SAFETY

in the

Science Classroom

2006

Alberta EDUCATION

SAFETY
in the
Science
Classroom

Kindergarten to Grade 12

2006

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Note: All Web site addresses were confirmed as accurate at the time of publication but are subject to change.

The primary intended audience for this document is:

Administrators	✓
Counsellors	✓
General Audience	✓
Parents	
Students	✓
Teachers	✓

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Beaker Tongs
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Table of Contents

Introduction

Hands-on activities are a fundamental part of science learning. In early grades, student's exploratory activities with materials provide the starting point for their concept and skill development. In later grades, students learn the techniques of controlled investigation and experimentation and, through practice, develop the skills of science inquiry and problem solving. Laboratory activities provide the starting point for understanding the nature of science and the interplay of evidence and theory.

The challenge for schools is to offer science activities that are both educationally rewarding and safe. This result can only be achieved through a team effort, involving all of those who set and administer school policies, design and maintain the learning environment, plan and deliver science programs, and select and prepare the materials used.

The goal of this K–12 science safety resource is to bring together information needed by administrators, planners, teachers and support staff to help them make sound decisions regarding science safety. The document identifies areas for decision making and action at a variety of levels. It supports planning and action by providing information on safety legislation and standards, safety hazards, and example procedures for eliminating or minimizing hazards.

The materials in this safety resource have been compiled from sources believed to be reliable and accurate; and to represent the best of current thinking on the subject. This resource is intended to serve as a starting point for planning good practices, but does not purport to specify the level of technical detail that some users may require, or to have anticipated every circumstance where safety may be a factor.

Alberta Education thus cannot assume responsibility for the validity or completeness of the information provided or for the consequences of its use. It can neither be assured that all necessary warnings and precautionary measures are contained herein, nor that additional information or measures may not be required due to particular exceptional circumstances.

PART A: GENERAL SAFETY MANAGEMENT

Chapter 1
Starting Points for Planning and Policy Setting

OVERVIEW

This chapter sets the stage for safety planning for science classrooms. The chapter outlines the roles of key stakeholders, and lists sample actions that are appropriate to these roles. It also summarizes legislative requirements that impact on planning for science safety. Finally, it provides general guidelines for promoting safety.

DUE DILIGENCE: AN APPROACH TO SCIENCE SAFETY

A first step in planning for science safety is to become aware of the potential hazards that science activities may present. Further steps focus on minimizing risks by taking reasonable safety precautions—in other words, by acting with due diligence.

In a legal context, due diligence means taking all reasonable steps to prevent accidents and injuries, thus avoiding the assumption of legal liability. However, due diligence is more than just a legal concept; it is a positive approach to avoiding accidents and injuries by identifying possible hazards, planning precautionary actions, and fulfilling one's responsibilities. This more general definition provides a common sense starting point for safety planning.

Principals, administrators, teachers and other staff can demonstrate due diligence by taking action in the following three key areas:

- ensuring awareness of potential risks and the related safety regulations
- ensuring staff competency in meeting these regulations, thereby avoiding unnecessary risk
- implementing monitoring and compliance strategies to ensure that regulations are met.

Awareness of Legislated Safety Requirements

Principals, administrators, teachers and other personnel need to know about the legislated requirements that apply to science programs offered in their schools. It is important to know about these regulations not only because they are legal obligations, but also because they help educators to better understand potential risks and the preventative measures that can be taken. Relevant legislation and requirements are summarized in this chapter inasmuch as they relate to safe practices in the science classroom. For access to the actual legislation, regulation, code or bylaw itself see Appendix J for the Web site addresses.

Staff Competency

As outlined in section 8 of the Teachers Code of Conduct, Alberta Teachers' Association (ATA) and section 13 of the *Occupational Health and Safety Regulation*, AR 62/2003, it is essential that teachers and other staff who perform potentially dangerous tasks are competent to handle these tasks. Competency means being aware of risks and properly trained in relevant procedures. One of the legal responsibilities of administrators is to develop and implement plans to provide staff this knowledge and training.

Evidence of staff competency may be required by provincial inspectors or investigators. For example, if a teacher was burned while handling chemicals in a science preparation area, a provincial investigator would determine whether the teacher:

- had received Workplace Hazardous Materials Information System (WHMIS) training
- knew where information on the chemicals was available
- knew how to use the appropriate safety equipment.

If the investigator found that the teacher was not competent to handle the chemicals, his or her employer could be held liable and charged under the Alberta Occupational Health and Safety legislation.

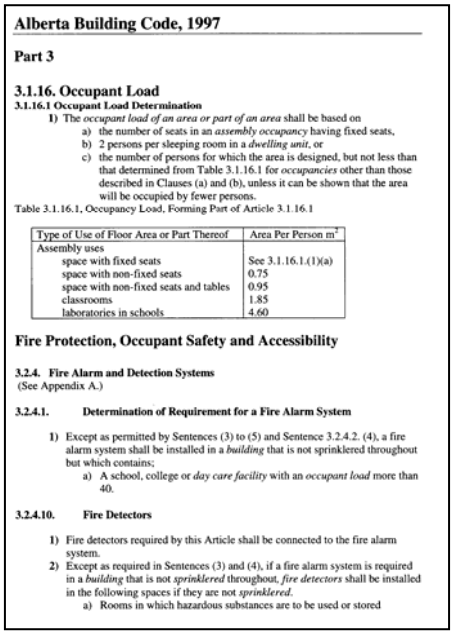
Monitoring and Compliance

The third area of due diligence involves monitoring work environments and activities to ensure compliance with health and safety legislation. For principals and administrators, this means monitoring their schools or work sites to make sure that staff comply with legislation and work in a safe and healthy manner. For teachers and other staff, it means identifying and following safe procedures, and reporting situations that create potential risks.

Monitoring and compliance can be supported by:

- discussing safety at staff meetings regularly
- reviewing plans, practices and responsibilities related to science safety periodically
- developing processes to keep staff aware of changes in legislation

- communicating regularly and sharing information on safety issues (for example, if an individual encounters a problem with a piece of equipment, he or she makes others in the school and district aware of the problem)
- evaluating unusual activities for safety considerations, and dealing with any health and safety issues before the activity begins
- reporting any violations of legislative requirements or district policy, using appropriate procedures
- giving regular attention to the following areas in planning:
  - emergency preparedness. Are plans updated as required to reflect changes? Are students' home telephone numbers current? Are drills conducted regularly?
  - hazard identification and control. Are hazards identified, evaluated and dealt with appropriately? Are inspections conducted regularly? Are recommendations dealt with promptly?
  - accident/incident reporting and investigation. Are all accidents reported to appropriate authorities as required? Has a near-miss incident-reporting system been set up and is it working effectively? Have incident statistics been analyzed and are appropriate actions being taken in response?
  - environmental protection. Are all releases (leaks or spills) being reported? Is hazardous waste being properly identified, stored and disposed of from the school?
  - safe work practices. Are safe operating procedures in place or being developed for hazardous activities? Are staff trained in these procedures? Are Material Safety Data Sheets accessible to staff in electronic or hard copy format?
  - training. Are all new staff given safety orientation training? Are existing staff members trained as necessary? Are training records kept?



Alberta Building Code, 1997

Part 3

3.1.16. Occupant Load

3.1.16.1 Occupant Load Determination

1) The *occupant load of an area or part of an area* shall be based on
- a) the number of seats in an *assembly occupancy* having fixed seats,
- b) 2 persons per sleeping room in a *dwelling unit*, or
- c) the number of persons for which the area is designed, but not less than that determined from Table 3.1.16.1 for *occupancies* other than those described in Clauses (a) and (b), unless it can be shown that the area will be occupied by fewer persons.

Table 3.1.16.1, Occupancy Load, Forming Part of Article 3.1.16.1

Type of Use of Floor Area or Part Thereof	Area Per Person m^2
Assembly uses	
space with fixed seats	See 3.1.16.1.(1)(a)
space with non-fixed seats	0.75
space with non-fixed seats and tables	0.95
classrooms	1.85
laboratories in schools	4.60

Fire Protection, Occupant Safety and Accessibility

3.2.4. Fire Alarm and Detection Systems
(See Appendix A.)

3.2.4.1. Determination of Requirement for a Fire Alarm System

1) Except as permitted by Sentences (3) to (5) and Sentence 3.2.4.2. (4), a fire alarm system shall be installed in a *building* that is not sprinklered throughout but which contains;
- a) A school, college or *day care facility* with an *occupant load* more than 40.

3.2.4.10. Fire Detectors

1) Fire detectors required by this Article shall be connected to the fire alarm system.

2) Except as required in Sentences (3) and (4), if a fire alarm system is required in a *building* that is not *sprinklered* throughout, *fire detectors* shall be installed in the following spaces if they are not *sprinklered*.
- a) Rooms in which hazardous substances are to be used or stored

KEY PLAYERS: ROLES AND RECOMMENDED ACTIONS

Responsibility for ensuring safety in the science classroom is shared by many members of the educational system, including:

- Alberta Education
- universities and colleges
- school boards and superintendents
- school administrators
- science teachers
- science technicians
- science students
- parents
- educational assistants
- volunteers.

Individuals in each of these groups have roles to play in promoting safety in the science classroom. Example role statements and recommended actions to fulfill each role are described below. Roles frequently overlap, and need to be aligned with local circumstances. For example, some schools employ science technicians to help teachers prepare materials for laboratory activities whereas in other schools, materials preparation is done directly by the teacher. Whatever the staffing pattern may be, it is up to everyone involved to work together as a team to ensure that responsibilities are determined, understood and fulfilled.

Alberta Education

Role: Make safety information available to Alberta schools.

Recommended Actions

- Develop and/or authorize resources that offer information and guidelines on safety in science classrooms and laboratories.
- Periodically update authorized science safety resources.
- Provide information sessions to highlight safety roles, strategies and resources.

Universities and Colleges

Role: Make safety information available to education students who take courses in science curriculum and instruction.

Recommended Actions

- Include safety knowledge and skills into curriculum and instruction courses delivered to students prior to their participation in classroom practicums.

School Boards and Superintendents

Role: Provide leadership and resources to support science safety.

Recommended Actions

- Develop safety policies and procedures consistent with current legislated requirements, and facilitate the implementation of these policies.
- Ensure that school and district staff carry out their safety responsibilities.
- Provide training and support to ensure staff competency.
  - Ensure that each school has staff trained in first aid and emergency care.
  - Ensure that staff are trained in the Workplace Hazardous Materials Information System (WHMIS) and in Transportation of Dangerous Goods (TDG), as required.
- Make staff assignments that support safe operation of science facilities on an ongoing basis, e.g., by assignment of science department heads or science technicians.
- Establish a system to monitor the effectiveness of safety policies and practices in their schools.
- Establish a system to periodically assess the adequacy of science facilities and safety equipment in each school, and provide for their ongoing maintenance.
- Make provisions for the safety of students with special needs or language difficulties.
- Request and/or direct safety and health investigations.

School Administrators

Role: Ensure safe policies and practices are in place at the school level, and support teachers in providing a safe working environment.

Recommended Actions

- Ensure that staff have required safety training and expertise.
  - Ensure that teachers and substitute/supply teachers of science have the expertise to teach the assigned curriculum safely.
  - Ensure that staff who handle hazardous materials and prepare laboratories have the expertise to do so safely.
  - Enable teachers and technicians to obtain training in science safety—in particular, to become familiar with the *Occupational Health and Safety Regulation*, AR 62/2003, to meet the requirements of the Workplace Hazardous Materials Information System (WHMIS) and the *Transportation of Dangerous Goods Act*.
  - Ensure proper disposal of chemical and organic wastes, in accordance with the *Environmental Protection and Enhancement Act*, R.S.A. 2000, c. T-2, *Canada Water Act*, R.S.C. 1985, c. C-11 and local bylaws.

- In setting policies and practices for school organization, give consideration to:
  - the numbers of students per science class
  - classroom size and facilities
  - curricular requirements.
- Ensure that facilities used for science activities are safe and appropriate for the activities carried out in them, and that necessary safety equipment is available. (See the Safety Equipment and Supplies section in Chapter 3 for further information.)
- Implement and maintain safe storage and waste disposal systems for hazardous substances used or produced in the school.
- Ensure that procedures are in place for hazard reporting, and that all safety concerns regarding facilities, equipment and procedures are addressed.
- Ensure that schools have effective policies and practices to follow in case of accidents and emergencies.
- Maintain accurate records of accidents and first aid treatments provided, report accidents as required by the *Occupational Health and Safety Regulation*, AR 62/2003, and document near-misses.
- Cooperate with outside personnel and agencies in promoting science safety (e.g., local Fire Marshal, Occupational Health and Safety, Alberta Environment).
- Stop any practices that jeopardize student or staff safety.
- Provide for the safety of students with special needs or language difficulties.
- Support disciplinary measures that the teacher may take to ensure safety in science classes.
- Ensure the school follows safety regulations and procedures.

Science Teachers

Role: Plan and prepare learning activities with a view to safety, and model and supervise safe practices in the science classroom/laboratory.

Recommended Actions

- Make prudent decisions regarding the selection of laboratory activities, taking into account the learning environment, the knowledge and skills of the students, and the teacher's knowledge, expertise and training to conduct activities in a safe and effective manner.
- Provide safety guidelines or lessons to students at the beginning of each year, term or course. Outline students' roles and actions in maintaining classroom safety, and the location and use of safety equipment, and, where appropriate, obtain written confirmation from students that these responsibilities are understood and accepted. (See Appendix B for a sample safety contract for elementary students and Appendix C for a sample safety contract for secondary students.)
- Explain and model safety procedures for each learning activity.
- Monitor students and correct behaviour that jeopardizes safety.

- Maintain a confidential list of students with any physiological (e.g., allergies, asthma) or physical disabilities. Use a buddy system or other system for those with special needs.
- Implement safety regulations specified by Board policy and relevant legislation.
- Contribute to developing and implementing school laboratory safety policy and procedures.
- Be familiar with the location and use of safety equipment and the location of main gas valves and electrical breakers.
- Report any defects in science equipment, facilities or practices to the school administrator responsible for safety.
- Verbally report any injuries or accidents to the school principal immediately, followed by a written report. Written reports of accidents are required under the *Occupational Health and Safety Regulation*. Also document near-misses so that colleagues can avoid similar situations (a recommended, but not legal requirement).
- Participate in health and safety training provided by the employer.
- Be WHMIS trained if handling chemicals. (If responsibilities include shipping and/or receiving chemicals, Transportation of Dangerous Goods (TDG) training is required.)
- Inform administration when work conditions or responsibilities have changed and additional training is required.
- Take on roles and responsibilities of a science technician that have not been designated to someone else.

Science Technicians

This section applies to staff that may have a variety of related titles, such as laboratory aid, laboratory assistant, laboratory technician or science technologist.

Role: In general terms, their responsibility is to assist in the preparation of science laboratory materials as requested by teachers for specific laboratory activities. However, their role may also include promoting and maintaining safety standards in laboratory and classroom activities, managing chemical inventories in accordance with WHMIS and other regulations, and ensuring that all science and safety equipment is in good condition.

Recommended Actions

- Maintain laboratory safety equipment and ensure it is accessible.
- Ensure all science equipment is in good working condition.
- Identify, document and inform teachers of safety problems related to specific lab activities, and adapt activities when necessary to eliminate problems while still meeting curriculum goals.
- Follow WHMIS and TDG regulations when dealing with chemicals, organic materials and waste.
- Conduct a yearly chemical inventory, ensuring Materials Safety Data Sheets (MSDSs) are current, and submit the inventory to the school's designated person responsible for hazardous materials.

- Ensure proper disposal of chemical/organic wastes in accordance with the *Environmental Protection and Enhancement Act*, *Canada Water Act* and local bylaws.
- Work with the science curriculum leader to promote safe procedures and maintain safety standards in all science activities.
- Keep safety in the forefront within the science department through meetings, articles, posters and other methods.

Science Students

Role: Support safety in the science classroom by acting responsibly and knowing how to respond to unsafe situations and emergencies.

Recommended Actions

- Inform the teacher of health concerns and circumstances that could affect personal safety, e.g., allergies, medications, use of contact lenses.
- Come to the laboratory appropriately dressed for lab work, e.g., closed shoes, long hair tied back, secured clothing or jewellery.
- Wear goggles and an apron, or use other safety equipment as required.
- Learn about the hazards posed by materials and equipment to be used in each activity, and about procedures to be used and/or avoided.
- Learn about the location and use of safety equipment.
- Follow all safety procedures and instructions, and act in a way that shows concern for everyone's safety.
- Begin activities only with the teacher's permission.
- Report unsafe situations or accidents to the teacher immediately.
- Dispose of all chemicals, specimens and other materials as instructed by the teacher.
- Wash hands thoroughly after each experiment.

Parents

Role: Support the school's efforts to provide safety in the classroom or laboratory.

Recommended Actions

- Inform the school about relevant student medical problems.

Educational Assistants and Volunteers

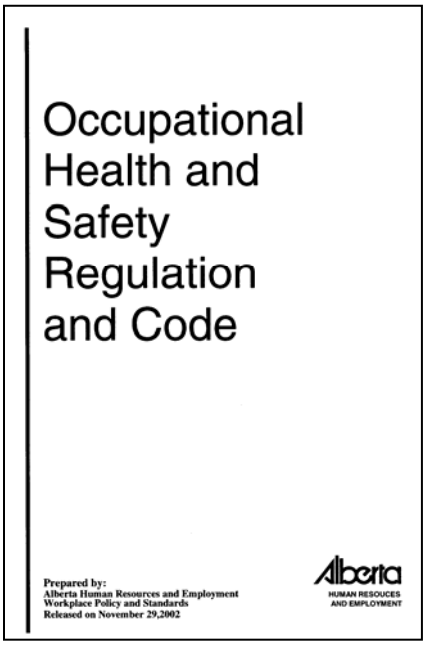
Role: Support the classroom teacher in maintaining safety.

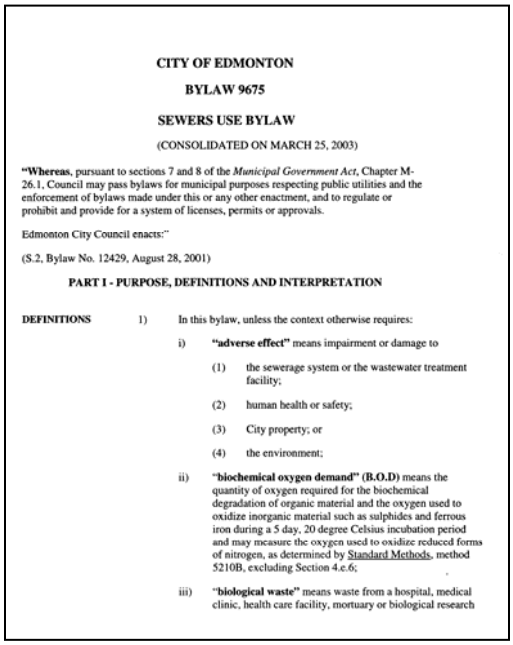
Recommended Actions

- Find out about the hazards posed by materials and equipment to be used in science activities, and about procedures to be used and avoided.
- Understand and model safe behaviour.
- Monitor equipment and student behaviour, and report any unsafe conditions to the teacher.

LEGISLATED REQUIREMENTS

Legislated requirements relevant to science safety are found in the following sources (listed by category). **Note**: The information provided in this section was current as of November 2005.





CITY OF EDMONTON

BYLAW 9675

SEWERS USE BYLAW

(CONSOLIDATED ON MARCH 25, 2003)

"Whereas, pursuant to sections 7 and 8 of the *Municipal Government Act*, Chapter M-26.1, Council may pass bylaws for municipal purposes respecting public utilities and the enforcement of bylaws made under this or any other enactment, and to regulate or prohibit and provide for a system of licenses, permits or approvals.

Edmonton City Council enacts:"

(S.2, Bylaw No. 12429, August 28, 2001)

PART I - PURPOSE, DEFINITIONS AND INTERPRETATION

DEFINITIONS 1) In this bylaw, unless the context otherwise requires:

i) **"adverse effect"** means impairment or damage to

(1) the sewerage system or the wastewater treatment facility;

(2) human health or safety;

(3) City property; or

(4) the environment;

ii) **"biochemical oxygen demand" (B.O.D)** means the quantity of oxygen required for the biochemical degradation of organic material and the oxygen used to oxidize inorganic material such as sulphides and ferrous iron during a 5 day, 20 degree Celsius incubation period and may measure the oxygen used to oxidize reduced forms of nitrogen, as determined by Standard Methods, method 5210B, excluding Section 4.e.6;

iii) **"biological waste"** means waste from a hospital, medical clinic, health care facility, mortuary or biological research

Fire and Building Codes

- *Alberta Fire Code,* 1997
- *Alberta Building Code,* 1997

Occupational Requirements

- *Labour Relations Code,* R.S.A. 2000, c. L-1
- *Occupational Health and Safety Act*, R.S.A. 2000, c. O-2
  Occupational Health and Safety Regulation, AR 62/2003
  Occupational Health and Safety Code
  - Chemical Hazards, Biological Hazards and Harmful Substances
  - Emergency Preparedness Plan
  - First Aid
  - Workplace Hazardous Materials Information System (WHMIS)
- *School Act*, R.S.A. 2000, c. S-3, and regulations
- *Teaching Profession Act*, R.S.A. 2000, c. T-2

Environmental Requirements

- *Environmental Protection and Enhancement Act*, R.S.A. 2000, c. E-12, and regulations
- *Waste Control Regulation*, AR 192/96
- *Canadian Environmental Protection Act,* 1999, S.C. 1999, c. 33

- *Canada Water Act*, R.S.C. 1985, c. C-11
- *Transportation of Dangerous Goods Act,* 1992, S.C. 1992, c. 34 and regulations
- local bylaws

Other Legislated Requirements

Hazardous Products Act, R.S.C. 1985, c. H-3

Many aspects of school safety are governed by more than one piece of legislation. For example:

- the "maximum permissible occupancy load" of science laboratories and classrooms is regulated by the *Alberta Fire Code*, 1997, which refers back to the *Alberta Building Code*, 1997 for base figures on "occupancy load"
- the use of chemicals is regulated under the *Occupational Health and Safety Code*, the *Hazardous Products Act*, the *Transportation of Dangerous Goods Act* and *Regulations* and the *Environmental Protection and Enhancement Act*, R.S.A. 2000, c. E-12. Additional aspects of chemical safety are regulated by the *Waste Control Regulation*, AR 192/96 and the *Canada Water Act*, R.S.C. 1985, c. C-11, and may be further regulated by municipal sewer and solid waste bylaws.

Fire and Building Codes

The following sections highlight some important elements of key legislation as they relate to science safety, and outline how teachers, administrators and other staff can meet these requirements.

Alberta Fire Code, 1997

The *Alberta Fire Code*, 1997 outlines standards for building designs, equipment and procedures required to minimize risk of fire and enable safe exit of occupants when fire occurs. Particular sections of the Code provide standards for:

- storage of combustible or dangerous substances (including combustible and flammable liquids with regards to their storage, arrangement, labelling and venting)
- chemical spill control
- fire safety plans
- emergency procedures, fire drills and fire department access
- fire protection equipment, including extinguishing systems, extinguishers, water supply systems, fire alarm systems and emergency power installations
- required fire doors and separations
- ventilation systems and strategies
- maximum permissible occupant load.

Factors used in determining the maximum permissible occupant load of a science room or laboratory include the type of use of the room, the room layout, the number and location of exits, and the size and location of furnishings. For advice on the maximum permissible occupant (student) load of a particular science facility, please request an evaluation by your local fire marshall or his/her designate.

Alberta Building Code, 1997

The *Alberta Building Code*, 1997 outlines standards for the design, construction and alteration of buildings in order to ensure the "life safety" of future occupants. Standards set by the *Alberta Building Code*, 1997 include electrical wiring, fire alarm systems, fire extinguisher requirements, emergency routes, and lighting and ventilation (including the venting of chemical storage areas).

Occupational Requirements

Labour Relations Code, R.S.A. 2000, (Chapter L-1)

In cases of a Labour Board inquiry into employment conditions, this code gives the board or an officer of the board the right to inspect the school premises, question employees and examine school records relating to safety inspections, fire drills and staff training programs.

Occupational Health and Safety Act, Regulation and Code

The *Occupational Health and Safety Act* along with the *Occupational Health and Safety Regulation* and *Occupational Health and Safety Code* were established to ensure reasonable levels of health and safety in the workplace. It deals with chemical hazards and harmful substances, hazard assessment, first aid, emergency preparedness, fire and explosion hazards, personal protective equipment and ventilation.

This Act has extensive implications for both employers and employees (referred to as "workers" in the Act). Note that Alberta Justice does not consider students to be workers under this legislation except for those in registered apprenticeship or off-campus work experience programs.

According to the Act:

- the employer is responsible for the health, safety and welfare of workers on the job
- the employer must provide information on and control hazards, and establish an occupational health and safety program
- employees must take steps to protect their own health and safety, and the health and safety of co-workers

- employees have rights under the Act to:
  - know about workplace hazards
  - participate in health and safety activities
  - refuse "work they believe may endanger the worker or others"
- suppliers must supply MSDSs and ensure that the biological or chemical products they supply are safe for use in the workplace when used according to the instructions they provide.

The following parts of the *Occupational Health and Safety Code* are particularly relevant for science classrooms.

Part 4: Chemical Hazards, Biological Hazards, and Harmful Substances:

- gives occupational exposure limits for a variety of chemical substances for periods of 15 minutes and 8 hours (exposure limits are described in ppm or mg/m^2). Given that schools do not normally have the means to measure the presence of chemicals in these low concentrations, schools often use other sources of information, specifically those provided by MSDSs, as an alternate guide to exposure limits. If further information is required on exposure limits, see Schedule 1, Table 2 of the *Occupational Health and Safety Code*
- provides specific employer obligations and procedures for treating overexposure or contamination
- prohibits eating, drinking and smoking in areas contaminated by a harmful substance
- includes a Code of Practice that governs the storage, handling, use and disposal of a number of specific chemicals and groups of chemicals used at work sites. (See Chapter 7 for a complete list of these substances.) The Code of Practice applies only in instances where the amounts of these chemicals exceed 10 kg when in pure form or, if in a mixture, 10 kg at a concentration of 0.1% or more.

Part 7: Emergency Preparedness Plan:

- states that employers must develop emergency response plans
- outlines the minimum requirements of such a plan, the need for updating the plan and the importance of employee training.

Part 11: First Aid:

- requires the employer to maintain first aid equipment and supplies, and a first aid room
- specifies contents of first aid kits for low-, medium- and high-hazard sites
- states that kits must be clearly labelled so that every worker knows their location.

Part 29: The Workplace Hazardous Materials Information System (WHMIS):

- outlines a system to inform people of the hazards of materials they might be handling in the workplace and minimize risks
- provides information for controlled or regulated chemicals with higher inherent risks
- specifies standards for:
  - labelling of chemicals: Labels alerting the user to hazards of the product and precautions for safe use are mandatory for controlled products
  - material safety data sheets (MSDSs): These sheets provide extensive information about the product, including potential hazards, health effects, proper handling and disposal, and by law must be provided by the supplier with any substance covered under WHMIS
  - WHMIS training and education: Knowledge about potential hazards and safety procedures is mandatory for teachers, laboratory technicians or any other person working with or near controlled products.

See Chapters 4 and 8 of this document for additional details on WHMIS and MSDSs, and Chapter 8 for details on labelling of chemicals. Agents or consultants that provide WHMIS training in your area can be found on the Work Safe Alberta Web site at http://www3.gov.ab.ca/hre/whs/network/condir/, or access an approved computer learning package such as *WHMIS and You* for in-school training and/or review.

***School Act,* R.S.A. 2000,** (Chapter S-3 and regulations)

The *School Act*, R.S.A. 2000, c. S-3 indicates the following responsibility for the care of students:

> "A board shall ensure that each student enrolled in a school operated by the board is provided with a safe and caring environment that fosters and maintains respectful and responsible behaviours." (Section 45 (8))

***Teaching Profession Act*, R.S.A. 2000,** (Chapter T-2)

The *Teaching Profession Act* indicates that teacher conduct is considered unprofessional if it "is detrimental to the best interests of students."

Environmental Requirements

***Environmental Protection and Enhancement Act (EPEA)*, R.S.A. 2000,** (Chapter E-12)

The EPEA was established to help protect and improve the environment. The Act is essentially preventative in nature: it ensures that potentially damaging activities can proceed only if their impact has been closely examined and provisions have been made to adequately protect the environment against damage. Approval licenses typically stipulate requirements for ongoing reporting on groundwater quality and air emissions. The Act also states that all polluters—including schools—are expected to pay for the cost of their actions. If any potentially damaging substance is released into the environment:

- the release must be reported immediately
- immediate steps must be taken to confine, clean up and dispose of the substance
- the environment must be returned to a condition that is satisfactory to Alberta environmental protection.

***Waste Control Regulation*,** (Alberta Regulation 192/96)

This regulation sets out requirements for handling, storing and disposing of hazardous wastes generated by industry or institutions, including schools or school districts, and stipulates how to deal with hazardous waste spills. Although specific waste products are not identified by name, the regulations describe the properties that determine whether waste materials can be disposed of in landfills.

***Canadian Environmental Protection Act*, 1999,** (Statutes of Canada, 1999, Chapter 33)

The *Canadian Environmental Protection Act*, 1999, S.C. 1999, c. 33 is the federal equivalent of the EPEA. The Act and its regulations describe procedures for storage, transport and disposal of hazardous wastes produced by industries as well as schools or school districts, and outlines how to deal with spills. Like the EPEA, this Act states that all polluters are expected to pay for the cost of their actions.

***Canada Water Act*, R.S.C. 1985,** (Chapter C-11)

This Act defines 'waste' as substances that alter water quality to the extent that its use would be detrimental to humans, animals, fish, or to plants that are useful to humans. It prohibits pollution of water in areas designated for restoring, maintaining or improving water quality, and specifies the penalties for doing so.

***Transportation of Dangerous Goods Act* (TDG), 1992,** (Statutes of Canada, 1992, Chapter 34)

The *Transportation of Dangerous Goods Act* and *Regulations* protects the general public and the environment during the transport of hazardous goods, including regulated chemicals ordered or disposed of by schools. TDG provides

a complementary system to WHMIS: during transportation, these products are called dangerous goods and are governed by the regulations of TDG. The TDG Act states that during transport, dangerous goods must be identified by:

- labels on containers
- placards on trucks
- shipping documents.

These TDG regulations terminate with the reception of the regulated/hazardous chemicals by a receiver, at the point of delivery. For this reason, the receiver must be TDG trained to receive the chemicals at a school or school district site. This person must also undergo TDG recertification every three years. Refer to Receiving Chemicals in Chapter 8 for more information on steps to follow when receiving chemicals. Once the regulated/hazardous goods have been unloaded from the transport vehicle and received, they become controlled products and fall under WHMIS regulations.

This information is important to staff and others in emergencies, as well as in routine activities. The TDG chemical classifications used in these labels and documents are international in scope, and as a result they are rigidly specified.

Local Bylaws

Large cities such as Calgary and Edmonton have established bylaws related to waste management and disposal, particularly disposal of substances classified as *hazardous*, *prohibited* or *restricted*. Smaller centres such as Red Deer, Lethbridge, Medicine Hat and Grande Prairie are following the lead of these larger centres in the development of documented bylaws restricting the limits of waste materials disposed of via the sewage system, and possibly, via the local landfill site(s).

In most cases, local bylaws support and reinforce the regulations of federal and provincial legislation, but they may also provide more specific disposal limits or other details. For example, in the City of Edmonton, the *City of Edmonton, Bylaw No. 9675, Sewers Use Bylaw* (14 December 2004) states that no person shall release or permit the release of any matter containing a hazardous waste into a sanitary sewer. It also states that a small quantity of waste water containing a prohibited or restricted waste may be released with prior permission of the City Manager, but only if it is determined to have a minimal adverse effect on the sewage system. The bylaw also lists wastes that cannot be disposed of via the drain. Similarly, the City of Calgary's bylaw prohibits or limits wastes disposal through drains, e.g., the bylaw limits the concentration of phosphates, sulfates and nitrates disposed through drains. Check with your municipal office or town/city council for relevant bylaws in your area.

Other Legislation

***Hazardous Products Act*, 1985:**

This Act defines what materials are designated as *controlled products* in Canada. Designation of *controlled products* has the following significance for schools:

- the Workplace Hazardous Materials Information System (WHMIS) requirements apply to all materials designated as *controlled products*. Suppliers of *controlled products* are required to provide a Material Safety Data Sheet (MSDS) for each product, and ensure the product or its container is labelled with required information and hazard symbols
- the advertising, sale and importation of *controlled products* for use in the workplace, including Canadian schools, is regulated under the Act.

IMPLEMENTING SAFETY IN THE SCIENCE CLASSROOM OR LABORATORY

The following general procedures are recommended to use in day-to-day routines of planning, preparation, guiding and follow-up to science activities. Two sets of guidelines are provided—a basic set of procedures for elementary schools, and a more extensive set of guidelines for junior and senior high schools. The more extensive guidelines reflect the increased complexity of science activities at the upper grade levels.

Science Safety Rules and Procedures

For secondary science students (not a conclusive list):

1. Read all directions before starting an experiment.
2. Behave responsibly in the science laboratory at all times.
3. Know the location and purpose of safety equipment.
4. Always alert the teacher immediately if any accident occurs.
5. If you wear contact lenses, notify the teacher. Some activities may require you to remove contact lenses.
6. When instructed, wear safety goggles and protective clothing.
7. Wear closed shoes during laboratory sessions.
8. Keep your hair tied back if it is long.
9. Do not use cracked or chipped laboratory glassware.
10. Use chemicals in the lab only.
11. Take only as much chemical as needed and never return excess chemicals to the original container.
12. Dispose of chemicals as directed by your teacher.
13. Hold bottles only by the base, not by the neck.
14. Do not taste anything unless you are instructed to do so.
15. Never eat or drink in the science classroom.
16. Never enter the chemical storeroom without permission.
17. Always clean off the bench and sink after an experiment.
18. Wash your hands thoroughly with warm water and soap at the end of the activity or laboratory session.

Elementary Schools

Elementary students thrive on hands-on activities. The opportunity to explore and investigate real materials is a powerful motivator for learning and provides starting points for concept and skill development. The benefits of hands-on activities are well-known to teachers, who regularly incorporate them into their programs, taking care to ensure student safety. Steps taken to ensure student safety involve all stages of planning, preparation, supervision and activity follow-up. Example strategies for ensuring safety in elementary science activities are described below, beginning with the early stages of planning.

Selecting Activities and Materials

- Consult teacher guides and safety resources to become familiar with risks posed by the activities and materials under consideration.
- Access and review information on student allergies and health conditions that could limit their involvement in science activities.
- Select activities and materials taking into account:
  - potential hazards
  - student allergies and health conditions
  - the knowledge, skills, maturity and disabilities of students
  - the equipment and facilities available to safely carry out the activity.
- Avoid bringing poisonous plants or wild animals—dead or alive—into the classroom, and do not engage in direct investigations of human body tissues and fluids.

Preparing Activities

- Obtain and prepare safety supplies; e.g., obtain personal equipment, such as goggles and gloves.
- Prepare materials for safe use; e.g., organize materials to facilitate safe distribution.
- Prepare for clean-up and disposal of chemicals and other waste products; e.g., label waste containers.

Introducing and Guiding Activities

- Involve students in preparing the classroom for safe activity by clearing work surfaces and aisles.
- Introduce equipment and supplies to be used, and how they can be used safely by identifying procedures to follow and actions to avoid.
- Ensure that all students are aware of risks inherent in the materials to be used.
- Ensure that students use personal protective equipment as required for the activity.
- Initiate short, simple tasks that provide opportunity for students to practise safe procedures before moving on to more complex tasks.
- Model safety at all times.
- Consider having students sign a safety contract as a commitment to safety. See Appendix B for a sample contract.

Follow-up Procedures

- Have students clean up their workspace, following safe and environmentally-responsible procedures.
- Have students wash their hands after taking part in activities that involve chemical or biological materials.

Junior and Senior High Schools

As in earlier grades, activities with real materials in junior and senior high schools can be powerful motivators for learning and provide starting points for concept and skill development. At the junior and senior high school levels, experience with materials also provides opportunities to learn about the nature of science investigation and to critically examine the link between evidence and theory. With the increasing complexity of concepts studied, investigations may involve more complex equipment and a broader range of materials than studied at the elementary level, creating new challenges for ensuring student safety.

The general strategies for ensuring science safety nevertheless have much in common with earlier levels, involving all stages of planning, preparation, supervision and activity follow-up. The following general strategies are thus recommended. It is further recommended that secondary schools refine and extend these practices to reflect the program, student characteristics, facilities and staff roles within the particular school.

Selecting Activities and Materials

- Consult teacher guides and safety resources to become familiar with risks posed by the activities and materials under consideration.
- Access and review information on student allergies and health conditions that could limit their involvement in science activities.
- Select activities and materials taking into account:
  - potential hazards
  - student allergies and health conditions
  - the knowledge, skills and maturity of the students
  - the equipment and facilities available to carry out the activity safely.
- Avoid bringing poisonous plants or wild animals—dead or alive—into the classroom, and do not engage in direct investigations of human body tissues and fluids.

Preparing Activities

- Obtain and prepare safety supplies; e.g., obtain personal equipment, such as goggles, aprons and gloves.
- Prepare materials for safe use; e.g., prepare dilute solutions in advance, organize materials to facilitate safe distribution.
- Prepare for clean-up and disposal of chemicals and other waste products; e.g., label waste containers.

Introducing and Guiding Activities

- Set standards for safety preparation and behaviour in laboratories. See Appendix A for example science safety rules and procedures that could be used with students.
- Introduce WHMIS and MSDS symbols, data sheets and safety procedures, and ensure that students understand the need for and application of these standards.
- Provide a general introduction to risks and safety procedures at the outset of the course. In this introduction, review procedures for:
  - handling medical emergencies and accidents
  - handling chemical wastes and spills
  - reporting defective equipment and potential hazards.
- Familiarize students with the location and use of safety equipment; e.g., eyewash stations.
- Introduce equipment and supplies to be used in each activity, and describe how they can be used safely by identifying procedures to follow and actions to avoid.
- Ensure that all students are aware of risks inherent in the materials to be used.
- Ensure that students use personal protective equipment as required for the activity.
- Provide opportunity for students to practise safe procedures.
- Model safety at all times.
- Consider having students sign a safety contract as a commitment to safety. Retain the contract, but recognize that this is not a legal document. See Appendix C for a sample contract.

Follow-up Procedures

- Have students clean up their workspace, following safe and environmentally-responsible procedures.
- Have students wash their hands after taking part in activities that involve use of chemical or biological materials.

Chapter 2
Emergency Preparedness and Response

OVERVIEW

This chapter provides information and strategies to prepare for contingencies in the science classroom, laboratory and science preparation areas. The chapter includes sections on planning emergency responses, responding to accidents and medical emergencies, and preparing accident reports.

GENERAL SAFETY AUDIT

A general safety inspection can be a good starting point for preparing to deal with emergencies that are more likely to occur in or impact science classrooms. Typically this inspection would be done as part of the larger school emergency planning process, and would include a thorough evaluation of general safety concerns such as fire prevention and response, as well as response to medical emergencies, gas leaks and other situations. In addition, special attention would be given to areas where chemicals are stored and used, since extra precautions and equipment are involved in these locations. An inspection checklist could be developed to assist in this process and to ensure that nothing is overlooked. See Appendix D for a sample inspection checklist devised for use in assessing safety in the chemical laboratory area.

EMERGENCY PREPAREDNESS PLANNING

Part 7 of the *Occupational Health and Safety Code* specifies that every workplace, including schools, must develop and implement an on-site emergency preparedness or response plan. Such a plan establishes procedures to deal with different kinds of emergencies and is tailored to the specific design, circumstances, and nature of the hazards of the school. Procedures must also tend to special needs students, for example, if they are an integral part of the school population. Any emergency that threatened the safety of students

or staff would then be dealt with according to this plan. Before engaging in the development of such a plan, review Part 7 of the *Occupational Health and Safety Regulation*, AR 62/2003, for the broad outline of what must be addressed by the plan and reference Part 2 of the *Occupational Health and Safety Explanation Guide* for more detail. Topics to be covered as identified in the Guide are:

- Hazard Assessment
- Hazard Elimination and Control
- Emergency Response
- Worker Training
- Incident Investigation.

Considerations in Emergency Preparedness Planning

Emergency plans address a number of different safety hazards and emergency situations. As a minimum, the plan would include the following:

- safety measures for fire, including prevention measures specified in the *Alberta Fire Code*, 1997, district regulations or elsewhere, and procedures to follow in the event of a fire in a science laboratory or elsewhere
- a building floor plan showing where all toxic substances are located
- procedures for dealing with the release or spill of toxic substances
- procedures for responding to a natural gas or propane leak
- procedures for responding to accidents and medical emergencies
- plans to ensure staff receive adequate orientation and training.

Creating Your Own Emergency Plan

A model plan should contain the following elements:

Statement of Purpose. A brief description of what the plan is intending to achieve is necessary to set planning parameters and to establish a benchmark against which all subsequent action is taken. In other words, if an event can be handled with day-to-day resources and procedures, it does not belong in the plan.

Concept of Operations. An overview of how the plan functions and its relationship to other activities helps rearrange the organizational framework needed for managing the situation. A classroom emergency plan could provide direction for a problem to be handled by an individual teacher within certain parameters. When conditions exceed those parameters, a school team of officials could establish control and provide direction and support to the affected area. If the problem affects the school at large, then the plan is interfaced with the district or the community emergency or crisis management plan.

Risk Assessment. To assist in developing adequate arrangements, a thorough risk assessment should be completed. Minimize the assessment process to those hazards/threats that actually warrant activation of the plan and include them in the document.

Authority. A reference to specific legislation / regulation / policy gives legal expression to the plan.

Activation. The conditions that must exist for the plan to be activated should be clearly stated. Care is required to avoid ambiguity often inherent in such statements. This can be overcome by stating routine conditions that do not justify activation of the plan along with the crisis conditions that mandate activation.

Notification. A means of alerting key officials about the onset of a crisis situation is highly recommended as a routine for quickly assembling a pre-designated crisis management team once the plan is activated. This may be part of a larger Communications Plan, but still must be included separately.

Centralized Control. A location for the crisis management team(s) to work from should be designated and prepared in advance as well as consideration for an alternate location. People in crisis like to know where the leadership team is at all times, and how to contact them.

Self-assessing. The plan should be self-assessing. This means a checklist of questions by which you can determine if the plan meets your needs or requires updating.

1. Check Sheets

These sheets outline the actions that should be taken when the plan is activated. Actions are listed in order of priority and can be used to assign key roles to individuals.

2. Appendices

The appendices contain the working documents that supplement the procedures defined in the Check Sheets.

3. References

This section provides a list of other resources that would be useful in designing an emergency plan.

Sources of Emergency Plans

As they develop or review their plans, schools may find it useful to consult the various models available on the World Wide Web. These models follow the generally accepted planning design principles, and are recommended only as a guideline to help school disaster planners develop, implement, assess and revise their emergency plans. In Alberta, Municipal Directors of Disaster Services are quite often available to assist with interpreting and applying planning strategies, taking into account each school and board's unique resources and the community emergency response support mechanism. Staff can also assist with reviewing drafts and evaluating existing plans.

Some useful resources and templates can be found at:

http://www.ccep.ca/cceptemp.html
http://www.ema.gov.au/agd/ema/emaSchools.nsf

Evaluating Your Emergency Planning

To evaluate whether your emergency preparedness planning is adequate, consider whether your plan is realistic, comprehensive and appropriate for the workplace and includes measures for implementation. With effective emergency planning:

- all potential emergencies are mentioned in the plan but it is the most probable events as determined by the hazard analysis and risk assessment that are developed into contingency arrangements
- the required supplies and equipment, e.g., fire extinguishers, respirators, first aid kit, are available and in good condition
- there is an effective process to announce the emergency to all staff members, students and visitors
- drills are carried out periodically testing response to one incident at a time
- records and evaluation of drills indicate that the plan is feasible
- staff members understand the plan
- staff members are aware of their roles if there is an incident or if an evacuation is necessary; staff and their back-ups are sufficiently trained to carry out these roles
- the required number of staff are trained in emergency and standard-level first aid
- all staff members are trained and prepared so that they know how to declare an emergency and initiate the alarm, and how to determine the required level of response; e.g., standby, escalation, evacuation or take cover.

Responding to Fire

A response procedure for a school fire would address the following elements:

- when to sound the local fire alarm
- when and how to evacuate the school (for example, would an appointed person take the building's Emergency Services Kit with them to the Command Centre?)
- who is responsible for notifying the fire department and school superintendent
- under what circumstances staff members may attempt to extinguish the fire, and procedures for doing so
- when and how to permit people to re-enter the building, or to carry out further evacuation procedures if staff and/or students will be unable to return
- procedures for securing utilities
- responsibilities and procedures for filing written reports with the supervisor of schools and the Fire Marshal.

Responding to Toxic Substance Leaks and Spills

The response plan should include procedures for emergency response to leaks and spills of toxic, caustic and reactive substances, particularly those that pose an immediate danger due to the quantity and location of the spill. The emergency plan should include:

- when and how to evacuate
- who is responsible for requesting emergency services and informing appropriate school officials
- procedures and responsibilities for providing the appropriate MSDS to the emergency responder, hospital or physician
- procedures and responsibilities for reporting the leak or spill and completing any follow-up investigation.

For spills of small quantities of less dangerous substances, a full emergency response may not be required. See Chapter 7 for clean-up procedures.

Responding to a Natural Gas or Propane Leak

Natural gas and propane are flammable gases that are used as fuels in science laboratories. Both are delivered under pressure. Any leakage of gas from pipes or fittings creates a risk of fire and/or explosion, particularly if the leakage is in a confined area, and especially if it remains undetected for some time. A slow continuous leak can lead to migration of gas through a room or building until it reaches a source of ignition, resulting in an explosive flash back to the source. A fire near the source of a leak may also cause the gas container or pipe to explode.

Emergency planning should address the following elements for natural gas or propane leaks that cannot be immediately stopped:

- when and how to evacuate the area
- who will alert the fire department and school district officials
- under what circumstances staff members may attempt to localize and/or dissipate the leaking gas, and procedures for doing so.

RESPONDING TO ACCIDENTS AND MEDICAL EMERGENCIES

To handle medical emergencies and serious injuries, each school is required by Occupational Health and Safety to have staff with emergency or standard-level first aid training. These individuals would have the expertise to administer the Heimlich maneuver, mouth-to-mouth breathing and cardiopulmonary resuscitation (CPR).

This section outlines first aid for both minor and major injuries that are most likely to occur in the science laboratory or classroom. Included are the first steps to alleviate damage and to treat the injury, as well as when to engage local emergency services. School districts may have additional procedures or regulations for responding to medical emergencies.

Corrosive chemical on the skin

Be familiar with the first aid measures given in the MSDS for chemicals used. The general rule is to wash the area immediately and thoroughly with cool water, or soap and water. The recommended time for this washing is 15–20 minutes. Remove contaminated clothing. If significant harm is detected or suspected, seek medical assistance.

Splashes into the eyes

Immediately flood the eye(s) with a gentle stream of cool water for 15–20 minutes, holding the eye(s) open if necessary. Close the eyelid and cover with a loose, moist dressing. Proceed to get medical help to assess the condition of the eye(s) and ensure no further damage occurs. Alkalis produce more serious burns than acids, but flushing should be done immediately regardless of the substance.

Foreign object in the eye

If no help is available, try to flush the eye clear on your own. Position an eyecup or small clean glass of water with its rim resting on the bone at the base of the eye socket and pour the water in, keeping the eye open. If you cannot clear your eye, seek emergency medical help.

To help a person with a foreign object in their eye:

Keep the person from rubbing their eye. Wash your hands. Seat the person in a well-lit area. Try to locate the object in the eye visually. Examine the eye by gently pulling the lower lid downward and instructing the person to look upward.

Reverse the procedure for the upper lid. Hold the upper lid and examine the eye while the person looks downward.

If the object is on the surface of the eye, you may be able to flush it out or remove it manually. While holding the upper or lower lid open, use a moistened tissue or the corner of a clean cloth to remove the object by lightly touching it. Once removed, flush the eye with a saline solution or lukewarm water. If you cannot remove the object easily, cover the eye with a soft cloth and seek emergency medical assistance.

If the object is embedded in the eye, do not remove the object. Apply a dressing over the eye in such a way that it does not make direct contact with the eye surface. Cover the dressing with a cup or ring pad, and seek emergency medical assistance.

If pain, vision problems or redness persists, seek emergency medical help.

Cuts

Put on disposable gloves to minimize risk of infection from the blood. If necessary, wash minor cuts with cool water to remove any foreign material, dry the area and cover with a bandage. In the case of major cuts with severe blood loss, apply a large compress, then apply direct pressure with the heel of your hand and transport to the hospital. If a piece of glass or other sharp object is imbedded in the wound, tent dress the area and add padding around the injury until it is higher than the imbedded object. Secure padding with a wrapping of gauze and seek medical help. For major cuts with minor bleeding, cover with a gauze pad, then transport the victim to hospital for further medical help. If glass or any other sharp object may still be in the wound, do not attempt to remove it. Be careful not to put undue pressure on the gauze while transporting the victim, since circulation may be cut off completely.

Ingestion of chemicals

The primary source of information in Alberta on prescribed treatment for ingested chemicals is the Poison and Drug Information Services, Foothills Hospital, Calgary; telephone: 403–944–1414 or 1–800–332–1414. They are on 24-hour call every day of the year. They should be called immediately if ingestion of a chemical occurs before proceeding with any treatment.

Another source of information on treatment would be found on the MSDS on file for the chemical. However, inconsistency in the treatment prescribed does occur depending upon the source of MSDSs. As well, it may not be consistent with that prescribed by the Poison and Drug Information Services. Note that the standard procedure to have the victim drink plenty of milk or water is no longer recommended.

Burns

Treatment of minor burns is basically a three-step process. Cool the burned area for about 15 minutes by running cool water over it, immersing it in cool water or cooling with a cold compress. Do not use ice for this time period as this may freeze the area of treatment. Apply a triple-antibiotic ointment or a moisturizer primarily to prevent drying. Loosely wrap the burned area with a sterile gauze bandage, avoiding excess pressure on the burned skin. If the burn is severe, cool the area as described above, wrap loosely with a moist dressing and transport the person to a hospital for medical assistance. If in doubt, seek medical assessment and/or treatment.

Burning clothing

Rapid action in extinguishing burning clothing is critical to minimizing exposure of the victim, and minimizing harm that may result. Several approaches are sometimes used and your local fire department or school district policy may recommend one of these as the preferred response. The “Stop, Drop and Roll” method is commonly recommended by fire departments. In conjunction with this technique, other heavy clothing or a fire blanket may be used to smother the flames. Fire blankets are not a Fire Code requirement and are not recommended by all fire departments. If a blanket is used, it must be removed immediately after the fire is out to minimize trapping of heat and sparks against the victim’s skin. Other options for extinguishing burning clothes include the use of an ABC dry-chemical fire extinguisher, spraying the victim with water or using an emergency shower, if available. Selection of any one of these options may be circumstantial; the use of the fire extinguisher, for example, may not be practical from a safety perspective if the fire is near the facial area and chemical spray will get into the victims eyes.

Once the fire is extinguished loose clothing can be removed if necessary, but any clothing adhering to the burned skin should not be removed. After the fire is out, follow the procedures for responding to burns described above.

Shock and fainting

Lie the person down if he or she is in shock and elevate the feet higher than the head. Loosen tight clothing, cover the person with a blanket and talk to him or her reassuringly. Do not give them anything to drink. If the person has fainted, place him or her in the *recovery position*; i.e., on their side with the head tilted back to keep the airway open. Ensure that the airway is clear and that they are breathing. Make the head comfortable, cover the person with a blanket, and leave him or her lying down. If there is a chance of injury due to the collapse, avoid moving the person if they are breathing until you can communicate with him or her to confirm no injury was sustained. On the other hand, if the airway is blocked and/or the victim is not breathing, the head may have to be tilted back or the victim may have to be laid on their back to begin artificial resuscitation or CPR. If other injuries are present or any symptoms persist, seek emergency medical assessment and/or treatment. If the casualty must be left alone, always place the victim in the recovery position, and ensure the airway is open.

Inhalation of toxic fumes

Move victim into fresh air and contact the Poison and Drug Information Services, Foothills Hospital, Calgary; telephone: 403–944–1414 or 1–800–332–1414 for information on treatment of victim.

If available on site, summon trained personnel who can administer oxygen and other medical procedures, as necessary. In severe cases, seek further medical treatment at a hospital.

Other medical emergencies

Being prepared to deal effectively with emergencies involving serious existing medical conditions such as asthma, anaphylactic shock, diabetes or epilepsy requires open communication between school administration, counsellors and parents. Teachers need to know if students have these conditions, as well as what to look for and what to do if the student becomes symptomatic. Basic training could be provided to assist teachers in dealing with, for example, seizures or insulin shock. If in doubt, seek medical assessment and/or treatment.

ACCIDENT REPORTING

An *accident* is an undesired event that causes or may cause harm to individuals, property or the environment. When an accident occurs, the first concern is the injured. Priority can then be placed on systematic investigation and proper reporting of the accident.

By law, certain work-related accidents must be reported as soon as possible to Alberta Workplace Health and Safety. Section 18 of the *Occupational Health and Safety Act* requires employers to:

- report certain injuries or accidents, including any injury or accident that results in a fatality or in a worker being admitted to hospital for more than two days
- report any unplanned or uncontrolled explosion, fire or flood that causes (or could cause) a serious injury
- conduct an investigation whenever a serious injury or accident occurs, and prepare a report that is available for inspection.

Accidents involving workers that fall under the jurisdiction of the *Workers' Compensation Act* must also submit a report to the Workers' Compensation Board within 72 hours of the incident. Laboratory aides and technicians fall under the scope of the Act; whereas teachers do not, except when teaching Career and Technology Studies (CTS) courses. Principals and assistant principals fall under the Act if teaching CTS courses or if injured while involved in nonteaching activities. Students do not fall under the Act unless on approved off-campus education programs, such as work experience. The *Workers' Compensation Act* requires both the employer and the employee to report injuries that result in the loss of at least one full day's work, and all injuries that require medical aid.

Both Occupational Health and Safety and the Workers' Compensation Board may choose to investigate the accident.

Schools can improve safety and show compliance with accident reporting requirements by ensuring that:

- all accidents and injuries are recorded, reported and investigated as appropriate
- staff know when and how to report accidents, including where to access reporting forms and instructions
- staff know what kinds of accidents will be investigated
- staff receive appropriate orientation and training and understand their responsibilities
- all required information is gathered and provided by supervisors for staff compensation claims
- general pre-planning has been done regarding accident investigation and reporting
- the underlying causes of accidents are determined
- measures are taken to prevent accidents from reoccurring.

See Appendix E for a sample Accident/Incident Report Form. This sample shows the type of information that is required in an accident report, as well as who is required to complete the report.

Near-miss Reporting

A near-miss is an event that could, but does not, result in an accident. Near-misses are also referred to as incidents or potential accidents.

Like accidents, near-misses are caused by unsafe acts or conditions. Examples of unsafe acts include handling of materials by someone without proper training, and failure to use personal protective equipment such as safety glasses. Examples of unsafe conditions include poor lighting, excessive noise and poor housekeeping.

Documentation of near-miss situations, although not required by law, should be done internally with the information on the incident shared with colleagues. In this way, near-miss reporting is a proactive means of improving safety awareness, identifying and tracking potential hazards and ultimately preventing accidents. Whenever a near-miss is recorded, it is important to identify, as far as possible, the unsafe acts and conditions that contributed to the incident. Actions can then be taken to reduce the risk of a similar incident or accident occurring in the future.

Accident/Incident Report Form

Part A – to be completed by individual(s) directly involved or injured in the incident.

☐ Medical Aid ☐ Lost Time ☐ Spill/Contamination/Environmental Release
☐ Near Miss ☐ Property Damage

IDENTIFY – Person(s) involved

Date and time of Incident

_____ _____ / ____ / ____ _____ AM / PM
First Name Last Name YR MO DD HH:min

☐ School Nurse
☐ Hospital
Date & Time of **Medical Evaluation**: ____ / ____ / ____ _____ ☐ Clinic or Family Physician
YR MO DD HH:mm

Exact details of injury/illness & treatment (eg. Body part involved, cut, strain, bruise, illness symptoms and date of onset, etc.)

_____
_____
_____
_____

W.C.B. Form: (Please check) ☐ Has been prepared and forwarded ☐ Not required

Description of Incident (Add additional pages if necessary)
State exactly the sequence of events leading to the incident, where it occurred, what the person was doing, the size, weight and type of equipment or materials involved, etc.

_____
_____
_____
_____
_____

WITNESSES (If any)

NAME	DEPARTMENT	PHONE #

PROPERTY DAMAGE

Identify property involved. Give machine name, too name, etc.	Description of damage or loss	Estimated value of loss

(over)

Parent/Guardian to notify: _____, phone # : _____

Completed by:_____ Date:_____
Print Name

_____ **Forward to Supervisor Immediately**
Signature

Part B – to be completed by Supervisor within 24 hours

Why did it happen? (conditions and/or actions contributing to injury / incident).

_____
_____
_____
_____
_____
_____
_____
_____
_____
_____

Parent/Guardian Notification: Name: _____
Date: _____
Time: _____

Corrective Actions to Prevent Re-occurrence	Action by whom & Date to be completed

Investigated by: _____ Title: _____

_____ Phone #:_____ Date:_____
Signature

Chapter 3
Facility Design and Safety Equipment

OVERVIEW

As the previous chapters have shown, many laws and regulations govern safety in science classes. Some of these relate to how we do things: the plans we put in place and the procedures we use. Others relate to the physical environment: the design of the facility and the safety supplies kept in that facility. This chapter outlines guidelines and rules surrounding facility design and safety equipment.

ASSESSING THE SUITABILITY OF FACILITIES FOR SCIENCE

The selection and planning of science activities must take into account the strengths and limitations of available facilities. Although some introductory activities do not impose any facility requirements, many others—particularly at the secondary level—require some minimal facility characteristics; e.g., flat-topped surfaces are needed for activities with containers of liquids. For some activities, the use of purpose-built laboratory facilities is a practical necessity.

When deciding whether a given facility is adequate to the needs, consider the following factors:

- Does the facility have flat topped surfaces? How much flat top surface will the class need?
- Does the facility have sinks? How many will the class need? Is the number sufficient for clean-up and emergency flushing?
- How many students are in the class, and how much space does the activity require? Keep in mind that overcrowding increases risks.
- How is the facility configured? Does it allow the teacher to see all the students? Does it provide easy passage from one area to another without risk of bumping into one another?
- Does the facility have appropriate emergency response equipment; e.g., an eyewash fountain, a shower, a fire extinguisher?
- Does the facility have sufficient storage and/or adjacent preparation areas that minimize the need to transport equipment and supplies through the school? Are the storage and preparation areas lockable?
- Does the facility have adequate ventilation?
- Does the facility have a functioning fume hood that can be used in teacher demonstrations?

In planning for science activities, teachers should also be aware of any local standards that may have been established. For example, in some cases a school or district may determine the maximum number of students for a given facility and/or the number of students under the guidance of one teacher in that facility.

FACILITY CHECKLIST

The following checklist is adapted from *Science and Safety, Making the Connection* (Council of State Science Supervisors, 2002). This is not an exhaustive checklist and is only intended to address the needs of science laboratories for grades 7 to 12.

Layout and Space

- ❒ The room has adequate space. See page 12 of Chapter 1 for specific details of the Building Code requirements.
- ❒ Aisle width is adequate to accommodate equipment and students with physical disabilities (1.2 to 1.5 metres).
- ❒ Workspace per student is adequate (1.5 to 2.0 metres width of workspace per student, depending on the activity).
- ❒ The teacher can see students in all locations of the room.
- ❒ The general light level is sufficient (538.2 to 1076.4 lumens per square metre, with diffuse lighting preferred).

Safety Equipment

- A telephone or intercom is available in case of emergencies.
- Fire detectors and heat detectors are installed in laboratories, science preparation rooms, chemical storage areas, waste disposal areas, and any other high-risk areas.
- At least one emergency eyewash station must be located in areas where corrosive chemicals are used, according to Occupational Health and Safety regulations for workers. Currently, there is no Canadian standard for the design or placement of emergency eyewash stations, therefore, those of the American National Standards Institute (ANSI) are used as a guide.

An emergency eyewash station is defined as one that provides a continuous flushing fluid to both eyes at a minimum of 1.5 L per minute for 15 minutes. It can be plumbed in or portable. Portable bottles (squeeze bottles) do not meet this standard. Squeeze bottles, however, are also to be made available for all activities where there is risk of materials entering the eye.

See the Safety Equipment and Supplies section in this chapter for information on maintenance of eyewash stations.

Exits

- The room has two exits, both with doors that open outward and have reinforced glass viewing windows or peepholes.
- Doors open easily and do not require a key to exit.
- Doorway widths are sufficient to accommodate students with physical disabilities, allow movement of equipment carts and serve as emergency exits.

Construction Materials

- ❒ Ceilings are constructed out of a material with a low flame-spread rating; e.g., drywall.
- ❒ Floors are even, free of cracks and have a nonskid surface (sheet flooring is preferable to tiles or carpets; tile floors should be covered with a nonskid wax).
- ❒ Laboratory bench surfaces are made of material resistant to acids, alkalis, solvents and temperate heat.

Ventilation

- ❒ Air in the room is recycled and mixed with outside air at a rate of 4 to 12 complete laboratory air changes per hour, depending on the chemicals used, or a minimum of 15 L per second per occupant.
- ❒ The exhaust ventilation system is separate from that of the chemical fume hood.
- ❒ The hood(s) of the exhaust ventilation system is/are located away from doorways, windows, high traffic areas or areas with disrupted airflow.
- ❒ Installation of chemical fume hoods in science rooms, although not required by the Alberta Building Code, is recommended for senior high school chemistry laboratories and rooms where chemicals are prepared. Where fume hoods exist, the functional and maintenance standards that apply are those of the American National Standards Institution. These include an average face velocity of at least 0.5 m/s and all individual face velocity readings above 0.43 m/s. Exhaust is vented to the outside wall or roof vent. For more details on fume hoods, see the Safety Equipment and Supplies section that appears later in this chapter.

Electrical

- ❒ There are sufficient electrical outlets (i.e., located at intervals of 2 to 2.5 metres) to make extension cords unnecessary, and all power outlets meet *Alberta Building Code*, 1997 standards. Where hot plates will typically be in use, it is recommended that each 15 amp circuit be restricted to two double plug-in outlets to prevent overload and tripping of breakers during times of maximum usage.
- ❒ Outlets within 1.5 metres of water are equipped with Ground-Fault Interrupters.
- ❒ Fume hood controls are located outside the fume hood in an immediately accessible area.

Plumbing

- ❒ Plumbing is free of leaks or cracks, and drains are made of chemical resistant material.
- ❒ Counter tops are lipped toward the sink.
- ❒ A plumbed-in emergency eyewash station and/or shower is/are provided in laboratories where corrosive chemicals are used. The preferred location of the shower is in an adjacent nook that is equipped with a wastewater holding receptacle, rather than direct drainage into a sewage system.
- ❒ Water taps may be located inside the fume hood cabinet if there is a main shutoff valve in another area of the laboratory.

Storage and Preparation Facilities

- ❒ Chemical storage area is adequate in size, well ventilated, secured from student access, built with material having a low flame-spread rating, and has an adequate drain at the lowest point. See Chapter 8 for more specific guidelines.
- ❒ Adequate area for the long-term storage of laboratory equipment and supplies and safety equipment.
- ❒ Preparation area, including bench space, sink and fume hood for making solutions and other materials for class use. It should also allow for storage of MSDSs, WHMIS and TDG information.
- ❒ Area for temporary storage of materials for later use, left-over materials from laboratory activities, and chemical waste storage for year-end disposal.
- ❒ Adequate refrigeration is available for storing fresh tissue/organs, enzymes, specific chemicals, agar plates and perishables.

Other Resources

Additional equipment, as indicated below, may in some situations help ensure that safe and efficient procedures are followed.

- ❒ Computer to track school equipment and chemical inventories and to access Internet information; e.g., regulations, MSDSs.
- ❒ Microwave to prepare materials such as gelatin and agar.
- ❒ Dishwasher to clean equipment, reducing the risk of injuries from broken glass and chemical exposure.

SAFETY EQUIPMENT AND SUPPLIES

Having the proper safety equipment and supplies in place in science areas of a school is critical to managing risks and dealing with emergencies that may arise. This section discusses essential safety equipment and some basic procedures for using these resources.

General Safety Equipment for Science Classrooms

With the exception of the fire blanket, this list identifies general safety equipment that is either essential or highly recommended in the science area of the school. Safety can be further enhanced by making sure teachers, students and technicians are familiar with the location and use of this equipment, that the equipment is easily accessible, and that safety posters are displayed.

Equipment	Comments
ABC-type dry chemical fire extinguisher	A 2.5 kg to 5 kg (5 lb to 10 lb) type 2, ABC extinguisher is recommended by the *Alberta Fire Code*, 1997 for laboratories. A type 4, ABC extinguisher is recommended for chemical storage areas. Note that the number in the extinguisher type refers to its volume capacity and the letters identify the class of fire(s) that can be put out. Refer to the Fire Extinguishers section discussed later in this chapter for Fire Code specifications on location of extinguishers. After use, the extinguisher will require service. Demonstrations should not be done with this extinguisher; a spare extinguisher may be reserved for that purpose.
First aid kit	One kit per room is recommended but is not mandatory according to the *Occupational Health and Safety Code*. Refer to the First Aid Kits section in this chapter.

Equipment	Comments
Eyewash station, emergency and personal (squeeze bottle)	Eyewash stations should meet Canadian Standards of Safety (CSA) and American National Standards Institution (ANSI) specifications. An emergency eyewash station is required in areas where corrosive chemicals are used. See the Facility Checklist section in this chapter for more detail. Ideally, the water supply should be tempered by mixing hot and cold water, and once activated should run hands free. All emergency eyewash stations, whether fixed or portable, require routine maintenance to ensure proper functioning and cleanliness. This requires that they be tested regularly to verify that they are operating properly. Such testing also prevents growth of microbes in stagnant residual water, and flushes out any dirt, rust or pipe scale that may be present. In areas with hard water, keeping a plumbed-in system operable is a major challenge. Two options that should be investigated to reduce rapid and frequent corrosion of the system is the use of a water softener or the attachment of the system to its own supply of distilled or buffered water, which can be replenished as required. In some situations, the most practical solution here may be to purchase a portable emergency eyewash unit with its own water supply. Where portable eyewash squeeze bottles are provided, the bottles are filled with buffered solution supplied by the manufacturer and changed regularly as per manufacturer's instructions. Also available for purchase is a buffered saline solution preserved with a suitable antibacterial agent. The antibacterial agent prolongs the shelf life of the bottle contents and the buffered saline solution is less irritating to the eyes than water out of the tap.
Simple/hand washing facilities	Hand washing facilities should be available in or near each science classroom.
Emergency shower (if chemicals are used)	 If large amounts of caustic or flammable stock are used, a deluge shower is required as specified on the chemical's MSDS. If diluted caustics or small amounts of flammable stock are used, a hand-held, telephone-style shower is sufficient.

Equipment	Comments
Fume hood (if chemicals are used)	One is strongly recommended for science preparation rooms in junior and senior high schools. The inclusion of a fume hood in high school chemistry laboratories is also recommended. In junior high, science programs and textbook resources do not call for chemicals requiring use of a fume hood. Fume hoods should meet ANSI specifications and should be inspected at least once a year by a qualified person. Fume hoods are invaluable when dispensing volatile liquids, and more toxic powdered chemicals to minimize inhalation of fumes and air-borne powder. In senior high school chemistry, they also become useful in performing reactions that generate toxic fumes.
Ultraviolet goggle sterilizing cabinet	A sterilizing cabinet is recommended in junior and senior high schools (one cabinet can serve several classrooms). The cabinet should have interlocking doors. A cabinet is not needed if each student has his or her own goggles or if other methods of sterilization, e.g., disinfectant solution, are used.
Discretionary ★Fire blankets (Not a Fire Code requirement)	★ Fire blankets are not recommended by all fire inspectors and require proper usage to avoid further damage to burned skin. Check with your local Fire Marshal for more details. Blankets containing asbestos should be removed from the school.

Personal Protective Equipment

The following list identifies personal protective equipment that should be present in every classroom that is used as a science laboratory. If injuries to students result from the failure to have or use personal protective equipment, negligence may be claimed. Appropriate safety equipment should be identified by the teacher for use during each laboratory activity as part of a routine with students prior to doing the laboratory activity. Refer to Student Safety Training in Chapter 4 for more information on use of personal protective equipment.

Equipment	Comments
Protective goggles or plastic face shields (one per student and teacher) 	Eye protection should be CSA approved and should be worn whenever there is the risk of eye injury. Goggles should be designed to completely enclose the eye area; fitted side-shields are one such option. If glasses are normally worn, goggles should fit over them. Protective equipment should be splash proof if used for chemistry. At the time of writing, goggles that completely enclose the eyes are only available through Northwest Scientific Supply, Victoria, BC. Some facility or procedure for sterilizing goggles after use is strongly recommended if goggles are shared.

Equipment	Comments
Laboratory coats or aprons	Laboratory coats and aprons should be made of approved material only, and should be worn when working with chemicals and when appropriate in other science activities; e.g., biology. Coats are preferable to aprons.
Sleeve protectors	Sleeve protectors should be worn when required.
Nonlatex disposable gloves (neoprene, nitrile or tactylon)	Gloves should be worn when handling hazardous chemicals and in biological experiments. Gloves should be used in combination with other measures because gloves may only slow down transmission of some materials, not completely prevent it. Note that some students and staff may have latex allergies.
Heat resistant gloves	Gloves should be made of treated texture silica or woven fabric. Do not use asbestos gloves.
One pair of beaker tongs 	Use tongs with heat resistant gloves when handling very hot equipment.
UV filtering glasses	Eye protection should be worn when UV sources are in use; e.g., discharge tubes, mercury or ion arcs, lamps for fluorescent 'black light' experiments. Appropriate glasses include Shields sunglasses or any glasses labelled "Blocks 99% or 100% of UV rays," "UV absorption up to 400 mm," "Special Purpose," "BS" or "Meets ANSI UV requirements."

Fire Extinguishers

The Alberta Fire Code indicates that the number and location of fire extinguishers should be governed by factors such as floor space, hazard levels and the physical design of the building. The Fire Code requires that a fire extinguisher be located in strategic sites along corridors. It also requires that a fire extinguisher be placed in either the chemical storage room or just outside this room, and recommends one in both locations, given the increased hazard level in the area. Although not compulsory by code, placement of a fire extinguisher in every laboratory is recommended.

In general, the initial selection and placement of fire extinguishers in schools is determined by design engineers prior to construction of a school. This is done in accordance with the Fire Code as well as the National Fire Protection Association (NFPA10) regulations. Schools contemplating renovations, placing additional extinguishers, or changing placement of existing units can contact the following office for more information: Alberta Municipal Affairs, Safety Services Branch, Office of the Administrator, Building and Fire Safety, Telephone: 1–866–421–6929.

The following chart shows fire extinguisher types that may be appropriate for use in schools (the type will be identified on an inspection label on the unit). ABC extinguishers are recommended (a Fire Code recommendation) for all school locations because they avoid the need to classify the fire and select the appropriate extinguisher, and because only one operational procedure must be learned and remembered.

Type	Extinguishing agent	Use
Class A	Water	Fires involving ordinary combustible materials such as wood, cloths or paper.
Class B	Dry chemical foam, carbon dioxide	Fires involving flammable liquids such as solvents, grease, gasoline or oil, and fires involving ordinary combustible materials.
Class C	Dry chemical and carbon dioxide	Fires involving electrical equipment.
Class D	Special dry powder medium or dry sand.	Fires involving combustible metals, magnesium, sodium, lithium or powdered zinc.
Class ABC	Dry chemical	All materials and fire types.

Schools can maximize the value of fire extinguishers by:

- placing extinguishers near an escape route, not in a 'dead end' location
- ensuring all teachers and support staff working in the science area know the location of all fire extinguishers, and understand when and how to use the kinds of fire extinguishers installed on site
- having fire extinguishers inspected once a year by the local fire department or an approved agency, with inspection records kept by the principal or district administrator.

First Aid Kits

First aid kits are required by schools under the *Occupational Health and Safety Code*. The contents of first aid kits are standardized and referred to by the number "1", "2" or "3." Schools occupied by 100 persons or more are required to have a number 3 first aid kit on hand at a central location that is designated as an access point for first aid services. In addition to maintaining a number 3 first aid kit in one central location, schools will normally maintain additional kits at or near facilities where activities may pose particular risks. To meet the needs of science laboratories, the recommended approach is to stock a number 1 kit in each laboratory or at a location readily accessible to several laboratories.

For further information on code requirements and guidelines, see Part 11 of the *Occupational Health and Safety Guide* at http://www3.gov.ab.ca/hre/whs/publiscation/pdf/ohs. Also see the *Occupational Health and Safety Code Explanation Guide,* part 11-6 at http://www3.gov.ab.ca/hre/whs/law/pdf/ohsc_p11.pdf. Note that the guide designates schools as "medium" hazard sites.

Kits are available from St. John Ambulance, Canadian Red Cross and most science supply companies. Number 1 kits are available as fanny packs that are suitable for use on field trips.

For field trips, the *Occupational Health and Safety Code* specifies a number 1 first aid kit (fanny pack) along with one certified first aider. The first aider does not necessarily have to be a field trip supervisor, but can be a trained employee at the field trip site. However, as part of their safety policy, school districts may require that a risk assessment be done prior to the field trip to determine what first aid equipment should be taken and what number of first aiders should go along if there are increased levels of risk.

The contents of first aid kits should be checked and replenished regularly. The kit container should be clearly marked and readily accessible, and should keep the contents dry and dust free.

The contents of a level 1 kit include:

10	antiseptic cleansing towelettes, individually packaged
25	sterile adhesive dressings, individually packaged
10	10 × 10 cm sterile gauze pads, individually packaged
2	10 cm × 10 cm sterile compress dressings, with ties, individually packaged
2	15 cm × 15 cm sterile compress dressings, with ties, individually packaged
2	7.5 cm conform gauze bandages
1	7.5 cm crepe tension bandage
3	cotton triangular bandages, minimum length of base 1.25 m
1	2.5 cm × 4.5 m adhesive tape

(continued)

5	safety pins, assorted sizes
1	pair of scissors
1	pair of tweezers
1	artificial resuscitation barrier device with a one-way valve
4	pairs of disposable latex or surgical gloves
1	first aid instruction manual (condensed)
1	inventory of kit
1	waterproof waste bag

Equipment for Clean-up and Disposal of Chemical Spills

The following list identifies items to keep in the laboratory in a clearly identified and accessible location for clean-up and disposal of spills. See Chapter 7 for clean-up and disposal procedures for different kinds of chemical spills.

Items	Comments
Acid, base and solvent spill kits	Spill kits are used for absorbing spills or diluting solutions of chemicals. Use these kits for clean-up of small spills (follow manufacturer's instructions).
Hazorb spill control pillows	These pillows are available from Lab Safety Supply Inc. Pillows are used to absorb spilled liquids (follow manufacturer's instructions).
Several litres asbestos-free vermiculite, bentonite or diatomaceous earth in container with scoop	These materials can be used for spills of solid chemicals, especially powders, and viscous or sticky liquids. Containers should be clearly labelled and contents disposed of safely.
Containers suitable for waste chemicals and solvents	Each chemical must be collected separately and labelled according to WHMIS specifications. Waste solvents should be collected only in a safety disposal can with an automatic pressure release closure.
Waste container for glass and sharp objects	A separate container for these items reduces the chance of injury to maintenance and janitorial staff responsible for normal garbage disposal.

Items	Comments
Large container of dry $NaHCO_3$ (baking soda)	Baking soda can be used to neutralize strong acids before disposal.
Plastic dustpan and brush	Use the dustpan and brush for sweeping up used sand, vermiculite or broken glass. Wash and dry both thoroughly after use.
45-cm long chemically-resistant rubber gloves	Gloves should be worn whenever dealing with spills, especially when broken glass is involved. Gloves are usually included with spill kits.
Heavy-duty garbage bags	For disposal of all solid waste, including used sand, vermiculite and contaminated broken glass. Dispose of each spill separately. Tie bags very securely, double bag if necessary and label for disposal.
Biohazard bags or extra thick garbage bags	For disposal of biological specimens and cultures.
Respirator	For pickup of certain spilled chemicals, as noted on MSDS sheets. Schools offering Science programs at grades 9 to 12 should have at least one respirator per preparation room or department.

Generic Spill Kit

A generic spill-kit mixture can be made simply by mixing equal volumes of sodium carbonate, bentonite (clay cat litter), and dry sand in a plastic container with a lid. Shake the container until the components are mixed. The contents can be mixed again just prior to use when cleaning up a chemical spill. This mixture is effective in the clean-up of the majority of spills. See Chapter 7, Managing the Release or Spill of Toxic or Corrosive Substances for more information on use.

MONITORING AND ASSESSMENT

Ongoing monitoring and assessment are important steps in maintaining and improving the condition of science facilities, equipment and materials. Regular performance of these activities supports a proactive approach to repairs and maintenance, which in turn reduces risks for accidents. Monitoring and assessment activities can take place through periodic inventory of equipment and materials, and the completion of laboratory checklists such as the one provided in Appendix D.

Chapter 4
Risk Management

OVERVIEW

All activities involve potential risks. In order to manage risks, teachers need to evaluate the risks involved in each potential activity, and make prudent choices in the selection and development of those activities. The selection of an experiment or demonstration should take into account what that activity will achieve, what potential hazards it involves and how to control or minimize these hazards. Risk management also means ensuring that staff have the proper safety education and training, including WHMIS and TDG training, and teaching safe attitudes and behaviours to students.

RISKS

Inherent Risks

Inherent risks arise as the direct consequence of the particular materials and activities used. Most science activities involve some inherent risks. For example, an activity aimed at helping students learn about heat might require use of heat sources and heat resistant containers, creating an underlying risk of burns and minor cuts. More serious risks are inherent in the use of particular chemicals, equipment or procedures.

Before selecting materials and activities, it is important to consider ways to minimize inherent risks. For example, in planning an activity that requires elementary students to transfer liquids from one container to another, teachers can avoid the inherent risk of cuts caused by broken glassware by opting instead to use plastic containers. Similarly, a teacher could minimize inherent risks in an activity involving the handling of acid solutions by preparing the solutions in advance, rather than have students prepare them as part of the activity. Decisions such as these should also take into account the learning outcomes, the grade level, and the skill level of students.

Situational Risks

Situational risks arise from the context in which the materials and procedures are used. For example, if heat sources are used in a crowded workspace, the situation of crowding creates an additional risk of burns. If situational risks are not considered, an activity that has low inherent risk can grow into a high-risk situation.

Situational risks can be minimized by ensuring that:

- teacher and students are aware of inherent risks involved in an activity
- teacher and students understand and are able to carry out appropriate procedures
- steps are taken to minimize potential distractions or disruptions
- workspaces are adequately sized and well-organized
- sufficient supervision and guidance are provided at all times.

The most effective way to minimize situational risks is through a collaborative effort between teachers and students. Teachers thus need to enlist students in planning for safety, and in establishing safe classroom procedures. This strategy for risk minimization can be supported by involving students in activities such as the following:

- identifying risks
- developing class lists of required and prohibited laboratory activities
- creating posters that show appropriate and inappropriate activities
- developing a safety contract for students to sign at the beginning of the school year.

CHOOSING SCIENCE ACTIVITIES

Safety is a primary concern in selecting activities for science classes. Factors to consider before proceeding with a science activity include:

- potential hazards (both inherent and situational risks)
- the knowledge, skills and maturity of the students
- the experience and expertise of the teacher
- the equipment and facilities available to safely carry out the activity.

Inherent risks increase dramatically with the use of materials that are highly toxic, corrosive or flammable. The selection of materials can thus help minimize risks. Even highly qualified teachers need to assess the risks of different alternatives and select the one that presents the least hazards for students—even though another choice might produce a more spectacular result. Alternatively, an activity might be carried out as a demonstration by a teacher with appropriate safety precautions in place. A further alternative is to use videos or CD–ROMs. Although this may take away from the drama of a live demonstration, it effectively communicates what students need to know and understand.

In addition, many of the approaches described in Chapter 8 under the heading Strategies for Minimizing Hazardous Waste Production are excellent ways to reduce safety risks. These strategies include microscale experiments, dispensing pre-measured quantities of chemicals and using laboratory stations.

Teachers should also be aware that the *Occupational Health and Safety Regulation*, AR 62/2003 (Part 1, item 14) specifies that "A worker who is not competent to perform work that may endanger the worker or others must not perform the work except under the direct supervision of a worker who is competent to perform the work." This clause places an onus on teachers to evaluate their own competence in choosing activities that they will carry out. This provision under the Act could also be the basis for a substitute or regular teacher to refuse an assignment that requires them to carry out specific tasks where they are not competent. It could also be a consideration in tasks that are assigned to, and accepted by, a science aide or science technician.

Field Trips

Field trips are a valuable addition to any science program, giving students the opportunity to explore applications of science and to investigate living things in their environment. Potential hazards associated with off-site excursions depend on the nature of the trip and the site visited, but in general the possibility of accidents can be reduced if the field trip is well-planned and organized. Field trip planning should be guided by district field trip policy that will often identify standards in such areas as supervision and first aid preparation. Planning for adequate supervision should take into account the age and number of students, the kinds of hazards present at the site, and the types of activities to be carried out. Planning for first aid preparation should also take into account the Occupational Health and Safety standard that specifies that a number 1 first aid kit be on hand for each 9 persons engaged in "off site work" or a number 2 kit for each 49 persons. (See page 46 for a list of kit contents).

Transportation is a further element of field trip planning. Local policy should be reviewed to determine what modes of transportation are considered acceptable and what guidelines apply. For example, there may be local guidelines on the use of parent-supplied transport.

Preparations for field trips safety should also include briefing student on safe and unsafe activities.

Museum, Zoo or Industrial Site

The two primary concerns for these kinds of trips are safe transportation and adequate supervision. Be aware of any on-site hazards if these exist, and make students and supervisors aware of them prior to the trip. Also ensure that a first aid kit and someone who can provide first aid (certified first aider) is available on site at all times. In many cases this may be available at the site to be visited, but if in doubt this should be included in trip preparation.

Nature Site

Field trips to environmental sites present their own set of challenges because students are exposed to the weather, physical hazards and local organisms. Taking the following precautions can reduce risks.

- Be thoroughly familiar with the site and any potential hazards. Visit the site prior to the field trip if necessary.
- Provide students with a map of the site, identifying the specific locations to be visited, the routes by which they will get there and the potential hazards.
- Specify the clothing and footwear to be worn.
- Special requirements such as insect repellant during breeding of biting insects, particularly mosquitoes.
- Use appropriate precautions and equipment if working on or near water; e.g., whistles, life jackets, throw line, 'buddy' system.
- Ensure supervisors are located so that all students have an adult relatively nearby at all times.
- Have a first aid kit and someone who can provide first aid on site at all times.
- Maintain access to a vehicle at all times in case of an emergency.
- Carry a cell phone to access emergency services and information.

For more information on Biology field trips, see Chapter 5.

SAFETY AWARENESS AND EDUCATION

Safety awareness and education is a responsibility at all levels of educational planning. All staff should be aware of hazardous materials and procedures used in their working environment, and have the knowledge and skill needed to eliminate or minimize risks to themselves and to others. As employers, school districts have responsibility to ensure that school staff have this knowledge and skill—a responsibility that also falls on each employee. As overseers of school programs and school environments, school districts also have responsibility for ensuring that students develop the knowledge, skills and attitudes they need to support their own safety and the safety of others. With appropriate safety education, all staff and students will be able to act responsibly, follow appropriate safety procedures to avoid hazards and injury, and deal appropriately with injury or accidents if they occur.

WHMIS

As described in Chapter 1, the Workplace Hazardous Materials Information System (WHMIS) is designed to identify and minimize risks for human health and safety. Under federal and provincial legislation, people in every workplace have the right and responsibility to know whether materials they are working with are hazardous, the nature of the hazard and what safety measures to take. Although students are not specifically referred to in WHMIS, except in the case of registered apprenticeship or work experience programs, their presence in the school workplace suggests that a level of care be provided consistent with WHMIS standards. This implies making students aware of any potentially hazardous materials in areas accessible to them, and providing training in the safety skills needed to use these materials. The safest and most practical

approach is to manage the environment so that student access to these materials is limited to times of teacher supervision.

Although the legal force of WHMIS requirements is not well-defined with respect to students, this is not the case when it comes to school staff and school districts. School staff are bound by the WHMIS requirements in its capacity as workers, and each school district is bound by the regulations that apply to employers. This means, among other things, that science teachers and other school staff who work with potentially hazardous materials, must be WHMIS trained. This training must be provided by the employer to enable the employee to:

- recognize risks of controlled products they are handling
- learn how to safely handle these materials
- know where the Manufacturer's Safety Data Sheets (MSDSs) are filed and how to use the information on them
- apply proper labelling to containers holding controlled products.

This training must be generic, as well as product- and site-specific, so that staff know, among other things, what hazardous materials they will encounter in their work location, where the hazardous materials and safety equipment are located, as well as the location of the MSDSs. Since the site-specific component of WHMIS training differs from school to school, science teachers that move to a new school should go through a safety orientation that covers such detail without having to repeat the generic WHMIS training.

Some districts require that staff working with WHMIS controlled products receive refresher training at least once every three years. Schools may find it useful to maintain records of courses taken, but this is not a formal requirement. The ability of workers to demonstrate the above knowledge and skills is sufficient evidence of the requirement being met.

For more details on what must be covered by WHMIS training, refer to part 1 of the *Occupational Health and Safety Code*, available at http://www.worksafely.org.

WHMIS training agencies in your area can be found on the Work Safe Alberta Web site at http://www3.gov.ab.ca/hre/whs/network/condir/, or by contacting Workplace Health and Safety. At the time of publication, the contact number was 1–866–415–8690. A number of online and CD–ROM training programs are also available from Workplace Health and Safety.

Staff Training

Training of science teachers and support staff would generally cover much of the following through WHMIS training. Any details not covered could be included as part of a school refresher/orientation for members of the science staff.

- legislation that regulates or defines safety standards in the school, particularly Occupational Health and Safety, Environmental Protection, WHMIS and TDG regulations

- due diligence and staff responsibilities
- school and/or district safety policies for science classrooms, laboratories and field trips
- safety equipment, location and use
- management of chemicals: location and safe storage, classes, specific risks, safe use of controlled products, and disposal of chemicals
- location of MSDSs and how to read them
- response to spills and spill clean-up
- response to accidents, including first aid procedures
- accident and near-miss reporting procedures
- review of basic laboratory techniques and identification of inherent hazards. See Appendix I for examples of such techniques and their hazards.

Transportation of Dangerous Goods Act and Regulation

The purpose of the *Transportation of Dangerous Goods (TDG) Act* and regulation is to protect the general public and the environment during the transportation of dangerous goods. The Act and regulation require that anyone transporting, shipping or receiving dangerous goods be trained and have their training certificate available for inspection. A training certificate is valid only for three years; after that time, the individual must be retrained and issued a new certificate. These requirements apply to anyone who:

- offers dangerous goods for transport, such as a shipper at a chemical supply company
- receives dangerous goods, such as the individual at a school who accepts delivery and signs the delivery docket or manifest
- handles dangerous goods by loading or unloading materials
- drives a vehicle carrying dangerous goods.

Principals and administrators are responsible for ensuring that staff members who receive or ship dangerous goods are TDG trained and certified. Certified staff will know:

- the classes of dangerous goods and associated hazards
- the information that is required on shipping documents
- what labels and markings are required on packages and containers
- what placards must be shown on vehicles
- what protective measures to adopt during transport
- what responsibilities they have if they are the shipper, receiver or transporter of the dangerous goods
- how and when to report accidents or incidents involving dangerous goods, especially those releases deemed dangerous occurrences.

Refer to Chapter 1 for more information on TDG regulations.

Environmental Protection and Enhancement Act and Local Bylaws

The *Environmental Protection and Enhancement Act*, R.S.A. 2000, c. E-12 (EPEA) and its regulations outline a system to protect, improve and ensure wise use of the environment. This provincial statute sets the standard on a broader regulatory level with regards to human environmental impact, whereas municipalities take responsibility for establishing specific guidelines and standards for waste management. Such standards are embedded in local bylaws, identifying prohibited or restricted materials and regulating where and what wastes may be disposed of via local landfill sites and the sewage system. For specific details about bylaws in your area, see the section on Bylaws in Chapter 1.

One way that principals and administrators can ensure compliance with EPEA regulations and local bylaws is by educating staff about these regulations. With proper training, staff who handle chemicals will know:

- how to ensure that chemicals are used, handled and disposed of in an environmentally-safe manner
- what emergency and reporting procedures to follow if there is a major accidental leak or spill requiring evacuation
- how to confine the release and ensure prompt clean-up takes place to restore the environment to a satisfactory condition
- what preventive and protective measures to use
- how to implement measures to minimize and/or recycle hazardous waste.

Refer to Chapter 1 for more information on the *Environmental Protection and Enhancement Act*, R.S.A. 2000, c. E-12 and local bylaws.

Use of Safety Equipment

Science teachers need to be familiar with the location, use and limitations of all safety equipment in the science area. Such familiarity may require initial training and periodic refresher sessions. Sharing this information with students will help them take appropriate action if the teacher is not immediately available in an emergency or accident.

Safety and the Student

Part of the role of science educators is not only to ensure a safe learning environment, but to instill in students an understanding of their own responsibilities in the science classroom. Learning about science includes learning to respect the materials being used, and this respect can be taught only by example. In this way, science teachers are role models—advocates and practitioners of safety. Increasing students' awareness of safety issues in general, and knowledge of safety practices specifically, is one of the most important ways to reduce situational risks.

Student Safety Training

Safety training is an integral part of learning laboratory techniques. Though infrequently put to the test, safety training is an excellent way of encouraging students to make safety a lifelong practice at home and in the workplace. As part of such training, general safety issues and student expectations would be addressed at the beginning of each course. These would be posted and periodically reviewed. See Appendix A for example science safety rules and procedures for students. More specific safety issues inherent in the activities would be discussed as part of the pre-activity instruction.

Safety expectations can be taught in a number of ways:

General Safety Practices

- handing out written copies of good laboratory practices and reviewing these with students throughout the term
- posting lists of safe practices in appropriate areas and reminding students of them on a regular basis
- modelling safe behaviour during all activities.

Specific Safety Concerns

- reviewing specific safety issues and procedures before each activity, including relevant WHMIS information, required personal protection equipment, and emergency response procedures in case of accidents.

Development of common expectations for student behaviours and procedures can be a helpful starting point in planning for safety training. By planning as a science team, and by sharing common lists of expectations and procedures, the science staff in a school can ensure consistency in their messages, and avoid student confusion about what they may and may not do. See Appendix H for Suggested Science Department Safety Policies and Procedures.

Making safety an integral part of every course helps to reinforce its importance and conditions students to think about safety whenever they undertake any activity in the laboratory.

Developing Safety Awareness and Responsible Habits

One of the most important ways to promote safety in science classrooms is to increase students' awareness of safe practices and to help them develop responsible attitudes. Good laboratory practices can be broken down into three time periods.

Before entering the laboratory

- confine long hair and loose clothing
- put on closed-toe shoes
- put on eye protection
- cover exposed areas of the body with chemical-resistant clothing (protective gloves, aprons or lab coats, and face shields) when using toxic or corrosive material

- know the hazards of chemicals to be used
- understand response procedures in case of an accident; if unsure, ask the teacher or check the MSDS information.

While in the lab

- behave responsibly and respect the safety of others at all times
- never work alone or unsupervised
- do not eat, drink or keep food in the laboratory
- never pipette by mouth
- replace stoppers and caps of chemical containers immediately after use
- treat a substance as hazardous unless definitely known as safe—read the WHMIS label to be sure
- work under a fume hood if using substances that produce a hazardous vapour or dust.

Prior to leaving the lab

- dispose of hazardous wastes in specified containers or as instructed by the teacher
- turn off and put away all equipment, and clean all glassware
- wash hands thoroughly.

The more awareness students have of these issues, the greater chance they will develop safe and responsible habits of mind. See Appendix A: Example Science Safety Rules and Procedures for a more comprehensive list of 'Dos' and 'Don'ts.'

PART B — SPECIFIC HAZARDS

Chapter 5
Biological Hazards

OVERVIEW

While chemical hazards may be the most obvious safety concern in the science classroom, biology-related activities present their own risks. Potential biological hazards include pathogens in specimens or cultures, and allergens in plants, animals or the chemicals used to store specimens. This section discusses common biological hazards, suggests ways of reducing associated risks and identifies official restrictions on biological materials in Alberta schools.

CHEMICAL HAZARDS IN BIOLOGY ACTIVITIES

Many activities in biology classes require the use of chemicals. As with any use of chemicals, accident prevention depends on assessing and minimizing risks related to the specific chemicals used. General steps for managing risks include:

- choosing the safest chemicals possible
- being aware of potential dangers
- instructing students in proper handling procedures and insisting that they are followed
- using appropriate protective equipment.

See Chapters 7 and 8 for more information on selecting, storing and using chemicals.

ACCIDENTAL INFECTIONS: SPECIMENS AND CULTURES

The most frequent known causes of laboratory-acquired infection are oral aspiration through pipettes, animal bites or scratches, and contact with an animal. Other common causes include cuts or scratches from contaminated glassware, cuts from dissecting instruments, spilling or dropping cultures, and airborne contaminants entering the body through the respiratory tract.

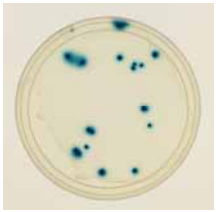
Use of Human Tissue and Fluid Specimens

In September 1987, following a review of the potential means of transmitting hepatitis or HIV (human immunodeficiency virus), Alberta Education issued a directive prohibiting activities deemed to cause unwarranted risks. This directive continues to be in force. All activities involving the extraction and analysis of samples of human fluid or tissue are prohibited in Alberta schools. This directive is noted in Alberta Education's *Guide to Education* and is further described in the document *A Clarification of Statements Prohibiting the Use of Human Body Substances in the Alberta Science Curriculum, 1988.*

This prohibition applies to all activities involving extraction of human tissue and fluid samples, including cheek cells, blood, saliva and urine. Alternative materials that schools may want to consider in place of these samples include prepared slides and simulated urine and blood. These materials are available from scientific and educational suppliers. In some instances, other mammalian, amphibian or reptilian sources may be substituted. There are also excellent videos, computer software and Web site resources available on these topics.

Cultures

Most micro-organisms are not harmful to humans and can be safely cultured. However, culturing harmless micro-organisms still has the potential risk of unintended contamination by pathogenic forms that may be simultaneously introduced to the culture plate. Although the body can routinely destroy small numbers of these pathogenic forms, it may be overwhelmed by large numbers. Teachers can reduce this risk by being aware of the hazards presented by infectious agents and their possible sources, and by using proper handling, storage and disposal techniques when working with cultures.



Some general practices to consider when culturing micro-organisms include the following.

- Do not intentionally culture anaerobic bacteria or pathogenic organisms. Pathogenic organisms can be bacteria, viruses, fungi or protozoa. Examples of these include:
  - bacteria that cause tuberculosis and pneumonia
  - fungi that cause athlete's foot and ringworm
  - protozoa that cause Giardiasis and Amoebic Dysentery

- Select materials for study that reflect student and teacher skills and the needs of the curriculum.
  - At the elementary level, use only print and digital images of micro-organisms, not live specimens.
  - At the junior high school level, use print and digital images, and where live specimens are to be used, select only micro-organisms that occur naturally on moldy bread, cheese or mildewed objects.
  - At the senior high school level, use micro-organisms that occur naturally on bread, cheese or mildewed objects as much as possible, and use other organisms with appropriate precautions. If swabs are taken (e.g., from door knobs or desks) and cultured, use precautions that allow for the possibility that some organisms might be pathenogenic. Culture the plates for a minimum time period, view within a sealed container, and dispose of as soon as possible.
- Grow cultures only at room temperature or in the range of 25°C to 32°C. Incubation at 37°C encourages growth of micro-organisms capable of living in the human body.
- Use a culture medium that is properly sterilized by autoclaving to avoid contamination from other sources and to minimize the chance of culturing pathogenic forms of bacteria.
- Use disposable Petri dishes rather than glass ones. When no longer needed, the cultures and plates can be disposed of in the regular garbage in a double-strength or double plastic bag.
- After inoculating the medium with micro-organisms, replace the cover and tape the plates shut. Subsequent observations can be made through the cover.
- Clean up any spills using proper procedures:
  1. Put on disposable gloves.
  2. Place paper towels over spill.
  3. Pour disinfectant such as 10% bleach solution on top of the towels and leave for 10 to 15 minutes.
  4. Wipe up the spill with the towels and discard into an airtight plastic bag or other appropriate container.
  5. Autoclave if possible.

Owl Pellets

Commercially purchased owl pellets are sterilized and do not pose any infectious hazards. This will not be the case with specimens that are personally collected in the wild by the teacher or any other individual.

Dissection

Animals and/or organs for dissection come in either preserved or fresh form. Two potential hazards that exist with dissections are infections and accidental cuts from sharp scalpels.

Preserved Specimens

Specimens sold for dissection now commonly come in an alcohol-based solution, thus avoiding the need to use formaldehyde or formalin. (See the Chemical Hazard Information Table in Chapter 9 for hazards associated with formalin and formaldehyde.) If specimens are injected with formalin, or preserved in a formalin solution, a chemical called "infutrace" can be used to convert the formaldehyde into a nontoxic product, eliminating exposure to the formaldehyde and its fumes.

Specimens should be removed from the shipping solution using gloves and tongs, and rinsed thoroughly before proceeding. If smaller numbers of specimens are required, vacuum-packed specimens may be a good alternative.

Disposal of alcohol-based preserved specimens can be done via routine solid waste disposal, i.e., trash/local landfill. Formalin-based specimens, on the other hand, must be sent to a government approved waste facility.

Fresh Tissues

Fresh beef, pork and lamb organs and tissues are commonly used for dissection. Chicken, on the other hand, often carries Salmonella, and is not a good option for dissection work except if well-cooked or boiled. Organs and tissues obtained from slaughterhouses or store meat departments will have been inspected for infectious agents. If kept refrigerated they should be stable for 10 to 14 days. Handle as you would fresh meat.

High-risk materials, such as animal tissues that potentially carry infectious agents, are controlled by the Health of Animal Regulations. For example, these regulations have recently placed restrictions on the availability of tissues and organs, such as eyes, from the heads of Alberta cattle because of bovine spongiform encephalopathy (BSE). Currently, all head tissues and organs from cattle over 30 months of age are to be removed and condemned; cattle under 30 months old are considered noninfectious. Check with a local slaughterhouse at any time to determine what materials are available for dissection and what safety precautions may be necessary.

GENERAL HAZARDS OF EQUIPMENT AND TECHNIQUES

Dissection

Dissection is an integral part of biology that attracts much student curiosity and interest. To minimize risks during such activities, consider the following safety precautions.

- Use preserved specimens or inspected animals or animal parts. Avoid using specimens in formalin or formaldehyde-based preservative.
- Use dissecting gloves.
- Discard remains of fresh specimens or alcohol-based preserved specimens in double bags or double-strength bags in regular trash.
- Clean equipment, wipe lab benches and wash hands after a dissection.

Activities Requiring Mouth Use

Some activities that involve the mouth include swabs in taste testing, PTC paper, spirometer mouthpieces and plastic-wrapped thermometers. To minimize risks during these activities, consider the following guidelines.

- Avoid mouth pipetting (even if pipetting bulbs are not available), as it can result in accidental ingestion of fluid.
- Consider using tympanic thermometers, which avoids insertion into the mouth.
- Ensure that any components that are placed in the mouth are used only once, then sterilized or discarded.
- Check that students do not have bleeding gums or open wounds in the mouth, which increases risks greatly.
- Ensure that students wash their hands thoroughly before and after each activity.
- After use, place in a secured double-strength plastic bag and dispose of in a regular garbage.

Bulbed pipette

Syringes

The most serious hazards associated with syringe use are accidental inoculation and aerosol production. The best way to eliminate these hazards is to avoid the use of needled syringes in science classes.

Inoculating Loops

Inoculating loops pose one potential hazard: The film held by a loop may break, producing an aerosol causing atmospheric contamination and subsequent inhalation. To minimize this risk:

- avoid jerky motions, shaking the loop or agitating the liquids
- dip inoculating loops into ethanol before flaming (bearing in mind the flammability of ethanol)
- allow the hot loop to cool after flame sterilization to avoid spattering when the loop is subsequently inserted into a micro-organism sample.

inoculating loop

Centrifuging

Centrifuges require close monitoring to ensure the careful balancing of inserted tubes and their contents. The centrifuge lid should remain in place during the time of operation. After use, centrifuges can be cleaned with ethanol under a fume hood to kill any bacteria present.

PLANT AND ANIMAL HAZARDS

The study of live plants and animals in the classroom poses potential risks of injury, infection and allergic reaction. To minimize these risks, consider the following common-sense precautions.

- Be very selective about the organisms brought into the school. Check for student allergies and any diseases the animal may carry. Two common diseases that can be carried by wild animals are rabies and psittacosis, that latter caused by a bacterium transmitted by birds.

rat

- Consider how you will dispose of the animal before acquiring it.
- Use domesticated animals or those available through reputable, licensed pet stores.
- Know and use proper handling techniques.
- Wear gloves to protect against biting and scratching.
- Explain to students the importance of acting respectfully and responsibly around the animals. Ensure that students do not tease the animals or put their fingers or other objects into the cages.
- Maintain animals in a clean, healthy environment.
- Discourage students from bringing sick animals into the laboratory, and do not allow students to bring in any animals that have died from unknown causes.

When selecting plants, be aware that many plants are poisonous or contain irritants, including a number that are often used as house plants. Make a point of checking for toxic properties of plants before using them in the classroom, and ensure that students wash their hands after handling plants or plant parts.

Some common poisonous plants to be aware of include:

- plants poisonous to touch due to exuded oils:
  Poison ivy (*T. radicans; R. diversiloba*)
  Oleander (*N. oleander*)
- toxic house or garden plants:
  Poinsettia (*E. pulcherrima*)
  Dieffenbachia (*D. maculata*)
  Castor bean (*R. communis*)
  Mistletoe (*V. album*)
  Lantana (*L. camara*, etc.)
  Hyacinth (*Hyacinthus orientalis, Scilla nonscriptus, and Agraphis mutans*)
- other plants that are poisonous when eaten:
  Tansy (genus *Tanacetum*)
  Foxglove (*D. purpurea*)
  Rhubarb leaves (*R. rhabarbarum*)
  Baneberry (*Actaea pachypoda; Actaea rubra*)
  Marsh marigold (*Caltha palustris*).

More information on toxic and nontoxic plants can be found at http://www.citysoup.ca. In the Search area, enter "Toxic and Nontoxic Plant Information."

FIELD TRIP HAZARDS

Planning for biological studies in the field needs to include consideration of the following specific hazards:

- allergic reactions, toxic effects or accidental infections. Be aware of any student allergies to plants, animals, pesticides, herbicides or other materials. Also be aware of dangerous plants or animals that may exist in the area such as stinging nettles, poison ivy or rattlesnakes, and bring appropriate first aid materials
- disease-carrying parasites such as ticks carrying Lyme disease. Students should check their clothing and other belongings for these organisms before returning to school
- diseases associated with handling animals. For example, deer mice can carry hantavirus and bats often carry rabies
- water-borne diseases such as Giardiasis (Beaver Fever) or those that may be released through fecal waste, particularly human waste.

If specimens are collected on a field trip and maintained at school for a period of time, consideration must be given to MSDSs, proper storage, and labelling of fertilizers, special foods or other chemicals required to support these organisms. Further guidelines for planning field trip activities can be found on page 53.

CLEANLINESS IN BIOLOGY

Areas where organisms are kept or cultured must be given special attention with regards to cleanliness. General safety guidelines to consider include the following.

- Do not store or consume food in these areas.
- Wash all used surfaces with a disinfectant (e.g., bleach) after each activity. Contact Health Canada, your local Health Authority or a science supply catalogue, for appropriate disinfectants.
- Clean shelves, cupboards, animal cages, autoclaves, fridges and other items at weekly intervals using an appropriate disinfectant.
- Wash hands after handling any kind of organism(s).

- If an autoclave is not available, sterilize equipment used in microbiology by boiling in a pressure cooker for 10 to 15 minutes. The heat provided by a microwave, on the other hand, is not uniform enough for this purpose. An ultraviolet light cabinet can be used to sterilize external surfaces. Liquid disinfectants and germicidal agents generally will not provide complete sterilization.

autoclave

Chapter 6
Physical Hazards

OVERVIEW

Physical hazards include mechanical, electrical, heat, sound and radiation hazards that may occur in physics laboratory activities as well as a variety of other science activities. Hazards in each of these categories have the potential to cause injuries (or, in some extreme cases, even death), but by taking general precautions, such as using appropriate protective equipment and emphasizing routine safety, physical hazards can be easily minimized.

MECHANICAL HAZARDS

Mechanical hazards rarely exist in a well-maintained laboratory where equipment is commercially produced, approved and in good working order. In general, safety can be increased by ensuring that equipment is well-maintained, that all equipment is turned off before leaving the area for any reason, and that students use equipment only with teacher supervision. In addition, there are some risks and safety measures to keep in mind when using specific kinds of equipment or performing specific kinds of activities.

Rotating Machinery

Machinery with rotating parts can catch loose clothing, hands or hair, potentially causing serious injuries. Uncovered parts may also fly off, creating additional risk, especially for eye injuries. To minimize risks:

- ensure rotating shafts, belts and pulleys are covered by guards, lids or covers
- check devices attached to a rotor before use to ensure that they are tightly fastened
- wear (and have students wear) eye protection when using uncovered, rapidly rotating parts, as in the demonstration of centripetal force and circular or periodic motion
- have students stand back as much as possible.

Tools

Careless use of tools or use of tools in poor condition can cause injuries to the hands, eyes, head and limbs. To minimize risks:

- regularly check tools for defects or damage
- provide students with clear instructions on safe use before they have access to tools.

Cutting Tools (Scalpels, Razor Blades)

These instruments tend to be very sharp; careless use can quickly result in deep cuts on the fingers and hands. To minimize risks:

- use extreme caution in handling cutting tools, and ensure that students do the same
- replacement of blades is best done by teachers or technicians
- wear eye protection when using cutting tools in case blade breaks.

Magnets

Large, powerful magnets or electromagnets can attract other magnets or iron/nickel objects with surprising force, which can cause painful pinching of fingers or hands if caught between the two. To minimize risks:

- inform students of this hazard before such magnets are used.

Glassware

Any kind of glassware has the potential to break, thus creating the risk for cuts or spilled materials. To minimize risks:

- wear goggles for eye protection
- use heat-resistant glassware, which is less likely to crack when heated
- avoid using glass containers that are cracked or chipped, since they may crack further during the experiment
- clean up any broken glass immediately and dispose of in a special waste bin.

Projectile Launchers

Projectile launchers are often used in the study of motion—sometimes as demonstration devices and sometimes as equipment for student laboratories. Equipment used includes such devices as ballistic pendulums, commercially-available devices that launch plastic and steel balls, and teacher-constructed devices that launch a variety of materials. Decisions about devices to be used for this purpose—and who will use them and how—need to recognize factors that can affect potential risk. These factors include the power of the launcher, the nature of the projectile, and the maturity, skill and safety awareness of the user. It is also critically affected by the location and orientation of the launcher when the device is operated, relative to the location of students. These devices should never be oriented in a way that puts students in the line of fire.

Use of such equipment where potential injury is a concern, should only be allowed under the direct supervision of a teacher. To minimize risk:

- wear goggles for eye protection
- participants and spectators should be behind the line of fire
- avoid use of projectiles with sharp points
- ensure that misfiring does not place participants or spectators at risk.

Testing Structural Design to Failure

Studies of the physics of design technology frequently include activities in designing, constructing, and testing models for strength and/or efficiency of performance. Such testing, particularly for strength, often requires stress-to-failure determination, which may require some precautions.

To minimize risks:

- assess all inherent risks of testing to determine necessary precautionary measures
- wear goggles for eye protection
- minimize height at which testing is done on collapsing structures
- use of heavy weights should be closely supervised.

ELECTRICAL HAZARDS

The two major risks related to electricity are electrical shock and fire. Some specific hazards and precautions are described below.

Faulty Wiring

Loose or broken connections or frayed connecting cords may create a short circuit. This can result from contact of the lead-in wires or internal connections in the equipment. Fire, electrical shock or equipment damage may result. To minimize risks:

- check external wiring of equipment before use
- verify normal function before making equipment available for student use.

Heavy-duty Usage of Lightweight Equipment

Equipment damage and overheating, and therefore fire, are always possible if equipment is in prolonged use at power ratings greater than for which the item was designed. To minimize risks:

- use equipment only as intended.

Electrical Equipment Near Water

Use of electrical equipment near water creates the potential for a shock hazard if water gets into the electrical system and a person makes contact with the water conducting current from the equipment. As well, there is potential for malfunction or failure of the equipment. To minimize risks:

- ensure equipment used near sinks or other water sources is properly insulated and grounded
- use ground-fault interrupter plugs where available
- switch off current at the wall outlet or unplug immediately if water gets into the electrical equipment, and do not use again until completely dry.

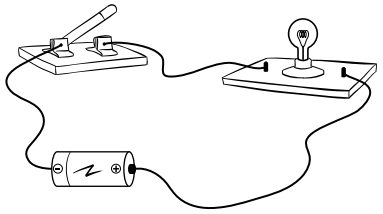
Electrical Equipment Near Flammable Liquids

The rotor of an electric motor generates sparks as it rotates past the brushes, which can ignite flammable vapours under poorly-ventilated conditions. To minimize risks:

- ensure that electrical equipment is used only in properly-ventilated areas, away from flammable liquids.

Shorting Dry Cell Circuits

Short circuits in devices not protected by a fuse can lead to overheating and to risk of fire or injury. Completing a circuit between terminals of a dry cell or dry cells without adding any resistance in the form of a bulb or other electrical device, will create such risks.



Contact with overheated wires can lead to skin burns or cause a fire if the wires are near flammable materials. Severe shorts can also cause dry cells to melt, give off toxic fumes and possibly explode. To minimize risks:

- ensure a circuit has at least one source of resistance; e.g., bulb, electric motor
- connect the battery/batteries last into a circuit if an open switch is not included.

Spark Timers

Spark timers are sometimes used in the study of motion in senior high school physics. This equipment uses a voltage surge to transfer carbon dots onto a ticker tape or paper sheet to mark the location of an object at preset time intervals. Spark timers that use ticker tape pose no significant hazard but spark timers attached to air tables do, since they use larger sheets of carbon paper that can transmit a minor electric shock to anyone who touches it. The shock itself is not the danger but the reaction to it can create unwanted hazards such as an elbow to the face of a by-stander. To minimize risk, warn students of the potential hazard.

High Voltage Equipment

Some student-wired laboratory set-ups and teacher-made demonstration equipment have the potential to deliver a high voltage discharge. Common risks include the following:

- capacitors that build up and store current can discharge on contact, generating a powerful shock in the process
- polarized capacitors can explode if incorrectly connected into a circuit
- tesla coils can cause severe skin burns
- electrostatic generators, particularly the Van de Graaf, can cause serious shocks if students join hands
- isolation transformers that use 120V AC current can be fatal since only one wire needs to be touched.

To minimize risks:
- ensure high voltage equipment is handled with extreme care
- ensure any use of such equipment is under the direct supervision and guidance of a qualified person
- ensure the equipment is in good working order before using it in the classroom.

HEAT HAZARDS

Heating devices create hazards of fire and injury. The potential risks posed by these devices vary with the heating device used and the way in which it is used. The analysis below identifies the pros and cons of using different devices and suggests procedures for minimizing risk.

In general, to reduce the risk of burns, students should:
- wear heat resistant gloves when handling heated objects or containers
- where possible, use test tube holders or tongs to handle hot equipment and containers
- never reach over an exposed flame or heat source
- use heat-resistance glassware for heating substances to prevent cracking and spilling of hot contents
- allow ample time for heated objects to cool before touching them.

Additional precautions for specific heat sources are listed below.

Bunsen Burners

Bunsen burners provide a direct and very efficient source of heat for laboratory purposes. However, there is a risk of burns particularly to student fingers and hands. As well, if the burner is used to heat water or a solution, the rapid heating can cause hot liquid to spurt out as it reaches its boiling point. To minimize risks:
- use Bunsen burners only if the activity requires high heat and if the maturity of the students is sufficient (in general, Bunsen burners would not be the preferred source of heat in elementary school and might also be avoided in junior high school)
- provide students with training on the use of Bunsen burners, particularly the routine of lighting and regulating flame intensity
- point the tube mouth away from anyone nearby when using Bunsen burners to heat a solution or water in a test tube
- do not use Bunsen burners or alcohol burners if flammable liquids are being used anywhere in the laboratory
- supervise students closely at all times during use.

Alcohol burners

Use of alcohol burners creates a significant burn hazard especially if there is any risk of the burner falling and breaking while it is lit or if it is turned upside down. The use of hot plates in place of alcohol burners is thus recommended as it creates a lower risk for students. Given the risks associated with use of alcohol burners, the National Science Teachers Association (NSTA) has taken a similar position with a recommendation that they should no longer be used in the science classroom or laboratory.

If alcohol burners are used, the following steps can be taken to minimize risks:

- use burners that are leak proof; i.e., do not leak if turned upside down
- supervise students closely during use
- avoid moving alcohol burners while lit
- never place burners on sloping surfaces
- place the burner well away from the edge of the table or counter on which it is set.

Hot plates

Electric hot plates with thermostatic controls provide a safer, controllable and reliable source of heat that meets the needs of science courses. However, they can still cause burns to skin. In addition, coiled hot plates, which might still be in use in some schools, have greater potential to cause burns because of the exposed coils. To minimize risks:

- ensure hot plates, as well as the heated materials and containers, are handled with care using proper techniques
- avoid coiled hot plates if possible, and take extra care if they must be used.

Primus Cartridge Burners

These also have a significant burn hazard associated with their use, much like that of the Bunsen and the alcohol burner. One major drawback of this heat source is the inability to control the air supply to the flame, thus the heat intensity of the flame is high (flame blue in colour) regardless of the size of the flame. Butane cartridges tend to be narrow and uniform in diameter and thus must be stabilized when in use. For these reasons, butane cartridges are not a good choice of heating at any grade level. To minimize risks:

- supervise students closely during use
- stabilize the cartridge while in use.

Butane Burners

These burners are relatively easy to use and function much like a Bunsen burner. They have separate adjustments for gas and for air. One drawback to their use is that the gas cartridges are not rechargeable and must be replaced once the gas is used up, making them more expensive to use than Bunsen burners.

Candles

Candles provide low intensity heat and thus are limited in their usefulness. However, they can be a good source of heat for activities where low intensity is required. The main problem with candles is their instability that can lead to tipping. To minimize risk:

- secure the candle firmly to a base to prevent tipping. For example, impaling the bottom of the candle onto a nail protruding from a board base is effective. Setting the candle into a small amount of melted wax that then solidifies is generally not adequate.

ROCKETRY HAZARDS

Rockets are devices containing combustible propellants that produce thrust by expelling hot gases. Depending on their physical size and the size of the motor(s), rockets are classified as model rockets or high powered (model) rockets. The guidelines and regulatory requirements that must be met for each of these are quite different.

Model Rockets

No special training or certification is required for building, installing and firing model rockets made of lightweight materials weighing 1.5 kg or less. Rockets in this category are restricted to types A to G motors producing up to a maximum of 160 Newton-seconds impulse, which in combination cannot exceed 320 Newton-seconds total impulse. For less powerful A to F motors, the person must be over the age of 12 years and be supervised by an adult. However, to purchase “G” level motors, a person must be 18 years old or older. Model rockets use premanufactured solid propellant rocket motors with black powder or composites as propellants.

Flying of model rockets should be done in accordance with the Canadian Rocketry Association safety code. These can be found at http://www.canadianrocketry.org. Also check with local authorities for bylaws regulating the firing of such rockets. Currently, in Calgary, for example, bylaw 36/74 prohibits firing of rockets from park lands that includes green

spaces, school and park reserves, city parks, as well as school yards. In Edmonton, a permit is required to launch model rockets from public-owned or controlled land, including any local park. Launching on private land does not require a permit as long as the rocket lands on the same private land.

Rocketry clubs and associations in Alberta that can be contacted for more information on rocketry include the Edmonton Rocketry Club, Calgary Rocketry Association, Lethbridge Rocketry Association, and the Cold Lake Rocketry Club.

High Powered (Model) Rockets

Rockets in this category have motors with an impulse over 160 Newton-seconds but not exceeding 40 960 N-s. Installing and firing such rockets is restricted to individuals over the age of 18, requires Canadian Association of Rocketry High Power certification and is restricted to approved launches. Transport Canada has set out requirements for launching high powered model rockets in Canada. These can be found at the Canadian Association of Rocketry Web site at http://www.canadianrocketry.org/.

The major inherent risks associated with firing rockets include possible burns and the potentially lethal impact of misguided rockets.

SOUND HAZARDS

Prolonged exposure to sound in excess of 85 decibels★ (dBA) causes cumulative damage to inner ear hair cells, which results in permanent loss of hearing at the specific frequencies to which the lost hair cells were sensitive. Such volumes might be created, for example, by loud music at school dances or by large generators in mechanical rooms. By contrast, high impact noise causes eardrum perforation. Such noise is generated by pneumatic tools such as jack hammers. The eardrum perforations will heal, but each time this happens scar tissue builds up on the eardrum and makes it less sensitive to sound waves. Any equipment or instruments generating significant sound should be monitored for loudness to ensure they do not exceed allowable occupational exposure limits set out in the *Occupational Health and Safety Code*.

★**Note**: A dBA is a measure of sound level in decibels using a reference sound pressure of 20 micropascals when measured on the “A” weighting network of a sound level meter.

RADIATION HAZARDS

Radiation is an insidious hazard associated with the decay of radioactive materials such as isotopes of uranium and thorium, as well as emissions from electronic equipment or other sources. Radiation is the emission of energy in either particulate or electromagnetic form and is generally classified into two distinct categories, ionizing and nonionizing.

Ionizing Radiation

Ionizing radiation has the potential to damage human tissue by breaking chemical bonds, removing electrons from atoms, or even breaking up the nucleus of atoms. It can affect the cells of the body, increasing risk of harmful genetic mutations, cancer, or, at worst, massive tissue damage leading to death within a few weeks. For this reason, possession and use of materials that emit such radiation is tightly controlled by the Atomic Energy Control Board (AECB) through the enforcement of several sets of regulations.

It should be noted that there is no readily-applicable standard specifying what amount of radiation exposure is safe. Perceptions range from zero tolerance to acceptable exemption levels set out in Schedule 1 of the Nuclear Substances and Radiation Devices Regulations for a variety of radioactive substances. These exemption levels, given in becquerels, do not require licensing as long as the possession limit of such sealed sources does not exceed 10 in any one calendar year.

In general, the level of radioactivity in materials considered acceptable for senior high school activities is so small that it approaches the level of normal background radiation. Such low levels do not require special licensing from the AECB, since potential health risks are minimal. These low-level sources are readily available through science supply companies. These have radioactivity levels measured in microcuries and can generally be disposed of via the local landfill. One should check with the district office to ensure this is the case. Furthermore, no elaborate safety equipment or protective measures are necessary.

Radioactive decay rates are given in curies or in the International System of Units in becquerels. A curie (Ci) is defined as 37 billion disintegrations per second as measured in 1 gram of radium. A becquerel equals one disintegration per second.

Special handling and shielding of radioactive materials is required in instances where activity levels exceed the exemption quantities set out in Schedule 1 of the Nuclear Substances and Radiation Devices Regulations. Materials that have such high levels of radioactivity are not recommended for school use. See http://www.nuclearsafety.gc.ca/eng/regulatory_information/Regulations/index.cfm for more information on these regulations and exemption limits in Schedule 1.

Radioactive materials available for purchase come in both sealed and unsealed containers. Sealed containers have the radioactive material permanently embedded within a metal, plastic or other medium. Such sources are easier to handle and are generally safer to use than the unsealed sources of the same material. Sealed sources in license-exempt quantities are also readily disposable.

The term "ionizing" radiation refers to radiation in several forms:

- alpha particles
- beta particles
- gamma rays
- ultraviolet radiation, particularly at higher frequencies.

Each of these forms of radiation has sufficient energy to break chemical bonds and damage human tissue. Potential harm is proportional to the energy absorbed which in turn is affected by the amount of exposure.

Although alpha particles can be stopped by a sheet of paper and beta particles by a layer of clothing, both are much more hazardous if ingested or inhaled. On the other hand, both gamma and x-rays easily pass through the human body. Lead shielding is necessary to protect against such rays.

Cathode ray tubes (CRTs) do not normally pose a radiation risk but can emit x-rays when a current is present and there is a potential of at least 5000 volts. To produce an appreciable x-ray beam requires 10 000 volts or more.

Protection from Ionizing Radiation

To minimize the potential hazards of ionizing radiation, consider the following precautions that limit exposure to the radioactive material.

- Use low-level radioactive material with emissions in millicuries.
- Keep the time for potential exposure to a minimum.
- Stay as far from the radiation source as possible. As a rule, if the distance is doubled, exposure is deduced by a factor of four.
- Monitor radiation levels throughout time of exposure with the use of a Geiger counter.
- Store in a suitably shielded container; e.g., a lead storage pot in a properly marked cabinet not frequently used by people.

Nonionizing Radiation

Radiation that has enough energy to move atoms in a molecule around or cause them to vibrate, but not enough to change them chemically, is referred to as nonionizing radiation. Examples of this kind of radiation are sound waves, visible light rays, lower frequency ultraviolet rays and microwaves.

Nonionizing radiation increases kinetic energy of molecules in body tissue, which leads to heat production. When short wavelength radiation, such as ultraviolet rays, is absorbed by the skin or eyes at a high enough intensity or for a long enough time, the result can be sunburn and painful "welder's flash" burns of the eye. Prolonged or chronic exposure to ultraviolet radiation may also lead to premature skin aging. At sufficiently high intensities, nonionizing radiation can disrupt essential physiological processes. However, in normal school laboratory practices, where low intensity radiation sources are used and exposure is minimized, levels will be well below specified limits and it is generally not necessary to measure actual field strengths.

Protection from Nonionizing Radiation

The best way to minimize the potential hazards of nonionizing radiation is to limit exposure to radiation sources by taking precautions such as the following.

- Keep the time for potential exposure to a minimum.
- Stay as far from the radiation source as possible (note that this is not the case with laser beams, which do not significantly change in intensity within the space of a typical school laboratory).
- Use appropriate shielding or protection, such as UV goggles or protective gloves.
- Never look directly into a laser beam, ultraviolet radiation source or bright light.
- Instruct students in proper operating and handling procedures, and ensure that they follow these procedures.

Potentially Hazardous Sources of Nonionizing Radiation

Ultraviolet radiation

Ultraviolet rays are high-energy rays that can produce skin burns and "welders flash burns" of the eye with enough exposure and light intensity. To reduce these risks:

- minimize skin exposure
- never look directly at a source of ultraviolet rays without appropriate eye protection.

Potential sources of ultraviolet rays include lasers, stethoscopes, microwave ovens, UV bulbs, welders, fluorescent bulbs, gas discharge tubes and burning magnesium ribbon.

Visible light and lasers

The direct or reflected viewing of any intense visible light source—electric arcs, burning magnesium ribbon, the Sun, or even collimated or focused beams from ordinary tungsten lights—can cause retinal damage. For example, looking at the sun requires the use of a solar filter equivalent to that of a welding mask.

The visible beam of light from a laser is focused by the lens of the eye and can cause severe retinal damage with very brief exposure if the laser is of sufficient power. For this reason, the Canadian Radiation Emitting Devices Regulation specifies that demonstration lasers for educational institutions be limited to 1 milliwatt beam power and be within the wavelength range of visible light (400 to 780 nanometres). For lasers meeting these criteria, the normal blink response time of 0.25 seconds is sufficient to prevent retinal damage. To further reduce risks:

- do not allow students to use lasers without close supervision
- use lasers in a well-lit room so that the pupils of the eye are small
- position lasers so that the beam cannot enter the eyes directly or by reflection.

Stroboscopes

Rhythmical pulses of light, especially in the range of 3 to 7 Hertz, can cause unpleasant or dangerous physiological effects in some people, including nausea and epileptic seizures. To minimize these risks:

- avoid the range of 3 to 7 Hertz
- warn students of potential effects and monitor them closely for unusual behaviour or onset of nausea during use of stroboscopes
- excuse students who know that flashing light has a negative effect on them.

Microwaves

All microwave ovens produced since 1971 are covered by a federal radiation standard that assures such ovens are safe. This standard limits leakage of microwaves to values well below the level at which heating or burning of human tissue would occur, even at distances as close as 5 cm.

Chapter 7
Chemical Hazards

OVERVIEW

Chemical hazards come in a variety of forms. Some chemicals are toxic or corrosive in nature; others are unstable when exposed to certain compounds or conditions; still others are carcinogenic or mutagenic. Most of the chemicals used in schools do not pose serious dangers. However, there are some chemicals that require more careful handling and others that should be avoided altogether. It is also important to know proper clean-up procedures, in case a spill does occur.

Before working with any chemical, particularly regulated or hazardous substances, teachers and students should be thoroughly familiar with its chemical and physical properties. Where possible, control risks by limiting chemical concentration and exposure. Keep in mind that "*The dose makes the poison*"; in other words, the higher the concentration of a chemical, the higher the toxic or corrosive hazard.

GENERAL SAFETY MEASURES

The following general guidelines can be followed to increase the margin of safety when working with chemicals.

- Ensure that the chemical is appropriately labelled and that the MSDS is readily available.
- Minimize exposure.
- Ensure that the acquisition, use and storage of toxic materials are based on real needs: if safer alternatives exist, use them.
- Do not handle or use hazardous chemicals unless you are WHMIS trained.
- Do not engage other staff in handling and using hazardous chemicals if they are not WHMIS trained.
- Before using any chemical, review its MSDS to determine potential hazards.
- Inform students of hazards and the necessary safety precautions. Never underestimate risks when mixing chemicals.
- Be prepared for accidents.
- Ensure chemicals and chemical wastes are stored with proper hazard identification.
- Do not keep stock bottles in the laboratory.
- Store chemicals in minimum quantities and in lower concentrations.
- Do not use toxic materials unless there is adequate protection from exposure.

CODE OF PRACTICE

Schools that stock any of the following substances should note that there is a specific Occupational Health and Safety Code requirement that may apply, depending on the quantity of material stocked.

arsenic and compounds	ethylene dibromide	methyl bromide
asbestos	ethylene oxide	methyl hydrazine
benzene	hexachlorobutadiene	perchlorates
beryllium	hydrazines	silica, crystalline
1,3-butadiene	hydrogen sulphide	styrene
cadmium	isocyanates	vinyl chloride
coal tar pitch volatiles	lead and compounds	zinc chromate

If the amount stocked for any of these substances exceeds the following quantities, the employer [in this case the school board] must have a code of practice governing the storage, handling, use and disposal of the substance. The amount on any of these substances that would trigger this requirement is specified as:

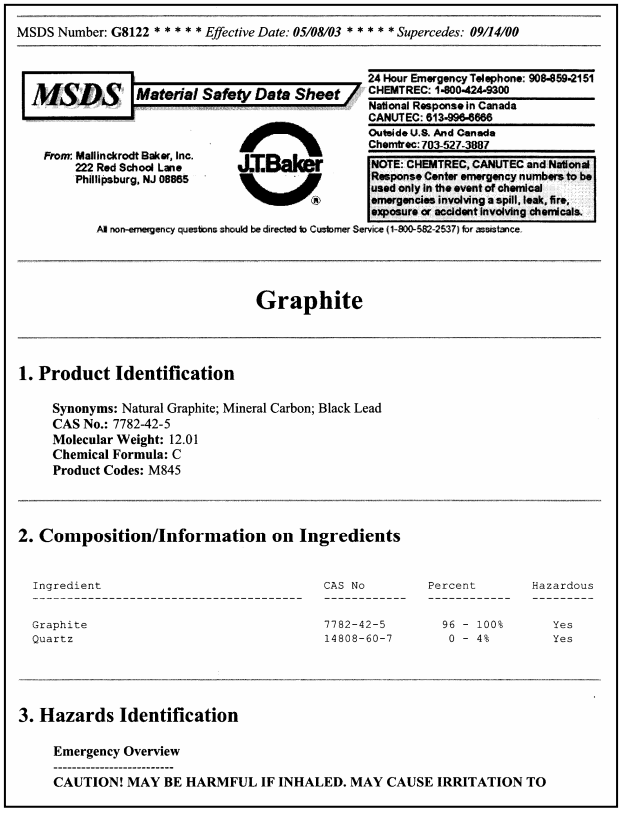
- 10 kilograms if in the form of a pure substance
- 10 kilograms if it is a component of a mixture in which it forms at least 0.1% of the mixture.

The code of practice must include measures to be used to prevent any uncontrolled release of the substance and the procedures to be followed if there is an uncontrolled release.

For further information on this requirement, see the *Occupational Health and Safety Code* Part 4, Section 26(1) at http://www3.gov.ab.ca/hre/whs/publications/pdf/ohsc-1.pdf and the corresponding section of the *Occupational Health and Safety Code Guide* at http://www3.gov.ab.ca/hre/whs/law/ohs_regcode_down.asp#eg.

MATERIAL SAFETY DATA SHEETS

Material safety data sheets (MSDSs) give detailed information about a chemical's composition, reactivity and health effects, as well as which protective equipment, safety procedures and emergency procedures to use. These sheets must be prepared by the product supplier and provided to the user (in this case the school) for all controlled chemicals. Suppliers may also be asked for MSDSs for other chemicals they supply. The MSDSs supplied by a chemical supply company are the legal source of information for those chemicals in case of an accident. In addition to the MSDSs supplied by chemical supply companies on order of chemicals, a variety of sources are available through MSDS online at http://www.ilpi.com/msds/index.html. Unfortunately, some sites listed have limited access, particularly for print-outs. A Web site with an extensive listing of chemicals and a number of companies from whom MSDSs can be obtained is available at http://www.msdssolutions.com.



MSDS Number: **G8122** * * * * * *Effective Date:* ***05/08/03*** * * * * * *Supercedes:* ***09/14/00***

MSDS Material Safety Data Sheet

From: Mallinckrodt Baker, Inc.
222 Red School Lane
Phillipsburg, NJ 08865

J.T.Baker

24 Hour Emergency Telephone: 908-859-2151
CHEMTREC: 1-800-424-9300
National Response in Canada
CANUTEC: 613-996-6666
Outside U.S. And Canada
Chemtrec: 703-527-3887

NOTE: CHEMTREC, CANUTEC and National Response Center emergency numbers to be used only in the event of chemical emergencies involving a spill, leak, fire, exposure or accident involving chemicals.

All non-emergency questions should be directed to Customer Service (1-800-582-2537) for assistance.

Graphite

1. Product Identification

Synonyms: Natural Graphite; Mineral Carbon; Black Lead
CAS No.: 7782-42-5
Molecular Weight: 12.01
Chemical Formula: C
Product Codes: M845

2. Composition/Information on Ingredients

Ingredient	CAS No	Percent	Hazardous
Graphite	7782-42-5	96 - 100%	Yes
Quartz	14808-60-7	0 - 4%	Yes

3. Hazards Identification

Emergency Overview

CAUTION! MAY BE HARMFUL IF INHALED. MAY CAUSE IRRITATION TO

MSDSs are an essential source of information about chemical hazards, so it is important that teachers and students be able to understand the sheets from a variety of suppliers. Although the numbering of sections and the order of appearance may differ from supplier to supplier, the following information must be on each MSDS:

I. PRODUCT IDENTIFICATION AND USE
- Manufacturer's Name
- Supplier's Name

II. HAZARDOUS INGREDIENTS

III. PHYSICAL DATA
- Colour, form, solubility
- Melting and boiling points
- Vapour pressure, specific gravity

IV. FIRE AND EXPLOSION DATA
- Flammability
- Flashpoint
- Fire-fighting procedures

V. REACTIVITY DATA
- Stability and Hazards

VI. TOXOLOGICAL PROPERTIES
Threshold Limit Values (TLV)
Effects of exposure
Carcinogenicity

VII. PREVENTATIVE MEASURES
Protective clothing
Protective equipment
Spill and handling procedures

VIII. FIRST AID MEASURES

IX. PREPARATION DATE OF MSDS

MSDSs are dated and expire at the end of a three-year period. Updating of MSDSs is generally done at the same time that the chemical inventory is updated. Official MSDSs can be filed in hard copy form or on a computer, as long as they are readily available to all staff using these chemicals. Online access to specific company MSDSs may also be available, but this method requires tracking the chemicals and the companies from which each chemical was ordered if more than one supply company was used. For more information about chemical management, see Chapter 8.

TOXIC AND CORROSIVE CHEMICALS

Toxic or corrosive properties are the most common hazards posed by chemicals in schools (see the Chemical Hazard Information Table in Chapter 9 for information about specific chemicals). A toxic substance is any substance that may cause damage by its chemical action when ingested, inhaled, absorbed or injected into the body in relatively small amounts. Damage can occur when materials:

- directly destroy tissue through corrosive action; e.g., NaOH reacts with moisture in the skin
- interfere with chemical reactions of the body; e.g., CO replaces O2 in hemoglobin
- disrupt the biological processes of the body; e.g., NO2 causes pulmonary edema and allergic responses.

Exposure to Toxic Materials

Toxic materials can enter the body by:

- inhalation—breathing in poisonous or corrosive vapours and dust (most common route by which toxic materials enter the body)
- ingestion—swallowing liquid or solid toxic materials
- direct entry—chemicals entering through open wounds or directly injected through punctures, allowing chemicals access to the bloodstream
- contact—absorbing toxic materials through skin, mucous membrane or eyes.

Since inhalation of vapours or dust is the most common way that toxic materials enter the body, every effort should be made to avoid circumstances that allow this to happen. Any activities that involve use of toxic materials in liquid, vapour or dust form should only be carried out under a fume hood.

Effects of Toxic Chemicals

Toxic effects can be local or systemic, acute or chronic. Local effects are confined to the area of the body that has come in contact with toxic materials; systemic effects occur throughout the body after absorption into the bloodstream. Acute effects are immediate and usually extremely serious or painful. With chemicals that can produce acute effects, poisoning may be suspected when any of the following are evident:

- strange odour on the breath
- discolouration of lips and mouth
- pain or burning sensation in the throat
- unconsciousness, confusion or sudden illness.

By comparison, chronic effects are long lasting and may take many years before becoming evident. Many substances, such as arsenic and mercury, have cumulative effects, meaning that poisoning may occur at lower concentrations through repeated exposures over a period of time. Such substances are sometimes known as insidious hazards.

Insidious substances include carcinogens, teratogens and mutagens. Carcinogens cause cancer in cells. Teratogens interrupt or alter the normal development of a fetus. These include chemicals such as ethanol and mercury compounds, viruses such as rubella, and ionizing radiation. Mutagens increase the rate of mutation of cells or organisms, and include chemicals such as nitrous acid, peroxides and dichromates, as well as certain viruses and radiation.

Insidious Hazards

The most obvious source of insidious chemical hazards is from substances known to have dangerous long-term effects, such as mercury and carcinogens, which are discussed below. These substances can cause damage through direct exposure or through leakage of vapours or fumes from chemical containers. However, even if such chemicals are not intentionally ordered and stored in the schools, insidious hazards can still exist and be easily overlooked. These hazards include:

- leaking gas cylinders
- formaldehyde from biological specimens (if these are still around)
- mixed chemicals that slowly react to form toxic products, particularly mixtures of waste materials
- neglected containers of dried solutions and residues of chemical products from past demonstrations and activities
- residue from chemicals improperly disposed of in the sink drain, resulting in subsequent interactions that cause the formation and release of toxic or other hazardous materials into the laboratory air (for chemicals that can be safely disposed of down the drain, see the Chemical Hazard Information Table in Chapter 9).

Mercury

One relatively well-known hazardous substance is mercury, which can have serious and cumulative effects on the gastrointestinal and central nervous systems. Open mercury evaporates and readily absorbs through the skin and respiratory system. Disposal of mercury and mercury compounds is also a major concern.

Given the hazards of mercury, it is not recommended for use in Alberta schools. Mercury thermometers should no longer be used in schools because of potential breakages and spills. If mercury is still in stock, the following steps need to be taken to manage it more safely:

- Store mercury in plastic bottles under a layer of water or oil.
- Keep the container sealed in a cool, well-ventilated area.
- Avoid opening the container and allowing vapours to escape.
- Wear gloves when handling containers.

Mercury spills from thermometers, thermostats or any other source must be cleaned up immediately and thoroughly, regardless of the size of the spill. Unless spills are promptly and thoroughly cleaned up and the area decontaminated, dangerous exposure to vapours will continue. In the past, the common practice for clean-up was to aspirate or sweep up any visible drops. Often, small droplets hidden in cracks and crevices were inadvertently left behind to evaporate into the atmosphere.

Mercury droplets from 10 to 1000 micrometres in diameter also stick to vertical surfaces and penetrate into porous flooring. In some cases, relatively large amounts of mercury may be left undiscovered after spills. Prompt and thorough clean-up of mercury spills is essential or cumulative exposure to mercury vapours can cause irreparable harm to those working in the area.

In Alberta, the clean-up procedures for mercury spills in schools are determined by local school boards. Some boards may permit school staff to clean-up spills using commercial spill kits, while others specifically restrict clean-up to professionals such as those at Hazmat Clean-Up. Check your school board's policy on mercury spill clean-up before proceeding with the actual process. If board policy allows staff clean-up, use a commercial spill kit that includes components to control vapours; i.e., aspirator, mercury absorbent and vapour absorbent.

Carcinogens

A carcinogen is a chemical, physical or biological substance that is capable of causing cancer. The damaging effects are subtle and imperceptible in the short term, thus carcinogenic substances are another insidious hazard that may be present in the laboratory and chemical storage area. A substance is considered to be carcinogenic if it has been evaluated and rated as a human carcinogen, an animal carcinogen or a potential carcinogen by the American Conference of Government Industrial Hygienists or the International Agency of Research on Cancer. These substances will also be categorized under WHMIS as Class D2.

Health Canada has tabled a list of substances assessed for carcinogenicity on its Web site at http://www.hc-sc.gc.ca/ewh-semt/occup-travail/whmis-simdut/compli-conform/carcinogenesis-carcinogenese_e.html. The Web site also has links to agencies to enable searches of the most current information. Carcinogenic properties are also indicated in the Chemical Hazard Information Table in Chapter 9.

Actual manifestation of cancer or tumors for most carcinogenic chemicals requires prolonged and often relatively constant exposure. Proper storage of such chemicals in airtight containers reduces this hazard by limiting exposure only to periods of chemical usage. However, the more frequent the use, the greater the exposure, particularly for powdered forms of these chemicals, which can be absorbed through the skin and lungs.

Fewer chemicals have carcinogenic properties compared to other risks, and those that do should be avoided, if possible. Whether to stock and use chemicals with carcinogenic properties will depend on curricular requirements, adequacy of facilities and the ability to safely handle these chemicals with the frequency required. Serious consideration should be given to using alternative chemicals wherever possible.

Corrosive Substances

Corrosive chemicals cause visible, usually rapid damage to human tissue at the site of contact. Often this corrosive quality is due to the reaction of the substance with water or moisture in the tissue. This is the case with strong acids and bases of 1M or greater concentration, nonmetal halides, dehydrating agents, halogens and oxidizing agents. The most serious corrosion hazards come with substances that are in a mist or gaseous state, since they can be readily absorbed through the skin or inhaled into the lungs.

The corrosive properties of chemicals commonly found in schools are identified and discussed in the Chemical Hazard Information Table in Chapter 9.

Minimizing Risks of Toxic and Corrosive Chemicals

Whenever chemicals are used, the onus is on the teacher to assess risks, determine proper handling procedures and convey this information to students before beginning the activity. Handling procedures used for all chemicals, and especially those with greater hazards, should aim to minimize exposure. This can be accomplished through strategies such as the following.

- Do not handle hazardous materials in open container, as vapours, dust and liquids can easily escape during normal handling.
- Do not heat hazardous materials, as smoke and vapour may be released in much greater quantity when material is hot.
- Avoid crushing or grinding solids or unnecessarily transferring powders, which creates dust.
- Use and store hazardous materials only in areas with adequate ventilation. Toxic vapours can rapidly accumulate to dangerous levels in a room, or part of a room, that does not have a constant replacement of fresh air.
- Do not lean over open bottles, as toxic vapours can be concentrated directly above the bottle even in well-ventilated rooms.
- Ensure chemicals are clearly labeled and check these labels every time a substance is used. Odour and appearance are not reliable guides to the toxicity of substances: Dangerous liquids can be clear and odourless, and toxic vapours may have little or no odour, even at dangerous concentration levels.
- Use proper protective gear such as correct clothing, face protection, fume hoods or respirators to prevent skin contact with hazardous materials and inhalation of toxic vapours.
- Do not chew gum, smoke, or store or consume food or beverages in an area where hazardous materials are used. Food, beverages and cigarettes can easily absorb hazardous vapours or be contaminated with unseen toxic dust. Poisons may also be transferred from hands to food or cigarettes.
- Follow proper clean-up procedures after each lab activity is finished. Substances left on benches or in beakers and bottles may expose others to these toxic materials.
- Ensure students wash their hands thoroughly after activities to avoid transferring toxic materials to food they eat.

Insidious hazards could be easily overlooked or ignored, even during routine safety inspections, because they do not have immediately obvious effects. To avoid or reduce these kinds of hazards, consider the following measures.

- Give specific attention to possible sources of insidious hazards during the safety inspection process.
- Prepare an inventory of insidious hazards that must be tended to regularly.
- Provide adequate ventilation in the form of hoods and forced air, as stated in current standards and codes.
- Avoid stock build-up of toxic, flammable or corrosive materials.
- Keep appropriate clean-up agents accessible in case of spills.
- Collect waste materials in separate containers and do not mix.
- Perform diligent and regular housekeeping.

OTHER CHEMICAL HAZARDS

Cryogenic Substances (liquefied/solidified gases)

Cryogenic substances are gases that are maintained in liquid or solid form at extremely low temperatures. The most common cryogens that are readily available to schools are solid carbon dioxide (dry ice) and liquid forms of hydrogen, oxygen, methane and nitrogen.

Cryogens pose several serious hazards. These include:

- *Explosive Pressure*. Cryogenic gas generates enormous pressure when it vapourizes within the container and when released through the valve. In the case of methane gas, for example, the expansion is 630 times that of the equivalent liquid volume.
- *Fire*. Flammable cryogenic substances present the same flammability hazard as their gaseous forms.
- *Embrittlement* of structural materials and human tissues. Most materials experience some degree of embrittlement at temperatures below –50° C. Contact with cryogenic liquids, their gases or the surfaces of their containers can lead to frostbite or more extensive freezing of tissue that can be very destructive. Living tissue can become completely frozen and so brittle that it will shatter on impact.
- *Asphyxiation*. Except for liquid oxygen, expansion of cryogens may displace a sufficient volume of air to cause asphyxiation. This is particularly true of dry ice, which sublimes into carbon dioxide gas and readily displaces normal air, since it is heavier than other atmospheric gases.

The use of cryogenic compounds is not required to meet any specific learner outcomes in Alberta science curricula. Instead, teachers sometimes use these substances to create special effects. Use of cryogens may require submission of a written “Safe Work Procedure” proposal to the Safety Services Department or an equivalent department. Before proceeding with ordering and using these substances, check the regulation requirements with your board office.

Only personnel with the necessary expertise and appropriate administrative approval should handle compressed gases or cryogenic substances, including dry ice. Use by students is not recommended. Anyone choosing to use cryogens should have a thorough knowledge of the characteristics of the substance at the temperatures and pressures being used, and the appropriate safety precautions for handling. They should also know how to recognize and eliminate leaks, and the requirements for short- and long-term storage.

To minimize risks, it is important to take every possible precaution, including the following.

- Use cryogens only in a properly ventilated space to avoid a build-up of gas that may cause fire, explosion or asphyxiation. Adequate ventilation is particularly important to prevent asphyxiation with the use of dry ice.
- Store containers of cryogenics in a cool, well-ventilated space, in an upright secured position, and vent containers properly to avoid explosion. Prolonged storage in a poorly ventilated area will cause metal valves to undergo chemical corrosion. If this occurs, store in a separate cool, dry room away from direct sunlight and sources of sparks or flame.
- Ensure warning signs and the name of the cryogen are all posted in locations where the substance is stored or used.
- Ensure vessels are appropriately labelled and filled only with the liquids that they were designed to hold.
- Perform operations slowly to minimize boiling and splashing.
- If liquid nitrogen is heavily contaminated with oxygen, handle it with precautions suitable for liquid oxygen. The appearance of a blue tint in liquid nitrogen is a direct indication of oxygen contamination.
- Take appropriate precautions when releasing cryogenic gases. If oxygen is used, remember that it does not burn but it does enhance burning of flammable materials, thus open flames or sources of sparks should be removed from the area.
- Ensure that all eyes are protected and all skin is covered by wearing goggles, a face shield, pants and boots, a laboratory coat or apron without pockets or cuffs, and loose-fitting gloves that can be easily removed.
- Remove watches, rings, bracelets and other jewellery.

Compressed Gases

Cylinders of compressed gases should be handled and stored in a similar fashion to cryogenic substances.

Containers used to store gases should meet the National Fire Protection Association (NFPA) standard, prescribed for both Canada and the United States.

Flammable Substances

Generally, substances that are highly flammable, particularly those that are also highly volatile, should not be used by students. If minute amounts are provided for student use, make sure the area is well-ventilated and far from open flames or sparks. Identify and eliminate any unwanted ignition sources that may exist, such as sparks that come with unplugging electrical cords and static electricity. Teacher demonstrations using flammable substances can be done under similar conditions or under the fume hood.

Again, cabinets and containers used to store gases should meet the National Fire Protection Association (NFPA) standard, which is relevant both in Canada and the United States.

Explosive Substances

Concentrated forms of unstable substances that have the potential to explode pose too great a risk to warrant use and should not be kept in schools. Some explosive substances in lower concentrations, such as hydrogen peroxide, are relatively safe. For more information on explosive substances, refer to this group in the "Reactive Nature of Chemicals" table in Chapter 9.

MANAGING THE RELEASE OR SPILL OF TOXIC OR CORROSIVE SUBSTANCES

Deciding how to handle a spill first requires understanding the health hazards associated with the substance. There are three immediate questions that must be answered:

- Is this substance highly toxic or corrosive?
- Does it give off toxic or corrosive fumes?
- Are the fumes potentially explosive?

Answers to these questions can be found in the pertinent MSDS sheets that should be accessible to users at all times, and be reviewed before commencing activities with the materials. For substances that are highly toxic or corrosive—ones that have a health rating of 3 or 4—any spills and releases of these substances must be handled by specially trained professionals who are equipped to deal with such emergencies. This may require evacuation of the school, particularly if toxic fumes are associated with the substance. See Chapter 2 for emergency procedures.

In the case of spills of acids and bases, local action by knowledgeable staff can be taken to neutralize the spill using materials prepared for that purpose. Once neutralized, the products can then be cleaned up and disposed.

Prompt clean-up is also the appropriate measure to deal with manageable quantities of other materials that are not highly toxic or corrosive. All wastes resulting from these cleanups should be contained separately. Placing all spilled or waste chemicals in a general waste bin may result in reactions with other chemicals or wastes placed in the container.

Corrosive Liquids

Less serious spills of corrosive liquids can be handled using the following steps.

1. Put on protective clothing/equipment (face shield, rubber gloves, rubber boots and lab coat) if the spill is concentrated.
2. Contain the spill with asbestos-free vermiculite, clay cat litter (bentonite) or diatomaceous earth.
3. Neutralize the substance. For acids, liberally apply sodium bicarbonate (baking soda) or sodium carbonate (soda ash), or apply a spill kit pillow. For bases, sprinkle boric acid or citric acid on the spill, or apply a spill kit pillow. Test with pH paper to ensure the substance is completely neutralized.
4. Dilute with plenty of water and mop up using an absorbent cloth.
5. Wash contents down the sink and clean spill area with water. Wipe dry with paper towels.

Note: Municipal bylaws and waste regulations may permit some substances to be disposed of through drains. If permitted in your area, wash the material down with plenty of water. Alternatively, absorbent materials (asbestos-free vermiculite or diatomaceous earth) may be used to soak up the solution. The resulting mixture can then be bagged, labelled and sent for disposal.

Flammable Liquids

Small amounts of solvents can be cleaned up as follows.

1. Immediately shut off all ignition sources, and open windows and vents leading directly to the outside for ventilation.
2. Contain and cover the spill with a mineral absorbent such as asbestos-free vermiculite, bentonite or diatomaceous earth.
3. Scoop the contaminated absorbent into a heavy gauge garbage bag or plastic bucket with lid.
4. Wash the spill area with soap and water, using a disposable cloth.
5. Dispose of the contaminated cloth in the same garbage bag.
6. Allow to evaporate under the fume hood.

Other Liquids (excluding mercury)

Water-soluble liquids

1. If necessary, contain with towels, asbestos-free vermiculite, bentonite or diatomaceous earth.
2. Dilute with water.
3. Mop up using paper towels or cloths. Very small spills can be swabbed directly into a sink and flushed with large volumes of water.
4. Check the Chemical Hazard Information Table in Chapter 9 or the MSDS for final disposal details.

Water-insoluble liquids

1. If necessary, contain with towels, asbestos-free vermiculite, bentonite or diatomaceous earth.
2. Cover the spill with mineral absorbent and scoop the contaminated material into a suitable container for disposal.
3. Wash the spill area with water and soap and wipe dry with paper towels.
4. Discard contaminated towels or cloth.
   Check the Chemical Hazard Information Table in Chapter 9 or the MSDS for final disposal details.

Solids

The critical factor in cleaning up solid chemicals is to avoid raising particles into the air and inhaling them.

1. Slowly sweep up granules or powder into a dustpan.
2. Mop up smaller amounts with a damp disposable cloth.
3. Wipe the area clean.
4. Determine appropriate disposal procedures from the Chemical Hazard Information Table in Chapter 9 or the MSDS.

Chapter 8
Chemical Management

OVERVIEW

Many chemicals can be managed safely by schools, depending on staff expertise and the facilities available. Chemicals designated as controlled, regulated or hazardous, however, require special attention through the full cycle of procurement, storage, use and disposal. Management of such chemicals requires a thorough understanding of their chemical properties, potential hazards, and what to do in case of an accident.

The focus of this chapter is on implementing a sound, comprehensive chemical management plan that addresses chemical purchasing, storage and inventory, as well as strategies for minimizing and managing chemical wastes. To ensure such a plan is working effectively requires auditing (and revising if necessary) processes for:

- ordering and receiving chemicals
- storing and handling chemicals
- disposing of chemicals.

CHEMICAL ACQUISITION

Choice of Chemicals

The selection of chemicals for use in school laboratories should be based on several considerations:

- curriculum needs
- value of the laboratory experiences provided to students
- chemical hazards
- likelihood of chemicals being used in multiple activities or classrooms
- maturity, knowledge and skills of the students
- availability of alternative activities and materials
- storage facilities and laboratory equipment available
- environmental considerations and costs related to disposal.

In many cases, nonregulated chemicals that can be bought at the local store can be used as substitutes for more hazardous chemicals. Choosing these less hazardous chemicals often reduces cost of purchase and disposal as well as the hazards associated with use. However, there are many chemicals required in science courses, particularly those in senior high school, that must be ordered from chemical supply houses. When choosing chemicals, consider whether the benefits outweigh the risks, and if they do not, look for safer substitutes.

If an activity that is being attempted for the first time calls for chemicals not on the shelf, schools may wish to borrow rather than purchase the chemicals, particularly if it is uncertain that these chemicals will be used again in the future. If borrowing requires transport between locations, TDG regulations must be observed.

Quantity Ordered

When determining how much of a specific chemical to order, consider the following factors:

- consumption rate
- stability of the chemical (most inorganic salts and dilute acids and bases stocked in schools do not deteriorate with time)
- future use of the chemical
- available storage space
- financial resources.

As a general rule, a “less-is-better” approach to chemical purchasing lowers inherent risks. Buying only what is needed, based on the factors above, also leads to better organization and less costly waste disposal at the end of the year. For less-stable compounds, particularly those that decompose over time, keeping amounts ordered to a minimum will greatly reduce safety and storage concerns and disposal costs. A reasonable shelf life for such substances would be a maximum of three years.

Suppliers sometimes sell large quantities of chemicals at considerable savings. Bulk purchase may be an option with frequently used chemicals, particularly those that are not considered hazardous or are not regulated. However, there are several reasons why such bulk orders may not be advisable:

- adequate storage space may be limited
- curricular changes may occur or teachers may choose different experiments, eliminating the need for the chemical
- initial cost savings from bulk purchasing may be eliminated by added disposal costs if a large amount of the chemical is no longer needed requires disposal.

Receiving Chemicals

Only TDG-trained (Transportation of Dangerous Goods-trained) personnel can receive incoming chemicals. Whenever an order of chemicals arrives, these individuals may follow the steps below or similar school or district procedures.

1. Check the integrity of each chemical and chemical container.
2. Check for WHMIS labelling and presence of MSDSs.
3. Write on each container the date received and the name of the school.
4. Enter information into a chemical inventory.
5. Store chemicals (apply colour coding, if that is the school's practice) and file paperwork.

STORAGE OF CHEMICALS AND HOUSEHOLD PRODUCTS

Storage of chemicals and other products requires thoughtful planning and appropriate facilities. Chemicals purchased from supply companies demand special attention with regard to safe storage. However, in addition to these chemicals, chemical storage areas in schools often contain consumer products, perishables, ice and frozen goods required by school science programs. Vitamins, antacids, detergents, yeast, soda drinks, vegetable oils, meats, dairy products, fruits, vegetables and baking products are a few of the materials that may be found in school science areas.

Some of these products fit into a chemical storage category; others require additional storage space, often in a refrigerator or freezer. Consumer products classified as controlled products should be integrated into the storage scheme used for all other chemicals. According to *Occupational Health and Safety Regulation*, AR 62/2003, materials for activities involving eating or tasting must not be used or stored in any areas used for hazardous chemicals, and therefore will also require an additional storage space outside of the chemical preparation and science laboratory areas. A refrigerator used for storing chemicals cannot be used for refrigeration of "eating" or "tasting" products. Once edible products are stored with chemicals in a refrigerator they are considered contaminated and can no longer be consumed.

Storage Facilities for Chemicals

The hazards associated with chemical use can be greatly reduced by storing all chemicals in suitable storage facilities. An ideal chemical storage area:

- is a separate area outside of the classroom
- can be accessed only by authorized personnel
- has locking doors with a key separate from those used to enter classrooms or preparation areas
- is adequately vented with a continuously running fan to prevent build-up of chemical fumes
- protects chemicals from direct sunlight and extreme temperatures
- has explosion-proof lights, switches and fan motor housing to prevent fires caused by electrical shorts or sparks in faulty switches
- has ground fault interrupter (GFI) circuits installed, especially near sinks
- has ceilings and walls made of gypsum boards or a similar noncombustible material
- has adequate cupboard space for each category of chemicals, as determined by the quantity on-hand and school requirements
- has sturdy, nonmetallic shelves that are securely fastened to the wall or are part of a securely fastened or supported cupboard
- has storage cupboards that are not airtight.

Flammables and concentrated acids may be stored in special cabinets purchased for these types of hazards. Such cabinets are available in metal, plastic or wood. Cabinets made of wood are suitable for bases. Since wood is not suitable for nitric acid, acids should be stored in plastic cabinets. Flammable cabinets are generally metallic but the wood ones are suitable for corrosive flammables such as organic acids; e.g., acetic, butyric, formic. Venting of these cabinets is not considered necessary but depends on air circulation or venting of the room in which they are stored.

The chemical storage area(s) in a school should be large enough to house all of the chemical stock used in the science program as well as the waste chemicals generated through use. A typical senior high school of 800 to 1000 students will require a room with approximately 100 linear metres of shelf space. A junior high school may require 50 metres of shelf space. The space requirements should reflect the science programs offered, including waste generated by these programs throughout the year. Schools offering Advanced Placement or International Baccalaureate courses will require additional space. If a school is unable to accommodate its chemical stores in a facility similar to the one described in this section, it is an indication that the school may need to reassess or reconsider the amount of material necessary to have in storage.

The chemical storage area should be equipped with appropriate safety equipment and supplies, including a first aid kit. See Chapter 3 for more information.

Chemical Storage Schemes

In the past, chemicals in schools may have been stored using a nonclassified system, with products placed on shelves in alphabetical order. Although this arrangement of chemicals appeared to be orderly, it resulted in highly reactive substances such as oxidizing agents and reducing agents being stored together, creating the risk of spontaneous reactions between incompatible chemicals. In some cases, flammable storage cabinets were used to store a variety of hazardous materials without consideration for their compatibility.

The risk of accidents can be greatly reduced by replacing this kind of nonclassified storage system with a scheme that separates incompatible groups and isolates chemicals that present special hazards. The suggested storage schemes that follow can be used as a guideline for safe storage of chemicals in schools. By separating flammable solvents from reactive chemicals, and corrosive liquids from toxicants, these schemes eliminate the risk of spontaneous fire or release of poisonous fumes. These schemes are adaptable to facilities of various designs and to various chemical inventories. Schools may or may not have all of the hazard categories, and some schools may establish other categories to meet their particular needs.

Scheme 1: Grades 1–8 (A storage scheme for limited quantities of low-hazard chemicals)

Scheme 1 provides for adequate separation of chemicals for most elementary and junior high schools up to Grade 8 where small quantities of low-hazard chemicals and dilute solutions are kept on hand. This scheme could also be adapted for Grade 9, but is not adequate for senior high schools. Scheme 2 provides a better model for senior high school use.

Oxidizing Agents	**General**	**Flammable Solids**
Acids	**Bases**	**Flammable Liquids**

Scheme 1 is based on six cupboards but may be expanded to seven or more to provide sufficient space for general storage items. The shelves in these cupboards need to be secure and strong enough to support the weight of all containers placed on them. These cupboards must not be airtight.

In addition to the cupboards shown, a fridge may also be needed to store perishables and frozen products. If the refrigerator is used for storing materials for tasting or eating, it should be placed away from the chemical storage area and not be used for storing chemical and biological specimens. Further information on safe storage of chemicals is included in the storage category notes below.

1. *Acids*
   Keep organic acids (e.g., acetic acid) and mineral acids (e.g., hydrochloric acid and sulfuric acid) on separate shelves. The acid cupboard should not contain any metal fixtures or objects.

2. *Bases*
   This cupboard would shelve household ammonia, sodium hydroxide and other hydroxides. It should not contain any metal fixtures or objects.

3. *Oxidizing agents*
   Peroxides, bleach and nitrates are examples of oxidizing agents. Most peroxides are not recommended for elementary and junior high schools, but hydrogen peroxide would be shelved here. These materials must be kept away from any flammable liquids or solids, as well as materials such as paper or cloth. Ammonium nitrate, if purchased for use in junior high schools, should be stored by itself, as it is a very strong oxidizing agent and is incompatible with most other chemicals.

4. *Flammable solids*
   Flammable solids include metal powders, carbon, charcoal and similar materials. These materials must be kept away from oxidizing agents.

5. *Flammable liquids*

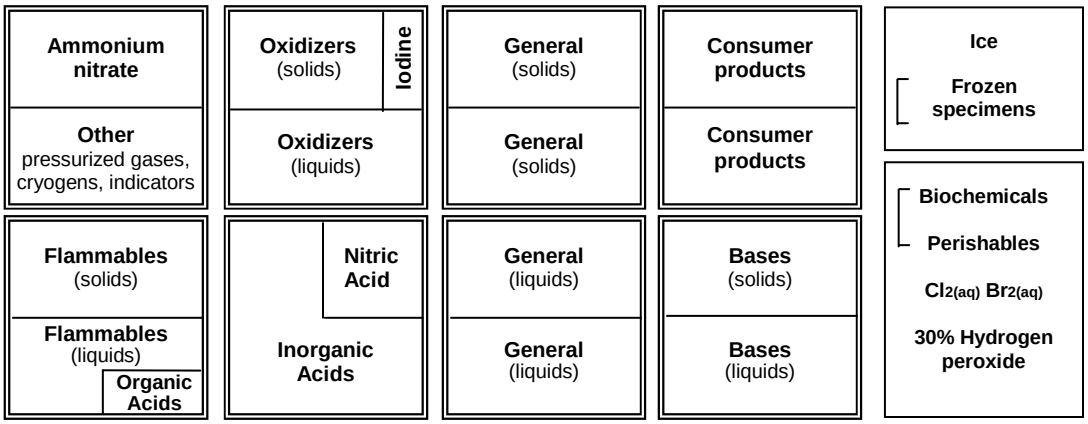
   Flammable liquids such as methanol and ethanol should be stored in a clearly labelled, cool and well-ventilated cupboard, separated from other cupboards by at least a partition. Refer to the *Alberta Fire Code* for regulations governing type, location, labelling, allowable quantities and other requirements for these storage areas. Avoid storing flammable liquids in a fridge, where lights, switches or thermostats can serve as ignition sources.

6. *General*

   This category includes any materials not covered in the other categories, such as Epsom salts, baking soda, starch, glycerin and vitamins.

Scheme 2: Grades 9–12 (A scheme for senior high schools)

Scheme 2 provides for adequate separation of chemicals in schools that offer science programs from grades 9 to 12. The scheme is based on a greater number of chemical categories than shown in Scheme 1 and includes provision for refrigerated storage of some chemicals.



Provide space between chemicals to facilitate access. Avoid storing chemicals more than three deep. If height of the cupboards requires the use of a step ladder or stool, it should have a nonslip surface.

1. Acids

Store organic acids such as vinegar above or separated from mineral acids. Store acid anhydrides with this group. Nitric acid is a strong oxidizing agent and should be isolated as well. It will build pressure over time and should be vented periodically. Parafilm or plastic electrical tape can be placed around lids for storage, to help prevent the escape of fumes. Plastic lids will deteriorate with time and should be replaced when this occurs. This cupboard should not contain any metal fixtures or objects unless coated with special paint.

2. Bases

Store any solid sodium hydroxide above or separated from dilute solutions of sodium hydroxide and household ammonia. Some bases will react with glass containers to form a filmy precipitate, and are best stored in base-resistant plastic bottles. Those that emit fumes should be sealed with parafilm or electrical tape. This cupboard should not contain any metal fixtures or objects.

3. Oxidizing agents

Store nitrates, potassium permanganate and iodine solids above or separated from their oxidizing solutions. Lids on bottles of iodine should be sealed with parafilm or electrical tape. These materials must be kept away from any flammable liquids or solids and materials such as paper or cloth.

Ammonium nitrate is an extremely strong oxidizing agent and is incompatible with most other chemicals. It should be stored away from other materials.

4. General

Inorganic substances such as baking soda, salt and copper sulfate would be found here as well as organic compounds such as glucose, indicators and starch. This category includes any materials not in any of the other categories. Some further separation may be desirable if available storage facilities allow.

5. Flammable liquids

Rubbing alcohol, ethanol, petroleum ether, and indicators dissolved in ethanol would be in this area. These materials should be stored in a clearly-labelled, cool and well-ventilated cupboard, separated from other cupboards by at least a partition. Ideally, flammables should be in a special cabinet manufactured for this purpose.

6. Flammable solids

Flammable solids include metal powders, carbon, charcoal and similar materials. These materials must be kept away from oxidizing agents. Refer to the *Alberta Fire Code*, 1997 for regulations governing type, location, labelling, allowable quantities and other requirements.

Setting Up a Chemical Inventory

A chemical inventory serves as an effective way of tracking chemical supplies. It is also an excellent opportunity for schools to improve safety by recording and organizing information about hazardous materials in the school. Such an inventory is an important part of safety planning because it includes MSDS and TDG data, depends on standardized labelling, and encourages thoughtful ordering and disposal. A chemical inventory provides a consolidated information

base for monitoring chemical usage, completing insurance claims, and coordinating waste disposal and recycling to reduce costs. It also allows for an integration of computer support systems and encourages sharing of information through computer networking. Finally, by establishing a system for monitoring chemical supplies on an ongoing basis, an inventory ensures program and support continuity when staff changes.

A computerized or electronic inventory is ideal because it is easy to update as chemicals come in or are removed from stock. The inventory can be stored centrally for easy access, with a copy supplied to the head caretaker and the individual(s) responsible for chemicals and hazardous materials in the school.

An effective chemical inventory will include the following information:

- name of chemical
- quantity of chemical
- supplier
- verification and date of MSDS
- date of purchase
- inventory review date
- hazard classification based on WHMIS requirements
- storage location
- disposal requirements.

For those choosing to track chemicals using a traditional paper-based inventory, a blank template of the sample inventory shown below is included as Appendix F of this document.

Chemical Inventory – Example
Completed by _____ Review Date _____

Chemical	Quantity	Supplier	MSDS Mo/Yr	Purchase Date	WHMIS Class	Storage Location	Disposal	Disposal Date (Empties)
Acetic acid (glacial)	4 L	Chem North	Nov-03	Dec-03	E,B	Acid cabinet	WF/I	Feb-04
Ethanol	2 L	Chem North	Jan-03	Jan-03	B, D1,D2	Flammables cabinet	A,WF/I	March-04

Inventory Control

Inventories should be updated annually to reflect product use and curriculum changes. The decision regarding the quantity ordered and stocked needs to take into account consumption rate, as well as the stability of the chemical. See the section Quantity Ordered on page 98 for factors that impact on chemical inventory. As chemicals are used or disposed of from the school site, they should be deleted from the inventory.

An annual check of chemicals on the shelves is a chance to:

- remove chemicals unsuited for the program(s)
- remove excess supplies, including chemicals no longer used because of program changes or activities selected
- remove contaminated, deteriorated and unidentified chemicals
- ensure a current MSDS is available for each chemical (MSDSs are updated by supply companies every three years)
- ensure a WHMIS label is on every chemical container
- confirm chemicals are in their proper location on the storage shelf
- ensure that opened containers are being used before new stock is opened
- visually inspect chemicals on the shelf to ensure they have not deteriorated or been contaminated by moisture or other substances.

Labelling

Proper labelling is one of the most important aspects of an effective and safe laboratory. Labels alert the user to the hazards of the product and provide precautions for its safe use. Therefore, they must present the required information clearly and legibly.

WHMIS Symbols and Labelling Conventions

Purchased stock chemicals kept in the storeroom, as well as materials that are generated in the laboratory, require proper labelling according to WHMIS regulations. WHMIS requires increased information on labels of potentially hazardous materials, often referred to as “controlled products” in legislation.

In terms of labelling and MSDS requirements, the WHMIS definition of controlled product does not include radioactive materials, pesticides, explosives, consumer products or materials covered under Food and Drug legislation; a sufficient amount of information is provided to workers through other means to ensure the safe use of these products. Wood and tobacco products and manufactured articles are excluded from all aspects of WHMIS. Other provincial health and safety laws and regulations cover the hazards of these materials.

WHMIS labelling uses the following symbols to indicate hazards:

WHMIS HAZARD SYMBOLS		
A	COMPRESSED GAS	
B	FLAMMABLE AND COMBUSTIBLE MATERIAL	
C	OXIDIZING MATERIAL	
D	POISONOUS AND INFECTIOUS MATERIAL	
D1	MATERIALS CAUSING IMMEDIATE AND SERIOUS TOXIC EFFECTS	
D2	MATERIALS CAUSING OTHER TOXIC EFFECTS	
D3	BIOHAZARDOUS INFECTIOUS MATERIAL	
E	CORROSIVE MATERIAL	
F	DANGEROUSLY REACTIVE MATERIAL	

Supplier Labels

These labels come with the chemicals from the chemical supply company. The formal "supplier label" contains seven elements of information inside a distinctly marked border:

- product name and address of the supplier
- WHMIS hazard symbol(s)
- precautionary statements(s)
- first aid information
- reference to the MSDS.

Example of a WHMIS supplier label:

All chemical containers, including the original container, must be labelled in such a way as to clearly identify the contents. There are a few situations where the supplier label may be slightly different from the basic model. This may be the case for controlled products in volumes less than 100 mL and for compressed gas cylinders having curved labels on their necks.

Workplace Labels

These labels are applied at the work site. They are used on controlled products that are transferred from the supplier's containers to work site containers. In the laboratory, for example, transfer containers and reaction vessels containing mixtures, solutions or reaction products must have a workplace label. Workplace labels are also used to replace supplier labels that have been damaged.

This form of label has four components as shown below.

Chemical Name (IUPAC):
Chemical Name (from MSDS):
Safe Handling Information (in point form):
See *Material Safety Data Sheet* for further information.

TDG Labels

During transport, controlled goods must be labelled using the procedures outlined in the *Transportation of Dangerous Goods Act and Regulations*. Transporting vehicles are required to display diamond-shaped placards that indicate the hazard categories of materials being transported. (See Chapter 1 for further information on TDG requirements.)

Consumer Restricted Products and Other Hazardous Materials

Other legislation in Canada requires precautionary labelling on containers of hazardous materials not covered under WHMIS, such as consumer restricted products, explosives, pesticides or radioactive substances. Consumer restricted products are hazardous chemicals that are packaged for consumer use at home or for recreational purposes. Such products include bleach, hydrogen peroxide, mineral spirits, drain cleaners and turpentine. These are not regulated as closely as controlled products. Accordingly, the supplier does not need to supply an MSDS with these products, but will nevertheless provide them on request. As with other consumer products, they have to be clearly labelled and indicate any hazards inherent in the product. When used in the workplace these products are subject to WHMIS regulations, which require that:

- they are correctly labelled
- workers know how to use, store, handle and dispose of them safely.

In some jurisdictions, liability suits have identified lack of proper labelling as a contributing cause of an accident. Careful labelling practices help prevent accidents and protect the teacher and school division/district from assuming unnecessary liability.

WASTE STORAGE AND DISPOSAL

Storage of Wastes and Surplus Chemicals

Surplus chemicals and chemical wastes created in experiments present the same kinds of hazards as stock chemicals ordered from supply companies. Chemical waste from individual experiments should be collected in clearly-labelled containers. With solutions, the water can be allowed to evaporate to leave a solid waste residue. Until each surplus chemical or waste material can be safely removed, it should be carefully stored in the cupboard normally used for that WHMIS classification. Proper waste storage includes:

- attaching appropriate identification and WHMIS labels
- categorizing and arranging waste by WHMIS class
- using a separate section or sections of the storage area, designated with a label stating “For disposal. Do not use!”
- avoiding physical contact between waste groups when wastes are stored
- keeping an inventory of waste materials.

Chemical wastes should be combined for storage according to the categories used by disposal companies. Common categories are shown in the table below, but it would be prudent to consult with your school's selected waste disposal company before beginning your sorting system.

Flammable	– liquids	
	– solids	
Corrosive	– liquids	– acids
		– bases
	– solids	– acids
		– bases
Oxidizers	– liquids	
	– solids	
Substances that react with water emitting flammable gas		
Unknown chemical waste		– liquid
		– solid
Mercury compounds	– liquid	
Polychlorinated biphenols		
Aerosols		
Bulk paint		
Oil (waste type 201)		
Glycol (waste type 202)		

Chemical Waste Inventory

Waste disposal records are the last stage in tracking a chemical's history at the school. These records are essential because:

- they are needed to keep the chemical inventory up-to-date, and to remove unnecessary labels and MSDS in cases where the chemical is no longer stocked
- shipping documents for chemical wastes (bills of lading for recyclables and manifests for hazardous waste) must be kept on file for a minimum of two years
- hazardous waste manifests can be useful in tracking and evaluating amounts of waste produced to help determine possible methods of reducing waste/surplus chemicals in the school or school district.

Disposal of Wastes and Surplus Chemicals

Surplus chemical and wastes generated in school activities will both require disposal. Selection of the best method for disposal of each waste will require consideration of the kind of hazard each presents, the severity of the hazard, its concentration, and whether the material is in pure form or part of an inseparable mixture. It also depends on local waste disposal regulations, provincial and federal regulations, and the expertise of school staff. Provincial legislation that

applies to waste disposal include the *Waste Control Regulation*, AR 192/96 of the *Environmental Protection and Enhancement Act,* R.S.A. 2000, c. E-12 and Regulation), as well as local or municipal regulations, bylaws or policies regarding sewers, landfills and the environment.

To avoid safety risks, periodically review the school's chemical inventory and remove chemicals that are not being used. Also remove any chemicals that may have been used in the past but are no longer considered appropriate for use. For example, containers of dissection preservative containing formaldehyde should be safely disposed of. The fumes from such containers can combine with those of hydrochloric acid to form bischloromethyl ether, a strong carcinogen at concentrations as low as 0.001 ppm.

Conducting a chemical inventory can help you identify and dispose of unneeded or dangerous chemicals such as the following:

- any chemicals that have deteriorated or become contaminated
- chemicals not utilized in current teaching lessons and unlikely to be used in the future
- chemicals for which MSDSs are not available
- any seldom-used chemical in excess amounts (several containers of the same chemical or unnecessarily large bulk quantities)
- unknown chemicals or chemicals without a WHMIS label
- chemicals that have exceeded their shelf life
- old solutions of formaldehyde or other dissection material preservatives.

The following materials require special disposal procedures:

- substances that are designated as hazardous (regulated) within the *Transportation of Dangerous Goods (TDG) Act*.
- all hazardous wastes, if the school produces a total of 5 kg or more of solid or 5 L or more of liquid hazardous wastes per month
- any containers of unknown substances.

Waste Broker and Waste Generator Identification Number

The three categories of materials listed above must be removed from the school by a licensed waste broker and disposed of by a licensed receiver. A *broker* is a company licensed by the province to pick up and transport controlled substances to a *receiver*, a licensed waste disposal facility. Disposal of waste from a school must be initiated through the school district office and the contract for removal will be between the district and the broker.

School districts may want to investigate a number of brokers in order to select one that best meets their particular needs. For a list of approved brokers, see Appendix G: List of Chemical Waste Brokers. Alternatively, to find a broker in their area, districts may contact the Regulatory Approvals Centre of Alberta Environment: Telephone: 780–427–6311 or Fax: 780–422–0154.

Before hazardous waste can be disposed of, school districts are required by the *Environmental Protection and Enhancement Act*, R.S.A. 2000, c. E-12 to obtain a provincial **waste generator identification number**, which must be provided to their waste broker. To obtain an identification number, districts may contact the Regulatory Assurance Division of Alberta Environment: Telephone: 780–427–5842 Fax: 780–427–1594.

Ecostations and sites designed for drop-off and disposal of household wastes are not appropriate for disposal of school chemical wastes.

Waste Management and Environmental Responsibility

Proper storage and disposal of surplus chemicals and hazardous waste is not only part of science safety, but also an environmental issue. By being environmentally conscious in the day-to-day management of school laboratories and materials, teachers and other school personnel can prevent unnecessary damage to the environment and instill responsible attitudes in students.

Chemical disposal regulations prevent indiscriminate dumping of chemical waste in the trash or down the drain where to do so would create environmental risks. Landfills, once thought of as the dumping place for all manner of materials, are now designated by classes based on their design. These class designations indicate the scope of wastes that a landfill of that design can safely accept. Municipal authorities can provide information on the class of local landfills and the types of chemicals that can be disposed of through regular trash. Similarly local sewer bylaws identify restrictions on materials that can be disposed via the drain.

The disposal column of the Chemical Hazard Information Table in Chapter 9 and the “Chemical Treatment” section in this chapter provide basic information on what chemicals can be disposed of via the drain or trash, and what treatment may be required before this can be done. For all other chemicals, it is best to strive for a “no-chemicals-down-the-drain” philosophy, whereby chemical waste is disposed of by an alternative means that avoids environmental impact. This approach to waste management may require that students and/or teachers place chemical wastes into labelled waste containers on completion of their use. Teacher caution in categorizing waste is needed to avoid placement of incompatible waste together. The waste is then managed in accordance with accepted best practices. In larger schools, the pooling of wastes for disposal through a waste broker may be the best strategy for ensuring safe disposal of many hazardous materials.

STRATEGIES FOR MINIMIZING HAZARDOUS WASTE PRODUCTION

There are several straightforward and practical ways to reduce the volume of chemical waste generated by science classes. Most of the strategies discussed here involve students using less chemicals, which results in less waste generated, less environmental impact and lower waste disposal costs. Other strategies suggest ways to recover chemicals for reuse or to make multiple uses of the chemical.

Microscale Experiments

Traditional practice in school laboratories is for students to perform experiments using gram quantities of chemicals. An alternate approach is to have students carry out microscale experiments in which chemical quantities are reduced to no more than 100 mg (0.1 g). Chemical experiments can be carried out successfully using these small quantities of materials, and many students enjoy the challenge of performing experiments on a miniature scale. When students are planning an experiment to investigate a particular question, they can be encouraged to think about using smaller volumes.

Microscale experiments may require the use of different glassware and equipment, or the use of existing equipment in new ways. Instead of beakers and Erlenmeyer flasks, teachers may use small test tubes or drop plates. Disposable pipettes calibrated to allow delivery of 0.5 mL or 1 mL can be used to deliver chemical solutions. Reaction plates with a series of wells can be used in performing qualitative analysis of inorganic ions. Disposable pipettes in which the stem has been cut short and a small wad of glass wool inserted can be substituted for filter funnels to collect a few crystals by filtration.

Dispensing Chemicals

Teachers will sometimes find it necessary to weigh the relative merits of dispensing premeasured quantities of chemicals to students versus teaching students to measure quantities for themselves. The decision on which approach is best will usually hinge on an assessment of the hazards associated with the chemical. If it is a chemical that is nontoxic and nonhazardous, such as sodium carbonate, then waste generated by students during measurement is not a major concern. If, on the other hand, the substance is magnesium ribbon, it may be more prudent to pre-cut the appropriate length of ribbon for each student to avoid pieces longer than necessary. Advance measurement by the teacher may also help to minimize waste and limit the possibility of spillage when more hazardous solutions are used.

Use of Lab Stations

Setting up activities at specific sites or stations, equipped with appropriate chemicals and supplies, makes it easier to control and manage chemical use by students. This approach helps avoid students having to carry chemicals from one place to another and reduces the chance of spills or other accidents. This approach is particularly beneficial in activities where the chemicals can be reused, as it eliminates the need for providing a separate set of chemicals for each group of students. In activities where probes are used for specific measurements or readings, solutions provided at a station could be used repeatedly as each group progresses through the station. Since students also leave everything behind once they are done at each station, there is less likelihood of chemicals being intentionally mixed by students out of curiosity. This reduces the generation of unknown and unnecessary wastes that are costly to identify and dispose of via chemical treatment plants.

Use of Demonstrations

Although there is educational value in having students perform experiments on their own, demonstrating a chemical reaction to an entire class can be an effective means of achieving an instructional goal and reducing resulting wastes, particularly in cases where the chemicals involved are more hazardous.

Use of Videos and Computer Simulations

These resources can be used to demonstrate reactions or experiments that otherwise would not be possible due to equipment limitations or because they are too dangerous to perform in class. Such visual presentations or simulations of more dangerous reactions avoids associated risks and provides a near first-hand experience for students. These resources can be used either as part of a class presentation or individually, at stations, by students.

Recovery and Recycling

One aspect of good chemical management is to recycle materials whenever possible. Before discarding uncontaminated chemicals or their solutions, consider other activities where these substances might be used. For example, copper sulfate solution produced when teaching students how to make solutions can be used for growing crystals, copper plating or in replacement reactions in the same or other courses. Similarly, crystals grown in one class may be redissolved for use in another because these solutions do not require great purity.

Chemical recovery requires some upfront planning and a space in the lab or chemical storage room where reconstitution can be done. Since most substances used are in solution form, reclaiming the material simply requires evaporating the water. If a recovered substance is stored in a container other than the original, then proper WHMIS labelling is required on the new container.

Distillation of Used Solvents

Recycling solvents requires the knowledge and experience of an expert chemist, as well as the appropriate equipment. Organic solvents such as methanol, ethanol and petroleum ether used in a reaction or as a solvent in chromatography can often be recovered for reuse by distillation. If possible, the distillation apparatus should be set up under a fume hood. The flask should be heated using a water bath (for low boiling solvents such as methanol and petroleum ether), oil bath or heating mantle. The contents of the distilling flask should never be allowed to evaporate to dryness.

Hazardous Waste Treatment

There are several methods of processing hazardous waste to reduce volume and/or toxicity in preparation for disposal. These processes can reduce disposal costs and environmental impact, especially for larger quantities. Since schools may still have chemicals on site that are no longer used or are not recommended for use in schools—for example, heavy metals such as lead—treatment processes for these substances have been included. Their inclusion, however, does not imply appropriateness for school use. Hazardous waste treatment includes evaporation of aqueous solutions and various chemical treatments.

Evaporation of Aqueous Solutions

When solutions contain chemicals not suitable for recovery, the volume of hazardous materials can be greatly reduced by allowing the solution to evaporate under a fume hood or in another well-ventilated area. Transfer the solution to a wide-mouthed container such as an evaporating basin or large beaker for maximum evaporation surface and allow to stand until a sludge remains. This sludge can be transferred to an appropriate labelled container for off-site disposal.

There may be cases where regulations restrict disposal down the drain but allow disposal via local landfill. In such cases, evaporate to dryness and dispose in solid trash.

Chemical Treatment

A number of substances can be chemically converted into an insoluble or less toxic form that may, in many cases, be disposed of by means other than a chemical waste facility. Appropriate personal protective equipment, including eye protection, gloves and laboratory coat, should be worn when performing the reactions. As far as possible, and in all cases where noted, the manipulations should be performed under a fume hood.

These chemical treatments should only be carried out by staff that have knowledge of the chemistry involved, and are experienced in working with chemicals. In all other cases the chemicals—in their original form—should be disposed of through a qualified waste broker.

Neutralization of Acids and Bases

Waste quantities of acids such as hydrochloric acid, sulfuric acid, nitric acid and acetic acid, and bases such as sodium and potassium hydroxides can be neutralized and washed into the drain. First, add the concentrated acids or bases to 20 times their volume of water so that their concentration is reduced below 5%. This should be done in an ice bath under a fume hood using an adequately sized container; e.g., 100mL of concentrated waste will require 2 L of water. Caution: never add water to concentrated acid. Add 5% sodium hydroxide solution or solid sodium carbonate (soda ash) to the dilute solutions of waste acid until the pH is between 6 and 8. Waste dilute solutions of base can be treated with waste dilute solutions of acid or with 5% hydrochloric acid solutions. The neutralized solutions can be washed down the drain.

Precipitation of Heavy Metal Salts

Although heavy metals are not recommended for school use, the process described here is for the benefit of schools that may still have these compounds on their shelves and are looking at discarding them.

An alternative to the evaporation of dilute aqueous solutions of heavy metal salts is to precipitate the metals as an insoluble salt that can be removed by filtration or by allowing the solid to settle and decanting the liquid. The residue can then be disposed of according to relevant guidelines. Specific directions for precipitating lead ions from solution as their silicate is described as well as the modifications needed to use this method for other heavy metal ions. The formation of the silicate can be summarized by the following generalized equation.

$Pb^{2+}(\quad)(aq) + Na_2SiO_3(aq) \rightarrow PbSiO_3(s) + 2Na(\quad)(aq)$

Add a 0.01 molar solution of a soluble lead salt (e.g., 0.166 g of lead II nitrate in 50 mL of water) to a 0.03 molar solution of sodium metasilicate (0.392g Na_2SiO_3 $9H_2O$ in 50mL of water). Stir well. Adjust the pH to about 7 by the addition of about 15 mL of 2 M aqueous sulfuric acid. Collect the precipitate by filtration or allow the mixture to stand until the solid has settled to the bottom of the container and the liquid can be poured off. Allow the solid to dry, then package and label for disposal.

For dilute solutions of lead salts of unknown concentration, the sodium metasilicate solution should be added until there is no further precipitation. Adjust the pH to a level between 7 and 8 with the addition of 2M sulfuric acid, and allow the solution to stand overnight before collecting the solid by filtration or allowing it to settle and pouring off the liquid. Solutions of cadmium and antimony salts can be treated similarly.

Several other heavy metal salts can also be precipitated in the same way as silicates. The quantities given for lead are also appropriate for 0.01 moles of these metals. The only modification necessary is a change in the pH at which the silicate is precipitated. This includes the Fe (II) & (III) ions, Zn(II) , Al(III), Cu (II), Ni (II), Mn (II) and Co (II) ions, all of which can be precipitated without

adjustment of the pH that results from the addition of the solutions of sodium metasilicate.

pH of Precipitation of Metal Ions Using Sodium Silicate

Metal Ion	pH for Maximum Precipitation	Concentration of Metal Ion Remaining in Solution
Iron II	9.5 – 10.0	5 pmm
Iron III	10.0 – 10.5	2 ppm
Zinc II	8.5	< 0.5 ppm
Aluminium III	8.5	< 2 pmm
Copper II	10.5 – 11.0	0.03 ppm
Cobalt II	9.5 – 10.0	0.08 ppm
Manganese II	9.5 – 10.0	0.2 pmm
Nickel II	9.5 – 10.0	0.3 pmm

Similarly, solutions of unknown concentration can be treated with sodium metasilicate solution until there is no further precipitation. Adjust the pH to the required value by the addition of 2 M sulfuric acid or 5% sodium hydroxide solution, and allow the mixture to stand overnight before collecting the solid by filtration or allowing it to settle and pouring off the liquid. After standing in the air to dry, the metal silicates should be placed in a labelled container for disposal. The liquids can be washed into the drain.

Reduction of Oxidizing Agents

Inclusion of this reduction process does not imply appropriateness for school use of some of the compounds identified here. The process is described, however, for the benefit of schools that may have these compounds on their shelves and are looking at discarding them.

Solutions of compounds such as potassium permanganate, sodium chlorate, sodium periodate and sodium persulfate should be reduced before being discarded into the drain to avoid uncontrolled reactions in the sewer system. The reduction can be accomplished by treatment with a freshly prepared 10% aqueous solution of sodium bisulfite or metabisulfite. Specific quantities and conditions for these reactions are detailed in the table below.

Oxidizing Agent Present in Waste Stream	Quantity and Concentration of Oxidizing Agent in Aqueous Solution	Quantity of 10% Aqueous Sodium Metabisulfite	Comments
Potassium Permanganate	2 L of 6%	1.3 L	Solution becomes colourless
Sodium Chlorate	1 L of 10%	1.8 L	50% excess reducing agent added
Sodium Periodate	1 L of 9.5%	1.7 L	Solution becomes pale yellow
Sodium Persulfate	1 L of 10%	0.5 L	10% excess reducing agent added

Treatment of Iodine and Iodine Solutions

Under the fume hood, cautiously add 1 gram of solid iodine to a solution of sodium thiosulfate (2.5 g sodium thiosulfate in 60 mL of water) also containing 0.1g of sodium carbonate. Stir the mixture until the iodine has all dissolved and the solution is colourless. Check the pH and if needed add solid sodium carbonate to bring the pH of the solution to a level between 6 and 8. The solution can then be washed into the drain. A summary of the reaction is:

$I_2(s) + Na_2S_2O_3(aq) + Na_2CO_3(aq) \rightarrow 2NaI(aq) + Na_2SO_4(aq) + S(s) + CO_2(g)$

Solutions of iodine can be dealt with as follows: Stir a sodium thiosulfate solution (4 g in 100 mL of water) containing sodium carbonate (0.1 g) into the iodine solution. Continue stirring until the solution becomes colourless. If necessary, add sodium carbonate to bring the pH to a level between 6 and 8. Treat the liquid for sulfides.

Bromine

Bromine is very toxic by inhalation and causes severe burns if spilled on the skin. It can be reduced to sodium bromide, a much more innocuous substance, by reaction with sodium bisulfite solution.

Under the fume hood, add bromine (5mL) to a large excess of water (1L). Slowly add a freshly prepared 10% solution of sodium bisulfite to the bromine water until all colour disappears. Neutralize the solution with sodium carbonate and wash into the drain.

$Br_2(l) + 2\ NaHSO_3(aq) \rightarrow 2NaBr(aq) + H_2SO_4(aq) + SO_2(g)$

Treatment of Sulfides

Under a fume hood, place 1 mol/L $FeCl_3$ solution (3 times the excess of solution to be disposed of) in a beaker, then add disposal solution with continuous stirring. A precipitate will form. Neutralize with sodium carbonate, a reaction that will release CO_2 gas.

A summary of the reaction can be given as follows:

$2\ Fe^{+++} + 3\ S^{2-} \rightarrow Fe_2S_3(s)$

Allow precipitate to settle and either decant solution or filter. Flush neutral solution down the drain and dispose of the precipitate to an appropriate landfill. If flushing of iron is a sewer concern, then all the material may be evaporated to dryness and disposed of via solid waste disposal.

Chapter 9
Chemical Hazard Information

OVERVIEW

Many chemicals have minimal hazards, making them relatively safe to use. Others pose inherent risks and require specific precautions. Still other chemicals must be handled with such extreme care that they are not practical or safe for use in schools. This chapter provides information on hazards for nearly 600 chemicals to help teachers, schools and districts select and use chemicals safely. Schools and jurisdictions may use this information as a starting point for reviewing chemicals currently on their shelves (particularly where chemicals have accumulated over the years) and reassessing the scope and contents of their chemical inventories.

The information in this chapter includes numeric ratings for health, flammability and reactivity, plus supplementary comments on the scope and severity of hazards. It also includes WHMIS and storage classifications, as well as transportation hazard classes and disposal methods. This information has been compiled from the most reliable and accurate sources available at the time of writing. It remains the responsibility of school jurisdictions and individual teachers to use this information carefully and cautiously and assume responsibility for the consequences of using this information.

Inclusion of a chemical in this listing does not signal appropriateness for school use, but is provided as preliminary information on potential concerns. Given the nature and severity of hazards involved, some of the chemicals listed are designated as *not appropriate for use in schools due to safety considerations.* Readers are advised to consult MSDS sheets and other current sources of more detailed information before using any of the chemicals listed here. Omission from this list is also not an indication of safety.

REACTIVE NATURE OF CHEMICALS

Chemicals can be grouped according to their chemical properties and general behaviour on exposure to other substances or environmental conditions. The following table provides information on types of reactive chemicals, which can be useful when designing a chemical storage scheme or deciding whether or not a chemical should be stocked for classroom use.

Reactive Nature of Chemical	Substances	Notable Characteristics	Handling and Storing
Explosive	• Fulminates★ • Nitroglycerin★ • Peroxides★ • Picric acid★ • Azides★ • Perchlorates (Na, K)★ • Hydrazines★ • Dioxane★ • Ether★ (excluding petroleum ether)	• Substances that decompose with such speed that they cause a rapid expansion of air, sometimes accompanied by burning gases and flying objects. • Explosion may be caused by shock, friction or heat. • May form explosive by-products on slow decomposition during storage; e.g., ether and dioxane may form explosive peroxides with varying storage time. These appear as grey-green precipitates.	★Do not order, use or store **concentrates** of this group of chemicals in schools. • Lower concentrations of some explosive substances (e.g., hydrogen peroxide at 3 to 7%) are safe.
Acid sensitive	• Alkali metals • Alkaline hydroxides • Carbonates • Carbides • Nitrides • Metals • Sulfides • Cyanides★	• Substances that react with acids to release heat, hydrogen and/or other explosive gas and toxicants.	• Isolate from reactive substances. • Wear and use adequate protection.

★ These chemicals are not recommended for schools because of their **reactive** nature.

Reactive Nature of Chemical	Substances	Notable Characteristics	Handling and Storing
Water sensitive	• Strong acids and bases • Acid anhydrides • Alkali metals • Alkali metal hydrides • Carbides★ • Aluminium chloride (anhydrous)	• Substances that react with water, releasing heat and/or flammable gases. • Ignition in moist air can cause explosions. • May produce acetylene or methane. • Spontaneous decomposition during extended storage may cause container to explode upon opening.	• Isolate from other reactive substances. • Store in cool, waterproof area. • Wear protective gear.
Oxidation-reduction sensitive (oxidizers only)	• Oxygen • Mineral acids • Perchlorates★ • Peroxides★ (excluding H2O2) • Chromates and dichromates • Permanganates • Halogens and Chlorates★	• Substances that undergo rapid oxidation or reduction releasing heat in the process. • Some are explosive.	• Isolate from each other and other potentially reactive substances. • Use adequate protection.
Special case-organic substances	• Acrolein★ • Benzene★ • Diethyl ether★	• Organic substances that are flammable may polymerize violently or form explosive peroxides. • May explode when exposed to many oxidants. • May be carcinogenic (benzene).	• Store in an airtight container in a cool place. • Isolate from oxidants.
Pyrophors	• Phosphorous (white or yellow)★	• Substances that burn spontaneously when exposed to air.	• Protect from air.

★ These chemicals are not recommended for schools because of their **reactive** nature.

ORGANIZATION OF THE CHEMICAL HAZARD INFORMATION TABLE

The Chemical Hazards Information Table in this chapter provides information to assist teachers and schools in deciding what chemicals to stock and use. The table lists hazard ratings for almost 600 chemicals, including a number of substances that have been used in schools in the past but that have serious risks associated with their use. As well, it provides additional information necessary for safe storage and disposal of the chemicals.

The absence of chemicals from this table does not imply that they are safe. Other sources should be consulted for information on these chemicals.

The Chemical Hazard Information Table is organized with the following column headings:

1. Chemical Name(s), State and Formula
2. Appropriateness for School Use
3. Hazard Ratings and Comments for Health, Flammability and Reactivity
4. WHMIS Hazard Classes
5. Chemical Storage Classes
6. TDG Hazard Classes
7. Chemical Disposal Methods

The content of each section, as well as the codes and conventions used in the table, is briefly explained below.

Chemical Name(s), State and Formula

The table lists chemicals alphabetically using names conforming to those of IUPAC and the Merck Index. Where an alternative name is acceptable, the substance will appear in the table under both names. The state or form of the substance is included since it implies concentration—a factor that must be known if the hazard levels are to be meaningful. The formula is provided as a means to cross-reference the names of substances, ensuring that the name used for a specific substance actually correlates with the correct substance by formula.

Appropriateness for School Use

To assist teachers, schools and districts in making safe choices, the chemicals listed in the table have been grouped into one of three categories, based on their relative safety. The hazards of a chemical tend to increase with its concentration. Keeping this in mind, it should be noted that some chemicals in the table are rated in the “B” or “C” category in concentrated form, but may be rated in the “A” or “B” category in the diluted form. Many acids and bases are rated in this way. For example: Hydrochloric acid [HCl (aq)].

Concentration	Category
5% or less	A
above 5%	B

Category A – Chemicals appropriate for use in schools under controlled conditions of use.

Chemicals in this category are ones for which the risks can be managed if used in limited quantities and concentrations, in controlled situations and following safe procedures. Use of these chemicals should take into account the maturity and skills of the students, the knowledge and skills of the teacher, and the needs of the curriculum.

Category B – Chemicals not appropriate for student use in schools except in junior and senior high school science courses under highly controlled conditions of use.

This category of chemicals is not appropriate for use by students in elementary science, but may be appropriate for use in junior and senior high school science courses when used in limited quantities under close supervision by well-qualified staff in appropriate facilities. If these chemicals are used, keep quantities and concentrations to a minimum, instruct students in safe use procedures, and ensure waste storage and disposal have been addressed. These chemicals may be appropriate for demonstration purposes in elementary schools by teachers with appropriate knowledge and skills.

Category C – Chemicals not appropriate for student use.

Chemicals placed in this category pose significant safety risks in one or more hazard categories (health, flammability or reactivity), making them dangerous to use unless major precautions are taken. Conditions required for safe use by students exceed what can be consistently and reliably provided by schools. Some chemicals in this category may be used for demonstration purposes by well qualified senior high school teachers following a thorough risk assessment.

Category D – Chemicals not recommended for school use by teachers or students because of excessive hazard levels.

For quick reference, category D chemicals have been itemized in alphabetical order in Appendix K at the back of this document.

Hazard Ratings and Comments for Health, Flammability and Reactivity

Hazard ratings given in the Chemical Hazard Information Table are based on the National Fire Protection Association (NFPA) Hazchem Code, which is also used by most large North American chemical suppliers. This hazard identification system attaches numerical values to hazard levels for health, flammability and reactivity of a chemical. Each category of hazards is rated on a scale of 0 to 4 (low to high). In addition, a special precautionary symbol may be used where necessary. In most cases, the hazard ratings given are for the pure form of the chemical.

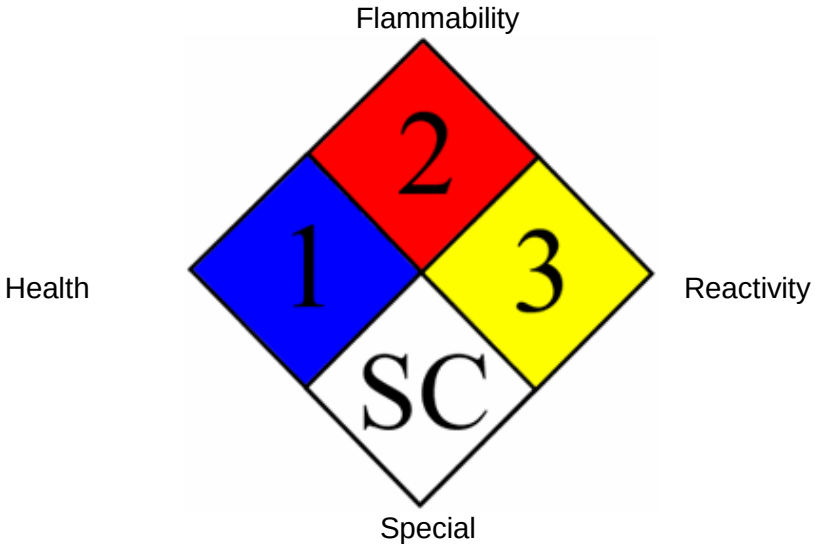
The hazard ratings for each chemical listed in the chart are based on information from multiple sources. Sources used in compiling the ratings were primarily the MSDS sheets provided by major supply companies. In many cases the ratings found in these MSDS sheets showed different values for the same chemical, which reflected different interpretations of the hazards involved. For example, it appears that in determining health ratings, some companies factor in the effects of prolonged and chronic exposure whereas other do not. In case of disagreements between sources, a further assessment was made of the information available before determining the rating given in the chart. To assist the user, additional information on the specific nature of the hazards posed by each chemical is provided in the comments section.

The health ratings given in the chart, as derived from MSDS sheets, focus primarily on short-term health effects. Currently available information on long-term effects—including carcinogenicity—is in many cases limited. More recent information may become available over time and will be reflected in current MSDS sheets.

In general, chemicals with a rating of 3 or 4 in one or more categories, but especially in health, are classified as inappropriate for student use. There are some exceptions to this rule, particularly in cases where the risks can be substantially reduced by using the substance in a less concentrated form, as is the case with solutions. In general, powdered or pure forms of carcinogenic substances or chemicals that produce toxic substances when they react will be identified as not appropriate for student use and in a number of cases will be identified as not appropriate for school use at all.

Note that the information in the chart is provided primarily to assist schools in determining what chemicals are appropriate for use. After the chemicals have been acquired, school staff should consult the MSDS sheet for more detailed information before using any of the chemicals.

Sample N.F.P.A. Hazchem Code



Note: The colour coding is often not consistent among manufacturers. Some omit colour entirely.

Following are the three categories and 5-point rating scale used in the NFPA. Hazchem codes are described in the Hazard Rating Chart below.

Health (Blue)		
4	**Danger**	May be fatal on short exposure. Specialized protective equipment required
3	**Warning**	Corrosive or toxic. Avoid skin contact or inhalation
2	**Warning**	May be harmful if inhaled or absorbed
1	**Caution**	May be irritating
0		No unusual hazard

Flammability (Red)		
4	**Danger**	Flammable gas or extremely flammable liquid
3	**Warning**	Flammable liquid flash point below 100° F
2	**Caution**	Combustible liquid flash point of 100° to 200° F
1		Combustible if heated
0		Not combustible

Reactivity (Yellow)		
4	**Danger**	Explosive material at room temperature
3	**Danger**	May be explosive if shocked, heated under confinement or mixed with water
2	**Warning**	Unstable or may react violently if mixed with water
1	**Caution**	May react if heated or mixed with water but not violently
0	**Stable**	Not reactive when mixed with water

Special Notice (White)	
~~W~~	Water Reactive
OX	Oxidizing Agent

Note: See http://www.nfpa.org/ for further information on the NFPA rating system.

WHMIS Hazard Classes

The Workplace Hazardous Materials Information System categorizes controlled substances into 6 classes and provides symbols for each of these. The classes are:

A. Compressed Gases
B. Flammable and Combustible Materials
C. Oxidizing Materials
D. Poisonous and Infectious Materials
   Division 1: Material causing immediate and serious toxic effects
   Division 2: Material causing other toxic effects
   Division 3: Biohazardous infectious material
E. Corrosive Materials
F. Dangerously Reactive Materials

This column of the Chemical Hazard Information Table shows which of these classes each chemical falls into. Substances that are not controlled are identified as NC on the table.

For more information about WHMIS, refer to Chapters 1, 4 and 8 in this document.

Chemical Storage Classes

The chemical classes assigned in this section of the table and outlined below are useful in devising a scheme for the safe storage of chemical groups in laboratories or chemical storage rooms. In some cases, a chemical may fall into more than one class. In such instances, flammability is the primary overriding property for storage classification.

Class #	Chemical Category and Symbol
1	Inorganic Acids (IA)
2	Strong Bases (SB)
3	Organic Acids (OA)
4	Flammable Solids (FS)
5	Flammable Liquids (FL)
6	Oxidizing Agents (OX)
7	Halogens (element form) (H)
8	Miscellaneous (M)

Chemical storage classes were discussed in some detail in Chapter 8 as an important aspect of chemical management.

TDG Hazard Classes

The classes and divisions of chemicals defined by TDG regulations are important for a number of reasons, including the classification of chemical waste when preparing for disposal pick-up. The hazard classes are numbered 1 to 9. Certain classes are further subdivided into numbered divisions. A waste's classification is stated as the class number followed by a point and the division number. For example, a classification of 4.3 means that the waste is in Division 3 of Class 4.

The table below briefly summarizes the nine classes and types of hazards involved. Refer to Part III of the *Transportation of Dangerous Goods Act and Regulations*, 1992 for specifics about the criteria and procedures needed to determine hazardous waste classes, divisions and packing groups.

Class 1 – Explosives	Explosives are classified into 6 divisions according to sensitivity and explosive potential. **Note**: This class of compounds is not recommended for school use.
Class 2 – Gases	Class 2 substances can be a gas, a mixture of gases, a mixture of gases with one or more vapours of substances included in other classes, an article charged with a gas, an aerosol or tellurium hexafluoride. These substances fall into one of three divisions. **Divisions** 2.1 Flammable gases 2.2 Nonflammable, nontoxic gases 2.3 Toxic gases

Class 3 – Flammable liquids	This class includes liquids (or liquids containing solids in solution or suspension) that have a flashpoint less or equal to 60.5°C, or liquids that are intended or expected to be at a temperature that is greater than or equal to their flashpoint at any time while the substance is in transport.
Class 4 – Flammable solids	**Divisions** 4.1 Flammable solids 4.2 Substances liable to spontaneous combustion 4.3 Substances which on contact with water emit dangerous quantities of flammable gases
Class 5 – Oxidizing substances and organic peroxides	**Divisions** 5.1 Oxidizing substances 5.2 Organic peroxides
Class 6 – Toxic and infectious substances	**Divisions** 6.1 Toxic substances 6.2 Infectious substances
Class 7 – Radioactive materials	This class includes radioactive materials with an activity greater than 74 kBq/kg.
Class 8 – Corrosive substances	This class includes materials that: • cause full thickness destruction of human skin; i.e., lesions that are permanent and destroy all layers of the outer skin • exhibit a corrosion rate that exceeds 6.25 mm/year at a temperature of 55°C.
Class 9 – Miscellaneous Products, Substances or Organisms	This includes any substance that does not meet the criteria for inclusion in classes 1 to 8 and contains one or more of the following: • genetically modified micro-organisms that may endanger human life • a marine pollutant • material to be transported at high temperatures • material that releases toxic substances through leaching • environmentally hazardous substances.

Chemical Disposal Methods

The appropriate methods for disposing of various chemicals depend on a number of factors, and must meet federal, provincial and local regulations. The Chemical Hazard Information Table uses the following symbols to indicate disposal options for each chemical.

Symbol	Disposal Method	Comments
WF/I	Chemical Waste Facility/Incinerator (government approved)	Substances identified as controlled/hazardous products must be disposed of through a waste facility by federal/provincial law. Nonregulated chemical waste may be disposed via a waste facility.
A	Dissipate into Air	Atmospheric gases only.
D	Drain	Dilute acids and bases containing no regulated constituents (pH of 5.5 to 10) and nonhazardous, noncontrolled salts can be disposed of this way.
R	Recycle	Local metal and plastic recycle depots.
N/P-T or N/P-D	Neutralize/Precipitate and dispose of in Trash or Drain	Follow neutralization/precipitation procedure and dispose of nontoxic byproducts in trash (T) or drain (D).
RS	Return to Supplier	Containers with remaining substance can be returned to supplier.
T	Trash (Landfill)	Dry, noncontrolled, nonhazardous wastes.

"Controlled products" are substances that fall into one or more of the WHMIS hazard classes. These include compressed gases, oxidizing materials and substances that are poisonous, infectious, flammable, combustible, corrosive or dangerously reactive. There is no master list of controlled products; however, any product with a hazard warning could be a controlled product.

CHEMICAL HAZARD INFORMATION TABLE

Note: One should become familiar with the background information to the Chemical Hazard Information Table in the introductory portion of this chapter before proceeding to the table for details on specific chemicals.

Chemical Name(s), State and Formula	Use in School Category	H*	F*	R*	Hazards	WHMIS Class	Storage Class	TDG Hazard Class	Disposal Methods
acetaldehyde --------- liquid (*ethanal, acetic aldehyde*) $CH_3CHO(l)$ or $C_2H_4O(l)$	D	3	4	2	Toxic; harmful by inhalation, ingestion, skin absorption; causes skin irritation or burns and severe eye irritation; affects the central nervous system, liver and kidneys; extremely flammable liquid and vapour; may form explosive levels of peroxides in storage; possible human carcinogen.	B, D1	5	3.1	WF/I
acetamide ---------- crystals (*acetic acid amide*) $CH_3CONH_2(s)$	C	1	1	0	May cause skin, eye and respiratory tract irritation; dust-air mixture explosive; possible human carcinogen.	D2	8	NR	WF/I
acetic acid, glacial -- liquid (*ethanoic acid*) $CH_3COOH(l)$ or $C_2H_4O_2(l)$	B	3	2	0	Corrosive; liquid and mist cause severe burns to all body tissue; may be fatal if ingested; harmful if inhaled; flammable liquid and vapour.	B, E	5, 1	8 (3)	N/P -D
acetic acid ---------- solution (*vinegar*) mixture: CH_3COOH ---------5 - 7% H_2O ---------- 93 - 95% $CH_3COOH(aq)$	A	1	0	0	Causes irritation of the nose, throat and respiratory tract; prolonged contact may cause burns and dermatitis.	NC	1	8	N/P-D
acetic anhydride ----- liquid (*acetic oxide, ethanoic anhydride*) $C_4H_6O_3(l)$	C	3	2	1 W	Corrosive; causes severe burns to any area of contact; severe eye and respiratory irritant; harmful if swallowed; flammable liquid and vapour; water reactive.	D1, D2, E	5	8 (3)	WF/I
acetone ---------- liquid (*2-propanone*) $CH_3COCH_3(l)$	B	1	3	0	Causes respiratory and eye irritation; vapours may cause drowsiness and dizziness causing depression of the central nervous system; harmful if swallowed; highly flammable.	B, D2	5	3	WF/I

Chemical Name(s), State and Formula	Use in School Category	H*	F*	R*	Hazards	WHMIS Class	Storage Class	TDG Hazard Class	Disposal Methods
aceto-carmine stain---------- solution mixture: carmine ---------- 0.5% acetic acid --------- 45.0% water ---------- 54.5%	B	1	0	0	May cause skin, eye and respiratory tract irritation; may cause gastro-intestinal tract discomfort if ingested.	D1, E	1	8	WF/I
aceto-orcein stain-solution mixture: acetic acid ---------- 45% orcein ---------- 2% water ---------- 53%	B	1	0	0	May cause irritation to eyes, skin and respiratory system; may cause gastro-intestinal tract discomfort if ingested.	E	1	8	WF/I or N/P - D
acetyl chloride -------- liquid (*ethanoyl chloride*) $CH_3COCl(l)$	D	3	3	2 W	Corrosive; causes severe burns to eyes and skin; harmful if inhaled or swallowed; highly flammable; reacts violently with water forming toxic phosgene.	B, D1	5	8 (3)	WF/I
acrolein ---------- liquid (*2-propenal, acrylaldehyde*) $C_3H_4O(l)$	D	3	4	1	Corrosive; causes severe irritation or burns to eyes and skin; highly toxic if inhaled or ingested; highly flammable; may be carcinogenic.	B, D1, E	5	6.1	WF/I
acrylic acid ---------- liquid (*2-ropenoic acid*) $C_3H_4O_2(l)$ or $CH_2CHCOOH(l)$	D	3	2	2	Toxic, may be fatal if swallowed; harmful if inhaled or absorbed through skin; causes burns to skin, eyes and mucous membranes; severe respiratory irritant; unstable, must be stored with MEHQ inhibitor and access to oxygen gas; flammable liquid and vapour.	B, D1, E	5	3 (8)	WF/I
adipic acid --------- powder (*hexanedioic acid, 1,4-butandicarboxylic acid*) $C_6H_{10}O_4(s)$ or $HOCO(CH_2)_4COOH(s)$	B	1	1	0	Causes irritation of the eyes; inhalation may cause irritation; powder-air mixture is explosive.	NC	3	NR	N/P - D

Chemical Name(s), State and Formula	Use in School Category	H*	F*	R*	Hazards	WHMIS Class	Storage Class	TDG Hazard Class	Disposal Methods
adrenaline ---------- powder (*epinephrine*) $C_9H_{13}NO_3$(s)	B	2	1	0	May cause irritation of eyes, skin, respiratory and digestive tracts; harmful by inhalation, contact with skin or if swallowed; excess absorption can be fatal; increases heart rate, blood pressure; powder-air mixture explosive.	D2	8	6.1	WF/I
agar, all culture --- powder mixture: agarose ---------- variable agaropectin -------- " glucose ---------- " ascorbic acid ---- " other ---------- "	A	2	1	1	May be irritating to eyes, skin, mucous membranes and upper respiratory tract; decomposes on exposure to light; combustible if heated or ignited.	NC	8	NR	T
L-alanine ---------- crystals (l-2 aminopropanoic acid) $C_3H_7NO_3$(s) or $CH_3CH(NH_2)COH$(s)	B	1	1	0	Dust may cause irritation of eyes, digestive and respiratory tracts; flammable if heated, combustible if heated or ignited, powder-air mixture is explosive.	NC	8	NR	T or D(aq)
alizarin ---------- crystals (*alizarin B or red, mordant red 11, turkey red*) $C_{14}H_8O_4$(s)	B	2	1	0	Skin and eye irritant; may be harmful if ingested or inhaled; flammable if heated, powder-air mixture is explosive.	D2	8	NR	T or D(aq)
alizarin red S------ solution mixture: alizarin ---------- 1.0% water ---------- 99.0%	B	1	0	0	Solution may cause mild skin and eye irritation.	NC	8	NR	D
alizarin red S ----- powder (*mordant red 3*) $C_{14}H_7NaO_7S$(s)	B	2	1	0	May cause severe irritation of skin, eyes, digestive and respiratory tracts; harmful if swallowed or inhaled; combustible if heated or ignited, powder-air mixture is explosive.	NC	8	NR	T or D(aq)

Chemical Name(s), State and Formula	Use in School Category	H*	F*	R*	Hazards	WHMIS Class	Storage Class	TDG Hazard Class	Disposal Methods
alizarin yellow R -- powder $C_{13}H_8NaO_5N_3(s)$	B	2	1	0	Causes severe eye and skin irritation, irritating to the mucous membranes and upper respiratory tract; may be harmful if swallowed or inhaled; combustible if heated or ignited, dust-air mixture explosive.	NC	8	NR	T or D(aq)
alum ---------- powder (*aluminium potassium-sulfate dodecahydrate*) $KAl(SO_4)_2 \bullet 12H_2O(s)$	A	2	0	0	Causes irritation of skin, eyes and respiratory tract; harmful if swallowed or inhaled.	D2	8	NR	T or D(aq)
aluminon ---------- crystals (*ammonium aurintricarboxylate*) $C_{22}H_{23}N_3O_9(s)$	B	2	1	0	Causes minor irritation of the skin and eyes; harmful by ingestion or inhalation; flammable if heated.	D2	8	NR	T or D(aq)
aluminium ----- foil or strips Al(s)	A	0	1	0	Metal strips or foil has no adverse effects; strips will readily burn if ignited.	B	8	NR	R or T
aluminium --------- powder Al(s)	B	1	1	1 ~~W~~	Metal powder may be irritating to eyes and respiratory system; not readily absorbed through skin, digestive tract or the lungs; chronic exposure may cause lung damage; powder readily burns or explodes if ignited; reacts slowly with water to liberate H_2.	B	8	NR	R or T
aluminium acetate (basic)----- powder mixture: $Al(C_2H_3O_2)_2OH(s)$ ---- 30% $Al_2O_3(s)$ ---------- 70%	A	1	1	0	Nuisance dust; may cause irritation to eyes, skin and respiratory tract; may be harmful if swallowed or inhaled; dust-air mixture is explosive.	NC	8	NR	T or D

Chemical Name(s), State and Formula	Use in School Category	H*	F*	R*	Hazards	WHMIS Class	Storage Class	TDG Hazard Class	Disposal Methods
aluminium ammonium-sulfate dodecahydrate ---- powder (*ammonium alum*) $AlNH_4(SO_4)_2 \bullet 12H_2O(s)$	A	1	0	0	May cause eye, skin, respiratory and/or digestive tract irritation; prolonged exposure may cause liver damage.	NC	8	NR	T or D(aq)
aluminium carbide ---------- powder $Al_4C_3(s)$	C	1	3	1	Causes irritation of eyes, mucus membranes and upper respiratory tract; highly flammable solid; contact with water liberates extremely flammable gases.	B	4	4.3	WF/I
aluminium carbonate ---------- powder $Al_2(CO_3)_3(s)$	A	0	0	0	No adverse effects.	NC	8	NR	T or D(aq)
aluminium chloride, anhydrous ---------- powder $AlCl_3(s)$	C	3	0	2 W	Corrosive; causes irritation and burns to skin, eyes, respiratory and digestive tracts; reacts violently with water forming HCl.	D2, E, F	8	8	WF/I or N/P-T
aluminium hydroxide ---------- powder (*aluminium hydrate*) $Al(OH)_3(s)$	A	1	0	0	Causes irritation of eyes and respiratory tract.	NC	2	NR	WF/I or N/P-T
aluminium nitrate nonahydrate ------- crystals $Al(NO_3)_3 \bullet 9H_2O(s)$	B - soln. C - crystals	2	0	0 OX	Causes irritation of skin, eyes and respiratory system; harmful if ingested or inhaled; strong oxidizing agent; can react violently as a result of shock or friction.	C, D1, D2	6	5.1	WF/I
aluminium oxide -- powder $Al_2O(s)_3(s)$	A	2	0	0	May irritate eyes and respiratory system; may be harmful if swallowed or inhaled.	NC	8	NR	T
aluminium phosphate --------- powder $AlPO_4(s)$	B - soln. C - powder	3	0	0	Corrosive; causes skin and eye burns and severe damage to digestive tract if ingested; causes severe irritation and possible burns to mucous membranes of respiratory tract if inhaled.	D1, E	8	NR	WF/I

Chemical Name(s), State and Formula	Use in School Category	H*	F*	R*	Hazards	WHMIS Class	Storage Class	TDG Hazard Class	Disposal Methods
aluminium potassium sulfate dodecahydrate----- crystals (*alum*) $AlK(SO_4)_2 \bullet 12H_2O(s)$	A	2	0	0	Causes irritation of skin, eyes and respiratory tract; harmful if swallowed or inhaled.	D2	8	NR	WF/I or N/P-T
aluminium sodium sulfate ---------- powder $NaAl(SO_4)_2(s)$	A	1	0	0	May cause mild irritation of the skin, eyes, respiratory and digestive tracts if inhaled or ingested.	NC	8	NR	WF/I or N/P-T
aluminium sulfate- powder $Al_2(SO_4)_3(s)$	A	2	0	0	May irritate skin; severe eye irritant; harmful if inhaled, ingested or absorbed through skin.	E	8	NR	WF/I or N/P-T
aluminium sulfide-granules $Al_2S_3(s)$	C	1	0	2 W	Irritating to skin, eyes and mucous membranes; reacts violently with water and acid-producing toxic H_2S.	F	8	4.3	WF/I
ammonia, anhydrous---------- gas (liquid under pressure) $NH_3(g)$ & $NH_3(l)$	C	3	1	0	Corrosive liquid and gas; irritating and causes burns to eyes and skin; may cause burns if ingested or inhaled; flammable vapour, air-gas mixture explosive.	E	2, 8	2.2 (8)	WF/I
ammonia water---- solution (*household ammonia*) mixture: NH_3 ---------- 10% H_2O ---------- 90% $NH_3(aq)$	A	2	0	0	Irritating to skin and mucous membranes; may cause burns with prolonged exposure; harmful if swallowed, absorbed through skin or with inhalation of fumes.	E	2, 8	8	WF/I
ammonia water---- solution (*ammonium hydroxide*) mixture: NH_3 ---------- 25 - 30% H_2O ---------- 70 - 75% $NH_3(aq)$	B	2	1	0	Irritating to skin and mucous membranes; may cause burns with prolonged exposure; harmful if swallowed, absorbed through skin or with inhalation of fumes; vapours flammable, concentrated air-gas mixture explosive.	E	2, 8	8	WF/I

Chemical Name(s), State and Formula	Use in School Category	H*	F*	R*	Hazards	WHMIS Class	Storage Class	TDG Hazard Class	Disposal Methods
ammonium acetate ---------- crystals $CH_3COONH_4(s)$	B	1	1	0	May cause irritation to eyes, skin, digestive and respiratory tracts; flammable if heated or ignited, particle-air mixture explosive.	D2	8	NR	T or D(aq)
ammonium bromide---------- crystals $NH_4Br(s)$	A	2	0	0	Causes irritation of skin, eye and mucous membranes of the respiratory tract; harmful by ingestion, inhalation or absorption through skin; affects the central nervous system and eyes.	D2	8	NR	T or D(aq)
ammonium carbonate ---------- powder $(NH_4)_2CO_3(s)$	B	2	0	2	Causes irritation of skin, eye and respiratory tract; harmful if swallowed or inhaled; unstable upon exposure to air; converts to ammonium bicarbonate.	D2	8	NR	T or D(aq)
ammonium chloride---------- powder $NH_4Cl(s)$	A	2	0	0	Irritating to skin, eyes and respiratory tract; harmful if swallowed or inhaled.	D2	8	NR	T or D(aq)
ammonium chromate ---------- crystals $(NH_4)_2CrO_4(s)$	B - soln. C - crystals	3	0	0 OX	Corrosive; causes severe irritation, burns to skin, eyes and mucous membranes; may be fatal by ingestion, inhalation or skin absorption; strong oxidizing agent, may explode when heated; mutagen; human carcinogen.	D1, D2, C, E	6	9	WF/I
ammonium citrate--powder $(NH_4)_2HC_6H_5O_7(s)$	B	2	1	0	May cause irritation to skin, eyes and respiratory tract; harmful if ingested or inhaled; flammable if heated or ignited, particle-air mixture explosive.	NC	8	NR	T or D(aq)
ammonium dichromate --------- crystals $(NH_4)_2Cr_2O_7(s)$	B - soln. C - crystals	3	1	1 OX	Corrosive; causes severe skin and eye irritation and burns to any area of contact; toxic by inhalation or ingestion; very strong oxidizing agent; combustible solid if ignited, also decomposes if heated; known human carcinogen.	D1, D2, C, E	6	5.1	WF/I or N/P-T

Chemical Name(s), State and Formula	Use in School Category	H*	F*	R*	Hazards	WHMIS Class	Storage Class	TDG Hazard Class	Disposal Methods
ammonium dihydrogen-phosphate ---------- crystals (*ammonium phosphate monobasic*) $NH_4H_2PO_4(s)$	B	2	0	1	Causes irritation to skin, eyes and respiratory tract; harmful if swallowed or inhaled.	NC	8	NR	WF/I
ammonium ferrous sulfate hexahydrate ------- crystals (*mohr's salt, ammonium iron(II)sulfate hexahydrate*) $(NH_4)_2FeSO_4 \bullet 6H_2O(s)$	B	2	0	1	May cause irritation of the skin, eyes, respiratory and intestinal tracts; may be harmful by inhalation or skin absorption; ingestion may cause iron poisoning, larger intakes can cause liver and kidney damage and other complications; unstable, air and light sensitive.	D1	8	9	WF/I
ammonium fluoride ---------- crystals $NH_4F(s)$	D	3	0	0	Corrosive; causes severe burns to skin, eyes, respiratory and digestive tracts; may be fatal by ingestion, inhalation or skin absorption; symptomatic effects may be delayed without sensation or onset of pain.	E	8	6.1	WF/I
ammonium hydrogen carbonate ---------- powder (*ammonium bicarbonate*) $NH_4HCO_3(s)$	A	1	0	0	Mildly irritating to eyes and respiratory membranes; ingestion can cause nausea and vomiting.	NC	8	NR	T or D(aq)
ammonium hydrogen-phosphate ---------- crystals (*ammonium phosphate, dibasic*) $(NH_4)_2HPO_4(s)$	B	2	0	0	Causes skin and eye irritation, may damage cornea; causes respiratory and intestinal tract irritation.	NC	8	NR	WF/I

Chemical Name(s), State and Formula	Use in School Category	H*	F*	R*	Hazards	WHMIS Class	Storage Class	TDG Hazard Class	Disposal Methods
ammonium hydroxide ---------- solution (*ammonia water*) mixture: NH_4OH ---------- 57% H_2O ---------- 43% (NH_3 ---------22% - 30%)	B - soln. C - crystal	3	1	0	Corrosive; causes severe burns to skin, eyes and gastro-intestinal tract, if ingested; inhalation causes severe irritation and inflammation of respiratory membranes; concentrated fumes explosive.	E	2	8	N/P-D
ammonium molybdate tetrahydrate -------- crystals $(NH_4)_6Mo_7O_{24}\bullet 4H_2O(s)$	B	2	0	0	Causes irritation to skin, eyes and respiratory tract; may be harmful if swallowed or inhaled; extended exposure affects kidneys and blood.	NC	8	NR	T or D(aq)
ammonium nitrate–crystals $NH_4NO_3(s)$	B	2	0	3 OX	Causes irritation to skin, eyes and respiratory tract; may be harmful if swallowed or inhaled; strong oxidizer; may decompose if heated; will explode if heated to 210°C; explodes more readily if contaminated with combustible material.	C, D2	6	5.1	WF/I
ammonium oxalate monohydrate ----- granules $(NH_4)_2C_2O_4\bullet H_2O(s)$	D	4	1	0	Toxic and corrosive; inhalation may be fatal due to spasm, inflammation and edema; extremely destructive to tissue of the mucous membranes and upper respiratory tract; causes severe burns to skin, eyes and gastro-intestinal tract, if ingested; may affect kidneys; combustible if heated or ignited.	E	8	8	WF/I
ammonium sulfate-crystals $(NH_4)_2SO_4(s)$	A	2	0	0	Skin, eye and respiratory irritant; may be harmful by inhalation, ingestion or skin absorption.	D2	8	NR	T or D(aq)

Chemical Name(s), State and Formula	Use in School Category	H*	F*	R*	Hazards	WHMIS Class	Storage Class	TDG Hazard Class	Disposal Methods
ammonium sulfide -- liquid $(NH_4)_2S(l)$	D	3	3	1	Corrosive; strong skin, eye and mucous membrane irritant, causes burns to any area of contact; may be fatal if swallowed or inhaled; harmful if absorbed through skin; highly flammable liquid and vapour; toxic hydrogen sulfide gas is released when heated.	B, D2	5	8 (3) (6.1)	WF/I
ammonium sulfite monohydrate ------ crystals $(NH_4)_2SO_3 \bullet H_2O(s)$	B	2	0	0	Causes irritation of eyes, skin, mucous membranes and upper respiratory tract; may be harmful by inhalation, ingestion or skin absorption.	NC	8	NR	T or D(aq)
ammonium thiocyanate -------- crystals $NH_4SCN(s)$	B	2	0	1	May cause irritation of skin, eyes and/or respiratory tract; harmful if swallowed, inhaled or absorbed through skin; emits toxic fumes when heated or in contact with acids.	NC	8	NR	T or D(aq)
ammonium thiosulfate ---------- powder $(NH_4)_2S_2O_3(s)$	B	2	0	1	Irritating to skin, eyes and respiratory system; harmful if inhaled, swallowed, or in contact with skin; decomposes and emits toxic gases when heated to temperatures above 104.4°C.	NC	8	NR	T or D(aq)
ammonium vanadate ---------- granules $NH_4VO_3(s)$	D	3	0	0	Highly toxic fume, mist and dust; may be fatal if inhaled or ingested; causes irritation to skin, eyes and respiratory tract; may damage lung tissue and bronchial airways.	D1	8	6.1	WF/I
amyl acetate ---------- liquid (*n-amyl acetate*) $CH_3COOC_5H_{11}(l)$	C	2	3	0	Causes irritation to the eyes, skin and respiratory tract; harmful if swallowed or inhaled; highly flammable liquid and vapour.	B, D1	5	3	WF/I

Chemical Name(s), State and Formula	Use in School Category	H*	F*	R*	Hazards	WHMIS Class	Storage Class	TDG Hazard Class	Disposal Methods
iso - amyl alcohol ---- liquid (*isopentyl alcohol*) $C_4H_{10}O(l)$ or $(CH_3)_2CHCH_2CH_2OH(l)$	B	2	2	0	Causes irritation to skin, mucous membranes and respiratory tract; severe irritant to eyes; harmful if swallowed, inhaled or ingested; hematotoxic; affects the central nervous system; flammable liquid and vapour; emits toxic fumes when burned.	B, D2	5	3	WF/I
n-amyl alcohol ------- liquid (*1-pentanol, n-pentyl alcohol*) $C_5H_{11}OH(l)$	B	2	3	0	Liquid causes skin and severe eye irritation with possible burns; vapours cause severe irritation of the respiratory tract; harmful if inhaled, swallowed or absorbed through skin; affects the nervous system; flammable liquid and vapour.	B, D2	5	3	WF/I
amylase ---------- powder composition - variable	B	1	1	0	May cause irritation of skin, eyes and respiratory tract; low ingestion hazard; dust-air mixture explosive.	NC	8	NR	T or D(aq)
aniline ---------- liquid (*amino benzene, benzenamine*) $C_6H_5NH_2(l)$	B - soln. C - pure liq.	3	2	0	Toxic; may be fatal by ingestion, inhalation and skin absorption; causes irritation to skin and respiratory tract; severe irritant to eyes; combustible liquid and vapour; mutagen.	B, D1	5	6.1	WF/I or N/P-D
antimony ---------- solid Sb(s)	B	2	1	0	Dust causes skin, eye digestive and respiratory irritation; prolonged exposure may cause blood abnormalities and cardiac disturbances; inhalation of fumes causes metal-fume fever; chronic inhalation may cause lever, kidney and cardiac changes; bulk metal combustible at high temperatures; dust-air mixture is explosive.	D1, E	8	6.1	WF/I

Chemical Name(s), State and Formula	Use in School Category	H*	F*	R*	Hazards	WHMIS Class	Storage Class	TDG Hazard Class	Disposal Methods
antimony pentachloride --------- liquid (*antimony perchloride*) $SbCl_5(l)$	D	3	0	1 ~~W~~	Corrosive; liquid causes severe burns to skin and eyes; extremely destructive to tissues of the mucous membranes and upper respiratory tract; may be fatal if ingested, inhaled or absorbed through skin; water reactive.	D1, E	8	8	WF/I
antimony sulfate---------- powder (*diantimony trisulfate*) $Sb_2(SO_4)_3(s)$	B	2	0	1	May cause skin, eye and/or respiratory tract irritation; harmful if swallowed, inhaled or absorbed through skin; chronic exposure may cause liver and kidney damage; decomposes if heated.	D2	8	6.1	WF/I
antimony sulfide ---------- powder (*diantimony trisulfide*) $Sb_2S_3(s)$	B - soln. C - powder	2	1	0	Causes irritation of skin, eye and mucus membranes of upper respiratory tract; harmful if inhaled, ingested or absorbed through skin; possible carcinogen; particle-air mixture explosive.	D2	8	NR	WF/I
antimony trichloride ---------- crystals (*trichlorostibine*) $SbCl_3(s)$	D	3	0	1 ~~W~~	Corrosive; contact with skin and eyes causes severe irritation or burns; harmful if inhaled, ingested or absorbed through skin; inhalation of dust may cause dizziness and difficulty breathing; ingestion causes nausea, vomiting and loss of consciousness; water reactive, releases heat and toxic fumes.	E	8	8	WF/I
antimony trioxide-- crystals (*diantimony trioxide*) $Sb_2O_3(s)$	B - soln. C - crystals	2	1	0	Causes irritation to skin, eyes, digestive and respiratory tracts; harmful if swallowed or inhaled; prolonged exposure affects the cardiovascular system and liver; powdered form flammable if heated; mutagen.	D2	8	6.1	WF/I

Chemical Name(s), State and Formula	Use in School Category	H*	F*	R*	Hazards	WHMIS Class	Storage Class	TDG Hazard Class	Disposal Methods
apatite ---------- crystalline (*fluorapatite, chlorapatite, hydroxlapatite*) $Ca_5(PO_4)_3 \cdot F/Cl/OH(s)$	A	1	0	0	Dust may cause irritation of skin, eyes, respiratory and digestive tracts.	NC	8	NR	T
L(+) arabinose ---- crystals (*pectin sugar*) $C_5H_{10}O_5(s)$	A	0	1	0	No adverse effects; flammable if heated or ignited; dust-air mixture explosive.	NC	8	NR	T
L-arginine ---------- powder $C_6H_{14}N_4O_2(s)$	A	0	1	0	No adverse effects; flammable if heated or ignited.	NC	8	NR	T
argon ---------- gas $Ar(g)$	A	2	0	0	Nontoxic but may produce suffocation by displacing the oxygen in the air.	NC	8	NR	A
arsenic --- powder or lump $As(s)$	D	4	1	0	Very strong neurotoxin; may be fatal if powder inhaled, or if swallowed or absorbed through the skin; known human carcinogen; may cause reproductive disorders; dust-air mixture is slightly explosive.	D1	8	6.1	WF/I
arsenic pentoxide- powder (*diarsenic pentaoxide*) $As_2O_5(s)$	D	3	0	0	Toxic by inhalation and/or ingestion; mutagen; may be a human carcinogen.	D1, D2	8	6.1	WF/I
arsenic trichloride --- liquid (*trichloroarsine*) $AsCl_3(l)$	D	3	0	0	Toxic; may cause skin, eye, respiratory and digestive tract irritation; may be fatal if swallowed; may cause cardiac disturbances, and/or liver and kidney damage; may cause central nervous system depression; human carcinogen.	D1, D2	8	6.1	WF/I

Chemical Name(s), State and Formula	Use in School Category	H*	F*	R*	Hazards	WHMIS Class	Storage Class	TDG Hazard Class	Disposal Methods
arsenic trioxide ---- powder (*diarsenic trichloride*) $As_2O_3(s)$	D	3	0	0	Toxic; causes skin and eye irritation; causes severe respiratory and digestive tract irritation or burns; highly toxic by ingestion and inhalation; may cause lung damage and cause central nervous system effects; may have adverse reproductive and fetal effects; human carcinogen.	D1, D2	8	6.1	WF/I
asbestos –----- fibrous solid mixture: silicates of Na, Mg, and Ca; most commonly chrysotile - $Mg_3(Si_2O_5)(OH)_4$ amosite $(MgFe)_7(Si_8O_{22})(OH)_2(s)$	D	1	0	0	Causes irritation of the eyes, nose and throat; prolonged inhalation of particles cause asbestosis and cancer.	D2	8	9	WF/I
ascorbic acid ------ crystals (*vitamin C*) $C_6H_8O_6(s)$	A	1	1	0	May cause mild irritations of the skin, eyes and respiratory tract; flammable if heated or ignited.	NC	3	NR	T or D(aq)
L-asparagine monohydrate ------ crystals $C_4H_8O_3N_2 \bullet H_2O(s)$	A	0	1	0	No adverse effects; flammable if heated or ignited.	NC	8	NR	T
L-aspartic acid ---- crystals $C_4H_7NO_4(s)$	A	0	1	0	No adverse effects; flammable if heated or ignited.	NC	3	NR	T
azure A ---------- powder $C_{14}H_{14}ClN_3S(s)$	A	2	0	0	May cause irritation of the eyes, skin and respiratory system; may be harmful if swallowed or inhaled.	NC	8	NR	T
azure B ---------- powder (*azure I*) $C_{15}H_{16}ClN_3S(s)$	A	2	0	0	May cause irritation of the eyes, skin and respiratory system; may be harmful if swallowed or inhaled.	NC	8	NR	T

Chemical Name(s), State and Formula	Use in School Category	H*	F*	R*	Hazards	WHMIS Class	Storage Class	TDG Hazard Class	Disposal Methods
baking soda ------- powder (*sodium hydrogen carbonate or bicarbonate*) $NaHCO_3(s)$	A	1	0	0	May cause slight irritation of the eyes, skin and respiratory tract.	NC	8	NR	T or D(aq)
barium ---- powder or solid Ba(s)	C - solid D - powder	3	1	2 W	Toxic; poisonous if powder inhaled or ingested; reacts violently with water and acids; flammable if heated.	D1, F	8	4.3	WF/I
barium carbonate--powder $BaCO_3(s)$	B	2	0	0	May cause irritation of the skin, eyes and respiratory tract; harmful if inhaled, may be fatal if swallowed; prolonged exposure affects muscles and central nervous system, may cause kidney damage.	D1	8	6.1	N/P-T or WF/I
barium chloride dehydrate ---------- solid $BaCl_2 \bullet 2H_2O(s)$	B - soln. C - solid	3	0	0	Toxic; may cause irritation to skin, eyes and respiratory tract; may be fatal if swallowed, harmful if inhaled; prolonged exposure affects heart, respiratory system and central nervous system.	D1, D2	8	6.1	N/P-T or WF/I
barium iodide ------ beads $BaI_2(s)$	B	2	0	0	Irritant to eyes, skin and mucous membranes; harmful if inhaled or swallowed; chronic exposure can cause severe gastroenteritis, slow or irregular heartbeat.	D2	8	6.1	N/P-T or WF/I
barium(IV) oxide -- powder (*barium peroxide*) $BaO_2(s)$	B - soln. C - powder	3	0	1	Toxic; skin or eye contact may lead to severe irritation or burns; may be fatal if swallowed; chronic exposure may lead to damage to CNS, spleen, liver, kidney and/or bone marrow; decomposes slowly in the presence of water.	D1, D2	8	6.1	WF/I

Chemical Name(s), State and Formula	Use in School Category	H*	F*	R*	Hazards	WHMIS Class	Storage Class	TDG Hazard Class	Disposal Methods
barium hydroxide - crystals (*barium hydrate*) $Ba(OH)_2(s)$	B	3	0	0	Toxic; causes irritation of the skin, eyes and respiratory tract; may be fatal if swallowed, harmful if inhaled; prolonged exposure affects muscles and central nervous system.	D1, E	2	6.1	N/P-T or WF/I
barium iodide ------ crystals $BaI_2(s)$	B	2	0	0	Causes irritation of the skin, eyes and mucous membranes; harmful if inhaled or swallowed; ingestion causes severe abdominal pain, vomiting, diarrhea, tremors and slow or irregular heartbeat.	D1	8	6.1	N/P-T or WF/I
barium nitrate ----- crystals *(black ash)* $Ba(NO_3)_2(s)$	B	3	0	0 OX	Toxic; causes irritation of the skin, eyes and respiratory tract; may be fatal if swallowed, harmful if inhaled; prolonged exposure affects muscles and central nervous system; strong oxidizer, may cause fire if in contact with reducing agents or combustibles.	C, D1, D2	6	5.1 (6.1)	WF/I
barium sulfide ---- crystals BaS(s)	B	2	1	1	Irritates and burns skin and eyes; harmful by ingestion or inhalation; acute over-exposure may be fatal; causes hair loss; decomposes when heated to produce toxic gas; particle-air mixture is combustible.	D1, D2	8	6.1	WF/I
bauxite -- chunks/granules mixture: aluminium silicates & oxides of Al, Si, Ti & Fe	A	1	0	0	Can cause mild irritation to skin, eyes, respiratory and digestive tracts; silicates known to be carcinogenic in humans with prolonged exposure.	NC	8	NR	T

Chemical Name(s), State and Formula	Use in School Category	H*	F*	R*	Hazards	WHMIS Class	Storage Class	TDG Hazard Class	Disposal Methods
Benedict's qualitative reagent –---------- solution mixture of: H_2O ---------- 73.5% $NaCO_3$------- 10.0%, $CuSO_4$------- 1.5%, $NaC_6H_5O_7$--- 15.0%	B	2	0	0	Causes severe irritation of the skin and eyes, as well as the respiratory and digestive tract if ingested or inhaled; long-term exposure may corrode the digestive tract with hemorrhaging and shock; may cause liver and kidney damage or cause adverse reproductive and fetal effects.	D2	8	6.1	WF/I or N/P-D
benzaldehyde ------- liquid (*benzoic aldehyde*) $C_6H_5CHO(l)$	B	2	2	0	Causes irritation of the skin, eyes and respiratory tract; harmful if swallowed or inhaled, prolonged exposure may cause central nervous system depression that can lead to unconsciousness, coma and possible death due to respiratory failure; combustible liquid.	B, D1, D2	5	NR	WF/I
benzaldehyde green ---------- crystals (*malachite green*) $C_{23}H_{25}ClN_2(s)$ or $C_{23}H_{26}N_2O(s)$	B	1	1	1	Contact with skin or eyes may cause irritation; ingestion may be harmful; flammable if heated; light sensitive. Note: Two forms—oxalate and chloride.	NC	8	6.1	WF/I
benzene ---------- liquid $C_6H_6(l)$	D	3	3	0	Toxic; causes irritation of the skin, eyes and respiratory tract; toxic by ingestion, inhalation and skin absorption, depresses the central nervous system; highly flammable; human carcinogen.	B, D1, D2	5	3	WF/I
benzenesulfonic acid 1.5 hydrate --------- crystals (*phenylsulfonic acid*) $C_6H_5SO_3H \bullet 1.5H_2O(s)$	D	3	0	0	Corrosive; causes burns to any area of contact; harmful if swallowed, inhaled or absorbed through the skin.	E	3	8	WF/I

Chemical Name(s), State and Formula	Use in School Category	H*	F*	R*	Hazards	WHMIS Class	Storage Class	TDG Hazard Class	Disposal Methods
benzoic acid ------ crystals (*benzenecarboxylic acid, phenylformic acid)* $C_7H_6O_2$(s)	A	2	1	0	Causes moderate irritation of the skin and severe irritation and possible injury to eyes; may be harmful if swallowed, inhaled or absorbed through skin; combustible if heated.	D2	3	NR	T
benzoyl peroxide - crystals *(dibenzoyl peroxide, acetoxyl, nericur)* $(C_6H_5CO)_2O_2$(s)	D	2	3	3 OX	Irritant of skin, eyes and respiratory tract; harmful if swallowed or inhaled; possible mutagen and carcinogen; highly flammable; strong oxidizer, reaction with reducing compounds can cause fire; extremely explosive, sensitive to shock, friction and heat.	B, C, D2, F	4,6	5.2	WF/I
beryllium metal ------- lump Be(s)	C	3	1	0	Very toxic if swallowed or inhaled; irritating to skin, eyes and respiratory system; human carcinogen.	D1, D2	8	NR	WF/I
beryllium salts ---------- crystals	D	3 or 4			Very toxic; human carcinogens.	D1, D2	-	-	WF/I
bile salts --------- powder (oxgall) formula not applicable	A	1	0	0	Causes irritation to skin, eyes and respiratory tract; may cause allergic reaction if sensitive to proteolytic enzymes.	NC	8	NR	T
bismuth ---------- powder or lump Bi(s)	B - lump C - powder	2	1	0	May cause irritation of the skin, eyes, digestive and respiratory tracts, particularly in powder form; prolonged exposure affects the central nervous system; may cause liver and kidney damage; powder flammable.	NC	8	NR	T
bismuth chloride pentahydrate ------ crystals (*bismuth trichloride*) $BiCl_3 \bullet 5H_2O$(s)	B	2	0	1	Causes irritation to skin, eyes and respiratory tract, may cause burns; decomposes in water to form bismuth oxychloride.	NC	8	NR	T

Chemical Name(s), State and Formula	Use in School Category	H*	F*	R*	Hazards	WHMIS Class	Storage Class	TDG Hazard Class	Disposal Methods
bismuth nitrate ---- crystals *(bismuth ternitrate)* $Bi(NO_3)_3(s)$	B	2	0	0 OX	Causes irritation to skin, eyes and respiratory tract; harmful if swallowed; strong oxidizer; reaction with reducing agents or combustibles may cause ignition.	C	6	5.1	WF/I
bismuth oxide ----- powder *(dibismuth trioxide, bismuth yellow)* $Bi_2O_3(s)$	A	0	0	0	No adverse effects.	NC	8	NR	T
Biuret reagent ----- solution mixture: NaOH ----- 28.00% $CuSO_4$ ----- 0.12% H_2O -------- 71.88%	A	2	0	0	Corrosive; harmful by inhalation, ingestion or skin absorption; causes burns of the skin, eyes, respiratory and digestive tract; irritation may lead to chemical pneumonitis and pulmonary edema.	D2, E	2	8 (6.1)	D
bleach ---------- solution (*sodium hypochlorite*) mixture: H_2O ----------80 – 99% NaClO----------– 1 – 20% NaClO(aq)	B	2	0	2 OX	Skin irritant, may cause burns to skin and eyes; harmful by inhalation, ingestion or through skin contact; light and temperature sensitive; decomposes with release of chlorine gas; oxidizer.	C, D1	6	8	D
bleaching powder ---------- granules (*calcium hypochlorite*) $Ca(ClO)_2(s)$	B	3	0	2 OX ~~W~~	Corrosive to eyes; minute amounts very harmful if ingested; extremely toxic if inhaled into lungs, burns mucous membranes; water reactive, emits toxic chlorine gas; rapidly decomposes on exposure to air; thermally unstable; oxidizer, decomposes at 180°C releasing oxygen.	C, D1, E	6	8	D-(aq) WF/I

Chemical Name(s), State and Formula	Use in School Category	H*	F*	R*	Hazards	WHMIS Class	Storage Class	TDG Hazard Class	Disposal Methods
borax ---------- powder (*sodium borate decahydrate*) $Na_2B_4O_7 \bullet 10H_2O(s)$	A	2	0	0	May cause irritation of skin, eyes and respiratory tract; harmful if inhaled or ingested.	NC	8	NR	T or D(aq)
boric acid ---------- crystals $H_3BO_3(s)$	A	2	0	0	May cause skin, eye and respiratory tract irritation; causes severe digestive tract irritation resulting in hemorrhaging and shock; may have adverse reproductive affects.	D2	1	NR	T or D(aq)
boron --- powder or chunks B(s)	C	3	3	0	Toxic by inhalation, ingestion or by skin absorption; irritant; may affect the CNS; highly flammable.	B, D1, D2	4	4.1	WF/I
brass ---------- solid mixture: copper---- variable (2 parts) zinc ------- variable (1 part) other metals -- variable	A	1	0	0	Finished alloy is not hazardous. Dust or fume is classified as skin and eye irritant.	C, D1	8	NR	R
bromine ------- liquid & gas $Br_2(l)$ or $Br_2(g)$	D	3	0	0 OX	Highly toxic by skin contact, inhalation or ingestion; severe skin irritant, causes severe burns; very strong oxidizer; reacts violently with many organic compounds.	D1	6,7	8 (6.1)	WF/I or N/P-D
bromine water – solution Br(aq)	B	3	0	0 OX	Corrosive vapour or mist; may cause irritation or severe burns to skin, eyes or respiratory tract; ingestion may cause digestive tract burns, abdominal pain, vomiting and possible death; oxidizer.	C, D1	6,7	8 (6.1)	WF/I or N/P-D
bromcresol green---------- powder $C_{21}H_{14}Br_4O_5S(s)$	A	2	1	0	May cause irritation of skin, eyes and respiratory tract; may be harmful if swallowed or inhaled; dust-air mixture explosive.	NC	8	NR	T

Chemical Name(s), State and Formula	Use in School Category	H*	F*	R*	Hazards	WHMIS Class	Storage Class	TDG Hazard Class	Disposal Methods
bromcresol green ---------- solution mixture: water ---------- >98.8% bromcresol green----------< 1.0% tetrasodium ethylene diamine tetraacetate ----------0.02%	A	1	0	0	May cause irritation of skin, eyes.	NC	8	NR	D
bromcresol purple----------powder $C_{21}H_{16}Br_2O_5S(s)$	A	2	0	0	May cause irritation of skin, eyes and respiratory tract; may be harmful if swallowed, inhaled or absorbed through skin.	NC	8	NR	T
bromcresol purple---------- solution mixture: water ---------- 99.96% bromcresol purple-–0.04% $C_{21}H_{16}Br_2O_5S(aq)$	A	1	0	0	May cause irritation of skin and eyes.	NC	8	NR	D
bromoethane ---------- liquid (*ethyl bromide*) $C_2H_5Br(l)$	C	2	3	0	A skin, eye and respiratory tract irritant; harmful if swallowed or inhaled; chronic exposure may lead to liver and kidney damage; an anaesthetic and a narcotic; highly flammable, low flash point, forms explosive mixtures with air.	B, D2	5	6.1	WF/I
bromophenol ------ powder $C_6H_5BrO(s)$	A	1	1	0	Causes irritation to skin, eyes, gastrointestinal and respiratory tracts; flammable if heated or ignited.	NC	8	6.1	WF/I
bromophenol blue–powder $C_{19}H_{10}Br_4O_5S(s)$	A	2	1	0	May cause irritation to skin, eyes and respiratory tract; may be harmful if swallowed or inhaled; flammable if heated, particle-air mixture explosive.	D1	8	6.1	T or D(aq)

Chemical Name(s), State and Formula	Use in School Category	H*	F*	R*	Hazards	WHMIS Class	Storage Class	TDG Hazard Class	Disposal Methods
4-bromophenol blue –---------- solution mixture: water ---------- 79.0% methyl alcohol ------ 20.0% bromophenol blue- < 1.0%	A	2	1	0	May cause irritation to skin, eyes and respiratory tract; may be harmful if swallowed or inhaled; flammable vapours.	D1	8	6.1	D
bromothymol blue –---------- solution mixture: water ---------- 99.9% bromothymol blue- 0.1%	A	1	0	0	May cause irritation to skin and eyes.	NC	8	NR	D
bromothymol blue–crystals $C_{27}H_{28}Br_2O_5S(s)$	A	2	1	0	May cause irritation to skin, eyes and respiratory tract; harmful if swallowed; flammable if heated, particle-air mixture explosive.	D1	8	NR	T
butane ---- liquefied gas $C_4H_{10}(l)$ & $C_4H_{10}(g)$	B	1	4	0	Eye and skin irritant, may be harmful if ingested, inhaled or through skin contact; can cause CNS depression; extremely flammable.	A, B	5	2.1	WF/I
1-butanol ---------- liquid *(butyl alcohol, propyl carbinol, n-butyl alcohol)* $C_4H_{10}O(l)$ or $CH_3(CH_2)_2CH_2OH(l)$	B	2	3	0	May cause irritation to skin, eyes and respiratory tract; harmful if swallowed, inhaled or absorbed through skin; affects the CNS, may affect liver and kidneys; highly flammable liquid and vapour.	B, D2	5	3	WF/I
2-butanone ---------- liquid *(methyl ethyl ketone)* $C_4H_8O(l)$ or $CH_3COCH_2CH_3(l)$	B	2	3	0	Vapour is an eye and skin irritant; may be harmful by ingestion, inhalation or through skin contact; prolonged exposure causes CNS depression; may cause damage to lungs and CNS; may be a mutagen; highly flammable.	B, D2	5	3	WF/I

Chemical Name(s), State and Formula	Use in School Category	H*	F*	R*	Hazards	WHMIS Class	Storage Class	TDG Hazard Class	Disposal Methods
iso-butyl alcohol ----- liquid (*2-methyl-1-propanol*) $C_4H_{10}O(l)$ or $(CH_3)_2CHCH_2OH(l)$	B	2	3	0	Causes irritation of the skin, eyes and mucous membranes; may be harmful if swallowed, inhaled or absorbed through skin; prolonged exposure affects the CNS; may damage the liver and kidneys; highly flammable.	B, D2	5	3	WF/I
sec-butyl alcohol ---- liquid (*2-butanol, 1-methyl propanol*) $C_4H_{10}O(l)$ or $CH_3CHOHCH_2CH_3(l)$	B	2	3	0	Causes irritation to skin, eyes and respiratory tract; harmful if swallowed or inhaled; affects the CNS; highly flammable liquid and vapour.	B, D2	5	3	WF/I
butyl alcohol-tert ----- liquid *(tert-butanol, 2-methyl-2-propanol)* $C_4H_{10}O(l)$ or $(CH_3)_3COH(l)$	B	2	3	0	Causes irritation to eyes and respiratory tract, may cause irritation to skin; harmful if swallowed or inhaled; affects the CNS; may affect liver and kidneys; highly flammable liquid and vapour.	B, D2	5	3	WF/I
n-butyl phthalate --- liquid (butyl phthalate) $C_6H_4(CO_2C_4H_9)_2(l)$	B	2	1	0	Causes skin and respiratory tract irritation and severe eye irritation; harmful if swallowed or inhaled; combustible if heated or ignited.	D2	8	9	WF/I
n-butyric acid --------- liquid *(butanoic acid,ethyacetic acid, propylformic acid)* $C_4H_8O_2(l)$ or $CH_3CH_2CH_2COOH(l)$	B	2	2	0	Causes severe irritation and possible burns to skin and eyes; may cause respiratory tract irritation; harmful if swallowed, inhaled or absorbed through skin; obnoxious odour; flammable liquid and vapour.	B, E	5,3	8	WF/I
cadmium metal -- solid bar Cd(s)	A	2	0	0	No special health hazards except for dust that may be released. For cadmium powder (dust) see below.	D1, D2	8	NR	R

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cadmium metal --- powder or chunks Cd(s)	C - chunks D - powder	3	1	0	Toxic by skin contact, inhalation or ingestion; may be fatal if inhaled; prolonged exposure causes damage to lungs and kidneys; dust-air mixture explosive; probable human carcinogen.	D1, D2	8	6.1	WF/I
cadmium salts ----- powder $CdCO_3$(s)	D	3	0	0	Toxic and a human carcinogen with prolonged exposure.	D1, D2	8	6.1	WF/I
caffeine ---------- powder (*1,3,7-trimethylxanthine*) $C_8H_{10}N_4O_2$(s)	B	2	1	0	Causes irritation to skin, eyes and respiratory tract; harmful if swallowed or inhaled; may cause birth defects; flammable if heated, particle-air mixture explosive.	D1, D2	8	6.1	WF/I
calcite ---------- crystalline (*calcium carbonate*) $CaCO_3$(s)	A	0	0	0	May cause irritation to skin, eyes and respiratory tract; nuisance dust.	NC	8	NR	T
calcium metal -------- solid Ca(s)	B	3	1	2 ~~W~~	Corrosive; contact may cause burns; harmful or fatal if swallowed or absorbed through skin; flammable solid; reacts with water.	B, E	8	4.3	WF/I
calcium acetate --- powder $Ca(CH_3COO)_2$(s)	A	0	0	0	No adverse affects.	NC	8	NR	T or D(aq)
calcium carbide - granules CaC_2(s)	C	2	4	3 ~~W~~	Causes severe skin and eye irritation; harmful if inhaled; unstable; extremely flammable; reacts violently with water liberating flammable acetylene gas.	B, D2	4	4.3	WF/I
calcium carbonate-powder (*calcite, aragonite, limestone*) $CaCO_3$(s)	A	1	0	0	May cause irritation to skin, eyes and respiratory tract; nuisance dust.	NC	8	NR	T or D(aq)

Chemical Name(s), State and Formula	Use in School Category	H*	F*	R*	Hazards	WHMIS Class	Storage Class	TDG Hazard Class	Disposal Methods
calcium chloride - granules (*dowflake)* $CaCl_2(s)$	A	2	0	0	Causes irritation and possible burns to skin, eyes and respiratory tract; harmful if swallowed or inhaled; releases chlorine fumes when heated.	D2	8	NR	T or D(aq)
calcium dihydrogen-phosphate monohydrate ------ crystals *(calcium phosphate monobasic)* $Ca(H_2PO_4)_2 \bullet H_2O(s)$	A	1	0	0	Direct contact with eyes causes severe irritation or burns; may cause respiratory tract irritation.	NC	8	NR	WF/I
calcium fluoride --- powder (*fluorite, acid spar*) $CaF_2(s)$	A	2	0	0	May cause irritation to skin, eyes and respiratory tract; may be harmful if swallowed or inhaled.	E	8	NR	T or D(aq)
calcium hydride - granules $CaH_2(s)$	C	3	2	2 ~~W~~	Corrosive; contact may cause burns; harmful if swallowed, inhaled or absorbed through skin; strong reducing agent; highly flammable solid; reacts with water.	B, D1, E	4	4.3	WF/I
calcium hydroxide-crystals (*slake lime, calcium hydrate*) $Ca(OH)_2(s)$	B	3	0	0	Corrosive; causes burns to skin and eyes and severe irritation to respiratory tract; harmful if swallowed or inhaled.	E	2	8	T or D(aq)
calcium hydroxide-solution mixture: H_2O ----------80 – 90% $Ca(OH)_2$ ---------- 10 –20% $Ca(OH)_2(aq)$	A - 5% or less B - more than 5%	3	0	0	Corrosive; causes burns to skin and eyes and severe irritation to respiratory tract; harmful if swallowed or inhaled.	E	2	NR	D
calcium hypochlorite –------- crystals (*bleaching powder*) $Ca(ClO)_2(s)$	B	3	0	1 OX ~~W~~	Corrosive; causes burns to area of contact; harmful if swallowed or inhaled; strong oxidizer; reacts with water; emits toxic chlorine gas when mixed with acid.	C, D1	6	5.1	D-(aq) WF/I

Chemical Name(s), State and Formula	Use in School Category	H*	F*	R*	Hazards	WHMIS Class	Storage Class	TDG Hazard Class	Disposal Methods
calcium nitrate tetrahydrate -------- crystals $Ca(NO_3)_2 \bullet 4H_2O(s)$	B - soln. C - crystals	2	0	3 OX	Causes irritation to skin, eye and respiratory tract; harmful if swallowed or inhaled; strong oxidizer; will ignite reducing agents or combustibles; may be explosive by shock or friction.	C, D2, F	6	5.1	WF/I
calcium oxide ----- powder $CaO(s)$	B	3	0	1 W	Corrosive; contact causes severe burns to skin, eyes and respiratory tract if inhaled; may cause alkali burns to mouth and throat if ingested; reacts with organic materials and water.	E	8	NR	WF/I
calcium oxalate monohydrate ------- powder $CaC_2O_4 \bullet H_2O(s)$	A	2	0	0	May cause irritation of skin, eye, respiratory and digestive tracts; harmful if swallowed or absorbed through skin.	D1	8	6.1	WF/I
calcium phosphate (dibasic)dihydrate- crystals $CaHPO_4 \bullet 2H_2O(s)$	A	0	0	0	May cause irritation of skin, eyes and respiratory tract.	NC	8	NR	T or D(aq)
calcium phosphate (tribasic) ---------- crystals $Ca_3(PO_4)_2(s)$ or $Ca_5(OH)(PO_4)_3(s)$	A	1	0	0	May cause irritation of skin, eyes, respiratory and digestive tracts.	NC	8	NR	WF/I
calcium propionate -------- granules $Ca(CH_3CH_2COO)_2(s)$	A	1	0	0	May cause irritation of skin, eyes, respiratory and digestive tracts, if large amounts ingested.	NC	8	NR	WF/I
calcium sulfate -- granules (*anhydrous gypsum*) $CaSO_4(s)$	A	1	0	0	Causes irritation to skin, eye and respiratory tract; may be harmful if swallowed.	NC	8	NR	WF/I
calcium sulfide ---- powder $CaS(s)$	D	3	1	1	Toxic; may be fatal if inhaled or ingested; irritant to skin and mucous membranes; flammable; oxidizes in dry air; decomposes in moist air to form H_2S; oxides of sulfur, calcium hydroxide, CO_2 and CO.	D1	8	NR	WF/I

Chemical Name(s), State and Formula	Use in School Category	H*	F*	R*	Hazards	WHMIS Class	Storage Class	TDG Hazard Class	Disposal Methods
camphor ---------- crystals (*2-bornanone*) $C_{10}H_{16}O$(s)	A	1	2	0	Causes irritation to skin, eye and respiratory tract; flammable.	B	4	4.1	T
caprylic alcohol---------- liquid (*n-octanol*) $C_8H_{18}O$(l) or $CH_3(CH_2)_6CH_2OH$(l)	B	2	2	0	Causes irritation to skin, eye and respiratory tract; may be harmful if swallowed or inhaled; affects the CNS; combustible liquid and vapour.	B, D1	5	NR	D
carbamide ---------- powder (*urea*) CH_4N_2O(s) or NH_2CONH_2(s)	A	1	1	0	May cause irritation of skin, eyes, respiratory and digestive tracts; particle-air mixture explosive.	NC	8	NR	T or D(aq)
carbolic acid –----- liquid or crystals (*phenol, phenic acid, phenylic acid*) C_6H_6O(s)	D	4	2	0	Toxic and corrosive; absorbed rapidly through skin; causes severe burns to any area of contact; may be fatal if swallowed, inhaled or absorbed through skin; affects CNS, liver and kidneys; flammable.	B, D1, D2	4 ,5,3	6.1	WF/I
carbon ----------powder (*graphite*) or rods C(s)	A - rods B - powder	1	1	0	Dust may cause mechanical skin and eye irritation, may cause irritation of the respiratory and digestive tracts; flammable, dust-air mixture explosive.	NC	8	4.2	T
carbon dioxide --------- gas CO_2(g)	B	2	0	0	Will elevate rate of breathing and heart rate; gas nontoxic but displaces oxygenated air and can cause rapid suffocation with high concentrations.	NC	8	2.2	A
carbon disulfide ----- liquid (*carbon bisulfide*) CS_2(l)	D	3	4	0	Toxic, may be fatal if inhaled or ingested; harmful if absorbed through skin; affects the CNS and heart, may cause liver and kidney damage; has adverse reproductive and fetal effects; extremely flammable liquid and gas.	B, D1, D2	5	3 (6.1)	WF/I

Chemical Name(s), State and Formula	Use in School Category	H*	F*	R*	Hazards	WHMIS Class	Storage Class	TDG Hazard Class	Disposal Methods
carbon tetrachloride–liquid CCl_4(l)	D	3	2	0	Toxic; may be fatal by inhalation or skin absorption; highly toxic by ingestion; causes irritation to skin, eyes and respiratory tract; readily absorbed through skin; reproductive toxin; flammable; emits toxic fumes; mutagen and possible human carcinogen.	D1, D2	5	6.1	WF/I
carborundum --------- solid (*silicon carbide*) SiC(s)	A	1	0	0	May cause mechanical irritation to skin and eyes, and irritation to the respiratory and digestive tracts; chronic inhalation of dust may lead to silicosis and lung damage.	NC	8	NR	T
carmine –---------- powder $C_{22}H_{20}O_{13}$•xAl(s)	A	2	0	0	May cause skin, eye and respiratory tract irritation; may be harmful if swallowed, inhaled or absorbed through skin.	NC	8	NR	WF/I
Carnoy's fluid --------- liquid mixture: ethanol ---------- 98.0% acetic acid (glacial)- 1.0% chloroform ---------- 1.0%	C	1	3	0	May cause irritation to skin, eyes and respiratory tract, possible burns to eyes; ingestion may cause discomfort and vomiting; highly flammable liquid.	B, D1, D2	5	3	WF/I
casein ---------- granules (*milk protein)* formula not applicable	A	0	1	0	No adverse health effects; flammable if heated or ignited.	NC	8	NR	T
caustic potash ------ pellets (*potassium hydroxide*) KOH(s)	B	3	0	1	Corrosive; causes severe burns to any area of contact; harmful by ingestion, inhalation or skin contact; unstable, absorbs carbon dioxide and moisture from air.	D1, E	2	8	WF/I or N/P-T
caustic soda -------- pellets (*sodium hydroxide*) NaOH(s)	B	3	0	1	Corrosive; causes burns to any area of contact; may be fatal if swallowed; harmful if inhaled; heat released when added to water.	D1, E	2	8	WF/I or N/P-T

Chemical Name(s), State and Formula	Use in School Category	H*	F*	R*	Hazards	WHMIS Class	Storage Class	TDG Hazard Class	Disposal Methods
cellulose acetate –powder (variable formula)	A	1	1	0	No adverse effects.	NC	8	NR	T or D(aq)
cellulose methyl ether---------- granules (*methyl cellulose*) $C_7H_{14}O_5X$ (X-variable)(s)	A	0	0	0	No adverse effects.	NC	8	NR	T
cesium metal ---------- solid Cs(s)	C	2	0	2 ~~W~~	May cause irritation of skin, eyes, respiratory and digestive tracts; may cause central nervous system effects, cardiac disturbances; reacts violently with water.	D1, D2, F	8	4.3	WF/I
cesium chloride -- crystals CsCl(s)	A	0	0	0	No adverse effects.	NC	8	NR	T
cetyl alcohol ------- powder (*1-hexadecanol, palmityl alcohol*) $C_{16}H_{34}O$(s) or $CH_3(CH_2)_{14}CH_2OH$(s)	A	1	1	0	May cause mild skin and eye irritation; powder-air mixture flammable.	NC	8	NR	T
chalcopyrite -------- chunks (*cupric ferrous sulfide*) $CuFeS_2$(s)	A	1	0	0	May be irritating to skin, eyes and respiratory tract; prolonged exposure may cause hemolysis of the red blood cells and injury to liver, lungs, kidneys and pancreas.	NC	8	NR	T
charcoal ----------solid (*carbon*) C(s)	A	1	1	0	Dust may cause mechanical skin and eye irritation; may cause irritation of the respiratory and digestive tracts; flammable.	NC	8	4.2	T
chlorine ---------- gas Cl_2(g)	D	4	0	0 OX	Extremely toxic if inhaled; strong oxidizer.	D1, D2	6, 7	5.1	WF/I

Chemical Name(s), State and Formula	Use in School Category	H*	F*	R*	Hazards	WHMIS Class	Storage Class	TDG Hazard Class	Disposal Methods
chloroform ---------- liquid (*trichloromethane*) $CHCl_3(l)$	D	2	0	0	Causes irritation to skin, eyes and respiratory tract; may be fatal if swallowed, inhaled or absorbed through skin; extended exposure may affect the CNS, cardiovascular system, liver and kidneys; possible human carcinogen.	D1, D2	8	6.1	WF/I
2 -chlorophenol ------ liquid (*o-chlorophenol, 2-hydroxychlorobenzene*) $C_6H_5ClO(l)$	C	3	2	0	Corrosive; very destructive of mucous membranes, inhalation may be fatal; harmful if swallowed or absorbed through skin; may cause liver and kidney damage; flammable; possible human carcinogen.	B, D1, D2	5	5	WF/I
chromic acid –----- solution (*chromium(VI) oxide solution*) mixture: H_2O ---------- 90% CrO_3 ---------- 10% $CrO_3(aq)$	C	3	0	1 OX	Corrosive; causes burns to skin, eyes and mucous membranes; highly toxic; powerful oxidizing agent; avoid contact with reducing agents and organic material. A human carcinogen as fume or dust.	C, D1, D2, E	1, 6	8	N/P-D
Chromium (III) acetate ---------- powder (*chromic acetate*) $C_6H_9CrO_6(s)$ or $Cr(CH_3COO)_3(s)$	B	1	1	0	May cause minor irritation of skin, eyes and respiratory tract; prolonged exposure causes cumulative lung damage; combustible if heated or ignited.	NC	8	6.1	WF/I
chromium(III) chloride hexahydrate ------- crystals $CrCl_3 \bullet 6H_2O(s)$	B	2	0	0	May cause skin, eye, respiratory and digestive tract irritation and possible burns; may be harmful if swallowed; may cause liver and kidney damage; may cause fetal effects.	NC	8	NR	WF/I

Chemical Name(s), State and Formula	Use in School Category	H*	F*	R*	Hazards	WHMIS Class	Storage Class	TDG Hazard Class	Disposal Methods
chromium(III) nitrate nonahydrate ---------- solid $Cr(NO_3)_3 \bullet 9H_2O(s)$	B	2	0	1 OX	May cause severe skin, digestive and respiratory tract irritation and possible burns; may cause methemoglobinemia; strong oxidizer, may explode when heated.	C, D2	6	5.1	WF/I
chromium metal ------ solid Cr(s)	A	1	0	0	Associated dust may cause irritation to skin, eyes and respiratory tract. For dust see effects below.	NC	8	NR	R
chromium metal -- powder Cr(s)	B	2	1	1	Dust causes skin, eye and digestive tract irritation; causes severe respiratory tract irritation; may cause lung, liver and kidney damage; oxidizes in air; dust-air mixture explosive.	NC	8	NR	R
chromium(III) chloride hexahydrate ----- powder $CrCl_3 \bullet 6H_2O(s)$	B	2	0	0	Causes skin and eye irritation and possible burns; causes respiratory tract irritation; may cause digestive tract irritation, may cause kidney and liver damage with prolonged exposure.	D1, D2	8	6.1	WF/I
chromium(III) nitrate nonahdrate --------- crystals $Cr\ (NO_3)_3 \bullet 9H_2O(s)$	B	2	0	1 OX	Irritant to skin and eyes with possible burns; harmful if swallowed or inhaled; strong oxidizer; may explode when heated.	D1	6	5.1	WF/I
chromium(VI) salts ---------- powder	D	3	0	1	Corrosive; all carcinogenic with long-term exposure.	D1 D2	6	5.1	WF/I
chromium(VI) oxide ---------- powder $CrO_3(s)$	D	3	0	1 OX	Corrosive; causes severe burns to every area of contact; harmful if swallowed or inhaled, affects the respiratory system, liver, kidneys, eyes, skin and blood; strong oxidizer; carcinogenic.	D1, D2	6	5.1, 8	WF/I

Chemical Name(s), State and Formula	Use in School Category	H*	F*	R*	Hazards	WHMIS Class	Storage Class	TDG Hazard Class	Disposal Methods
chromium potassium sulfate•12 hydrate----------granules $CrK(SO_4)_2•12\ H_2O(s)$	B	2	0	0	Causes skin, eye and respiratory tract irritation; harmful if swallowed or inhaled.	D2	8	NR	WF/I
citric acid ---------- powder $C_6H_8O_7(s)$	B	2	0	0	Causes skin and respiratory tract irritation; causes severe eye irritation; may cause digestive tract irritation; moisture sensitive.	E	3	NR	N/P-D
Clayton yellow ---- powder (*thiazole yellow G*) $C_{28}H_{19}N_5Na_2O_6S_4(s)$	B	0	1	1	No adverse effects; flammable if heated or ignited, air-dust mixture explosive; light sensitive.	NC	8	NR	T
cobalt ----- powder or solid $Co(s)$	B - solid D - powder	2	0	0	Powder may cause irritation to eyes, skin and respiratory tract; harmful if swallowed; powder will oxidize in air; possible human carcinogen.	D2	8	4.1	R or WF/I
cobalt(II) acetate – crystals $Co(C_2H_3O_2)_2•4H_2O(s)$	A	1	0	0	Causes irritation to skin, eyes and respiratory tract; harmful if swallowed or inhaled; chronic exposure may effect the thyroid, lungs, heart and kidneys.	NC	8	NR	WF/I or N/P-T
cobalt(II) carbonate–----------powder $CoCO_3(s)$	B	2	0	0	Causes irritation to eyes, skin and respiratory tract; harmful if swallowed or inhaled; chronic exposure may effect the thyroid, lungs, heart and kidneys.	D1, D2	8	6.1	WF/I or N/P-T
cobalt(II) chloride, anhydrous & hexahydrate ------- powder $CoCl_2$ & $CoCl_2•6H_2O(s)$	B	2	0	0	May cause irritation of skin, eyes and mucous membranes; may be harmful if inhaled or absorbed through skin; toxic by ingestion; possible carcinogen.	D1, D2	8	6.1	WF/I or N/P-T

Chemical Name(s), State and Formula	Use in School Category	H*	F*	R*	Hazards	WHMIS Class	Storage Class	TDG Hazard Class	Disposal Methods
cobalt(II) nitrate hexahydrate ------- crystals $Co(NO_3)_2 \bullet 6H_2O(s)$	B	2	0	0	Causes irritation of skin, eyes and mucous membranes; harmful if inhaled or absorbed through skin.	C, D2	8	6.1	WF/I
cobalt(II) sulfate heptahydrate ------ crystals $CoSO_4 \bullet 7H_2O(s)$	B	2	0	0	Causes irritation of skin, eyes and mucous membranes; may be harmful if inhaled or absorbed through skin.	D1, D2	8	6.1	WF/I or N/P-T
colchicine ---------- powder $C_{22}H_{25}NO_6(s)$	D	4	1	0	Corrosive and highly toxic if swallowed; causes severe irritation of eyes; causes irritation of skin and respiratory tract; may be fatal if inhaled, or absorbed through skin; may cause birth defects; affects the reproductive system; combustible if heated or ignited.	D1, D2	8	6.1	WF/I
collodion solution --- liquid (*pyroxylin solution*) mixture: ethyl ether --------- 60-70% ethyl alcohol ------- 22-26% nitrocellulose ----- ~5.2 %	C	2	4	0	Causes skin irritation and possible burns, moderate eye irritation; harmful if inhaled, swallowed or absorbed through skin; extended exposure to vapour can cause lung damage; may cause central nervous system depression or reproductive and fetal effects; may cause liver and kidney damage; prolonged exposure to air may form unstable explosive peroxides; extremely flammable; possible human carcinogen.	B, D2	5	3	WF/I
congo red ---------- solution mixture: water ---------- 99.0% congo red ---------- 0.1% $C_{32}H_{22}N_6Na_2O_6S_2(aq)$	B	1	0	0	May cause irritation to skin and eyes; excessive absorption through skin or by ingestion may be harmful.	D1, D2	8	9	WF/I

Chemical Name(s), State and Formula	Use in School Category	H*	F*	R*	Hazards	WHMIS Class	Storage Class	TDG Hazard Class	Disposal Methods
congo red ---------- powder $C_{32}H_{22}N_6Na_2O_6S_2$(s)	C	3	1	0	Toxic; may be fatal by ingestion, inhalation or by skin absorption; causes irritation of eyes and possibly skin; possible human carcinogen; combustible if heated or ignited; dust-air mixture explosive.	D1, D2	8	6.1	WF/I
copper metal ------ powder Cu(s)	D	2	0	0	Causes irritation to skin, eyes and mucous membranes; harmful if swallowed or inhaled; affects the liver and kidneys; chronic exposure may cause tissue damage.	NC	8	NR	R
copper metal - strip or wire Cu(s)	A	0	0	0	No adverse effects.	NC	8	NR	R
copper(II) acetate monohydrate ------- powder $Cu(CH_3COO)_2 \bullet H_2O$(s)	B	2	0	0	Causes irritation to skin and respiratory tract, causes eye burns; harmful if swallowed.	NC	8	9	WF/I or N/P-T
copper(II) bromide –----------crystals $CuBr_2$(s)	B	2	0	0	Causes irritation to skin, eyes and respiratory tract; harmful if swallowed; affects central nervous system, liver and kidneys.	NC	8	NR	WF/I or N/P-T
copper(II) carbonate basic---------- powder $(CuCO_3 \bullet CU(OH)_2$(s)	B	2	0	0	Causes irritation to skin, eyes and respiratory tract; harmful if swallowed; affects the liver and kidneys.	D1, D2	8	NR	WF/I or N/P-T
copper(I) & (II) chloride (anhydrous) -------- crystals CuCl & $CuCl_2$(s)	B	2	0	0	Causes irritation to skin, eyes, respiratory and digestive tract; harmful if inhaled or swallowed; may cause lung, liver and kidney damage.	D1, D2, E	8	8	WF/I or N/P-T

Chemical Name(s), State and Formula	Use in School Category	H*	F*	R*	Hazards	WHMIS Class	Storage Class	TDG Hazard Class	Disposal Methods
copper(II) nitrate· hemihydrate ------- crystals $Cu(NO_3)_2 \bullet 2.5H_2O(s)$	B	2	0	0 OX	Causes irritation to skin, eyes and respiratory tract; harmful if swallowed; affects the liver and kidneys; strong oxidizer; contact with other material may cause fire.	C, D2, E	6	5.1	WF/I
copper(II) oxide -- powder $CuO(s)$	B	2	0	0	Causes irritation to skin, eyes and respiratory tract; harmful if swallowed; affects the liver and kidneys.	D2	8	NR	T
copper(II) sulfate anhydrous & pentahydrate-------- powder $CuSO_4$ & $CuSO_4 \bullet 5H_2O(s)$	B	2	0	0	May cause irritation to skin, eyes and respiratory tract; harmful if swallowed; affects the liver and kidneys.	D1, D2	8	9	WF/I or N/P-T
copper(II) sulfide - powder $CuS(s)$	B	2	0	0	Causes irritation to skin, eyes and respiratory tract; harmful if swallowed; affects the liver and kidneys.	NC	8	NR	WF/I or N/P-T
cream of tartar ---- powder (*potassium hydrogen tartrate*) $KHC_4H_4O_6(s)$	A	0	0	0	No adverse effects.	NC	8	NR	T
cresol ---------- liquid (*cresylic acid*) $C_7H_8O(l)$	B	2	2	1	May cause severe skin and eye irritation; harmful by inhalation, ingestion, or absorption through skin; chronic exposure may cause damage to kidneys, liver, lungs, blood or central nervous system; flammable.	B, D1	5	6.1	WF/I
cryolite ---------- chunk (*sodium aluminum fluoride*) $Na_3AlF_6(s)$	C	3	0	0	Toxic; extremely destructive of mucous membranes and upper respiratory tract; harmful by inhalation; ingestion or through skin absorption; prolonged exposure through inhalation or ingestion can cause serious damage to health.	D1, D2	8	8	WF/I

Chemical Name(s), State and Formula	Use in School Category	H*	F*	R*	Hazards	WHMIS Class	Storage Class	TDG Hazard Class	Disposal Methods
crystal violet ------- powder (*gentian violet*) $C_{25}H_{30}N_3Cl(s)$	B	2	1	0	Causes irritation to skin, eyes and mucous membranes; may cause eye injury; harmful if swallowed; possible human carcinogen; dust-air mixture explosive.	D1, D2	8	6.1	T
crystal violet stain ---------- solution mixture: ethanol ---------- <12.0% methyl alcohol ------ <1.0% phenol ---------- <1.0% crystal violet ------- < 0.4% water ---------- balance	B	2	1	0	May cause irritation of skin, eyes, respiratory and digestive tract; inhalation of high concentrations causes central nervous effects; may cause liver and kidney damage and reproductive and fetal effects; possible human carcinogen.	D2	8	3 (6.1)	WF/I
cyclohexane ---------- liquid (*hexamethylene*) $C_6H_{12}(l)$	B	2	3	0	Respiratory, eye, and skin irritant; harmful by inhalation, ingestion or skin absorption; highly flammable.	B	5	3	WF/I
cyclohexanol --------- liquid (hexalin,*cyclohexyl alcohol*) $C_6H_{12}O(l)$	B	2	2	0	Severe skin and eye irritant; harmful by inhalation, ingestion or skin absorption; flammable; reacts violently with oxidizing agents.	B, D1	5	3	WF/I
cyclohexene ---------- liquid (*tetrahydrobenzene)* $C_6H_{10}(l)$	B	1	3	0	Skin, respiratory tract and eye irritant; highly flammable; strong offensive odour.	B, D2	5	3	WF/I
cysteine ---------- crystals $C_3H_7NO_2S(s)$ or $HSCH_2CH(NH_2)COOH(s)$	A	1	0	0	May be harmful if swallowed.	NC	8	NR	T
cystine ---------- crystals (*L-cystine*) $C_6H_{12}N_2O_4S_2(s)$	A	0	0	0	No adverse effects.	NC	8	NR	T

Chemical Name(s), State and Formula	Use in School Category	H*	F*	R*	Hazards	WHMIS Class	Storage Class	TDG Hazard Class	Disposal Methods
dextrose ---------- crystals (*glucose*) $C_6H_{12}O_6$(s)	A	0	0	0	No adverse effects.	NC	8	NR	T
diastase ---------- powder (*amylolytic enzymes*) formula not applicable	A	0	1	0	Mechanical irritant, no adverse health effects; combustible if heated or ignited; dust-air mixture explosive.	NC	8	NR	T
1,4 – dibromo-benzene ---------- crystals (*p - dibromobenzene*) $C_6H_4Br_2$(s)	B	1	0	0	Causes irritation to skin, eyes and respiratory tract.	NC	8	NR	WF/I
dibutyl phthalate ---- liquid (*n-butyl phthalate*) $C_6H_4 (CO_2C_4H_9)_2$(l)	B	2	1	0	Causes skin and respiratory tract irritation and severe eye irritation; harmful if swallowed or inhaled; combustible if heated or ignited.	D2	8	9	WF/I
p-dichloro-benzene ---------- crystals (*I,4-dichlorobenzene*) $C_6H_4Cl_2$(s)	B	2	2	0	Causes irritation to skin, eyes and respiratory tract; harmful if inhaled, swallowed or absorbed through the skin; affects the respiratory system, liver, kidneys and blood; flammable, forms explosive vapour-air mixture; possible human carcinogen.	D1, D2	4	9	WF/I
1,2-dichloroethane - liquid $ClCH_2CH_2Cl$(l)	C	2	3	0	Harmful if swallowed, inhaled or absorbed through skin; affects the central nervous system, liver, kidneys and cardiovascular system; flammable liquid and vapour; possible human carcinogen.	B, D1, D2	5	3 (6.1)	WF/I

Chemical Name(s), State and Formula	Use in School Category	H*	F*	R*	Hazards	WHMIS Class	Storage Class	TDG Hazard Class	Disposal Methods
dichloromethane ---- liquid (*methylene chloride*) $CH_2Cl_2(l)$	C	2	1	0	Causes irritation and possible burns to skin, eyes and respiratory tract; may be absorbed through skin; may depress central nervous system function; combustible if heated or ignited; vapours may form explosive mixture with air; mutagen and possible human carcinogen.	D1, D2	8	6.1	WF/I
2,4-dichlorophenoxy-acetic acid --------- powder (*2,4 D*) $C_8H_6Cl_2O_3(s)$	C	3	0	1	Toxic if swallowed or inhaled; eye, skin and respiratory irritant; may be harmful by skin contact; may cause central nervous system damage; possible human carcinogen; decomposes in water.	D1, D2	8	6.1	WF/I
1,2-dichlorotetrafluoro-ethane ---------- gas (*freon 114*) $CClF_2CClF_2(g)$ or $C_2Cl_2F_4(g)$	B	1	0	0	May irritate skin, eyes and respiratory tract; contributes to ozone depletion in the atmosphere.	NC	8	NR	WF/I
diethyl ether ---------- liquid (*ethyl ether*) $C_4H_{10}O(l)$ or $C_2H_5OC_2H_5(l)$	D	2	4	1	Causes skin, eye and respiratory irritation; harmful by ingestion, inhalation or skin absorption; may cause inebriation or coma; extremely flammable; unstable, reacts with air to form explosive peroxides while in storage.	B, D1	5	3	WF/I
dimethylglyoxime-- powder *(diacetyldioxime)* $C_4H_8N_2O_2(s)$	B	1	1	0	May irritate skin, eyes and respiratory tract; harmful if swallowed; flammable if heated.	NC	8	NR	WF/I

Chemical Name(s), State and Formula	Use in School Category	H*	F*	R*	Hazards	WHMIS Class	Storage Class	TDG Hazard Class	Disposal Methods
dimethyl sulfate ------ liquid $(CH_3)_2SO_4(l)$	D	4	2	0	Toxic and corrosive; causes severe burns to any area of contact; vapours extremely toxic, a few whiffs can be fatal; vapours have no odour or immediate irritation to warn of inhalation exposure; may also be fatal if swallowed or absorbed through skin; delayed effects are severe inflammation, chest tightness, trouble breathing and severe pulmonary damage; flammable liquid and vapours; possible human carcinogen.	B, D1, D2	5	6.1 (8)	WF/I
2, 4–dinitrophenol- powder (*aldefin*) $C_6H_4N_2O_5(s)$	D	3	2	0	Toxic by inhalation and ingestion, danger of cumulative effects; flammable, may explode when heated.	B, D1, D2	4	4.1	WF/I
1,4-dioxane ---------- liquid (*1,4-diethylene dioxide*) $C_4H_8O_2(l)$	D	3	3	1	Most toxic by inhalation, easily absorbed through lungs; poisoning has poor warning properties; anhydrous form oxidizes slowly forming explosive peroxides in storage; highly flammable; a possible human carcinogen.	B, D1, D2	5	3	WF/I
diphenylamine ---- crystals (*n-phenylbenzeneamine*) $C_{12}H_{10}NH(s)$	C	3	1	0	Toxic, inhalation causes systemic poisoning; causes irritation to skin, eyes and respiratory tract; harmful if swallowed, inhaled or absorbed through skin; affects the blood; prolonged exposure damages the nervous system, liver, kidneys and bone marrow; flammable if heated; possible mutagen.	NC	8	6.1	WF/I

Chemical Name(s), State and Formula	Use in School Category	H*	F*	R*	Hazards	WHMIS Class	Storage Class	TDG Hazard Class	Disposal Methods
dry ice ---------- solid/gas (*carbon dioxide*) $CO_2(s)$ & $CO_2(g)$	C	2	0	0	Cryogenic solid; causes frostbite or extensive freezing of flesh on contact; gas will elevate rate of breathing and heart rate; gas nontoxic but displaces oxygenated air and can cause rapid suffocation with high concentrations.	NC	8	9	A
EDTA ---------- powder (*ethylenedinitrilotetraacetic acid*, *edetic acid*) $C_{10}H_{16}N_2O_8(s)$ or the dihydrate $C_{10}H_{12}N_2Na_4O_8 \bullet 2H_2O(s)$	A	2	0	0	Causes eye irritation, may cause irritation to skin and respiratory tract; may be harmful if swallowed or inhaled.	NC	8	NR	WF/I
eosin B ---------- powder $C_{20}H_6Br_2N_2Na_2O_9(s)$	A	2	1	0	May cause irritation to skin, eyes or respiratory tract; may be harmful if swallowed, inhaled or absorbed through skin; combustible if heated or ignited.	NC	8	NR	WF/I
eosin Y ---------- solution mixture: water ---------- 99.8% eosin Y ---------- 0.2% $C_{20}H_6Br_4Na_2O_5(aq)$	A	1	0	0	May cause irritation of the eyes and skin; excessive absorption through skin or by ingestion may be harmful.	NC	8	NR	D
eosin Y ---------- powder $C_{20}H_6Br_4Na_2O_5(s)$	A	2	0	0	May cause irritation of the eyes, skin, respiratory and digestive tracts; harmful if inhaled or absorbed through skin; may be harmful if ingested.	NC	8	NR	WF/I
epinephrine 99% - powder (*adrenalin*) $C_9H_{13}NO_3(s)$	B - soln. C - powder	2	1	0	Causes skin and eye irritation; harmful if swallowed, inhaled or absorbed through skin; increases heart rate, blood pressure; may cause central nervous system depression; excess absorption can be fatal; powder-air mixture explosive.	D2	8	6.1	WF/I

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epsom salts ------ powder (*magnesium sulfate heptahydrate*) $MgSO_4 \bullet 7H_2O(s)$	A	1	0	0	Dust may be slightly irritating to respiratory system; may be harmful if swallowed.	NC	8	NR	T
eriochrome black T-- liquid mixture: water ---------- 0.8% methyl alcohol ------ 98.4% ammonium hydroxide ---------- 0.3% eriochrome black T - 0.4%	B	2	3	0	Causes irritation of skin, eyes and respiratory tracts; harmful if inhaled, swallowed or absorbed through skin; highly flammable liquid and vapour.	B, D1, D2	5	3 (6.1)	D
eriochrome black T-powder $C_{20}H_{12}N_3NaO_7S(s)$	A	1	0	0	Causes eye irritation; may cause irritation of the skin, digestive and respiratory tracts.	NC	8	NR	T
ethanoic acid, glacial ---------- liquid (*glacial acetic acid*) $CH_3COOH(l)$	B	3	2	0	Corrosive; liquid and mist cause severe burns to all body tissue; may be fatal if ingested; harmful if inhaled; flammable liquid and vapour.	B, E	5	8 (3)	WF/I or N/P-D
ethanoic acid--------solution (*acetic acid*, *vinegar*) mixture: CH_3COOH --------- 7% H_2O ---------- 93% $CH_3COOH(aq)$	A	1	0	0	Causes irritation of the nose, throat and respiratory tract, prolonged contact may cause burns and dermatitis.	NC	1	NR	N/P-D
ethyl acetate ---------- liquid $CH_3COOC_2H_5(l)$ or $C_4H_8O_2(l)$	B	2	3	0	Causes irritation to skin, eyes and respiratory tract; harmful if swallowed or inhaled; affects the central nervous system; highly flammable liquid.	B, D2	5	3	WF/I
ethyl alcohol ---------- liquid (*ethanol*) $C_2H_5OH(l)$	B	0	3	0	Causes moderate skin and severe eye irritation; inhalation or ingestion of high concentrations may depress the central nervous system; highly flammable.	B, D1, D2	5	3	D

Chemical Name(s), State and Formula	Use in School Category	H*	F*	R*	Hazards	WHMIS Class	Storage Class	TDG Hazard Class	Disposal Methods
ethylamine ---- liquid & gas (*monoethyamine*) $C_2H_7N(l)$ & $C_2H_7N(g)$	D	3	4	0	Corrosive; higher concentrations destructive to skin, airway and eyes; inhalation may be fatal; vapours extremely flammable.	B, D1	5	3	WF/I or RS (gas in cylinder)
ethyl bromide --------- liquid (b*romoethane*) $C_2H_5Br(l)$ or $CH_3CH_2Br(l)$	D	2	3	0	Irritating to skin and eyes; very irritating upon inhalation; narcotic, may cause liver and kidney damage; harmful if swallowed; highly flammable, forms explosive mixture with air; possible carcinogen, mutagen.	B, D1, D2	5	6.1	WF/I
ethyl butyrate --------- liquid $C_6H_{12}O_2(l)$	B	1	3	0	Vapours may cause skin, eye, mucous membrane and upper respiratory tract irritation; may be absorbed through skin; highly flammable liquid.	B	5	3	WF/I
ethylene dichloride -- liquid (*1,2 - dicholoroethane)* $ClCH_2CH_2Cl(l)$	D	2	3	0	Harmful if swallowed, inhaled or absorbed through skin; causes irritation to skin, eyes and respiratory tract; inhalation of concentrated amounts affects the central nervous system, liver, kidneys and cardiovascular system; highly flammable liquid and vapour; possible human carcinogen.	B, D1, D2	5	3 (6.1)	WF/I
ethylenediamine ----- liquid (*1,2-ethanediamine)* $C_2H_8N_2(l)$	D	3	2	0	Corrosive; causes burns to any area of contact; very destructive of mucous membranes; harmful if inhaled, swallowed or absorbed through skin; flammable liquid and vapours; mutagen, negative reproductive effects.	D2	5	8 (3)	WF/I
ethylenedinitrilotetraacetic acid (EDTA) -------- powder (*edetic acid*) $C_{10}H_{16}N_2O_8(s)$ or $C_{10}H_{12}N_2Na_4O_8 \bullet 2H_2O(s)$	A	2	0	0	Causes eye irritation; may cause irritation to skin and respiratory tract; may be harmful if swallowed or inhaled.	NC	8	NR	WF/I

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ethylene glycol ------- liquid (*1,2-ethanediol*) $C_2H_6O_2(l)$	B	2	1	0	Irritating to skin, eyes and respiratory system; harmful if swallowed, can be lethal to some people; possible risk to fertility and fetal development; combustible at higher temperatures.	D2	8	3	WF/I
ethyl ether ---------- liquid (*diethyl ether*) $C_4H_{10}O(l)$	D	2	4	1	Causes skin, eye and respiratory irritation; harmful by ingestion, inhalation or skin absorption; may cause inebriation or coma; extremely flammable; unstable, reacts with air to form explosive peroxides while in storage.	B, D2	5	3	WF/I
ethyl iodide ---------- liquid (*iodoethane*) $C_2H_5I(l)$	C	2	1	1	Causes irritation to skin, eyes and respiratory tract; harmful if swallowed or inhaled; can affect the nervous system and motor control with repeated exposure; reacts with water forming toxic fumes; decomposes in light and air releasing free iodine; combustible if heated.	D2	8	6.1	WF/I
Fehling's reagent A ---------- solution mixture: copper(II) sulfate -- 4.43% water ---------- 95.57% $CuSO_4(aq)$	B	2	0	0	Splashes may cause irritation to skin or eyes, misting or vapours from heating may cause irritation of the respiratory tract; may be harmful if swallowed.	D1, D2, E	8	9	WF/I or N/P-D
Fehling's reagent B ---------- solution mixture: sodium potassium tartrate ---------- 24% potassium hydroxide - 7% water ---------- 69%	B	2	0	0	Splashes cause eye and skin burns; may cause severe respiratory or digestive tract irritation and burns if inhaled or ingested.	D2, E	8	8	D

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feldspar ---------- chunks (*kaolinite*) $H_4Al_2Si_2O_9 \bullet SiO_2(s)$	A	1	0	0	Dust may irritate skin, eyes, respiratory and digestive tracts; repeated prolonged inhalation can lead to silicosis.	NC	8	NR	T
florisil ---------- solid (*magnesia-silica gel*) MgO3.75 $SIO_2 \bullet XH_2O(s)$	A	1	0	0	May cause irritation of the skin, eyes and respiratory tract.	NC	8	NR	T
fluorine ---------- gas $F_2(g)$	D	4	0	4 OX ~~W~~	Extremely corrosive and toxic gas; direct exposure of skin and eyes produces burns in seconds; severely irritates nose and throat; most powerful oxidizing agent, reacts explosively with a wide range of organic and inorganic substances; water reactive.	D1, C, F	6, 7	2.3	RS
fluorite ---------- solid (*calcium fluoride, fluorspar*) $CaF_2(s)$	A	2	0	0	Dust may cause irritation to skin, eyes and respiratory tract; may be harmful if swallowed or inhaled.	NC	8	NR	T
formaldehyde ----- solution (*formalin, methanal*) mixture: HCHO ---------- 37% CH_3OH ----------12 - 15% H_2O ---------- 48 - 53%	D	3	2	0	Toxic by inhalation, ingestion and through skin absorption; extremely destructive to tissues of the mucous membranes and upper respiratory tract; ingestion may be fatal or cause blindness; flammable liquid and vapour; mutagen; probable human carcinogen.	B, D1, D2	5	3 (8)	WF/I
formalin ---------- solution mixture: HCHO ---------- 3 - 4% CH_3OH ---------- 1 - 1.5% H_2O ---------- 94 - 96%	C	2	2	0	Harmful by inhalation and through skin absorption; causes irritation to skin, eyes and respiratory tract; ingestion may be fatal or cause blindness; mutagen; probable human carcinogen; flammable vapour.	B, D1, D2	5	9	WF/I

Chemical Name(s), State and Formula	Use in School Category	H*	F*	R*	Hazards	WHMIS Class	Storage Class	TDG Hazard Class	Disposal Methods
formic acid -------- solution (*methanoic acid*) mixture: formic acid -------- 85 - 98% water ---------- 02 - 15% HCOOH(aq)	B	3	2	0	Corrosive; causes severe burns to skin, eyes, mucous membranes and respiratory tract; may be fatal by ingestion, inhalation or skin absorption; flammable liquid; decomposes to produce carbon monoxide during prolonged storage thus potential explosive hazard.	B, E	1, 5	8	WF/I or N/P-D
d-fructose --------- powder $C_6H_{12}O_6$(s)	A	1	1	0	Powder may cause mild irritation of the eyes and respiratory tract; flammable if heated.	NC	8	NR	T
fuchsin (acid) –-----powder (*acid violet 19*) $C_{20}H_{17}N_3Na_2O_9S_3$(s)	B	2	1	0	May cause irritation of skin, eyes and respiratory tract; may be harmful if swallowed, inhaled or absorbed through skin; combustible if heated.	D2	3	NR	T
fumaric acid ------- powder (*2-butenedioic acid*) $C_4H_4O_4$(s)	B	2	1	0	May cause skin, respiratory and digestive tract irritation; causes eye irritation; may cause kidney damage, flammable if heated.	D2	3	NR	WF/I or N/P-D
galactose ---------- powder $C_6H_{12}O_6$(s)	A	0	1	0	No adverse affects; combustible if heated or ignited, dust-air mixture explosive.	NC	8	NR	T
galena ---------- solid (*lead(II) sulphide*) PbS(s)	A	2	0	0	Dust may irritate the skin and eyes; harmful if swallowed or inhaled.	D1	8	6.1	T
gallium --- solid or powder Ga(s)	A	2	0	0	Causes skin, eye and respiratory tract irritation; may cause gastro-intestinal tract irritation with nausea, vomiting and diarrhea; may cause bone marrow abnormalities with damage to blood forming tissues.	D2	8	8	T

Chemical Name(s), State and Formula	Use in School Category	H*	F*	R*	Hazards	WHMIS Class	Storage Class	TDG Hazard Class	Disposal Methods
gentian violet ----- solution mixture: methyl alcohol ------ 20.0% water ---------- 78.5% ammonium oxalate- 1.0% gentian violet ------ 0.5%	B	2	1	0	May cause irritation to skin, eyes, respiratory and digestive tracts; harmful and possibly fatal if swallowed or inhaled in excess; flammable vapours.	D1, D2	8	NR	D
gentian violet ------ powder (*crystal violet*) $C_{25}H_{30}N_3Cl(s)$	B	2	1	0	May cause skin and respiratory irritation; causes severe eye irritation; harmful if swallowed; may be harmful if inhaled; combustible if heated or ignited, air-powder mixture explosive; may be a human carcinogen.	D1, D2	8	6.1	T
germanium–powder/solid Ge(s)	B - solid C - powder	2	2	0	Causes skin, eye, mucous membrane and respiratory tract irritation; may be harmful if absorbed through skin, inhaled or ingested; may cause damage to liver and kidneys; flammable solid, dust-air mixture explosive.	B, D2	8	6.1	T- solid WF/I- powder
gibberellic acid --- powder $C_{19}H_{22}O_6(s)$	A	1	1	0	May cause skin, eye, respiratory and digestive tract irritation; flammable if heated.	NC	3	NR	D
glucose ---------- powder (*dextrose*) $C_6H_{12}O_6(s)$	A	0	1	0	No adverse affects. Flammable if heated.	NC	8	NR	T
glutamic acid ----- crystals $C_5H_9NO_4(s)$	A	1	1	0	May cause skin, eye, respiratory and digestive tract irritation; combustible if heated or ignited, dust-air mixture explosive.	NC	3	NR	WF/I or N/P-T

Chemical Name(s), State and Formula	Use in School Category	H*	F*	R*	Hazards	WHMIS Class	Storage Class	TDG Hazard Class	Disposal Methods
glycerin ----- viscous liquid (*glycerol, 1,2,3-propanetriol*) $C_3H_8O_3(l)$	A	1	1	0	May cause skin and eye irritation; ingestion of large amounts may cause irritation of the intestinal tract; inhalation of mist may irritate the respiratory tract; contact with strong oxidants (chromium trioxide, potassium chlorate, potassium permanganate) may be explosive; flammable if heated.	NC	8	NR	D
glycine –---------- crystals $C_2H_5NO_2(s)$	A	1	0	0	May cause skin, eye, respiratory and digestive tract irritation, the latter with ingestion of large amounts.	NC	8	NR	T
D-glycogen --------- powder (*animal starch*) $(C_6H_{10}O_5)_n(s)$	A	0	1	0	No adverse health effects; flammable if heated or ignited, air-dust mixture explosive.	NC	8	NR	T
gold ---- powder or pieces Au(s)	A	1	0	0	Powder may cause, eye, respiratory and digestive tract irritation.	NC	8	NR	R
graphite ---------- solid (*carbon*) C(s)	A - solid B - powder	1	1	0	Dust may cause skin, eye and respiratory tract irritation; may be harmful if inhaled; cancer hazard with long-term exposure if quartz present; flammable solid.	NC	8	4.2	T
halite ---------- crystalline (*sodium chloride*) NaCl(s)	A	1	0	0	Dust may cause irritation to eyes, skin and respiratory tract.	NC	8	NR	T
hematite ---------- chunks (*iron(III) oxide*) $Fe_2O_3(s)$	A	0	0	0	No adverse effects.	NC	8	NR	T
n-heptane ---------- liquid $C_7H_{16}(l)$	B	1	3	0	Causes skin and eye irritation; ingestion causes irritation with nausea, vomiting and diarrhea; inhalation causes respiratory tract irritation with dizziness headache and unconsciousness; flammable liquid.	B	5	3	WF/I

Chemical Name(s), State and Formula	Use in School Category	H*	F*	R*	Hazards	WHMIS Class	Storage Class	TDG Hazard Class	Disposal Methods
n-hexane ---------- liquid $C_6H_{14}(l)$	B	2	3	0	Harmful by skin absorption, inhalation or ingestion; vapours irritating to mucous membranes and respiratory tract; may cause liver and kidney damage; flammable.	B, D2	5	3	WF/I
1,6-hexanediamine -- solid (*hexamethylenediamine*) $C_6H_{16}N_2(s)$	C	3	2	0	Corrosive; may cause severe irritation and possible burns to skin, eyes, respiratory and digestive tracts; may be harmful if swallowed, inhaled or absorbed through skin; may cause liver damage; may cause fetal effects; flammable solid.	E	4	8	WF/I
l-(+) histidine ----- crystals $C_6H_9N_3O_2(s)$	A	1	0	0	May cause irritation to skin, eyes, digestive and respiratory tracts.	NC	8	NR	T
hydrochloric acid– solution (*muriatic acid*) mixture: HCl ---------- 36.5% H_2O ---------- 63.5% HCl(aq)	A - 5% or less B - more than 5%	3	0	0	Corrosive; causes eye and skin burns; harmful if vapours inhaled or liquid swallowed, may cause severe respiratory or digestive tract irritation with possible burns; may cause fetal effects.	[D1, E	1	8	WF/I or N/P-D
hydrofluoric acid-- solution mixture: HF ---------- 48 - 52% H_2O ---------- 48 - 52% HF(aq)	D	4	0	1	Extremely corrosive and toxic; vapour causes severe burns to skin, eyes and respiratory tract; burns to skin may not be immediately painful or visible; may be fatal if swallowed or inhaled; causes bone damage; reaction with metals generates explosive hydrogen gas.	D1, D2, E	1	8 (6.1)	WF/I or N/P-D
hydrogen ---------- gas $H_2(g)$	B	0	4	0	No adverse effects; highly flammable gas.	A, B	8	2.1	A

Chemical Name(s), State and Formula	Use in School Category	H*	F*	R*	Hazards	WHMIS Class	Storage Class	TDG Hazard Class	Disposal Methods
hydrogen cyanide -- liquid or gas (*hydrocyanic* or *prussic acid if aq*) HCN(l) or HCN(g)	D	4	4	2	Very toxic; severe irritation of eyes and respiratory tract; very toxic by inhalation, skin contact or ingestion; potentially fatal if inhaled or swallowed; highly flammable, vapours may cause flash fire; avoid contact or mixing with oxidizers, alkalis, amines, sulfuric acid, acetaldehyde, hydrogen chloride + alcohol.	B, D1, D2, E	5, 1	6.1	WF/I
hydrogen peroxide ---------- solution mixture: hydrogen peroxide -- 30% water ---------- 70% H_2O_2(aq)	B	3	0	1 OX	Corrosive; causes burns to skin, eyes and respiratory tract; harmful if swallowed or inhaled; strong oxidizer, contact with oxidizable material may cause violent combustion; decomposes into water and oxygen; can decompose violently upon heating.	C, E, F	6	5.1 (8)	D
hydrogen peroxide ---------- solution mixture: hydrogen peroxide-2 - 4% water ---------- 96 - 98% H_2O_2(aq)	A	1	0	1 OX	Causes eye irritation, may be harmful if swallowed; oxidizer; decomposes into water and oxygen.	C	6	NR	D
hydrogen sulfide –----- gas H_2S(g)	D	4	0	0	Very corrosive and toxic; low concentrations (50 ppm) cause eye and respiratory membrane irritation; death occurs in 1–4 hours at 300–500 ppm, immediate respiratory arrest in excess of 1000 ppm; toxic by ingestion or inhalation; severe exposures, short of death, may cause long-term symptoms including lung damage, memory loss, paralysis of facial muscles or nerve tissue damage.	A, D1, D2, E	8	2.3 (2.1)	RS

Chemical Name(s), State and Formula	Use in School Category	H*	F*	R*	Hazards	WHMIS Class	Storage Class	TDG Hazard Class	Disposal Methods
hydroquinone ---- crystals (*1,4-benzenediol*) $C_6H_6O_2(s)$	B	2	1	0	Causes irritation to skin, respiratory tract and eyes; repeated exposure to dust may cause eye injury; harmful if inhaled or swallowed; combustible if heated or ignited, powder-air mixture explosive.	D1, D2	8	6.1	WF/I
indigo carmine ----- powder $C_{16}H_8N_2Na_2O_8S_2(s)$	A	2	0	0	May cause skin or eye irritation; may be harmful if swallowed, inhaled or absorbed through skin.	NC	8	NR	T
indium ---------- solid In(s)	A	1	1	0	Solid has low toxicity; high concentrations of dust may irritate eyes, mucous membranes, skin and upper respiratory tract; flammable dust-air mixture.	NC	6	NR	T
3-indoleacetic acid --- solid (*heteroauxin, IAA*) $C_{10}H_9NO_2(s)$	A	0	0	0	No adverse effects to skin, eyes, respiratory or digestive tracts; may cause fetal effects with chronic exposure based on animal studies.	NC	8	NR	WF/I or N/P-D
indophenol sodium salt --------- crystals $C_{12}H_8NaNO(s)$	B	1	1	0	Causes irritation to skin, eyes and respiratory tract; harmful if swallowed, inhaled or absorbed through skin; flammable if heated or ignited.	D1	8	NR	WF/I
inositol ---------- crystals (*hexahydrox-ycyclohexane*) $C_6H_6(OH)_6(s)$	B	1	1	0	May cause skin, eye or respiratory tract irritation; flammable if ignited or heated, dust-air mixture explosive.	NC	8	NR	T
iodine ---------- crystals $I_2(s)$	B	3	0	1 OX	Corrosive; crystals and vapours cause severe irritation or burns to skin, eyes, respiratory tract and any area of contact; may be fatal if swallowed or inhaled; affects cardiovascular and central nervous systems; strong oxidizer, contact with oxidizable material may cause fire.	C, D1, D2, E	6 (7)	6.1 (8)	WF/I or N/P-D

Chemical Name(s), State and Formula	Use in School Category	H*	F*	R*	Hazards	WHMIS Class	Storage Class	TDG Hazard Class	Disposal Methods
iodoethane ---------- liquid (*ethyl iodide*) $C_2H_5I(l)$	B	2	1	1 ~~W~~	Causes irritation to skin, eyes and respiratory tract; harmful if swallowed or inhaled; narcotic, can affect the nervous system and motor control with repeated exposure; reacts with water forming toxic fumes; decomposes in light and air releasing free iodine; combustible if heated.	D2	8	6.1	WF/I
iron ---------- powder Fe(s)	B	1	1	1	A skin, eye and mucous membrane irritant; combustible if powder is exposed to flame.	NC	8	4.1	T
iron ---------- filings Fe(s)	A	0	0	0	No adverse effects.	NC	8	NR	R or T
iron(III) ammonium citrate ---------- powder $xFe•xNH_3•C_6H_8O_7(s)$	A	0	1	0	May cause irritation to skin, eyes and respiratory tract; may be harmful if swallowed; combustible if heated.	NC	8	9.2	WF/I
iron(II) ammonium sulfate hexahydrate ------- crystals (*mohr's salt)* $Fe(NH_4)_2(SO_4)_2•6H_2O(s)$	A	2	0	0	Causes irritation to skin, eyes and respiratory tract; harmful if swallowed or inhaled; may cause liver damage and cardiac disturbances; decomposes if heated.	NC	8	9	WF/I or N/P-D
iron(III) ammonium sulfate ---------- crystals $FeNH_4SO_4(s)$	A	1	0	0	May cause irritation of the skin, eyes, respiratory and digestive tracts; may cause cardiac disturbances, and liver and kidney damage.	NC	5	NR	WF/I or N/P-D
iron(II) chloride hydrate ---------- crystals $FeCl_2•xH_2O(s)$	B	3	0	1	Corrosive; causes severe irritation to skin, eyes, mucous membranes and respiratory tract; harmful by skin absorption, inhalation or ingestion; may cause liver, kidney, pancreas damage and cardiovascular collapse; reacts violently with oxidizing agents; unstable.	E	8	8	WF/I or N/P-D

Chemical Name(s), State and Formula	Use in School Category	H*	F*	R*	Hazards	WHMIS Class	Storage Class	TDG Hazard Class	Disposal Methods
Iron(III) chloride hexahydrate ------- crystals $FeCl_3 \bullet 6H_2O(s)$	B - crystals C - powder anhydrous	3	0	0	Corrosive; extremely destructive to tissues of skin, eyes, mucous membranes and upper respiratory, tract; swallowing can cause severe burns to mouth, throat and stomach; affects the liver.	D1, E, F	8	5.1	WF/I or N/P-D
iron(III) nitrate nonahydrate ------- crystals $Fe(NO_3)_3 \bullet 9H_2O(s)$	A	2	0	0 OX	Causes severe irritation of the skin, eyes and respiratory tract; harmful if inhaled or ingested; affects the liver; strong oxidizer, contact with flammable material may cause fire.	C	6	5.1	WF/I
Iron(III) oxide ------ powder $Fe_2O_3(s)$	A	2	0	0	May cause irritation to skin, eyes and respiratory tract, harmful if inhaled.	NC	8	NR	WF/I or N/P-D
iron(III) sulfate, hydrated ---------- powder $Fe_2(SO_4)_3 \bullet xH_2O(s)$	A	2	0	0	Causes irritation to skin, eyes and respiratory tract; harmful if swallowed or inhaled; affects the liver.	NC	8	NR	T or D
iron(II) sulfate ----- crystals heptahydrate (*ferrous sulfate 7 - hydrate*) $FeSO_4 \bullet 7H_2O(s)$	A	1	0	0	Causes irritation with excessive inhalation or prolonged exposure to skin; exposure to eyes causes irritation that could be damaging; low toxicity, used as a food and feed iron supplement.	D2	8	NR	T
iron(II) sulfate heptahydrate ------- powder $FeSO_4 \bullet 7H_2O(s)$	A	2	0	0	Causes severe irritation to eyes; may cause irritation to skin, mucous membranes and respiratory tract; moderately toxic by ingestion; may affect the liver, kidneys, cardiovascular and central nervous systems.	D2	8	NR	T or D(aq)
iron(II) sulfide ----- powder $FeS(s)$	A	2	1	0	Dust causes irritation of skin, eyes and mucous membranes; prolonged inhalation may lead to pulmonary fibrosis, damage to kidneys and liver; dried form flammable, will spontaneously ignite if exposed to air.	NC	8	4.1	WF/I

Chemical Name(s), State and Formula	Use in School Category	H*	F*	R*	Hazards	WHMIS Class	Storage Class	TDG Hazard Class	Disposal Methods
iso-amyl alcohol ------ liquid (*isopentyl alcohol*) $C_4H_{10}O(l)$ or $(CH_3)_2CHCH_2CH_2OH(l)$	B	2	2	0	Causes irritation to skin, mucous membranes and respiratory tract, severe irritant to eyes; harmful if swallowed, inhaled or ingested; hematotoxic; affects the central nervous system; flammable liquid and vapour, emits toxic fumes when burned.	B, D2	5	3	WF/I
iso-pentyl alcohol -- liquid (*iso-amyl alcohol*) $C_4H_{10}O(l)$ or $(CH_3)_2CHCH_2CH_2OH(l)$	B	2	2	0	Causes irritation to skin, mucous membranes and respiratory tract, severe irritant to eyes; harmful if swallowed, inhaled or ingested; hematotoxic; affects the central nervous system; flammable liquid and vapour, emits toxic fumes when burned.	B, D2	5	3	WF/I
kerosene (kerosine) -liquid mixture: aromatics---------- 15.9% cycloparaffins ------ 52.8% paraffins ---------- 30.8% alkenes ---------- 0.5%	B	0	3	0	May cause irritation of eyes, mucous membranes, skin and lungs with prolonged or repeated exposure; overexposure may affect the central nervous system and cause heartbeat irregularities; flammable mixture.	B, D2	5	3	WF/I
kinetin ---------- solid $C_{10}H_9N_5O(s)$	A	0	0	0	May cause irritation of the skin, eyes, respiratory and digestive tracts.	NC	8	NR	T
Knop's reagent ---- solution mixture: $MgSO_4 \cdot 7H_2O$ ------ 1.0g KH_2PO_4 ---------- 0.2g KNO_3 ---------- 1.0g $Ca(NO_3) \cdot 4H_2O$ ---– 1.0g $FeCl_3$ (1% soln.) -- 1.0 drop H_2O ---------- 1.0 L	A	1	0	0	May cause irritation of the skin, eyes, respiratory and digestive tract.	D2	8	NR	D

Chemical Name(s), State and Formula	Use in School Category	H*	F*	R*	Hazards	WHMIS Class	Storage Class	TDG Hazard Class	Disposal Methods
lactic acid - crystals/liquid (*2-hydroxypropanoic acid*) $C_3H_6O_3(s)$ or $CH_3CHOHCOOH(s)$	B	3	1	0	Corrosive; causes irritation and burns to any area of contact; harmful if swallowed or inhaled; extremely destructive to tissue of the skin, eyes, mucous membranes and respiratory tract; crystals combustible if heated or ignited.	E	3	8	WF/I or N/P-D
lactose –-- crystals/powder $C_{12}H_{22}O_{11}(s)$	A	0	1	0	Dust may cause eye and skin irritation; dust-air mixture explosive, combustible solid if heated.	NC	8	NR	T
lauric acid --------- crystals (*dodecanoic acid*) $C_{12}H_{24}O_2(s)$ or $CH_3(CH_2)_{10}COOH(s)$	B	1	1	0	May cause irritation of the skin, eyes, respiratory and digestive tract; combustible if heated or ignited, fine dust-air mixture explosive.	D2	3	NR	WF/I or N/P-D
lead metal ---------- strips Pb(s)	B - strips D - powder	3	0	0	Toxic, particularly the dust or powder; dust causes irritation to skin, eyes and respiratory tract; may be fatal if swallowed or if dust inhaled; a neurotoxin with prolonged exposure but also affects the kidneys, blood and reproductive system; possible human carcinogen dependent on duration and level of exposure.	D2	8	9	R
lead(II) nitrate ---- powder $Pb(NO_3)_2(s)$	B	2	0	0 OX	May cause skin, eye and respiratory tract irritation; may cause digestive tract irritation with nausea, vomiting and diarrhea; can be fatal if enough dust is inhaled or if ingested; neurotoxin with chronic or prolonged exposure, affects the central nervous system, kidneys, blood and reproductive system; strong oxidizer.	C, D1, D2	6	5.1 (6.1)	WF/I

Chemical Name(s), State and Formula	Use in School Category	H*	F*	R*	Hazards	WHMIS Class	Storage Class	TDG Hazard Class	Disposal Methods
Lead compounds (other than nitrate) ------- powders	C - soln. D - powder	3	0	0	Toxic; cause skin, eye and respiratory tract irritation; may be fatal if swallowed or inhaled; neurotoxin with chronic or prolonged exposure, also affects the kidneys, blood, liver and reproductive system; Pb phosphate and Pb acetate are a cancer hazard in humans.	D1, D2	8	6.1	WF/I
lime water --------- solution mixture: $Ca(OH)_2$ ---------- 0.16% H_2O ---------- 99.84% $Ca(OH)_2(aq)$	A	0	0	0	May cause irritation of the skin, eyes, respiratory and digestive tracts.	NC	8	NR	D
lithium ---------- solid Li(s)	C	3	2	1 ~~W~~	Corrosive; causes eye and skin burns; may cause severe respiratory or digestive tract irritation or burns; may cause kidney damage and central nervous effects; light sensitive; reacts with water; flammable solid.	B, E	4	4.3	WF/I
lithium acetate dihydrate ---------- crystals $LiCH_3COO \bullet 2H_2O(s)$	A	2	0	0	Causes eye irritation; may cause irritation of the skin, respiratory and digestive tracts; harmful if swallowed, inhaled or adsorbed through skin; may cause kidney damage and central nervous effects.	D2	8	NR	T
lithium bromide --- crystals anhydrous LiBr(s)	A	2	0	0	May be harmful if swallowed; causes eye, skin and respiratory tract irritation; chronic or excessive intake may cause kidney, cardiac and central nervous system effects and/or damage.	D2	8	NR	WF/I
lithium carbonate - powder $Li_2CO_3(s)$	A	2	0	0	May cause irritation of the skin, eyes, respiratory and digestive tracts; harmful if swallowed or inhaled, affects the central nervous system, muscles and kidneys.	D2	8	NR	T

Chemical Name(s), State and Formula	Use in School Category	H*	F*	R*	Hazards	WHMIS Class	Storage Class	TDG Hazard Class	Disposal Methods
lithium chloride --- crystals LiCl(s)	A	2	0	0	Causes irritation of the skin, eyes and respiratory tract, skin irritation may be severe; harmful if swallowed or inhaled, affects the central nervous system, muscles and kidneys.	D2	8	NR	T
lithium fluoride ---- crystals LiF(s)	B	2	0	0	May cause severe eye and skin irritation and possible burns; causes respiratory or digestive tract irritation; may cause kidney damage, central nervous effects, cardiac disturbances and skeletal abnormalities.	D2	8	6.1	WF/I
lithium hydroxide monohydrate ------ crystals $LiOH \bullet H_2O(s)$	B	3	0	0	Corrosive; causes burns to any area of contact; may be fatal if swallowed or inhaled.	D1, E	2	8	WF/I or N/P-D
lithium iodide ----- crystals LiI(s)	B	2	0	0	May be harmful if swallowed; causes eye, skin and respiratory tract irritation; chronic or excessive intake may cause kidney, cardiac and central nervous system effects and/or damage.	D2	8	6.1	WF/I
lithium nitrate ---- granular $LiNO_3(s)$	B - soln. C - granule	2	0	3 OX	Causes irritation to skin, eyes and respiratory tract; harmful if swallowed or inhaled, affects the central nervous system, respiratory system, muscles and kidneys; strong oxidizer, contact with combustible material may cause fire; dangerous explosive risk when shocked or heated.	C, D1, D2	6	5.1	WF/I
lithium sulfate ----- crystals $Li_2SO_4 \bullet H_2O(s)$	B	2	0	0	May cause irritation to skin, eyes and respiratory tract; harmful if inhaled or swallowed; affects muscles, lungs, central nervous system and kidneys.	NC	8	NR	T or D(aq)

Chemical Name(s), State and Formula	Use in School Category	H*	F*	R*	Hazards	WHMIS Class	Storage Class	TDG Hazard Class	Disposal Methods
litmus blue -------- powder (*lichenblue*) formula (variable)	A	2	0	0	Causes irritation to skin, eyes and intestinal tract; may be harmful if swallowed, inhaled or adsorbed through skin.	NC	8	NR	T
Lugol's iodine stain ---------- solution (*bouchardat's reagent*) mixture: I_2 ---------- 5% KI ---------- 10% CH_3COOH ----- 10% H_2O ---------- 75%	B	2	0	1	Causes irritation to skin, eyes and respiratory tract; may burn skin on contact; harmful if swallowed or inhaled; chronic low-level ingestion may cause mental depression, nervousness, insomnia and sexual impotence.	D2	7	8 (9e)	WF/I
lycopodium ------- powder (*club moss spores*, *vegetable sulfur)* formula not applicable	B	1	2	0	Causes eye and gastro-intestinal tract irritation; may cause irritation of the skin and respiratory tract; possible allergen; flammable powder, easily ignited by open flame, can produce an explosive flash.	D2	8	4.1	WF/I
magnesium --------- powder Mg(s)	C	0	1	1 ~~W~~	May cause skin, eye and respiratory tract irritation; flammable solid, burning releases UV light and heat; may react with water to form explosive hydrogen gas.	B, D2	8	4.1	WF/I
magnesium ---------- strips Mg(s)	A	0	1	1	Flammable solid if heated, releases UV light and heat upon burning.	B, D2	8	4.1	R
magnesium acetate---------- powder $Mg(CH_3COO)_2 \bullet 4H_2O(s)$	A	1	0	0	May cause irritation to eyes and respiratory tract.	NC	8	NR	T or D(aq)
magnesium bromide ---------- granular $MgBr_2(s)$	A	2	0	0	Causes irritation to skin, eyes, respiratory and digestive tracts; may be harmful if swallowed, inhaled or absorbed through skin.	D2	8	NR	T

Chemical Name(s), State and Formula	Use in School Category	H*	F*	R*	Hazards	WHMIS Class	Storage Class	TDG Hazard Class	Disposal Methods
magnesium carbonate ---------- powder $MgCO_3(s)$	A	1	0	0	May cause irritation to skin, eyes and respiratory and digestive tracts.	NC	8	NR	T
magnesium chloride hexahydrate –------- crystals $MgCl_2 \bullet 6H_2O(s)$	A	2	0	0	May be harmful by ingestion, inhalation or skin absorption.	NC	8	NR	T
magnesium hydroxide ---------- powder $Mg(OH)_2(s)$	A	1	0	0	May cause irritation to skin, eyes, digestive and respiratory tracts.	D2	2?	NR	WF/I or N/P-D
magnesium nitrate hexahydrate –------- crystals $Mg(NO_3)_2 \bullet 6H_2O(s)$	A	2	0	0 OX	Causes irritation to skin, eyes and respiratory tract; may be harmful if swallowed or inhaled; strong oxidizer, contact with combustible material may cause fire.	C, D2	6	5.1	WF/I
magnesium oxide - powder $MgO(s)$	A	1	0	0	May cause irritation to skin, eyes and respiratory tract.	NC	8	NR	T
magnesium(IV) oxide ---------- powder (*magnesium peroxide*) $MgO_2(s)$	B	2	0	0 OX	May cause irritation to skin, eyes, mucous membranes and upper respiratory tract; may be harmful if swallowed, inhaled or absorbed through skin; oxidizer, contact with combustible material may cause fire.	C	6	5	T
magnesium sulfate heptahydrate ------- powder (*epsom salts)* $MgSO_4 \bullet 7H_2O(s)$	A	1	0	0	Dust may be slightly irritating to respiratory system, may be harmful if swallowed.	NC	8	NR	T
magnetite ---------- chunks (*iron oxide*) $Fe_3O_4(s)$	A	1	0	0	May cause irritation to skin, eyes and respiratory tract; prolonged inhalation of dust or fumes may lead to metal fume fever.	NC	8	NR	T

Chemical Name(s), State and Formula	Use in School Category	H*	F*	R*	Hazards	WHMIS Class	Storage Class	TDG Hazard Class	Disposal Methods
malachite green--- solution mixture: water ---------- 55% malachite green ----- 45%	B	2	0	0	Harmful if swallowed; contact with skin, eyes, digestive and respiratory tracts may cause irritation, risk of severe eye damage.	NC	8	8	WF/I
malachite green --- crystals (*aniline green, china green, benzaldehyde green*) $C_{23}H_{25}N_2Cl(s)$ or $C_{23}H_{26}N_2O(s)$	B	2	0	0	Harmful if swallowed; contact with skin or eyes may cause irritation and eye damage. * Note the two chemical forms.	NC	8	6.1 (8)	WF/I
malachite green --- crystals (*aniline green, china green, benzaldehyde green*) $C_{48}H_{50}N_4O_4 \bullet 2HC_2O_4(s)$	B	2	0	0	Harmful by inhalation or ingestion; irritates skin, eyes and mucous membranes.	NC	6.1, 8	NR	WF/I
maleic acid ---------- solid (*butenedioic acid, toxilic acid*) $C_4H_4O_4(s)$	B - soln. C - solid	3	1	1	Corrosive; causes skin and severe eye irritation and possible burns; may cause severe digestive and respiratory tract irritation and possible burns; may be harmful if swallowed or absorbed through skin; may cause kidney damage; combustible if heated.	E	3	8	WF/I or N/P-D
maleic anhydride --- lumps (*2,5-furandione*) $C_4H_2O_3(s)$	B - soln. C - lump	3	1	1	Corrosive; causes burns to skin and eyes; causes respiratory tract irritation and possible burns, digestive tract irritation with nausea and diarrhea; harmful if swallowed; combustible if heated, dust-air mixture explosive; decomposes slowly with water to form maleic acid.	E	4, 3, 8	8	WF/I
malic acid –--------- crystals (*hydroxybutanedioic acid*) $C_4H_6O_5(s)$	B	1	1	0	Causes irritation to skin, eyes and respiratory tract; may be harmful if swallowed; combustible at elevated temperatures or if ignited, dust-air mixture explosive.	NC	3	NR	WF/I or N/P-D

Chemical Name(s), State and Formula	Use in School Category	H*	F*	R*	Hazards	WHMIS Class	Storage Class	TDG Hazard Class	Disposal Methods
malonic acid ------- crystals (*propanedioic acid*) $CH_2(COOH)_2(s)$	B	1	1	0	Causes irritation to eyes; may cause irritation to skin and respiratory tract; may be harmful if swallowed; combustible at elevated temperatures or if ignited, dust-air mixture explosive.	NC	3	NR	WF/I or N/P -D
maltose ---------- granules $C_{12}H_{22}O_{11}(s)$	A	0	1	0	No adverse effects; combustible if heated or ignited, dust-air mixture explosive.	NC	8	NR	T or D(aq)
manganese—powder/solid Mn(s)	B - solid C - powder	2	1	1	Powder may cause irritation to skin, eyes and respiratory tract; harmful if swallowed or inhaled, causing chronic damage to health; chronic exposure affects the central nervous system; dust is flammable; decomposes slowly in contact with water.	NC	8	NR	R /T- solid WF/I- powder
manganese(II) carbonate hydrate ---------- powder $MnCO_3 \bullet XH_2O(s)$	A	1	0	0	May cause irritation to skin, eyes, digestive and respiratory tracts; chronic inhalation affects the central nervous system.	NC	8	NR	WF/I or N/P-D
manganese(II) chloride tetrahydrate ------- crystals $MnCl_2 \bullet 4H_2O(s)$	A	2	0	0	May cause irritation to skin, eyes and respiratory tract; harmful if swallowed or inhaled; affects lungs, central nervous system, blood and kidneys.	D2	8	NR	T or D(aq)
manganese(IV) oxide ---------- powder (*manganese dioxide*) $MnO_2(s)$	A	2	0	1 OX	Causes skin and eye irritation; harmful if inhaled, ingested or absorbed through skin; may affect central nervous system; oxidizing agent, may cause fire in contact with combustible material.	C, D2	6	5.1	WF/I or N/P-D
manganese sulfate monohydrate ------ granular $MnSO_4 \bullet H_2O(s)$	A	2	0	0	May cause irritation to skin, eyes and respiratory system; harmful if swallowed or inhaled; affects lungs, central nervous system, blood and kidneys.	D2	8	NR	T or D(aq)
D-mannose -------- crystals (*seminose, carubinose*) $C_6H_{12}O_6(s)$	A	0	1	0	No adverse affects; will burn if heated and dust-air mixture explosive.	NC	8	NR	T or D(aq)

Chemical Name(s), State and Formula	Use in School Category	H*	F*	R*	Hazards	WHMIS Class	Storage Class	TDG Hazard Class	Disposal Methods
marble chips ---------- chips (*calcium carbonate)* $CaCO_3(s)$	A	1	0	0	Dust may cause irritation to skin, eyes and respiratory system.	NC	8	NR	T
menthol ---------- solid (*hexahydrothymol*) $C_{10}H_{20}O(s)$	A	0	0	0	May cause irritation of the eyes, skin, respiratory and digestive tracts.	NC	8	NR	T or D(aq)
mercury ---------- liquid (*quicksilver*) Hg(l)	C	3	0	0	Corrosive; causes burns to skin, eyes and respiratory tract; may be fatal if swallowed or inhaled, harmful if absorbed through skin; chronic exposure affects the central nervous system and kidneys. If stocked in schools, mercury should be stored in a sealed plastic bottle to prevent evaporation and breakage.	D2	8	8	R or WF/I
mercury compounds	C	3	0	0	Toxic.	D2	8	6.1	WF/I
methane -------- gas/liquid (*natural gas*) $CH_4(g)$ & $CH_4(l)$	B	1	4	0	Excessive inhalation may cause difficulty breathing, nausea, dizziness, suffocation or coma; extremely flammable, will produce explosive mixture with air.	B	5	2.1	WF/I or RS-cyl.
methionine –-------- crystals (*acimethin*) $C_5H_{11}NO_2S(s)$	A	1	1	0	Dust may cause irritation to skin, eyes, digestive and respiratory tract; may cause reproductive and fetal effects; flammable if heated or exposed to flame.	NC	8	NR	WF/I
methyl alcohol(99%)--liquid (*methanol, gas line antifreeze*) $CH_3OH(l)$	B	2	3	0	Causes eye, skin and respiratory tract irritation; harmful if swallowed, inhaled or absorbed through skin; highly flammable.	B, D1, D2	5	3 (6.1)	WF/I

Chemical Name(s), State and Formula	Use in School Category	H*	F*	R*	Hazards	WHMIS Class	Storage Class	TDG Hazard Class	Disposal Methods
methylbenzene ------- liquid (*toluene, phenylethane*) C_7H_8(l)	C	2	3	0	Irritant to skin, eyes, respiratory and digestive tract; harmful if inhaled or absorbed through skin; harmful or fatal if swallowed; may cause liver and kidney damage or affect the blood or central nervous system; highly flammable liquid and vapour.	B, D2	5	3	WF/I
methylcellulose ------- solid (*cellulose methyl ether*) $C_7H_{14}O_5$ X(s)	A	0	0	0	No adverse effects.	NC	8	NR	T
methylene blue ---- crystals (*basic Blue 9*) $C_{16}H_{18}ClN_3S•3H_2O$(s)	A	2	1	0	Dust may cause mechanical irritation of eyes; harmful if swallowed, no adverse effects if inhaled; combustible if heated or ignited, dust-air mixture explosive.	NC	8	NR	T or D(aq)
methylene blue---- solution mixture: water ---------- 99.-% methylene blue ------<1.0% $C_{16}H_{18}ClN_3S$(aq)	A	0	0	0	May cause irritation to eyes; no other adverse effects.	NC	8	NR	D
methylene chloride -- liquid (*dichloromethane*) CH_2Cl_2(l)	C	2	1	0	Causes irritation and possible burns to skin, eyes and respiratory tract; may be absorbed through skin; may depress central nervous system function; combustible if heated or ignited, vapours may form explosive mixture with air; mutagen and possible human carcinogen.	D2	5, 8	6.1	WF/I

Chemical Name(s), State and Formula	Use in School Category	H*	F*	R*	Hazards	WHMIS Class	Storage Class	TDG Hazard Class	Disposal Methods
methyl ethyl ketone --liquid (*2-butanone*) C_4H_8O(l) or $CH_3COCH_2CH_3$(l)	C	2	3	0	Causes mild irritation to skin, vapour causes moderate irritation to eyes, nose and respiratory tract; higher than 350 ppm exposure causes central nervous system depression; very high concentrations cause unconsciousness and possible death; flammable liquid, vapour-air mixture explosive.	B, D2	5	3	WF/I
2-methyl,1-propanol - liquid (*iso-butyl alcohol*) $C_4H_{10}O$(l) or $(CH_3)_2CHCH_2OH$(l)	B	2	3	0	Causes irritation to skin, eyes and respiratory tract; harmful if swallowed, inhaled or ingested; affects the central nervous system; flammable liquid and vapour.	B, D2	5	3	WF/I
methyl orange ------- solid (*C.I. acid orange 52*) $C_{14}H_{14}N_3NaO_3S$(s)	B	2	0	0	May cause irritation of the skin, eyes and respiratory tract; harmful by skin absorption, inhalation or ingestion.	D1, D2	8	6.1	WF/I
methyl orange ---- solution mixture: water ---------- 99.9% methyl orange ------ 0.1% $C_{14}H_{14}N_3NaO_3S$(aq)	A	1	0	0	May cause irritation of the skin, eyes and respiratory tract; excessive exposure may be harmful by skin absorption, inhalation or ingestion.	NC	8	NR	WF/I
methyl red –---------- solid (*C.I. acid red*) $C_{15}H_{15}N_3O_2$(s)	B	1	1	0	May cause skin, eye, digestive and respiratory tract irritation; chronic exposure may causes liver damage.	NC	8	NR	WF/I
methyl red –-------- solution mixture: methyl alcohol ----- 99.98% methyl red ---------- 0.02% $C_{15}H_{15}N_3O_2$(aq)	B	2	3	0	Causes eye, skin and respiratory tract irritation; harmful if swallowed, inhaled or absorbed through skin; highly flammable.	D2	5	3 (6.1)	WF/I

Chemical Name(s), State and Formula	Use in School Category	H*	F*	R*	Hazards	WHMIS Class	Storage Class	TDG Hazard Class	Disposal Methods
methyl salicylate ----- liquid (*wintergreen oil, betula oil*) $C_8H_8O_3(l)$	A	2	1	0	Causes irritation of the skin, eyes and respiratory tract; harmful if swallowed, inhaled or absorbed through skin; affects the kidneys and central nervous system.	D2	8	NR	WF/I
methyl violet ------- solution mixture: water ---------- 99.98% methyl violet ------- 0.02% $C_{24}H_{28}N_3Cl(aq)$	A	1	0	0	May cause mild irritation to skin, eyes, digestive and respiratory tracts.	NC	8	6.1	WF/I
methyl violet ------- crystals (*C.I.basic violet 1*) $C_{24}H_{28}N_3Cl(s)$	A	2	0	0	Causes irritation to skin and eyes; harmful if swallowed or inhaled.	NC	8	6.1	WF/I
mica ---------- sheets (*muscovite, micro, dry ground, wet ground mica*) $KAl_2Si_3O_{10}(OH)_25H_2O(s)$	A	1	0	0	Dust may irritate eyes and respiratory tract; chronic lung damage results from extended inhalation; respirable particles of quartz are hazardous to inhale.	NC	8	NR	R or T
Million's reagent -- solution mixture: mercury ---------- 25% nitric acid ---------- 50% water---------- 25%	C	3	0	0	Toxic; causes burns to skin, eyes, respiratory and digestive tracts; extremely corrosive to mucous membranes; may cause reproductive effects; may cause teratogenic effects.	D1, E	1	6.1 (8)	WF/I
Mohr's salt -------- crystals (*ammonium ferrous sulfate*) $FeH_8N_2O_8S_2(s)$	B	2	1	0	May cause irritation of the skin, eyes, respiratory and intestinal tracts if taken internally; harmful by ingestion, inhalation or skin absorption; flammable if heated.	D1	8	9	WF/I or N/P-D
molybdenum metal ---------- powder Mo(s)	A	1	0	0	May be irritating to skin, eyes, nose, throat and respiratory tract; dust-air mixture could be explosive with strong ignition.	NC	8	NR	WF/I

Chemical Name(s), State and Formula	Use in School Category	H*	F*	R*	Hazards	WHMIS Class	Storage Class	TDG Hazard Class	Disposal Methods
naphthalene ------ crystals (*moth balls, tar camphor*) $C_{10}H_8(s)$	C	3	2	0	Toxic; irritating to eyes, skin and respiratory system; harmful by inhalation, ingestion or skin contact; possible human carcinogen; flammable.	B, D2	4	4.1	WF/I
nichrome wire -------- solid mixture (alloy): nickel -------- 80 - 90% chromium -- 10 - 20%	A	1	0	0	Solid metal forms of nickel and chromium have no adverse effects.	NC	8	NR	R
nickel ---------- powder Ni(s)	D	1	1	1	Powder may cause irritation to skin, eyes and respiratory tract; causes gastrointestinal irritation with nausea, vomiting and diarrhea if ingested; powder pyrophoric, can ignite spontaneously; human carcinogen.	D2	4	4.1	WF/I
nickel ---------- strip Ni(s)	A	0	0	0	Stable, no adverse effects.	NC	8	NR	R
nickel ---------- salts	D	–	–	–	Human carcinogens with long-term exposure.	D2	–	–	WF/I
ninhydrin monohydrate ------- powder $C_9H_6O_4(s)$	B	2	1	0	Irritating to skin, eyes and respiratory tract; harmful if swallowed; combustible if heated or ignited, powder-air mixture explosive.	D2	8	NR	T
nitric acid --------- solution mixture: HNO_3 ---------- 62 - 75% H_2O ---------- 25 - 38% $HNO_3(aq)$	B - dilute C - conc.	3	0	0 OX	Corrosive; liquid and vapour causes severe damage to skin, eyes and mucous membranes; strong oxidant.	C, D1	1, 6	8 (5.1)	WF/I or N/P-D
nitrobenzene --- oily liquid (*nitrobenzol, oil of mirbane*) $C_6H_5NO_2(l)$	C	3	2	1	Toxic; may be fatal if swallowed, inhaled or absorbed through skin; causes irritation to skin and eyes; affects blood, liver, kidneys and reproductive system; possible cancer hazard; combustible liquid and vapour.	B, D1, D2	5	6.1	WF/I

Chemical Name(s), State and Formula	Use in School Category	H*	F*	R*	Hazards	WHMIS Class	Storage Class	TDG Hazard Class	Disposal Methods
nitrogen ------- liquefied gas $N_2(l)$ & $N_2(g)$	C	3	0	0	Skin and eye contact with liquid causes cryogenic burns; gas nontoxic but in confined spaces, will displace oxygenated air and cause asphyxiation.	A	8	2.2	A
nitrogen dioxide –------- liquefied gas $NO_2(l)$ & $NO_2(g)$	D (commercial cylinders)	4	0	0 OX	Very toxic and corrosive, short-term exposure causes irritation and possible burns to skin, eyes and respiratory tract; potentially fatal if inhaled; strong oxidizer, contact with combustible material may cause fire.	D1, C	6	2.3 (5.1) (8)	WF/I
octyl acetate ---------- liquid (*2-ethylhexyl acetate*) $C_{10}H_{20}O_2(l)$	A	1	2	0	Causes skin and eye irritation, may cause respiratory and digestive tract irritation; combustible liquid.	B	5	NR	WF/I or RS – cyl.
octyl alcohol ---------- liquid (*n-octanol, caprylic alcohol*) $C_8H_{18}O(l)$	B	2	2	0	Causes irritation to skin, eye and respiratory tract, may be harmful if swallowed or inhaled; affects the CNS; combustible liquid and vapour.	B, D1	5	NR	WF/I
oleic acid –-------- oily liquid ((*z*)*-9-octadecenoic acid*) $C_{18}H_{34}O_2(l)$	A	1	1	0	Causes irritation to skin, eyes, digestive tract and respiratory tract, if mist is inhaled; combustible if pre-heated and ignited.	NC	3	NR	WF/I or N/P-D
orangeIV ---------- powder (*tropaeolin OO, C.I. 13080*) $C_{18}H_{14}N_3NaO_3S(s)$	B	2	1	0	May cause irritation to skin, eyes and respiratory tract; may be harmful by skin absorption, inhalation or ingestion; combustible if heated or ignited, powder-air mixture explosive.	D2	8	NR	T
orangeIV --------- solution mixture : water ---------- 99.9% orangeIV ---------- 0.1% $C_{18}H_{14}N_3NaO_3S(aq)$	A	1	0	0	May cause irritation to skin, eyes and respiratory tract; may be harmful by skin absorption or ingestion with excessive exposure or intake.	NC	8	NR	D
orcein ---------- powder $C_{28}H_{24}N_2O_7(s)$	A	1	0	0	May cause irritation to skin, eyes, respiratory and digestive tracts.	NC	8	NR	T

Chemical Name(s), State and Formula	Use in School Category	H*	F*	R*	Hazards	WHMIS Class	Storage Class	TDG Hazard Class	Disposal Methods
oxalic acid --------- crystals (*ethanedioic acid*) $C_2H_2O_4(s)$	B - soln. C - crystals	3	1	0	Corrosive; causes severe irritation to skin, eyes and respiratory tract; harmful if inhaled or absorbed through skin; may be fatal if ingested; may cause kidney damage; combustible solid below 101°C.	D1, E	3	8	WF/I or N/P-D
oxygen ---------- gas $O_2(g)$	A	0	0	0 OX	No adverse effects; supports combustion, accelerates burning.	A, C	6	2.2 (5.1)	A
palmitic acid -------- crystals (*hexadecanoic acid*) $C_{16}H_{32}O_2(s)$	A	1	1	0	Causes irritation to skin, eyes, respiratory and digestive tracts; combustible if heated or ignited, dust-air mixture explosive.	NC	3	NR	WF/I or N/P-D
pancreatin ---------- powder (*diastase vera*) (variable composition)	B	1	1	0	Causes irritation to skin, eyes, respiratory tracts; combustible if heated or ignited.	NC	8	NR	T
paradichloro – benzene ---------- crystals (*I,4-dichlorobenzene*) $C_6H_4Cl_2(s)$	C	2	2	0	Causes irritation to skin, eyes and respiratory tract; harmful if inhaled, swallowed or absorbed through the skin; affects the respiratory system, liver, kidneys and blood; flammable, forms explosive vapour-air mixture; possible human carcinogen.	D1, D2	4	9	WF/I
paraffin –---------- solid $C_nH_2n+_2(s)$	A	1	1	0	May cause mild irritation to eyes and digestive tract; dust or fumes may irritate the respiratory tract; flammable.	NC	8	NR	T
paraformaldehyde-powder $(CH_2O)_n(s)$	D	3	1	1	Corrosive; causes severe irritation to skin, eyes, respiratory and digestive tracts and possible burns; releases formaldehyde when dissolved in water; flammable solid.	B, D1, D2	8	4.1	WF/I or N/P-D
pentane (n) ---------- gas $C_5H_{12}(g)$	C	2	4	0	Causes irritation to skin, eyes and respiratory tract; harmful if inhaled or ingested; highly flammable liquid.	B, D1	5	3	WF/I

Chemical Name(s), State and Formula	Use in School Category	H*	F*	R*	Hazards	WHMIS Class	Storage Class	TDG Hazard Class	Disposal Methods
pentyl alcohol -------- liquid (*amyl alcohol, 1- pentanol*) $C_5H_{11}OH(l)$	B	2	3	0	Liquid irritates the skin and causes severe irritation or eyes with possible burns; vapours cause severe irritation of the respiratory tract; harmful if inhaled, swallowed or absorbed through skin; affects the nervous system; flammable liquid and vapour.	B, D2	5	3	WF/I
pentyl (*iso*) alcohol -- liquid (*iso-amyl alcohol*) $C_4H_{10}O(l)$ or $(CH_3)_2CHCH_2CH_2OH(l)$	B	2	2	0	Causes irritation to skin, mucous membranes and respiratory tract; severe irritant to eyes; harmful if swallowed, inhaled or ingested; hematotoxic; affects the central nervous system; flammable liquid and vapour; emits toxic fumes when burned.	B, D2	5	3	WF/I
pepsin ---------- powder (variable composition)	B	1	1	0	May causes irritation to skin and eyes; combustible if heated or ignited.	NC	8	NR	T
perchloric acid --- solution mixture: $HClO_4$ ---- 70% H_2O ------- 30% $HClO_4(aq)$	D	3	0	3 OX	Corrosive; causes severe burns at site of contact; very harmful through skin contact, inhalation and ingestion; unstable, will decompose explosively at higher temperatures or if allowed to dehydrate; contact with wood, paper and other cellulose products may lead to explosion; strong oxidizer.	C, E	1, 6	5.1 (8)	WF/I or N/P-D
petroleum ether –---- liquid mixture: n-pentane --------- 85+% methylpentane -- small % cyclopentane ---- small % dimethylbutane - small % other hydrocarbons ----- variable	C	2	4	0	Irritating to skin, eyes and respiratory system; harmful by inhalation, ingestion or skin contact; extremely flammable liquid.	B, D1	5	3	WF/I

Chemical Name(s), State and Formula	Use in School Category	H*	F*	R*	Hazards	WHMIS Class	Storage Class	TDG Hazard Class	Disposal Methods
phenol ---------- solid (*carbolic acid, phenic acid*) $C_6H_6O(s)$	D	4	2	0	Corrosive and toxic; causes severe burns to any area of contact; may be fatal if swallowed, inhaled or absorbed through skin; absorbed rapidly through skin; affects CNS, liver and kidneys; causes adverse reproductive and fetal effects; flammable.	B, D1, D2	3, 4, 5	6.1	WF/I
phenolphthalein -- needles $C_{20}H_{14}O_4(s)$	B	1	1	0	May cause skin, eye, digestive and respiratory tract irritation; prolonged exposure may have adverse reproductive effects; may be carcinogenic; combustible at higher temperatures or if ignited.	NC	8	NR	T
phenolphthalein -- solution mixture: phenolphthalein 0.5 -1.0% ethyl alcohol ----- 50 - 95% methyl alcohol -----1 - 2 % isopropyl alcohol - 1 - 2%	B	2	3	0	May cause skin, eye, digestive and respiratory tract irritation; prolonged exposure may have adverse reproductive effects; may be carcinogenic; combustible at higher temperatures or if ignited.	B	5	3	WF/I
phenol red –-------- solution mixture: water ---------- 73 - 75% ethanol ---------- 24 - 26% phenol red -------- < 1.0%	B	1	2	0	May cause irritation to skin, eyes, digestive and respiratory tracts; flammable vapour; excessive intake may depress the central nervous system.	NC	5	NR	D
l-phenylalanine -- crystals $C_9H_{11}NO_2(s)$	A	1	0	0	Skin, eye and respiratory tract irritant.	NC	8	NR	T
phenylhydrazine ---- liquid (*hydrozinobenezene*) $C_6H_8N_2(l)$	C	3	2	0	Corrosive; causes irritation of respiratory tract and burns to any area of contact; harmful if swallowed, inhaled or absorbed through skin; affects blood, liver, kidneys and respiratory system; combustible solid, liquid and vapour.	B, D2	5	6.1	WF/I

Chemical Name(s), State and Formula	Use in School Category	H*	F*	R*	Hazards	WHMIS Class	Storage Class	TDG Hazard Class	Disposal Methods
phenyl salicylate -- crystals (*2-hydroxybenzoic acid, phenyl ester*) $C_{13}H_{10}O_3(s)$ or $C_6H_4(OH)COC_6H_5(s)$	B	2	0	0	May cause skin, eye, digestive and respiratory tract irritation; overexposure may cause reproductive disorders.	D2	8	NR	WF/I
phenylthiocarbamide paper (*phenylthiourea*, *PTC paper*) $C_7H_8N_2S(s)$	B	3	1	0	Toxic; exposure to larger amounts very toxic by inhalation, skin contact, or if swallowed; minute amounts in PTC paper not a serious danger; paper flammable.	D1	8	6.1	T
phosphoric acid -- solution mixture: H_3PO_4 ---------- 74 - 95% H_2O ---------- 5 - 26% $H_2PO_4(aq)$	B	3	0	0	Corrosive; causes severe irritation and burns to any area of contact; harmful if swallowed or fumes inhaled.	E	1	8	WF/I or N/P -D
phosphorus, amorphous red ---- powder P(s)	C	2	1	1	Causes eye irritation; may be harmful if swallowed or fumes inhaled; flammable solid, may ignite from friction.	B	8	4.1	WF/I
phosphorus, purified yellow ---------- waxy solid (*white phosphorus*) $P_4(s)$	D	3	4	2	Corrosive; causes severe skin and eye burns; harmful if absorbed through skin; acute inhalation causes serious damage to lungs and respiratory tract; may be fatal if swallowed; extremely flammable, ignites spontaneously on exposure to air; fumes from burning phosphorus extremely irritating.	B, D1	4	4.2	WF/I
phosphorus pentoxide –---------- powder (*phosphoric anhydride*) $P_2O_5(s)$	C	3	0	3 ~~W~~	Corrosive; fumes cause irritation to eyes and respiratory tract; causes burns to any area of contact; harmful if swallowed or inhaled; reacts violently with water to form phosphoric acid.	D1, E	8	8	WF/I

Chemical Name(s), State and Formula	Use in School Category	H*	F*	R*	Hazards	WHMIS Class	Storage Class	TDG Hazard Class	Disposal Methods
phosphorus trichloride ---- fuming liquid $PCl_3(l)$	C	3	0	2 ~~W~~ OX	Corrosive; causes severe burns to any area of contact; may be fatal if swallowed or inhaled; reacts with water; strong oxidizer, contact with other material may cause fire.	C, D1	8	5.1 (8)	WF/I
phthalic acid -------- powder (*1,2-benzenedicarboxylic acid*) $C_8H_6O_4(s)$	B	1	1	1	Causes irritation of skin, eyes, respiratory and digestive tracts; decomposes if heated, powder-air mixture explosive.	NC	3	NR	WF/I or N/P-D
picric acid ---------- crystals (*2,4,6-trinitrophenol*) $C_6H_3N_3O_7(s)$	D	3	4	4	Toxic; causes skin and respiratory tract irritation, and severe eye irritation; harmful if swallowed, inhaled or absorbed through the skin; affects the liver, kidneys and blood; stable in water but explosive if allowed to dry, becomes increasingly shock, heat and friction sensitive as moisture lost; flammable solid.	B, D1, D2, F	3, 4	4.1	WF/I or N/P-D
platinum (metal) ------- solid Pt(s)	A	1	1	0	May cause irritation of skin, eye, respiratory and digestive tracts; flammable solid.	NC	8	NR	R
polyethylene ---------- solid $[C_2H_4]_n(s)$	A	1	1	0	Dust a respiratory tract and a mechanical eye irritant; combustible if heated or ignited.	NC	8	NR	R
polypropylene ---------- solid $[C_3H_6]_n(s)$	A	1	1	0	Dust may be an eye and respiratory tract irritant; combustible at high temperatures.	NC	8	NR	R
polystyrene ---------- solid (*dylene)* $[C_8H_8]_n(s)$	A	1	1	0	Dust an upper respiratory irritant and a mechanical eye irritant; combustible if heated or ignited.	NC	8	NR	R
polyvinyl acetate ------ solid (*PVA*) $(C_4H_6O_2)_n(s)$	A	0	0	0	No adverse effects.	NC	8	NR	R, T

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polyvinyl alcohol - granules $[CH_2CHOH]_n$(s)	B	0	2	0	Nuisance dust, mechanical irritation of eyes; flammable if ignited or heated, may form combustible dust concentrations in air.	NC	8	NR	R or T
potassium (metal) ---- solid K(s)	C	3	3	2 ~~W~~	Corrosive; causes burns to all areas in contact; harmful or fatal if swallowed; harmful if absorbed through skin; water reactive; flammable solid, ignites when exposed to air.	B, D1, E	4	4.3	WF/I
potassium acetate- powder KCH_3COO(s)	A	1	0	0	May cause mild irritation to the skin, eyes and respiratory tract.	NC	8	NR	T or D(aq)
potassium bromate ---------- powder $KBrO_3$(s)	B - soln. C - powder	3	0	1 OX	Toxic; causes irritation to skin, eyes and respiratory tract; harmful if dust inhaled or absorbed through skin, may be fatal if swallowed; may cause kidney damage; strong oxidizer, may ignite combustible material.	C, D1, D2	6	5.1	WF/I
potassium bromide ---------- crystals KBr(s)	B	2	0	0	May cause irritation of the skin, eyes and respiratory tract; harmful if swallowed or inhaled; affects the central nervous system and eyes.	D2	8	NR	T
potassium carbonate ---------- powder K_2CO_3(s)	A	2	0	0	Causes severe irritation to skin, eyes and respiratory tracts; harmful if swallowed or inhaled.	D2	8	NR	T
potassium chlorate –---------- powder $KClO_3$(s)	B - soln. C - powder	2	0	3 OX	Causes irritation to skin, eyes and respiratory tracts; harmful if swallowed, may cause methemoglobinemia, liver or kidney damage; strong oxidizer, contact with other material may cause fire; decomposes when heated releasing oxygen gas, may explode.	C, D2	6	5.1	WF/I

Chemical Name(s), State and Formula	Use in School Category	H*	F*	R*	Hazards	WHMIS Class	Storage Class	TDG Hazard Class	Disposal Methods
potassium chloride ---------- crystals $KCl(s)$	A	1	0	0	May cause severe irritation to skin, eyes and respiratory tract.	NC	8	NR	T
potassium chromate ---------- crystals $K_2CrO_4(s)$	D	3	0	1 OX	Corrosive; causes severe burns to area of contact; harmful if swallowed or inhaled; affects the respiratory system, liver, kidneys, eyes, skin and blood; strong oxidizer, contact with other material may cause fire; releases oxygen gas upon decomposition; human carcinogen.	C, D1, D2	6	5.1 (8)	WF/I or N/P-D
potassium dichromate ---------- powder $K_2Cr_2O_7(s)$	D	3	0	1 OX	Corrosive; causes severe burns to area of contact; harmful if swallowed or inhaled; affects the respiratory system, liver, kidneys, eyes, skin and blood; strong oxidizer, contact with other material may cause fire; releases oxygen gas upon decomposition; human carcinogen.	C, D1, D2	6	5.1 (8)	WF/I or N/P-D
potassium dihydrogen-phosphate, --------- crystals (*potassium phosphate, monobasic*) $KH_2PO_4(s)$	A	1	0	0	May cause irritation to eyes, skin, respiratory and digestive tracts.	NC	8	NR	WF/I
potassium ferrocyanide ---–---- powder $K_3Fe(CN)_6(s)$	B	2	0	1	May cause irritation to skin, eye and respiratory tract; may be harmful if swallowed or inhaled; decomposes if heated releasing cyanide gases.	NC	8	NR	WF/I
potassium hydrogen-carbonate ---------- crystals (*potassium bicarbonate*) $KHCO_3(s)$	A	1	0	0	May be a mild irritant to skin, eyes, digestive and respiratory tracts.	NC	8	NR	T or D(aq)

Chemical Name(s), State and Formula	Use in School Category	H*	F*	R*	Hazards	WHMIS Class	Storage Class	TDG Hazard Class	Disposal Methods
potassium hydrogen-oxalate- powder or crystals (*potassium binoxalate*) $KHC_2O_4(s)$	A	1	0	0	Causes irritation of the skin, eyes, respiratory and digestive tracts; harmful if swallowed.	D1, D2	8	NR	T or D(aq)
potassium hydrogen-phosphate ---------- powder (*potassium phosphate, dibasic*) $K_2 HPO_4(s)$	A	1	0	0	May be harmful if swallowed.	NC	8	NR	WF/I
potassium hydrogen-phthalate –---------- powder $KH_5C_8O_4(s)$	B	1	1	0	May cause irritation to skin, eyes and respiratory tract; combustible if heated or ignited, air-dust mixture explosive.	NC	8	NR	T or D(aq)
potassium hydrogen-sulfate ---------- powder (*potassium bisulfate*) $KHSO_4(s)$	B - soln. C - powder	3	0	0	Corrosive; causes burns to any area of contact; may be harmful if swallowed.	E	8	8	WF/I
potassium hydrogen-tartrate –---------- powder (*potassium bitartrate, cream of tartar*) $KHC_4H_4O_6(s)$	A	0	0	0	No adverse effects.	NC	8	NR	T or D(aq)
potassium hydroxide----------pellets (*caustic potash*) KOH(s)	B	3	0	1	Corrosive; causes severe burns to any area of contact; harmful by ingestion, inhalation or skin contact; unstable, absorbs carbon dioxide and moisture from air.	D1, E	2	8	WF/I or N/P-D

Chemical Name(s), State and Formula	Use in School Category	H*	F*	R*	Hazards	WHMIS Class	Storage Class	TDG Hazard Class	Disposal Methods
potassium iodate -- powder $KIO_3(s)$	B - soln. C - powder	2	0	3 OX	May cause severe irritation to skin, eyes and respiratory tract with possible burns; may cause kidney damage and central nervous system effects; strong oxidizer, enhances combustion of other substances; can be explosive if exposed to heat or flames, mechanical shock or friction.	C, D2	6	5.1	WF/I or N/P-D
potassium iodide -- crystals KI(s)	A	1	0	1	May cause irritation to skin, eyes, respiratory and digestive tracts; may cause fetal effects; light and moisture sensitive.	D2	8	NR	T or D(aq)
potassium nitrate - crystals $KNO_3(s)$	B	2	0	0 OX	Causes irritation of the skin, eyes and respiratory tract; harmful if swallowed, inhaled or absorbed through skin; strong oxidant, may cause fire in contact with combustible material.	C, D2	6	5.1	WF/I
potassium nitrite - granules $KNO_2(s)$	B	2	0	0 OX	Causes severe irritation of the skin, eyes and respiratory tract; harmful or fatal if swallowed, harmful if inhaled or absorbed through skin; strong oxidant, may cause fire in contact with combustible material; will decompose under extreme heat.	C, D2	6	5.1	WF/I
potassium oxalate-crystals $K_2C_2O_4 \bullet H_2O(s)$	B - soln. C - crystals	3	0	0	Corrosive; causes severe burns to every area of contact; may be fatal if swallowed, harmful if inhaled.	D1, D2	8	6.1	T or D(aq)
potassium permanganate ---- crystals (*condy's crystals*) $KMnO_4(s)$	B	3	0	1 OX	Corrosive; dust causes severe irritation and burns to skin, eyes and mucous membranes of the digestive and respiratory tracts; chronic exposure may impair the central nervous system; strong oxidizing agent, may ignite combustible materials; may decompose if heated above 150°C causing explosion.	C, E	6	5.1	WF/I or N/P-D

Chemical Name(s), State and Formula	Use in School Category	H*	F*	R*	Hazards	WHMIS Class	Storage Class	TDG Hazard Class	Disposal Methods
potassium phosphate, monobasic ---------- powder $KH_2PO_4(s)$	A	1	0	0	May cause irritation to eyes, skin and respiratory tract; may be harmful if swallowed or inhaled.	NC	8	NR	WF/I
potassium phosphate, dibasic ---------- powder $K_2HPO_4(s)$	A	1	0	0	No adverse effects to eyes, skin or respiratory tract; may be harmful if swallowed.	NC	8	NR	WF/I
potassium phosphate, tribasic ---------- powder $K_3PO_4 \bullet xH_2O(s)$	B	2	0	0	Causes irritation and possible burns to eyes, skin, respiratory and digestive tract; harmful if swallowed or inhaled.	E	8	8 (6.1)	WF/I
potassium sodium tartrate ---------- powder (*Rochelle salt*) $KNaC_4H_4O_6 \bullet 4H_2O(s)$	A	1	1	0	May cause irritation to eyes, skin and respiratory tract; combustible if heated or ignited, dust-air mixture explosive.	NC	8	NR	T or D(aq)
potassium sulphate - powder $K_2SO_4(s)$	A	1	0	0	May produce mechanical irritation to eyes and irritation to skin, respiratory and digestive tracts.	D2	8	NR	T or D(aq)
potassium sulfide - powder $K_2S(s)$	C	3	1	2	Toxic; very destructive to mucous membranes; causes burns by inhalation, ingestion or through skin contact; flammable, anhydrous form may be spontaneously combustible; reacts with acids to release toxic H_2S.	D1, D2	8	4.2 (6.1)	WF/I
potassium sulfite -- crystals $K_2SO_3(s)$	B	2	0	0	Irritating to skin, eyes and respiratory system; may be harmful if swallowed, inhaled or absorbed through skin.	D2	8	NR	T or D(aq)
potassium thiocyanate --------- crystals KSCN(s)	B	2	0	0	Causes irritation to eyes, skin and respiratory tract; harmful if swallowed or inhaled.	D2	8	NR	WF/I
L- proline ---------- powder $C_5H_9NO_2(s)$	A	1	0	0	May cause irritation to skin, eyes, respiratory and digestive tracts.	NC	8	NR	T or D(aq)

Chemical Name(s), State and Formula	Use in School Category	H*	F*	R*	Hazards	WHMIS Class	Storage Class	TDG Hazard Class	Disposal Methods
propane ---------- liquid/gas $C_3H_8(l)$ or $C_3H_8(g)$	B	1	4	0	May be harmful if inhaled, asphyxiant at high concentrations; highly flammable, vapours heavier than air and collect in low areas or along the floor; liquid gas can cause freeze burns.	A & B	5	2.1	RS WF/I
n-propanol ---------- liquid (*n-propyl alcohol, rubbing alcohol*) $C_3H_8O(l)$ or $CH_3(CH_2)_2OH(l)$	B - small volume	2	3	0	Causes irritation of the skin, eyes and respiratory tract; harmful if swallowed, inhaled or absorbed through skin, may affect the central nervous system; flammable liquid and vapour.	B, D2	5	3	D or WF/I
propionic acid --- oily liquid (*propanoic acid, methyl acetic acid*) $C_3H_6O_2(l)$ or $CH_3CH_2COOH(l)$	B - soln. C - conc.	3	2	0	Corrosive; causes severe irritation and burns to skin, eyes, respiratory and digestive tracts; extremely destructive to mucous membranes, harmful if absorbed through skin, inhaled or ingested; flammable liquid; mutagen.	B, D1	3, 5	8	WF/I or N/P-D
sec-propyl alcohol --- liquid (*iso-propyl alcohol*) $C_3H_8O(l)$ or $(CH_3)_2CHOH(l)$	B	2	3	0	Causes irritation to eyes and respiratory tract; harmful if swallowed, inhaled or absorbed through skin; affects the central nervous system; flammable liquid and vapour.	B	5	3	WF/I
propylene glycol -oily liquid (*1,2 propanediol*) $C_3H_8O_2(l)$ or $CH_3CHOHCH_2OH(l)$	A	0	1	0	May cause irritation to skin and eyes; combustible if heated or ignited.	NC	8	NR	WF/I
prussic acid --------- liquid (*hydrogen cyanide, anhydrous, hydrocyanic acid*) $HCN(l)$	D	4	4	2	Highly toxic; vapour irritates skin, eyes and mucous membranes; short-term exposure leads to death by rapid absorption through skin or by inhalation; also toxic by ingestion; flammable fumes.	B, D1, D2, E	1, 5	6.1	WF/I

Chemical Name(s), State and Formula	Use in School Category	H*	F*	R*	Hazards	WHMIS Class	Storage Class	TDG Hazard Class	Disposal Methods
P.T.C.- embedded in paper (*phenylthiocarbamide, phenylthiourea*) $C_7H_8N_2S(s)$	B	3	1	0	Toxic; exposure to larger amounts very toxic by inhalation, skin contact, or if swallowed; minute amounts in PTC paper not a serious danger; paper flammable.	D1	8	6.1	T
pyridine ---------- liquid (*azabenzene*) $C_5H_5N(l)$	C	3	3	0	Corrosive; causes severe irritation and burns to skin, eyes, respiratory and digestive tracts; harmful if absorbed through skin, inhaled or ingested, may be fatal; long-term exposure may cause liver, kidney or central nervous system damage; reacts violently with some acids and oxidizing agents; flammable liquid, flash point 19°C.	B, D2, E	5	3	WF/I or N/P-D
pyrite ---------- chunks (*iron disulfide*) $FeS_2(s)$	A	2	1	0	Dust irritating to skin, eyes and respiratory tract; ingestion leads to release hydrogen sulfide by a reaction with stomach acid; prolonged inhalation may lead to pulmonary fibrosis, damage to kidneys and liver, fine powder flammable.	NC	8	NR	T
pyrogallol ---------- powder *(pyrogallic acid, 1,2,3-benzenetriol)* $C_6H_6O_3(s)$	B	2	1	0	Causes irritation to skin, eyes and respiratory tract; harmful if swallowed, inhaled or absorbed through skin; affects the respiratory system, liver, kidneys, eyes, skin and blood; combustible if ignited or heated.	D2	3	6.1 (8)	WF/I
quartz ---------- crystalline (*silica*) Si(s)	A	1	0	0	Dust or granules can be a mild skin irritant, prolonged overexposure to dust leads to silicosis; may be carcinogenic.	NC	8	NR	R or T
quinaldine red ------ powder $C_{21}H_{23}IN_2(s)$	B	2	0	0	May cause irritation; may be harmful if inhaled, ingested or absorbed via skin.	NC	8	NR	WF/I

Chemical Name(s), State and Formula	Use in School Category	H*	F*	R*	Hazards	WHMIS Class	Storage Class	TDG Hazard Class	Disposal Methods
quinine sulfate dihydrate –---------- powder (*quinicardine*) $(C_{20}H_{24}N_2O_2)_2 H_2SO_4 \bullet H_2O(s)$	B	2	1	0	May cause irritation to skin, eyes and respiratory tract; harmful if swallowed, may be harmful if inhaled; prolonged exposure affects the cardiovascular and central nervous system; flammable if heated or ignited, dust-air mixture explosive.	D2	8	NR	WF/I
Rennett tablets -------- solid (*rennin*) (variable composition)	A	0	1	0	May cause irritation of the eyes, chronic exposure may produce an allergenic sensitization in susceptible individuals.	NC	8	NR	T
resorcinol –--------- powder (*1,3-benzenediol*) $C_6H_6O_2(s)$	B - soln. C - powder	3	1	0	Toxic; causes severe irritation to skin and eyes, less to the respiratory tract; harmful if absorbed through skin or inhaled, may be fatal if ingested; long-term exposure affects liver, kidneys, cardiovascular system, central nervous system and spleen; combustible if ignited or heated.	D1, D2	8	6.1	WF/I
rhodanine ---------- crystals (*rhodanic acid*) $C_3H_3NOS_2(s)$	B	2	1	0	May cause irritation to skin, respiratory and digestive tracts, irritant to eyes; harmful if swallowed; combustible at elevated temperatures or if ignited, dust-air mixture explosive.	D2	8	NR	WF/I
Rochelle salt –------ powder (*potassium sodium tartrate*) $KNaC_4H_4O_6 \bullet 4H_2O(s)$	A	1	1	0	May cause irritation to eyes, skin and respiratory tract; combustible at elevated temperatures or if ignited, dust-air mixture explosive.	NC	8	NR	T or D(aq)
rosolic acid ------- powder (*aurin*) $(HOC_6H_4)_2C:C_6H_4:O(s)$	B	1	1	0	Irritant to eyes, skin and respiratory tract; combustible at elevated temperatures or if ignited, dust-air mixture explosive.	NC	3	NR	WF/I

Chemical Name(s), State and Formula	Use in School Category	H*	F*	R*	Hazards	WHMIS Class	Storage Class	TDG Hazard Class	Disposal Methods
rubbing alcohol ------- liquid (*n-propyl alcohol, n-propanol*) $C_3H_8O(l)$ or $CH_3(CH_2)_2OH(l)$	B	2	3	0	Causes irritation of the skin, eyes and respiratory tract; harmful if swallowed, inhaled or absorbed through skin, may affect the central nervous system; flammable liquid and vapour.	B, D2	5	3	D or WF/I
safranin O –--------- solution mixture: water ---------- 98.8% sodium benzoate --- 0.2% safranin O ---------- 1.0%	A	1	0	0	May irritate the eyes and skin. No other adverse effects.	NC	8	NR	D
safranin O –--------- powder $C_{20}H_{19}N_4Cl(s)$	A	1	0	0	Dust irritates the eyes and skin. No other adverse effects.	NC	8	NR	WF/I
salicylic acid–--------crystals (*2-hydroxybenzoic acid*) $C_7H_6O_3(l)$ or $HOC_6H_4COOH(l)$	B	2	1	0	Causes irritation to skin, eyes and respiratory tract; harmful if swallowed, inhaled or absorbed through skin; affects the central nervous system, kidneys and pancreas; combustible at elevated temperatures, dust-air mixture explosive.	D1, D2	3	NR	WF/I or N/P-D
selenium –---------- shot Se(s)	B	2	0	0	Dust causes severe irritation to skin, eyes and respiratory tract; dust harmful if swallowed or inhaled; affects the liver, kidneys, blood and spleen.	D1	8	NR	WF/I
serine –---------- powder $C_3H_7NO_3(s)$	A	1	0	0	May cause irritation to skin, eyes, digestive and respiratory tracts.	NC	8	NR	T or D(aq)
silicic acid --------- granules (*silica gel*) $H_2SiO_3(s)$	A	1	0	0	May cause irritation to skin, eyes, digestive and respiratory tracts.	NC	3	NR	T
silicon ---- crystals/powder Si(s)	B - crystal C - powder	1	3	0	May cause irritation to skin, eyes, digestive and respiratory tracts; may cause central nervous system depression; flammable powder.	B, D2	4	4.1	WF/I

Chemical Name(s), State and Formula	Use in School Category	H*	F*	R*	Hazards	WHMIS Class	Storage Class	TDG Hazard Class	Disposal Methods
silicon dioxide ---- granules (*silica, quartz, sand*) $SiO_2(s)$	A	2	0	0	May cause eye irritation; harmful if dust inhaled, carcinogenic over extended period of inhalation.	D2	8	NR	T
silver (metal) –--------- solid and foil Ag(s)	A	0	0	0	Dust may cause mild skin, eye or mucous membrane irritation; prolonged exposure can cause permanent blue-grey staining of eyes, skin, nose, mouth and throat.	NC	8	NR	R
silver acetate ------- powder $AgC_2H_3CO_2(s)$	A	1	0	0	Causes irritation to skin, eyes and respiratory tract; may cause digestive tract irritation.	D2	8	NR	N/P -R
silver bromide ------ powder AgBr(s)	A	1	0	0	May cause irritation to skin, eyes and digestive tract.	D2	8	NR	N/P -R
silver chloride –----- powder AgCl(s)	A	1	0	0	May cause irritation to skin, eyes and digestive tract; causes respiratory tract irritation.	D2	8	NR	N/P -R
silver nitrate –------ crystals $AgNO_3(s)$	B	3	0	0 OX	Corrosive; causes burns to any area of contact; may be fatal if swallowed, harmful if inhaled; strong oxidizer, contact with combustible material may cause fire.	C, D1, E	6	5.1	N/P -R
silver oxide ---------- powder $Ag_2O(s)$	A	2	0	1 OX	Contact with skin and eyes causes severe irritation and possible burns; may cause irritation of the respiratory tract; harmful if swallowed; strong oxidizer, contact with combustible material may cause fire; absorbs CO_2 from air.	C, D2	6	5.1	N/P-R
silver sulfate-------- crystals $Ag_2SO_4(s)$	A	1	0	0	May cause irritation to skin, eyes, respiratory and digestive tract.	D2	8	NR	N/P -R

Chemical Name(s), State and Formula	Use in School Category	H*	F*	R*	Hazards	WHMIS Class	Storage Class	TDG Hazard Class	Disposal Methods
soda lime –---------- pellets mixture: ethyl violet ------ < 1% NaOH ---------- < 2% KOH ---------- < 3% $Ca(OH)_2$ -------- > 80%	B	3	0	0	Corrosive; causes severe burns to any area of contact; causes severe irritation to respiratory tract; harmful if swallowed or inhaled; absorbs CO_2 from air to form calcium carbonate.	NC	2	8	WF/I or N/P-D
sodium (metal) -------- solid Na(s)	C	3	3	2 ~~W~~	Corrosive; contact may cause burns; harmful if metal absorbed through skin, harmful or fatal if ingested; flammable solid, ignites spontaneously in air; reacts violently with water releasing explosive hydrogen gas.	B, E	4	4.3	N/P-D or WF/I
sodium acetate anhydrous & trihydrate --------- crystals $CH_3COONa(s)$ & $CH_3COONa•3H_2O(s)$	A	1	1	0	May cause skin, eye and respiratory tract irritation; combustible if heated or ignited, particle-air mixture explosive.	D2	8	NR	T or D(aq)
sodium arsenite --- powder $NaAsO_2(s)$	D	3	0	0	Toxic; causes irritation to skin, eyes and respiratory tract; may be fatal by ingestion or inhalation; may cause liver and kidney damage; carcinogen.	D2	8	6.1	WF/I
sodium benzoate -- powder $C_6H_5COONa(s)$	B	1	1	0	May cause skin, eye and respiratory tract irritation; ignition possible if heated, dust-air mixture explosive.	NC	8	NR	T
sodium borate ------ powder decahydrate (*borax*) $Na_2B_4O_7•10H_2O(s)$	A	2	0	0	Causes irritation of the eyes, skin and respiratory tract; harmful if swallowed, inhaled or absorbed through skin.	NC	8	NR	T or D(aq)
sodium bromate --- powder $NaBrO_3(s)$	B	2	0	1 OX	Causes irritation to eyes, skin, digestive and respiratory tracts, oxidizing agent.	C, D1	6	5.1	WF/I

Chemical Name(s), State and Formula	Use in School Category	H*	F*	R*	Hazards	WHMIS Class	Storage Class	TDG Hazard Class	Disposal Methods
sodium bromide -- granules NaBr(s)	B	2	0	0	May cause irritation to eyes, skin and respiratory tract; harmful if swallowed; affects the central nervous system and eyes.	NC	8	NR	D
sodium carbonate anhydrous --------- granular Na_2CO_3(s)	A	2	0	0	May cause eye and skin irritation with possible burns and irritation of respiratory and digestive tracts; harmful if inhaled or swallowed.	D1, D2	8	NR	T or D(aq)
sodium chlorate --- crystals $NaClO_3$(s)	B	2	0	2 OX	Causes irritation to eyes, skin and respiratory tract, harmful if swallowed; may cause damage to blood, liver or kidneys; strong oxidizing agent, contact with combustible material may cause fire.	C, D1	6	5.1	WF/I or N/P-T
sodium chloride -- granules NaCl(s)	A	1	0	0	Dust may cause irritation to eyes, skin and respiratory tract.	NC	8	NR	T or D(aq)
sodium chromate tetrahydrate --------- powder $Na_2CrO_4 \bullet 4H_2O$(s)	B - soln C - crystals	3	0	1 OX	Corrosive; causes severe burns to any area of contact; harmful if swallowed or inhaled; affects the respiratory system, kidneys, eyes, skin and blood; strong oxidizer, contact with combustible material may cause fire; human carcinogen.	C, D1, D2	6	5.1 (8)	N/P-T or WF/I
sodium citrate ------ powder dihydrate $Na_3C_6H_5O_7 \bullet 2H_2O$(s)	A	1	0	0	May cause irritation to eyes, skin, digestive and respiratory tracts.	NC	8	NR	T or D(aq)
sodium dichromate dihydrate ---------- powder $Na_2Cr_2O_7 \bullet 2H_2O$(s)	B - soln. C - crystals	3	0	2 OX	Corrosive; causes burns to skin, eyes, respiratory and digestive tracts; may be fatal if swallowed, harmful if inhaled or if absorbed through skin; causes cardiac disturbances, may cause blood and kidney damage; strong oxidizer, may cause fire if in contact with combustible material; human carcinogen.	C, D1, D2	6	6.1 (8)	WF/I or N/P-D

Chemical Name(s), State and Formula	Use in School Category	H*	F*	R*	Hazards	WHMIS Class	Storage Class	TDG Hazard Class	Disposal Methods
sodium dihydrogen-phosphate ---------- crystals (*sodium phosphate monobasic dihydrate*) $NaH_2PO_4 \bullet 2H_2O(s)$	A	1	0	0	May cause irritation of the skin, eyes, respiratory and digestive tracts.	NC	8	NR	WF/I
sodium ethanoate--crystals (*sodium acetate*) $CH_3COONa(s)$ & $CH_3COONa \bullet 3H_2O(s)$	A	1	1	0	May cause skin, eye and respiratory tract irritation; combustible if heated or ignited, particle-air mixture explosive.	D2	8	NR	T or D(aq)
sodium fluoride ---- crystals $NaF(s)$	B - soln. C - crystals	3	0	0	Toxic; causes irritation to skin and eyes, and severe irritation to respiratory tract, irritation effects may be delayed; may be fatal if swallowed or inhaled; prolonged exposure affects the respiratory, circulatory, central nervous system and kidneys; may cause mottling of teeth and bone damage.	D1, D2	8	6.1	WF/I
sodium hydrogen-carbonate ---------- powder (*sodium bicarbonate, baking soda*) $NaHCO_3(s)$	A	1	0	0	May cause slight irritation of the eyes, skin and respiratory tract.	NC	8	NR	T or D(aq)
sodium hydrogenphosphate anhydrous –------- granules *(sodium hydrogen phosphate dibasic*) $Na_2HPO_4(s)$	A	1	0	0	May cause irritation to skin, eyes and respiratory tract.	NC	8	NR	WF/I

Chemical Name(s), State and Formula	Use in School Category	H*	F*	R*	Hazards	WHMIS Class	Storage Class	TDG Hazard Class	Disposal Methods
sodium hydrogensulfate monohydrate ------- crystals (*sodium bisulfate*) $NaHSO_4 \bullet H_2O(s)$	B - soln. C - crystals	3	0	2 ~~W~~	Corrosive; causes burns to any area of contact; may be harmful or fatal if swallowed; causes severe irritation and burns to respiratory tract; reacts violently with moisture in air or with water or steam.	E	8	8	WF/I
sodium hydrogensulfite (*sodium bisulfite*)- granules mixture: $NaHSO_3(s)$ ------- 58 - 99% $Na_2SO_5(s)$ -------- 1 - 42%	B	2	0	1	Causes irritation to eyes, skin and respiratory tract; harmful if swallowed or inhaled, reacts with acids and water releasing toxic SO_2 gas; oxidizes to the sulfate on exposure to air and moisture.	d2	8	NR	WF/I
sodium hydroxide -- pellets (*caustic soda*) NaOH(s)	B	3	0	1	Corrosive; causes burns to any area of contact, may be fatal if swallowed; harmful if inhaled; heat released when added to water.	D1, E	2	8	WF/I or N/P-D
sodium hydroxide- solution (*caustic soda*) mixture: H_2O ---------- 80 - 90% NaOH ---------- 10 - 20% NaOH(aq)	A - 5% or less B - more than 5%	3	0	1	Corrosive; causes burns to any area of contact, may be fatal if swallowed; harmful if inhaled; heat released when added to water.	D1, E	2	8	WF/I or N/P-D
sodium hypochlorite -------- solution (*bleach*) mixture: H_2O ---------- 80 - 99% NaClO----------– 1 - 20% NaOCl(aq)	B	2	0	2 OX	Skin irritant, may cause burns to skin and eyes; harmful by inhalation, ingestion or through skin contact; light and temperature sensitive, decomposes with release of chlorine gas; oxidizer.	C, D1	6	8	D

Chemical Name(s), State and Formula	Use in School Category	H*	F*	R*	Hazards	WHMIS Class	Storage Class	TDG Hazard Class	Disposal Methods
sodium iodate ------ powder $NaIO_3(s)$	B	2	0	1 OX	Causes irritation to skin, eyes and respiratory tract; harmful if swallowed or inhaled; strong oxidizer, may cause fire in contact with combustible material; may explode with strong mechanical shock or friction.	C	6	5.1	WF/I
sodium iodide ------ crystals NaI(s)	B	2	0	1	Causes irritation to skin, eyes and respiratory tract; harmful if swallowed or inhaled; chronic exposure produces "iodism" with headache, fever, laryngitis, bronchitis and iodine mumps; absorbs moisture; decomposes if heated releasing toxic fumes of iodine and sodium oxide. Note: Added to table salt for iodine source.	D2	8	NR	T or D(aq)
sodium metabisulfite ------ granules $Na_2S_2O_5(s)$	B	2	0	1	Causes irritation to eyes, skin and respiratory tract; harmful if swallowed or inhaled; slowly oxidizes to the sulfate on exposure to air and moisture; reacts with acids and water releasing toxic SO_2 gas.	D2	8	NR	D-(aq) or WF/I
sodium metasilicate pentahydrate ------- powder $Na_2SiO_3 \bullet 5H_2O(s)$	B	3	0	0	Corrosive when wet; severe irritant to skin, causes rapid burns to eyes and severe burns to mouth, throat and stomach if ingested; harmful if inhaled.	D2, E	8	8	WF/I or N/P-D
sodium nitrate ----- crystals $NaNO_3(s)$	B	2	0	1 OX	May cause irritation to eyes, skin and respiratory tract; harmful if swallowed or inhaled; strong oxidizer, contact with combustible material may cause fire; decomposes explosively if heated to >538°C or with severe impact.	C, D2	6	5.1	WF/I

Chemical Name(s), State and Formula	Use in School Category	H*	F*	R*	Hazards	WHMIS Class	Storage Class	TDG Hazard Class	Disposal Methods
sodium nitrite ----- granules $NaNO_2(s)$	B	2	0	1 OX	Causes irritation to eyes, skin and respiratory tract; harmful if swallowed, inhaled or absorbed through skin; strong oxidizer, contact with combustible material may cause fire; explosion risk if heated to 537°C or with severe impact.	C, D1, D2	6	5.1	WF/I
sodium oxalate ---- powder $Na_2C_2O_4(s)$	D	3	0	0	Corrosive; causes burns to any area of contact; harmful if inhaled, may be fatal if ingested; may affect the kidneys.	D1, D2	8	6.1 (8)	WF/I
sodium peroxide --granules $Na_2O_2(s)$	C	3	0	1 OX ~~W~~	Corrosive; causes burns to any area of contact; harmful if swallowed or inhaled; reacts with water; strong oxidizer, contact with combustible material may cause fire.	C, D1, D2	6	5.1	WF/I
sodium phosphate tribasic dodecahydrate -- crystals $Na_3PO_4 \bullet 12H_2O(s)$	B	2	0	1 ~~W~~	Causes irritation of the skin, eyes and respiratory tract; harmful if swallowed or inhaled; reacts with water.	NC	8	NR	WF/I
sodium propionate- powder $NaC_3H_5O_2(s)$ or $CH_3CH_2COONa(s)$	A	1	0	0	Causes irritation of the skin and eyes.	NC	8	NR	T or D(aq)
sodium silicate ----- powder (*water glass*) $Na_2SiO_3(s)$	B	3	0	0	Corrosive; causes severe burns to any area of contact, harmful if swallowed or inhaled.	D2	8	8	WF/I
sodium silicate nanohydrate -------- powder (*water glass*) $Na_2SiO_3 \bullet 9H_2O(s)$	B	3	0	0	Corrosive; causes severe irritation to skin, eyes and respiratory tract; harmful if swallowed or inhaled.	D2	8	8	WF/I
sodium sulfate ----- powder $Na_2SO_4(s)$	A	1	0	0	May cause irritation of skin, eye, respiratory and digestive tract.	NC	8	NR	T or D(aq)

Chemical Name(s), State and Formula	Use in School Category	H*	F*	R*	Hazards	WHMIS Class	Storage Class	TDG Hazard Class	Disposal Methods
sodium sulfide nonahydrate -------- crystals $Na_2S•9H_2O(s)$	D	3	0	1	Corrosive; causes severe burns to any area of contact, harmful if swallowed or inhaled; unstable in storage, decomposes in contact with moisture and acids forming toxic combustible hydrogen sulfide gas.	B, D1	8	8	WF/I
sodium sulfite ------ crystals $Na_2SO_3(s)$	A	2	0	0	May cause irritation of skin, eye and respiratory tract; harmful if swallowed.	D2	8	NR	WF/I
sodium tetraborate decahydrate -------- crystals (*sodium borate, borax*) $Na_2B_4O_7•10H_2O(s)$	A	2	0	0	May cause irritation of skin, eye, respiratory and digestive tract, may cause adverse reproductive effects.	NC	8	NR	T or D(aq)
sodium thiocyanate --------- crystals NaSCN(s)	B	2	0	1	Causes irritation to skin, eyes and respiratory tract; harmful if swallowed or inhaled; may affect heart, blood, thyroid and central nervous system; decomposes on exposure to light.	D1, D2	8	6.1	WF/I
sodium thiosulfate--crystals $Na_2S_2O_3(s)$	B	2	0	0	May cause irritation of skin, eye and respiratory tract; may be harmful if swallowed or inhaled.	D2	8	NR	T or D(aq)
starch ---------- powder $(CH_2O)_n(s)$	A	0	1	0	May cause irritation to skin, eyes and respiratory tract; may form explosive dust-air mixture.	NC	8	NR	T
stearic acid --------- powder (*octadecanoic acid*) $C_{18}H_{36}O_2(s)$ or $CH_3(CH_2)_{16}COOH(s)$	A	1	1	0	May cause irritation of skin, eye and respiratory tract; combustible if heated or ignited, air-dust mixture explosive.	NC	3	NR	WF/I or N/P-D
strontium ---------- solid Sr(s)	C	3	4	2 ~~W~~	Corrosive; contact may cause burns; harmful or fatal if swallowed; flammable solid, granules ignite spontaneously with air; reacts with water.	D2, E	4	4.3	WF/I

Chemical Name(s), State and Formula	Use in School Category	H*	F*	R*	Hazards	WHMIS Class	Storage Class	TDG Hazard Class	Disposal Methods
strontium acetate hemihydrate -------- crystals $SrC_4H_6O_4 \bullet 0.5\ H_2O(s)$	A	0	0	0	No adverse effects.	NC	8	NR	T
strontium chloride hexahydrate -------- powder $SrCl_2 \bullet 6H_2O(s)$	B	2	0	0	May cause irritation of skin, eye and respiratory tract; may be harmful if swallowed or inhaled.	D2	8	NR	WF/I or N/P-D
strontium nitrate --- powder $Sr(NO_3)_2(s)$	B	2	0	0 OX	Causes irritation of skin, eyes and respiratory tract; harmful if swallowed, inhaled or absorbed through skin; strong oxidant, fire risk in contact with organic material.	C, D2	6	5.1	WF/I
styrene –---------- oily liquid (*ethenylbenzene*) $C_8H_8(l)$	C	2	3	2	Causes irritation of skin, eyes and respiratory tract; harmful if swallowed, inhaled or absorbed through skin; affects the central nervous system, liver and reproductive system; flammable liquid and vapour; stabilized form polymerizes at room temperature.	B, D1, D2	5	3	WF/I
succinic acid ------- crystals (*butanedioic acid*) $C_4H_6O_4(s)$ or $HOOCCH_2CH_2COOH(s)$	A	1	1	0	Causes irritation of skin, eyes and respiratory tract, irritation to eyes may be severe; combustible if heated or ignited, air-dust mixture explosive.	D2	3	NR	T or D(aq)
sucrose ---------- crystals $C_{12}H_{22}O_{11}(s)$	A	0	1	0	High concentration of dust may irritate the eyes and respiratory tract; combustible if heated or ignited, air-dust mixture explosive.	NC	8	NR	T or D(aq)
sudan III ---------- powder $C_{22}H_{16}N_4O(s)$	A	0	1	0	No adverse health affects; combustible if heated or ignited, dust-air mixture explosive.	NC	8	NR	WF/I
sudan IV ---------- powder $C_{24}H_{20}N_4O(s)$	A	0	1	0	May cause skin, eye and respiratory tract irritation; combustible if heated or ignited, dust-air mixture explosive.	NC	8	NR	WF/I

Chemical Name(s), State and Formula	Use in School Category	H*	F*	R*	Hazards	WHMIS Class	Storage Class	TDG Hazard Class	Disposal Methods
sulfamic acid ------- crystals (*amidosulfonic acid*) H_3NO_3S(s)	B - soln. C - crystals	3	0	0	Corrosive; causes severe irritation and burns to every area of contact; may be fatal if swallowed, harmful if inhaled.	D2, E	3	8	WF/I
sulfur –---------- solid S_8(s)	B	2	1	0	Dust irritating to skin, eyes and respiratory system; may be harmful if absorbed through skin, inhaled or ingested; sulfur dust-air mixture explosive; combustible if heated or ignited releasing toxic sulfur dioxide.	D2	8	4.1	WF/I
sulfuric acid –------- solution mixture: H_2SO_4 ---------- 52 - 100% H_2O ---------- 0 - 48% H_2SO_4(aq)	A - 5% or less B - more than 5%	3	0	2 W	Corrosive; liquid and mist causes severe burns to all body tissues; may be fatal if swallowed or contacted with skin; harmful if inhaled; water reactive, releasing heat; cancer hazard with prolonged exposure to sulfuric acid mist.	D1, D2, E	1	8	WF/I or N/P-D
sulfurous acid ------ solution (*hydrogen sulfite*) mixture: H_2SO_3 ---------- 6 - 12% H_2O ---------- 88 - 94% H_2SO_3(aq)	A - 5% or less B - more than 5%	3	0	0	Corrosive with prolonged contact, causes burns to any area of contact; harmful if inhaled or ingested.	D1, D2, E	8	8	N/P-D
tannic acid ---------- powder (*tannin*) $C_{76}H_{52}O_{46}$(s)	A	2	1	0	Causes irritation to skin, eyes and respiratory tract; may be harmful if swallowed or inhaled; large amounts can cause liver and kidney damage; combustible if heated or ignited, dust-air mixture explosive.	D1, D2, E	3	NR	WF/I
L-tartaric acid ----- crystals (*2,3-dihydroxy-butanedioic acid*) $C_4H_6O_6$(s)	A	1	1	0	May cause irritation to skin and eyes; combustible if heated or ignited, dust-air mixture explosive.	E	3	NR	N/P-D or WF/I

Chemical Name(s), State and Formula	Use in School Category	H*	F*	R*	Hazards	WHMIS Class	Storage Class	TDG Hazard Class	Disposal Methods
tetrachloroethylene -- liquid (*ethylene tetrachloride*) $Cl_2CCCl_2(l)$	C	2	0	0	Harmful if swallowed, inhaled or absorbed through skin; causes irritation to skin, eyes and respiratory tract; severe or prolonged exposure affects the central nervous system, liver and kidneys; may be a human carcinogen.	D1, D2	1	6.1	WF/I
thallium metal --------- solid Tl(s)	C	3	0	0	Toxic metal; may be fatal by absorption through skin, ingestion or by inhalation of dust. Ingestion leads to nausea, vomiting, convulsions and death due to central nervous system damage; prolonged or repeated exposure may result in hair loss, kidney damage, paralysis and death.	D1, D2	8	6.1	WF/I
thioacetamide ----- crystals (*ethanethioamide*) $C_2H_5NS(s)$	A	2	1	0	Causes irritation to skin, eyes and respiratory tract; harmful if swallowed, inhaled or absorbed through skin; possible carcinogen; combustible if heated or ignited, dust-air mixture explosive.	D1, D2	8	NR	WF/I
thorium ---------- solid Th(s)	D	3	0	0	Toxic, radioactive element; avoid skin contact or inhalation of dust.	D1, D2	8	6.1	WF/I
thymol blue --------- powder (*thymolsulfonephthalein*) $C_{27}H_{30}O_5S(s)$	A	1	1	0	May cause irritation to skin, eyes and respiratory tract; combustible if heated or ignited.	NC	8	NR	WF/I
thymolphthalein --- crystals $C_{28}H_{30}O_4(s)$	A	1	0	0	May cause irritation to skin, eyes and respiratory tract.	NC	8	NR	WF/I
tin(II) chloride –--- crystals $SnCl_2(s)$	A	2	0	0	May cause severe eye and respiratory tract irritation, and digestive tract irritation with nausea, vomiting and diarrhea; may cause liver damage; hygroscopic.	D2	8	8	WF/I

Chemical Name(s), State and Formula	Use in School Category	H*	F*	R*	Hazards	WHMIS Class	Storage Class	TDG Hazard Class	Disposal Methods
tin metal ---------- granules or mossy flakes Sn(s)	A	1	1	1	May cause irritation to skin, eyes and respiratory tract; oxidizes especially in presence of moisture; dust-air mixture explosive.	NC	8	NR	T
tin(II) oxide –------- powder SnO(s)	A	1	0	0	May cause irritation to skin, eyes and respiratory tract; may cause digestive tract irritation with nausea, vomiting and diarrhea; may cause central nervous system effects.	NC	8	NR	T
tin(IV) oxide –------ powder SnO_2(s)	A	1	0	0	May cause irritation to skin, eyes, digestive and respiratory tracts.	D2	8	NR	T
tin(II) sulfate ------- powder $SnSO_4$(s)	A	2	0	0	May cause irritation to skin and respiratory tract, causes irritation to skin and digestive tract with nausea, vomiting and diarrhea; may cause central nervous system and reproductive effects; moisture sensitive.	D2	8	NR	T or D(aq)
titanium(IV) chloride---------- powder $TiCl_4$(s)	C	3	0	2 ~~W~~	Corrosive; causes severe irritation and burns to every area of contact; may be fatal if inhaled, may cause lung damage; harmful if ingested; water reactive.	D2, E, F	8	6.1 (8)	WF/I
titanium metal ---------- solid Ti(s)	A	1	0	0	Relatively nontoxic, dust can cause mild irritation of the respiratory system; dust-air mixture explosive.	NC	8	NR	R or T
titanium(IV) oxide - powder TiO_2(s)	A	1	0	0	May cause irritation to skin, eyes and respiratory tract.	NC	8	NR	T
toluene ---------- liquid (*methylbenzene*) C_7H_8(l)	C	2	3	0	Causes irritation to skin, eyes and respiratory tract; harmful if inhaled or absorbed through skin, harmful or fatal if swallowed; may affect the liver, kidneys, blood system or central nervous system; flammable liquid and vapour.	B, D2	5	3	WF/I

Chemical Name(s), State and Formula	Use in School Category	H*	F*	R*	Hazards	WHMIS Class	Storage Class	TDG Hazard Class	Disposal Methods
1,1,1-trichloroethane- liquid (*methylchloroform*) $C_2H_3Cl_3(l)$ or $CH_3CCl_3(l)$	C	2	1	1	Causes irritation of the skin, eyes and respiratory tract; harmful if swallowed, inhaled or absorbed through skin; affects the central nervous system, liver, kidneys, and cardiovascular system; possible carcinogen; hydrolyzes slowly in water to form hydrochloric and acetic acids; combustible if heated or ignited, causes ozone degradation.	D2	8	6.1	WF/I
1,1,2-trichloro-1,2,2-trifluoroethane -------- liquid (*freon*) $CCl_2FCClF_2(l)$	C	2	0	0	Causes irritation to eyes and respiratory tract; harmful if inhaled; affects the cardiovascular and central nervous systems. Destroys ozone in upper atmosphere.	D2	8	9	WF/I
triethanolamine ----- liquid (*trolamine*) $C_6H_{15}NO_3(l)$ or $(HOCH_2CH_2)3N(l)$	B	2	1	1	Causes skin irritation and severe irritation of the eyes; harmful if swallowed, chronic exposure may lead to liver and kidney damage; flammable, air-vapour mixture explosive; light and air sensitive.	D1	8	NR	WF/I
trisodium phosphate---------- crystals (*sodium phosphate tribasic, TPS*) $Na_3PO_4 \bullet 12H_2O(s)$	A	2	0	1 ~~W~~	Causes irritation of the skin, eyes and respiratory tract; harmful if swallowed or inhaled; reacts with water.	NC	8	NR	WF/I
tryptophan ---------- crystals $C_{11}H_{12}N_2O_2(s)$	A	1	0	0	May be irritating to skin, eyes, respiratory and digestive tracts.	NC	8	NR	T
tungsten –---------- solid W(s)	A	1	2	1	Dust may cause irritation to skin, eyes, digestive and respiratory tracts; flammable solid, may ignite spontaneously in air.	B	4	4.2	R or T
tungstic acid -------- powder $H_2WO_4(s)$	B	2	0	0	Causes eye irritation, harmful if swallowed or inhaled, chronic inhalation hazard.	D2, E	1	NR	WF/I or N/P-D

Chemical Name(s), State and Formula	Use in School Category	H*	F*	R*	Hazards	WHMIS Class	Storage Class	TDG Hazard Class	Disposal Methods
turpentine –---------- liquid $C_{10}H_{16}$(l)	B	2	3	0	Causes irritation to skin, eyes, digestive and respiratory tracts; harmful by ingestion, inhalation or skin absorption; flammable liquid and vapours, flashpoint 35ºC.	B, D2	5	3	WF/I
tyrosine(L & DL) -- crystals $C_9H_{11}NO_3$(s)	A	2	0	0	May cause irritation to skin, eyes and respiratory tract; may be harmful if swallowed, inhaled or absorbed through skin.	D2	8	NR	T
universal indicator–solution mixture: methyl alcohol --- 10 - 20% ethyl alcohol –-- 60 - 100% methyl ethyl ketone- <0.5% ethyl acetate ----------<0.2% phenolphthalein ----- <1.0% methyl red ---------- <1.0% bromothymol Blue - <0.2% thymol blue ---------- <0.5% butter yellow -------- < 0.1% water ---------- balance	A	2	3	0	Causes irritation of the skin and respiratory tract, severe irritation of the eyes; may be fatal by excessive ingestion, inhalation or skin absorption; flammable liquid.	B, D1	5	6.1	WF/I
urea ---------- powder (*carbamide*) CH_4N_2O(s)	A	1	0	0	Causes irritation to skin, eyes and respiratory tract; dust can be an explosive hazard if heated.	NC	8	NR	T
urethane – crystals/powder (*carbamic acid, ethyl ester*) $C_3H_7NO_2$(s)	B	1	1	0	Causes irritation to skin, eyes and respiratory tract; may cause irritation to digestive tract; solid and dust-air mixture combustible; possible human carcinogen.	NC	8	NR	WF/I

Chemical Name(s), State and Formula	Use in School Category	H*	F*	R*	Hazards	WHMIS Class	Storage Class	TDG Hazard Class	Disposal Methods
valeric acid ---------- liquid (*n-pentanoic acid*) $C_5H_{10}O_2(l)$	B	2	1	0	Irritates the skin, causes severe eye and respiratory tract irritation and possible burns; ingestion may cause irritation with nausea, vomiting and possible burns; flammable if heated or ignited.	E	3	8	WF/I or N/P-T
L-valine ----–-------- crystals $C_5H_{11}NO_2(s)$	A	1	0	0	May cause irritation to skin and severe irritation to eyes and respiratory tract.	NC	8	NR	T
vanadium ---------- powder V(s)	B	2	1	0	Causes irritation to skin and respiratory tract, and severe irritation to eyes; may cause irritation to digestive tract.	D2	8	NR	R or T
vinegar ---------- solution (*acetic acid*) mixture: CH_3COOH --------- 5 - 7% H_2O ----------93 - 95% $CH_3COOH(aq)$	A	1	0	0	Causes irritation of the nose, throat and respiratory tract; prolonged contact may cause burns and dermatitis.	NC	1	NR	N/P-D
vinyl acetate ---------- liquid $C_4H_6O_2(l)$	C	1	3	1	Irritant to skin, eyes and mucous membranes; highly flammable; possible human carcinogen.	B, D2	5	3	WF/I
vitamin C ---------- crystals (*ascorbic acid*) $C_6H_8O_6(s)$	A	1	1	0	May cause mild irritations of the skin, eyes, respiratory and digestive tracts; flammable if heated or ignited.	NC	3	NR	T or D(aq)
water glass --------- solution (*sodium silicate*) mixture: H_2O ----- 60 - 65% Na_2SiO_3- 35 - 40% $Na_2SiO(aq)$	B	2	0	0	Causes severe irritation to skin, eyes and respiratory tract; harmful if swallowed or inhaled.	D2	8	NR	WF/I
wintergreen oil ------- liquid (*methyl salicylate*) $C_8H_8O_3(l)$	A	2	1	0	Causes irritation of the skin, eyes and respiratory tract; harmful if swallowed, inhaled or absorbed through skin; affects the kidneys and central nervous system.	D2	8	NR	WF/I

Chemical Name(s), State and Formula	Use in School Category	H*	F*	R*	Hazards	WHMIS Class	Storage Class	TDG Hazard Class	Disposal Methods
xylene (1, 2 & 1, 4 forms)---------- liquid (*dimethylbenzene*) $C_8H_{10}(l)$	C	2	3	0	Causes irritation of the skin, eyes and respiratory tract; may be harmful if swallowed or inhaled; causes central nervous system depression; flammable liquid and vapour, vapour-air mixture explosive.	B, D1, D2	5	3	WF/I
zinc acetate --------- powder $ZnC_4H_6O_4(s)$	A	2	1	0	Causes irritation of the skin, eyes and respiratory tract; harmful if swallowed or inhaled; combustible if heated or ignited.	D2	8	NR	WF/I or N/P-T
zinc carbonate ----- powder $ZnCO_3(s)$	A	2	0	0	May cause irritation to skin, eyes and respiratory tract; may be harmful if swallowed, inhaled or absorbed through skin.	D2	8	9	WF/I or N/P-T
zinc chloride ------ granules $ZnCl_2(s)$	B - soln. C - granules	3	0	0	Corrosive; causes burns to any area of contact; harmful if swallowed or inhaled, extremely destructive to mucous membranes; affects the cardiovascular system.	D1, D2, E	8	8	WF/I or N/P-T
zinc metal--(mossy) chunks Zn(s)	A	2	1	1	Dust may cause irritation to skin, eyes and respiratory tract; harmful if swallowed or inhaled; dust-air mixture explosive, water reactive.	D2	8	NR	R or T
zinc nitrate hexahydrate -------- crystals $Zn(NO_3)_2 \bullet 6H_2O(s)$	A	2	0	2 OX	Causes irritation to skin, eyes and respiratory tract; harmful if swallowed or inhaled; strong oxidizer, increases flammability of combustible substance in contact with it.	C, D1	6	5.1	WF/I
zinc oxide ---------- powder ZnO(s)	A	1	1	0	May irritate the respiratory tract; dust-air mixture explosive.	NC	8	NR	T
zinc sulfate heptahydrate ------- crystals $ZnSO_4 \bullet 7H_2O(s)$	A	2	0	0	Causes irritation to skin, eyes and respiratory tract; harmful if swallowed, inhaled or absorbed through skin.	D2	8	NR	WF/I or N/P-T

Chemical Name(s), State and Formula	Use in School Category	H*	F*	R*	Hazards	WHMIS Class	Storage Class	TDG Hazard Class	Disposal Methods
zinc sulfide ---------- powder ZnS(s)	A	1	0	1 ~~W~~	Causes irritation to skin, eyes and respiratory tract; harmful if swallowed or inhaled; contact with stomach acid produces toxic hydrogen sulfide; reacts with water to produce zinc sulfate.	D2	8	NR	T
zirconium ---------- chunks Zr(s)	A	0	1	0	Metal nontoxic; combustible if heated.	NC	8	4.1	R or WF/I
zirconium ---------- powder Zr(s)	A	1	2	0	Causes some irritation to skin, eyes and respiratory tract; ingestion causes severe irritation to mucous membranes; flammable.	B, D1	4	4.1	WF/I

APPENDICES

Appendix A: Example Science Safety Rules and Procedures

Referenced on pages 21, 58 and 59 of this document.

1. Learn about safe and unsafe practices before beginning science activities.
   - Pay attention to safety notes provided by the teacher or textbook.
   - Find out what procedures are safe and which ones are unsafe.
   - Learn the location, purpose and use of safety equipment.
   - Speak out if you have a safety concern or question.
2. Use protective devices and clothing to ensure safety of eyes, face, hands and body.
   - When instructed, wear safety goggles and protective clothing.
   - Wear closed shoes during laboratory sessions.
   - Tie your hair back if it is long.
3. If you wear contact lenses, notify the teacher. Some activities may require you to remove contact lenses.
4. Behave responsibly at all times during science activities.
5. Use chemicals safely and responsibly.
   - Take only as much chemical as needed and never return excess chemicals to the original container.
   - Handle chemical containers safely; e.g., hold bottles by the base, not by the neck.
   - Use chemicals in the lab only.
   - Dispose of chemicals as directed by your teacher.
6. Alert the teacher immediately if an accident or spill occurs.
7. Clean up your work area after science activities.
8. Wash your hands thoroughly with warm water and soap at the end of each activity.
9. Do not use equipment if it appears to be in an unsafe condition. For example, do not use cracked or chipped glassware.
10. Do not eat or drink in the science classroom. Do not taste anything unless you are instructed to do so.

Appendix B: Sample Student Safety Contract/Agreement—Elementary

Referenced on pages 8 and 19 of this document.

Class: _____ Student's Name: _____

Teacher's Name: _____

Room: _____

I am learning to be a good scientist. I know that to learn science safely I must be neat, organized and responsible.

I promise to:

- be prepared for science activities
- listen to directions and make sure that I understand them before I start
- follow directions
- observe carefully
- be calm and quiet so that I can learn more
- handle equipment carefully and put it away when I am done
- wash and return all things to their proper places, then wash my workspace and my hands
- follow all safety rules.

Student (signature): _____ Date: _____

Parent (signature): _____ Date: _____

Appendix C: Sample Student Safety Contract/Agreement—Secondary

Referenced on pages 8 and 21 of this document.

Class: _____ Student's Name: _____

Teacher's Name: _____

I understand that accidents can be caused by being unprepared, careless or in a hurry. I will come to class prepared to be responsible, so that my safety and welfare as well as that of others is not jeopardized.

I will:

- follow all written and oral instructions given by the teacher
- ask any questions or state any concerns I have before beginning a laboratory procedure
- behave in a manner that will ensure the health and safety of myself and others in the laboratory or classroom at all times
- use protective devices for my eyes, face, hands, body and clothing during laboratory activities
- know the location and use of first aid and fire extinguishing equipment
- refrain from eating, drinking, chewing gum or applying cosmetics in the laboratory
- keep my work area clean and free of clutter during laboratory class.

I have read the written science safety rules prepared by my teacher and agree to follow these and any other rules.

Student's signature: _____ Date: _____

Parent's signature: _____ Date: _____

Teacher's signature: _____ Date: _____

Please list any known allergies or health problems, such as asthma, epilepsy, heart condition that may affect participation in science activities. If additional space is needed, please use the back of this sheet.

_____

_____

Do you wear contact lenses: ❑ YES ❑ NO

Students wearing contact lenses need to be identified in case of accidents that might require contact lens removal. Removal of contact lenses will be done by trained personnel in cases where the student cannot remove them on his/her own. All students will be required to wear safety goggles for certain activities, even if they wear contact lenses or prescription glasses.

Parent/Guardian Signature: _____ Date: _____

Appendix D: Chemical Laboratory Safety Inspection Checklist

Referenced on pages 23 and 49 of this document.

Inspect By: _____ Date: _____

Building and Room: _____

A. Documentation	Yes	No	N/A	Comments
Science safety rules and procedures are posted?				
Emergency procedures are posted?				
Chemical spill response guidelines are available?				
Chemical inventory is available and up to date?				
MSDSs are available for all controlled products?				
WHMIS and other training records available?				

B. Housekeeping

Benches and sinks are clean and tidy?				
Exit doors are unobstructed?				
Aisles are unobstructed?				
No tripping hazards are present (e.g., cords, hoses, equipment)?				
Separate disposal bin is available for broken glass?				
No food or drink is present in the laboratory?				

C. Emergency and Safety Equipment

Appropriate fire extinguisher(s) is available?				
First aid kit is accessible and fully stocked?				
Safety glasses are available and in use?				
Laboratory coats and gloves are available and properly used?				
Eyewash is available and accessible?				
Emergency shower is available and accessible?				
Spill kit accessible and fully stocked?				

D. Chemical Storage

All chemicals have WHMIS compliant labels?				
Chemicals are segregated by compatibility class?				
Chemicals are dated upon receipt?				
Peroxides are labelled with container opening date?				
All gas cylinders are upright and secured in cool storage?				
Chemical waste is properly stored and labelled?				

Appendix E: Accident/Incident Report Form

Referenced on page 32 of this document.

Part A – to be completed by individual(s) directly involved or injured in the incident.

☐ Medical Aid ☐ Lost Time ☐ Spill/Contamination/Environmental Release
☐ Near-Miss ☐ Property Damage

IDENTIFY – Person(s) involved

Date and time of Incident

_____ / ____ / _____ _____ AM / PM
First Name Last Name YR MO DD HH:min

Date and Time of **Medical Evaluation**: ____ / ____ / ____ / _____

☐ School Nurse
☐ Hospital
☐ Clinic or Family Physician

YR MO DD HH:mm

Exact details of injury/illness and treatment (e.g., body part involved, cut, strain, bruise, illness symptoms and date of onset, etc.)

_____
_____
_____
_____

W.C.B. Form: (Please check) ☐ Has been prepared and forwarded
☐ Not required

Description of Incident (add additional pages if necessary)
State exactly the sequence of events leading to the incident, where it occurred, what the person was doing, the size, weight and type of equipment or materials involved, etc.

_____
_____
_____
_____
_____

WITNESSES (If any)

NAME	DEPARTMENT	TELEPHONE NO.

PROPERTY DAMAGE

Identify property involved. Give machine name, tool name, etc.	Description of damage or loss	Estimated value of loss

(over)

Parent/Guardian to notify: _____ Telephone No. : _____

Completed by: _____ Date: _____

Print Name

_____ **Forward to Supervisor Immediately**

Signature

Part B – To be completed by Supervisor within 24 hours.

Why did it happen? (conditions and/or actions contributing to injury / incident)

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

Parent/Guardian Notification: Name: _____

Date: _____

Time: _____

Corrective Actions to Prevent Reoccurrence	**Action By Whom and Date to Be Completed**

Investigated by: _____ Title: _____

_____ Telephone No.:_____ Date:_____

Signature

Chemical Inventory

Review date _____

Chemical	Quantity	Supplier	MSDS Mo/Yr	Purchase Date(s)	Storage Location	Disposal

Appendix G: List of Chemical Waste Brokers

Referenced on page 111 of this document.

This information was current as of August 2005. Changes since that date will be reflected in the listing provided by Alberta Environmental Protection at http://www3.gov.ab.ca/env/waste/rr/index.html. Click on *Alberta Facilities with an Environmental Protection and Enhancement Act* Approval to bring up a current list.

Approval ID.	Company Name	Location	Telephone No.	Type of Operation
71724	652395 Alberta Ltd. (L & P Disposals)	High Level	780–926–2988	High Level Used Oil Recycling Facility
10522	Astra Battery Recycling Inc.	Wetaskiwin	780–352–6477	Wetaskiwin Battery Recycling
140712	BK Oilfield Disposal Ltd.	Sexsmith	780–538–1338	Sexsmith Waste Storage Facility
19712	Bearspaw Carbon	Crossfield	403–946–4655	Crossfield Hazardous Waste and Hazardous Recyclables
48516	Byram Industrial Services Ltd.	Drayton Valley	780–542–4733	Pembina Hazardous Waste Landfill
11366	Canadian Oil Recycle Corp.	Spirit River	780–864–2140	Spirit River Used Oil Storage and Transfer Facility
11442	CCR Technologies Ltd.	Brooks	403–543–6699	Brooks Solvent Recycling
1821	Ceda Reactor Ltd.	Edmonton	780–472–6766	Edmonton Waste Management
136500	CFR Chemicals Inc.	Red Deer	403–346–2214	Red Deer Hazardous Recycling Storage and Processing Facility
49829	City of Edmonton	Edmonton	780–496–6797	City of Edmonton South ECO Station
202459	City of Edmonton	Edmonton	780–496–7977	City of Edmonton Northwest ECO Station Facility
151196	City of Edmonton, Transportation & Street	Edmonton	780–496–4621	Edmonton Hazardous Waste Storage
10348	Clean Harbors Canada, Inc.	Ryley	780–663–3828	Ryley Hazardous Waste Landfill
233	Criterion Catalysts & Tech.	Medicine Hat	403–528–8390	Medicine Hat Catalyst Regeneration and Manufacturing Plant
134	Custom Environmental	Edmonton	403–440–1825	Elmjay Industrial Park Hazardous Waste Storage
83252	Custom Industrial Cleaners	Drayton Valley	780–542–2462	Drayton Valley Used Oil Storage and Recycling Facility
10195	DBS Environmental	Lethbridge	403–328–4833	Lethbridge Hazardous Waste and Recyc. Storage and Transfer Fac.
1744	Earth Tech (Canada) Inc.	Swan Hills	780–333–4197	Alberta Special Waste Treatment Centre
167152	Eco-Max Inc.	Slave Lake	780–849–5549	Slave Lake Hazardous Waste Recyclable Storage Facility
522	EIL Environmental	Onoway	780–448–0866	Onoway Hazardous Waste Storage and Transfer
9963	EnviroSORT Inc.	Red Deer	403–342–7823	Red Deer (Blindman Industrial Park) Hazardous Waste
70990	EnviroSORT Inc.	Grande Prairie	780–532–7384	Grande Prairie Hazardous Recyclable Storage Facility
207217	Enviro West Inc.	Big Valley	780–416–8444	Big Valley Hazardous Recyclable Storage Facility
77465	Enviro Waste Management Services Ltd.	Peace River	780–624–4613	Peace River Hazardous Waste Storage and Recyclable Facility
183662	General Recycling Industries Ltd.	Edmonton	780–461–5555	Edmonton Battery Storage Facility
71259	Great Western Containers Inc.	Edmonton	780–440–2222	Edmonton South Container Reconditioning Facility

Reproduced from Alberta Environment, "Alberta Facilities with an Environmental Protection and Enhancement Act Approval to Manage Hazardous Waste/Hazardous Recyclables, "June 24, 2005, http://www3.gov.ab.ca/env/waste/rr/pubs/ApprovedFacilitiesForHazardousWasteAndRecyclables.pdf (Accessed August 2005).

Approval ID.	Company Name	Location	Telephone No.	Type of Operation
72803	Great Western Containers Inc.	Calgary	403–279–2191	Calgary Hazardous Waste (Drum Reconditioning) Plant
49861	Hazco Environmental Services Ltd.	Beaverlodge	780–354–3279	Beaverlodge Waste Storage and Transfer
10050	Hazco Environmental Services Ltd.	Calgary	403–297–0444	Calgary Waste Storage and Transfer
206356	Hazco Environmental Services Ltd.	Edmonton	780–456–1444	Edmonton Waste Processing and Transfer Facility
9790	Hub Oil Company	Calgary	403–273–2515	Calgary Used Oil Recycling Plant
1559	Jasper National Park	Jasper	780–852–6170	Jasper Hazardous Waste Storage
69000	Little Dipper Holding Ltd.	Lloydminister	888–333–0657	Lloydminster Hazardous Recyclable Storage/Processing
132	Maple Leaf Metal Industries Ltd.	Edmonton	780–468–3951	Edmonton Metal Processing
9729	Newalta Corporation	Airdrie	403–948–1360	Airdrie Shurtleff Oil Processing
149	Newalta Corporation, Edm. Processing	Edmonton	780–440–6780	Edmonton Fuel Blending and Used Oil Processing
101	Newalta Corporation, Edm. Tank Farm	Edmonton	780–440–6780	Strathcona Hazardous Recyclable
119	Newalta Corporation	Grande Prairie	780–469–2324	Grande Prairie Used Oil and Waste Plant
9774	Newalta Corporation	Lacombe	403–948–1360	Lacombe Bunker Fuel Blending Plant
9716	Newalta Corporation	Redwater	780–942–2240	Redwater Sludge Dewatering
1505	Newalta Corporation, Ray. Processing	Raymond	403–752–3213	Raymond Solvent Recycling and Fuel Blending
1459	Newalta Corporation, Ray. Tnkfrm	Raymond	403–752–3213	Oil and Waste Solvent Collection and Storage
1399	Newalta Corporation	Calgary	403–236–2203	Calgary Hazardous Waste Storage and Transfer
194967	Newalta Corporation	Morinville	780–942–2240	Morinville Disposal Well Tank Farm
11385	Pat's Off-Road Transport Ltd.	Medicine Hat	403–527–4774	Redcliff Hazardous Recyclable Storage
207336	Product Management Corporation	Calgary	403–236–4036	Calgary Reverse Logistics Facility (Hazardous Waste Storage and Transfer Facility)
68686	RB Williams, Edmonton Processing	Edmonton	780–438–2183	Edmonton Hazardous Recycling/Industrial Waste
192751	Rotex Manufacturing & Distributing Ltd.	Edmonton	780–465–0637	Edmonton Hazardous Recyclable Processing Facility
140	Safety Kleen Canada Inc.	Nisku	780–955–2788	Nisku Hazardous Waste Storage and Transfer
10111	Safety Kleen Canada Inc.	Calgary	403–243–3877	Calgary Hazardous Recyclable Storage and Transfer
11531	Sumas Environmental Services Inc.	Big Valley	780–955–2390	Big Valley Waste Solidifi/calcifica/Fixation Plant
184498	Sumas Environmental Services Inc.	Nisku	780–955–2390	Nisku Hazardous Waste Facility
17929	The ECL Group of Companies, Tnkfrm	Edmonton	780–466–3030	Edmonton Recyclable Storage and Fuel Blending
1439	The Recycle Systems Company	Nisku	780–955–2508	Nisku Aerosol Recycling Plant
11614	University of Calgary	Calgary	403–220–6345	Calgary Haz. Waste and Recycl. Storage and Transfer
20370	U of A	Ellerslie	780–492–5655	Ellerslie Waste Management
21004	Van Brabant Oil Ltd.	Morinville	780–939–5073	Morinville Waste Oils and Lube Filters
200305	WasteCo Environmental Services Ltd.	Leduc	780–980–6665	Leduc Storage, Recycle and Transfer Station Facility

Appendix H: Suggested Science Department Safety Policies and Procedures

Referenced on page 58 of this document.

Teacher classroom practice should be a good example of safety in action and be consistent with laboratory procedures set out for students. Example policies and procedures for science teachers include:

Policies

1. Safety always precedes other priorities in planning for laboratory activities. If the design of an investigation compromises safety it should be modified or avoided.
2. Materials to be used in student activities are prepared and the classroom environment set up in ways that minimizes safety risks.
3. Teachers model safe behaviour and provide guidance, direction and supervision to support student safety.
4. In preparation for science activities, students are made aware of potential risks, appropriate procedures, procedures to avoid, and procedures to follow in case of an accident.
5. Open-ended investigations proposed by students are not be approved until a complete risk assessment has been done and precautions can be identified before any hazards are encountered.
6. In general, if the regular classroom teacher is absent, practical laboratory activities should not be done. Special concessions may be made if the supply or substitute teacher is an experienced science teacher.

Procedures

1. Teachers hand out, discuss and post laboratory rules and procedures for students.
2. Teachers diligently enforce laboratory rules.
3. Teachers require students to report all accidents.
4. Teachers do not leave students unsupervised in laboratories.
5. Teachers are aware of the location of all emergency equipment such as fire extinguishers, first aid kits and eyewash facilities, and know how to use them.
6. Teachers educate their students about the emergency procedures of the school and the fire exits in their area.
7. Teachers inform students of any hazards that may be associated with specific activities and the precautions they should take to minimize these risks.
8. Lock science laboratories when not in use.
9. Turn off gas taps at the end of each class/day. Put away any 110 volt operated electrical apparatus when not required for classroom use.

Appendix I: Basic Laboratory Techniques

Referenced on page 56 of this document.

1. Lighting a Bunsen Burner

Steps to follow are:

a. Attach the rubber intake hose of the Bunsen burner to the nearest gas valve.
b. Check that all gas valves at the laboratory benches are shut off, then open the main gas valve.
c. Close off air intake ports at the base of the barrel so as to produce a cool red flame upon lighting. This is done either by rotating the barrel clockwise until it stops or rotating a sleeve at the base of the barrel to cover intake ports.
d. If there is a gas valve at the base of the barrel check that it is open about one-half to one revolution.
e. Fully open the valve attached to the intake hose. If there is no valve at the base of the barrel, then partially open the valve at the intake hose. Using a flint striker or a match, light the gas at the top of the barrel. If there is too much gas/air mixture coming through the barrel, it will create a strong current of gas difficult to light and one that may blow out the match. If this happens, check the air intake ports to ensure they are closed. Once lit, you should have a cool red flame.
f. The air ports can then be opened by turning the barrel counterclockwise or rotating the sleeve to get the desired intensity of flame (blue flame is hottest).
g. The gas valve can be opened further to get a bigger flame.

2. Making the Alcohol Burner Flame More Visible

The alcohol burner flame tends to be pale blue in colour making it somewhat difficult to see which increases the probability of burns. Add some salt to the burner fuel to colour the flame orange, making it more visible.

3. Pouring Solutions Into a Funnel Filter

Pour the liquid along a glass stirring rod, the end of which is in line with the centre of the filter in the funnel. This will avoid slashing of solution or liquid.

4. Diluting Concentrated Acids and Bases

Working with concentrated acids or bases safely requires careful handling and an understanding of hazards involved. The following steps help to reduce the inherent hazards associated with these concentrates:

a. Put on a long sleeved laboratory coat, rubber gloves and full face protection.
b. Determine the volume ratio of water and acid/base required for the concentration intended and the total volume of dilute acid/base needed. Lets assume 1 L of 10% sulfuric acid is required and 50% sulfuric acid is on the shelf. To get a 10% concentration requires a ratio of 2 mL of 50% acid to 8 mL of distilled water. Therefore, to make 1 L of 10% acid, add 200 mL of the acid to 800 mL of water.
c. Measure the required amount of the concentrated acid or base in a graduated cylinder. This can be done in a fume hood to avoid inhaling fumes, particularly acid fumes that are very corrosive. Now add it slowly to the proportionate amount of water in another container. Using a glass stirring rod, stir the water as the acid

or base is added to dissipate the heat. Never add the water to the concentrated acid or base as this causes an excessive build-up of heat and spattering may result.

d. Avoid inhaling concentrated acid vapours.

5. Cutting Glass Tubing

Follow the procedure as outlined.

a. Etch the glass with a triangular file.
b. With the etch facing away from you, hold the tubing with both hands so that the thumbs are pressing on each side of the etch. Apply gentle pressure on the thumbs to snap the tubing.
c. Glazing of fire polishing the cut end of the tubing in a hot Bunsen burner flame will remove the rough edges.

6. Inserting Glass Tubing Into a Stopper

Safe insertion of tubing or a thermometer into a rubber stopper can be done as follows:

a. Ensure there are no rough edges on the end being inserted. If necessary, glaze the end in a hot flame and let cool.
b. Lubricate the glass with glycerin, vaseline or stopcock grease.
c. Wrap a cloth around the tubing or thermometer, or put on thick gloves before starting the insertion.
d. Grasp the tubing close to the end to be inserted with the fingers of one hand and the stopper in the fingers of the other. Avoid grasping either with the palm of your hand.
e. Insert with a rotating motion while applying gentle pressure. Avoid excessive force that can snap the tubing. If excessive force is required check to ensure the hole is large enough to accommodate the tubing.

Note: If glass tubing or thermometers remain in stoppers for prolonged periods of time the stoppers will harden and the glass will bind to the stopper surface. Do not attempt to push or pull glass tubing or thermometers from rubber or cork stoppers that have hardened. It is best to cut away the stopper from the glass with a sharp knife or scalpel.

7. Boiling Liquids

Liquids often boil in an uneven fashion called “bumping” because bubbles of steam cannot form regularly on the smooth container walls. This leads to irregular flashes of superheating that results in large bubbles of steam erupting violently to the surface causing splashing and spitting, or, at worst, expulsion of contents from full containers.

Bumping can be prevented by adding a few boiling chips to the liquid before you start heating. These chips provide a rough surface upon which bubbles can form. Avoid adding the chips to liquids near boiling temperature because this can cause immediate boiling over of the liquid. “Porous” boiling chips cannot be reused since the pores become filled with liquid on cooling. “Sharp” chips like silicon carbide or coal are reusable until they become coated with residues and become ineffective.

8. Heating Flammable Liquids

Heating flammable liquids should be done in a water bath heated by a hot plate. Test tubes of flammable liquid can be placed in a beaker of water large enough to immerse the test tube contents but small enough to keep the tubes upright. If the use of an open flame cannot be avoided in heating the water bath container, place the container on a wire gauze or alternative surface to ensure that the flame does not reach the flammable vapours. Alternatively, a larger metal tray of water placed on a stand plus a beaker of water set into the tray to hold test tubes of flammable liquid would be the safest arrangement when an open flame is used. If it is the beaker itself that holds the flammable liquid, then it may have to be weighed down to offset buoyancy while in the water bath.

9. Avoiding a Van De Graaff Discharge

Operating a Van De Graaff generator in a draft-free room with low humidity may result in a build up of electric charge on your body if your shoes are nonconducting and prevent flow of current to the floor. Once electrified, you will get an electric discharge if you touch any grounded object such as the metal switch to turn the machine off. To avoid this unpleasant “zap” hold a small metal object in your hand while using the generator, then touch it against ground before turning off the generator switch with your other hand.

10. Removing Stuck Glass Stoppers

Follow the procedure outlined below:

a. Stand the bottle in a large sink.
b. Cover the stopper and the neck of the bottle with a cloth.
c. Gently tap the stopper. If the jammed stopper is glass, use another glass stopper to tap against it, since glass stoppers will set up a resonance that will often successfully loosen the stopper stuck in the bottle.
d. If possible, run the neck of the bottle under a stream of hot water to allow for expansion of the neck, then repeat the tapping.
e. If these measures fail, it will be necessary to break the neck of the bottle to remove its contents. Score around the neck with a glass file, then apply a point of hot glass to the score mark. The neck should break cleanly along the score mark.

11. Weighing Chemicals

When handling chemicals, keep the following points in mind:

a. Wear a protective apron and gloves.
b. Always place the powdered chemical on paper (filter paper, hand towel) when weighing necessary amounts; avoid chemical contact with metal pan of balance.
c. Use a fume hood when handling powders of more toxic or corrosive chemicals to avoid inhalation.
d. Replace the cover or stopper on the chemical container as soon possible, particularly for more volatile substances.
e. If required to smell the chemical or solution, hold the container slightly in front of and beneath your nose and waft the fumes towards your nostrils with your hand. Never smell it directly.

12. Use of Scalpels

Remember the following points when using scalpels:

a. Always cut away from fingers near the area being dissected.
b. Never try to catch a scalpel that has been dropped.
c. After completing a series of dissections immerse in 5% sodium hypochlorite solution for at least 30 minutes to prevent carry over of contaminants. Follow with a thorough cleaning of scalpels.

13. Use of an Autoclave

Autoclaves are high pressure steam or dry heat devices used to sterilize infected or potentially infected material, or to prepare for sterilized solutions or equipment. To operate an autoclave safely, remember the following points:

a. Ensure the door is completely closed before starting the sterilization process.
b. Use containment procedures when sterilizing known infected material. Wear full protection including a long-sleeved laboratory coat or gown, protective gloves and a face mask as a minimum protection against infection.
c. Always use a “hot hand” or glove to remove any article from the autoclave. It must never be presumed that the autoclave has cooled down.
d. Carry out regular sterilization effectiveness testing using spore strips or an equivalent.
e. Regularly check mechanical parts of the autoclave for normal functioning. Poorly maintained autoclaves can be lethal.

14. Pressure Cooker Type Autoclave

a. Ensure safety valve is clear and operative.
b. Tighten wing nuts evenly by tightening two opposite nuts simultaneously.
c. Do not allow the operational pressure (gauge reading) to exceed that specified in the operation manual. Generally, this will be between 101.3 kPa to 138 kPa (15–20 psi) pressure.
d. Allow to cool before opening the stopcock to equalize pressure.
e. Remove the cover only when the pressure has been equalized.

15. Shaking a Test Tube

The proper and safe technique of shaking the contents of a test tube is as follows:

a. Place a stopper into the tube.
b. Shake the tube by flicking it with your finger or by holding the stopper with your thumb and turning the tube over several times.

Appendix J: Web Site Addresses for Acts, Regulations, Codes and Bylaws

Referenced on page 4 of this document.

Environmental Protection and Enhancement Act
http://www.qp.gov.ab.ca/documents/Acts/E12.cfm?frm_isbn=0779727215
(Accessed August 2005)

Waste Control Regulation (Alberta)
http://www3.gov.ab.ca/env/protenf/legislation/factsheets/waste.html (Accessed August 2005)

Environment Protection Act (Canada)
http://laws.justice.gc.ca/en/C-15.31/fulltoc.html (Accessed August 2005)

Hazardous Products Act (Canada)
http://www.cbsa-asfc.gc.ca/E/pub/cm/d19-5-1/d19-5-1-e.pdf (Accessed August 2005)

Labour Relations Code (Alberta)
http://www.qp.gov.ab.ca/documents/acts/L01.cfm (Accessed August 2005)

Occupational Health and Safety Act (Alberta)
http://www.qp.gov.ab.ca/documents/Acts/O02.cfm?frm_isbn=0779714946
(Accessed August 2005)

Occupational Health and Safety Code
http://www3.gov.ab.ca/hre/whs/publications/pdf/ohsc-1.pdf (Accessed August 2005)

Transportation of Dangerous Goods Act (Canada)
http://laws.justice.gc.ca/en/T-19.01/fulltoc.html (Accessed August 2005)

Canada Water Act
http://laws.justice.gc.ca/en/C-11/24944.html (Accessed August 2005)

School Act (Alberta)
http://www.qp.gov.ab.ca/documents/Acts/S03.cfm?frm_isbn=077973212X
(Accessed August 2005)

Teaching Profession Act (Alberta)
http://www.qp.gov.ab.ca/documents/Acts/T02.cfm?frm_isbn=0779732332
(Accessed August 2005)

Sewer Service Bylaw (City of Calgary Bylaw 24M96)
http://www.calgary.ca/docgallery/bu/cityclerks/24m96.pdf (Accessed August 2005)

Sewer Use Bylaw (City of Edmonton Bylaw 9675)
http://www.edmonton.ca/bylaws/C9425.doc (Accessed August 2005)

Appendix K: Category D Chemicals

Referenced on page 123 of this document.

1. acetaldehyde
2. acetyl chloride
3. acrolein
4. acrylic acid
5. ammonium fluoride
6. ammonium oxalate
7. ammonium sulfide
8. ammonium vanadate
9. antimony pentachloride
10. antimony trichloride
11. arsenic
12. asbestos
13. arsenic pentoxide
14. arsenic trichloride
15. arsenic trioxide
16. barium powder
17. benzene
18. benzenesulfonic acid
19. benzoyl peroxide
20. beryllium salts
21. bromine liquid/gas
22. cadmium metal powder
23. cadmium salts
24. calcium sulfide
25. carbolic acid
26. carbon disulfide
27. carbon tetrachloride
28. chlorine gas
29. chloroform
30. chromium (VI) oxide
31. chromium (VI) salts
32. cobalt powder
33. colchicine
34. copper metal powder
35. diethyl ether (ethyl ether)
36. dimethyl sulfate
37. dinitrophenol
38. 1,4-dioxane
39. ethylamine (liquid and gas)
40. ethyl bromide
41. ethylene dichloride
42. ethylenediamine
43. fluorine
44. formaldehyde
45. hydrofluoric acid
46. hydrogen cyanide (hydrocyanic acid)
47. hydrogen sulfide
48. lead metal powder
49. lead compounds (powders)
50. nickel metal (powder)
51. nickel compounds
52. nitrogen dioxide (commercial cylinders of gas)
53. paraformaldehyde
54. perchloric acid
55. phenol
56. phosphorus (yellow)
57. picric acid
58. potassium chromate
59. potassium dichromate
60. prussic acid
61. sodium arsenite
62. sodium oxalate
63. sodium sulfide
64. thorium

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