secondary cells such as lead-acid accumulators should be

carried out in a well-ventilated area.

20.4.3 High Voltage Equipment

1. Any experimentation requiring the use of high voltage would be safer if the floor is covered with effective insulating materials.
2. Nobody should be allowed to work alone in a room when using high voltage equipment.
3. Suitable screen or barrier for protection against electric shock should be provided whenever necessary.
4. All high voltage equipment should always be kept clean.
5. It is essential to ensure that there is a large current-limiting-resistor in series with the positive terminal, fitted into the extra high tension (EHT) power supply.
6. Ensure that there is no protruding or exposed metal parts on the plugs when connecting to the EHT power supply.
7. Always connect the negative terminal to the earth terminal of an EHT power supply unless otherwise instructed.
8. Users should always switch off the EHT power supply before making adjustments to the circuit.
9. The Van de Graaff generator can produce extremely high voltage. Generally the equipment is reasonably safe as the current is at the microampere level, but some people (e.g. those with weak hearts) are susceptible to health risk. The generator should be discharged before making any alteration and the chassis of the generator should be properly earthed.

20.4.4 Safety Check

1. Danger from electricity can arise in the laboratory through ageing and resulting breakdown of the insulation. An electrical appliance in which heat is generated (e.g. hotplates, ovens, furnaces and motors) is particularly susceptible to damaged insulation. Frequent inspection of the state of the insulation should be carried out.
2. Flexible cables should be replaced as soon as wear becomes noticeable; damaged cables should be wholly replaced, never patched.

21 USE OF RADIOACTIVE SUBSTANCES

The use of radioactive sources for teaching purposes in schools is governed by the *Code of Practice on the Use of Radioactive Sources for Teaching Purposes in Schools* which was issued by the Radiation Board. The Code of Practice is reproduced below for reference.

21.1 General Rules

1. Students should not be exposed to ionizing radiation unless there is a valid reason for doing so: demonstrations and experiments that result in exposure should be relevant to the course of instruction.

2. The use of sealed radioactive sources in schools shall be solely for the performance of simple experiments to demonstrate fundamental principles, and the sources used and the methods of using such sources shall be such as to ensure that the degree of risk is very small.

3. No demonstrations or experiments involving the deliberate exposure of students, staff or any other persons to ionizing radiation shall be performed.

4. Experiments should be carefully planned to minimise the exposure time, and preliminary rehearsals of the experiment procedure using simulated sources should be encouraged.

21.2 Control of Sources

1. The Radiation Board is the statutory body which controls the use and/or possession of radioactive substance and irradiating apparatus in Hong Kong. Schools may be exempted from the requirement of applying for a licence if the total quantity of radioactive sources to be possessed and used by the individual schools does not exceed the limit specified in Section 21.3. Schools wishing to avail themselves of the opportunities to use radioactive sources should apply to the Secretary, Radiation Board (c/o Radiation Health Unit, Department of Health, 3/F., Sai Wan Ho Health Centre, 28 Tai Hong Street, Sai Wan Ho, Hong Kong) for exemption from obtaining a radioactive substances licence.

2. It shall be the responsibility of a graduate science teacher, who shall be designated the source custodian, to supervise the use of sealed radioactive sources within the school. Should the source custodian leave the school for any reason, a fresh application for exemption will have to be made in respect of the newly appointed source custodian.

3. The source custodian shall be responsible for the procurement, storage, issue and return of sources, the correct use of all sealed sources and the disposal of radioactive waste.

4. The source custodian shall arrange for routine checks, at intervals not exceeding 12 months, of the efficiency and condition of monitoring instruments and all sealed sources by wipe test (The source is wiped with a swab or tissue, moistened with ethanol or water; the activity removed is measured. Acceptance limit : 200 Bq). All the results shall be entered into a logbook which shall be made

available for inspection by any Radiation Board Inspector on request.

5. All sealed sources failing the routine checks should be treated as defective and withdrawn from use until proved otherwise.

6. The teacher in charge of a class shall account for all sealed sources before the period of instruction is concluded.

7. Sealed sources shall be used by a student only when under the direct personal supervision of a teacher.

8. The immediate responsibility of radiation safety in any experiment involving ionizing radiation shall rest with the teacher in charge.

21.3 Storage and Labelling

1. Maximum amount in store:

   The activity of individual sealed sources kept in a school laboratory should be the minimum practicable and shall in all cases be no greater than the following exemption limit:

Sealed sources	Quantity
Cobalt-60, Strontium-90, Radium-226, Americium-241	♦ Not more than two sources for each type ♦ Each source less than 200 kBq
Insoluble radium-226 sources of activity less than 750 Bq to be used with diffusion cloud chamber	♦ Not more than 10 sources ♦ Totally not more than 7.5 kBq in 10 sources

   Remarks: Should a school wish to use other sources or radioactive substances not in the Physics Standard Equipment and Furniture Lists, the Radiation Health Unit, Department of Health should be consulted (Tel: 2977 1868).

2. All sealed sources shall be kept in a locked metal container.

3. Access to this container shall be limited to authorised member of the school staff.

4. The metal container shall be permanently labelled (see Appendix V) with a warning sign to indicate that it contains radioactive substances.

5. Individual sources shall be stored in separate, appropriately labelled containers or compartments within the locked metal container.

6. Each source shall be easily identifiable by the user.

7. Sealed radioactive sources and their containers shall be permanently labelled with the type of radionuclide together with the activity at specified date.

21.4 Handling of Sources

Sealed radioactive sources shall be handled with care and unnecessary handling of sources should be avoided. The following rules shall apply :

1. Sources shall be transported between the laboratory and their place of storage in their containers.

2. **Radioactive sources shall only be handled by tongs or forceps.** Teachers should note that specially designed tongs for the safe handling of sources are available from commercial suppliers.

3. Sealed α-emitting radioactive sources shall be handled with extreme care because of the necessarily fragile nature of their construction.

4. Sealed sources should whenever possible be kept at a distance greater than 30 cm from the user and any other persons in the vicinity, and should be pointed away from the human body.

21.5 Damage to, Loss, Disposal and Removal of Sources

1. Retention of defective, obsolete or unnecessary radioactive sources is undesirable and positive steps should be taken for the safe disposal of such sources. They should either be returned to the suppliers and the Radiation Board notified; or be disposed of in a manner approved by the Radiation Board. The return can be carried out through an agent subject to the approval of the Radiation Board.

2. If any radioactive source is to be moved outside the specified school premises or the school is relocated to a new address, prior approval must be obtained from the Radiation Board and the removal must be covered by a valid permit.

3. In the event of damage to, or loss of any sources, the following shall be notified immediately :

   Physicist on-duty, Department of Health (Tel: 7110 3382 call 1912) and

   the Senior Occupational Health Officer, Labour Department
   (Tel: 2852 4045)

   In all cases, the Secretary of Radiation Board shall be notified in writing within 48 hours.

21.6 Health Risk

When due consideration is given to the limitation on the type of source, the activity of radioactive substances to be used in schools, and the time in any one year such sources will be used by any one teacher or student, the health risk from exposure to ionizing radiation to both teachers and students is extremely small. However, it is essential that students appreciate the nature of the hazard and the degree of care considered necessary in the handling of radioactive substances.

22 USE OF LASERS

A laser is an intense, highly coherent, directional and monochromatic beam of light. Appropriate safety precautions should be taken when lasers are used in schools.

22.1 General Requirements

1. Schools should use Class II lasers (maximum output power not exceeding 1 mW) for teaching purposes.

   Remarks: Recently, Class IIIA laser pointers (maximum output power not exceeding 5 mW) are available in the commercial market. Laser beam from such pointers may lead to damage of the eyes if viewed directly. The use of such pointers should be avoided. If teachers wish to use a laser pointer in presentation, it would be safer to use a Class II laser pointer.

2. A graduate science teacher should be appointed to be responsible for the procurement, storage, issue and return of lasers and associated safety equipment.

3. The teacher-in-charge should draw up a list of safety rules and operating procedures, and ensure that these are observed when experiments involving the use of lasers are carried out.

4. Any person using the laser should be familiar with its operation procedures and the safety precautions.

22.2 Safety Precautions

22.2.1 Alert for Exposure to Laser Beam

1. Students should be reminded that laser beam may lead to damage of the eyes if viewed directly or indirectly.

2. **Never view the source of laser beam directly** and any part of the skin should not be exposed to the direct beam.

3. Any collimating instrument such as telescope or microscope should not be used to view the laser beam directly.

22.2.2 Use of Protective Equipment

1. Whenever possible, non-reflective or absorbing materials should be used in the vicinity of the laser to prevent specular reflection.

2. When reflection cannot be avoided, for example at a lens surface, position some protective screens so that students and teachers are not exposed to the reflection of laser beam.

3. The protective screens should be made of non-flammable materials. They should be optically opaque and painted a matt grey colour.

4. All persons who may enter or work in the laser area and are liable to be

exposed to laser radiation should wear appropriate protective goggles.

22.2.3 Position of Laser

1. The laser beam path should be positioned well above or below the eye level of the students.
2. The laser source should be rigidly fixed so that the direction of the beam cannot be inadvertently altered.
3. The laser should not be fired unless it is correctly aimed at the target area. Do not align the laser beam with the power on.

22.2.4 Conducting Experiment

1. When a laser is in operation, warning signs (see Appendix V) should be displayed in conspicuous locations both inside and outside the experiment area and on doors giving access to the area.
2. Experiments with lasers should be carried out in brightly lit rooms to avoid enlarging the pupils of the eyes.
3. Students should stand behind the laser before firing. They should never be closer to any part of a laser experiment than 1 m when the power is on.
4. The laser should be switched off immediately after an experiment.
5. The laser when not in use should be kept under lock so that it is accessible only to authorised members of the staff.

22.2.5 Accidental Exposure

1. In case of accidental exposure to laser beam, students should react instantly by closing the eyes and turning the head away.
2. Any accidental exposure or even suspicion of exposure of the eyes to laser beam should be reported and medical treatment should be sought at once.

23 FIRST AID IN THE LABORATORY

Regulation 55(2) of the *Education Regulations* states that at least 2 teachers in every school shall be trained in administering first aid. Teachers and school staff qualified in administering first aid should be in a better position to render valuable assistance in the event of emergencies and accidents. School principals should encourage their science staff and students to undergo some form of training in first aid. These training courses can be obtained from Hong Kong Red Cross, Hong Kong St John Ambulance, Scout Association, Girl Guides Association, etc.

In the event of any serious injury, or whenever in doubt, medical aid should be sought without delay. Schools can call an ambulance to send the patient(s) to hospital. **All injuries to the eyes should be regarded as serious cases.**

23.1 Action in an Emergency

23.1.1 Fainting

A certain degree of faintness or dizziness may result from any accident, and the following measures should be taken:

1. Ensure the patient's air passages remain open and clear and that he or she is breathing adequately. Loosen any tight clothing. If breathing and pulse stop, cardiopulmonary resuscitation must be applied immediately (see Section 23.2) and call an ambulance at the same time.
2. Observe the level of responsiveness based upon eye opening, verbal and motor responses. Note any changes in the state of unconsciousness.
3. Check breathing rate and pulse regularly.
4. Examine and treat any serious injuries.
5. Examine possible cause of fainting.
6. Place the patient in the recovery position (see Section 23.3).
7. Cover the patient with a blanket.
8. If the patient recovers consciousness, reassure and observe him/her. Advise him/her to see a doctor.
9. Do not give anything to an unconscious patient by mouth.

23.1.2 Electrical Injury

1. Under safe circumstances, switch off the power supply, and remove him/her from contact with the electrical source. Never touch the patient with bare hands until you are sure that he/she is no longer in contact with the source. If you cannot break the current immediately, stand on some dry insulating materials, such as a wooden box and remove the patient from the source with other dry insulating objects.
2. Check the point of contact on the body for burn, which may be severe.

Place a sterile dressing over the burn and secure with a bandage. Seek medical treatment.

3. It is essential that cardiopulmonary resuscitation must be started immediately if the shock has produced respiratory and cardiac arrest. (see Section 23.2)

23.1.3 Heat Burns and Scalds

1. Place the affected area under slowly running cold water until the pain fades.
2. Remove any rings, watches, belts, shoes or other constricting clothing from the injured area before it starts to swell, but do not remove any clothing adhering to the burn.
3. Do not apply lotions, ointments or any other chemicals to the injured area.
4. Do not break blisters or remove any loose skin.
5. Cover the affected area with a dry, sterile dressing/gauze and then secure with bandage. Never use adhesive dressing.
6. As far as possible, immobilise the affected part so as to minimise pain.
7. For severe burns, medical aid should be sought without delay.

23.1.4 Chemical Burns

When handling chemical burns, only water should be used for first-aid treatment. Do not apply any chemical on the affected area.

1. Place the affected area under slowly running cold water until the pain fades.
2. Remove any contaminated clothing carefully, but avoid making contact with the chemical yourself.
3. For severe burns, medical aid should be sought without delay. It is essential that flooding of the affected area has to be continued all the while when an ambulance is being summoned to send the patient to hospital for treatment. A sample of the chemical or the name and composition of the chemical should also be taken to the hospital for reference or identification.

23.1.5 Eye Injuries

1. All eye injuries should be regarded as serious cases and medical treatment should be sought without delay.
2. If chemical has entered into the eye, flush the eye with running cold water or using eye wash unit immediately for at least 10 minutes. Ensure that water drains away from his/her face and not into the other eye. Do not attempt to neutralise the chemical in the injured eye by acid or alkali.

Advise the patient not to rub his/her eye.

3. Do not attempt to remove foreign objects such as glass pieces from the eye. Keep the patient still and send for medical aid immediately.

4. Cover the eye with a sterile eye pad.

23.1.6 Cuts and Bleeding

1. Avoid touching the wounds with bare hands or having direct contact with blood. Always use a pair of disposable plastic/vinyl gloves.

2. Protect the wound with a sterile swab. Clean the areas around the wounds with water using liquid soap if necessary. Take care not to wipe off any blood clots.

3. If bleeding persists, apply direct pressure. Apply proper dressing after bleeding has stopped.

4. In serious cases, the patient should lie down with the injured part raised. Apply direct pressure to the wound over a clean dressing. If bleeding continues, do not remove the dressing, but apply further pads on top of the original one. Then bandage the wound firmly. Excessive blood loss may lead to shock. Medical assistance should be summoned immediately.

5. Blood-contaminated materials should be properly handled and the following precautionary measures need to be taken:

   - Avoid touching blood-contaminated materials with bare hands. Always use a pair of disposable plastic/vinyl gloves.
   - Use household bleach (diluted with water in the proportion of 1:5) to clean up the contaminated areas.
   - Blood-soiled gloves, dressings and swabs, etc. should be placed in double plastic bags and then sealed for disposal.

23.1.7 Chemicals Swallowed

1. If the chemical has not been swallowed, ask the patient to spit it out and wash the mouth with plenty of water.

2. If the chemical has been swallowed, give the patient plenty of water or milk to drink. Medical assistance should be summoned immediately.

3. If medical consultation has to be sought, a sample of the swallowed poison or vomit should be sent along to hospital for identification.

23.1.8 Inhalation of Toxic Gases

1. Open any doors and windows. Remove the patient to a safe place without endangering yourself.

2. Check his airway and ensure it is not blocked.

3. Place him in the recovery position (see Section 23.3) even if he is conscious.

This allows him to aspirate even if he vomits.

4. If the patient's breathing stops, carry out artificial respiration. If the pulse also stops, start cardiopulmonary resuscitation. (see Section 23.2)
5. Seek medical aid immediately.

23.2 Cardiopulmonary Resuscitation

If injury results in unconsciousness and that breathing and pulsation stop, cardiopulmonary resuscitation should be carried out. First-aid treatment should be given without delay, otherwise the brain cells will be damaged within 3-4 minutes. Cardiopulmonary resuscitation includes artificial respiration and chest compression.

The following are descriptions on artificial respiration and chest compression. They should not be regarded as a substitute of the training offered by first-aid organisations. These procedures should be conducted by persons qualified in administering first aid.

23.2.1 Artificial Respiration

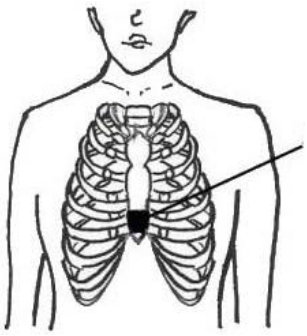
Artificial respiration involves the direct blowing of air into the patient's lungs to help the restoration of normal breathing.

1. Lay the patient on his back.
2. Check the airway and ensure it is free from obstruction.
3. Head tilt-chin lift and check breathing.
4. Breathe in deeply. Open your mouth wide and make an airtight seal over the mouth of the patient, meanwhile, pinch his nostrils with your fingers. Then blow gently. (If the patient's mouth is injured, your mouth should seal over his nose.)
5. During blowing, watch for chest expansion.
6. If the patient's chest does not rise, check that his mouth and throat are clear of any obstruction.
7. After blowing air into his lungs twice, check for pulse.
8. If a pulse is felt, continue to give inflation at a rate of 12-16 times per minute until natural breathing is restored.
9. If the pulse stops, carry out chest compression.

23.2.2 Chest Compression

If the patient's heart stops when artificial respiration is being conducted, chest compression should also be carried out for maintaining blood circulation.

1. Place the heel of one hand on the lower half of the patient's breastbone.
2. Cover this hand with the heel of the other hand and interlock your fingers.
3. Keeping your arms straight, press down about 4-5 cm and then release.
4. Continue to press 15 times at a rate of 80 times per minute.



During the process of cardiopulmonary resuscitation, artificial respiration and chest compression should be carried out alternatively. If there is only one first aider, the ratio of chest compression and artificial respiration is 15:2 (If there are two first aiders, the ratio is 5:1). Always check if there is any sign of return in breathing and pulse. If the pulse returns, chest compression should be discontinued. However, artificial respiration should be continued until natural breathing is restored.

23.3 Recovery Position

If the patient loses consciousness but his breathing and pulsation continue, place him in the recovery position. Such position enables him to vomit freely from his mouth.

Recovery position

23.4 First-aid Facilities

23.4.1 The First-aid Box

Each science laboratory should be equipped with a first-aid box marked clearly with "FIRST AID" and "**急救**". Sections (3) and (4) of Regulation 55 of the *Education Regulations* require, respectively, that all science teachers and laboratory technicians should be familiar with the contents of the first-aid box and their use and that all first-aid boxes shall be maintained fully equipped at all times.

The first-aid boxes should be installed in prominent and easily accessible positions in the science laboratories. Their contents should be regularly checked

to ensure that all the recommended materials and equipment are kept in sufficient quantity as well as maintained in good conditions at all times.

The following is a list of first-aid items recommended for school science laboratories:

- Antiseptics, e.g. Savlon, alcohol
- Sterile cotton wool
- Disposable plastic/vinyl gloves
- Sterile dressings/gauze
- Adhesive plaster
- Bandages (of different sizes)
- Forceps
- Safety pins
- Scissors
- Sterile adhesive dressings (of different sizes)
- Sterile eye pad
- Triangular bandages

It is recommended to include an item list in first-aid boxes for ease of checking the contents. A first-aid manual should also be kept inside each laboratory for reference. Other items such as ointments (which may accelerate absorption of some chemicals through skin) should not be provided in the first-aid boxes for laboratories.

In each school, a team of 2 or more staff members should be designated to be responsible for the first-aid boxes. Schools should also ensure that at least one member of the team is available during normal school hours. A notice specifying the names of the members of the team has to be affixed to the first-aid boxes.

23.4.2 Eye Wash Unit

Each science laboratory should be equipped with an eye wash unit beside the first-aid box for rinsing eye purpose. The eye wash bottle should always be kept clean with distilled water kept inside being replaced regularly to prevent growth of germs.

Eye wash unit

24 LABORATORY ACCIDENTS AND INSURANCE

When an accident involving injuries occurs in a laboratory, first aid should be administered to the injured as appropriate, and the school head should be notified as soon as possible. In the event of any serious injury, or whenever in doubt, medical aid should be sought without delay. The most effective way of securing medical aid urgently is to make a 999 telephone call for an ambulance. All injuries to the eyes should be regarded as serious.

24.1 Accident Records

A record of all accidents (including minor accidents) in each science laboratory should be kept by the teacher-in-charge of the laboratory. Each entry should contain: names of persons involved (teachers/laboratory staff/students), place, date, time, nature of accident, cause of accident, experiment being performed, extent of injury and treatment given.

Following each serious laboratory accident (e.g. an accident in which medical advice has been sought), a detailed accident report, using the standard report form in Appendix IX, should also be sent to schools' respective Regional Education Offices.

The safety management systems (e.g. the Standing Committee on Laboratory Safety) of schools should review the laboratory accident records when monitoring the standard of laboratory safety in their schools. Appropriate preventive measures should then be taken to minimise the occurrence of laboratory accidents.

24.2 Common Laboratory Accidents Reported in Schools

As one of the ways to monitor the standard of safety in school science laboratories, the Education Department conducted annual surveys of laboratory accidents occurring in science laboratories from 1995/1996 to 1999/2000. The information so obtained were analysed and the findings disseminated to all secondary schools, drawing their attention to accidents that are common in science laboratories, as well as preventive measures that can be taken. The followings are some of the findings of the annual surveys.

On average four hundred schools responded to the survey each year, about half of them reported that no laboratory accident of any kind occurred. An average total of about 880 accident cases were reported each year. The majority of the accidents were due to the carelessness of students. A breakdown of the number of cases in different types of the reported accidents is given in Appendix X. The nature/cause of the reported accidents are summarised below:

Type of Accidents	Nature/Cause
Cuts	Small cuts caused by broken glass apparatus (e.g. test tubes, or glass tubing), tools (e.g. dissecting instruments, cork borer or cutter) or sharp edges.
Heat burns or scalds	Carelessness in handling hot objects (e.g. tripods, glassware, metal rods/plates, crucibles or combustion spoons), hot

Type of Accidents	Nature/Cause
	liquids, Bunsen flame or lighted matches.
Chemicals on skin	Spillage of chemicals during transfer or heating of chemical liquids, washing up of apparatus containing chemical mixtures, opening the container of chemical or breakage of glass containers. Concentrated sulphuric acid, phenol and sodium hydroxide were the most common harmful chemicals involved. Students' mischievous behaviour of pouring chemicals to others.
Chemical spillage	Small-scale spillage of chemicals during transfer. Spillage of mercury from broken mercury thermometers or from its container. Incorrect techniques exercised by students in using apparatus such as separating funnel.
Eye accidents	Chemical liquids or solids which splashed onto the eyes, giving rise to slight irritation or discomfort. The chemicals commonly involved were copper(II) sulphate, dilute acids and alkalis. Students unintentionally rubbed their eyes with hands contaminated with chemicals. Students looked at bright light through a magnifying glass.
Substances catching fire	Accidental ignition of flammable liquids (e.g. ethanol or ethyl ethanoate). Ignition of gas coming out from defective burner tubings or from opened gas tap not connected to Bunsen burner. Ignition of blackout curtain by focused sunlight from optical instrument.
Discomfort arising from inhalation of gases	Discomfort after inhaling a small amount of chemical vapour (e.g. sulphur dioxide, bromine or ammonia) from reaction mixtures or town gas from leaking gas taps.
Bites by animals	Rats biting students and laboratory staff during experiments or when preparing for dissection experiments.
Others	Accidents of various natures were reported. Over 90% of the cases under this category were mere accidental breakage of glassware or damage of equipment. Students were hurt when they knocked on floor, stools, benches, or cupboards. Tasting of chemicals (e.g. copper(II) sulphate) by students.

24.3 Insurance

Schools should ensure that adequate insurance has been obtained to cover public liabilities arising from accidents and personal injuries to students and staff, employees' compensation as required by the *Employees Compensation Ordinance* and fire in case of accidents.

Aided and caput schools may refer to the relevant Administration Circular on the Block Insurance Policy arranged by the Education Department. Private schools may refer to the Circular Memorandum on Insurance in Schools issued by the Education Department to obtain adequate insurance cover.

REFERENCES

1. Books / Pamphlets

Title	Author / Source	Publisher
Safety Precautions in Integrated Science Experiments (1999)	Education Department	
Guidelines on Outdoor Activities (1996)	Education Department	
Guidelines on the Prevention of Blood-borne Diseases in Schools (2001)	Department of Health and Education Department	
A Safety Handbook for Science Teachers, 4th Edition (1991)	K. Everett & E. W. Jenkins	John Murray
A Guide to the Factories and Industrial Undertakings (Dangerous Substances) Regulations (1999)	Occupational Safety and Health Branch, Labour Department	
A Guide to Part VII of the Occupational Safety and Health Regulation (Manual Handling Operations) (2001)	Occupational Safety and Health Branch, Labour Department	
Chemical Safety Data Sheets : Volume 1-5 (1989)	Rebecca Allen (editor)	Royal Society of Chemistry
Chemistry of Hazardous Materials (1997)	Eugene Meyer	Brady Games
Compressed Gases: Safe Handling Procedures (ACS Laboratory Safety Series) (1995)	George Whitmyre	American Chemical Society
Emergency Medical Response to Hazardous Materials Incidents (1997)	Richard H. Stilp & Armando S. Bevelacqua	Delmar Publishers
Fume Cupboards in Schools (Revision of Design Note 29) (1998)	Department for Education & Employment, UK	Her Majesty' s Stationery Office
Guidance Notes on Manual Handling Operation (1999)	Occupational Safety and Health Branch, Labour Department	
Handbook of Laboratory Health and Safety (1995)	R. Scott Stricoff, Douglas B. Walters, Authur D. Little	John Wiley & Sons
Hazardous Chemicals : A Manual for Science Education (1997)	Scottish Schools Equipment Research Centre (SSERC) Limited	

Title	Author / Source	Publisher
Hazardous Chemicals Desk Reference (1997)	Richard J. Lewis	John Wiley & Sons
Hazardous Materials Chemistry for Emergency Responders (1997)	Robert Burke	Lewis Publishers, Inc.
Hazards During Chemicals in Use and Safety Guidelines (1999)	Occupational Safety and Health Branch, Labour Department	
Hazcards 1995 Edition, update 2000	Consortium of Local Education Authorities for the Provision of Science Services (CLEAPSS)	School Science Service, Brunel University
Health, Safety and Risk (2001)	Dorothy Warren	Royal Society of Chemistry
Hong Kong Poisonous Plants (1988)	Urban Council, Hong Kong	
Improving Safety in the Chemical Laboratory: A Practical Guide (1991)	Jay A. Young (editor)	John Wiley & Sons
Laboratory Safety: Principles and Practices (1995)	Diane O. Fleming, John H. Richardson, Jerry I. Tulis	American Society for Microbiology
Laser and Eye Safety in the Laboratory (1995)	Larryl Matthews, Gabe Garcia (editor)	IEEE
Managing Occupational Safety and Health in School (2001)	Occupational Safety and Health Branch, Labour Department	
Material Safety Data Sheets (2000) (*http://144.214.35.115/public/safety/msds/msds.htm*)	City University of Hong Kong	
Occupational Safety and Health Guide —Occupational Safety and Health in Schools (2000)	Occupational Safety and Health Branch, Labour Department	
Prudent Practices in the laboratory – handling and disposal of chemicals (1995)	National Research Council	National Academy Press
Radiation Safety for Laboratory Technicians (1983)	Charles A. Kelsey	Warren H Green
Safe and Exciting Science (1999)	Association for Science Education	ASE Publications
Safe Storage of Laboratory Chemicals (1991)	David A. Pipitone (editor)	John Wiley & Sons

Title	Author / Source	Publisher
Safeguards in the School Laboratory, 10th edition (1996)	Association for Science Education	ASE Publications
Safety in Academic Chemistry Laboratories, 6th Edition (1995)		American Chemical Society
Safety in Chemical Laboratory (2001)	Occupational Safety & Health Council	
Safety in Science Education (1996)	Department for Education and Employment (DfEE)	Her Majesty' s Stationery Office
Safety Reprints, 1st Edition (1996)	Association for Science Education	ASE Publications
Topics in Safety, 3rd Edition (2001)	Association for Science Education	ASE Publications

2. Teaching Kits /CD-ROMs

Title	Publisher	Type
Chemical Safety Kit (1997)	Occupational Safety & Health Council and Education Department	Teaching kit
Chemical Safety (Ver 1.1, 2000)	Occupational Safety & Health Council and Education Department	CD-ROM
Electrical Safety (2000)	Occupational Safety & Health Council, Education Department and CLP Power Limited	CD-ROM
Hazardous Chemicals – An Interactive Manual for Science Education (2000)	Scottish Schools Equipment Research Centre (SSERC)	CD-ROM
Occupational Safety and Health Bookshelf (2000)	Occupational Safety & Health Council and Labour Department	CD-ROM

APPENDIX I

EDUCATION REGULATIONS IN CONNECTION WITH SAFETY IN SCHOOL LABORATORIES

(21) (1) The supervisor shall ensure that all necessary safety precautions are adopted in school workshops and science laboratories and shall modify or extend those precautions as the Director may require.

(2) The supervisor and principal shall ensure that no instruction is given in the use of tools or the operation of machines or in science experiments except by a responsible teacher.

(24) The Director may limit the number of pupils who may at any one time receive instruction in any school workshop or science laboratory.

(26) All machinery, machine tools, hand tools and other equipment in a school workshop or science laboratory shall be suitable for the courses and shall be maintained in proper working order.

(27) No pupil shall be permitted to enter any school workshop or science laboratory unless a teacher is present.

(31) No poisonous or dangerous substance shall be kept without the permission of the Director in any place in school premises except in a science laboratory or a store room that has been approved in writing for such purpose by the Director.

(32) The principal of every school shall appoint a teacher to be in charge of every science laboratory and store room which has been approved by the Director under regulation 31.

(33) A teacher who is appointed under regulation 32 to be in charge of a science laboratory or a store room shall :

(a) cause every poisonous substance and dangerous substance in such laboratory or store room :

(i) to be kept in a proper container clearly marked with the name of the substance, and with the word "Dangerous" or the words "危險" or any word or words of similar meanings; and

(ii) to be stored in a locked room or cupboard, except when the substance is being used for the purpose of a lawful experiment in practical science which is carried out under the control of a teacher; and

(b) keep the key to such locked room or cupboard in his control

APPENDIX II

OCCUPATIONAL SAFETY AND HEALTH IN SCHOOLS

With effect from May 1997, the safety and health of employees in schools is protected by the *Occupational Safety and Health Ordinance* and its subsidiary Regulation. It is the responsibility of employers to ensure, as far as reasonably practicable, the safety and health of all employees at work. Employees should, as far as reasonably practicable, cooperate with their employers to comply with the requirements of the law so as to protect the safety and health of themselves and any other persons that may be affected.

To successfully manage safety and health at work, the Labour Department has advised every school to establish an occupational safety and health management system which includes the following elements :

a) a safety and health policy statement to show the management's commitment;
b) organization structure of the management system, with a clear allocation of safety responsibilities;
c) an assessment of the safety and health risks which should be updated when situations change;
d) safety and health regulations to be observed in the workplace;
e) education, instruction and training on occupational safety and health;
f) emergency plans, drills and first aid arrangements,
g) a regular review of the system to ensure its effectiveness; and
h) documentation to keep proper record and ensure continuity of activities.

The Education Department has advised all secondary schools to set up a standing committee on laboratory safety (SCLS) (see Chapter 2). The SCLS can help promote the standard of laboratory safety through closer coordination and better equip schools to deal with emergency situations. Though SCLS is rather similar to the above system, schools should actively review their safety management systems to ensure that the requirements of *Occupational Safety and Health Ordinance* are also observed to protect the safety and health of their employees at work.

Further information about the subject or assistance can be obtained from the Occupational Safety and Health Branch of the Labour Department (Tel: 2559 2297) or on the Internet web pages of the Labour Department at *http://www.info.gov.hk/labour*.

APPENDIX III

LABORATORY SAFETY INSPECTION CHECKLIST

This safety checklist is intended for use by laboratory staff in secondary schools. It facilitates the maintenance of the safety standard of secondary school science laboratories. This checklist is by no means exhaustive. Schools may modify the checklist in accordance with the needs and conditions of their school laboratories.

Note: D = daily, W = weekly, M = monthly, T = once a term

Frequency [Note]				Descriptor	Check Mark	
D	W	M	T		Yes	No
				First-aid Equipment		
D				1. Is the first-aid box fully equipped and easily accessible?		
	W			2. Is the eye wash bottle clean and the distilled water replaced?		
				Fire-fighting Equipment		
	W			1. Is the CO_2/dry powder fire extinguisher serviceable and fully charged for immediate use?		
	W			2. Is the fire blanket available for immediate use?		
	W			3. Are the sand buckets dry and free from rubbish?		
				Personal Protective Equipment		
	W			1. Are there sufficient safety spectacles/goggles available for immediate use?		
	W			2. Are the safety spectacles/goggles clean, free from scratches and in good condition?		
	W			3. Is the safety screen available for immediate use?		
	W			4. Is the face shield available for immediate use?		
		M		5. Is the safety goggles for laser protection (if any) available for immediate use?		
		M		6. Have the safety spectacles/goggles, face shield and safety screen been cleaned with detergent/disinfectant?		
	W			7. Are laboratory gowns and protective gloves (e.g. disposable plastic gloves, chemical/heat resistant gloves and leather gloves for animal handling) available for immediate use?		
	W			8. Is the respirator available for immediate use?		
				Exits/Passages		
D				1. Are all exits/passages free from obstructions?		
D				2. Are all entrances to the laboratories locked by the end of the school day to avoid unauthorised entry?		
				Electrical Supply		
	W			1. Are plugs, sockets and switches securely screwed, without cracks and free from signs of overheating?		
	W			2. Are electrical fittings free from loose/exposed wires?		
			T	3. Does the residual current device operate when the test button is pressed?		
D				4. Is the main switch switched off by the end of the school day (if applicable)?		
				Gas Supply		
	W			1. Are Bunsen burners maintained in good condition (e.g. the barrels are free from obstructions, the collars are not stuck, etc.) and the tubing free from any signs of deterioration?		

Frequency Note				Descriptor	Check Mark	
D	W	M	T		Yes	No
D				2. Have all gas taps been closed by the end of the school day?		
D				3. Is the main gas supply valve switched off by the end of the school day?		
				Water Supply/Drainage System		
		M		1. Are the water taps functioning properly?		
		M		2. Are the catchpot recovery traps/sinks free from leakage?		
				Fume Cupboard		
D				1. Is the fume cupboard functioning properly?		
D				2. Is the working area inside the fume cupboard clean and clear for immediate use?		
				Floor		
D				1. Is the floor kept in a safe condition (e.g. no loose floor tiles, no slippery areas, etc.)?		
				General Storage		
D				1. Are all hazardous chemicals kept in a locked store/cupboard?		
D				2. Do all hazardous chemicals carry suitable hazard warning labels?		
	W			3. Have blurred labels on reagent bottles been replaced?		
	W			4. Are incompatible chemicals (e.g. hydrochloric acid and methanal, strong oxidizing agents and strong reducing agents, etc.) separately stored from each other?		
	W			5. Are corrosive chemicals stored at a low level and protected from kicking?		
		M		6. Are reactive chemicals (e.g. phosphorus, alkali metals, etc.) covered with sufficient immersion fluids?		
		M		7. Are short-life chemicals (e.g. diethyl ether, alkali metals, etc.) free from any signs of deterioration?		
		M		8. Is the spill control kit for dealing with chemical spills in good condition and readily accessible?		
		M		9. Are the safety information (e.g. MSDSs) for all the hazardous chemicals stored readily available?		
		M		10. Are all radioactive substances (if any) stored in a locked metal container?		
		M		11. Are heavy items stored at a low level?		
			T	12. Is the quantity of each chemical stored in the laboratory kept to a practical minimum and just sufficient for routine uses?		
			T	13. Is the laser (if any) kept under lock?		
				Storage of Chemical Wastes		
	W			1. Are chemical wastes properly separated and stored?		
	W			2. Are the storage pails and catcher trays free from signs of leakage?		
				Others (please specify)		

Signature:			
Inspecting Personnel:		**Date:**	

APPENDIX IV – RISK ASSESSMENT FORM

<table>
<tr><td colspan="4">Title of the Experiment / Task:</td></tr>
<tr><td colspan="4">Outline of the procedures:</td></tr>
<tr><td>Hazardous substances being used or made (e.g. chemicals, microorganisms), hazardous procedure or equipment</td><td>Nature of the hazards (e.g. toxic, flammable, potentially infectious)</td><td>Control measures and precautions (e.g. substitute chemicals; reduce scale; use fume cupboard, safety screen, protective gloves or safety spectacles, etc.)</td><td>Source(s) of information (e.g. Handbook on Safety in Science Laboratories, MSDSs or Hazcards, etc.)</td></tr>
<tr><td></td><td></td><td></td><td></td></tr>
<tr><td colspan="3">Disposal of residues:</td><td rowspan="2">Prepared by: _____

Date: _____</td></tr>
<tr><td colspan="3">Remarks:</td></tr>
</table>

APPENDIX V

SAFETY SYMBOLS

Safety symbols such as warning signs and hazard warning symbols serve to caution laboratory users as well as all those in the vicinity.

1. Warning signs – Standard warning signs have been established for a number of hazardous situations, such as handling of radioactive sources and operation of laser. The metal container of radioactive sources should be permanently labelled with a warning sign to indicate that it contains radioactive substances. When a laser is in operation, warning signs should be displayed in conspicuous locations both inside and outside the experiment area and on doors giving access to the area. Some examples of warning signs are shown below:

DANGER
Laser beam

CAUTION
Radiation

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

	Hazard warning symbols commonly used in schools	**Hazard warning symbols used in industry**
Physio-chemical Hazards		
		

	Hazard warning symbols commonly used in schools	Hazard warning symbols used in industry
		
Health Hazards		
		
		
		

APPENDIX VI

AN ABSTRACT OF SCHEDULE 1 TO WASTE DISPOSAL (CHEMICAL WASTE) (GENERAL) REGULATION

Acids, alkalis and corrosive compounds

Acetic acid above 10% acetic acid by weight

Chromic acid above 1% chromic acid by weight

Fluoboric acid above 5% fluoboric acid by weight

Formic acid above 10% formic acid by weight

Hydrochloric acid above 5% hydrochloric acid by weight

Hydrofluoric acid above 0.1% hydrofluoric acid by weight

Nitric acid above 5% nitric acid by weight

Perchloric acid above 5% perchloric acid by weight

Phosphoric acid above 5% phosphoric acid by weight

Sulphuric acid above 5% sulphuric acid by weight

Ammonia solution above 10% ammonia by weight

Potassium hydroxide solution above 1% potassium hydroxide by weight

Sodium hydroxide solution above 1% sodium hydroxide by weight

Potassium hypochlorite solution above 5% active chlorine

Sodium hypochlorite solution above 5% active chlorine

Hydrogen peroxide solution above 8% hydrogen peroxide by weight

Acids or acidic solutions, NES with acidity equivalent to above 5% nitric acid by weight

Bases or alkaline solutions, NES with alkalinity equivalent to above 1% sodium hydroxide by weight

NES = Not Elsewhere Specified

APPENDIX VII

SOME COMMON PLANTS KNOWN TO CONTAIN IRRITANTS

Alocasia odorata (Alocasia)

Euphorbia milii (Crown of Thorns)

Euphorbia pulcherrima (Poinsettia)

Euphorbia tirucalli (Milk Bush)

Excoecaria agallocha (Milky Mangrove)

Narcissus tarzetta (Chinese Sacred Lily)

Nerium indicum (Oleander)

Rhus chinensis (Sumac)

Rhus hypoleuca (Sumac)

Rhus succedanea (Wax Tree)

Thevetia peruviana (Thevetia)

Vinca rosea (Periwinkle)

APPENDIX VIII

DEALING WITH EMERGENCY SITUATIONS DURING OUTDOOR/FIELDWORK ACTIVITIES

The general guidelines when dealing with emergency situations involve:

- Keep calm
- Request for help

1) In case of getting lost

a) Stop going onwards. Keep calm and stay together;

b) Locate the present position by making use of the last known positions such as peaks and rivers, or by referring to the map and compass;

c) Decide whether to go back, or to go for an established landmark, or to stay; and

d) If you have to stay at the spot, try to make the location known as conspicuously as possible. Send out distress signals by using a torch, a whistle or a signalling mirror. (Try to use the international distress signal, i.e. six blasts on a whistle or six flashes of a torch or six movements to attract attention, with a minute between each sequence, to guide the rescue party.)

2) In case of a hill fire

Panic causes energy loss and poor judgement. Act calmly and do not run unless absolutely necessary.

Avoidance/escape

a) Abandon highly inflammable material and non-essential equipment;

b) Drink water and saturate handkerchiefs and clothing;

c) Avoid dense vegetation and undergrowth;

d) Head in the opposite direction or to the side and rear of a fire;

e) Avoid moving uphill with a steep slope, and move downhill as far as possible; and

f) Beware of fallen power lines, falling burnt-outs trees, and observe the wind direction.

Survival

If flames have cut off your escape:

a) Cover yourself with adequate clothing (NOT synthetic). Ensure that the clothing does not catch fire easily;

b) In dense smoke, restrict your breathing and keep low, as the air closest to the ground is cooler and fresher;

c) Cover yourself with a completely wet garment (if possible) or damp dirt; cover your mouth and nose with a water-saturated handkerchief or cloth;

d) Jump into a reservoir or river as far as possible and cover your face with a wet garment to keep out of smoke and fumes;

e) If your clothes catch fire, roll on the ground or use other clothes (wool) or wet garment to smother it; and

f) Find a drain, ditch, tunnel, etc. and remove anything that is inflammable.

3) In case of heavy rain

Heavy rain causes flooding and makes streams rise rapidly into dangerous torrents, sometimes washing away bridges and parts of footpaths. You should not cross rivers in flood that are knee-deep or above. Do not wade across the river under the heavy rain unless in a desperate situation. It would be better to use a bridge, even if this means a long detour or a long wait for the rain to ease off.

If it is impossible to avoid crossing the river, adhere strictly to the following rules:

a) The group leader should check that individual participants have made proper preparation and that each participant is made secure from the bank before crossing the river;

b) Avoid jumping from boulder to boulder;

c) Take small steps to maintain a steady posture;

d) Each participant should face upstream while crossing the river and should be attached to a rope linked with the bank to form a safety link; and

e) The safest crossing point is often between bends.

APPENDIX IX

REPORT ON ACCIDENT CONCERNING SCIENCE EXPERIMENTS/FACILITIES IN SCHOOL

To: Regional Education Office (HK / Kln / NTE / NTW *)
** Please delete whichever is inappropriate*

1. Name of School : _____

   Address : _____

   Tel. No. : _____ Fax No. : _____

   Name of Principal : _____

2 Occurrence of accident

   Date : _____ Time : _____

   Place : _____

   Class : _____ No. of students in class : _____

3. Nature of accident (e.g. fire, explosion, heat burns/scalds, chemical burns, etc.)

   _____

   _____

4. Name(s) of student(s) involved (with age in bracket), and description of injury (if any) caused by the accident

   _____

   _____

   _____

5. Name(s) of teacher(s)/laboratory staff involved, and description of injury (if any) caused by the accident

   _____

   _____

   _____

6. Cause of the accident (e.g. wrong procedure, or carelessness or malicious action of students or others, faulty equipment, etc.)

   _____

   _____

7. Title of the experiment performed when the accident occurred (if applicable)

_____

_____

8. Distribution of students at time of accident

   (a) Group experiment :
   Number of students in each group _____

   (b) Demonstration experiment :
   Location of students _____

9. Location and activity of the teacher in charge of the class at time of accident

_____

10. First aid given (if any)

_____

_____

11. Was any of the following telephoned for help? Yes / No *

	Put a "✓" as appropriate	Time notified	Time arrived
Police	☐	_____	_____
Fire Services	☐	_____	_____
Ambulance	☐	_____	_____

Action taken by the above on arrival:

_____

_____

12. Was the Regional Education Office (HK / Kln / NTE / NTW *) notified of the accident by telephone? Yes / No *

Date and time notified: _____

13. Was the parent(s) or guardian(s) of the injured student(s) notified of the accident?

Yes / No*

14. Name(s) and designation(s) of witness(es) to the accident (if any)

_____

_____

15. General remarks on the accident (if any)

_____

_____

_____

16. Particulars of the teacher in charge of the class at time of accident (if applicable)

Name (Print) : _____

Qualifications : _____

Teaching experience (number of years) : _____

17. Particulars of the laboratory technician in charge of the laboratory where the accident occurred (if applicable)

Name (Print) : _____

Qualifications (including professional qualifications) :

_____

Working experience (number of years) : _____

18. Reporting person(s) (Put a "✓" as appropriate) :

☐ Teacher _____ _____

(Name) (Signature)

☐ Laboratory technician _____ _____

(Name) (Signature)

Signature of principal: _____

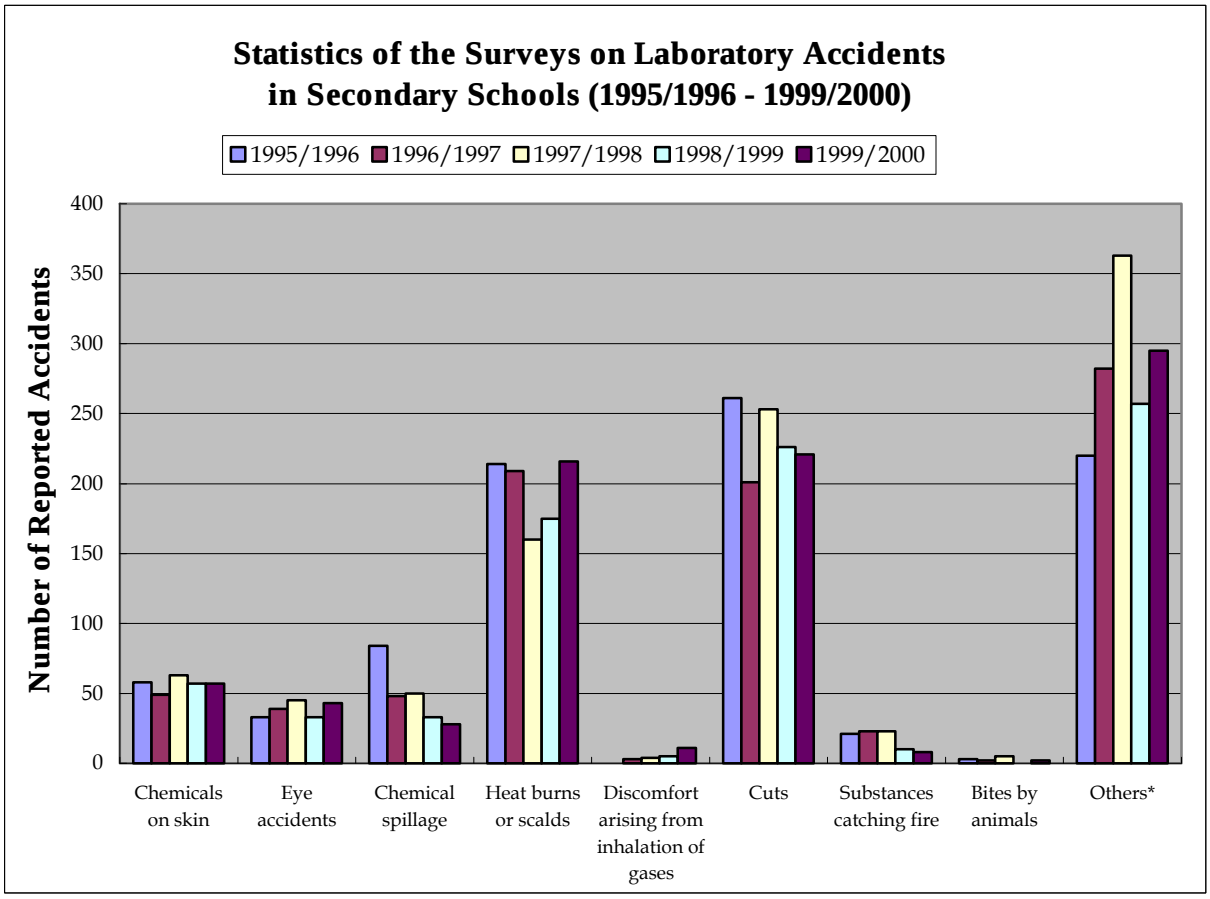
Date : _____

APPENDIX X

STATISTICS OF THE SURVEYS ON LABORATORY ACCIDENTS IN SECONDARY SCHOOLS (1995/1996 - 1999/2000)

Type of accident	1995/1996	1996/1997	1997/1998	1998/1999	1999/2000
Chemicals on skin	58	49	63	57	57
Eye accidents	33	39	45	33	43
Chemical spillage	84	48	50	33	28
Heat burns or scalds	214	209	160	175	216
Discomfort arising from inhalation of gases	—	3	4	5	11
Cuts	261	201	253	226	221
Substances catching fire	21	23	23	10	8
Bites by animals	3	2	5	0	2
Others*	220	282	363	257	295
	894	856	966	796	881
Number of schools responded	429	421	437	355	448
Number of schools reported laboratory accidents	205	200	185	160	189
Percentage of schools reported laboratory accidents	48%	48%	42%	45%	42%

** Over 90% of the cases under this category were mere accidental breakage of glassware or damage of equipment. Most of these cases did not involve any injury.*



APPENDIX XI

CHEMISTRY EXPERIMENTS REQUIRING PARTICULAR CARE

From bitter experience, laboratory accidents always result from a combination of hazardous situations and human error. To minimise these, science teachers must be prepared to take up certain professional responsibilities in addition to playing the normal roles of a teacher. Science teachers should pay full attention to students working in the laboratory, select alternative safer experiments when such are available, impart to students the awareness of laboratory safety and warn students not to conduct potentially hazardous experiments outside school laboratories.

Chemistry experiments requiring particular care are classified into three categories depending on the risk and seriousness of the hazard:

Category U— ***U***nsuitable. These experiments are considered unsafe to be conducted in schools.

Category D— ***D***emonstration. These experiments involve a considerable element of danger and are recommended for teacher demonstration only.

Category C— ***C***aution. These experiments can be performed by students with caution and only under close supervision of the teacher.

In addition, experiments marked (F) denotes that the use of the fume cupboard is recommended. However, teachers may have to use their discretion and allow some of these experiments to be carried out in a very well-ventilated laboratory, using minimal quantities of materials.

The lists of experiments in the subsequent sections should not be taken as exhaustive. Under certain circumstances, experiments not listed may still present some risk. However, it is hoped that the lists will serve to illustrate experiments that are more widely known as dangerous.

Category U

These experiments are considered unsafe and schools are strongly advised NOT to conduct these in the laboratories. Students should also be warned NOT to carry out these same experiments by themselves outside the school.

U 1. Oxidation of ammonia, using oxygen in an enclosed apparatus.
U 2. Heating ammonium dichromate(VI) with aluminium or magnesium powder.
U 3. Electrolysis of molten cadmium iodide.
U 4. Preparation of carbonyl chloride.
U 5. Mixing chlorates with concentrated sulphuric acid or combustibles.
U 6. The reaction between halogens and ammonia.
U 7. The reaction of hydrogen and chlorine. (This refers to the gas syringe and similar experiments. Burning hydrogen at a jet in chlorine is acceptable as a teacher demonstration.)
U 8. The reaction between chlorine and ethyne. (The reaction in which gases are generated simultaneously by adding dilute hydrochloric acid to a mixture of bleaching powder

and calcium carbide is acceptable as a teacher demonstration, in which case a safety screen or the fume cupboard is recommended.)

U 9. Preparation of chlorine oxides.
U10. Preparation of cyanogen.
U11. Explosion of a mixture of ethene or ethyne with oxygen.
U12. Grinding or warming mixtures of chlorates, permanganates or nitrates with combustible substances such as carbon, sawdust, sulphur, and powdered metals such as magnesium and aluminium.
U13. Preparation of hydrogen cyanide by the action of acids on cyanides or cyanoferrates.
U14. Mixing nitrates with combustibles.
U15. Heating nitrates with sodium thiosulphate or tin(II) chloride.
U16. Preparation of *N*-nitrosamines from amines. (Note that these are carcinogens.)
U17. Action of chloric(VII) acid (perchloric acid) and chlorates(VII) (perchlorates) on combustibles.
U18. Mixing permanganates with concentrated sulphuric acid or combustibles.
U19. Preparation of rocket fuels.
U20. Preparation and heating of ammonium nitrate(III) (ammonium nitrite).
U21. Heating mercury.
U22. Explosion of hydrogen with air and with oxygen.

Category D

All of the following experiments involve a considerable element of danger and are recommended for teacher demonstration only. Teachers should be thoroughly familiar with the technique to be used. It is assumed that these experiments will have been rehearsed before being performed in front of a class for the first time.

D 1. Oxidation of ammonia by air or oxygen in an open vessel.
D 2. Heating ammonium dichromate(VI) ("Volcano" experiment). A fume cupboard is needed to avoid possible inhalation of chromate dust. (F)
D 3. Heating ammonium nitrate. Heating a mixture of ammonium chloride and sodium nitrate is considered safer. Use safety screens.
D 4. Igniting ethene or ethyne in a gas jar.
D 5. Large scale generation and collection of hydrogen.
D 6. Burning hydrogen in air and in chlorine. Use safety screens.
D 7. Reduction reactions using hydrogen. Use safety screens for the normal scale experiment.
D 8. Reduction of metal oxides with carbon monoxide (or town gas). (F)
D 9. Preparation of hydrogen sulphide. (F)
D10. Heating lithium. Use safety screens.
D11. Heating mercury(II) oxide. (F). The fume cupboard is essential.
D12. Preparation of phosphine. (F)
D13. Burning yellow phosphorus. (F)
D14. Reactions of potassium and sodium with water. Use safety screens.
D15. Heating potassium chlorate(V) and manganese(IV) oxide. Many safer alternatives for oxygen preparation are available. Use demonstration to illustrate catalysis only. Use safety screens.
D16. The reaction between sulphur and zinc. Do not confine the mixture in any way, i.e. heat the mixture on a ceramic centred gauze or mineral fibre paper. Use safety screens.
D17. Thermit reaction of metal oxides with powdered aluminium. Use safety screens. Iron(III) oxide and chromium(III) oxide are safe oxides to use. Do not use copper(II) oxide, manganese(IV) oxide or chromium(VI) oxide.

D18. Combining nitrogen and hydrogen. Use gas syringes.
D19. Heating potassium manganate(VII) (potassium permanganate). Eye protection is essential.

Category C

Some experiments, listed below, may present dangers to students. Teachers should be particularly vigilant when their students are performing these experiments. Small scale experiments are recommended, thereby minimising the effect of any experimental accident that may occur.

C 1. Reactions of aryl and acyl halides. (F)
C 2. Reactions of calcium carbide with water.
C 3. Preparation of chlorine using potassium manganate(VII) (potassium permanganate) and concentrated hydrochloric acid. Cover the permanganate with water first. This experiment is highly dangerous if sulphuric acid is used by mistake instead of hydrochloric acid. It would be safer to use fresh bleaching powder or sodium chlorate(I) (sodium hypochlorite) and dilute hydrochloric acid or sulphuric acid.
C 4. Reaction of chlorine with metals. (F)
C 5. Reactions involving hydrogen sulphide. (F)
C 6. Heating iodine in air. (F)
C 7. Organic nitrations. (F). In some cases when only a mild nitrating agent, such as dilute nitric acid, is necessary, a fume cupboard is not needed (e.g. nitration of phenols).
C 8. Pipetting of solutions of ethanedioic acid (oxalic acid) and ethanedioates (oxalates). Pipette fillers should be used.
C 9. Reactions of phosphorus halides with water. (F)
C10. Polymerisation and depolymerisation of acrylics. (F)
C11. Polymerisation of phenylethene. (F). The fume cupboard is essential.
C12. Burning of polymers such as polyvinyl chloride (PVC), polystyrene, etc. (F)
C13. The reactions of concentrated sulphuric acid. Use a fume cupboard if corrosive or toxic gases are likely to be evolved.
C14. The reactions of concentrated nitric acid. (F). Use a fume cupboard since nitrogen dioxide, which is toxic, is often evolved.
C15. Thermal cracking of medicinal paraffin. Gases liberated from a heated reaction vessel may be collected over water. In such cases, there is the likelihood of sucking back when the heat source is removed before the delivery tube is disconnected from the reaction vessel. This may cause water sucking back into the hot reaction vessel resulting in cracking. As a preventive measure, the delivery tube should first be disconnected from the reaction vessel before the heat source is removed.

APPENDIX XII

USEFUL TELEPHONE NUMBERS

Departments/Organisations	Telephone Numbers
Education Department	
Hong Kong Regional Education Office	2863 4646 (Fax: 2865 0658)
Kowloon Regional Education Office	2782 8383 (Fax: 2770 2012)
New Territories East Regional Education Office	2639 4876 (Fax: 2672 0357)
New Territories West Regional Education Office	2437 7272 (Fax: 2416 2750)
Science Section	2712 8476 or 2762 0305 (Fax: 2194 0670)
Chemical Waste Treatment Centre	2434 6452
Controlled Chemicals Group, Custom and Excise Department	2541 4383
Electrical and Mechanical Services Department	2882 8011
Environmental Protection Department	2755 3554
Government Laboratory	2762 3700
Hong Kong Observatory	Dial-a-weather 187 8200 (Cantonese) or 187 8066 (English)
Licensing and Certification Command, Fire Services Department	2723 8787
Occupational Safety and Health Branch, Labour Department	2559 2297
Occupational Safety and Health Council	2739 9000
Radiation Health Unit, Department of Health	2977 1868
School Division, Architectural Services Department	2867 3853

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