SECONDARY SCIENCES AND LABORATORY SAFETY GUIDELINES

Table of Contents

ACKNOWLEDGEMENTS

This document has been prepared to meet the need of the Calgary Board of Education, as an employer, to have Risk Management practices in place for teachers of secondary science, laboratory technicians and students. The development of this document has been a joint venture of the departments of Insurance and Risk Management, Safety Services and School Support Services, Curriculum Support. Revision of this document has been done through the efforts of staff from Safety Advisory Services, Curriculum Design and Assessment and various high schools.

Many thanks to the teachers and laboratory technicians who worked countless hours editing, re-editing and developing new content. Their passion for working safely in science areas was evident throughout the development process and comes through clearly.

The original edit and development team:

Mark Lewis, Crescent Heights High School
Joan Liland, Mount Royal Junior High
Rebecca Michaels, Forest Lawn High School
Theresa Michiel, Henry Wise Wood High School
George Preston, Dr. Gordon Higgins Junior High School
Wally Burfield, CBE Safety Services
Pat Kaiserseder, Curriculum Support

The Revision was undertaken by a group of Science Learning Leaders and Science Technicians from across the system including:

Deborah Miller	Science Learning Leader	Sir Winston Churchill High School
Karen Williams	Science Technician	Bowness High School
Joseph Michaud	Science Specialist	Learning Innovation

This document should and will be reviewed regularly and updated as needed. Comments and suggestions are welcome and may be directed to CBE Insurance and Risk Management or CBE Learning Innovation, Science Specialists.

*   *   *   *

GENERAL

AN APPROACH TO SCIENCE SAFETY

Regulations

The first step in promoting science safety is acknowledging that many science activities present potential hazards. The second step is recognizing that reasonable and prudent safety practices greatly reduce the likelihood of accidents. To ensure a safe working environment for students and staff, everyone involved must take all reasonable steps to avoid risks. In other words, they must act with due diligence.

Due diligence is a positive approach to risk avoidance based on accepting and fulfilling one's responsibilities. This provides a useful, common-sense starting point in planning for the health and safety needs of students and staff; knowing about possible hazards and taking precautions are the basis for creating a safe learning environment.

Health and safety requirements that are mandated by law are designed to protect students, staff, the public, physical plants, and the environment. The requirements are legal obligations but also help educators to better understand potential risks and the preventative measures that can be taken.

Legislation that is relevant to science safety exists at the municipal, provincial and federal levels. Numerous acts, codes and regulations are relevant to the practices within CBE schools. Sources are listed and may change over the life of this document. Any changes made to these acts, codes and regulations supersede statements within this document.

Alberta Building Code
Alberta Environmental Protection and Enhancement Act and Regulations
Alberta Fire Code
Canadian Environmental Protection Act
Clean Air Act
Employment Standards Code and Regulations
Hazardous Products Act and Controlled Products Regulations
Labour Relations Code Occupational
Health and Safety Act, Regulation, and Code
School Act and Regulations
Teaching Profession Act
Transportation of Dangerous Goods Act and Regulation
Water Act

CBE policy, directives and other guidance must also be followed in regards to practice in all science facilities.

Staff Competency

It is essential that staff members who perform potentially dangerous tasks have the competency to handle these tasks. Competency includes awareness of the proper procedures as well as necessary training and development. One of the responsibilities of Principals and Administrators is to develop and implement plans to ensure that staff has the necessary knowledge and training.

RECOMMENDED RESPONSIBILITIES

Responsibility for ensuring a safe environment in the science classroom is shared by six main groups:

School Board and Principals
Science Learning/Team Leaders
Science Teachers
Science Technicians (where applicable)
Science Laboratory Pages/Assistants
Science Students

Recommended Responsibilities of CBE and Principals

The CBE and school principals are committed to safety and to providing as safe a science learning environment as possible. Following the practices listed below can ensure this:

- Recommend that this Risk Management Manual on "Secondary Sciences and Laboratory
- Safety Guidelines" be referred to when teaching science in each school.
- Provide up-to-date safety information, as it becomes available, to each science teacher.
- Only assign qualified teachers of science to teach science classes. These teachers are to designate all science classes to the science laboratories. If this is not possible, the school principal(s) and the teacher(s) concerned must be consulted to ensure that the safest solution is achieved that ensures the safety and security of both students and staff.
- Provide safety seminars and workshops that teachers and appropriate staff are encouraged to attend to ensure up-to-date knowledge about current acceptable procedures related to safety in the science class (this may include, but not be limited to transportation of dangerous goods, storage and handling of chemicals).
- Ensure that unsafe facilities and equipment are not used and are repaired or replaced as soon as is practical.
- Ensure that all chemicals and materials are stored following strict safety practices and guidelines. Refer to CBE manual “The Management of Chemicals and Hazardous Materials”.
- Develop a procedure for the periodic disposal of hazardous and outdated substances from schools following strict acceptable safety practices.
- Ensure that the facilities in each school meet the requirements of “Alberta Fire Code”, “Alberta
- Building Code”, and the Occupational Health and Safety Act, EPEA, TDGA.
- Report accidents to Insurance/Risk Management, Safety Services and the Workers' Compensation Board, as required.
- Designate a person to be responsible for reuse, recycle and disposal of all substances.

School Principals should strive to provide teachers and students with safe learning environments that incorporate safe science facilities.

Recommended Responsibilities of Science Learning/Team Leaders and Science Technicians

The personal safety of students and teachers must be the continual concern of everyone at the CBE. Learning/Team Leaders can ensure the safety of the students and the teachers in the schools by carrying out the following practices:

- Ensure that all science teachers have access to this Risk Management Manual on "Secondary Sciences and Laboratory Safety Guidelines" and are instructed that it is their responsibility to read and follow these guidelines.
- Ensure that science teachers demonstrate and incorporate safe science practices into each science class, so that all students, teachers and visitors follow safety procedures.
- Ensure all science teachers have access to science safety resources and updates of safety materials.
- Ensure that substitute teachers have the ability to safely and properly conduct any activities that have been planned by the absent teacher or, in the event they are unable to do so, that plans are altered so that neither the substitute teacher nor any students are put at risk.
- Have safety on the agenda of every science staff meeting.
- Advise all science teachers to become familiar with the operation of any unfamiliar equipment or procedures prior to presenting this to students. This training may be conducted by a person external to the school or a staff member trained in the use of the equipment.
- Ensure that each science laboratory and classroom used for lab work is equipped with recommended safety equipment.
- Fire extinguishers are installed and maintained. Science leaders should ensure that all areas used for teaching science have accessible extinguishers.
- Ensure that each science teacher knows how to use all laboratory safety equipment.
- Ensure that all staff are informed and trained in emergency procedures.
- Follow all chemical procedures as explained in the current CBE manual "Management of Chemicals and Hazardous Materials" which deals with WHMIS (Workplace Hazardous Materials Information Sheet) and TDG (Transportation of Dangerous Goods).
- Ensure that any overcrowding in laboratories is brought to the attention of the Principal.
- Accidents are more apt to occur in an overcrowded environment.
- Ensure that the Principal is informed in writing of any condition that makes the Science area an unsafe learning environment.
- A "Student/Teacher Accident Report" Form must be completed by the appropriate teacher whenever an accident occurs.
- Conduct monthly safety inspections of all science laboratories and storage facilities.
- Every laboratory, classroom and storage area must be inspected at least once a month to identify and correct potentially dangerous situations. The "Science Areas Safety Survey" (Appendix 8) should be completed at this time.

Recommended Responsibilities of Science Teachers

The ***most*** important factors of safety in science education are the teachers':

Attitude
Knowledge
Practice
Enforcement of the rules
Common Sense

> **NOTE:** Every student **MUST** be made aware general safety practices and procedures as well as the potential hazards in every laboratory activity and receive safety instructions before the activity commences.

Teachers are advised to practice the following in order to be as effective as possible in running a safe science program:

- Keep informed about current safety ideas/concepts, procedures and regulations.
- Maintain ***every*** science area as a safe environment for both teachers and students by frequently inspecting for clutter and faulty equipment and facilities. Frequently inspected facilities should include gas fixtures, electrical outlets and connections, fume hoods and exhaust fans.
- Adhere to all practices as outlined in the CBE manual "Management of Chemicals and Hazardous Materials."
- Be familiar with the material in the appendices of this manual. These appendices include:
  - Contact Lens Letter
  - Student Science Safety Guidelines
  - Student Safety Contract
  - General Safety Guidelines
  - Material Safety Data Sheets Activity
  - Student Handout: Mechanical and Electrical Hazards
  - Student Handout: Radiation Protection
  - Science Areas Safety Checklist
  - Semester Safety Checklist
- Ensure that foods and/or beverages are not consumed or stored in the laboratories or preparation rooms. If a science laboratory facility is being used for classes other than science, food and beverages still must not be consumed.
- Do not use science refrigerators to store food intended for human consumption. The refrigerators in the preparation rooms should be labeled indicating that all food stored in the refrigerator is for experimental use only and not for human consumption.
- Complete the "Incident Report - Students/Teachers or Visitors - non WCB" Form for any accident that occurs in the laboratory. This form is available as a download from the staffroom.

- Insist that students wear goggles and laboratory aprons when appropriate for the activity. Goggles and laboratory aprons are required when heat, glassware or chemicals are involved.
- Set a good example by always practicing the safety procedures you teach.
- Ensure that substitute teachers have the ability to safely and properly conduct any activities that have been planned by the absent teacher or, in the event they are unable to do so, that plans are altered so that neither the substitute teacher nor any students are put at risk.
- Have a plan of action in case of an emergency in your class. Share this plan with all staff and students involved in the activity.
- Know the location of the safety equipment and the main valves for all utilities. Know how to operate these items.
- Ensure that the shut-off valve for the natural gas service for the laboratory is turned off when not in use.
- Report to your superior, in writing, any condition within your science classroom/laboratory that can potentially present a hazard to the safety and security of individuals located in that room. Keep a copy of the report.
- The teacher must consult and abide by the "Off-Site Activities Procedures Manual" when conducting field trips.

The Special Needs Student in the Science Laboratory

Teachers are responsible for arranging a program to meet the needs of any special needs students enrolled in their class. **Every teacher is responsible to ensure that all students are aware of the potential hazards that exist when they are attempting any assigned science activities.**

The science teacher should ensure the safest environment for a student with special needs by contacting and soliciting support from all appropriate CBE support units and support staff such as the school nurse, Student Services, ELL Team, etc.

Recommended Responsibilities of Student Laboratory Pages/Assistants and their Supervisors

Student laboratory pages/assistants fulfill a valuable role in the operation of a Science Department. They are given much greater responsibilities and greater access to the science area than a regular student. All members of the Science Department must keep this in mind when dealing with the student laboratory pages/assistants.

Science Departments operating a student laboratory page/assistant program must carry out the following practices:

- Be very selective when hiring the students for this program.
- Ensure that the students receive thorough training in all aspects of laboratory safety including:
    - The use of all safety equipment
    - The use of chemical spill control equipment
    - The procedure for laboratory fires
    - The procedure for emergency evacuation
    - Who and where to contact the appropriate person in case of an emergency
    - The location and the procedures for the use of the entire main shut-offs (natural gas, electricity, water) in each work area.
- Whenever student laboratory pages/assistants are working in a science area, either a teacher or a science technician must be present in that area to supervise their work and certificated staff must be available for consultation or in case of an emergency.
- Ensure that no friends, relatives, acquaintances, or any unauthorized persons are present where the laboratory pages/assistants are working.
- Give the student pages/assistants precise instructions on the tasks to be carried out and on all safety considerations.
- Pages / Assistants MUST use appropriate personal protective equipment (safety goggles, laboratory aprons and rubber gloves).
- Have a teacher present in the room whenever the assistants are performing any experiments.
- Always ensure that under NO circumstance unauthorized or unsupervised experimentation takes place.
- Always ensure that any personal injury to student pages/assistants, NO MATTER HOW MINOR, be reported to the teacher at once.
- Ensure that the student pages/assistants wash their hands with soap and water when finished working. Have student pages/assistants use rubber gloves when washing apparatus.

Recommended Responsibilities of Science Students

Science students share the responsibility for their own safety and the safety of others jointly with the teacher while in the laboratory.

Students should:

- Operate in a manner consistent with the expectations of the General Science Safety Guidelines (Appendix 4)
- Carry out science activities only with the teacher's permission and as instructed by the teacher.
- Inform the teacher of any special circumstances such as special medications, contact lenses and other medical devices or allergies.
- Report unsafe situations to the teacher immediately.

TEACHER LIABILITY

(Thanks to the Safety Committee of the Science Teachers' Association of Ontario)

A teacher's liability is a serious matter. The following is an outline of what a teacher should know about liability:

A teacher's legal duties include:

- informing students about any hazards associated with educational activities and instructing them in how to avoid these hazards
- fulltime supervision of students in classes and laboratories
- acting in a manner that a prudent parent would at all times

Conditions indicating competent supervision:

- good discipline
- students carry on in an orderly fashion
- rules formulated for guidance of students
- supervisor present; and supervisor and students following generally accepted practices

In cases of alleged negligence, the following is usually asked:

- Was supervision adequate?
- Could the accident have been foreseen and prevented?
- Was there contributory negligence by another party?

For the most part, a teacher can avoid legal problems involving students by maintaining safe classroom or laboratory. This can be accomplished by:

- supervising students to ensure proper working techniques and conduct
- eliminating foreseeable hazards
- acting like a prudent parent in general

PRACTICES AND PROCEDURES

RECOMMENDED PRACTICES FOR TEACHERS

DURING THE FIRST WEEK OF ANY SCIENCE COURSE THE TEACHER MUST*:*

- Provide a basic laboratory safety lesson to every student that includes the WHMIS information. ***Provide a reason for the safety procedures to help the student relate to the importance of a particular safety rule.***
- Provide each student with a copy of the safety procedures that the student is expected to follow in the laboratory.
- Outline the plan of action that the students are expected to follow in case of an emergency.
- Familiarize every student with safety equipment available in the laboratory by demonstrating its use and location.

<u>NOTE:</u> It is a **MUST** that each student is made aware of the potential hazards in every laboratory activity and receives safety instructions before the activity is attempted.

Teachers require this information to be recorded as part of the pre-lab write-up.

Before Conducting an Experiment …

The teacher should carry out the following practices before conducting each and every experiment. It is recommended that only authorized experiments be carried out and that they be carried out only in laboratory facilities that are equipped or can be equipped to support a particular experimental procedure or activity.

- Ensure that the science laboratory is equipped with the necessary and proper safety equipment and that it is in good working order and repair.
- Know the location and mode of operation of the main shut-off for gas, water and electricity.
- Ensure that all substances being used are properly contained and appropriately labeled.
- Test all experiments before the students perform them. Do not use any new products or un- tried substitutes without first testing them to determine possible limitations or hazards.
- Know the appropriate first aid procedures for any injury that may result from exposure to the reactants, the products and/or the equipment and apparatus used in carrying out any assigned experiments. (Material Safety Data Sheets - MSDS, safety references and first aid information should be accessible in the event of any emergency)
- Direct students to prepare for an experiment in advance by doing the pre-lab write-up.
- Emphasize conducting experiments in logical, organized steps, avoiding unnecessary movement or crowding.
- Establish a routine of having students make a safety check of apparatus' before using them in experiments.
- Ensure that matches or spark lighters are the only ignition sources used.

- Organize the laboratory area so that students have access to only the amount of chemicals needed for the activity. Consider micro-scaling labs whenever it is reasonable. (Use commercially available spot plates, with small depressions - reactions can still be observed with minimal chemical quantities.)
- Instruct students on the potential hazards and risks inherent in the experiment or procedure.
- Demonstrate the techniques and equipment required to effectively and safely carry out the experimental procedures for a specific lab.
- Instruct students on the safe handling and the appropriate disposal of any chemicals which will be used or produced in an authorized experiment.
- Instruct students on the appropriate first aid procedures for any injury resulting from exposure to reactants, products and/or the equipment and apparatus used in carrying out any assigned experiments.
- Instruct students in safety matters with the "ULTIMATE AIM" in mind. The "Ultimate Aim" is "to prevent accidents from happening and to enable students to engage in scientific investigations and experimentation; to design their own techniques with confidence, to appreciate the contributions of science to society and to enjoy their participation in the process of doing and learning science without the fear of injury".

While Conducting an Experiment ...

The teacher must carry out the following practices while conducting each experiment.

- **Wear the appropriate Personal Protective Equipment such as safety goggles, aprons, etc., and use the necessary safety equipment such as a fume hood. Ensure that students do the same.**
- Ensure that students are kept a safe distance from any demonstration that may project material, produce a flash, release fumes or has the possibility of explosions, implosions, splash or flame. Teachers should try out such demonstrations beforehand. The demonstration apparatus should be surrounded with mesh screens or shields. If it is necessary for the teacher to remain close by the demonstration, the teacher should also use protective face and eyewear.
- Ensure that students are not inserting glass tubing in stoppers or replacing scalpel blades in scalpels unless supervised or have had instruction in carrying out these procedures.
- Be present in the room at **ALL** times during an experiment.

After Conducting an Experiment ...

The teacher must carry out the following practices after conducting each experiment.

- Ensure that all chemicals have been stored or disposed of properly.
- See that all equipment / glassware used in the experiment have been returned in good repair, cleaned and are stored in a proper, well-organized manner.
- Lock all high security items (such as balances, microscopes and chemicals) in the appropriate storage areas.
- Remind all students that they must wash their hands with soap and water before leaving the laboratory.
- Check that all spills have been properly cleaned up so no hazard remains and that all clean-up materials have been disposed of or stored properly.

SAFETY IN BIOLOGY

This section contains safety practices that will help make the study of biology a safe and effective experience and help develop an appreciation for the complexity of life. (It is also necessary to refer to other sections and appendices of this manual depending on the type of activity that is being carried out.)

NOTE:

Like toxic chemicals and substances, microorganisms, present a potential hazard to students performing biological experiments. Working with them requires special handling, storage and disposal techniques. Teachers must be aware of the potential hazards presented by infectious agents and their possible sources.

General Considerations and Precautions

- Pathogens (disease causing organisms) must not be intentionally brought into the science classroom.
- *The study and observations of live cultures of micro-organisms is no longer indicated in the junior high program of studies.*
- Food must not be stored in refrigerators in laboratories where specimens (live or preserved) or chemicals are stored.
- Food for consumption and laboratory areas are not a good combination. Snacks or lunches must **not** be consumed in an area where labs occur. When a lab involves tasting or food preparation, an alternative location (e.g. cafeteria or food studies room) away from science laboratory facilities should be used.
- Hands must be thoroughly washed using soap and hot water after working with any specimens or cultures.
- After working with live specimens or cultures, all surfaces used must be washed down with disinfectant EP66 as per Safe Work Practice No. 4-5 *(Laboratory and preparation Room Cleaning)*. This disinfectant is provided by the Facility Operator Head.
- At regular intervals shelves, cupboards, animal cages, autoclaves, refrigerators, etc., should be thoroughly cleaned with disinfectant EP 66.
- Students **MUST NOT** bring sick animals into the laboratory. Animals that have died from unknown causes must not be permitted in the laboratory.
- Only supplier preserved specimens are permitted. The use of formaldehyde as a preservative shall be kept to a minimum, as formaldehyde is a toxic chemical.
- It is recommended that vacuum-packed or freeze-dried specimens be used or, where not available, specimens preserved in solutions other than formaldehyde (NOTE: formaldehyde is not permitted in schools. If preserved specimens cannot be obtained in solutions other than formaldehyde, the specimens cannot be brought into schools).
- Specimens should be discarded in two garbage bags immediately after use in dissection as there are some species of bacteria that can begin to grow on specimens, which have been in preservatives.
- All discarded animal remains shall be placed in two plastic garbage bags, which would then be securely tied before disposal.

Blood and Cheek Tissue Sampling ... these activities are strictly prohibited!

• Investigations requiring body fluids for activities such as blood typing or requiring cheek cell scrapings are **prohibited** by Alberta Education. For such studies, replace or modify these activities by using prepared microscope slides or audio-visual materials.

Chemicals: Management, Procedures, Storage

(Refer to "Chemical Management", "Chemical Procedures" and "Chemical Storage" found in later sections of this manual)

Disposal of Chemical and Biological Materials

(Refer to the sections on Disposal)

Dissections (see also Preserved Specimens)

• Be aware of the potential for exposure to parasites, fungus and/or disease organisms when doing dissections.

• Safety goggles and disposable gloves must be worn.

• Students should not replace scalpel blades. To prevent injury, safety goggles and pliers must be used when replacing the scalpel blades.

• All materials to be used for dissection should be purchased from a Biological Supply Company or a government inspected slaughterhouse. *NEVER* dissect material when the source of the specimen is unknown such as donated wild animal parts.

• Food for human consumption should not be stored in refrigerators containing dissection materials or chemicals.

• Immediately clean and bandage any scratches or cuts received during the dissection.

• If it is necessary to store a partially dissected specimen, store it only for a short period of time in a sealed container.

• Specimens should be discarded in two plastic garbage bags immediately after dissection as bacteria can begin to grow on decomposing specimens.

• Washand disinfect dissection equipment thoroughly after each use.

• Disinfect laboratory bench surface with EP 66.

• Wash hands thoroughly with soap and hot water immediately after carrying out a dissection.

• Owl pellets should be purchased from a science supply company to ensure sterilization. They should not be collected from the outdoors.

Live Specimens

Teachers of science have a responsibility to develop in their students a respect for life and an understanding of the conditions necessary for its perpetuation. Students should learn their responsibilities toward living organisms and should be involved in their care and maintenance. They should take pride in their ability to maintain animals and plants in a healthy state in a proper environment for which they, the students, are responsible.

Teachers keeping live animals should be aware of student allergies that could be triggered by those animals. Appropriate steps should be taken to ensure safety and comfort of those students.

Refer to CBE Administration Policy – AR 6004 (Animals in Schools) and any other relevant CBE policies.

Great care must be taken in the handling of plants in order to minimize the danger of poisoning or allergic reactions. The simplest protection is to use protective gloves if a potential allergic reaction is suspected. Always wash with soap and water immediately after handling plants.

NOTE: Great care should be taken when handling flowers and moulds so that pollen and spores are not excessively distributed throughout the laboratory. Some students may be severely allergic to pollen or spores.

Microbiology

Micro-organisms, like toxic chemicals, are a potential hazard to persons performing biological experiments. Working with them requires special handling, storage and disposal techniques. Teachers must be aware of the hazards presented by infectious agents and their possible sources.

• Food for human consumption **MUST NOT** be stored in refrigerators containing cultures.

• Liquid disinfectants and germicidal agents generally have limited effectiveness and should not be relied upon for complete sterilization. Always encourage sanitary practices.

• The study and observations of live cultures of micro-organisms is no longer indicated in the junior high program of studies.

• Cultures should not be incubated at temperatures higher than 32ºC. Higher temperatures encourage the growth of micro-organisms that are capable of living in the human body, which could be pathogenic.

• Anaerobic bacteria **MUST NOT** be cultured.

• Due to the possibility of culturing tetanus-causing organisms, bacteria from soils MUST NOT be cultured anaerobically.

• Avoid working with unknown bacteria and fungi. If you grow these organisms (in a petri dish) after collecting them from samples of air, soils, etc., you should consider them pathogenic. Such samples should remain sealed and should be disposed of according to current CBE practice. **No sub-culturing** of these species should be done and the petri dishes should remain sealed. Use cultures of known, non-pathogenic bacteria, if you want to train students to use simple microbiological techniques. These bacteria may be obtained from biological supply companies. Cultures of these organisms can be manipulated safely while using standard sterile techniques.

• Use sterile swabs in the culturing of micro-organisms. Serilize with the appropriate disinfectant after use. If inoculating loops are used in the transferring of cultures, flame before and after use.

• Petri dishes should be securely closed, when samples are collected but not sealed completely (to avoid anaerobic cultures). They should not be reopened. Discard in two garbage bags when use of cultures is finished and disposed of in the normal manner (see also Disposal)

• Wash hands with soap and hot water immediately after performing any microbiology work.

• All surfaces used must be washed down with the appropriate disinfectant EP 66.

Pesticides

• Treat pesticides as you would any other dangerous chemical. Know the safe handling, the disposal and the first aid procedures for each pesticide used. **MSDS sheets must be available**. (Pesticides include herbicides, insecticides, and fungicides.)

• Only small quantities of household-strength pesticides can be used. The use of large quantities or any quantity of commercial-strength pesticides requires a provincial license.

• It is recommended that non-toxic insecticides be used, if at all possible.

• The main concern is the absorption of the pesticide through the skin or inhalation. Follow the manufacturers' instructions exactly. Generally, work in a well-ventilated area, avoid breathing in the vapors by using a mask and use disposable gloves whenever handling pesticides.

• Wash hands with soap and hot water immediately after handling pesticides.

Pipetting

• **Never pipette by mouth!**

• Use a bulb, an aspirator or other pipette-filling device when pipetting any liquid.

• Check the pipette to be used to ensure that it is not cracked or chipped and that it is clean.

Preserved Specimens

Preserving medium should be handled with great care. Be aware that the preservative may have severe effects on the students in the laboratory. If possible, obtain the Material Safety Data Sheet (MSDS) for the preserving medium of any preserved specimens you purchase. If this is not possible, then the chemical composition of it should be obtained, so that the safe handling of it can be determined. Consider the purchase of specimens preserved by alternative methods such as freeze drying or vacuum-packing.

The following practices should be carried out in order to provide a safe environment when handling preserved specimens:

• Only supplier preserved specimens are permitted.

• Specimens ordered should be in an odourless holding solution and not formaldehyde based.

• Keep all containers containing preserved specimens tightly sealed.

• Wash all preserved specimens thoroughly **before** they are handled.

• Always use preserving medium under a fume hood.

• Formaldehyde cannot be used

• Specimens should be discarded in two plastic garbage bags immediately after dissection as there are some species of bacteria that can begin to grow on specimens, which have been in preservatives. Also, preservatives do not necessarily destroy the eggs of some parasitic worms.

• Wear safety goggles and disposable gloves whenever handling the specimens.

• Be aware of any adverse reactions that students in the laboratory may be having to either the preserving solutions or the preserved specimens.

• Wash hands thoroughly with soap and water immediately after handling the preserved specimen.

Disposal and Management of Biological Materials

(Refer to Administrative Regulations 8006.1 – Disposal of Hazardous Waste)

The greatest hazards in the biology classroom come from dissected organisms and micro-biological specimens. Biological specimens are to be thoroughly rinsed with water, and then packaged in securely tied double plastic garbage bags. Used petri dishes and cultures can be treated with 1 part household bleach: 9 parts of water and then rinsed and packaged in securely tied double garbage bags. They may then be disposed of as regular material destined for city landfill. Scalpels and razor blades, etc., should be placed in a metal or thick plastic container that is labeled as biohazardous waste before removal for disposal. All disposal containers must be clearly labeled as to their contents.

SAFETY IN CHEMISTRY

General

All teachers of science **MUST** be familiar with the information below as well as the sections listed:

- CBE manual 'Management of Chemicals and Hazardous Materials"
- Appendix 4 of this manual - General Science Safety Guidelines

All activities related to the use of chemical substances should be conducted in accordance with federal, provincial and municipal legislation. Teachers, science technicians and other staff leading such activities should be familiar with that legislation, found on page 6 of this document.

Anyone responsible for storing or putting away chemicals should be familiar with the section on Chemical Storage, later in this document.

All staff and student pages are required to have WHMIS training and are responsible for the use of controlled sub- stances subject to the following:

Users must adhere to WHIMIS legislation;
Students must be adequately supervised when using controlled substances;
Students must be instructed in the proper handling of these substances;
Proper safety equipment shall be maintained in the area and used when these substances are used;
All staff shall be knowledgeable in handling materials and dealing with incidents and accidents resulting from the use of these substances.

WHMIS training for staff must be completed with the online course provided by Safety Advisory Services. (See website under *Element 5, Training and Orientation*)
WHMIS instruction is required for all students (especially student pages) before they can enter a laboratory.

All teachers must send home the following information for parents to read and sign. Samples can be found in Appendices 1, 2, and 3.

Contact Lens Letter

Student Science Safety Guidelines

Student Safety Contract

NOTE: Appropriate eye protection, footwear, and laboratory aprons or coats must be worn during any activity involving chemicals (including household), heat and/or glassware.

- Caution is urged for all chemicals (including many over-the-counter products) used in schools. Avoid use of chemicals that present high risks.

- Only chemicals required to instruct the current Programs of Study should be used/stored. Unwanted chemicals should be disposed of according to Chemical Disposal, later in this document.

- Purchase only the quantity of chemical required for the current instructional year - chemicals have recommended shelf lives and buying in bulk may be false economy.
- Consider use of teacher demonstrations or audio-visual presentations where risks do not warrant student experimentation.
- Use the safest chemical possible that illustrates the concept being taught (for example, there are many possible choices for precipitation reactions).
- Use micro scale laboratory techniques whenever possible. (For example, use spot plates or small test tubes rather than beakers).
- Use proper storage techniques (see Chemical Storage, later in this document).
- The teacher, not the student, is responsible for disposal of all potentially dangerous chemicals. Students should be instructed to use waste buckets, which are then handled appropriately by the teacher.
- Wash hands with soap and water immediately after handling a chemical.
- Chemicals must be disposed of according to CBE procedures as outlined in "The Management of Chemicals and Hazardous Materials".

NOTE: It is a **MUST** that each student is made aware of the potential hazards in every lab activity and receives safety instructions before the activity is attempted. Many teachers require this information to be recorded as part of the pre-lab write-up.

Chemical Selection and Usage

Chemicals not Recommended

THESE CHEMICALS ARE NOT SUITABLE FOR USE IN THE SCIENCE CLASSROOM OR IN THE SCIENCE LABORATORY DUE TO SAFETY CONSIDERATIONS!

These chemicals should not be stored nor should they be isolated when generated in a preparation. Common names and International Union of Physical and Applied Chemists (IUPAC) names have been used.

Lead and its compounds were removed from CBE schools in 2005 and are not to be re-introduced

A

acetaldehyde (ethanol)
acrylonitrile (vinyl cyanide; 2-propenenitrile; cyanoethene)
acetyl chloride
acrolein
acrylic Acid
aluminum chloride
4-aminodiphenyl (xenylamine, p aminodiphenyl)
4, 4'-diaminobiphenyl (benzidine, p- diaminophenyl)
ammonium bifluoride
ammonium dichromate
ammonium fluoride
ammonium oxalate

ammonium sulfide
ammonium vanadate
aniline (aminobenzene, phenylamine)
antimony and its compounds
arsenic and its compounds
asbestos
azides

B
benzene
barium powder
benzidine
benzenesulfonic acid
benzo(a)pyrene (3,4 – benzopyrene)
benzoyl peroxide
beryllium and its compounds
bromine (liquid/gas
bromine water

C
cadmium and its compounds
calcium sulfide
carbolic Acid
carbon disulphide
chloroform
chromium (dust)
chromium compounds
cobalt Powder
colchicine
copper Metal Powder
cresol (ortho)
cupferron (ammonium *N*-nitrosophenylhydroxylamine)
cylinders of chlorine gas
cyanides
carbon tetrachloride
chlorine gas
chlorine water

D
1, 2-dibromoethane (ethylene dibromide)
1, 2-dichloroethane (ethylene dichloride)
diethyl ether (ethoxyethane)
dimethyl sulphate
dinitrophenol
1, 4-dioxane

E
ethylamine (liquid and gas)
ethyl Bromide
ethylene dichloride
ethylene diamine

F
formaldehyde (methanol) – excluding biological specimens
formalin
fuming sulphuric acid

fluorine

H
hydrazine
hdrogenCyanide
hydrofluoric acid
hydrogen sulphide

L
lead and Lead compounds

M
mercury
metal carbonyls
metal picrates

N
1-napthylamine
nickel metal powder
nickel compounds
nitrogen dioxide – commercial cylinders
2-napthylamine
nitrobenzene
4-nitrobenzene
2,4’-dinitrodiphenol
1-nitronapthalene
napthylene
2-nitronapthalene
nitrosamines
nitrosophenol

P
perchlorates
perchloric acid
paraformaldehyde
potassium Metal
phenol
phenylhydrazine
potassium dichromate
potassium chromate
prussic acid
phenyl isocyanate
phenylthiourea
phosphine
phosphorus (white, red, or yellow)
picric acid
piperidine
polybrominated biphenyls (PBBs)
polychlorinated biphenyls (PCBs)

S
sodium dichromate
sodium oxalate
sodium metal
sodium sulphide

T
thallium and its compounds
thioacetamide
toluene
thorium

V
vinyl chloride monomer

Z
zinc chromate

<u>Chemicals to be Used with Extreme Caution</u>

These chemicals should be used with great care.

A
acetamide
acetic anhydride
acetone
acids Alcohols
alkali metals
alkalis
alkanes
alkenes
ammonia
ammoniacal silver nitrate
ammonium nitrate
abrium and its compounds

B
boric acid

C
calcium
calcium hydride
calcium oxide (quicklime)
chlorates
copper compounds

D
dry ice

E
ethers

F
formic acid

H
hydrogen peroxide (30%)

I
iodine

K
ketones

M
metals (powdered)
mercury compounds
methane
methanol
methylene chloride

N
ninhydrin
nitrogen (liquid)

O
oxalic acid and its oxalates
oxygen (liquid)

P
permanganates
peroxide (inorganic and organic)
phosphorus compounds (binary) Potassium metal
potassium iodate

S
silver nitrate
silver nitrate in ammonia
sodium hydride
sodium nitrite
sulphur dioxide

X
xylenes

Chemical Storage

It is recommended that schools consult the Alberta document, Safety in the Science Classroom, the CBE manual, "Management of Chemicals and Hazardous Materials" or contact CBE Safety Advisory Services to ascertain the Provincial and local regulations and conditions which must be observed in regard to the storage of dangerous materials.

Chemical Storage Area

• Every science department should have a distinct secure chemical storage area that is separate from any work area. The entrance must not be gained by simply entering a classroom or a laboratory, but must be accessible to authorized personnel by means of a locked, self-closing door. A separate storage room for chemicals is the best means of providing safe and secure chemical storage. The chemical storage area must be maintained in a clean, neat and well organized manner.

• Storage areas should be power ventilated with a supply of fresh air to ensure the removal of all hazardous vapours. All storage areas should prevent the chemicals from being exposed to excessive temperature ranges and direct sunlight.

• Storage areas should contain the following:

- Corrosives cabinet (preferably two,, one for acids and one for bases)
- Flammables cabinet
- Refrigerator with freezer
- Brush and dustpan
- Disposal containers for both paper and glass
- Splash-proof safety goggles
- Fire extinguishers (5 lb. ABC type)
- Chemical spill clean-up kit
- Chemical safety reference material
- Chemical inventory and MSDSs
- Eyewash station
- First aid kit
- Safety step stool
- Schematic of room layout

- There should be no open flames, sources of sparks and localized heating units in a chemical storage area.
- The structural safety of storage shelves annually.
- All shelving units should be securely fastened to the wall or the floor. Do not store materials on top of wall-hung cupboards. Do not overload shelves. Crowded or warped shelves present a safety hazard.
- Large bottles, including all acids and bases, should be stored close to floor level, but not on the floor. Bottles of acids and bases should be stored in heavy duty plastic trays in order to limit the flow in the event of a bottle breaking or leaking.

Organizing Chemical Storage

• Chemicals are organized separately as solids and solutions.

• To provide a safe chemical storage environment, chemicals should be stored according to their WHMIS classification:

- Compressed gases
- Flammables
- Oxidizers
- Toxics and WHMIS not controlled (General storage)
- Corrosives
- Acidic
    - organic - solids
        - liquids (Flammable)
    - inorganic
- Alkaline
- Reactive
- and WHMIS Not Controlled and General Storage

Each group should have its own distinct storage area, separated from each other as much as possible, within the main storage area or storage room.

The incompatibility of a chemical must be determined before that chemical is put into storage.

Preserved specimens should not be stored in the chemical storage area. If the vapours from hydrochloric acid and formaldehyde combine, they form bischloromethyl ether. Bischloromethyl ether is a strong carcinogen at a concentration of 0.001 ppm.

	Acids, inorganic	Acids, oxidizing	Acids, organic	Alkalis (bases)	Oxidizers	Poisons, inorganic	Poisons, organic	Water-reactive	Organic solvents
Acids, inorganic			**X**	**X**		**X**	**X**	**X**	**X**
Acids, oxidizing			**X**	**X**		**X**	**X**	**X**	**X**
Acids, organic	**X**	**X**		**X**	**X**	**X**	**X**	**X**	
Alkalis (bases)	**X**	**X**	**X**				**X**	**X**	**X**
Oxidizers			**X**				**X**	**X**	**X**
Poisons, inorganic	**X**	**X**	**X**				**X**	**X**	**X**
Poisons, organic	**X**	**X**	**X**	**X**	**X**	**X**			
Water-reactive	**X**	**X**	**X**	**X**	**X**	**X**			
Organic solvents	**X**	**X**		**X**	**X**	**X**			

Compressed gases

Gas cylinders should not be stored in the chemical storage area since the valves could undergo corrosion.
Store gas cylinders in a cool dry place away from direct sunlight or localized heat (less than 50°C), open flames or sparks.
Empty gas cylinders should be labeled EMPTY. A small residual pressure must be maintained in an empty gas cylinder to minimize the possibility of air contamination.
Small cylinders of pressurized gas are expensive and often difficult to properly store. The “lecture sphere” is appropriate for most schools and is easily stored.
If small lecture cylinders are used they should be stored upright in the chemical storeroom.

Care should be taken to store these gases in their appropriate storage categories. Flammable gases should not be stored alongside oxygen.
If large cylinders are used they must be chained to the wall or to the cart designed for their transportation, with their protective caps on.

Flammables and Combustibles

FLAMMABLE LIQUIDS are defined as those liquids that have a flash point below 38°C.

COMBUSTIBLE LIQUIDS are defined as those liquids that have a flash point at or above 38°C.

A secondary science flammables cabinet will usually contain a shelf for:

- solid flammables/combustibles such as metal powders;
- liquid hydrocarbons such as alcohols, alkanes and alkenes;
- organic acids such as glacial acetic acid.

Flammable liquids should not be stored in a household refrigerator. The lights, switches and thermostats can serve as ignition sources. A "flammables" cabinet is the only type to be used.
Flammable materials should be stored in an approved ULC-C1275 vented flammable storage cabinet. This cabinet must be vented to the outside to prevent the build-up of explosive or toxic vapours.
The amount of flammable and combustible materials stored should be limited to a year's supply.
The maximum volume of flammable liquids to be stored in a room is 10 L maximum, of which no more than 4 L is Class 1 liquid (reference MSDS). Flammable liquids in excess of this amount may be stored in a room provided the room has no openings directly to public portions of the building
If liquids are stored in approved, closed containers only (not dispensed, processed, etc.), the room must have an ABC Class fire extinguisher.
If Class 1 liquids are stored in a room and dispensing, processing, etc. operations take place, the room must have continuous mechanical ventilation and ABC Class fire extinguisher. (Ventilation ducts are not to be used for any other ventilation or exhaust system.)
The screen in the mouth of approved metal containers is a spark-arresting device and **must not be removed.**

Oxidizers

An oxidizer is a chemical that causes or contributes to the combustion of another material by yielding oxygen or another oxidizing substance whether or not the material, is itself, combustible. Oxidizers may be solids, liquids, or gases. Typical oxidizers include chlorates, nitrates, permanganates and nitrites.

These materials present a fire and explosion hazard when in contact with organic or combustible materials.
The primary consideration in the storage of these materials is that they must be isolated from all flammable or combustible material.

Toxics

Toxic substances have the capacity to injure the body by direct chemical action.

Toxic chemicals may have other associated hazards (compressed gas, corrosive or flammable) and require the appropriate storage for that hazard.
Toxic chemicals without other hazards are for the most part not incompatible with other substances. Provided chemicals are being stored in a separate secure room, toxics may be stored with WHMIS not controlled substances on general storage shelves.
A separate locked cabinet for toxics must be used for storing toxics when there isn't a separate chemical storage room.

Corrosives

Corrosive chemicals are substances that are injurious to body tissues or corrosive to metals by direct chemical contact. Corrosive chemicals can be of any phase (gas, liquid, or solid).

Perhaps the most serious hazard associated with corrosives is from substances in the gas phase. These corrosives enter the body via absorption through the skin and by inhalation.

It is a mistake to think of corrosive solids as being relatively harmless because they can be removed more easily than liquids. Solid corrosives are usually rapidly dissolved by the moisture in the skin and even more rapidly by moisture in the respiratory and alimentary systems. For example, phenol is an ***extremely*** dangerous solid and should not be stored in schools.

The most familiar corrosive chemicals encountered in laboratories are acids and bases.

i) Acidic corrosives

a. Organic acids

Organic acids react with inorganic (mineral) acids and some are also flammable.
Solid organic acids are generally not flammable and can be stored on a separate designated chemical shelf.
Liquid organic acids are stored on separate shelf in the flammables cabinet or in a separate compartment isolated from inorganic acid fumes within a corrosives cabinet.

b. Inorganic acids

Nitric acid should be stored by itself, because of its tendency to react with many different chemicals including other acids;
Sulphuric acid is incompatible with hydrochloric acid;
Hydrochloric and phosphoric acids may be stored on the same shelf;

If not in a corrosives cabinet, acids should be stored on a shelf as close as possible to the floor, but not on the floor as they could be accidentally kicked.

ii) Alkaline corrosives

Bases should be stored in heavy duty plastic trays in order to limit the flow in the event of a bottle breaking or leaking;
When possible, concentrated alkaline solutions should be stored in a designated closed cupboard or alkaline corrosives cabinet.
Solid alkalines are stored on a separate designated shelf in the chemical storage area.

Acids act on body proteins causing denaturation and destruction of the protein structure. The denatured protein produces a protein barrier, which will limit the activity of the acid (although this is very painful). Bases however penetrate deeply with little or no pain and no protein barrier is produced, since the protein is completely broken down by the base. Therefore, bases can cause greater skin or eye damage than acids because the protein barrier formed by acids is not formed by bases.

CORROSIVE SOLIDS — the effects of solid corrosives are related to their solubility in skin moisture and to the duration of contact. Some examples are:

- Alkali Metal Hydroxides (eg. NaOH)
- Alkali Metal Carbonates (eg. Na_2CO_3)
- Alkali Metal Sulphides (eg. Na_2S)
- Alkaline Earth Hydroxides (eg. $Ca(OH)_2$)
  Elemental Alkali Metals (eg. Na)
- Trisodium Phosphate

Hazards of corrosive solids are:

- Solutions of corrosive solids are readily absorbed through the skin.
- Many solid corrosives can cause delayed injury.
- Corrosive alkalis may not produce immediately painful reactions.
- Dusting — many corrosive solids dust readily, which may then be inhaled.

It is a mistake to think of corrosive solids as being relatively harmless because they can be removed more easily than liquids. Actually, solid corrosives are usually rapidly dissolved by the moisture in the skin and even more rapidly by moisture in the respiratory and alimentary systems.

For example, phenol is an ***extremely*** dangerous solid and should not be stored in schools.

CORROSIVE GASES — Perhaps the most serious hazard associated with corrosives is from substances in the gas phase. These corrosives enter the body via absorption through the skin and by inhalation. Corrosive gases are grouped by solubility and effect upon the respiratory system. Be aware that the products of a reaction may include a corrosive gas.

GROUP I	HAZARD
Ammonia Hydrogen Chloride Formaldehyde	Very soluble; affects upper respiratory tract.
GROUP II	HAZARD
Iodine Sulphur Dioxide	Soluble; affects upper respiratory tract and bronchi.

The harmful effect of a corrosive gas is not a direct relationship between concentration and exposure duration. To make the problem worse, there are primary effects that can produce severe immediate damage and even death without causing systemic injuries. When evaluating possible effects it is necessary to consider the concentration, solubility and duration of exposure.

A common corrosive gas is ammonia. Corrosive substances may react with another material to give off corrosive, toxic and flammable gases, and may react to produce other hazardous substances.

Examples:

Hydrochloric Acid — Can liberate gases such as hydrogen, and hydrogen cyanide. With formaldehyde this produces chloromethoxychloromethane, a very potent carcinogen.

Nitric Acid — Can oxidize cellulose material, creating a self-igniting condition. Extremely exothermic when mixed with organic materials.

Sulphuric Acid — Powerful oxidizer. Can dehydrate organic material rapidly with the production of heat.

Perchloric Acid — Strong oxidant and dehydrating agent. Explodes on contact with many organic substances. **"Not allowed in science classrooms or science laboratories!"**

Halogens — Will support combustion, may ignite powdered metals (on contact). React violently with organic substances.

Principles of Corrosive Chemical First Aid

- In the event of contact with eyes, remove contact lenses if worn, then **immediately flush the eyes with water and continue to flush for 15 minutes**. Get medical attention if necessary. **The first few seconds after contact are critical.** Immediate flushing of the eyes may prevent permanent damage. An eyewash fountain is preferred; however, an eyewash hose or any other source of water should be used in an emergency. Remember, the one and only emergency treatment is to dilute the chemical immediately by complete flushing with water. The patient's eyelids may have to be forced open, so that the eyes may be flushed. Alkali (base) burns are usually more serious than acid burns.

- Strong chemicals burn the skin rapidly. There is no time to waste. Begin flushing the area with water immediately. Carefully remove and discard clothing including socks and shoes. Continue to flood the area, while clothing is being removed.

- The precautionary warning on the product label should be consulted for full first-aid information. Provide the label information to the attending physician.

- Neutralizers and solvents other than water should not be used by the first aide. The spread of a skin absorbing corrosive poison can result in death.

Protection

In all cases where a procedure involves a corrosive chemical, wear protective goggles. If corrosive gases or solids are involved where dusting may occur use the fume hood.

Reactive Chemicals

Reactive chemicals can be referred to as substances that will, under certain conditions, enter into violent reactions with spontaneous generation of large quantities of heat, light, gas or toxicants. They are to be avoided or used with extreme caution.

The types of reactive chemicals can be classified as follows:

> Explosives — substances which will decompose with such speed to cause rapid expansion of air, sometimes accompanied by burning gases and flying objects. Some substances are time sensitive in a dangerous manner. Many substances are oxidized by atmospheric oxygen. Ether may form explosive peroxides after sitting for varying periods of time. The containers should not be moved if there is any doubt about stability. **Explosives are NOT to be stored in schools nor isolated from reactions.**
>
> Acid Sensitive Chemicals — react with acids to release heat, hydrogen, explosive gases, and toxicants.
>
> Water Sensitive Chemicals — react with water to evolve heat and/or flammable or explosive gases. Very few are used in secondary schools. Store only what is necessary and label "Keep Away From Water". Water sensitive chemicals should be stored under mineral oil or in a shatter-proof desiccator as appropriate.
>
> Oxidation-Reduction — reactions can occur in any phase. The reactions tend to generate heat and are often explosive. Oxidizers and reducers must be stored separately.
>
> Pyrophoric Substances — burn when exposed to air. These are not to be stored nor used in schools.

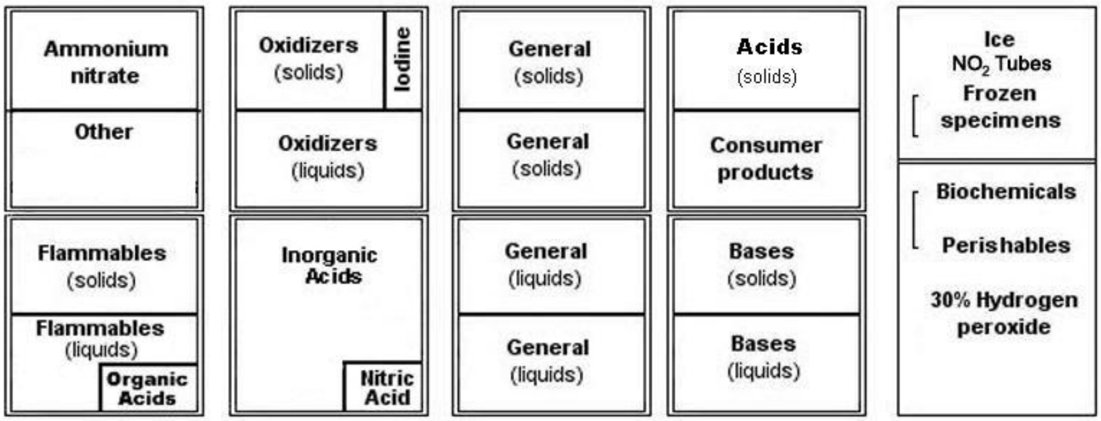
General Precautionary Measures

When dealing with reactive substances the following guidelines should be followed:

- Isolate reactive materials (refer to Chemical Storage).
- Have plenty of water available for flushing where water sensitive substances are *not* involved.
- Do not have water (extinguishers, sprinklers, etc.) in areas where water sensitive chemicals are stored.
- Store in a well-ventilated, cool, dry area and protect from sunlight.
- Label properly including the date received and opened, especially in the case of peroxidizable compounds.
- Protect from shock.
- Keep away from flammables.
- When handling, wear adequate protective equipment.
- Order only what you will use during the year. **Do not overstock**.
- Regularly discard old chemicals.

A Suggested Model for Chemical Storage

The following schematic indicates how the various classes of compounds might be separated:



• Electrical switches should be outside the door.
• Shelving should be adjustable.
• No chemicals should be stored higher than 2.5 metres. A safety stepstool should be used to access chemicals above eye level.
• Chemicals should not be stored more than several containers deep with adequate space to allow easy access. Never stack bottles on top of each other.

If a designated chemical storage room is not available:

The principles of proper chemical storage can still be maintained without a separate room.

- The room must be secure and adequately vented by an exhaust fan to prevent the accumulation of harmful vapours.
- A flammables cabinet should house the solvents and other flammable materials.
- Acid and alkaline solutions can be stored on corrosive resistant trays as close to the floor as possible.
- Poisons must be kept in a separate locked cabinet.
- Oxidizers should be kept on a separate shelves.
- This is a difficult system to adequately maintain. Good housekeeping is a constant problem when chemical storage is not housed in one, separate room.
- General miscellaneous chemicals can be alphabetical if not incompatible.

Disposal and Spill Management of Chemicals

(Refer to Administrative Regulations 8006.1 – Disposal of Hazardous Waste)

<u>NOTE:</u> For specifics about acceptable methods and practices for disposal of chemicals and biological materials, refer to the CBE manual "Management of Chemicals and Hazardous Materials" or contact CBE Safety Services.

Disposal

The disposal of waste chemicals and potentially hazardous materials is, by necessity, a common occurrence in school science laboratories. This section does not provide specific detailed information for the disposal of such materials. Rather, it attempts to indicate what resources the teacher or science technician can use to properly dispose of waste chemicals.

Dispose of wastes properly to protect yourself, others and the environment by using the following techniques:

a. dispose of broken glass in a specifically designated and labeled container, kept well below eye level.

b. dispose of chemicals by using these techniques:

1. neutralize acids and bases
2. precipitate and filter heavy metals
3. store flammable waste in labeled safety cans
4. heavy metal salts, evaporated by room temperature evaporation, should be kept in labeled containers until disposed of according to current practice
5. flush neutralized, soluble light metal salts down the drain.

Chemical Spills

The primary duty of the teacher when a chemical has been spilled is to ensure the safety of all students. Following this, the chemical waste must be disposed of as follows:

- Weak acids and bases (pH 5.5 - 10.0) can be flushed down sinks with large quantities of water. Small amounts of solvents can be evaporated in a fume hood. Small spills of poisonous or highly reactive materials must be dealt with responsibly.

- For spills of concentrated acid and base preparations (3M/L or above) commercial spill kits should be used. First attend to the needs of anyone who may have come in contact with the acid or base and then take quick action with the spilled material. The person cleaning up should protect his/her body with a face shield, rubber gloves, rubber boots, and a laboratory coat. Large spill kits can be used to absorb and neutralize the spill.

SAFETY IN PHYSICS

General

Most hazards encountered in the Physics laboratory deal with electricity and the handling of equipment. Additional hazards may be encountered in the use and handling of chemicals, radiation sources and other “specific” apparatus. The following practices will help create a safe environment for the study of Physics.

• Ensure that students are kept a safe distance from any demonstration that may project material, produce a flash, release fumes or has the possibility of explosions, implosions, splash or flame. Teachers must perform such demonstrations beforehand. The demonstration apparatus should be surrounded with mesh screens or shields where appropriate. If it is necessary for the teacher to remain close by the demonstration, the teacher should also use protective face and eyewear where appropriate.

• Secure any apparatus that could be hazardous if tipped over. This can be accomplished by means of stands, clamps and various types of holders.

• Electrical cords should be secured away from student traffic. Electrical devices should be disconnected from power supplies when not in use.

• Store all Physics apparatus away from any stored chemicals.

• Large or heavy equipment and apparatus should be stored appropriately close to the floor and should not be stored on top of any cupboard or shelving.

Low Pressure and Vacuum Apparatus

• Use round-bottomed, thick-walled flasks for reduced pressure activities — an Erlenmeyer flask should not be used for low pressure activities.

• Check all glassware for defects prior to being used for any laboratory activities.

• Shield the apparatus using an explosion shield in order to provide protection against implosion. Students must have eye protection during the demonstration or activity.

• Make every effort to protect all persons involved from: ultraviolet radiation, infrared radiation and/or x-rays. Use proper shielding and eye protection, energize equipment for a short period of time and avoid direct viewing of radiation sources.

• Handle fluorescent tubes with care. The tubes contain mercury and phosphor coated glass. The ballasts also contain hazardous materials that must be disposed of properly.

• Dispose f all vacuum tubes by using a canvas bag and a hammer, and then disposing of the remains along with other broken glass.

Flashing and Strobe Lights

• Check all strobe lights for possible electrical leakage and poor grounding. Since most strobe lights use a high voltage capacitor this check should be made before every use.

• Ensure that all persons are informed that a flashing light or strobe light will be used before any demonstration.
Flashing light may cause nausea, disorientation and headache. Certain frequencies of strobe light have been linked to epileptic seizures. Most people affected by flashing and strobe lights will know of its effect on them and the prior warning should avoid most problems. Most people find frequencies of three to seven Hertz (Hz) disturbing. These frequencies should be avoided.

Cathode Ray Tubes

• Read the manufacturer's specifications and instructions carefully.

• Do not use voltages in excess of 5kV.

• Inspect the glass before each use --- chipped or cracked tubes may implode.

Radio wave, microwave and infrared sources

• Read the manufacturer's specifications and instructions carefully.

• These sources are generally of low intensity and do not present a significant hazard.

• Inspect the apparatus before each use for damage.

• Hazards are related to "frequency of source", "intensity of source", "distance from the source" and the "time of exposure". Generally, intensity and time are very low in high school labs.

Microwaves.

• Read the manufacturer's specifications and instructions carefully.

• Do not use an unshielded microwave generator.

• Ensure that no one is exposed to a microwave intensity greater than 5 mow/cm^2. Note that a person can suffer tissue damage without being aware of it.

NOTE: Infrared and radio wave sources used in schools are usually of very low intensity and used only occasionally. If this practice continues, they do not appear to present a significant hazard. Any change in these conditions should be accompanied by precautions to reduce the exposure of students and teacher to radiation.

REFERENCE MATERIAL REGARDING SPECIFIC HAZARDS

Cryogenics

It is highly recommended that liquid nitrogen not be used!

<u>NOTE:</u> Cryogens are not normally required to meet the learner outcomes of junior or senior secondary science curricula, therefore, it is not anticipated that you will store them in your school.

Before a teacher is permitted to use cryogens in a CBE classroom, the teacher must prepare a written Safe Work Procedure and submit it to Safety Services for approval. This approval is for the school for any qualified teacher who uses the procedure as written and approved. The Safe Work Procedure must include the following information:

- A copy of the lab procedure including materials.
- Personal protective equipment being used for student and staff.
- Precautions that will be taken to minimize risk of accident/injury.

TDG training must be completed if the materials are being transported by the teacher (example: carbon dioxide is readily available from suppliers)
Safe handling and storage procedures for all materials from the time the materials arrive at the school until they are transported from the school.

If you do use cryogens for a special demonstration:

- Store in well ventilated areas;
- Use only approved storage vessels having pressure relief fitting;
- Avoid contact of moisture to prevent ice plugging relief devices;
- Keep all sources of ignition away.

<u>Rules for Handling</u>

- *Always* wear skin protection equipment (face shield, pot holder); gloves could be frozen to the skin.
- Use in a well-ventilated area.
- Do not allow containers to become plugged with ice.
- Use care in transporting.

Common cryogenic gases used in commercial laboratories are: hydrogen, oxygen, methane, nitrogen and fluorine. The handling and storage of all cryogens requires special attention and, because of their extremely cold nature, presents common hazards.

- **Pressure Build Up** — due to a high expansion rate on vaporization. If the mechanism for cooling cannot keep the cryogen in liquid phase, the internal pressure in the container increases so tremendously that an explosion is likely unless proper venting has been provided. For example, liquid methane expands to approximately 630 times its initial volume when it vaporizes.

- **Embrittlement of Structural Materials** — most materials experience some degree of embrittlement at these low temperatures. Living tissue can become frozen and so brittle it will break into pieces.

- **Contact with Tissue** — (Cryogenic burns) Cryogenic liquids, their gases and surfaces are a serious hazard to living tissues through frostbite or actual freezing. For example, cessation of circulation of blood occurs in the damaged area. The possibility of a blood clot forming is high. Subsequent normal circulation of blood may be prevented.

- **Fire and Explosions —** Cryogenic substances that are flammable present the same hazards as their gaseous form. The majority of liquid rocket propellants are cryogenic liquids.

- **Asphyxiation —** Even though a cryogenic liquid may not be toxic or corrosive, evaporation can release sufficient volume of the vapors to cause asphyxiation through displacement of air.

Eye Hazards

NOTE: Safety goggles must be worn in laboratories whenever there is the possibility of chemicals, materials or projectiles impacting the eye.

Goggles must be splash-proof and CSA approved. These can be purchased through CBE Stores. It is recommended that goggles be disinfected between uses. A disinfecting station could use cotton swabs and rubbing alcohol, or disinfecting wipes, or soap and warm water.

It is strongly suggested that all secondary schools offer students the opportunity to purchase their own CSA approved safety goggles for classroom use.

The eye is probably the most vulnerable portion of the body surface from an injury standpoint. It is also a most important link between the individual and the outside world. Every effort should be made to protect the eye.

Despite its defences, the eye is easily damaged. The eye is a complex, specialized organ that does not recover from injury as other tissues do. The eye possesses relatively few blood vessels. Consequently, injuries are much slower to heal and may not fully recover.

Foreign bodies present the most common danger to the eye. Particles can lodge on the surface of the eye where they are generally irritating, or sharp objects can penetrate deeply into the eye where they may cause no pain. Certain types of particles can be extremely damaging to the eye. For example, pure copper and iron particles, which might penetrate the eye, could result in the loss of sight because of their toxic effects on the tissue.

In the laboratory, flying glass, possibly from heating or breakage, can also cause severe eye injury.

The eye reacts differently to different chemical agents. If acid reaches the eye, the eye precipitates a protein barrier that reduces penetration of the acid into the eye tissue. On the other hand, caustic material in the eye is much more hazardous because the eye has no defense as with acid, and the caustic material readily penetrates into the eye tissue.

Laboratory procedures that can generate liquid droplets or splashes include pouring, stirring, blending, heating, and reaction of chemicals. Cleaning of glassware and breaking of containers can also cause chemicals to reach the eye.

The wearing of contact lenses in a laboratory situation is of special attention. Before classes begin, the teacher must be aware of all students who wear contact lenses. These students must pay special attention to wearing safety goggles whenever there is the risk of injury to the eye. A sample letter regarding contact lens use in the laboratory is located in the appendix section of this manual.

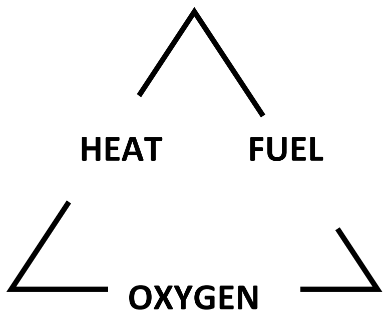
A basic tenet of any eye protection policy should be a statement such as:

"Approved eye protection must be worn at all times by everyone in a laboratory involving chemicals, explosive materials, compressed gases, hot liquids or solids, injurious radiation or other identifiable hazards such as glassware and projectiles."

Fire Prevention

Fire Awareness

BURNING is the rapid oxidation of a fuel by an oxidizer (usually air) with the liberation of heat and light. A fire can be started when sufficient energy is present to initiate the reaction. The process of burning involves the three interrelated components: fuel, oxidizer and energy source. These three components make up the fire triangle. Removal of at least one side of the fire triangle is the basis of fire control and safety.



A Fire Safety Program

Due to the frequent use of flammable materials in laboratories, the potential for severe personal injury and extensive property damage is very high. The goal of every science teacher should be to reduce the chance of fire to the lowest probability possible.

Elements of a successful fire control program include adequate education of individuals in the hazards of fire; the use of proper laboratory procedures; the maintenance of proper chemical storage facilities; and the provision and maintenance of effective fire control equipment.

Dealing with a small Fire

- In all cases of fire, pull fire alarm and evacuate.

Some Don'ts

- Don't throw water over a chemical fire.
- Don't use a fire extinguisher on standing beakers and flasks.
- Don't turn on water after a flaming container is placed in a sink.

Suggested Procedures

- Stock reasonable quantities of solvents.
- Rehearse experiments students will perform and use minimum quantities of materials.
- Store solvents in an approved fire resistant cabinet.
- Store oxidizers and reducers separately.

Sources of Fires

Fire has always been one of the hazards of laboratory operation. Laboratories make use of flammable materials including solids, liquids and gases. The following are among the more common sources of fire hazards encountered in school laboratories:

- ignition of solvent vapors
- ignition by reactive chemicals
- uncontrolled chemical reactions
- inadequate storage and disposal techniques
- heating due to electrical faults
- loose clothing and hair ignited by the Bunsen burner
- misuse of gas cylinders
- inadequate maintenance
- static electrical build-up
- inadequate laboratory design
- inadequate temperature control, especially in areas where solvents are stored

Fire Extinguishers

The type of fire and extinguisher used are related. Learn the different classes of fire and the proper extinguisher to use. An extinguisher may act on any of the three sides of the Fire Triangle, or all three of them, to extinguish the fire. Usually, however, an extinguisher either cools the area so a fire will not burn (remove energy source) or smothers the fire (remove oxidizer) or both.

Fires and Fire Extinguishers

FIRE CLASSIFICATION	FIRE SUPPRESSION
CLASS A — fires involving ordinary combustible materials such as wood, cloth paper	Water Dry chemical extinguisher can also be used
CLASS B — fires involving flammable liquids such as solvents, greases, gasoline and oil	Dry chemical foam, CO_2 (Carbon Dioxide)
CLASS C — fires involving electrical equipment.	Non-conducting agents such as dry chemical or carbon dioxide.
CLASS D — fires involving combustible metals such as magnesium, sodium, lithium, powdered zinc	Special dry powder medium or dry sand

Basic Requirements as to the Location and Condition of Fire Extinguishers

• Maintain in operable condition — a private contractor checks extinguishers in the CBE regularly.
• Never reuse a used extinguisher — have it recharged.
• Have all extinguishers clearly marked as to class and use.
• Locate conspicuously — have location marked with signs — preferably near an exit door.
• Mount at an accessible height.
• Check monthly.

Fire Safety Equipment

Every school laboratory should be equipped with the following firefighting devices:

- A suitable chemical spill kit.
- An adequate number of 5 kg ABC type dry chemical fire extinguishers.
- Teachers trained in the correct use of the appropriate equipment.

Fire Blankets

- Fire blankets are not used to extinguish a fire on a person but to smother a fire on a bench
- A student whose clothing has caught fire should stop, drop to the floor and roll around.

Insidious Hazards

Insidious hazards are conditions within the laboratory that represent potential health hazards and, because they are not usually conspicuous (seen, tasted, smelled, or felt) are easily overlooked and ignored. However, they may cause local or systemic, acute or chronic effects, depending upon the nature of the substance and duration of exposure. In addition, insidious hazards represent a type of problem that one may never be aware of until chronic, systemic poisoning has occurred. All too often insidious or hidden hazards are overlooked during routine safety inspections. Substances such as mercury, present in small droplets on a floor, can emit toxic vapor over a long period of time. Explosive perchlorates can form in fume hoods and ventilation systems.

Shock sensitive azide salts form in copper drainpipes, which are exposed to sodium azide solutions. Improperly sealed containers of toxic liquids such as carbon tetrachloride and leaking cylinders of toxic gases can poison the air. In fact, defective safety devices represent a category of insidious hazards.

NOTE: Mercury is not allowed in the science classroom or science laboratory!

The Mercury Hazard

One of the most common insidious hazards is mercury, not only in laboratories but also in homes. Mercury is widely used in such various items as electric switches, amalgams, boilers, barometers, thermometers, lamps, and cells. At one time, mercury compounds were common reagents found on many laboratory stock shelves. Its widespread use and hazardous nature has caused mercury to be often overlooked or ignored, even when its hazards are understood. It may be common practice to aspirate or sweep up any visible drops after an accident involving mercury, but many small droplets may be hidden in small cracks and crevices where they are left to evaporate into the atmosphere.

- Mercury is capable of forming explosive compounds, such as mercury fulminate.
- Its maximum permissible concentration (PC) is 0.05 mg/m^3 averaged over an 8-hour exposure.
- Its accumulated effect works on the gastrointestinal and central nervous system.
- One mL can increase the mercury level of millions of cubic meters of air to above the PC.

Other Insidious Hazards

In the laboratory, one common source of insidious hazards is the sink drain. If aqueous solutions are disposed of by flushing down the drain, this can lead to the build- up of toxic or other hazardous materials that may be released into the laboratory air upon contact with a catalyst. Some of the other insidious hazards include:

- Coal process products;
- Peroxide formed in old or improperly stored ethers;
- Mixed chemicals that can slowly react to form toxic products or build pressure
- Liquid chemicals in glass containers stored above eye level;
- Unlabeled chemicals;
- Reactive chemicals stored on the same shelf
- Ignition sources in flammable solvent areas,
  Contaminated laboratory aprons.

Control Measures for Insidious Hazards

- Maintain a list of insidious hazards.
- Provide adequate ventilation in the form of hoods and forced air (0.5 m/s);
- Do not allow stock build-up of toxic, flammable, oxidizers, or corrosive materials;

- Have efficient and appropriate clean up agents for spills;
- Have suitable disaster equipment available (extinguishers, respirators, etc.);
- Have an emergency plan in place that everyone is aware of.
- Have both an evacuation and an alternative evacuation plan in place.

Material Safety Data Sheets (MSDS)

Material Safety Data Sheets should be supplied with hazardous chemicals and may be requested for other chemicals. Teachers and students should be familiar with the type of information contained on MSDS and be able to interpret the sheets from a variety of chemical suppliers. More information about MSD sheets can be found in the CBE manual “Management of Chemicals and Hazardous Materials”, in the section on WHMIS.

Appendix 5 is a student activity designed to teach students how to interpret an MSD sheet.

Mechanical and Electrical Hazards

Mechanical and electrical hazards will seldom exist in a well-maintained laboratory. When commercially produced, approved equipment is in good working order with all protective devices and guards in place, there is little opportunity for an accident to occur.

Mechanical Hazards

• All **rotating machinery** — when guards, lids and covers are not in place over exposed shafts, belts, pulleys, loose clothing, hands and long hair can quickly get caught.

• **Use Of Tools (Including Glass Cutting Operations)** — Carelessly used tools and tools in poor condition are the source of many accidents resulting in crushed or cut fingers and hands, eye injuries, lesions and abrasions on arms, legs and head.

• **Heavy Equipment And Materials Stored Overhead** — An accident can cause "mechanical" injuries to the back, arms, legs and head if a heavy overhead item slips while being moved. Mechanical injuries are the result of excessive forces applied to the body.

• **Crowding Around Equipment That Is Running** — a crowded space near equipment means those students closest to the device have no place to move when an accident happens. Movement of some students in the group will often push others at the front against the equipment where they may be injured.

• **Leaving Unattended Equipment Running** — It is your responsibility to be near the equipment that you are using to warn others of any hazards. You must be ready to shut off equipment quickly if it breaks down or if an accident occurs.

• **Use of faulty Equipment and Tools** — Equipment and tools that do not operate as they should or contain weak points or damaged parts, may break and cause injury as they come apart, overheat and cause a fire, or contain an electrical short or uncovered conductor that could cause an electrical shock.

Electrical Hazards

• **Faulty Equipment** — Poor or broken connections (i.e. frayed connecting cords) may lead to overheating of the input lead or the device itself, or shorting of the circuit to some part of the equipment touched by people (i.e. the metal case). Damage to the equipment, or a fire or electrical shock may result. Any apparatus that produces a "tingle" should never be used and should be repaired immediately.

• **Improperly Used Equipment** — Equipment damage, overheating and, therefore, fire are possible if equipment is in prolonged use at power ratings greater than that for which the item was designed. Never use multiple plug adapters or remove the ground prong from a plug.

• **Installations and Modification That Do Not Meet Code Standards** — Code specifications are intended to provide safe access to electrical power. If changes or additions are needed in the existing system an electrician must make them. Improperly made alterations can present a fire or electrical shock hazard if excessive current can flow in the new circuits, or if connections are not properly made and insulated. Use only equipment that has CSA approval.

• **Electric Equipment Used Near Water** — If equipment that is not properly insulated and grounded is used near water (i.e. near sinks) there is a danger of electric shock. Never touch an electrical apparatus and a plumbing fixture at the same time.

• **High Voltage Equipment (including Tesla coils and charted capacitors**) — Student-wired laboratory set-ups and teacher-made demonstration equipment frequently have exposed connections that present a very real danger of electrical shock when high voltages are being used (i.e. the connection of a high voltage source to a gas discharge tube). Ensure all high voltage terminals on all transformers, power supplies, induction coils, etc., are labeled.

• **Liquid Spills on Electric Equipment** — If liquid spills on the equipment, replace it with dry equipment. Ensure that it is thoroughly dried before it is used again.

• **Use of Extension Cords** — Avoid using extension cords. If one is to be used, ensure it is in good repair and has the proper rating for the intended use. Do not pull on cords to remove plugs from sockets; pull on the plug.

• **Maximum Voltage in Laboratory Experiments** — Use a maximum of 20V in laboratory experiments. If this needs to be exceeded ensure that there is direct teacher supervision and, if possible, a limiting load resistance in the power supply.

• **Reaction to Electric Current and Shock** — Each individual reacts differently to electrical current and shock. Great care must be taken to shield high voltage-low current equipment, such as a Van de Graft Apparatus. It is never safe for anyone to receive electrical current or shock.

• **Air Tables** — are commonly used, and present a shock hazard to students.

• **Live Electrical Connections** — Make the live connection, when wiring an electrical circuit, the last act in assembling and the first act in disassembling. Disconnect the power source before making any circuit changes. Avoid bringing both hands in contact with the "live" sections of the circuit.

• **Use of Isolation Transformers** — The use of an isolation transformer is recommended for 120V AC teacher demonstrations. Since only one wire from a standard 120V AC need be touched to produce a possibly fatal result, an isolation transformer should be used in demonstrations with exposed circuit components, such as conductivity testing.

• **Electric Apparatus and Flammable Fluids** — Use electrical apparatus away from flammable liquids. Heat or a spark generated by such apparatus could easily ignite such liquids. Never store electrical equipment near corrosive or flammable substances; unnecessary damage may occur.

• **Short Circuiting Batteries** — Avoid short circuiting batteries. Hazards could result from the generation of heat and vapors causing burns, toxic and corrosive fumes and explosions.

• **Storage of Electrical Equipment** — Use extreme caution when touching and storing electrical equipment immediately after use — the heat build-up may be hazardous.

• **Plugs and Sockets** — Insert and remove plugs from sockets by holding the plug so that any flashback will not burn the palm of the hand.

• **Electrical Accidents** — If a student is suffering an electric shock, **DO NOT TOUCH** the student. The victim must be disconnected from the power supply by a rescuer who is insulated from the electric current, or the current must be shut off before the victim can safely be touched.

Appendix 6 is a student handout outlining good mechanical and electrical practices.

Radiation Hazards

"If there are any questions about the levels of radiation that are acceptable or which radiation emitting devices are acceptable, contact the CBE Safety Advisory Services for clarification."

Radiation is everywhere. Today, with more electronic equipment and a greater variety of experimental procedures, including nuclear experiments, an increase in radiation sources exists in the school laboratory. Radiation is a hidden hazard because its presence is not perceived by our senses. Radiation is capable of causing a variety of biological damage with results ranging from no observable effects to serious disability and death.

Radiation is the emission of energy from a substance. The energy can pass through space and be reflected or absorbed, or may pass through a receiving substance. The form that radiation takes may be particulate or electromagnetic wave (or photon). The emission of radiation can be a spontaneous event or the results of some stimulation of the source materials by its interaction with another source of energy.

In ordinary discussion, "radiation" and "radioactivity" are often used as interchangeable terms. Radioactivity is just one case covered by the general term "radiation", which includes the following forms, divided into two classes:

Ionizing Radiation	Non-Ionizing Radiation
X-rays **Cathode rays** **Radioactivity:** alpha particles beta particles neutron particles) gamma rays	**Ultra-violet light** **Visible light** (including spectroscopic sources such as mercury, hydrogen, iodine, and sodium vapor discharge tubes) **Infra-red light** **Microwaves** **Radio waves**

When absorbed, ionizing radiation causes atoms in the receiving materials to lose electrons — to become ionized. The result is a drastic alteration of the chemical activity of the atom and, therefore, a change in the nature of any molecule containing the ionized atom. In general, the high energy of short wavelength electromagnetic waves or high velocity particles is required to cause the ionization of most atoms, especially when they are combined in molecules. The generally lower energy, longer wavelength, non-Ionizing radiation can be absorbed by molecules resulting in heat (an increase in their kinetic energy) rather than causing atoms to lose electrons. This increase in kinetic energy of the molecules sometimes results in an alteration or destruction of the molecule. The effect is dependent upon the energy intensity of the radiation, as well as its form (particle or wave), some overlap in the "Ionizing" and "non-Ionizing" classes can exist.

<u>Where do the Hazards Exist?</u>

Ionizing Radiation

Radioactive Isotope Samples — Low intensity sources of radioactive isotopes that may be purchased include metal discs containing small amounts of the radioisotopes of uranium and thorium and crystalline compounds of the radioisotopes of uranium, thorium, potassium, and rubidium. Uranium and thorium emit alpha, beta, and gamma radiation; potassium and rubidium emit beta and gamma radiation. The metal discs, when unshielded, should not come in contact with bare skin. The powders of the crystalline compounds must be well contained to prevent spilling on skin, clothing, or work surfaces and to prevent escape into the air where they can contact skin or be inhaled. Powders are most easily contained if they are kept slightly damp.

Vacuum and Discharge Tubes — Cathode Ray Tubes operating at accelerating voltages > 5 kV may emit cathode rays capable of producing tissue damage. In addition, X-rays can result from the operation of any vacuum tube or gaseous discharge tube operated at voltages > 5 KV. In the absence of any specific information about cathode ray and X-ray emission from the equipment used, keep operating voltages as low as possible with 5 kV as the maximum.

Non-Ionizing Radiation

Ultra-Violet Lamps and Electric Arcs — Ultra-violet lamps, such as those used to detect the presence of certain compounds by their fluorescence, must be used in such a way that the source can never be looked at directly. Electric arcs produce very high intensities of ultra-violet light and must never be used as an open source. If an arc is used to provide intense visible light, it must be enclosed except for an exit pupil where a filter can be used to absorb ultra-violet light from the desired visible light beam.

Lasers — The beam of light from even low power lasers, when focused by the lens of the eye, can cause severe retinal damage with very brief exposure. Before lasers are used in the classroom, teachers should instruct students about the acceptable use of a laser and the potential hazards associated with their use. Lasers must be used under the close direction of a teacher, in a well-lit room so that the pupils of the eye are small, and only when positioned in such a way that the beam cannot enter anyone's eye, either directly or by reflection. It should also be noted that the direct or reflected viewing of any intense visible light source (e.g. electric arc, burning magnesium ribbon, the sun, collimated or focused beams from ordinary tungsten lights) can cause retinal damage.

Microwave Generators — The microwave radiation generators used in school laboratories are low intensity. However, there is an indication that exposure to low intensity microwaves may have biological and psychological effects. Since these generators are a radiation source that is absorbed by tissue, care should be taken to minimize the exposure. Prevent access to the beam by shielding its path or restricting admittance to the area through which the beam passes.

Microwave ovens used in cafeterias, Home Economics and Science laboratories may present a hazard if faulty, or if tight closing of the door is prevented. They should be checked for microwave emission every three to six months.

NOTE: Infrared and radio wave sources used in schools are usually of very low intensity and used only occasionally. If this practice continues, they do not appear to present a significant hazard. Any change in these conditions should be accompanied by precautions to reduce the exposure of students and teacher to the radiation.

A Radiation Protection Policy

Most of the radiation hazards in schools are of an insidious nature. Therefore, protection of staff and students from exposure to radiation will require careful planning of experimental set-ups and procedures and the maintenance of all radiation sources in good order. All potentially hazardous equipment and materials must be available for use only under the direct supervision of a teacher familiar with the safe use of the item. The onus is on the teacher to be aware of potential dangers and to convey this information to the students. The teacher must instruct students in proper operating and handling procedures and must insist that they be followed. You will find a student handout about Radiation Protection as Appendix 7.

The aim of safe procedures for handling radiation sources is to do everything possible to reduce the exposure to radiation at all times. Three general principles can be used to minimize exposure:

• At all times stay as far from the source as possible. For collimated and focused beams of radiation, always stay out of the beam path. For non-collimated emissions, the intensity is inversely proportional to the square of the distance between you and the source. **Distance** is the best and often simplest protection.

• Know what kind of **shielding** is effective in absorbing the radiation, and use it.

• Keep the **time** for potential exposure at a minimum. In most cases, your body is capable of quickly repairing, or compensating for, many small amounts of physiological damage spread over a long time. However, its reparability can be overcome if the same total amount of damage is done during one continuous interval.

Rocketry Hazards

If Rocketry is being considered as an activity involving students, either directly or as a demonstration, procedures and steps that satisfy the Principal, Insurance/Risk Management and Safety Services Units must be followed to ensure the safety and security of all present, to include students, teachers, and volunteers. As the teacher carries out the curriculum connections audit, they must also complete a safety audit of the activity. It must also be noted that solid fuel rockets are not to be fired from Calgary Board of Education property and that permission to go off-site for such an activity must be approved through the Duty of Care Unit. The teachers involved must be qualified and must have received training in rocketry safety.

Toxic Hazards

A toxic substance has the potential to cause injury by direct chemical action with body systems. Almost any substance is toxic when taken in excess of "tolerable" limits. Toxic substances include corrosive as well as poisonous materials.

Toxic materials can enter the body in four ways:

- **Inhalation** — breathing in poisonous or corrosive vapors and dust is by far the most common route by which toxic materials enter the body.
- **Ingestion** — swallowing liquid or solid toxic materials.
- **Direct Entry to the Blood Stream** — chemicals in open wounds may be rapidly distributed throughout the body (direct injection through punctures can occur).
- **Contact** — absorption of toxic materials through skin, mucous membrane, and eyes.

The effects of corrosive materials are usually rapid but the effects of poison may not be immediately noticed. In fact, many substances (i.e. arsenic and mercury) are cumulative and poisoning can be the result of several exposures over a period of time.

Poisoning **may** be suspected when any of the following are evident and access to poisons is possible:

- Strange odor on the breath
- Discoloration of lips and mouth
- Unconsciousness, confusion or sudden illness
- Pain or burning sensation of the throat;
- Open bottles or packages of drugs or poisonous chemicals found in the presence of students.

Toxic materials damage the body by interfering with the functions of cells in body tissue. The damage can occur as the destruction of tissue by direct corrosive action (i.e. NaOH contact with skin), interference with chemical reactions of the body (i.e. CO replaces O_2 in hemoglobin), disruption of biological processes (i.e. NO_2 causes pulmonary edema, and allergic responses).

Toxic effects can be local or systemic as well as acute or chronic. Local effects are confined to the area of the body that has come in contact with toxic materials. Systemic effects occur throughout the body after absorption into the bloodstream. Acute effects are more or less immediate while chronic effects may take many years before they become evident.

The potential for contact with toxic materials exists in many areas of the school curriculum and extracurricular activities. Chemistry experiments are the most obvious situations with potential hazards. However, a person may be exposed to toxic substances from unsuspected sources. Toxic materials may be involved incidentally as part of a laboratory or demonstration procedure.

Careful consideration must be given to all materials used and produced in an activity. For example, the dust of heavy metal minerals may be inhaled during the breaking of rock samples. Inadequate clean up can lead to exposure to toxic materials after a laboratory procedure is finished. The next person working with the articles may contact substances left on benches, beakers and bottles. Students may ingest toxic materials they have been in contact with if they do not wash very thoroughly before eating or smoking. Foods and beverages readily absorb many vapors and must not be brought into a laboratory.

A Toxic Materials Protection Program

Accident prevention will depend on forethought, identification of hazards, alert observation of student behavior, and careful instruction of the students. The onus is on the teacher to be aware of potential dangers and convey this information to students.

NOTE:

The teacher must instruct students in proper handling procedures and must insist that they be followed. The acquisition, use and storage of toxic materials must be considered with safety in mind. The safest alternative, in activities and in materials, should be used. Toxic materials should be used only when there is adequate protection from exposure. Minimum quantities only should be stored. Stock bottles should not be allowed into the laboratory.

Hazardous Situations

- **Handling toxic materials from open containers** — vapors, dust, liquids can easily escape during normal handling.
- **Heating toxic materials** — fumes and vapors may be released in much greater quantity when material is hot.
- **Creating dusts of toxic materials** — crushing and grinding solids, transferring powders may release dust into the air.
- **Use of toxic materials in areas without adequate ventilation** — toxic gases can rapidly accumulate to dangerous levels in a room, or part of a room that does not have a constant replacement of contaminated air. Toxic vapors can be in high concentration immediately above an open bottle even in well ventilated rooms — no one should lean over a bottle.
- **Storage of toxic materials without proper ventilation** — dangerous levels of toxic substances accumulate in the air and on surfaces in closed, unventilated storage areas.
- **Storage of toxic materials without proper hazard identification** — the hazards must be clearly seen and understood every time a substance is used in order to avoid dangerous mistakes. WHMIS labeling must be used.
- **Use of toxic materials without proper protective gear** — skin contact with hazardous materials and inhalation of toxic vapors must be prevented by the use of correct clothing, face protection, fume hoods or respirators.
- **Storing or consuming food and beverages (including coffee), chewing gum and smoking in an area where toxic materials are used** — food, beverage and cigarettes can readily absorb toxic vapors or become contaminated with unseen toxic dust. Poisons may be transferred from hands to food and cigarettes.

NOTE: Odors and appearance are not reliable guides to the toxicity of substances. Many toxic vapors have little or no odor, even in dangerous concentrations.

* * * * *

APPENDICES

APPENDIX #1: Contact Lens Letter

Dear Parent:

The wearing of contact lenses in some laboratory environments can pose a danger to the eyes and/or the contact lens. Some chemical companies and universities forbid the use of contact lenses even when protected by safety goggles. Listed below are some facts to be considered concerning contact lens use in the laboratory environment.

1. Should an accident occur which involves splashing chemicals into the eye, the contact lens may hold the chemical in the eye.

2. In such an accident as described above, the time it takes to remove the contact lens is added to the time before washing and/or medication can be administered.

3. Soft contact lenses may increase the risk because they may pick up chemicals which enter the air as fumes. In such cases damage may occur to the contact lens, if not to the eye.

In spite of the above facts, there are teachers and professors who have continued to wear contact lenses in the laboratory and have not experienced any difficulty. We realize also that some students may not have glasses to wear instead of lenses. The decision to wear or not wear contact lenses in the laboratory should, therefore, be that of the students and the parents. Of course, all students must wear safety goggles in certain activities, even if they wear contact lenses or prescription glasses.

Please check the appropriate choice below, sign and return to your son/daughter's teacher. Whatever your decision should be, it is up to your son/daughter to follow your choice. Contact the teacher immediately if you have questions about the information supplied in this letter.

_____ My son/daughter does not wear contact lenses and will wear goggles during labs.

_____ My son / daughter will wear contact lenses under goggles during every lab.

_____ My son/daughter will occasionally wear contact lenses during labs and will also wear goggles during labs.

_____ My son/daughter will remove contact lenses prior to a lab and will wear glasses under goggles.

Student Name: ______________________________

Parent/Guardian Signature: ______________________________

APPENDIX #2: Student Science Safety Guidelines

Your personal safety and the safety of those around you are determined by the care with which you follow some general guidelines for safety in the laboratory. Remember that accidents can be prevented by using common sense and attention to the experiment and your teacher's instructions at all times.

1. Notify your teacher if you wear contact lens or if you have any medical concerns.
2. Know the location and use of the;
   - first aid kit
   - eye wash station
   - fire blanket
   - acid/base neutralizers
   - fire extinguisher
   - MSDS binders
   - broken glass container
   - emergency gas shut-off
3. Come to the lab properly dressed for laboratory work; i.e. no loose clothing (jackets, scarves, baggy or excessively long sleeves), no skin showing on your feet, long hair tied back, no dangling jewelry. Some hair products are very flammable; avoid using them the day of a lab requiring you to use an open flame.
4. Come to each lab fully prepared for the work you will do; complete pre-lab work your teacher has assigned.
5. Always keep your working area clean and uncluttered. Bring only what you need to your lab bench.
6. Always wear eye protection (approved safety goggles), and aprons when doing an experiment involving chemicals or heating, and do not remove them until instructed to do so by your teacher. Wearing eye protection also applies anytime there is a danger from fine dust, fumes, mists, sprays, or impact due to glass breakage.
7. Check the label on a bottle containing a chemical before using it. Note WHMIS specifications on the label of the container.
8. If you are diluting acids, remember to always add the acid to water.
9. Never:
   - Taste chemicals.
   - Leave a flame unattended even for a moment.
   - Pour a flammable liquid near an open flame.
   - Use a flammable liquid near an open flame.
   - Perform an unauthorized experiment.
   - Remove any equipment or chemicals from the laboratory without the permission of your teacher.
   - Handle hot glass with bare hands.
   - Pull out electrical cords by the plug
10. If there is a chemical spill, notify your teacher immediately. Do not clean it up yourself.
11. When heating the contents of a test tube, keep the test tube tilted and moving slowly back and forth through the flame. The open end of the test tube should be pointed away from yourself and your classmates.
12. Do not pipette or scoop out of a stock bottle. Never return unused reagents to a stock bottle. Ask you teacher what to do with unused chemicals.

13. When required to smell chemicals, waft the air above the substance to your nose. Never place your nose directly above the substance you are sniffing.
14. Notify your instructor of any defective equipment.
15... Report every accident, no matter how minor the accident seems to you.
16. Dispose of all chemicals, specimens, materials and broken glass as instructed by your teacher. If in doubt, ask.
17. Always wash your hands with soap and water after performing an experiment.
18. When you have completed an activity, return CLEAN equipment and glassware to its proper storage area. Be sure work bench is clean and free of spills as well.
19. Know and follow WHMIS regulations.
20. No food or drink of any description should be in the room while a lab is in progress.
21. Never perform any unauthorized labs or activities in the lab room.
22. Only operate gas valves during lab time IF and WHEN NEEDED

APPENDIX #3: Student Safety Contract

1. I have received instructions on safety in the laboratory, including the location and use of the safety equipment.

2. I have read and I understand the Laboratory Safety Guidelines and my responsibilities in making my lab work as safe as is possible.

3. I have included the Science Student Safety Guidelines in my notes.

4. I have agreed to abide by the Science Student Safety Guidelines for my own safety and for the safety of those around me.

5. I will include the specific lab safety instructions, provided by my teacher for each lab activity, in my lab reports.

5. I understand that failure to observe the Science Student Safety Guidelines, or the teacher's instructions, may result in my laboratory privileges being suspended for a period of time.

6. I understand that I can be held responsible for careless and unsafe practices on my part that cause harm to others and/or damage to the property of others.

7. I will follow all verbal and print instructions provided by my teacher for each activity.

Student Name: (please print) Last ______________________ First ________________

Daytime parent telephone number for emergencies: work_________________cell: ____________

Do you wear contact lenses regularly? _____ occasionally? _____

If so, what type?____

Medical concerns to be aware of (allergies, restrictions): __________________________

____

Are there any science lab activities that you choose to not participate in because of religious beliefs or health issues? If 'yes' please identify:

____

Teacher: ____

Course: ____

Student Signature: ___________________________________ Date: ________________

Parent/Guardian Signature: ____________________________ Date: ________________

APPENDIX #4: General Science Safety Guidelines

Recommended <u>General</u> Safety Practices with Students for Science Teachers

- Implement all aspects of WHMIS including labeling, MSDS and education.
- Secure any equipment that could be hazardous if tipped over.
- Surround apparatus with safety shields or mesh screens whenever there is the possibility of combustion, splash, explosion or implosion.
- Always use equipment for the purpose for which it was designed.
- Organize for learning in the following manner:
    - Enforce the safety policies with students.
    - Model safe lab practices to students (wear a lab coat, wear safety goggles, no food or drink in the lab, etc.)
    - Limit traffic in the laboratory - minimize movement from laboratory stations during experiments; ensure a clear path to eye wash stations, sinks and waste containers.
    - Organize student stations to have necessary equipment handy, or give clear instructions about the locations of equipment student may use. Place tall or glass objects, like thermometers, graduated cylinders or flasks, away from desk edges.
    - Collect completed safety contract and contact lens letter information from every student, every semester, in every course before any lab work is done. These must be stored by the school for three years.

Recommended Chemistry Instruction Practices for Science Teachers

- Before starting any activity, personally review the MSDS for each chemical that will be used or produced during the activity.
- Wear all the safety equipment that is necessary for the chemicals being used and insist on the same for your students.
- Avoid moving equipment and supplies such as chemicals, glassware, and gas cylinders through crowded hallways. Class change times or other periods of heavy traffic should be avoided whenever possible.
- Limit the amount of each chemical used in the laboratory. Use micro techniques and equipment whenever possible. Avoid having stock bottles of chemicals in the laboratory. Never use them for the dispensing of individual quantities.
- Keep all chemicals that are to be used in the laboratory in labeled, closed containers. Use chemical-resistant, plastic containers whenever possible for chemicals. Use labeled squeeze or plastic dropping bottles for the dispensing of small quantities of liquids.
- Use different labeled spatulas, dropper or pipette for different chemicals. Never use the same spatula, dropper or pipette to obtain different chemicals. Close the chemical container immediately after use.
- The teacher should personally dispense all potentially dangerous chemicals to students.
- Avoid tasting or smelling chemicals. Ensure that you are aware of the full consequences if it is deemed necessary to taste or smell a chemical. Instruct students to use correct techniques where tasting or smelling are a required part of the lab exercise.
- Use fume hoods whenever flammable, irritating, noxious or harmful gases are involved in an activity. All dilutions of concentrated chemicals should take place in a fume hood.

- Avoid the use of contact lenses when in the chemistry laboratory. They are not a substitute for eye protection and they may add to the hazard of using chemicals, such as corrosive water soluble vapors.
- Add chemicals to water, **NEVER add** water to chemicals!
- Dispose of chemical products in the proper manner, as per CBE guidelines.

Teacher Instructions to Students in the Handling of Biological Specimens

- While dissecting animals, use a sharp scalpel or scissors, and always cut away from yourself and wear gloves.
- Handle animals and plants with care. Always wash your hands thoroughly after working with plants and animals.
- Cultures of microorganisms must be handled carefully, follow teacher instructions
- **Do not** prepare cultures of human cheek cells or other tissues. Use prepared slides instead.
- Never return unused chemicals to the stock bottles. Dispose of appropriately.
- Keep a clean laboratory area. Clean up all spills immediately. For large spills use a Spill Clean-Up Kit. Wash the laboratory bench immediately after each experiment.
- Wash hands with soap and water immediately after handling a chemical. Long term exposure to any chemical should be avoided.

Safe Disposal Techniques for Teachers.

Remember to have labeled waste disposal containers available for students so chemicals are not poured down the drain. Complete disposal information is located in the current CBE manual "The Management of Chemicals and Hazardous Materials". Follow recommended guidelines for disposal of all chemicals.

Fire in a Laboratory

Should a fire occur, follow your school fire plan. More complete information regarding fires can be found in the Fire Prevention section.

Contain harmful Gases

Plan to contain and neutralize harmful gases by using properly vented, closed systems.

Use Personal Protective Devices

The teacher must be a role model in the use of personal protective devices. It must be ensured that students wear such equipment as instructed. Do not allow loose-sleeved clothing, bare feet, or bare skin on the feet. Tie back long hair and remove dangling jewelry.

Be Aware of Student Health Problems

Consider student health problems such as allergies, impaired vision, limited mobility and epilepsy. Discourage the use of contact lenses in classrooms where corrosive vapors are being used.

Maintain Good Housekeeping

Teachers and students should have uncluttered, organized workstations. Housekeeping should also extend to the storage rooms and in the laboratory in general.

NOTE: Students should always alert the teacher in case of an accident.

APPENDIX #5: Material Safety Data Sheets: Student Activity

OBJECTIVE: To be able to read and to interpret an MSDS.

MATERIALS:

1. Transparencies of a blank MSDS, and one for copper (II) sulphate (optional)
2. One set per student or group of 2-3 of:
   a. Blank MSDS (included)
   b. MSDS for sodium hydroxide (included)
   c. MSDS for sodium hydroxide from present supplier,if available

PROCEDURE:

1. Have students examine a blank MSDS, noting the details of each of the nine sections.

2. You may wish to assign specific chemicals to each student or group and have them complete the blank MSDS, then report to class. One recommendation is to have students select a chemical from the list of the top 50 chemicals produced in the world, by mass (use a web search engine to acquire this list).

3. Examine the MSDS for sodium hydroxide with the class. Discuss the need for each section and note the comments for this chemical in each section. If you have a copy of an actual MSDS from your current supplier it may be interesting to compare the two in terms of the detail presented.

4. When students have completed examination of the MSDS, the teacher may wish to ask questions such as:
   a. What is the common name for sodium hydroxide? (caustic soda)
   b. Section 3 says that sodium hydroxide is hygroscopic. What does this mean?
   c. Why is this a problem when using it in a lab?
   d. How can sodium hydroxide enter your body, according to the MSDS?
   e. If a student is conducting a lab and splashed some sodium hydroxide in his eye, would that be a problem? Describe the danger. How is the danger magnified when splashed into an eye wearing a contact lens? What should the teacher and student do to treat the eye?
   f. If the lab required the use of an open flame, what precautions should be taken? Using sodium hydroxide near an open flame?
   g. Does sodium hydroxide react with other substances? Give an example.

5. Using a transparency of an MSDS for copper (II) sulphate, the teacher should question students to determine if they know how to read the chemical name, know conditions to avoid, know health and fire hazards, and recognize special precautions when using this chemical.

Sodium Hydroxide

Section 1: Product and Company Identification

Sodium Hydroxide

Synonyms/General Names: Caustic Soda, Lye
Product Use: For educational use only
Manufacturer: JonesChemical Industries, Inc., Jonesville, AB.

24 Hour Emergency Information Telephone Numbers

CHEMTREC (USA): 800-424-9300 **CANUTEC (Canada): 613-424-6666**

Smithville Chemistry; 123 4th street Edmonton (800) 800-8000; www.sodiumhydroxide.com

Section 2: Hazards Identification

White pellets, flakes or beads, no odour.

WARNING! Strongly corrosive to body tissue and moderately toxic by ingestion.
Large amount of heat released when mixing with water.
Target organs: Respiratory and gastrointestinal system, eyes, skin.

HMIS (0 to 4)	
Health	3
Fire Hazard	0
Reactivity	3

This material is considered hazardous by the OSHA Hazard Communication Standard (29 CFR 1910.1200).

Section 3: Composition / Information on Ingredients

Sodium Hydroxide (1310-73-2), >99%

Section 4: First Aid Measures

Always seek professional medical attention after first aid measures are provided.

Eyes: Immediately flush eyes with excess water for 15 minutes, lifting lower and upper eyelids occasionally.
Skin: Immediately flush skin with excess water for 15 minutes while removing contaminated clothing.
Ingestion: Call Poison Control immediately. ***Do not induce vomiting***. Rinse mouth with cold water. Give victim 1-2 cups of water or milk to drink.
Inhalation: Remove to fresh air. If not breathing, give artificial respiration.

Section 5: Fire Fighting Measures

Noncombustible solid. When heated to decomposition, emits acrid fumes of sodium oxides.
Protective equipment and precautions for firefighters: Use foam or dry chemical to extinguish fire. Firefighters should wear full firefighting turn-out gear and respiratory protection (SCBA). Cool container with water spray. Material is not sensitive to mechanical impact or static discharge.

Section 6: Accidental Release Measures

Use personal protection recommended in Section 8. Isolate the hazard area and deny entry to unnecessary and unprotected personnel. Sweep up spill and place in sealed bag or container for disposal. Wash spill area after pickup is complete. See Section 13 for disposal information.

Section 7: Handling and Storage White

Handling: Use with adequate ventilation and do not breathe dust or vapour. Avoid contact with skin, eyes, or clothing. Wash hands thoroughly after handling.
Storage: Store in Corrosive Area [White Storage] with other corrosive items. Store in a dedicated corrosive cabinet. Store in a cool, dry, well-ventilated, locked store room away from incompatible materials.

Section 8: Exposure Controls / Personal Protection

Use ventilation to keep airborne concentrations below exposure limits. Have approved eyewash facility, safety shower, and fire extinguishers readily available. Wear chemical splash goggles and chemical resistant clothing such as gloves and aprons. Wash hands thoroughly after handling material and before eating or drinking. Use NIOSH-approved respirator with a dust cartridge.
Exposure guidelines Sodium Hydroxide: OSHA PEL: 2 mg.m^3 and ACGIH TLV: N/A, STEL: 2 mg/m^3 ceiling.

Section 9: Physical and Chemical Properties

Molecular formula	NaOH.	**Appearance**	White pellets, flakes or beads.
Molecular weight	40.00.	**Odor**	No odor.
Specific Gravity	2.13 g/mL @ 20°C.	**Odor Threshold**	N/A.
Vapor Density (air=1)	3.4.	**Solubility**	Completely soluble in water.
Melting Point	323°C.	**Evaporation rate**	N/A. *(Butyl acetate = 1).*
Boiling Point/Range	1388°C.	**Partition Coefficient**	N/A. *(log P_{OW}).*
Vapor Pressure (20°C)	N/A.	**pH**	14, very basic, (corrosive).
Flash Point:	N/A.	**LEL**	N/A.
Autoignition Temp.:	N/A.	**UEL** N/A.	

Section 10: Stability and Reactivity

Avoid heat and ignition sources. Preparing aqueous solution generates excessive heat – use care when mixing with water.
Stability: Stable under normal conditions of use and storage.
Incompatibility: Acids, organic compounds, metals, moisture.
Shelf life: Indefinite if container kept tightly closed. Will absorb moisture.

Section 11: Toxicology Information

Acute Symptoms/Signs of exposure: *Eyes*: Redness, tearing, itching, burning, damage to cornea, conjunctivitis, loss of vision.
Skin: Redness, blistering, burning, itching, tissue destruction with slow healing. ***Ingestion***: Nausea, vomiting, burning, diarrhea, ulceration, convulsions, shock. ***Inhalation***: Coughing, wheezing, shortness of breath, headache, spasm, inflammation and edema of bronchi, pneumonitis.
Chronic Effects: Repeated/prolonged skin contact may cause thickening, blackening or cracking. Repeated eye exposure may cause corneal erosion or loss of vision.
Sensitization: none expected
Sodium Hydroxide: LD50 [oral, rabbit]; N/A; LC50 [rat]; N/A; LD50 Dermal [rabbit]; 500 mg/24hr severe
Material has not been found to be a carcinogen nor produce genetic, reproductive, or developmental effects.

Section 12: Ecological Information

Ecotoxicity (aquatic and terrestrial): Ecological impact has not been determined.

Section 13: Disposal Considerations

Check with all applicable local, regional, and national laws and regulations. Local regulations may be more stringent than regional or national regulations. Small amounts of this material may be suitable for sanitary sewer disposal after being neutralized to pH 7.

Section 14: Transport Information

DOT Shipping Name: Sodium Hydroxide, solid. **Canada TDG:** Sodium Hydroxide, solid.
DOT Hazard Class: 8, pg II. **Hazard Class:** 8, pg II .
Identification Number: UN1823. **UN Number:** UN1823 .

Section 15: Regulatory Information

EINECS: Listed (215-185-5) . **WHMIS Canada:** E: Corrosive liquid.
TSCA: All components are listed or are exempt. **California Proposition 65:** Not listed.
The product has been classified in accordance with the hazard criteria of the Controlled Products Regulations and the MSDS contains all the information required by the Controlled Products Regulations.

Section 16: Other Information

Current Issue Date: January 23, 2009

Chemical Name:

Section 1: Product and Company Identification

Synonyms/General Names:
Product Use:
Manufacturer:

24 Hour Emergency Information Telephone Numbers
CHEMTREC (USA): 800-424-9300 **CANUTEC (Canada): 613-424-6666**

Section 2: Hazards Identification

HMIS (0 to 4)
Health
Fire Hazard
Reactivity

Section 3: Composition / Information on Ingredients

Section 4: First Aid Measures

Eyes:
Skin:
Ingestion:
Inhalation:

Section 5: Fire Fighting Measures

Protective equipment and precautions for firefighters:

Section 6: Accidental Release Measures

Section 7: Handling and Storage

Handling:
Storage:

Section 8: Exposure Controls / Personal Protection

Exposure guidelines

Section 9: Physical and Chemical Properties

Molecular formula
Molecular weight
Specific Gravity
Vapour Density (air=1)
Melting Point
Boiling Point/Range
Vapour Pressure (20°C)
Flash Point:
Autoignition Temp.:

Appearance
Odour
Odour Threshold
Solubility .
Evaporation rate
Partition Coefficient
pH
LEL
UEL

Section 10: Stability and Reactivity

Stability:
Incompatibility:
Shelf life:

Section 11: Toxicology Information

Acute Symptoms/Signs of exposure:
Eyes:
Skin:
Chronic Effects:
Sensitization:

Section 12: Ecological Information

Ecotoxicity (aquatic and terrestrial):

Section 13: Disposal Considerations

Section 14: Transport Information

DOT Shipping Name:
DOT Hazard Class:
Identification Number:

Canada TDG:
Hazard Class:
UN Number:

Section 15: Regulatory Information

EINECS:
TSCA:

WHMIS Canada:
California Proposition 65: Not listed.

Section 16: Other Information

APPENDIX #6: Student Handout: Mechanical and Electrical Hazards

Equipment Use

- USE OF EQUIPMENT WITH EXPOSED PARTS — Uncovered shafts, gears, belts and pulleys may catch clothing, long hair or hands and drag them into the machinery.

- USE OF FAULTY EQUIPMENT AND TOOLS — Equipment and tools that do not operate as they should or contain weak points or damaged parts may break and cause injury as they come apart, overheat and cause a fire, or contain an electrical short or uncovered conductor that could cause an electrical shock.

- MOVING HEAVY OBJECTS OVERHEAD — balance and effective strength are reduced when applying a force overhead. Heavy items can slip resulting in loss of balance when reaching up to move an object.

- USE OF ELECTRICAL EQUIPMENT NEAR WATER — Water provides a good path for electricity. The hazard of electric shock is greatly increased when electrical equipment is used near water (i.e. by a laboratory sink) — especially if the equipment is not properly insulated and grounded or the circuit outlet is not protected by an isolating transformer or a ground fault circuit interrupter (G.F.C.I.).

- USE OF MODIFIED AND TEMPORARY EQUIPMENT AND CONNECTORS — Electrical hazards may exist when modification to equipment or the electrical supply system leave connections uncovered or allow large electric currents to flow in the wires. Shock and fire could result under these conditions.

- USE OF HIGH VOLTAGE EQUIPMENT — The voltages used to run gas discharge and cathode ray tubes and the voltages developed in some parts of electronic equipment often reach very high levels. All conductors and connection points carrying high voltage current must be very well insulated to prevent electric shock.

- CROWDING AROUND EQUIPMENT THAT IS RUNNING — A crowded space near equipment means that the students closest to the device have no place to move when an accident happens. And, movement of some students in the group will often push others at the front against the equipment where they may be hurt.

- LEAVING EQUIPMENT RUNNING UNATTENDED — Unattended equipment left running may present a hazard to other people. If needed, equipment should be quickly and easily shut down if it malfunctions or if an accident occurs.

Protection

- Do not operate any equipment or use any tools without prior instruction in their safe use from your teacher.

- Do not use any equipment or tools that are damaged or that fail to operate as you expect them to operate.

- Only properly insulated and grounded equipment may be used near a laboratory sink or in any wet area.
- Use only the equipment specified by your teacher. Do not attempt to alter this equipment in any way.

- Be sure that adequate electrical insulation covers all electrical conductors (wires) and connectors (plugs) before you turn on any equipment or laboratory set up.

- Do not crowd around, nor push people, where any equipment is being operated. Stay outside of the NO CROWDING ZONE around all equipment being used by other people.
- Shut off all equipment when you and your partners are going to move away from your work station.
- Grasp plug to remove from socket. Do not pull on cord.
- Do not touch hot plates to verify whether hot or cold.

Accident Procedures

- ALERT THE TEACHER and turn off all equipment in the area of the accident. Confusion at an accident site may cause conditions leading to more accidents.
- Be sure to have all injuries, no matter how minor, looked at and documented by your teacher(incident report filed). Infection can develop quickly in a dirty cut or burn. What may seem to be a sprain or bruise can be a broken bone.
- If another student is involved in a serious accident, be prepared to follow teacher instructions. Do not crowd around the accident site.
- If another student is suffering an electric shock, DO NOT TOUCH the student. The victim must be disconnected from the power supply by a trained rescuer who is insulated from the electric current, or the current must be shut off before the victim can safely be touched.

APPENDIX #7: Student Handout - Radiation Protection

Radiation Source

- **Use of Isotopes** — contact with materials containing radioisotopes can cause severe tissue damage.
- **Use of Cathode Ray and Gas Discharge Tubes —** energetic electrons and X-rays emitted from these tubes may cause biological damage if high operating voltages are used.
- **Use of Ultra-Violet Lamps and Electric Arcs** — ultra-violet light can cause very painful inflammation of some parts of the eye. The eye can be permanently damaged by intense ultra-violet light from electric arcs. Prolonged exposure of skin can produce “sunburn”.
- **Use of Intense Visible Light Sources (Lasers, etc.)** — the light receiving retina in the back of your eye can be permanently damaged by direct viewing of very bright light sources.
- **Use of Microwave Generators (and Faulty Microwave Ovens)** — microwaves can cause the body to overheat and permanently damage heat sensitive organs.

Protection

- Always follow procedures exactly as indicated by your teacher.
- Stay as far away as possible from radiation sources. *DO NOT* handle radioactive material.
- Use protective shielding between you and the radiation source.
- Work with radiation sources for only brief periods.
- *NEVER* look into a beam of a laser, ultraviolet source or any other bright light.

Accident Procedures

- **Alert the teacher** — if you suspect that you have been exposed to radiation or feel any discomfort such as nausea, headache or a pain in the eye, tell your teacher.
- Turn off all electrical equipment; cover all radioactive sources with shielding before leaving your work area.

APPENDIX #8: Science Areas Safety Checklist

(to be done monthly)

ROOM: SCIENCE LABORATORY

A. Housekeeping	Yes	No	Comment	Date Completed
1. Are the rooms tidy and free of litter on the floor? 2. Is there a clear aisle to both exits? 3. Is there a clearly marked container for broken glass? 4. Are materials safely stored? 5. Are the tops of cupboards free from heavy objects? 6. Are all surfaces clear and uncluttered? 7. Is the classroom free of stock bottles? 8. Is the equipment returned to its location after use? 9. Are chemical waste containers emptied on a regular basis, into the appropriate storage container?				
B. General Conditions	**Yes**	**No**	**Comment**	**Date Completed**
1. Is the ventilation adequate? 2. Are the exhaust vents clear of blockages? 3. Are the exits clearly marked? 4. Do the exit doors swing outwards? 5. Are there exposed wires around electrical outlets? 6. Are sinks cleaned and water run regularly? 7. Is their emergency lighting where no natural light is available?				
C. Equipment	**Yes**	**No**	**Comment**	**Date Completed**
1. Is there an easily accessible fire extinguisher? 2. Has the extinguisher been inspected, tagged, dated and initialed? 3. Is the extinguisher an ABC type? 4. Is there a fully stocked first aid kit? 5. Are spill kits easily accessible? 6. Is hand soap available at each sink? 7. Is personal protective equipment (goggles, shields, aprons) available? 8. Is there an easily accessible eyewash / deluge shower in or near the room? 9. Is it capable of at least 15 minutes of continual flushing 10. Is there an inspection sticker present on the fume hood(s) older than a year, if yes schedule an inspection of the unit prior to use, (Refer to Safe Work Practice 26-1).				

D. Natural Gas	Yes	No	Comment	Date Completed
1. Is there a readily accessible master shut-off for the room? 2. Are the pipes and cut off valves properly color coded and labeled?				

ROOM: STORAGE – PREPARATION AREA

A. <u>Housekeeping</u>	Yes	No	Comment	Date Action Completed
1. Does the room have an overall tidy appearance? 2. Are clear aisles maintained at <u>all</u> times to the exits? 3. Does the room have emergency lighting? 4. Is there <u>adequate</u> ventilation in the area? Mechanical exhaust? 5. Are refrigerators used exclusively for chemical/bacterial culture storage?				
B. <u>Equipment</u>	Yes	No	Comment	Date Action Completed
1. Is there a spill control kit in this room? 2. If present, does the kit contain rubber gloves, eye protection, and apron? 3. Is there an easily accessible eyewash/deluge shower present?				
C. <u>Materials</u>	Yes	No	Comment	Date Action Completed
1. Is there a fume hood? 2. If present, is the hood used for chemical transfer only, not storage?				
D. <u>Chemicals</u>	Yes	No	Comment	Date Action Completed
1. Are large bottles of chemicals stored close to the floor? 2. Are chemicals stored according to similarities in chemical properties? 3. Are incompatible chemicals separated and stored apart? 4. Are <u>all</u> chemicals clearly labeled? 5. Do the labels include the date of purchase? Hazard, i.e. flammable, corrosive? 6. Does label show basic first aid for chemical contact? 7. Are MSD sheets available for all chemicals stored?				
E. <u>Compressed Gases</u>	Yes	No	Comment	Date Action Completed
1. Are compressed gas cylinders present? 2. If present, are these cylinders fastened securely? 3. If present, are valves operating properly and free of excessive corrosion?				

<u>NOTE:</u> Any hazards observed which may affect students should be brought to the attention of the Principal.

Checklist completed by: ____________________________ ____________________________
(Print Name) (Signature)

Date: ______________________

APPENDIX #9: Semester Safety Checklist

ROOM: ___________________________

A. Physical Features of the Lab/Prep. Room	Yes	No	Comment	Date Action Completed
1. Exits are clearly marked. 2. Electrical outlets all function properly. 3. Taps do not leak. 4. Exhaust fan is working. 5. Fume hood fan(s) are working. 6. Gas outlets work properly. 7. Glassware is properly stored in the room 8. Hardware is properly stored in the room. 9. Main water shut-off tap is clearly marked. 10. Main water shut-off tap is functioning. 11. Main gas shut-off valve is clearly marked. 12. Main gas shut-off valve is functioning. 13. Main electrical shut-off switch/panel is clearly marked.				
B. Safety Features of the Lab/Prep. Room	**Yes**	**No**	**Comment**	**Date Action Completed**
(i) Fire Protection 1. The room is outfitted with heat detectors. 2. A multi-purpose fire extinguisher is conveniently installed and fully charged. 3. An approved fire blanket is accessible for immediate use. **(ii) Eyewash** 1. An eyewash station is accessible in areas of need. 2. Water has been replaced in portable eyewash station(s). **(iii) Broken Glass Container** 1. A clearly marked broken glass container is available. **(iv) Spill neutralizers** 1. A chemical spill kit is available. **(v) First Aid** 1. A fully stocked first aid kit is accessible. 2. An up-to-date emergency phone number list is included with the first aid kit.				

B. Safety Features of the Lab/Prep. Room	Yes	No	Comment	Date Action Completed
(vi) Storage/Chemical Storage				
1. All hazardous chemicals are stored in a prep room and not in a classroom.				
2. Storage areas are orderly with unobstructed floor space.				
3. Only authorized personnel have access to storage areas.				
4. Chemicals are properly stored and labeled, (see Suggested Model for Chemical Storage, earlier in this manual).				
5. All shelving is secure.				

Potential Structural Hazards in the Laboratory and Storeroom

These hazards mainly refer to shortcomings in the accommodation. It is important that they should be recognized, not only in order to effect improvement, but also to take particular care until improvements can be carried out.

Facilities	Comments
Floors	• Should be level throughout, with no steps in the laboratory/stores area. • Should be without defects (i.e. loose or broken tiles, uneven patches, cracks) • Should be without cracks, which can harbor spilled chemicals. Sheet flooring is far preferable to tiles or carpeting. • Chemical storerooms should have an adequate drain at the lowest point to cope with flooding. • Should be capable of being washed.
Doors	• No doors should be defective or jam. • All doors should open toward the nearest safety exit without use of a key. • All doors should have a safety glass window at head height. • No doors should be situated in an obscure area, i.e. around a blind corner.
Exits	• All science classrooms should have two exits. * • Exits should be clearly marked. • Exit route markers with non-slip surfaces should be painted on the floor.
Ceilings	• Should be non-flammable. Flammable ceiling materials, such as polystyrene tiles, should be removed and replaced with materials having a low flame spread rating (i.e. drywall).
Plumbing	• Should be without defects (leaks or cracks). • Drains should be made of chemical resistant material. • Worktops lipped towards sink. Spills will then flow into the sink rather than outwards onto the floor. • Gooseneck faucets must have vacuum breaks.
Fume Hood	• Fume hood system must have a minimum air flow (face velocity) of 0.5 metres/second, (refer to CBE Safe Work Practice 26-1 Chemical/Biological Fume Hood(s). • All fume hood(s) shall have an inspection sticker present on the fume hood confirming a yearly inspection has been completed and the units meet specifications.

Facilities	Comments
Fume Hood (cont.)	• Fitted with a sink. • Provided with adequate lighting, (500-750 lux ambient plus task lighting). • All controls for the operation of the fume hood must be located outside the fume hood. • Fume hoods must not be connected to a common duct. • Fume hoods ventilation systems must not re-circulate discharged air into the laboratory or other work areas.

Extractor Fans	• Laboratories should be adequately ventilated by extractor fans separate from the fume hood system. For normal laboratory purposes a minimum of 5 changes of air per hour or 15 L. per second per occupant is satisfactory.

*If one of these exits is through a storeroom, it should be replaced by a direct exit.

Checklist completed by: ____________________________ ____________________________

(Print Name) (Signature)

Date: ______________________