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Science Safety Guidelines

Grades Primary–12

Science Safety Guidelines

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Disclaimer

The information and materials in these guidelines have been compiled from sources believed to be reliable and to represent the best current opinions on the subject in order to provide basic safety guidelines to be followed in Nova Scotia schools. These guidelines are intended to serve as a starting point for good practices and do not purport to specify minimum legal standards.

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Contents

Introduction

Background

A major concern of science educators today is how to provide students with the exposure to laboratory activities while maintaining a safe learning environment. The information in this manual is intended to help educators provide a complete science safety program that supports an exciting and meaningful science curriculum and reduces the risk of injury to staff and students.

Teachers should be constantly alert to potential dangers. Common sense can go a long way toward maintaining a safe environment. Some risk is inherent in almost all science activities and to minimize these risks the following factors have to be considered:

- ability of teaching personnel to ensure a safe program
- support from administrators in promoting safety
- knowledge of subject matter and of chemicals and equipment used
- assurance of co-operation from students who have been taught their responsibilities in the labs

Not all hazardous materials can be eliminated from the program—nor would we want them eliminated if we are to provide a meaningful science curriculum. Yet some of our schools are unable to provide the conditions necessary for the safe use of all chemicals in their laboratories. The decision to use certain substances in the school laboratory should be based on the best available knowledge of each chemical's particular hazard and the availability of proper handling facilities. When the risk outweighs the benefit and no substitute is available, then the experiment should be eliminated from the program.

Accidents do not just happen—they are caused. If the potential cause can be detected and eliminated, fewer accidents should happen. Accidents can be prevented by

- an educational safety program
- proper supervision of students
- instruction in appropriate laboratory techniques
- good laboratory housekeeping

Science teachers who have been alerted to the hazards in the labs, who have provided a student educational safety program, and who promote sound laboratory techniques are in a better position to ensure a safe and successful science program.

Responsibilities

Encouraging a positive safety attitude is a responsibility shared among the following four main groups:

- school boards and superintendents
- school administration
- science teachers
- students

The co-operation of all these groups helps to develop a strong safety consciousness both inside and outside our schools.

Responsibilities of School Boards and Superintendents

The school boards and superintendents have a responsibility to

- ensure that schools comply with safety practices, these guidelines, and all procedures identified under these guidelines
- provide regular in-service education so that staff may increase their knowledge of safety measures in order to provide a safe working and learning environment
- provide specific chemistry in-service training
- provide facilities that ensure the safety of all students including students with disabilities
- initiate planning for the necessary improvements and procedures that ensure science safety
- arrange for waste disposal on a periodic basis

Responsibilities of School Administration

School administrators have the responsibility to

- ensure that schools comply with safety practices, these guidelines, and all procedures identified under these guidelines
- ensure that science laboratory activities are being taught and supervised only by teachers with the required expertise to teach such activities safely
- ensure that substitute teachers not be required to supervise laboratory activities unless they are familiar with the students, the specific topic of study, and safety requirements
- support in-service education to improve the safety knowledge of teachers, including training in first aid and the Workplace Hazardous Materials Information System (WHMIS)
- enforce disciplinary measures if safety guidelines are not being followed
- ensure that science classes be of an appropriate size to allow teachers to adequately supervise laboratory activities

- ensure that science laboratory enrolment does not exceed the capacity of the available lab stations, based on the Department of Education building guidelines
- provide and ensure that an accurate inventory of laboratory equipment and materials is annually updated and a copy provided to the local fire department
- respond to written, specific reported safety concerns
- provide teachers with the necessary resources and equipment that will ensure safety in the laboratory, including a copy of these guidelines
- make provisions for the safety of students with disabilities as well as for those with cultural or language difficulties
- carry out routine safety inspections and identify problems to be rectified, where possible at the school level
- direct any safety concerns that cannot be corrected at the school level to the appropriate district personnel

Responsibilities of the Science Teacher

The science teacher has the responsibility to

- follow safety practices, these guidelines, and all procedures identified under these guidelines
- provide for the safety of students
- reasonably anticipate the potential problems and hazards associated with an activity and take reasonable precautions to prevent foreseeable accidents
- instruct students in the proper and safe way to carry out science lab activities and supervise to see that instructions are followed
- provide opportunity for students to practise safety procedures as appropriate to the curriculum and facilities
- provide for students a safety contract at their level, which should be signed by them and their parents or guardians, indicating that they have read, understood, and accepted their safety responsibilities
- enforce rules that will result in reasonable and sensible behaviour
- ensure, prior to the commencement of a particular laboratory activity, that a review of particular dangers and necessary actions is given
- ensure that equipment used in science laboratories is in safe working order and report, in writing, any faulty equipment or other hazards to the school administration
- not leave students unsupervised in the laboratory or storage area
- keep dated, written records of any injuries related to laboratory activities and report such incidents to the school administration immediately
- collect and provide information about students who have medical conditions such as epilepsy, asthma, or severe allergies and who may require special attention

- participate in training as provided for an up-to-date first-aid course and receive instruction in the WHMIS as outlined in provincial and federal legislation
- provide a lesson plan for an activity that may be carried out safely by a substitute teacher
- lock science laboratories and storage areas when he or she is not present
- not conduct a laboratory activity if he or she feels that safety is being compromised and provide written notification to the principal stating the specific safety concerns and the actions required to correct the problem

Responsibilities of Science Students

Science students have a responsibility to

- follow school procedures and notices
- listen to and obey the instructions of the teacher in the science lab and behave safely and responsibly
- perform any experimental activity in the lab only with the expressed permission of the teacher and/or with the teacher's supervision
- report to the teacher immediately any dangerous situations and/or accidents

A student will be suspended from participating in current and future laboratory activities after refusing to follow acceptable laboratory practices or behaving in ways that create a dangerous situation for the student or other students.

Legal Aspects of Science Safety

The following points are not intended to provide comprehensive coverage of the law governing science safety. They are included to increase teacher awareness of some of the inherent risks in many activities and to promote a questioning and cautious attitude.

Negligence may be defined as conduct that falls below a standard of care established by law to protect others against an unreasonable risk of harm. There are at least three major types of negligence:

- malfeasance—doing that which should not have been done
- misfeasance—improperly performing a lawful act
- nonfeasance—failing to do what should have been done

Guidelines to Safe Practices

- Teachers are expected to protect the health, welfare, and safety of their students.
- Teachers are expected to be able to foresee the reasonable consequences of their actions and inactions.
- Careful planning is expected for all activities. The following questions can be used as a guide when planning an activity:
  - What are the hazards?
  - What are the worst-case scenarios?
  - How can I prepare for the worst-case scenarios?
  - What practices, safety equipment, and protective facilities are prudent and appropriate?
- Teachers must carefully instruct their classes and must give careful directions.
- Teachers should create an environment in which appropriate laboratory behaviour is maintained.
- Teachers should report any hazardous or potentially hazardous conditions to supervisory personnel immediately. The report should be written, and the teacher should retain a personal copy.
- Teachers shall be aware of school board and provincial policies related to lab activities.

The Nova Scotia *Occupational Health and Safety Act* sets out the general duties of employers, supervisors, and employees and describes how safety and health programs are to operate. Under the act, the government issues regulations that detail the government's safety requirements. The WHMIS Regulations have particular application to laboratories. Reference to these can be found at <www.gov.ns.ca>.

Provincial environmental laws and regulations also affect laboratory operations. When considering the development of safety guidelines, boards should be aware of the provincial laws and regulations as well as federal laws.

Elementary Years

Although scientific experimentation in the elementary years may not be conducted in as much depth as in high school, and the equipment and chemicals may not be as sophisticated, the attention to safety is just as important. More detailed information can be found throughout these guidelines.

Safety is an important concern in the elementary science classroom because students are learning new skills and working with unfamiliar equipment and materials that can pose some degree of hazard. Safety in the elementary school science classroom depends upon the wise selection of experiments, materials, resources, and field experiences, as well as consistent adherence to correct and safe techniques. It also requires thorough planning, careful management, and constant monitoring of students' activities. Teachers should access Material Safety Data Sheets (MSDS) to be aware of the properties, possible hazards, and proper use and disposal of all materials used in the classroom. MSDSs are provided by suppliers. If the MSDS is not available in your school building, contact the supplier.

Chemical Hazards

Any household chemical brought in to the school should be treated with the same precautions as other chemicals.

Hazardous effects of all chemicals to be used in the laboratory or classroom should be known.

Sample Chemical Hazards

(This is not a complete list.)

Chemical	Hazard
Bleach	• When mixed with acid, chlorine gas is produced. • When mixed with another bleach and/or cleaner, harmful gas is produced.
Drain cleaner	• Drain cleaner is caustic (corrosive). • When mixed with water, extreme heat is produced. • When mixed with another drain cleaner, could cause a violent reaction.
Finely powdered substances	• Finely powdered substances should not be placed near a heat source as there is a danger of spontaneous combustion.

Biological Hazards

The following section includes biological hazards that elementary students are likely to encounter. Teachers should take the following precautions:

- Inform the principal before bringing any animals into the school.
- Do not allow students to handle animals without proper instruction and supervision.
- Find out any possible diseases carried by the type of animal you may be considering.
- Follow all local, provincial, and federal guidelines regarding the care and treatment of animals.
- Keep animals in a clean, comfortable environment and give them food and water regularly.
- Make arrangements for care of the animals during times when the school is closed

Sample Biological Hazards

(This is not a complete list.)

Issue	Hazards/Precautions
Disease	• Animals and birds can carry disease (for example, turtles and chickens can carry salmonella). • Dead animals that have not been properly prepared may be diseased. • Obtain animals only from a reputable supplier. • All mammals must have been inoculated against rabies. • Do not allow stray or wild animals in the classroom.
Cleanliness	• Students must wash their hands before and after contact with animals.
Scratches and bites	• Wear gloves when handling animals. • Obtain medical treatment if you or a student are scratched or bitten.
Aquatic animals	• Fish, mollusks, sea urchins, etc., can cause wounds, infections, or allergic reactions.
Plants	• Unless it is known to be safe, treat any plant as poisonous. • Do not allow students to put any part of a plant in or near their mouths. • Avoid contact with the plant juice or sap; it can irritate the skin. • Ensure that students wash their hands after handling plants, especially before eating.
Fire	• Use extreme caution when using a flame. • Long hair must be tied back. • Loose clothing is dangerous around a flame. • Melting wax and flame can cause serious burns.

Issue	Hazards/Precautions
Earth and space science	• Asbestos samples are not allowed. • Viewing the sun with the naked eye during an eclipse should not be allowed.
Light and sound	• Do not expose students to extremely loud or continuous sounds. • Damage to the ears is irreversible and cumulative. • Direct exposure to bright lights can cause permanent eye damage. • Do not permit students to use laser pointers or pens. • Lasers can cause eye damage if the beam enters the eye; if doing a demonstration, use only a low-power laser.
Machines	• Simple machines and other moving objects can catch loose clothing or hair and pinch fingers. • Belts, pulleys, levers, hand mixers, and so on, should not be used by students without teacher supervision.

Secondary Years

Scientific experimentation is required in the curriculum in grades 7–12. For example, the chemistry strand requires access and use of a chemistry lab at these levels. Schools must ensure that equipment and chemicals are given the attention to safety that is necessary.

No matter what grade level, safety is a primary concern in the classroom. As students become older, more opportunity is given to them to work with more sophisticated apparatus and chemicals.

While the guidelines, cautions, and recommendations given for the elementary students also apply, the following additional notes are provided for teachers in junior and senior high schools.

Biological Hazards

In laboratory exercises and demonstrations involving cells, tissues, or organisms, it is impossible to guarantee an absolutely sterile environment for all students and teachers at all times.

Concerns have been raised by the Canadian medical community regarding the handling of mammalian tissues, partially in response to the emergence of pathogens such as the virus that causes Acquired Immune Deficiency Syndrome (AIDS). AIDS and other diseases such as hepatitis, that are transmitted through direct cellular contact by intrusion of foreign fluids have been diagnosed in large numbers throughout the world.

The education value of investigations such as blood sampling or cheek cell scrapes cannot justify the increased health risk to students and staff of these and other related procedures. Blood sampling and cheek cell scrapes are not allowed. The Nova Scotia Department of Education firmly believes that the health and well-being of all members of the education community must be a prime consideration in selecting learning activities.

Guidelines

- Students and teachers are to use authorized supplies from a science company to ensure safe products are used.
- Handling body substances of unknown status could endanger health.

Biological Samples: Categories and Precautions

Categories	Precautions
Handling micro-organisms	• Clean and disinfect all work surfaces before and after handling micro-organisms. • Avoid bacteria, fungi, etc., known to be pathogenic. • Grow cultures at room temperature. • Do not culture anaerobic bacteria, soil bacteria, or swabs from any surface that may contain micro-organisms from a human source. • Sterilize petri dishes containing cultures before disposal. • Seal petri dishes with transparent tape before they are passed around the class. • Avoid spattering cultures to prevent aerosol formation, which is a common means of infection. • Flame wire loops and needles before and immediately after transfer of cultures. • Do not move throughout the lab with a wire loop containing a culture.
Dissections	• Any organs used must be purchased from a scientific supply company. • Do not dissect wild or stray animals found dead outside. • Use dissecting instruments with care; make sure they are rust free and clean. • Ensure that students use disposable gloves. • Wash hands thoroughly before and after dissection. • Use an appropriate pan; never dissect in your hands.
Plants	• Treat any plant as though it were poisonous. • Handle with care. • Do not allow students to put any part of a plant in or near their mouths. • Avoid skin contact with the juice or sap of plants. • Wash hands thoroughly before and after handling plants.

Prohibited Biological Samples

Experiments or demonstrations involving

- mammalian blood
- urine and fecal materials
- cheek cell scrapings
- human cell or tissue sampling
- fresh or frozen mammalian tissue (except federally inspected meat)
- organs except those purchased from a scientific supply company

Chemical Hazards

Of all the sciences, chemistry poses the most problems for safety. Consequently, all chemistry teachers must consider the hazards, minimize them as much as possible, and train students to work safely. Chemistry teachers must maintain a personal professional development plan in order to be knowledgeable about safety and chemicals. A laboratory period on safety precautions and procedures to be used in the event of an accident must begin the year. This is the time to allay the fears of students who find laboratory work threatening. Students must have an attitude of respect for the laboratory, with the realization that they must understand the procedures, learn the required techniques, and approach experiments seriously. They must be assured that all experiments are safe under these conditions. Safety precautions for each laboratory experiment should be noted just before students are to begin it. An opportunity must be provided for students to ask questions about procedures or techniques involved.

Chemical Samples: Hazards and Concerns

Categories	Precautions
Hydrogen gas	• Use only in an operational fume hood. • Do not use around open flames.
Acids	• Must be prepared in an operational fume hood. • Acids are corrosive. • Know the correct procedures for dilution and clean-up of spills. • Dilution of HCl should be done in a fume hood; vapours are toxic. • Always add acid to water.
Bases	• Can be more corrosive than acids. • KOH and NaOH pellets must be kept in a tightly sealed bottle. • NH_4OH greater than 3 M must be used in a fume hood.

Prohibited Chemical Samples

The following chemicals should not be used in any school. If they are found to be present, they should be disposed of immediately by school board protocol.

- acrylonitrile
- ammonium dichromate
- arsenic
- arsenic trioxide
- asbestos (in any form)
- azobenzene
- benzene
- benzotrifluoride (trifluorotoluene)
- benzoyl peroxide
- beryllium
- beryllium chloride
- bromine
- cadmium
- carbon tetrachloride
- carbon disulphide
- carbon monoxide
- castor beans
- chlorinated ethers
- chlorine gas
- chloroform
- chromic acid
- chromium
- chromium oxide (chromium trioxide)
- cynogen (oxalic acid dinitrile)
- dichloromethane (methylene chloride)
- dimethyl sulphate
- dimethyl sulphide
- dimethyl ether
- dinitrobenzene
- ethylamine
- ethylene dichloride
- ethylene oxide
- fluorine
- formaldehyde
- fuming acids
- gasoline

- guanidine carbonate
- guanidine nitrate
- hydrocyanic acid
- hydrofluoric acid
- hydrogen peroxide (30%)
- hydrogen sulphide
- lead arsenate
- metallic peroxides of Ba and Ca
- mercury (and all compounds)
- Millon's reagent
- nickel (II) sulphate
- nicotine
- nitrogen dioxide
- nitroglycerin
- perchlorates
- perchloric acid
- perchloroethylene
- petroleum naptha
- phenol
- phosgene
- phosphorus chloride
- picrates
- picric acid
- polychlorinated biphenyl (PCBs) (microscope immersion fluid)
- potassium cyanide
- potassium
- powdered metals (e.g., Mg, Al, Pb)
- sodium cyanide
- sodium arsenate
- sodium arsenite
- sodium peroxide
- sulphur dioxide
- vinyl chloride

Restricted Chemical Samples

The following chemicals may be used only in schools that possess adequate safety equipment and storage facilities to permit their safe use. These chemicals, where used, should be stocked in minimum quantities only.

- acetaldehyde
- acetylene
- ammonium perchlorate
- calcium carbide
- cyclopropane
- diethyl ether
- dimethylamine
- ethyl acetate
- lithium (metal)
- lithium hydride
- low-intensity sources containing uranium, thorium, potassium, or rubidium
- methyl ethyl ether
- nitric acid (can explode)
- PTC (Phenylthiocarbamide or 1-phenyl-2-thiourea)
- petroleum ether (ligroin)
- sodium (metal)
- toluene

Chemical Storage

Chemicals should never be stored in alphabetical sequence. Flammables and acids must be stored in appropriate cabinets. This prevents highly reactive substances from being placed side by side on a shelf, which could possibly result in spontaneous reactions.

Ideal chemical storage is to completely isolate each major class of material and even isolate some materials within each class.

Features of a chemistry lab storage include

- a well-designed room permitting safe storage of all chemicals
- locked doors isolating the storage room from preparation and classroom areas
- chemicals segregated into classes
- a colour-coded labelling system
- well lit and away from direct sunlight and heat sources
- switches and fan motor housing installed to prevent fires from electrical shorts or sparks in faulty switches
- chemical storage off the floor
- shelves (preferably wood) attached firmly to the walls
- avoiding the use of metal shelf supports or clips
- three separate cabinets for acids, flammables, and severe poisons
- separate storage for nitric acid

Date chemicals as they are received, ensure that there is a current MSDS, and record the information on your inventory list (see Appendix A). Acceptable chemicals for use in science activities may also be found in Appendix B.

An Interim Alternative to a Separate Chemical Storage Room

While a separate room is preferable for chemical storage, the principles of proper chemical storage can be maintained without a separate room. If a science preparation room is used as the chemical storage room, it is appropriate to

- prevent the accumulation of harmful vapours by adequately and continuously venting to the exterior with an exhaust fan
- equip the room with a properly vented flammables cabinet to house all solvents and flammable materials
- store acid and basic (alkaline) solutions separately in closed and vented cabinets
- keep toxic chemicals (poisons) in a separate locked cupboard
- keep oxidizers and reducers on separate shelves as far from each other as possible
- store hydrolyzing (water reactive) solids in a separate area
- alphabetically store compatible chemicals

This is a challenging system to maintain adequately. Good housekeeping can be a problem when chemical storage is not housed in a separate room.

Note: When the science preparation room is used as the chemical storage room, it must not be used as a general teacher preparation area/working station (teachers are not to be present in the room other than when preparing chemicals for laboratory instruction).

Hazard Classes of Chemicals

Chemicals may be put into eight general categories for aid in creating a workable storage system. Precautionary measures taken in storing these chemicals would be similar in each of the categories.

Each category must be physically separated, and storage must be appropriate for the type of chemical.

Hazard Classes

Class	Comment
Flammables and combustibles	• Store these items in a CSA-approved cabinet away from strong oxidizing agents such as $KMnO_4$, K_2CrO_4, $K_2Cr_2O_7$, or HNO_3. • Keep the storage cabinet in a cool place. • Ensure that the storage cabinet is vented. • A 120 L cabinet should be sufficient for most schools. • Acetic acid should be stored with flammables and combustibles.
Acids	• Store acids in an acid cabinet or acid-resistant plastic trays. • Store acids only in a vented cabinet. • Store acids away from bases, active metals (Li, Ca), cyanides, sulphides, and sulphites. • Store nitric and acetic acids separately.
Bases	• Store bases away from acids. • Store bases in corrosion-resistant plastic trays at floor level. • Vent aqueous ammonia (“ammonium hydroxide”) periodically.
Oxidizing agents	• Store these away from flammable and combustible materials and reducing agents. • Nitric acid is to be stored with oxidizing agents.
Reducing agents	• This class includes metals and metal powders. • Store away from oxidizing agents. • Some, such as alkali metals, must be kept away from water sources.
Compressed gases	• Store compressed gases upright. • Store them in a cool, well ventilated place. • Store them away from other chemicals. • Secure to a wall or bench to prevent them from falling.
Toxic substances	• Store poisons above waist height in a locked cabinet.
General storage	• Separate incompatible chemicals (see Appendix B for incompatibility of chemicals). • Store organics and inorganics separately.

Spills

Teachers must review MSDSs for all chemicals before using them in a lab so that they can react to any spills or other mishaps that may occur.

Spill	Procedure
Small amounts	• Flush weak acids and bases down sinks with large amounts of water. • Evaporate solvents in the fume hood.
Large amounts	• Neutralize acids with dry sodium carbonate, then with plenty of water. • If concentrated HCl spills, remove people from the area and follow safety neutralization procedures. • Neutralize bases with dilute HCl or acetic acid, then with plenty of water. • Absorb spills with vermiculite, diatomaceous earth, or clay kitty litter, and dispose of according to the school board guidelines. • For large spills of poisonous, corrosive, or reactive materials, evacuate the lab, notify the administration, and seek immediate assistance from the school board guidelines. • Commercial spill kits may be obtained from scientific supply companies.
Solid	• Sweep up with a brush into a plastic dustpan and place in a waste container for disposal; contact your school board. • Place clean, broken glass in the glass disposal container. • Place broken glass contaminated with a hazardous solid with the spoiled solid for disposal.
Liquid	• Absorb with vermiculite, diatomaceous earth, or clay kitty litter.
Acids and bases	**Acid** • Sprinkle with solid sodium carbonate or sodium bicarbonate. • When fizzing (CO_2) stops, sweep with a brush into a dustpan and dispose of in the glass container. **Base** • Neutralize with a dilute acid such as acetic acid, dilute HCl, boric acid, or sodium bisulphate. • Once neutralized, sweep up like a treated acid spill.
Organic liquids	• Absorb with a spill pillow or scoopfuls of dry, solid absorbent. • Put in container for disposal according to table in Appendix B.

Dangerous Reactions

Students may only use chemicals authorized by the teacher. Procedures for their use must be clear to the student before experimenting begins. Changes in procedures must never be made without the teacher's specific permission. This permission must not be given unless the teacher is certain that the change is safe. **To prevent unplanned experimentation, all chemicals not actually in use must be securely locked.**

Specific Hazardous Reactions

The following is a list of combinations that will result in dangerous reactions:

- nitric and/or chromic acids with any of the following:
  - acetic acid
  - ethylene glycol
  - peroxides
  - permanganates
  - hydroxyl compounds
  - ammonia
  - camphor
  - glycerol
  - turpentine
  - alcohol
  - aniline and hydrogen peroxide
  - zinc
  - aluminum
  - magnesium

  (spontaneous ignition or explosive)

- nitric and sulphuric acid with acetone (spontaneous ignition or explosive)

- acetylene in the presence of copper tubing with halogens, silver, and their compounds, or hydrogen peroxide (explosive)

- aqueous ammonia with iodine or silver (explosive)

- ammonia with sodium or calcium hypochlorite (poisonous gas); with halogens, hydrogen, or hydrogen fluoride (explosive)

- ammonium nitrate, potassium chlorate, chromates, potassium permanganate, or sulphur with organic compounds (explosive)

- chlorine with ammonia, hydrogen, turpentine, or acetylene (explosive)

- activated carbon and calcium hypochlorite (explosive)

- sodium or calcium carbide with water (explosive)

- hydrogen peroxide with most metals, metal salts, flammable fluids, or combustible materials (rapid decomposition)

- sulphuric, nitric, hydrochloric, or phosphoric acids with chlorates, or permanganates (explosive, exothermic)

- oxalic acid with silver (explosive)

- oxygen (gas) with grease, hydrogen, flammable liquids, solids, or gases (explosive)

- phosphorous pentoxide with water (exothermic)
- a combination of potassium chlorate, sugar, and concentrated sulphuric acid is unpredictable (explosive)
- potassium nitrate with sodium acetate in the solid state (explosive)
- potassium permanganate with glycerol, benzaldehyde, or ethylene glycol (exothermic)

Potentially Hazardous Experiments and Possible Substitutes

Experiment	Reason for Danger	Possible Substitute or Protective Measures
Any experiment involving phosphorous	• Potential high combustibility	• Teacher demonstration only
Burning magnesium	• Eye damage • UV light produced	• Burn behind glass or cobalt glass
Laser beams for physics only	• Eye damage	• Never look directly into the beam • Prevent strong and direct reflections
Preparation of oxygen (heating potassium chlorate)	• Violent reaction of chlorates when in contact with organic material; e.g., carbon, burnt splint, rubber, or dust	• React H_2O_2 with MnO_2 cautiously
Radioactive materials	• Radiation	• Use adequate shielding
Solubility using carbon tetrachloride	• Poisonous vapour	• Use T.T.E. (Trichlorotrifluoroethane)
Static electricity discharge from Van der Graff generator	• Possible discharge to the eye may cause medical conditions	• Wear glasses and keep front of face away from charged sphere
Use of flammable volatile liquids, e.g., ether or alcohols as solvents	• Should not be used when sparks will be present, e.g., spectrum tubes, electric switches, static discharge	• Use nonflammable liquids rather than ether • Always check the surroundings for apparatus that may produce sparks
Vapourization of iodine or benzoic acid	• Toxic bronchial irritants	• Teacher demonstration or use minute quantities

Experiment	Reason for Danger	Possible Substitute or Protective Measures
Zinc and sulphur explosion (to illustrate a synthesis reaction)	• Spews out molten sulphur, zinc, and sulphur dioxide • Explosive power may be enough to break the test tube • Zinc sulphide is an irritant	• Teacher demonstration only • Use small amounts (dime-size amount) • Operate on flat tin can lid

Generation of Toxic or Irritant Gases

In addition to those chemicals designated as prohibited and restricted, many substances of a hazardous nature may be generated in the laboratory. Gases such as ozone (O_3), plus gaseous forms of hydrogen chloride (HCl), iodine (I_2), or diphosphorous pentoxide smoke (P_2O_5) are toxic and/or irritating products. Other toxic substances such as sulphuric acid (from sulphur trioxide) and ammonium chloride (NH_4Cl) may be present in the air as finely divided particles. Teachers should avoid producing these substances; but if they must be used or generated, a properly operating fume hood must be provided.

Fire Safety

There are three aspects to this topic: prevention, evacuation, and control.

Prevention means eliminating or keeping very close control over flammable or potentially explosive materials in science laboratories. This involves procedures for handling storage, spills, disposal, and training students to use dangerous materials safely. Prevention is obviously the most important aspect for teachers to be proactive.

In the event of a fire, the evacuation of students is the first consideration. Fire drills are mandatory, and each student must know the planned route and alternative route if the original is blocked. All science laboratories must have two exits that are clearly labelled with exit signs. The need for orderly evacuation should be stressed in the event that the route needs to be changed, and the direction from the PA system, or by other means, has to be heard.

When students are safely out of the area and the alarm has been given, fire control should be considered. There are three factors that are required before a fire can begin: a source of flammable material, an oxidizing agent (usually air), and sufficient heat to cause the material to ignite. Fire control is directed towards the elimination of one, two, or all three of these factors. Although there are limited possibilities for removing burning material once it has been ignited, one source of flammable material can be eliminated if the master valve for the propane gas is clearly marked and shut off in the event of a fire. The second and third factors, air and the source of heat, can be controlled by the use of fire extinguishers and/or fire blankets. The location of these items

should be clearly marked, and all teachers and students should be trained in their use.

Hazard	Precaution
Using a Bunsen burner	• Tie hair back. • Avoid loose clothing. • Remove hats with protruding brims. • Do not use butane lighters for lighting a Bunsen burner.
Flammable and combustible liquids	• Be aware of the flashpoint of the liquids in use. – flammable liquids: the flashpoint is below 22.8° C – combustible liquids: the flashpoint is between 37.8° C and the boiling point is below 37.8° C – refer to Appendix B for information on the flammability of substances • Keep these items away from open flames and other heat sources. • Keep quantities in use to a minimum. • Use adequate ventilation.
Gases	• Flammable gases such as hydrogen, methane, and propane may form explosive mixtures with air at relatively low concentrations. • When H_2 is collected for testing, ensure that only small (e.g., test tube) quantities are ignited. • When using H_2, ensure adequate ventilation.
Reactions	• Highly exothermic reactions may produce enough energy to start a fire if flammable or combustible substances are present. • Be aware of all fire risks and take adequate precautions when carrying out any demonstration that is not part of the core curriculum. • Do not allow students to mix any chemicals except as part of an authorized lab activity or under the supervision of a teacher.
Electrical fires	• Electrical fires are caused when too large a current is passed through electrical equipment or wiring causing it to overheat.

All labs must have at least one A, B, or C fire extinguisher mounted on a wall near an exit door. If more than one extinguisher is provided, these should be at opposite ends of the room.

Fire extinguishers must

- be located in conspicuous places that are clearly marked by signs
- be mounted at an accessible height and located near area of use
- be maintained in operable condition and completely checked at least once a year
- be recharged before being used again
- be clearly marked with the class and use of the extinguisher

In addition to fire extinguishers each lab should have the following:

- a fire blanket made of fire-proof wool/rayon material; not to be used where spillage and fire spreading is possible
- teachers trained in the use of the appropriate equipment
- sand

In case of fire, teachers should do the following:

- Evacuate all students.
- Pull the fire alarm.
- Call the fire department if the alarm is not connected to the fire department.
- If it is a small fire in a container, allow it to burn out.
- If it is a larger fire, place a fire resistant blanket cover over the mouth of the container.
- **Never** throw water on a chemical fire.
- **Never** use a fire extinguisher on standing beakers or flasks.
- **Never** turn on water after a flaming container has been placed in the sink.

Electrical, Mechanical, and Radiation Hazards

Mechanical and Electrical Equipment

Mechanical and electrical hazards will seldom exist in a well-maintained laboratory. All equipment must be CSA approved and in good working order.

Mechanical and Electrical Hazards Protection

Accident prevention will depend on the proper maintenance of all mechanical and electrical equipment and the careful instruction of students in the safe use of the equipment. The onus is on the teacher to be aware of potential dangers and to convey this information to the students.

Teachers must

- ensure that all equipment and tools are in good working order
- instruct the students on the safe use of all equipment and tools
- be sure that all rotating equipment is operated with all covers, lids, and guards in place
- require that eye protection be worn during any grinding or pounding operations
- remind students to tie up loose clothing and long hair
- clearly tag, take out of service, and report all faulty equipment
- use only CSA- or ULA-approved equipment

- use electric equipment at its rated capacity only
- be sure that all equipment is shut off when not in use
- ensure regular safety inspections
- store all heavy items as close to the floor as possible

Electrical Hazards

Item	Concerns/Precautions
Electricity	• Use fuses or circuit breakers when necessary to limit the amperage in circuits. • Insulate live parts of circuits. • Clearly identify high and low voltage connections of induction cells.
Water	• Make sure hands are dry when working with circuits. • Do not perform electrical experiments near water, wet floors, or wet benches. • Stand on rubber mats or carpet when working with electricity. • Outlets should be in waterproof boxes on the top of benches or suspended from the ceiling.
Standards	• Equipment should be CSA approved. • Periodically check for frayed cords, exposed live wires, or leakage of current. • If it is necessary to use electrical cords, do not run cords across walkways or aisles. • Secure cords to the floor.
Safety	• Avoid bridging a live circuit with both hands.
Fire, electric shock, and damage	• Check for and remove frayed or broken electric cords. • Use equipment properly. • Only use equipment that is CSA approved. • Be sure that electric equipment is properly grounded. • Ensure adequate installation and proper alterations to an electric power system. • Use high-voltage equipment properly.

Mechanical Hazards

Item	Concerns/Precautions
Equipment with moving parts	• Ensure that moving parts are guarded. • Tie long hair back. • Avoid loose clothing, hats with protruding brims, and jewellery. • Wear safety glasses or goggles. • Periodically check equipment to see that it is in good working order.
Glassware	• Make sure that glassware is safe for heating—use brands such as Pyrex. • Hot and cold glassware look alike—be sure of what you are touching. • Use tongs or heat-resistant gloves to handle hot glassware. • Cool hot glassware on ceramic tiles or ring stand base. • Always clamp flasks and beakers when heating them on a ring stand. • Do not use glassware that is cracked or broken and dispose of it properly.
Porcelain	• Do not use cracked or damaged porcelain and dispose of it properly.
Tools	• Use tools properly and with care. • Use tools that are in excellent condition.
Storage of equipment	• If materials are stored overhead, be careful when lifting so as not to cause injury to the back, arms, legs, or head. • Equipment should be stored so that it does not fall or slip off a shelf and cause injuries.
Rotating equipment	• Be aware of fingers, long hair, and loose clothing that may get caught if guards, lids, and covers are not in place.

Radiation Hazards

Item	Concerns/Precautions
Visible light	• Never look directly at a bright light source such as magnesium or the sun. • If bright enough, everyday sources of light can cause eye damage. • Be careful when using strobe lights as they may induce seizures.
Lasers	• Students may not use laser pointers or pens. • Lasers can cause eye damage if the beam enters the eye. • Do not allow students to look at the beam. • A lab laser shall have maximum 5 mW. • When in use, keep ambient light levels high so that students' pupils are small.
Ionizing radiation	• Use low-intensity sources containing uranium, thorium, potassium, or rubidium. • Do not allow sources to come in contact with the skin. • If sources are in powder form, keep sealed to prevent contact with the skin or ingestion.

Workplace Hazardous Materials Information System (WHMIS)

The Workplace Hazardous Materials Information System (WHMIS) was legislated by the Canadian federal and provincial governments on October 31, 1988. The provincial regulations are part of the Occupational Health and Safety Act. This was done to ensure that all workers in Canada have information on any chemicals that they may come in contact with in the workplace. The three components to WHMIS are labelling, MSDS, and education and training. Search the Internet for the latest WHMIS regulations for official, final authority.

Websites

Workplace Hazardous Material System Regulations
<www.gov.ns.ca/just/regulations/regs/ohs6489.htm>

Interpretation Guide for Nova Scotia WHMIS Regulations
<www.gov.ns.ca/enla/ohs/whmisreg.pdf>

Occupational Safety General Regulations
<www.gov.ns.ca/just/regulations/regs/ohsgensf.htm>

Occupational Health and Safety Act
<www.gov.ns.ca/legislature/legc/statutes/occph_s.htm>

First Aid in Science Education

It is recommended that science teachers be trained in first aid in accordance with Occupational Health and Safety (OHS) requirements. This training is to ensure that teachers act efficiently and promptly for injuries common to science education: eye injuries, burns, poisoning, bleeding, and electrical shock.

Emergency numbers should be posted in a conspicuous place in the laboratory or classroom, as well as by the telephone that would normally be used in the event of an accident. These numbers should include fire, police, poison control, hospital, ambulance, and school board.

Students Having Medical Problems

It is essential that teachers are aware of any students who have medical problems such as diabetes or epilepsy that may cause them to be incapacitated. Teachers should also know of students who may be taking drugs that may have side effects or students who may have allergic reactions. In all such cases, any precautions, treatment in the event of attacks, and emergency numbers should be known. Any information of this type provided to the teacher should be treated as confidential.

First-Aid Kits

All schools are required by provincial regulations to have an accessible first-aid kit. All P–6 schools that have a dedicated science classroom must have one Nova Scotia #3 first-aid kit. All grades 7–12 dedicated science laboratories must have one Nova Scotia #3 first-aid kit. The contents of the kit is listed in the provincial First-Aid Regulations.

These kits should be checked periodically (at least once a month) as some items such as adhesive dressings tend to be used often and may need frequent replenishment.

Personal Protective Equipment for Students

If injuries to students result from the failure to have or use personal protective equipment, negligence may be claimed. Safety training is an integral part of learning lab techniques, and it is an excellent way of ensuring that safety becomes a lifelong practice. Teachers should check the MSDSs and the lab activity description before doing the laboratory exercise. The following list of items shall be available to all students and utilized during the conduct of specific laboratory activities when appropriate.

Safety Item	Comments
Safety glasses or goggles	• Students must wear eye protection. • Shared goggles should be sterilized between uses with ultraviolet radiation or a disinfectant solution. • Prescription glasses **do not** provide adequate protection. • Safety glasses or goggles must have fitted side shields.
Laboratory coats	• Each student should purchase or be provided with his/her own lab coat/covering.
Disposable gloves	• Disposable gloves must be used by students when handling corrosive chemicals, toxic chemicals, biological stains, or potentially infectious material. **Note**: Some disposable gloves offer no protection against some organic solvents. Be aware of the possibility of latex allergies.

Safety Equipment for Science Classrooms/Labs

The teacher and students must be familiar with the location and the use of safety equipment. It is imperative that the equipment is checked at least twice a year and should be located for easy access.

Equipment such as first-aid kits, showers, fire blankets, fire extinguishers, eye washes, sand buckets, and so on should be properly labelled with instructions for use. In the event that any of this equipment is not readily visible, signs must indicate its location.

The following is a minimum list of required safety equipment items as is appropriate to the curriculum as prescribed by the Minister of Education.

Classroom/Lab Safety Equipment

Equipment	Explanation
Fire extinguisher	• ABC-type dry chemical; must be inspected by a qualified individual once a year
Fire blanket with wall stand	• replace existing asbestos blankets with wool/rayon type • use only for smothering clothing fires
Eye wash station	• plumbed eye wash preferred; change the fluid in the container on a regular basis
First-aid kit	• minimum required contents as specified by the provincial Occupational Health and Safety First-Aid Regulations
Emergency shower	• should be readily accessible within 50 feet of all work stations
Safety goggles	• must be worn by teachers and students when doing all chemical experiments • approved eye protection must be worn at all times by everyone in a laboratory situation involving chemicals, explosive materials, compressed gases, hot liquids or solids, injurious radiation, or other identifiable hazards
Face shield	• to be worn by the teacher when necessary
Safety shield	• to be used when appropriate
Glass disposal container	• metal pail or cardboard box labelled “broken glass, handle with care.”

Equipment	Explanation
Chemical spill kit	• available from chemical supply companies • used for acid, base, and organic solvent
Chemical-resistant rubber gloves	• used for cleaning up spills or for handling corrosive or toxic chemicals • used when handling preserved organisms
Lab coats	• should be worn in the lab
Heat-resistant gloves and tongs	• used when handling hot objects • gloves should be made of treated textured silica or woven fabric • do not use **asbestos gloves**
Fume hood	• must have a working extractor fan with a minimum airflow (velocity) of 0.5 m/s • should be inspected yearly • needed for preparing acid and base solutions • should be fitted with a sink • must be provided with adequate lighting (500–700 lux ambient lighting) • all controls for its operation must be located outside the fume hood • must be connected to a common duct • must not discharge air outside the building • must be checked regularly to ensure it is in proper working order
Hand washing facilities	• should be in each science lab
Vermiculite, diatomaceous earth, clay kitty litter	• used for chemical spills
Dustpan and brush	• used for brushing up used sand, vermiculite, and broken glass • wash and clean thoroughly after each use
Acid storage cabinet	• must be locked when not in use
Rubber transport bucket	• used to transport bottles of concentrated acid
Flammables storage cabinet	• must be locked when not in use
Master propane gas control	• must be visibly labelled • needed for chemical lab (specifically for Science 9 and above)

Safety Professional Development

Little success can be expected from professional development unless the teachers attending see it as important to their work with students and feel that it has the active support of the school administration—principal, curriculum supervisor, and superintendent. Administrative support must extend to the provision of any necessary equipment for the school that is recommended during professional development sessions. Administrative support should be committed before the sessions.

The ultimate goal of safety professional development is to manage classroom activities to reduce the risk of injury. To reach this goal, the following should be considered:

- science safety guidelines training for all science teachers
- WHMIS training for everyone who works with chemicals
- raising awareness of safety in the minds of teachers by increasing their knowledge of resources available, procedures, and the need for skills such as first aid
- strengthening background knowledge in areas such as dangerous chemicals, proper storage, and dealing with emergencies
- planning, setting up, and evaluating a school science safety program

These professional development programs shall be provided to teachers during in-service days provided by the teachers' provincial agreement.

It should be kept in mind when formulating goals for a specific professional development session that they should be narrow enough to be met in the time available and broad enough to be useful to as many teachers as possible. It cannot be overemphasized that the goals must be clear, not only to the organizers, but also to the participants. These goals should be provided before the sessions to focus the attention of teachers on the topic under consideration.

Successful professional development will encourage active participation rather than passive listening or watching. Possible activities for professional development include discussions based on films, overhead transparencies, and slides; planning sessions in which participants will plan certain aspects of safety for their school; case studies and tests; accident simulation, perhaps by role-

playing; and demonstrations (e.g., incompatible chemicals). There is no doubt that the activity approach, like any good thing, can be taken to extremes; there is a need for other formats to provide variety in the sessions. A description of various kinds of sessions that might be used to meet the goals for safety professional development follows.

Discussion Sessions

When discussion sessions are held, it is very important that effective direction is given so that productive discussion takes place. Leadership that will direct the discussion into positive channels is essential for success. The following techniques are suggested.

One type of discussion starter is a case study of mishaps. It is suggested that a variety of studies be provided for different grades and disciplines. The studies should be based on the assumption that all mishaps are predictable, and the case study should provide the conditions for a group to predict the outcome of an incident. The actual outcome can then be reported and discussed.

Another form of case study could be an incident report with the group being asked how it could be prevented. The goal of this type of approach is to initiate discussion that should be directed to the teachers' actual situations.

Overheads predicting unsafe laboratory practices can be placed on a screen, and teachers can be asked to identify hazards that could result in an accident.

Having initiated discussion, it is essential that a strong chairperson be present to ensure that the discussion follows useful channels. Allowing discussion to turn into a complaint session is usually unproductive. A complaint should always be turned into a clear statement of a problem, and a solution to it should be sought by the group.

In addition to discussion sessions, other formats such as "buzz" sessions and brainstorming should be considered. These could deal with topics such as, "What are the situations that should be looked at in our school with regard to safety?" "How do you discuss safety without making students afraid of science?" "Should there be parental involvement in the safety program?"

Planning sessions are all-important in school professional development sessions. It is useless to have a one-day session on safety without follow-up. There must be planned carry-over so that teaching staff will be aware of the need for safety at all times and the need to make students aware of it. Planning of a school safety program, as outlined here, is recommended as an excellent topic for a professional development session.

Professional development will be required to encourage teachers to study these safety guidelines and to familiarize them with the available resources that are provided.

Appendices

Appendix A: Chemical Inventory

The inventory should include chemicals stored or used in the chemistry lab. If you have an MSDS (Material Safety Data Sheet) for the chemical, put a check mark in the right-hand column. If not, ask the chemical supplier to provide an updated MSDS (less than 3 years old), if one is available.

School:	
Completed by:	
Date:	
Storage Location:	

Chemical Purchase/ Receive Date	Chemical/Brand Name	Storage Location(s)	MSDS Preparation Date

Appendix B: Chemicals Used in Science Activities

The table in this appendix is an alphabetical list of the chemicals commonly used in science activities in Nova Scotia (particularly at the high school level) and the hazards and handling precautions associated with their use. The codes used in the table to indicate toxicity, flammability, and reactivity are assigned in accordance with the *Guidelines on Toxic and Hazardous Chemicals Used in Educational Institutions*, published by Health and Welfare Canada, with some modification. These codes are explained below.

Toxicity

A toxic substance can interact chemically with the body to produce harm or injury. However, the severity of the injury depends upon several factors:

- the dosage
- the duration or frequency of exposure
- the route of exposure (e.g., inhalation, skin, mouth, and eyes)
- the chemical state of the substance

Several terms are used to report the level of toxcity of a substance.

- Lethal Dose Fifty (LD50)
  - The LD50 of a substance is the dose of the substance that causes death in half (50 percent) of a group of test animals exposed to the substance.
  - The LD50 is usually reported in mg/kg of body weight of the animal.
  - Species of animal tested and route of exposure are included.
  - The lower the value of LD50, the more toxic the substance.
  - If the substance is a gas or vapour and the animal is exposed by inhalation, the Lethal Concentration Fifty (LC50) is often reported in ppm (parts per million)
- Toxic Dose Fifty (TD50)
  - The TD50 of a substance is the dose of the substance in milligrams of a substance per kilogram of body weight required to show a specific toxic effect in 50 percent of a group of test animals.
  - If the substance is a gas or vapour, the TD50 may be reported as the concentration of the substance in air showing a toxic effect in 50 percent of a group of test animals.

Although not given in the table below, exposure limits may be included in MSDS.

- Threshold Limit Values (TLV)—permissible exposure limits
  - These are the maximum concentrations of a substance in the air to which most people may be exposed by inhalation without suffering adverse effects.
  - The time-weighted average TLV covers a person for eight hours a day for five days a week.
  - The short-term exposure limit TLV covers exposure by inhalation for no longer than 15 minutes without harm if no more than four exposures a day occur.
  - The ceiling TLV is the maximum concentration that must not be exceeded, even briefly.
  - The lower the values of TLV, the more dangerous the substance.

Examples of Toxins

Carcinogens

Carcinogens are substances capable of causing cancer or cancerous growths in mammals.

Known labels indicate that enough information exists that shows a definite relationship between exposure to a substance and cancer in humans.

Probable labels indicate that there is limited evidence in humans and/or sufficient evidence in experimental animals.

Some carcinogens are more potent than others, and risk increases with level and duration of exposure.

Mutagens

Mutagens are substances capable of causing changes in the genetic material of a cell that can be transmitted during cell division.

The extent of the hazard to humans associated with exposure to mutagens is less clear than it is with carcinogens. However, it is recommended that similar caution that be exercised in handling substances that are mutagenic.

Teratogens

Teratogens are substances that are capable of producing abnormalities in offspring resulting from exposure of a pregnant woman to the substance at a concentration that would be unlikely to have an effect on the woman. The human fetus is particularly at risk during the embryonic stage of development, which is between two and eight weeks.

Rating	Hazard	Explanation
4	Extremely Dangerous	• oral LD50 value no higher than 50 mg/kg • dermal LD50 value no higher than 40 mg/kg • inhalation LC50 value less than 50 ppm over 4 hours • highly corrosive materials causing tissue damage after brief exposure to minimal amounts
3	Dangerous	• oral LD 50 value between 50 and 500 mg/kg • dermal LD 50 value between 40 and 200 mg/kg • inhalation LC 50 value between 50 and 200 ppm over 4 hours • corrosive materials causing tissue damage on splash contact
2	Caution	• oral LD 50 value between 500 and 2500mg/kg • dermal LD 50 between 500 and 2500 mg/kg • inhalation LC 50 value between 200 and 1000 ppm over 4 hours • corrosive materials causing tissue damage on extended contact (1 hour)
1	Low	• oral LD 50 value greater than 2500 mg/kg • dermal LD 50 value greater than 1000 mg/kg • inhalation LC 50 value greater than 1000 ppm over 4 hours • non-corrosive materials

Flammability

Flammability is defined as the lowest temperature at which a liquid gives off enough vapour to be ignited at the surface of the liquid. Flammable liquids have a flashpoint below 37.8° C, while combustible liquids have a flashpoint between 37.8 and 93.3° C.

Rating	Hazard	Explanation
4	Extremely Dangerous	• flammable gases in air • liquids or solids with a flashpoint less than 0° C and boiling point less than 35°C • solids that can ignite spontaneously with air or moisture
3	Dangerous	• liquids or solids with a flashpoint between 0° C and 20° C
2	Caution	• liquids or solids with a flashpoint between 20° C and 50° C • solids that may be ignited readily by heat or flame
1	Low Hazard	• liquids or solids with flashpoints less than 100° C

Reactivity

Rating	Hazard	Explanation
4	Extremely Dangerous	• may explode spontaneously • may react vigorously with water • very strong oxidizing or reducing agents • monomers that may polymerize violently
3	Dangerous	• may explode if heated or detonated • reacts with water to produce heat or hazardous gases • strong oxidizing or reducing agents • may deteriorate during storage
2	Caution	• oxidizing agents that react with combustible materials to produce explosive mixtures • may undergo rapid exothermic reactions
1	Low Hazard	• materials with low reactivity

Storage

This section gives information about the storage hazard class to which each chemical belongs. The codes used are as follows:

- A—Acids (non-oxidizing)
- B—Aqueous solutions of bases
- D—Do not store—prepare or obtain as required
- F—Flammable and combustible materials
- G—Gases
- GI—General storage (inorganic chemicals)
- GO—General storage (organic chemicals)
- O—Oxidizing agents
- PD—Permanently sealed samples for display purposes
- R—Reducing agents
- S—Special storage

Disposal

The school board must arrange for waste disposal on a periodic basis. This section gives information about the disposal of each chemical. The codes used are as follows:

- A—Dilute aqueous solutions may be flushed down the drain with large amounts of water, provided that the pH is between 4 and 11.
- B—Solids in their original containers should be retained; contact the individual at the school board responsible for hazardous waste.
- C—Package separately for disposal in a labelled container. Contact the individual at school board responsible for hazardous waste.

- D—Place with non-halogenated organic solvents in a labelled container and contact the school board.
- E—Place with halogenated organic solvents in a labelled container and contact the school board.
- F—Permanently sealed samples for display purposes should be reused.
- G—Return gas cylinders to supplier.

Disposal of Biological Materials

All microbiological specimens and dissected organisms may pose a hazard and must be disposed of in a safe and environmentally appropriate manner. These wastes must be accumulated in a leak-proof, covered container and disposed of in a manner that meets all municipal, provincial, and federal regulations. Teachers or administrators should determine how this material is disposed of by their school board and follow the board's procedures.

Disposal of Chemicals

When chemicals have been used or are no longer safe to store, they must be discarded in such a way that they will not cause damage by exploding, poisoning the surroundings, starting fires, or damaging plumbing. It is essential to know the physical and chemical properties of any substance before it is discarded: state; flammability; how corrosive it is; how reactive with water and other chemicals in the sewer system such as copper, lead, and plastic; and how poisonous the substance will be to the environment at the sewer outflow.

Problems with blocked-up plumbing can be avoided if a small plastic container is provided in each sink for nonreactive solid waste. Suitable plastic containers can be made by cutting the top from laundry bleach bottles. Holes can be punched in the bottom of these containers to prevent them from filling with water. These containers should be emptied regularly.

When in doubt about the disposal of a chemical, teachers should research the chemical for appropriate procedures. If doubt still remains, the teacher should refer to the disposal list, refer to MSDS, and then, if necessary, call the school board contact.

Flammable liquid waste should never be poured down the sink drain, because the flammable vapours could accumulate in the plumbing, move to an ignition source, and cause a serious explosion. When performing experiments that result in the accumulation of flammable liquid wastes, a safety can should be provided for collection of wastes, and the teacher should dispose of the flammable liquid, according to the proper disposal procedure.

It is an excellent practice to use separate containers for flammable solid wastes and nonflammable solid wastes, especially broken glassware. The mingling of broken glassware with paper and other

trash can present a definite hazard to the custodial help performing collection and disposal.

Broken Glass and Other Sharps

Uncontaminated broken glass and other sharp materials must be packaged in sturdy, puncture-resistant containers. The container must be labelled as "Sharps—Handle with Care." The label should be signed and dated. These wastes may be deposited directly in the dumpster that serves your building.

Sharps that are contaminated with chemicals or radioactivity should be collected and packaged in the same fashion as uncontaminated sharps. In addition to the labels described above, the label must indicate the nature of the contamination. For information on the appropriate disposal route for contaminated sharps, contact the individual at your school board responsible for arranging the disposal of hazardous material.

CHEMICAL	Toxicity	Flammability	Reactivity	Storage	Disposal	COMMENTS
Acacia						• see gum arabic
Acetic acid concentrated, glacial CH_3COOH	4	2	3	F	A, C	• corrosive, flammable • dilute solutions (such as vinegar) are less hazardous • keep away from bases and oxidizing agents
Acetone, C_3H_6O	1	4	1	F	D	• highly flammable, irritant • keep away from oxidizing agents
Aluminum, Al (forms other than powder)	1	1	1	R	C, F	• powdered form is highly reactive • keep away from oxidizing agents, halogens, and acids
Aluminum chloride, $AlCl_3$	2	1	2	GI	A, C	• anhydrous compound is corrosive; reacts vigorously with water to produce corrosive and toxic acidic vapours • hydrated compound is less hazardous
Aluminum sulphate, $Al_2(SO_4)_3$	1	1	1	GI	A, C	• low hazard
Ammonia (ammonium hydroxide) concentrated, $NH_3(aq)$	3	1	3	B	C	• corrosive; releases toxic ammonia gas • keep away from acids, metals, halogens (reacts with halogens to produce highly explosive products)
Ammonium acetate NH_4CH_3COO	1	1	1	GI	A, B	• low hazard • keep away from strong oxidizing agents and acids
Ammonium chloride, NH_4Cl	2	2	2	GI	A, B	• also called sal ammoniac • causes skin and eye irritation • keep away from acids, bases, and silver and lead salts
Ammonium dihydrogen phosphate, $NH_4H_2PO_4$	1	1	1	GI	A, B	• also called monobasic ammonium phosphate • low hazard

CHEMICAL	Toxicity	Flammability	Reactivity	Storage	Disposal	COMMENTS
Ammonium hydrogen phosphate, NH_4HPO_4	1	1	1	GI	A, B	• also called dibasic ammonium phosphate • low hazard
Ammonium hydroxide						• see ammonia
Ammonium nitrate, NH_4NO_3	1	1	3	S	A, C	• highly reactive and explosive if heated • can explode at lower temperatures if contaminated • keep away from oxidizing and reducing agents, metals, and organic materials
Ammonium sulphate, $(NH_4)_2SO_4$	1	1	1	GI	C	• low hazard
Antimony, Sb (forms other than powder)	2	1	1	PD	C, F	• toxic, flammable in powdered form • keep away from oxidizing agents and acids • keep only as sealed sample for display
Baking soda						• see sodium hydrogen carbonate
Barium chloride, $BaCl_2$	3	1	1	GI	C	• highly toxic • keep away from acids and oxidizing agents
Barium nitrate, $Ba(NO_3)_2$	3	1	2	O	C	• highly toxic, oxidizing agent • keep away from reducing agents and organic and combustible materials
Basic copper (II) carbonate						• see copper (II) carbonate, basic
Benedict's solution	2	1	1	GI	C	• mixture of copper (II) sulphate, sodium carbonate, and sodium citrate • basic and corrosive
Benzoic acid, C_6H_5COOH	2	1	1	GO	C	• low hazard • keep away from bases and oxidizing and reducing agents

CHEMICAL	Toxicity	Flammability	Reactivity	Storage	Disposal	COMMENTS
Biuret reagent	2	1	1	GI	C	• mixture of copper (II) sulphate and sodium hydroxide in water solution • basic and corrosive
Bluestone						• see copper (II) sulphate
Bromothymol blue, $C_{27}H_{28}Br_2O_5S$	1	1	1	GO	A	• low hazard if dilute solutions are used
1-Butanol, C_4H_9OH	2	2	1	F	D	• flammable • irritant • keep away from oxidizing agents and reactive metals
Calcium, Ca	3	2	3	R	C	• flammable • reacts vigorously with water to produce flammable hydrogen gas • keep away from water, acids, and oxidizing agents
Calcium carbonate, $CaCO_3$	1	1	1	GI	B	• also called limestone, chalk, marble chips • reacts with acid to generate carbon dioxide gas
Calcium chloride, $CaCl_2$	2	1	1	GI	A, B	• irritant • low hazard
Calcium hydroxide, $Ca(OH)_2$	1	1	1	GI, B	A, C	• also called slaked lime • saturated $Ca(OH)_2$ is limewater • irritant
Calcium nitrate, $Ca(NO_3)_2$	1	1	3	O	A, C	• oxidizing agent • keep away from reducing agents, organic materials, and acids
Calcium oxide, CaO	3	1	3	GI	C	• also called lime • corrosive • reacts vigorously with water • keep away from water and acids

CHEMICAL	Toxicity	Flammability	Reactivity	Storage	Disposal	COMMENTS
Calcium sulphate, $CaSO_4$	1	1	1	GI	B	• also called gypsum, plaster • low hazard • keep away from aluminum powder
Carbon, C (forms other than powder)	1	1	1	GI	B	• also called graphite, charcoal • powdered form is more reactive and is a fire hazard • keep away from oxidizing agents
Carbon dioxide, CO_2	1	1	1	G	G	• solid form, known as dry ice, is very cold; will cause frostbite; handle with tongs or gloves
Chalk						• see calcium carbonate
Charcoal						• see carbon
Chlorine, Cl_2 (aqueous)	2	1	2	O	C	• handle with care • keep away from reducing agents, metals, acids, and bases
Chromium, Cr (forms other than powder)	1	1	1	PD		• powdered form is a fire hazard • keep away from acids and oxidizing agents • keep permanently sealed; only for display
Citric acid, $C_6H_8O_7$	1	1	1	GO		• low hazard • keep away from acids and oxidizing and reducing agents
Cobalt (II) chloride, $CoCl_2$	2	1	1	GI	C, F	• hexahydrate is less toxic than anhydrous
Cobalt (II) nitrate, $Co(NO_3)_2$	2	1	3	O	A, B	• oxidizing agent • keep away from reducing agents and organic material
Copper, Cu (forms other than powder)	1	1	1	GI	C	• powdered form is a fire hazard

CHEMICAL	Toxicity	Flammability	Reactivity	Storage	Disposal	COMMENTS
Copper (II)carbonate, basic, $CuCO_3.Cu(OH)_2$	3	1	1	GI	C	• also called cupric carbonate, basic copper (II) carbonate • toxic • reacts with acids to produce co_2 gas
Copper (II) chloride, $CuCl_2$	3	1	1	GI	C, F	• also called cupric chloride • toxic
Copper (II) nitrate, $Cu(NO_3)_2$	2	1	3	O	C	• also called cupric nitrate • oxidizing agent • keep away from reducing agents and organic material
Copper (II) oxide, CuO	2	1	1	GI	C	• also called cupric oxide • keep away from reducing agents and metals
Copper (II) sulphate, $CuSO_4$	2	1	1	GI	C	• also called bluestone, cupric sulphate • toxic; irritant • available as pentahydrate or anhydrous
Cream of tartar						• see potassium hydrogen tartrate
Cupric carbonate						• see copper (II) carbonate
Cupric chloride						• see copper (II) chloride
Cupric nitrate						• see copper (II) nitrate
Cupric oxide						• see copper (II) oxide
Cupric sulphate						• see copper (II) sulphate
Dextrose						• see glucose
Dry ice						• see carbon dioxide
Epsom salts						• see magnesium sulphate
Ethanol, C_2H_5OH	1	3	1	F	D	• also called ethyl alcohol • flammable • denatured alcohol is poisonous • keep away from oxidizing agents, metals, and acids

CHEMICAL	Toxicity	Flammability	Reactivity	Storage	Disposal	COMMENTS
Ethyl acetate, $CH_3COOC_2H_5$	1	4	1	F	D	• highly flammable • keep away from oxidizing agents
Ethyl alcohol						• see ethanol
Ethylene glycol, $C_2H_6O_2$	2	1	1	GO	D	• also called antifreeze • toxic if ingested • keep away from oxidizing agents
Ferric chloride						• see iron (III) chloride
Ferric nitrate						• see iron (III) nitrate
Ferric oxide						• see iron (III) oxide
Ferrous sulphate						• see iron (II) sulphate
Gelatin	1	1	1	GO	A, B	• low hazard
Germanium, Ge	1	1	1	PD	C, F	• powdered form is flammable • keep away from oxidizing agents • keep permanently sealed; only for display
Glucose, $C_6H_{12}O_6$	1	1	1	GO	A, B	• also called dextrose • low hazard
Glycerin						• see glycerol
Glycerol, $C_3H_8O_3$	1	1	1	GO	A	• also called glycerin • low hazard • keep away from oxidizing agents as violent reactions can occur
Graphite						• see carbon
Gum arabic	1	1	1	GO	C	• also called acacia • low hazard • keep away from oxidizing agents
Gypsum						• see calcium sulphate

CHEMICAL	Toxicity	Flammability	Reactivity	Storage	Disposal	COMMENTS
Hydrochloric acid, concentrated, $HCl_{(aq)}$	3	1	3	A	A, C	• also called muriatic acid • corrosive • keep away from bases and metals • dilute solutions are less hazardous
Hydrogen peroxide (3%)	1 4	11	14	O O	A C	• Oxidizing agent • Keep away from reducing agents, organic materials, and metals
Iodine	2	1	2	GI	C	• Corrosive • Irritating vapour • Keep away from metals, ammonia
Iron, Fe (forms other than powder)	1	1	1	GI	C	• Often in the form of steel wool • Powdered form is a fire hazard • Keep away from oxidizing agents, acids, and non-metals
Iron (III) chloride, $FeCl_3$	2	1	1	GI	A, B	• also called ferric chloride • corrosive • anhydrous compound reacts vigorously with water producing acidic vapours • keep away from oxidizing agents and alkali metals
Iron (III) nitrate, $Fe(NO_3)$	2	1	2	O	A, C	• also called ferric nitrate • oxidizing agent; irritant • keep away from reducing agents, and organic material
Iron (III) oxide, Fe_2O_3	1	1	1	GI	B	• also called ferric oxide • low hazard
Iron (II) sulphate, $FeSO_4$	2	1	1	GI	C	• also called ferrous sulphate • low hazard
Isopropanol						• see 2-propanol
Lead, Pb (forms other than powder)	2	1	1	GI	C	• powdered form is a fire hazard • chronic exposure can cause poisoning

CHEMICAL	Toxicity	Flammability	Reactivity	Storage	Disposal	COMMENTS
Lead (II) nitrate, $Pb(NO_3)_2$	2	1	3	O	C	• oxidizing agent • chronic exposure can cause poisoning
Lead (II) oxide, PbO_2	2	1	1	GI	C	• chronic exposure can cause poisoning
Lime						• see calcium oxide
Limestone						• see calcium carbonate
Limewater						• see calcium hydroxide
Lithium, Li	4	4	4	R	C	• flammable solid • reacts with water forming flammable h_2 gas • store under mineral oil • keep away from air, water, oxidizing agents, and acids
Lithium chloride, LiCl	2	1	1	GI	C	• low hazard
Litmus	1	1	1	GO	A, B	• low hazard
Lugol's iodine stain	2	1	1	GI	C	• this is a solution of iodine in water • irritant • keep away from metals and ammonia
Lye						• see sodium hydroxide
Magnesium, Mg (forms other than powder)	1	2	2	R	C	• powdered form is highly reactive and flammable • reacts with water to form flammable H_2 gas • keep away from water, oxidizing agents, and water
Magnesium sulphate, $MgSO_4$	1	1	1	GI	C	• heptahydrate is called epsom salts • low hazard
Manganese dioxide						• see manganese (IV) oxide

CHEMICAL	Toxicity	Flammability	Reactivity	Storage	Disposal	COMMENTS
Manganese (IV) oxide, MnO_2	2	1	2	S	C	• also called manganese dioxide • oxidizing agent • keep away from other oxidizing agents, reducing agents, and organic material
Marble chips						• see calcium carbonate
Methane, CH_4	1	4	1	G	G	• flammable gas • simple asphyxiant • keep away from oxidizing agents
Methanol, CH_3OH	2	3	1	F	D	• also called methyl alcohol; wood alcohol • flammable • toxic • ingestion can cause blindness • keep away from oxidizing agents and metals
Methyl alcohol						• see methanol
Methylene blue, $C_{16}H_{18}ClN_3S$	2	1	1	GO	A	• dilute solutions are low hazard
Methylene chloride						• see dichloromethane
Mineral oil	1	1	1	GO	D	• also called paraffin oil • possibly carcinogenic if inhaled • combustible • keep away from oxidizing agents
Muriatic acid						• see hydrochloric acid
Nickel, Ni (forms other than powder)	2	1	1	GI	C, F	• powdered form is a fire hazard and possible carcinogen • keep away from oxidizing agents
Nickel (II) chloride, $NiCl_2$	2	1	1	GI	C	• toxic • irritant

CHEMICAL	Toxicity	Flammability	Reactivity	Storage	Disposal	COMMENTS
Nickel (II) nitrate, $Ni(NO_3)_2$	2	1	3	O	C	• oxidizing agent • toxic • keep away from reducing agents, organic material
Nitric acid, concentrated, HNO_3	4	1	4	O	A, C	• corrosive • oxidizing agent • dilute solutions are less hazardous but still require care • keep away from reducing agents, organic materials, and metals
Nitrogen, N_2	1	1	1	G	G	• simple asphyxiant • liquid form is extremely cold; handle with insulated gloves
Oil of cloves	1	1	1	GO	D	• low hazard
Paraffin oil						• see mineral oil
Phenolphthalein, $C_{20}H_{14}O_4$	2	1	1	GO	A, B	• dilute solutions are low hazard
Phenyl 2-hydroxybenzoate, $C_{13}H_{10}O_3$	2	1	1	GO	C	• also called salol, phenyl salicylate • low hazard
Phenyl salicylate						• see phenyl 2-hydroxybenzoate
Phosphoric acid, concentrated, H_3PO_4	3	1	4	A	A, C	• corrosive • keep away from metals and bases
Phosphorus, red, P_4	2	2	2	GI	C	• flammable solid • toxic • keep away from oxidizing agents, metals, organic materials, and bases
Plaster						• see calcium sulphate
Potassium bitartrate						• see potassium hydrogen tartrate
Potassium bromide, KBr	1	1	1	GI	A,B	• low hazard

CHEMICAL	Toxicity	Flammability	Reactivity	Storage	Disposal	COMMENTS
Potassium chlorate, $KClO_3$	2	1	4	O	C	• oxidizing agent • may form explosive mixtures with combustible material • keep away from reducing agents, organic material, metals, and non-metals
Potassium chloride, KCl	2	1	1	GI	A, B	• low hazard
Potassium chromate, K_2CrO_4	2	1	4	O	C	• oxidizing agent • carcinogen • keep away from reducing agents, and organic material
Potassium dichromate, $K_2Cr_2O_7$	3		2	O	C	• oxidizing agent • carcinogen • keep away from reducing agents, and organic material
Potassium hydrogen tartrate, $KHC_4H_4O_6$	1	1	1	GO	A, B	• also called potassium bitartrate, cream of tartar • low hazard
Potassium iodide, KI	2	1	1	GI	C	• low hazard • keep away from oxidizing agents
Potassium nitrate, KNO_3	2	1	3	O	A, C	• oxidizing agent • can form explosive mixtures with combustible material • keep away from reducing agents and organic material
Potassium permanganate, $KMnO_4$	2	1	3	O	C	• oxidizing agent • keep away from reducing agents, organic material, and acids
Potassium thiocyanate, KSCN	2					• toxic • keep away from acids
Propane, C_3H_8	1	1	2	GI	C	• flammable gas • simple asphyxiant • keep away from oxidizing agents

CHEMICAL	Toxicity	Flammability	Reactivity	Storage	Disposal	COMMENTS
2-propanol, $(CH_3)_2CHOH$	2	4	1	G	G	• also called isopropanol, rubbing alcohol • flammable • toxic if ingested • keep away from oxidizing agents
Sal ammoniac		3	1	F	D	• see ammonium chloride
Salol						• see phenyl 2-hydroxybenzoate
Sand						• see silicon dioxide
Silica gel						• see silicon dioxide
Silicon, Si (forms other than powder)	1	2	2	PD	C, F	• powdered form is flammable • keep away from oxidizing agents • keep permanently sealed; only for display
Silicon dioxide, SiO_2	1		1	GI	B	• also called silicon (IV) oxide, silica gel, sand • finely powdered form can cause lung damage if inhaled
Silicon (IV) oxide						• see silicon dioxide
Silver, Ag (forms other than powder)	1	1	1	GI	C, F	• powdered form is a fire hazard • toxic by inhalation
Silver nitrate, $AgNO_3$	3	1	3	O	C	• oxidizing agent • toxic, corrosive • keep away from reducing agents, organic material, and ammonia
Slaked lime						• see calcium hydroxide

CHEMICAL	Toxicity	Flammability	Reactivity	Storage	Disposal	COMMENTS
Sodium, Na	4	4	4	R	C	• flammable solid • reacts vigorously with water to produce flammable H_2 gas; can spontaneously ignite in moist air • store under mineral oil away from air • keep away from water, acids, and oxidizing agents
Sodium acetate, CH_3COONa	1	1	1	GI	A, B	• low hazard • keep away from oxidizing agents
Sodium bicarbonate						• see sodium hydrogen carbonate
Sodium bisulphate						• see sodium hydrogen sulphate
Sodium bromide, NaBr	1	1	1	GI	A, B	• low hazard
Sodium carbonate, Na_2CO_3	2	1	2	GI	A, C	• also called washing soda • corrosive and basic • reacts vigorously with acids to form CO_2
Sodium chloride, NaCl	1	1	1	GI	A, B	• low hazard
Sodium chromate, Na_2CrO_4	2	1	2	O	C	• oxidizing agent • carcinogen • keep away from reducing agents and organic material
Sodium dihydrogen phosphate, NaH_2PO_4	1	1	1	GI	A, B	• also called sodium phosphate, monobasic • low hazard
Sodium hydrogen carbonate, $NaHCO_3$	1	1	1	GI	A, B	• also called sodium bicarbonate, baking soda • low hazard • reacts vigorously with acids to form CO_2
Sodium hydrogen phosphate, Na_2HPO_4	1	1	1	GI	A, B	• also called sodium phosphate, dibasic • low hazard

CHEMICAL	Toxicity	Flammability	Reactivity	Storage	Disposal	COMMENTS
Sodium hydrogen sulphate, $NaHSO_4$	2	1	2	GI	A, C	• also called sodium bisulphate • acidic • corrosive
Sodium hydroxide, NaOH	4	1	4	GI, B	A, C	• also called lye • highly corrosive • keep away from acids and metals
Sodium iodide, NaI	1	1	1	GI	C	• low hazard • keep away from oxidizing agents
Sodium nitrate, $NaNO_3$	1	1	3	O	A, C	• oxidizing agent • can form explosive mixtures with combustible material • keep away from reducing agents, organic materials, and metals
Sodium phosphate, Na_3PO_4	2	1	1	GI	A, B	• also called sodium phosphate, tribasic; trisodium phosphate, TSP • basic, corrosive
Sodium phosphate, monobasic						• see sodium dihydrogen phosphate
Sodium phosphate, dibasic						• see sodium hydrogen phosphate
Sodium phosphate, tribasic						• see sodium phosphate
Sodium sulphate, Na_2SO_4	1	1	1	GI	A, B	• low hazard
Sodium sulphite, Na_2SO_3	2	1	2	GI	C	• reducing agent • reacts with acids to form toxic SO_2 gas • keep away from oxidizing agents and acids
Sodium thiosulphate, $Na_2S_2O_3$	1	1	1	GI	A, B	• low hazard • reacts with acids to form toxic SO_2 gas

CHEMICAL	Toxicity	Flammability	Reactivity	Storage	Disposal	COMMENTS
Stannous chloride						• see tin (II) chloride
Starch	1	1	1	GO	A, B	• low hazard
Steel wool						• see iron
Strontium chloride, $SrCl_2$	2	1	1	GI	C	• low hazard
Sucrose, $C_{12}H_{22}O_{11}$	1	1	1	GO	A, B	• also called table sugar • low hazard
Sulphur, S_8	1	2	1	GI	C	• combustible solid • keep away from oxidizing agents, reducing agents, and metals
Sulphuric acid, concentrated, H_2SO_4	4	1	4	A	A, C	• highly corrosive and reactive • dilute solutions are less hazardous • keep away from bases, reducing agents, organic material, metals, and oxidizing agents
Table sugar						• see sucrose
Tartaric acid, $C_4H_6O_6$	1	1	1	GO	A, B	• low hazard
Tin, Sn (forms other than powder)	1	1	1	GI	C	• powdered form is a fire hazard
Tin (II) chloride, $SnCl_2$	2	1	2	GI	C	• also called stannous chloride • irritant • keep away from reducing agents, oxidizing agents, and metals
Toluidine blue, $C_{15}H_{16}ClN_3S$	2	1	1	GO	A	• dilute solutions are low hazard
1,1,1-Trichloroethane	1	1	1	GO	E	• irritant • keep away from metals and bases
1,1,2-Trichlorotrifluoroethane, $C_2Cl_3F_3$	1	1	1	GO	E	• keep away from metals
Washing soda						• see sodium carbonate

CHEMICAL	Toxicity	Flammability	Reactivity	Storage	Disposal	COMMENTS
Wood alcohol						• see methanol
Zinc, Zn (forms other than powder)	1	2	2	R	C	• reducing agent • powdered form is reactive • mixtures with combustible materials may ignite in contact with moist air • keep away from non-metals, oxidizing agents, acids, and organic materials
Zinc (II) nitrate, $Zn(NO_3)_2$	1	2	3	O	A, C	• oxidizing agent • keep away from reducing agents, organic material, and non-metals
Zinc (II) sulphate, $ZnSO_4$	2	1	1	GI	A, C	• low hazard

Appendix C: Sample List of Chemical Suppliers

Boreal Laboratories Ltd.
399 Vansickle road
St. Catharines ON L2S 3T4
Phone: (800) 387-9393
Fax: (800) 668-9106
www.boreal.com

Carolina Biological Supply Company
PO Box 6010
Burlington NC USA 27216-6010
Phone: (800) 334-5551
Fax: (800) 222-7112
www.carolina.com

Central Scientific Company (CENCO)
401 Vansickle Road
St. Catharines ON L2S 3T6
Phone: (800) 268-4355 or (905) 984-8800
Fax: (905) 984-5118
www.cenconet.com

Fisher Scientific
PO Box 4508, Station E
Ottawa ON K1S 5A9
Phone: (800) 267-3556 or (613) 228-0542
Fax: (800) 463-2996 or (613) 226-7658
E-mail: help@fishersci.ca
www.fishersci.ca

Merlan Scientific
247 Armstrong Ave
Georgetown ON L7G 4X6
Phone: (800)387-2474
Fax: (905)877-0929
www.merlan.ca

Northwest Scientific Supply Company
301-3060 Cedar Hill Road
PO Box 6100, LCD1
Victoria BC V8P 5L4
Phone: (800) 663-5890 or (250) 592-2438
Fax: (800) 797-5773 or (250) 592-1341
E-mail: service@newscience.com
www.newscience.com

Sargent Welch-Cenco
403 Vansickle Road
St. Catharines ON L2S 3Z7
Phone: (800) 727-4368
Fax: (800) 676-2540

Wards
397 Vansickle Road
St. Catharines ON L2S 3T5
Phone: (800) 387-7822
Fax: (905) 984-5952
www.wardsci.com

Appendix D: Sample Science Classroom Inspection

Item to Be Inspected	Safe	Unsafe	Action
Are fire exits and route signs legible and easily seen by all?			
Are ceiling and exit doors free of combustible materials such as artwork, posters, paper, etc? As a guideline, no more than 20 percent of the total wall surface (including boards, cupboards, windows, etc.) should be covered with combustible materials.			
Where there is an exit door is there a clear path through classroom furniture? As a general guideline, the width of the clear path should be the same width as the door(s).			
Are CSA approval labels on all electrical equipment?			
Are electrical outlets, cover plates, and wall switches secure and undamaged?			
Are extension cords in good condition and used for temporary purposes only?			
Are multi-use cords equipped with power bars?			
Do windows open easily and stay open according to their design?			
Are air quality, temperature, and ventilation acceptable to meet applicable standards? Concern may be determined by conversation with occupants of the classroom.			
Are ventilation and heating ducts kept unobstructed by books, paper, etc.?			
Are ceiling tiles in place, unbroken, and with no sign of mold formation?			
Are the ceiling, walls, and floor free of water leaks?			
Are floor tiles or carpeting securely fastened to reduce tripping hazards?			

Item to Be Inspected	Safe	Unsafe	Action
Are shelves or shelving units firmly anchored to the wall? Storage of all items should follow the following guide: heavy objects on low shelves, light objects on high shelves, and breakable objects such as glass items on low shelves.			
Are step stools or small ladders available for accessing items stored on high shelves?			
Is storage on top of wall-mounted cupboards limited to lightweight objects such as empty boxes?			
Do paper cutters have guards in place and is the torsion spring adjusted to hold the blade up when released?			
Are first-aid stations available?			
Are chemical containers kept closed when not in immediate use?			
Is local ventilation, such as a fume hood, used when transferring chemicals from one container to another?			
Are desktop exhaust vents fully operational and clear of debris?			
Is the fume hood, if present, used for chemical transfer only, not for storage?			
If natural light is not available, is there emergency lighting in the science lab and prep room?			
Is there a dolly available to move large objects?			
Are specimens bagged for disposal? Preserved specimens are not biological hazards and can be bagged for disposal in the regular garbage.			
Are teacher workstations located outside the chemical area?			
Is there an accessible fire extinguisher (CO_2 or dry chemical type) wall-mounted in each science room and prep room? Does the extinguisher have an inspection tag indicating the date of the inspection?			
Is the natural gas emergency shut-off valve location clearly marked (where classroom has gas supply)? Is there clear access to gas shut-off valves?			

Item to Be Inspected	Safe	Unsafe	Action
Are eyewash stations available and operational? The location should be clearly marked using standard signs and regular testing should be in place.			
Is personal protective equipment (PPE) available and used (e.g., goggles, face shields, aprons, and gloves)?			
Are WHMIS workplace labels on all decanted chemicals or where original labels are missing or illegible?			
Are all chemicals clearly labelled?			
Are MSDSs available for all hazardous chemicals?			
Is there an up-to-date inventory of chemicals being stored?			
Are quantities of all chemicals kept as low as possible; are all chemicals present required for the program?			
Are corrosive chemicals stored in a mechanically vented storage cabinet?			
Are flammable chemicals stored in approved storage cabinets?			

Appendix E: Safety for Science Students

Many schools have a science safety contract for their students. This information connects to the responsibilities of science students.

- Maintain quiet, orderly behaviour during laboratory periods.
- Always be alert. Take care not to bump another student. Remain in your lab station while performing an experiment; an unattended experiment could result in an accident.
- Study the procedure of the experiment before performing it. If you are uncertain about the correct procedure to be followed, ask the teacher.
- Advise your teacher of any medical condition (contact lenses, allergies, respiratory problems, etc.) that might be aggravated by a particular experiment.
- Never attempt unauthorized experiments. No laboratory work may be carried on without the teacher's permission. Do not begin an experiment until directed to do so by the teacher.
- Each student should be provided with his/her own lab coat in chemistry labs and, where appropriate, in other science courses.
- Avoid loose, bulky clothing, such as winter jackets, coats, etc., and dangling jewellery. Sandals, and bare feet are prohibited. Keep long hair tied back, especially when an open flame is nearby.
- Never bring food or drink into the laboratory, and do not drink or eat from lab equipment.
- The storage room is out of bounds to all students except when permission has been granted to individuals by the teacher.
- Student backpacks should be stored separately from lab work places.
- Stand up while doing an experiment unless directed otherwise by the teacher.
- Never wear expensive clothing when laboratory work is to be done.

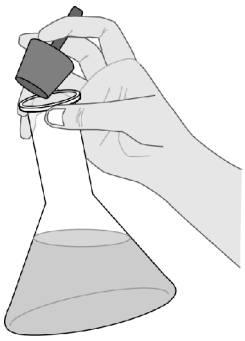
Personal Protection

- Wear safety glasses or face shields when instructed to do so by your teacher.
- Know the location and correct operation of all safety equipment.
- The most common type of student injury is a burn caused by touching objects that have just been heated. Determine whether an object is hot by bringing the back of your hand up close.

Lab Practices

- Keep all work areas clean and tidy. Clean and wipe dry all desks, tables, or laboratory work areas at the end of each laboratory activity.
- Never carry hot equipment or dangerous chemicals through a crowd of students.
- Always waft odours towards your nose with your hand. Never breathe them directly.
- Wash your hands after handling any chemicals. Check with your teacher to see if gloves should be worn.
- Learn to light a Bunsen burner correctly. Keep your head back from the burner during the process.
- Never leave an almost colourless Bunsen burner flame unattended. If the burner is to be kept lit, shut off the air vent and decrease the gas supply to produce a flame resembling that of a candle.
- Use a water bath when heating corrosive liquids in a test tube.
- Use the proper type of tongs when handling hot crucibles or beakers. The crucible must be held at the very end of the crucible tongs. Place a hot crucible on a ceramic square or on the base of a ring stand. Do not allow hot objects to contact the laboratory table top.
- When evaporating a solution to dryness in an evaporating dish, place a watch glass over the dish as protection from spattering.
- When removing an electric plug from its socket, pull the plug and not the cord. Report frayed cords to the teacher. Bare electrical wires can be extremely dangerous.

Chemicals



- Never taste chemicals. Use caution when handling all chemicals.
- Mercury is highly toxic. (**Note**: Mercury is prohibited.) Never handle it with your bare hands. Report any spilled or exposed mercury. It will ruin gold and silver jewellery on contact.
- Learn and use the correct method for pouring chemicals from reagent bottles. Hold the glass stopper above the hand and between the index and the middle finger so the same hand can grasp the bottle.
- When pouring chemicals from a beaker, use a stirring rod to direct the flow.
- Be especially careful with organic solvents—many are highly flammable and some are toxic.

Glassware

- Report sharp edges on prisms, mirrors, glass plates, metal objects, etc., to the teacher so they can be removed or repaired. Do not work with glass tubing that has jagged edges or edges that have not been fire polished.
- Check glass tubing to ensure that the flow of gas is not obstructed.

- Place broken glassware in a container provided for that purpose. Be especially careful not to leave broken glass on benches or in sinks. Use a separate container for insoluble residues. Never empty these into the sink.
- When heating a liquid or solid in a test tube, keep the tube moving in the flame. Hold the tube at an angle and heat the tube evenly on the sides and bottom. Point the tube's mouth away from others.
- Clamp Erlemeyer flasks and beakers to ring stands in addition to supporting them on wire gauze and a ring.

Disposal

- Dispose of chemicals and specimens as instructed by the teacher.
- Flush sink drains thoroughly after using chemicals if they are disposed of in the sink.
- Never return unused solutions to stock containers or reagent bottles.

First Aid

- Rinse any skin burn immediately with lots of water. If an eye is involved, irrigate it without interruption for a minimum of 15 minutes. Refer to the Material Safety Data Sheet (MSDS) for the chemical involved for specific directions.
- Report all injuries to the teacher immediately, regardless how minor.

Spills

- Beware of what appears to be drops of water on laboratory benches. They may be corrosive liquid.
- Report all breakages and spilled chemicals to the teacher.

Appendix F: Animal Experimentation

- All experiments must be carried out under the supervision of a teacher. It is the responsibility of the teacher to ensure that students have the necessary comprehension for the study to be undertaken.

- Biological experimentation is essential for an understanding of life processes. Such studies should lead to a respect for all living things. Capable students, anxious to pursue a career in biological sciences, must receive the necessary encouragement and direction. All aspects of the project must be within the comprehension and capabilities of the student undertaking the study.

- Lower orders, such as bacteria, fungi, protozoa, and insects, can reveal much basic biological information. If experiments are to be conducted on living subjects for science projects, then only lower orders of life may be used.

- Students should not be allowed to take animals home for the purpose of carrying out experimental studies. All studies involving animals **must** take place in a suitable area in the school.

- **Vertebrate animals are not to be used in experiments for projects, with the following exceptions**:
  - observations of normal living patterns of wild animals in their free habitats or in zoological parks, gardens, or aquaria
  - observations or normal living patterns of pets, fish, or domestic animals

- Observational studies may be used in science only on chicken egg embryos. If egg embryos are subjected to experimental manipulations, the embryo must be destroyed humanely two days prior to hatching. If normal egg embryos are to be hatched, satisfactory humane provisions must be made for disposal of the chicks. If such arrangements cannot be made, then the chicken embryos must be destroyed on the 19^{th} day of incubation. No eggs capable of hatching may be exhibited in science projects.

- Cells purchased or acquired from biological supply houses or research facilities may be used in science projects. (**Note**: Guidelines from this document **prohibit** the use of mammalian cells, tissues, plasma, or serum.)

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Some of the references consulted in the preparation of this safety manual are listed below.

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