SAFETY IN ELEMENTARY SCIENCE AND TECHNOLOGY

A Reference Guide for Elementary School Educators

Science Teachers' Association of Ontario /
L'Association des professeurs de sciences de l'Ontario

Encouraging Excellence in Science Education Through Leadership & Service

Science Teachers' Association of Ontario
STAO APSO
L'Association des professeurs de sciences de l'Ontario

Acknowledgements

This K – Grade 8 Science and Technology Safety Resource was developed and produced through a partnership of the Science Teachers' Association of Ontario/L'Association des professeurs de sciences de l'Ontario (STAO/APSO) and the Toronto District School Board (TDSB).

The partners wish to thank everyone who supported the preparation of this resource including.

Project Managers: Stephan Bibla
Jeff Major
Denis McGowan

Writers: Leesa Blake
Kris Levey
Audra Morgan
Brad Parolin
Nandanee Sawh
Otto Wevers

Contributor: Annelies Groen, Karen Johnson

Editors: Carmen Yu, Julia Lee

Safety Reviewer: Dave Gervais, STAO Safety Committee
Curriculum Reviewer: Chuck Hammill, STAO Elementary Curriculum Committee
Content Reviewers: Chris Broadbent, Health and Safety, TDSB
University of Guelph
Equity Reviewer: Moira Wong

Designer: Andrea MacLeod

Please direct information or inquiries to:

Website: www.stao.org

Email: info@stao.org

Mail:
STAO/APSO Safety Committee
c/o Membership Office
Box 771
Dresden ON N0P 1M0

Fax: 1-800-754-1654

ISBN 978-1-894592-63-5 Safety in Elementary Science and Technology

Printed February 2014

Disclaimer

The enclosed information and the conclusions, findings and opinions expressed herein is to be considered as suggestions and recommendations only and is neither to be considered as legal requirements nor as the policy of The Science Teachers' Association of Ontario/L'Association des professeurs de sciences de l'Ontario (STAO/APSO). 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, or because of local present, new or modified legislation in any region where the enclosed information is followed. Neither the STAO/APSO nor the individual contributors, on behalf of themselves, their agents, sub-committees or anyone acting on their behalf, make any representations, warranties or guarantees regarding the correctness or sufficiency of the information, outcome or the use to which the information in this publication is put and are not assuming any liability for any claims, losses or damages arising out of the use of this publication or any of the material herein. The conclusions, findings and opinions expressed herein are those of the individual contributors and not of STAO/APSO. School boards, as employers, must comply with all Acts and Regulations eg., Occupational Health and Safety Act and WHMIS regulations as they pertain to safety in the workplace. Teachers should follow the employer's instructions. However, if the teacher feels that the board requirements will result in an unsafe procedure, then the teacher has the right to refuse work provided that students have been secured safely away from the unsafe environment.

Specific situations will require discussions with the principal and the board's Joint Health & Safety Committee. Finally, the teacher may require professional legal counsel.

Table of Contents

Introduction

This resource is written for elementary school teachers and administrators to provide guidance for the safe delivery of hands-on science and technology programs to students. The resource focuses closely on the elementary science and technology curriculum (*The Ontario Curriculum, Science and Technology, Grades 1–8 (2007) Revised*).

A Safety Planning Framework is used throughout this resource to assist teachers in planning hands-on activities for each strand in the curriculum. The Framework helps teachers to:

- identify hazards;
- assess risks; and
- make safety plans.

In elementary school, students explore scientific and technological concepts using equipment, materials, and strategies as well as hand and power tools (and the associated skills). The materials and equipment used in elementary science and technology programs are usually less hazardous than those used in secondary school programs. Nevertheless, teacher training is essential to help ensure that student activities are conducted safely and effectively.

For the purposes of this document, "students" **includes** students with English language learning needs, religious accommodation needs, and various special education needs:

- accommodations only;
- modified programs and modified expectations with the possibility of accommodations; and
- alternative programs with alternative expectations.

1

Ontario's Grades 1–8 Science and Technology Curriculum and Safety

1.1 Safety and the Curriculum

Teachers

Teachers must assume a number of roles and responsibilities to facilitate their students' safe participation in scientific inquiry and technological problem solving. Teachers are

> *...responsible for ensuring the safety of students during classroom activities and for encouraging and motivating students to assume responsibility for their own safety and the safety of others.*
>
> (*The Ontario Curriculum Grades 1–8, Science and Technology, 2007, revised, p.8*)

The Science and Technology curriculum policy document further specifies that

> *...teachers must model safe practices at all times and communicate safety expectations to students in accordance with school board and Ministry of Education policies.*
>
> (*The Ontario Curriculum Grades 1–8, Science and Technology, 2007, revised, p.29*)

The curriculum document suggests that, to conduct activities safely in their classrooms, teachers should have:

- the knowledge required to safely use the materials, tools, and procedures for the activity;
- the knowledge to care for living things—plants and animals—when brought into their classroom and after students have finished working with them; and
- the skills required to perform tasks efficiently and safely.

Students

Students also have responsibilities for their own safe participation in science and technology activities. Students demonstrate that they accept these responsibilities when they:

- maintain a well-organized and uncluttered work space;
- follow established safety procedures;
- identify possible safety concerns;
- carefully follow the instructions and example of the teacher;
- suggest and implement appropriate safety procedures; and
- consistently show care and concern for their safety and that of others.

(*The Ontario Curriculum Grades 1–8, Science and Technology, 2007, revised, p. 30*)

Curriculum Expectations and Training

The curriculum document specifies that students should investigate scientific and technological concepts using a variety of equipment, materials, tools, and strategies. It also requires that students conduct all of these investigations safely, as described in the specific curriculum expectation 2.1, in all strands and all grades. For example, in the Understanding Life Systems strand, Grade 3, the curriculum states that students will

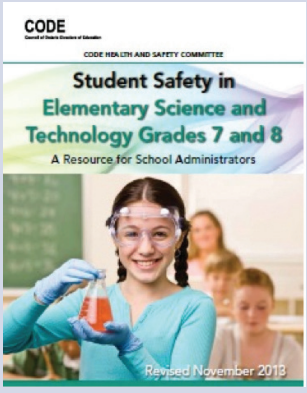
> *...follow established safety procedures during science and technology investigations (e.g., avoid touching eyes when handling plants; never taste any part of a plant unless instructed to do so by a teacher).*

In the Understanding Structures and Mechanisms strand in Grade 8, students will

> *...follow established safety procedures for working with apparatus, tools, materials, and electrical systems (e.g., tie hair back before working with drills, saws, and sanders).*

Consequently, teachers need appropriate training in order to provide safety instructions to students. The importance of **teacher training** is stressed in the curriculum document:

> *Teachers supervising students using power equipment such as drills, sanders, and saws need to have specialized training in handling such tools.*
>
> (*The Ontario Curriculum Grades 1–8, Science and Technology, 2007, revised, p.30*)



Guidance on the specialized training that should be provided is found in the CODE (Council of Ontario Directors of Education) publication, *Student Safety in Elementary Science and Technology Grades 7 and 8: A Resource for School Administrators*. This resource emphasizes the importance of teacher safety training with a focus on:

- selection and use of materials and equipment;
- safer alternatives;
- tool use; and
- procedures to follow in case of an accident or unexpected outcome.

The References chapter lists several publications that suggest strategies for teaching students with special education needs, as well as English language learners.

1.2 Science and Technology for All Students

Teachers have a responsibility to help all students learn, including those with special education needs. It is important therefore to plan investigations that recognize the diversity of strengths and learning needs in a class. Teachers should respect students' particular abilities without compromising the safety of any students. This may require the redesign of an activity or the preparation of alternative or supplemental materials. The goal is that the activity can be safely performed by a student with special education needs, or by the class that includes him or her.

Some students have IEPs (Individual Education Plans) that describe necessary accommodations or modifications. Note that some students without IEPs may also require accommodations. Appropriate accommodations include:

- giving directions for an activity orally as well as in writing to help all students participate safely regardless of their reading level;
- providing a lower working surface for a student in a wheelchair; and
- allowing additional time if necessary.

More detailed information on accommodations and modifications is provided in the curriculum document section *Planning Science and Technology Programs for Students with Special Education Needs*.

Teachers should ensure that all students in the class, including English language learners, understand the directions and the safety procedures and precautions for all activities. For example, a teacher may use safety signage depicting universally understood symbols. Audio support may also be needed for some students.

2

Legislation, Regulations, and Standards

2.1 School Board Policies and Procedures

Employers/school boards are responsible for setting standards of practice that provide guidance for establishing a safe working environment. Provincial legislation, regulations, municipal by-laws, and individual school board policies and procedures take precedence over the advice in this document. School boards are required to:

- provide teacher training for health and safety:
- prepare a written health and safety policy; and
- develop and maintain a program to implement the policy.

(Occupational Health and Safety Act: http://www.e-laws.gov.on.ca/html/statutes/english/elaws_statutes_90o01_e.htm#BK39)

"Provincial legislation, regulations, municipal by-laws, and individual school board policies and procedures take precedence over the advice in this document."

It is important for everyone in a school board—teachers, administrators, and students—to acknowledge that they have a shared responsibility for the safety of students involved in an inquiry-based science and technology program.

Teachers

Teachers' duties and responsibilities are described throughout this resource. In addition to duties, teachers are also expected to support and reinforce board policies and procedures through actions such as:

- checking that equipment is safe to use and reporting any defects to the administration;
- setting aside unsafe tools and equipment for repair or disposal;
- ensuring that power tools are tagged and locked-out when not in use; and
- ensuring that students are wearing appropriate personal protective equipment (PPE).

Administrators

Principals and vice-principals, particularly those with limited science and technology training, may have difficulty in assessing whether or not appropriate safety precautions are in place for the elementary science and technology programs in their schools. However, they can use relevant and informed questioning to initiate an open and collaborative discussion with teachers about health and safety practices in their programs. A set of sample questions (such as "Is there any additional training that you require?") is provided in the CODE

publication, *Student Safety in Elementary Science and Technology Grades 7 and 8: A Resource for School Administrators*. This publication also provides a checklist of health and safety requirements for science and technology facilities and activities. The questions and checklist can facilitate informed dialogue between teachers and administrators. In this way, administrators can be reassured about the safety practices in their schools' science and technology programs.

Students

Students are also expected to be actively engaged in ensuring a safe environment during their science and technology program. In addition to their responsibilities described in Section 1.1, students must always:

- listen to instructions and follow instructions to help prevent accidents;
- act sensibly in the laboratory to prevent tripping, falling, spillages, and breakages; and
- wear personal protective equipment when told to do so.

2.2 The Education Act

Ontario's *Education Act* sets out the specific duties and responsibilities of school boards, supervisory officers, principals, vice-principals, teachers, parents, and students. Regulation 298 of the *Education Act* specifies teachers' legal obligations with respect to their students' safety:

> O. Reg 298, 20. (g), Duties of Teachers
> *ensure that all reasonable safety procedures are carried out in courses and activities for which the teacher is responsible*
>
> *http://www.e-laws.gov.on.ca/html/regs/english/elaws_regs_900298_e.htm*

"The Education Act imposes obligations on school administrators as well as on teachers".

The *Education Act* imposes obligations on school administrators as well as on teachers. For example, the Act states that the principal of the school should appoint teachers who will present each program well, and in a manner that is safe for the students. This could include ensuring that the appropriate safety equipment (such as eye protection) is available, and that the teacher models all necessary safety routines.

2.3 The *Occupational Health and Safety Act*

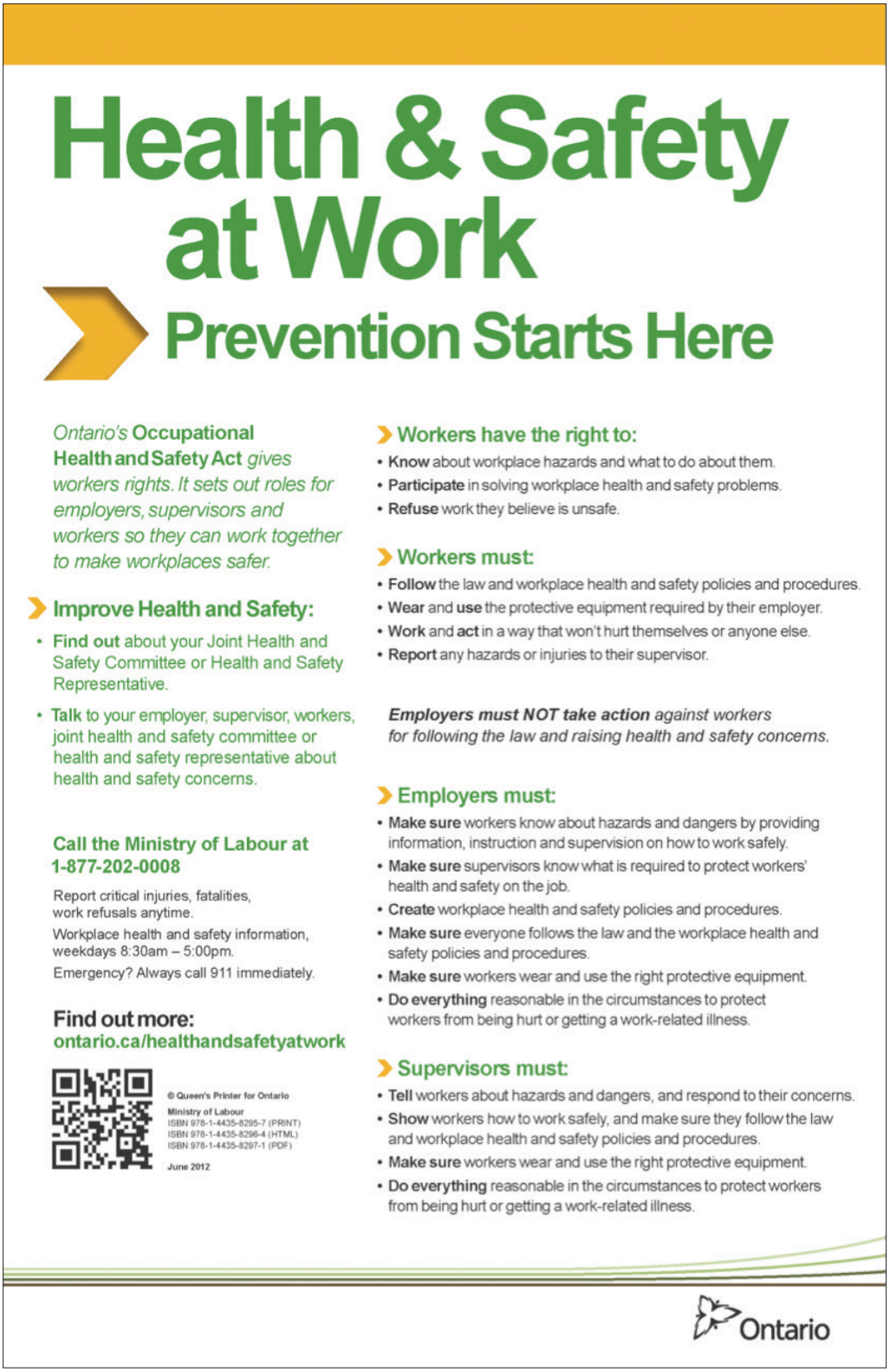
The Ministry of Labour is responsible for enforcing the *Occupational Health and Safety Act* (OHSA). (See References for contact information.)

The major purpose of the OHSA is to protect workers' (teachers') health and safety on the job (**Figure 2.1**). Under the OHSA, every worker has the right to:

- know about workplace hazards and what to do about them;
- participate in solving workplace health and safety problems; and
- refuse work they believe is unsafe.

Principals and vice-principals are considered as supervisors as defined in the OHSA, and have responsibilities for health and safety practices in schools. The poster provides a short summary. A more detailed summary can be found in the CODE (Council of Ontario Directors of Education) publication, *Student Safety: A Guide for Supervisory Officers, Principals and Vice-Principals*.

Figure 2.1 This Ministry of Labour poster summarizes workers' health and safety rights and responsibilities and the responsibilities of employers and supervisors.



Health & Safety at Work

Prevention Starts Here

Ontario's **Occupational Health and Safety Act** *gives workers rights. It sets out roles for employers, supervisors and workers so they can work together to make workplaces safer.*

Improve Health and Safety:

- **Find out** about your Joint Health and Safety Committee or Health and Safety Representative.
- **Talk** to your employer, supervisor, workers, joint health and safety committee or health and safety representative about health and safety concerns.

Call the Ministry of Labour at 1-877-202-0008

Report critical injuries, fatalities, work refusals anytime.

Workplace health and safety information, weekdays 8:30am – 5:00pm.

Emergency? Always call 911 immediately.

Find out more:
ontario.ca/healthandsafetyatwork

Ministry of Labour
ISBN 978-1-4435-8295-7 (PRINT)
ISBN 978-1-4435-8296-4 (HTML)
ISBN 978-1-4435-8297-1 (PDF)
June 2012

Workers have the right to:

- **Know** about workplace hazards and what to do about them.
- **Participate** in solving workplace health and safety problems.
- **Refuse** work they believe is unsafe.

Workers must:

- **Follow** the law and workplace health and safety policies and procedures.
- **Wear** and **use** the protective equipment required by their employer.
- **Work** and **act** in a way that won't hurt themselves or anyone else.
- **Report** any hazards or injuries to their supervisor.

***Employers must NOT take action** against workers for following the law and raising health and safety concerns.*

Employers must:

- **Make sure** workers know about hazards and dangers by providing information, instruction and supervision on how to work safely.
- **Make sure** supervisors know what is required to protect workers' health and safety on the job.
- **Create** workplace health and safety policies and procedures.
- **Make sure** everyone follows the law and the workplace health and safety policies and procedures.
- **Make sure** workers wear and use the right protective equipment.
- **Do everything** reasonable in the circumstances to protect workers from being hurt or getting a work-related illness.

Supervisors must:

- **Tell** workers about hazards and dangers, and respond to their concerns.
- **Show** workers how to work safely, and make sure they follow the law and workplace health and safety policies and procedures.
- **Make sure** workers wear and use the right protective equipment.
- **Do everything** reasonable in the circumstances to protect workers from being hurt or getting a work-related illness.

Ontario

http://www.labour.gov.on.ca/english/hs/pdf/poster_prevention.pdf

2.4 Workplace Hazardous Materials Information System (WHMIS)

The Ministry of Labour is responsible for the administration and enforcement of the provincial Workplace Hazardous Materials Information System (WHMIS) legislation. A guide to WHMIS is available from the Ministry of Labour. (See References.)

Under WHMIS, information on hazardous materials is to be provided in three ways:

- supplier labels on the original containers of controlled products;
- Material Safety Data Sheets (MSDS) to provide detailed hazard and precautionary information; and
- worker education programs.

Labels on Hazardous Materials

Controlled products are hazardous materials that are sometimes used in science and technology classroom settings. Appropriate labels help identify the hazard and cautions.

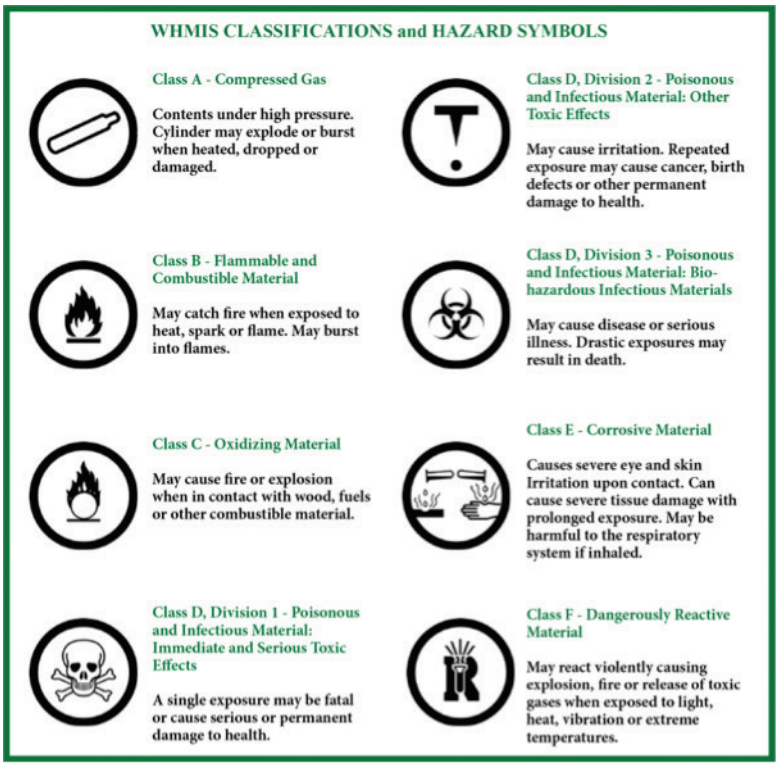
These materials should have a supplier label on the container when they arrive at the school. When the materials are not in the original container, a workplace label provides key information.

SUPPLIER LABEL

The supplier of the controlled substance must provide this label on the container of the material. This label must include the information indicated in **Figure 2.2**.

Figure 2.2 The supplier label includes one or more WHMIS symbols

Figure 2.3 WHMIS hazard symbols



WORKPLACE LABEL

Original or stock containers of controlled products must remain in the safe storage area. When some material is transferred into a portable container for class use, the new container requires a Workplace Label (Figure 2.4). This label has three components:

- chemical identifier;
- instructions for safe use; and
- reference to the MSDS.

Figure 2.4 Acceptable format for a workplace label

Hydrogen Peroxide (3%)

Body tissue irritant

Wear safety goggles and gloves.

Flush eyes and skin with water immediately if you come into contact with hydrogen peroxide.

MSDS available

THE GLOBALLY HARMONIZED SYSTEM OF CLASSIFICATION AND LABELLING OF CHEMICALS

The Globally Harmonized System (GHS) will require changes to federal and provincial legislation and regulations. These new laws are expected to be in place by 2015.

A transition period has started. Teachers and administrators need to be aware that during this period *both* sets of symbols will exist in school boards and schools.

Further information is available at http://www.ccohs.ca/oshanswers/chemicals/ghs.html.

Students should learn to recognize WHMIS warning symbols on containers of hazardous materials. For example, in the Understanding Matter and Energy strand in Grade 7, it is expected that students will "follow established safety procedures for handling chemicals and apparatus (e.g., *wash hands after handling chemicals, take note of universal warning symbols*)."

Material Safety Data Sheets (MSDS)

The MSDS is prepared by the supplier of the controlled product and provides detailed information about the material including its composition, reactivity, necessary personal protective equipment and first aid.

Worker Education Programs

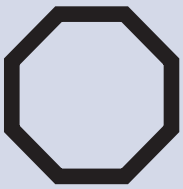
Workers (teachers) have the right to know about the hazardous materials in their work area. Specifically, they have the right to review labels and MSDSs and to receive education and training on associated safe procedures.

2.5 Consumer Products and Containers

Many potentially dangerous substances do not come in packages with WHMIS symbols. Materials such as table salt, glycerin, cleaning agents, and varnish are household chemicals (consumer products). Unlike the controlled substances that use WHMIS and are purchased from science supply companies, certain consumer products are labelled using Hazard Symbols, different than WHMIS hazard symbols. Hazard symbols were developed for people buying and using materials around the home. For example, aerosol cans of insect spray sold and packaged as retail products do not require a WHMIS label and data sheet as a condition of sale. Although employers do not have to acquire a WHMIS label and MSDS for any consumer product that is purchased from a retail outlet, many retail outlets such as hardware or specialty chemical stores may supply a customer with an MSDS upon request. Some employers (school boards) restrict the purchase of consumer chemical products. Please contact your school board for the appropriate policy.

In certain situations household chemicals can be just as hazardous as the controlled substances that use WHMIS. Students should be warned that many household chemicals, or combinations of household chemicals, are hazardous. Keep the containers and/or packaging for such products because they provide detailed information about hazards, precautions, storage and disposal. Avoid covering important details with other labels.

Consumer Product symbols are framed by one of two shapes, which signify whether it is the contents of the container or the container itself that is dangerous.



An octagon (stop sign) means the contents of the container are dangerous.

The upside-down triangle means that the container is dangerous.

Figure 2.5 — The types of hazards identified on consumer products

Symbol	*Danger*
Explosive Container 	This container can explode if heated or punctured. Flying pieces of metal or plastic from the container can cause serious injuries, especially to your eyes.
Corrosive Material 	This product can burn your skin or eyes on contact. If swallowed it can damage your throat and stomach.
Flammable Material 	This product or its vapour, can catch fire easily if it is near heat, flames or sparks.
Toxic Material 	Licking, swallowing, or in some cases breathing in this product can cause illness or death.

There are four hazard symbol pictures to indicate that a material is toxic, corrosive, flammable, or explosive (**Figure 2.5**).
As consumers, we need to be aware of the information that the containers provide:

a) a hazard symbol
b) a signal word (EXTREME DANGER, DANGER or CAUTION)
c) a primary hazard statement
d) the specific hazard statement
e) negative instructions
f) positive instructions
g) the first aid treatment.

Signal words underneath the symbol explain the degree of risk.

Signal word:
DANGER EXPLOSIVE

The degree of hazard is indicated by a signal word, which is written below the symbol. There are three signal words:

- **CAUTION** means temporary injury may be frequent. Death may occur with extreme exposure.
- **DANGER** means may cause temporary or permanent injury or death.
- **EXTREME DANGER** means exposure to very low quantities may cause death or temporary or permanent injury.

Most students will be exposed to consumer products in their homes. Students should learn to recognize symbols and key terms for consumer products. When students work with a consumer product during a class activity, use this opportunity to review the hazards to ensure safer practice at home and at school.

2.6 Student Allergies

Anaphylaxis is a severe and systemic allergic reaction that results in circulatory collapse or shock, and can be fatal. It requires avoidance strategies and immediate response in the event of an emergency.

An *Act to Protect Anaphylactic Pupils: Sabrina's Law* came into force in Ontario on January 1, 2006. This law, commonly called "Sabrina's Law," ensures that all school boards have policies or procedures in place to address anaphylaxis in schools. School board policies and procedures must include:

- regular training for school staff on dealing with life-threatening allergies;
- creating an individual plan for each pupil who has an anaphylactic allergy; and
- strategies that reduce the risk of exposure to anaphylactic causative agents in classrooms and common school areas.

(These points are paraphrased from the original document: Healthy Schools, Sabrina's Law: http://www.edu.gov.on.ca/eng/healthyschools/anaphylaxis.html)

Teachers should be aware of students with known allergies in their classrooms. This information is usually available through the school office. Allergies should be taken into consideration when planning activities that require handling foods, plants, animals, or other potentially allergenic materials. For example, an increasing number of people have serious and often life-threatening allergies to nuts and nut products. Avoid using these ingredients and plan activities that are inclusive of all students.

2.7 The Environmental Protection Act (EPA)

This is Ontario's key legislation for environmental protection. It grants the Ministry of the Environment broad powers to address the discharge of contaminants that cause negative effects. The Act specifically:

- prohibits the discharge of any contaminants into the environment that cause or are likely to cause negative effects;
- limits the amounts of certain approved contaminants that may be discharged; and
- requires that any spills of pollutants be reported to the Ministry and cleaned up in a timely fashion.

http://www.e-laws.gov.on.ca/html/statutes/english/elaws_statutes_90e19_e.htm

2.8 Standards of Practice for the Teaching Profession

The Ontario College of Teachers (OCT) has developed Standards of Practice for the Teaching Profession. This framework encourages members to "strive to be current in their professional knowledge...to inform professional judgement in practice."

In 2013 the OCT published a professional advisory entitled *Safety in Learning Environments: A Shared Responsibility*. This advisory keeps all OCT members, including teachers, consultants, vice-principals, and principals, up to date on issues related to safety. The document addresses the safety of students in a variety of learning situations.

Of particular relevance to science and technology programs is the following advice to minimize safety risks. The educator should:

- know and apply legislation and the employer's policies with respect to student safety in general;
- know and apply legislation and the employer's policies regarding the specific activity being conducted with students;
- ensure that all students have the necessary training, knowledge, and skills to undertake an activity, to respond safely, and to report unsafe activities or situations;
- identify and report deficiencies in the environment or in equipment used with students;
- know the special needs identified for the students, such as allergies, as well as any accommodations or modifications that may be required;
- determine whether parental consent is required, authorizing students' use of tools, materials, or equipment, before using them in an activity; and
- monitor, modify, or stop an activity that may be unsafe.

(These points have been paraphrased from the original document.)

> "Assess whether the activity is appropriate given the number of students and their relative abilities, disabilities and ages."
>
> Ontario College of Teachers, Professional Advisory, *Safety in Learning Environments: A Shared Responsibility*, April 4, 2013

3

Safety Planning Framework for Science and Technology Activities

Introduction to Safety Planning Framework

An educator can never anticipate every possible situation. Routinely incorporating safety planning is the best way to ensure a safe environment for teaching and learning. This chapter presents a framework for safety planning (**Figure 3.1**). Applying this framework is an effective way to promote the safety of both students and staff.

Figure 3.1 Five-step framework for safety planning

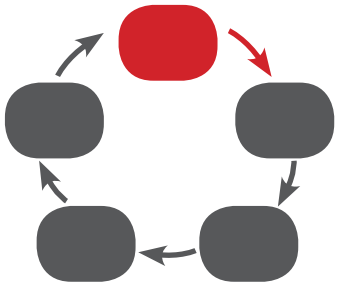
The sections in Chapter 4 show how this planning framework can be applied to the four strands of the Grades 1–8 Science and Technology curriculum. Safety practices that require specialized knowledge are outlined in Chapter 4.

HAZARDS AND RISKS

A hazard is an inherent danger in a space, material, or activity that may cause harm. Hazards can be identified by using reason, prior experience, or scientific knowledge.

A risk is the likelihood that a hazard will cause harm. Risk is dependent on context. Risk of harm for a hazard may change from one context to another.

3.1 Identify the Hazards



The first step in promoting safety is identifying the hazards associated with an activity. Consider:

- the nature of the space for learning;
- equipment and materials used by students; and
- the nature of the activity and safer alternatives.

The Nature of the Space for Learning

Regular classrooms are appropriate for most science and technology activities in Grades 1 through 8. The classroom environment is familiar to both teacher and students, so it is typically the safest place to carry out lessons. It is still important to keep in mind the factors that contribute to a safe physical environment. See **Table 3.1**.

Table 3.1 — Safety Considerations in the Classroom

Factor	*Safety Concern*
Height of work surfaces	Counters that are too low or too high can be uncomfortable and lead to accidents.
Lighting	Lighting should be sufficient for detailed work to prevent accidents. Lower lighting levels (for energy conservation) may be adequate for some tasks, but insufficient when students are working with tools and equipment.
Noise levels	The teacher must be able to gain the attention of the students at all times. In a noisy setting, cues for gaining students' attention include turning off the lights momentarily or flashing a bright light.
Tidiness	Clutter contributes to slips, falls, and knocking things over.
Visibility	Proper supervision is critical for identifying unsafe behaviours.
Student behaviour*	Accidents are usually caused when students move erratically and quickly. Such actions can result in • slips on wet, dusty, or dirty floors; • trips over objects on the floor such as knapsacks, sports equipment, books, extension cords, coats, and feet in aisles; and • collisions with obstacles such as chairs, stools, benches, book racks, and open cupboard doors
Clean-up of equipment and materials	Clean-up routines clarify when students should continue to wear personal protective equipment. Clean-up during or after activities also ensures that materials that could cause harm are put away. Students should always wash their hands after science and technology activities.

* According to the Ontario School Boards' Insurance Exchange (OSBIE), horseplay or fooling around is the number one cause of reportable accidents in science and technology programs in Ontario schools.

Within the classroom, there are several ways to organize students and manage the space. For each, there are advantages and disadvantages to consider, as **Table 3.2** outlines.

Table 3.2 — Classroom Organization Options

Classroom Setup	*Advantages*	*Disadvantages*
Perimeter stations	• plenty of dedicated space for activities • no exposed cords to trip on • good storage below counters	• possible blocked sight lines to table tops and activities, reducing the ease of direct supervision
Learning centres	• self-contained work areas • minimal student movement with materials and tools • allows for different levels of complexity or independence	• need for customized supervision and support of each centre • need for additional activities because timing of each centre may be different
Work at student desks	• high student engagement and enjoyment • wide variety of results	• possible blocked sightlines • adequate quantities of materials and equipment needed • higher risk of accidental spills/breakage
Teacher demonstration	• clear modelling of safety and lab techniques • a high degree of control for the teacher • minimal use of materials • lowest risk of accidental spills and breakage • opportunity for eye-catching activities that can be easily repeated	• possible blocked sight lines for students • limited involvement for students • difficulty in judging level of student engagement

ADDITIONAL LEARNING TOOLS

In some settings, there is an opportunity to complement science and technology programming with information and communications technology (digital learning) by using:

- science probes to measure and record data;
- cameras to video or photo-document the process;
- software for data management and reporting;
- simulation software to elicit critical thinking; or
- the Internet to conduct research.

Teachers may have access to power tools, which may be located and used:

- in the classroom;
- in a small room next to the classroom; or
- in a separate room that can accommodate a whole class.

The integration of digital learning and power tool use comes with advantages and disadvantages such as those listed in **Table 3.3**.

Table 3.3 — Program Complement Options

Program complement	*Advantages*	*Disadvantages*
Integrating digital learning with hands-on lab work	• student independence to run simulations • more attention per student • class split between information and communications technology (ICT) and hands-on activity	• need for computer maintenance • higher cost • need for well-directed ICT activity worksheets • necessity to monitor student use of the Internet
Integrating hands-on technological problem solving with power tools	• more flexibility in student engagement • opportunity to construct using a wider variety of materials • faster completion of the task • fewer tools in use, simplifying supervision	• requirement for specialized training in use of power tools • higher standards of maintenance required for power tools compared to hand tools • higher vigilance required than for hand tools

LOCATION

For many topics in science and technology, learning environments outside the classroom offer more authenticity. While all learning environments share basic safety issues of proper supervision and care, there are specific hazards that need to be taken into account when a class is taken to another setting (**Table 3.4**).

Table 3.4 — Class Relocation Considerations

Setting	*Hazards*	*Questions to Consider*
Classroom	Insufficient space	• Is there adequate space for both the activity and safe student movement? • Is there sufficient /appropriate storage and disposal so that projects are out of the way?
Other places in the school	Unsafe working environment	• Can all students be seen? Can they all be engaged by the situation? • Is there adequate ventilation for the activity? • Does the space accommodate the group safely? • Can the group exit safely and easily?
Outside the school	Appropriate safety plan and procedures	• Is there a safety plan to handle emergencies? • How will the teacher ensure that all students are accounted for and/or visible to the supervisor(s)? • Is there an adequate number of adult supervisors for the group size?

Equipment and Materials

The teacher should consider any potential hazards before proceeding with an activity. Students:

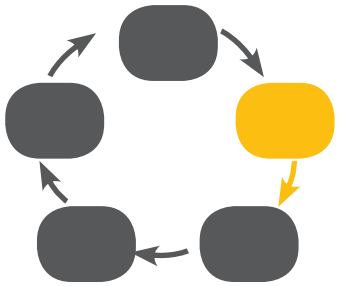
- may be unfamiliar with the science and technology equipment and materials;
- may not initially have the knowledge and skills required to work safely;
- should understand that there is a safe way to handle and use the equipment and materials; and
- should understand that incorrect use of specialized equipment and materials may result in breakage or injury.

The Nature of the Activity and Safer Alternatives

When planning a hands-on activity for students, the following questions should be considered:

- Do I understand the hazards involved in working with the equipment and materials required for this investigation?
- Do I know how to use the equipment and materials required by the investigation?
- Can I supervise the students efficiently and safely as they conduct the activity?
- Are there safer alternative hands-on activities?
- Is there a plan for students who have special education needs, English language learning needs, or religious accommodation needs?
- Is there a plan for cleanup afterwards, including disposal if required?

3.2 Assess the Risks



A hazard in one class may pose a greater risk than the same hazard in another class. An educator should use professional judgement when assessing a risk in each situation. When assessing the risk, the educator should consider:

- the nature of the hazard and possible injuries;
- students' readiness (knowledge, skills, and maturity) to engage in the activity; and
- the environment or location.

The Nature of the Hazard and Possible Injuries

Each safety plan should be tailored to the nature of the hazard. The teacher should keep in mind the kinds of injuries that could result from the hazard. A good plan requires that the teacher know the whereabouts of all students in the class to minimize unforeseen hazards. For known hazards, steps taken to reduce the risks need to be proportional to the injury that might ensue. For example, as students progress in science and technology, they will learn to cut materials using a variety of tools: scissors, knife, saw, and perhaps a power tool such as a scroll saw. Since a power tool can potentially cause a more serious injury than can a hand tool, the teacher should give more attention to safety instruction and supervision around the use of power tools.

Students' Readiness to Engage in the Activity

Assessing risks is really about knowing the students and considering their readiness:

- What is the student's prior experience?
- What knowledge of this particular equipment do they have?
- Have students demonstrated that they have the knowledge, skills, and maturity to participate safely in the activity?
- What specific knowledge for reducing the risk do they have?
- Do any of the students have special needs (such as allergies), or require any accommodations or modifications or language learning needs?
- Are there any behaviour issues that necessitate special planning?
- Are there possible gender-associated attitudes or behaviours that may be associated with readiness for active learning? Should any gender/religious accommodation be made? Would co-educational grouping or partnering of students be appropriate, or not?

When planning an activity, the teacher should consider what students know, what they are able to do, and the safety habits of mind they have already developed. Children do not automatically make connections between their actions and the consequences for themselves, others, and the environment.

In general, children grouped by age share many physical and emotional characteristics. The teacher can use these common characteristics as a guide when assessing the risks associated with various activities (**Table 3.5**). These common characteristics are discussed in the section on Student Development and Program Implications in *The Ontario Curriculum, Health and Physical Education, Grades 1–8, Interim Edition (2010), Revised* (www.edu.gov.on.ca/eng/curriculum/elementary/healthcurr18.pdf). Keep in mind that there are always "exceptions to the rule," so the risk in one classroom may be different from the risk in another.

The Environment

The same hazard could be much more risky in some environments than in others. For example, the use of a long stick carries a greater risk of injury in a classroom than out in a playing field. The amount of space, degree of supervision, and so on should all be considered when assessing risk.

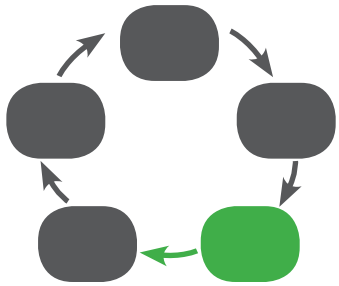
Table 3.5 — Typical Characteristics of Young Children, and their Implications

Grade	*Physical characteristics*	*Emotional characteristics*	*Implications for safety planning*
JK, K, 1	• Children may be able to reach adult-height counters. • Gross motor skills are still developing in some. Those who lack gross motor skills are more prone to walking into or tripping over obstacles. • All students are developing fine motor skills. Students who lack fine motor skills are more prone to knocking over objects or spilling when pouring.	• Young children have a general lack of fear and little consideration for safety. • They are beginning to distinguish between acceptable and unacceptable behaviour. • Attention spans are likely to be short.	• Rules for safe behaviour should be clear and simple. Establish routines and follow them consistently. • Use simple visual reminders around the classroom. • Ensure that materials for students are age appropriate. • Supervise small-group investigations closely. • Have a plan for taking care of accidental spills so that floors remain safe.
2–5	• Children demonstrate a considerable range of gross and fine motor skills, but skills may be inconsistent because of growth spurts. • Students may become clumsy when excited.	• There is a general lack of fear, but an awareness of safety requirements is developing. • With prompting, children are beginning to consider the needs of others and of the environment.	• Gradually release control for safety in very familiar situations. • Children can follow established safety routines in familiar circumstances and after repetitive teaching and learning situations. • Continue to teach safety rules explicitly for unfamiliar situations. • Use safer materials such as plastic spoons or cups for measuring. Sippy cups should not be used.
6–8	• Accelerated growth rates affect hand-eye co-ordination.	• Feelings of empathy are developing, but fluctuate considerably. • Children often pretend to be more independent than they really want to be or sometimes are ready for. When students have demonstrated that they are ready, allow them to make some of their own decisions.	• Encourage risk taking in planning activities that are based on recent learning. Check to ensure that the plans include safety precautions. • Explain how following instructions and working safely will earn students greater freedom, thus motivating them to continue complying with the safety rules.

3.3 Make Safety Plans

With the hazards identified and the risks assessed, the time has come to make safety plans. The educator should consider:

- the legislation and workplace standards and procedures;
- effective practices to ensure safety for both staff and students; and
- any personal protective equipment (PPE) required.



The Legislation and Workplace Standards and Procedures

Teachers are expected to review and understand the relevant legislation and workplace standards and procedures. (See Chapter 2 of this resource.)

Effective Practices to Ensure Safety

Some effective practices (see samples below) apply to all subject areas of the science and technology program. When utilized effectively, these practices contribute to the safety of both staff and students.

HYGIENE

Like the duty of supervision, basic hygiene is a precaution that is fundamental to all activities. Plan time for hand-washing and ensure that clean water, soap, and paper towels are available.

FIRST AID

Every teacher should have easy access to a first aid kit, or know how and where to quickly find someone with first aid training. If in the classroom, the first aid kit should be placed somewhere visible and easy for the teacher to reach. It should contain basic supplies for treating minor cuts and burns. NOTE: It is unwise for those who have not had formal training to attempt first aid. However, the effects of some injuries may be reduced if teachers are able to take appropriate, immediate remedial measures (basic first aid) while waiting for trained first aid to arrive.

Teachers should never give or apply medication. However, students in anaphylactic shock must receive a dose of epinephrine immediately. An epinephrine autoinjection (using a device such as an EpiPen) can be critically important and is easily administered by a properly trained person. Always follow the employer's protocols in responding to such emergencies, in attending to and reporting injuries, and by seeking

medical attention for more serious injuries.

SAFE STORAGE OF CHEMICALS AND EQUIPMENT

Storing chemicals safely is critical in the school setting:

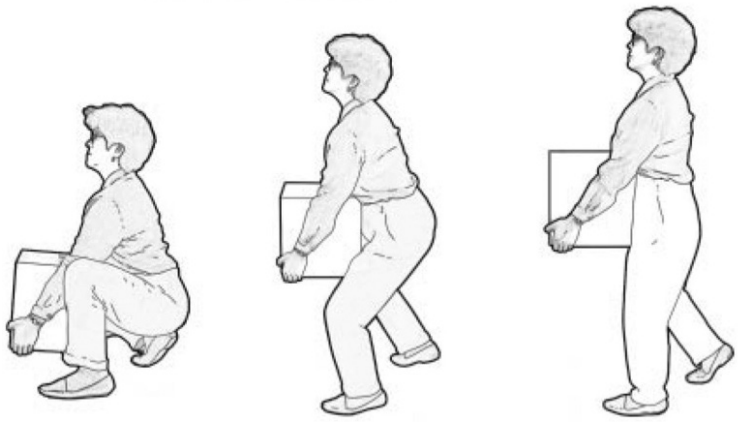
- Chemicals must be stored securely in containers with an appropriate label; (See WHMIS, Section 2.4 for information on labels.)
- Only small quantities of chemicals should be stored;
- A record must be kept of all stored chemicals;
- All chemicals should be stored in a locked cupboard or room away from all heat sources; and
- At all times, the storage and disposal of chemicals should be done in accordance with school board procedures and policies.

Sections 7 D) and E) in *SOS* (*Safe ON Science, Science Teachers' Association of Ontario, 2010*) provide more detailed information on the storage and disposal of hazardous chemicals.

Storing materials or equipment at high or low levels can be a hazard. If objects are stored high up, the teacher should ensure that they are not too heavy and that an appropriate step stool is available. This reduces the risk of objects being dropped.

When items are stored at ground level and must be lifted, it is wise to use proper lifting technique: place the feet flat on the ground, bend the knees, hold the object close to the body, then lift by straightening the knees while keeping the back as upright as possible (**Figure 3.2**).

Figure 3.2 Using proper lifting technique to reduce the chance of back injury while lifting a heavy object



SOURCING ACTIVITIES ON-LINE

Teachers should always follow carefully any school board policies and procedures regarding Internet use. Unlike most printed resources, online information may not be edited or verified.

Inaccurate, misleading, and dangerous information is widely available. It is therefore important to set clear parameters for any student assignments and to pre-screen any sites that they will visit.

It is wise to consult an experienced teacher, preferably one with subject-specific expertise, before attempting any demonstrations or activities sourced on the Internet.

Teachers should ask the following questions about any activity being considered:

- Is the demonstrator a recognized subject expert?
- Are exact compositions and proportions stated for materials used?
- Are the nature and toxicity of by-products known?
- Is the safe and proper disposal of by-products shown?

If the answer is No to any of the above questions, the teacher should seek more information about the activity or find an alternative activity.

Personal Protective Equipment

Personal protective equipment (PPE) helps reduce the risk of harm from a hazard in the classroom. Standard items used in science and technology activities include safety or protective eyewear, gloves, mask, and an apron or lab coat (**Table 3.6**). Employers are not required to provide PPE but generally they do. If the employer does provide PPE then the employee (teacher) must wear it and the supervisor must ensure that it is worn.
(See Occupational Health and Safety Act (OHSA): http://www.e-laws.gov.on.ca/html/statutes/english/elaws_statutes_90o01_e.htm#BK42)

Students should be given notice of an upcoming lab activity so that those who normally wear contact lenses can wear glasses for the activity. They should wear protective eyewear *in addition* to corrective glasses.

Students may be reluctant to wear chemical splash goggles because of hygiene, improper fit, and scratched lenses. Ensure that goggles and straps are cleaned regularly with disinfectant, are in good working order, and do not obscure a student's vision.

The Canadian Standards Association, Occupational Health and Safety Program, has published Standard CSA Z94.3 referring to eye and face protection.

• Wear goggles during the activity. (They should fit over eye glasses.)

• If you wear contact lenses, if at all possible wear eye glasses on the day of the activity.

http://ohs.csa.ca/standards/Personal_Protective/index.asp

Table 3.6 — Personal Protective Equipment (PPE)

Personal Protective Equipment	*Body Part Protected*	*Potential Hazard Reduced*	*Why It Is Needed*
Chemical splash goggles 	Eyes	• splashing liquid • spraying solid or liquid • dust • corrosive vapour • corrosive or irritating liquid • projectiles, including broken glass	Students should wear chemical splash goggles whenever they handle glassware, powders, and/or liquids (including hot water). Splash goggles fit snugly against the skin on the forehead and cheeks, creating a barrier that prevents dust, liquids, splashes, and sprays from entering the eyes.
Impact-resistant safety glasses with side protection 	Eyes	• projectiles or other moving objects	Almost anything can break. Glasses with top and side panels protect the eyes from the impact of something moving toward the face.
Nitrile gloves 	Hands	• corrosive or poisonous materials • allergy to latex or vinyl • unknown or contaminated substances	Gloves protect skin on hands when handling potentially hazardous materials (e.g., household cleaning products) and unknown substances (e.g., material collected outdoors). Nitrile gloves reduce the risk of an unexpected allergic reaction to latex or vinyl, which could be a problem if other types of gloves are used.
Oven mitts or heat-resistant leather gloves	Hands	• heat hazard	Cloth or silicone oven mitts protect hands when picking up hot objects.
Mask 	Respiratory system	• dust	A mask that covers the nose and mouth provides some protection from dust that can be created during activities.
Lab coat or apron	Clothing and skin	• substances that may stain fabric or irritate skin	Clothing protects skin, and a lab coat protects clothing. Wearing a lab coat reduces the risk of exposure to substances that can soak through clothing to the skin.

CHEMICAL SPLASH GOGGLES

Students should wear chemical splash goggles whenever they handle powders and/or liquids to prevent dust, liquids, splashes, and sprays from damaging the eyes. Wearing goggles also reduces the risk of damage to the eyes by broken glass (for example, when beakers are in use) and hot water. Chemical splash goggles provide a greater level of protection than safety glasses.

IMPACT-RESISTANT SAFETY GLASSES/GOGGLES

For activities where objects or parts are in motion (such as investigations of simple machines or flight), or are purposely thrown or launched, both students and teacher should wear impact-resistant glasses.

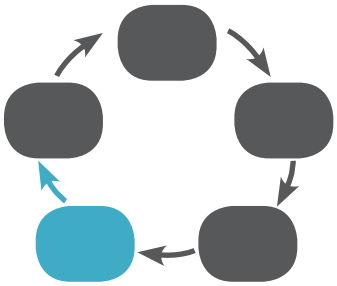
GLOVES

Teachers may need to wear heat-resistant gloves or oven mitts when working near a heat source. Teachers should wear nitrile gloves when there is a sharps hazard associated with blades or broken glass. Students should wear appropriately sized disposable non-latex gloves when handling plant materials.

LAB COATS OR APRONS

Lab coats are not required by students in elementary science and technology programs. They can, however, contribute to the excitement of engaging in activities, and protect children's clothes during activities involving water and soil. If they are worn, they must fit properly and be fastened using snaps rather than buttons.

3.4 Act Safely



All students in the classroom must have a shared understanding of the safety plans. The teacher should take the time to:

- review the activity with students;
- invite and answer questions; and
- reduce or eliminate distractions so that the focus can be on the activity and the necessary precautions.

Reviewing the Activity

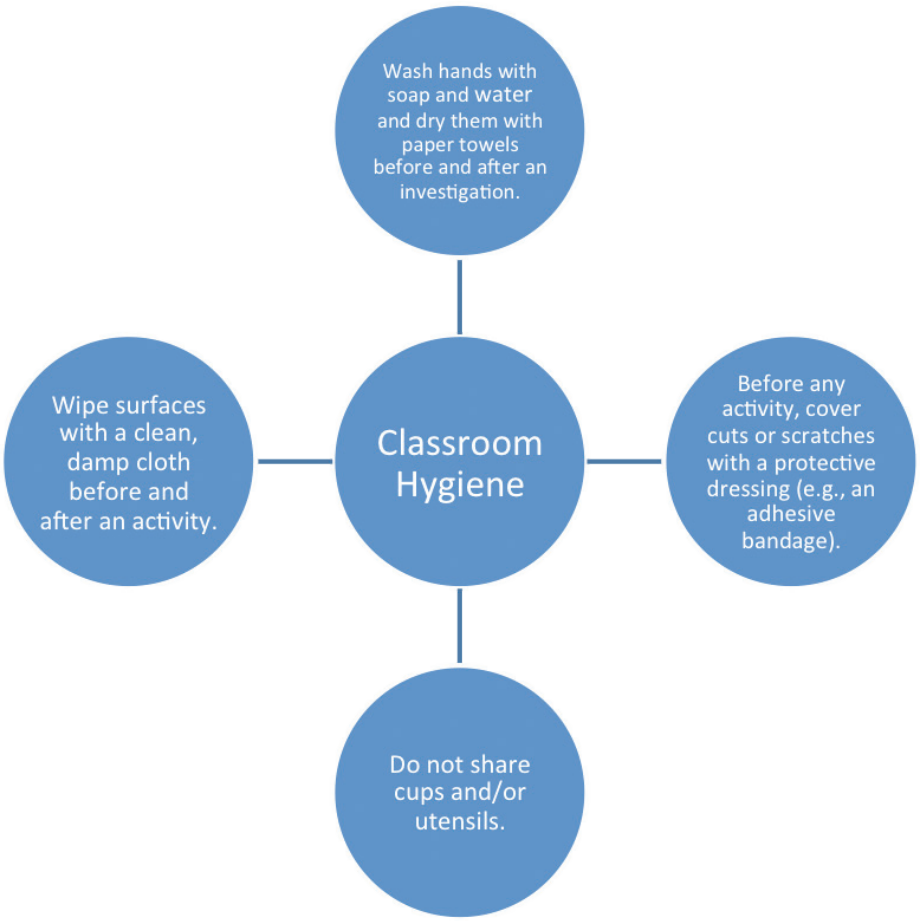
Most children lack the experience that drives safe behaviour, so teachers must establish baseline rules. Students could contribute to developing these rules which can be then be displayed as a poster or anchor chart (**Figure 3.3**). When the rules are posted and frequently referred to, they anchor the habits of mind that we are encouraging. With practice and explanation, most children develop the empathy and perspective needed to understand the effect of their actions on others and on their environment. As the class explores different areas of science and technology, add more rules to the anchor chart (**Figure 3.3**).

Figure 3.3 Sample safety anchor chart

CLASSROOM HYGIENE

Basic hygiene includes careful hand washing after handling chemicals, soil, plants, or animal or microbial material. A hygiene anchor chart may be beneficial (**Figure 3.4**). When an activity involves soil or any living organisms, school board procedures for cleaning work surfaces must be followed, such as using an approved disinfectant. Remember that students should never handle concentrated cleaning or disinfecting solutions.

Figure 3.4 Sample hygiene anchor chart



Reduce or Eliminate Distractions

The intention to be safe is not sufficient. Teachers must learn how to reduce or eliminate distractions so that they can carry out their safety plans effectively.

HEALTH CANADA GUIDELINES FOR PROPER METHODS OF HAND WASHING

Using Soap

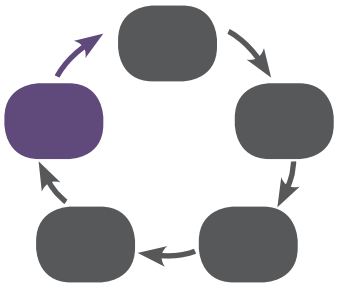
Wash your hands frequently with soap and water for at least 20 seconds. In most cases antibacterial soap is not necessary for safe, effective hand hygiene. Wipe and dry your hands gently with a paper towel or a clean towel. If you have sensitive skin, or if water is not available, use an alcohol-based hand rub instead.

Using Alcohol-Based Hand Rubs

An alcohol-based hand rub can be used if soap and water are not available. If your hands are visibly soiled, it is best to use soap and water. If it's not possible to wash with soap and water, use towelettes to remove the soil, then use an alcohol-based hand rub.

http://www.hc-sc.gc.ca/hl-vs/iyh-vsv/diseases-maladies/hands-mains-eng.php

3.5 Reflect, Revise, and Report



After the activity, the teacher should take a moment to consider:

- the effectiveness of the safety plan;
- what went well and what needs to be changed; and
- reporting any issues or accidents.

The Effectiveness of the Safety Plan

The non-occurrence of an accident does not mean that the students were always safe. It is important to take a moment to reflect on the activity to determine whether the activity was appropriate, properly sequenced, and sufficiently explained and modelled for students. At this stage, the teacher should identify whether more safety instruction in the future is warranted.

What Went Well and What Needs to be Changed

Reflecting on how well safety was managed is an important skill for both teachers and students. Students can be included in the process of reflecting on the activity. Even when no accident occurred, there may be an opportunity to point out a "near miss" or "close call." Teachers should consider how effective the safety plans were in improving their understanding of:

- special needs and possible accommodations for those needs;
- modified expectations with possible accommodations;
- alternative expectations;
- English language learning needs; and
- religious accommodation needs.

This can engage students in thinking critically about how the class as a whole can achieve higher levels of safe practice.

Reporting Issues or Accidents

If there is an incident that results in injury during a science and technology class, the teacher should follow the employer's expectations for filing an accident report. Many employers have a form for reporting worker-related accidents or injuries (**Figure 3.5**).

If a student is injured, an administrator will have to file a report with the OSBIE (Ontario School Boards' Insurance Exchange). The teacher must report and provide details of the incident (date, time, and type of incident), the nature of the incident (cause, location), a description of the incident (how and where), and names of witnesses.

Figure 3.5 A typical accident report form

Toronto District School Board

EMPLOYEE'S REPORT OF ACCIDENT/INJURY

Form 699D
Sept. 2010
Page 1 of 1

AFTER FORM IS FULLY COMPLETED, FAX IMMEDIATELY TO (416) 393-8533.

INJURED WORKER (Report this injury or accident to your Principal/Dept. Head/Team Leader/Supervisor immediately.)

PERSONAL INFORMATION	
LAST NAME:	FIRST NAME:
DATE OF BIRTH:	SOCIAL INSURANCE #:
ADDRESS:	CITY: POSTAL CODE:
HOME PHONE:	WORK PHONE:
EMPLOYMENT INFORMATION	
JOB TITLE:	SCHOOL/LOCATION:
REGION:	SUPERVISOR'S NAME:
REGULAR HOURS OF WORK: FROM: TO:	SUPERVISOR'S TITLE:
INJURY INFORMATION	
DATE OF INJURY:	TIME OF INJURY:
DATE & TIME LAST WORKED (**ONLY IF LOSING TIME**):	RETURN DATE (IF KNOWN):
DATE & TIME REPORTED TO PRINCIPAL/DEPT. HEAD/TEAM LEADER/SUPERVISOR:	
REGULAR SCHEDULED OVERTIME: DAYS: HOURS: FROM (hrs/min) TO (hrs/min)	

PERSON PROVIDING INFORMATION (IF OTHER THAN INJURED WORKER)		
NAME:	OCCUPATION:	SCHOOL/DEPT:
DATE AND TIME YOU WERE MADE AWARE OF INJURY:		
WITNESS OR PERSON HAVING KNOWLEDGE OF INJURY		
NAME:	OCCUPATION:	SCHOOL/DEPT:

DESCRIPTION OF ACCIDENT (PROVIDE CLEAR, CONCISE, COMPLETE INFORMATION)

1) **DESCRIBE INJURY** (Part of body affected, including left/right side, and type of injury, e.g., pain, cut, bruise):

2) **ACCIDENT LOCATION**:

3) **HOW DID THE ACCIDENT OCCUR?** (What were you doing? What happened? How did it happen? Problem with equipment? Size/weight/type of materials involved? Building environment? Substandard practices? People?):

4) **HAVE YOU HAD A PREVIOUS SIMILAR INJURY?**

INITIAL TREATMENT OF INJURY (INDICATE WHICH OF THE FOLLOWING APPLIES)

( ) FIRST AID only (No medical visit)

( ) DOCTOR* ( ) HOSPITAL* ( ) CHIROPRACTOR* ( ) PHYSIOTHERAPIST*

*GIVE NAME/ADDRESS/PHONE NO:

PLEASE ATTACH A SEPARATE PAGE IF MORE SPACE IS REQUIRED.

4

Connecting Safety to the Curriculum

In the science and technology program students use specialized equipment and materials that are not used in other curricula. At the same time, students are developing their skills in scientific inquiry and technological problem solving. Working with specialized science equipment and materials helps to engage students as part of the scientific community as they prepare for further studies in secondary school science programs.

The four parts of this chapter relate directly to the four strands of the Grades 1–8 Science and Technology curriculum policy document. However, the information and safety practices outlined are not grade specific.

4.1.1 Selecting a Site and Materials for a Food Garden

There are many factors to consider when selecting a site for a food garden. Access to water and good sun exposure are important. The teacher might need to consider travel patterns on the school ground. Whatever site is selected, it is important that the school administration has confidence that the soil is healthy for food growing. For example, Toronto Public Health identifies three levels of concern regarding the safety of garden soil (**Table 4.1**).

Table 4.1 — Assessing Risk when Selecting the Site for a Food Garden

Level of Concern	*Description of Potential Garden Site*
Low	Site is and has always been one of the following: • residential land • parkland (green space used for recreational purposes) • farmland • child care centre • school land
Medium	Site is or has once been one of the following: • risk-managed park, where there is active risk mitigation to ensure that the park is safe for use by the public • orchard • hydro corridor • commercial land uses (excluding gas stations, dry cleaners, print and auto body shops) • infill area • former landfill • former lead reduction zone • any land within 30 m of a rail line or a major arterial road
High	Site is or has once been one of the following: • industrial land • gas station • dry cleaner • printing and auto body shops • rail line or depot • land with indications of dumping or burning or presence of smells or staining of the soil

http://www1.toronto.ca/staticfiles/city_of_toronto/toronto_public_health/healthy_public_policy/lead/files/pdf/urban_gardening_assessment.pdf

IDENTIFY THE HAZARDS

Selecting a Site

The possibility of soil contamination is a reality in most environments. Contaminated soil poses some hazard to those who work with the

soil and to those who eat the food grown there. Hazards related to contaminated soil fall into two categories: chemical hazards and biological hazards.

Two potential ***chemical hazards*** include exposure to heavy metals (e.g., lead, mercury) and polycyclic aromatic hydrocarbons (solvents and/or fuels). In an urban environment these contaminants may be left behind from previous land usage. For medium- and high-concern situations (listed in **Table 4.**1, above), the soil should be tested by a professional.

Biological hazards include bacteria from sewage, water run-off, or manure, or parasites such as roundworms from pet or wildlife feces.

Selecting Building Materials

Building materials such as pressure-treated lumber contain preservatives that may leach into the soil during prolonged contact with moisture. These products pose a chemical hazard.

The existence of a contaminant in the soil is not an indication that using the site poses an elevated health risk. Teachers should, however, take care when deciding which type of garden design is best suited for use by children.

ASSESS THE RISKS

If any of the hazards identified above are likely to be present, soil samples should be sent for testing and interpretation. The Agriculture and Food Laboratory at the University of Guelph conducts a wide range of soil tests to support the establishment of healthy gardens. (See References.)

MAKE SAFETY PLANS

The teacher should create a safe garden plan based on knowledge of the site and interpretation of any soil test results, if they were required. If the history of the land is known and the presence of contaminants is not a factor, a regular in-ground garden can be prepared. If there is concern that some soil contaminants exist in the location, a raised bed

CHEMICAL HAZARDS IN URBAN GARDENS

Toronto Public Health has published a detailed guide outlining chemical hazards: Assessing Urban Impacted Soil for Urban Gardening: Decision Support Tool—Technical Report and Rationale.

Toronto: City of Toronto, May 2011. http://www.tcgn.ca/wiki/uploads/DonationsTradesSharing/urban_gardening_assessment.pdf

PRESSURE-TREATED WOOD

Chromated copper arsenate (CCA) is a preservative containing arsenic, chromium, and copper. It is used in pressure-treating wood to protect it from fungi and insects. Since 2003 wood products have been treated with organo-metallic preservatives. These products have a green appearance, but do not include the arsenic and chromium components that occur in CCA-treated wood.

http://www.epa.gov/oppad001/reregistration/cca/cca_consumer_safety.htm

http://www.hc-sc.gc.ca/cps-spc/pubs/pest/_fact-fiche/cca-acc/index-eng.php

is a better choice. A barrier (plastic or mesh) can be used to keep the new soil from becoming contaminated. The ground surrounding the raised bed should also be covered to prevent contaminated dust from blowing onto the growing food. If the existing soil is too contaminated to grow food for human consumption, consider creating a container garden with new soil.

Pressure-treated wood should not be used to create raised beds and container gardens. Food should not be stored in boxes made of pressure-treated wood.

4.1.2 Creating a Garden and Harvesting Produce

Students will likely be very excited when they start to see their garden grow and produce food. The teacher should consider the safety issues before allowing students to harvest and eat the fruits of their labour.

IDENTIFY THE HAZARDS

In general, working in a garden is a healthy activity. However, students may be exposed to environmental, biological, chemical, and mechanical hazards in a garden, so should take precautions to stay safe.

Environmental Hazards

These include possible ***sunburn*** resulting from exposure to ultraviolet light and ***dehydration***. These are discussed at length in Section 4.4.1, Nature Study.

Biological Hazards

Hazards associated with soil ***microorganisms*** may affect students working with soil and compost. Microorganisms are discussed in Section 4.1.1, Selecting a Site and Materials for a Food Garden. Students engaged in weeding may experience contact dermatitis and scratches from thorns. In many gardens, wood is a common material. Students may get wood slivers, which pose an ***infection*** hazard. Contaminated soil, water, hands, and surfaces may lead to contamination of food from bacteria, viruses, or parasites. Contaminated food is a hazard that can lead to food-borne illnesses. Some hazards, including toxic plants, are discussed in Section 4.1.3, Studying Plants.

Chemical Hazards

Chemical pesticides are banned in most Ontario jurisdictions, so should not be a cause for concern. Any chemical fertilizers should be carefully selected and applied to minimize the students' exposure. Hygiene procedures should be followed (Figure 3.4).

Some seeds are pre-treated with fungicides or other chemicals. When selecting seeds for planting, teachers may prefer to use untreated seeds. (See Section 4.1.3.)

Mechanical Hazards

These include the materials and tools that students use in a garden. Students should follow the plans outlined in **Table 4.2**.

Table 4.2 — Hazards and Safe Use of Garden Tools

Garden Tools	*Hazards*	*Safe Practices*
Tools with long handles (shovel, fork, rake, hoe, and broom)	• cuts, puncture wounds, bruises • back strain • tripping	• Wear appropriate footwear: closed toes; no sandals. • Use appropriately sized tools: able to be handled safely by students. • Dig keeping a straight back. • Lean tools against a wall or stand them in the ground when not in use; do not lay tools on ground. • Ensure that there is space around you; be aware of others working near you.
Hand tools (trowel and fork)	• wrist strain • back strain • tripping • knee pain	• Use correctly sized tools. • Have plants and other materials close by to avoid stretching. • Do not throw soil about. • Ensure that there is space around you; be aware of others working near you.
Watering can	• back strain • tripping	• If using a large watering can, do not fill it completely. • Keep back straight and knees bent when lifting.
Pots	• back strain • tripping	• Use pots that will not be too heavy when full of soil. • Keep back straight and knees bent when lifting.
Stakes	• eye injuries	• Cover end of stakes with coloured tape or garden cane toppers to avoid eye injury when bending over.

ASSESS THE RISKS

Teachers should encourage children to ask for help if anything seems too difficult or dangerous for them to do. For example, young children are prone to hernias from lifting heavy objects. The teacher should be aware of this risk.

Children under five years old are at greater risk of contracting food-borne illness than are older children for two main reasons. First, younger children may not follow safe hand-washing practices after using washroom facilities. Second, the immune systems of children under five years old are still immature.

Students who are ill should not harvest or handle food for

consumption. Suggest that these students perform other beneficial tasks, such as weeding.

MAKE SAFETY PLANS

Tool Use

Students should be shown how to use the tools properly, and reminded that tools may have sharp edges. The teacher should not give more tools out to students than can be safely monitored. All tools and containers should be cleaned before and after use.

Harvesting

Students should be reminded not to eat anything until both hands and produce have been thoroughly cleaned.

When harvesting plants for food, students must exercise proper care. They should review hygiene and cleanliness, perhaps using a hygiene anchor chart (Figure 3.4 in Section 3.4). Some students love to get their hands dirty; consider letting them harvest roots such as carrots and radishes. Allow other students to harvest above-ground crops such as tomatoes, peppers, and berries.

Encourage students to wear suitable clothing: no open-toed shoes or sandals; long pants and long sleeves; and sunscreen and hats to protect against sunburn.

Demonstrate how to brush, gently shake, or rub off any excess garden soil or debris before putting the produce into the harvest container or bringing produce into the kitchen. Shaking roots vigorously may damage the produce and may throw soil into the eyes of nearby students.

Allow sufficient time for hand-washing.

Storage

The food should remain unwashed until it is to be eaten. Washing produce before storing can hasten the rate of spoilage and promote bacterial growth. If produce must be washed before being stored it should be dried thoroughly with clean paper towels before storing.

If the produce requires refrigeration, store it in bins or on shelves above any raw meats, poultry, or seafood to prevent cross contamination. Storing fresh produce in cloth bags or perforated plastic bags allows air to circulate. Fruits or vegetables that have been cut, peeled, or cooked should not be left at room temperature for more than two hours, or one hour if the temperature is above 32°C (90°F). Prepared food should be stored in the refrigerator in covered containers.

Washing

All plants should be checked thoroughly for damaged or bruised areas (which should be cut away). Produce that looks rotten should be discarded or composted.

Delicate fruits and vegetables (such as berries, lettuce, and mushrooms) should be washed in bowls of cool water. More robust produce (such as carrots, celery, and apples) can be washed under cool running water, while rubbing briskly with the hands or a vegetable brush to remove dirt and surface microorganisms. Alternatively, they could be scrubbed in a bowl of clean water (as sink drains can harbor microorganisms).

Insects

Insects are prevalent around gardens. At certain times of the year there will be a profusion of different insects: bees in spring and summer; wasps in summer and autumn; mosquitoes and midges in summer; red ants in spring, summer, and autumn. Students should recognize these and know how to behave when potentially dangerous flying insects are nearby! The teacher can model appropriate behaviour.

The teacher should review individual plans for students with anaphylaxis, in case of insect stings or bites. The plan should include

- the type of allergy, monitoring, and avoidance strategies and appropriate treatment;
- a readily accessible emergency procedure for the pupil, including emergency contact information; and
- easily accessible storage for epinephrine autoinjectors, where necessary.

http://www.edu.gov.on.ca/eng/healthyschools/bill3qanda.html

4.1.3 Studying Plants

Students generally benefit from studying plants in their native habitat: outdoors. Besides the healthy physical activity, being outdoors evokes children's curiosity and gives them the opportunity to practice field observation skills in an authentic way. Seeing the native habitat helps students understand:

- what conditions are optimal for plant growth; and
- how the plant is part of a complex ecosystem that includes other plants, insects, soil microbes, and herbivores. The interrelationships contribute to the overall stability and function of the ecosystem.

IF POISONING OCCURS

If a child eats or touches a plant, berry, seed, bulb, or wild mushroom that may be poisonous, call the Poison Centre immediately: 1-800-268-9017 or 416-813-5900

Be prepared to give the following information:

- Any symptoms of illness your child displays.
- Name of plant (if you know it). The responders at the Centre are specialists in poison information; they are not plant specialists. They cannot identify plants over the phone.
- How much and what parts were eaten
- How recently it was eaten or touched
- Age of child

The Poison Centre is open seven days a week, 24 hours a day.

www.ontariopoisoncentre.com/ontariopoisoncentre/default.asp

IDENTIFY THE HAZARDS

Many children touch or eat plants that may be poisonous, according to the Ontario Poison Centre. There are many toxic plants in Ontario. Some cause minor irritations, and others are deadly. In general, plants are hazardous for one of three reasons. They may:

- be poisonous when ingested;
- cause irritations such as itchiness and rashes upon contact; or
- cause allergic reactions.

Accidental poisoning from plants occurs mainly in the autumn, when young children eat attractive plant berries. The plants listed in Table 4.3 are examples of those that can cause serious harm.

When planting seeds for a plant study, particularly with the help of very young students, the teacher may choose to use seeds that have not been treated with any pesticides or fungicides. Consider obtaining seeds from organic growers.

ASSESS THE RISKS

In general it is difficult to assess the level of risk that individual students face from specific plants.

Plants or plant parts are the most common source of allergens and the most likely to cause allergic reactions.

Table 4.3 — Poisonous Plants

Plant	*Description*	*Distribution*	*Toxic effect*
Climbing/bittersweet nightshade *Solanum dulcamara* [Solanaceae/ Nightshade family]	• woody vine • small, purple flowers • green berries that ripen to red in late August to October	• south, central and eastern Ontario; west to east shore of Lake Superior	• The leaves and unripened fruit are toxic.
White baneberry *Actaea pachypoda* [Ranunculaceae/ Buttercup family]	• 30–80 cm tall • brilliant white berries with a black dot	• forests in southern, central and western Ontario	• All parts produce an irritant that, when ingested, causes distress to the mouth and throat, stomach cramps, and vomiting.
Jack-in-the-pulpit *Arisaema triphyllum* [Araceae/Arum family]	• dense cluster of scarlet berries forming in late summer and autumn	• woods and thickets in south, central, and western Ontario	• All parts cause a severe burning sensation in the mouth, throat, and mucous membranes
Poison ivy *Rhus radicans/ Toxicodendron radicans* [Anacardiaceae/ Cashew family]	• creeping plant • alternate compound leaves with three leaflets	• throughout Ontario	• Skin contact results in skin irritation ranging from mild redness to oozing blisters with severe itchiness.
Bloodroot *Sanguinaria canadensis* [Papaveraceae/ Poppy family]	• single stem from 5– 15 cm high • single white flower blooms from April to early May • pale, lobed green leaf that doubles in size after blooming	• rich forests of southern and central Ontario, north and west of the Great Lakes to the limits of the boreal forest	• Ingestion results in tunnel vision, vomiting, diarrhea, irritated mucous membranes, fainting, and possibly coma.
Giant hogweed *Heracleum mantegazzianum* [Apiaceae (Umbelliferae)/ Parsley family]	• tall flowering stems up to 5 m high • very large, compound leaf blades	• throughout southern Ontario	• Sap causes redness, swelling, or blistering of skin, made worse by sunlight. • Skin may remain sensitive to UV light for years.
Water hemlock *Cicuta maculata* [Apiaceae (Umbelliferae)/ Parsley family]	• up to 2.2 m tall • small, white flowers from July to August	• wet habitats throughout Ontario	• Water hemlock is one of the most toxic plants in North America. • Ingestion causes seizures and can be deadly for livestock and humans.
Black cherry *Prunus serotina* [Rosaceae/ Rose family]	• bark resembling burned corn flakes • flowers in May–June • drooping clusters of dark-coloured, fleshy berries in late August and September	• southern, central, and eastern Ontario	• The seeds, leaves, twigs, and bark of black cherry contain a deadly toxin.

More information on poisonous plants available at Ontario Nature: http://onnaturemagazine.com/field-trip-poisonous-plants.html

Some students may know that they or someone in their family has had a reaction to a plant. For example, some children may have been exposed to poison ivy. For these children, additional exposure poses a greater risk because repeated exposure to urushiol (an oily compound in the sap) causes the skin to become more sensitive. Asking students to share personal and family information will help assess prior knowledge and identify students for whom special precautions are necessary. A check of student medical forms will also alert the teacher to any known allergies or similar issues.

When conducting investigations in a natural setting, it is good practice to first survey the study area for potential hazards, including noxious or poisonous plants. A field guide can provide information on poisonous and irritable plants that are inappropriate for study in elementary school programs.

MAKE SAFETY PLANS

Safe edible plants such as beans, peas, tomatoes, onion, cabbage, and squash, provide ample opportunities to engage students in the direct study of plants. This list is not exhaustive.

Most hazards, including irritations of the intestinal tract (mouth/throat/stomach) and poisoning, can be avoided by creating a safe learning environment. If plants are to be handled indoors, it should be done carefully to ensure that pollen or spores are not excessively distributed throughout the classroom.

SAFETY PROTOCOL FOR STUDYING PLANTS OUTDOORS

Students should
- not eat any plants, berries, or mushrooms found on a hike,
- keep their hands away from mouth/nose/eyes to minimize contact with irritants,
- use gloves, if necessary, to avoid touching unknown plants and soil,
- wear proper footwear, socks, and long pants during outdoor studies in areas that may contain poison ivy, and
- wash their hands after working with plants or soils.

Alternative activities should be prepared for students with known plant-related allergies.

4.1.4 Studying Animals

Animals in the classroom provide an engaging opportunity to boost observation skills. Ongoing study and care can also help learners develop empathy and an appreciation for some elements of the natural world. Educators should consult local by-laws, provincial laws, and school board policy and procedures regarding the care and use of animals before bringing animals into the classroom. The keeping of pet animals in institutional settings such as schools is a controversial and sensitive issue. When decisions are being made about the use and care of animals being brought into in the classroom, there must be a process that involves informed, purposeful, and active decision-making by students, parents/guardians/caregivers, support staff (school custodians), teachers, and administrators.

Care of a classroom pet provides an opportunity to learn about the conditions necessary for their health and well being: nutrition, cleanliness, space, exercise, and temperature. These factors must be central to the learning experience. Including students in the care can help them develop respectful attitudes toward another living creature. It is the teacher's responsibility to provide care and maintenance for the animal, and the teacher must supervise all interactions and ensure that the animal is not distressed. Prepare a long-term care plan before

Table 4.4 — Considerations when Choosing Classroom Pets

Animal	*Hazard*	*Precaution*	*Responses*
gerbil, hamster	• allergens • bites	• Wear disposable gloves for cleaning • Wear leather gloves for handling	• Contact the school office • Apply First Aid • Request medical assistance if necessary
fish	• disease transmission * • long life	• Use a net • Wear waterproof gloves • Plan for care beyond the classroom	• Contact the school office, wash hands, use hand sanitizer • Arrange for an alternative home if necessary
reptile and amphibian **	• bites • salmonella infection	• Only the teacher should handle reptiles • Wear waterproof gloves	• Wash hands • Use hand sanitizer
bird **	• allergens • bites • salmonella infection	• Wear safety/leather gloves	• Wash hands • Use hand sanitizer

* The aquarium water may pose a greater risk than the animal.
** There are many cautions regarding reptiles and birds. Further information is provided by the Public Health Agency of Canada: www.phac-aspc.gc.ca/fs-sa/fs-fi/salm-pets-animaux-eng.php

bringing a pet into the classroom. It is especially important to ensure that a plan is in place for the care of an animal during long school holidays e.g., Christmas, March Break, the Easter weekend. Spend time researching the care required for any animal considered for a classroom pet. **See Table 4.4.** Before obtaining an animal, the teacher should check with the school board/employer to determine whether the animal under consideration is acceptable.

IDENTIFY THE HAZARDS

Hazards to Humans

There are several physical hazards involved with any animal–human contact. There are also environmental hazards and emotional considerations. The teacher should consider these before deciding to bring an animal into the classroom.

Physical contact with the animal can lead to some students experiencing health effects—infection, allergic dermatitis, asthma, physical injury—that could require medical treatment. An animal may be the source of an infectious pathogen. Disease transmission between humans and animals is not common, but can happen.

Handling animals can be a stressful experience for some students. Either through fear or accident, direct contact can lead to injury to the handler. Spoiled food or biological waste in the animal's home could form noxious substances that, if touched, can lead to contact dermatitis. Handling animals can also trigger allergic responses in sensitive students.

The ***environment*** of the classroom pet must co-exist with the classroom environment. Consider the space required for housing and how this affects the room. In addition, there must be a safe space for storing food and other materials. These materials must be fresh and free from pests such as ants. The bedding, food, and excreted material may be allergen sources.

Emotional responses to animals can vary widely. Some students may want to handle the animal excessively; others may have phobias regarding the animal. A good classroom experience depends on a supportive climate. Prepare students for the ongoing care that the

animal requires. Animals used as classroom pets must never be considered disposable items. Transitioning away from access to the pet and care routines may cause some students emotional turmoil.

Hazards to the Animal

An animal may experience harm through careless handling, through acquiring a pathogen and becoming ill, or from inadequate care. Inadequate housing or overcrowding can result in behavioural issues that may result in physical harm to the animal(s).

ASSESS THE RISKS

When animals are being handled in the classroom, there are risks to the teacher, students, and animals involved.

As the main caretaker, the teacher is at greatest risk from bites or scratches, contact dermatitis, and exposure to infectious pathogens. Inexpert handling in particular puts the handler at risk of a physical injury.

There is always a chance that the animal will die or have to be euthanized. The expected lifespan of the animal should be taken into account as its early demise may cause distress. Some students may form a strong bond with the pet and feel the loss more acutely than others. If a classroom pet dies, this event can be used to explore students' understanding of death and grief, and to encourage students to share their feelings. There may also be some discussion about students' reluctance to express their vulnerabilities.

Extensive handling can put the animal at risk and cause life-threatening stress. Unskilled handling is particularly dangerous to the animal. It is the teacher's responsibility to ensure the animal's wellbeing.

MAKE SAFETY PLANS

Handling Precautions

Have appropriate hand sanitizer available for cleaning hands after touching the animal directly, or after cleaning the area occupied by the animal. Review the information related to proper hygiene outlined in Chapter 3.

SAFETY EQUIPMENT AND MATERIALS FOR ANIMAL CARE

- hand sanitizer
- disposable gloves
- leather gloves
- impact glasses
- appropriate cleaning agents

Disposable gloves provide a barrier between the animal and the handler's skin. This further reduces the transmission of infection or contact with chemicals that might damage the skin. Leather gloves can be used to handle an animal that might bite. Even a docile animal can be aggressive when highly stressed.

Any injury to the teacher or student must be reported to the office and the appropriate protocol followed. An injured animal may require veterinary care.

Environmental Precautions

Provide the animal with sufficient space for active movement in the cage. The animal cage should be clean and free from defects such as cracks or rusty areas. These can become escape opportunities. The cage should include a secure door with a locking mechanism or a removable top to remove the animal for cage cleaning. Avoid cages with spring-assisted doors that could snap back onto a finger or the animal.

Have a cover for the cage to provide privacy for the animal. Remove the cover for access to light and fresh air for most of the day.

Food should be stored in an appropriate container that keeps the food fresh and free from dust and other organisms, such as mice or cockroaches. If fresh food is required, have a storage area that keeps the food cool. Caution students to not eat the animal food.

Store clean bedding material in an area where it is inaccessible to dirt, students, or other curious animals.

Use cleaning agents that are acceptable for school use and not harmful to animals. Use these materials according to the employer's direction, and store them securely away from students. See Section 2.5 for more information about household products.

A plan should be in place to deal with a student's allergic reaction resulting from contact with the animal or exposure to its environment.

Emotional Precautions

If a classroom animal dies, check Board procedures and local municipal rules regarding disposal of the remains. The class may be permitted to

choose a location to dispose of the remains. The teacher may choose to organize an activity or ceremony to show respect for the deceased animal and to allow students to share their feelings and emotions about the death.

The animal may outlive the school year, in which case arrangements must be made for its care during the vacation and "handing over" to a new class or a new home.

Other Considerations

Classroom pets must not be used in experiments being conducted in the classroom. There is no justification for distressing an animal through deprivation. Students can observe animal behaviour and be involved in providing a healthy living environment that includes adequate food and all other needs. Comparing the nutritional needs of a classroom pet can lead to a discussion regarding healthy human eating, and the different stages of growth (such as childhood, adolescence, adulthood). Space requirements offer the possibility of addressing the need for physical activity for all animals—including humans.

4.1.5 Studying Ourselves

Children are intrigued by how their bodies work and will readily engage in inquiry activities to learn more. Students of all ages need guidelines on ways to safely and appropriately investigate how their bodies work in relation to their surroundings. The risks of physical or emotional injury can be minimized through careful classroom management.

IDENTIFY THE HAZARDS

Although students engage in daily physical activity, parental permission may be required for students to participate in certain activities related to a scientific inquiry. The teacher should check for any medical conditions that are already on record with the school office. Before deciding to use students as subjects to study the human body, it is important to consider the physical and environmental hazards, and emotional stresses.

Physical hazards exist when students are asked to exercise or move in unfamiliar ways. This may result in falls, strains, or overexertion. If studies take place outdoors, then ***environmental hazards*** (e.g., location, weather), as outlined in Section 4.4.1, Nature Study, are present.

Whenever we bring attention to physical traits or physical and cognitive abilities as part of a lesson, we are confronted with the ***emotional stress*** associated with poor self-esteem and bullying. Children with poor self-esteem may experience fear or shame with respect to their physical attributes. Children may also experience bullying, which can have short and long-term effects and may interfere with learning.

Another emotional stress may arise if a student becomes concerned about measurements that fall outside of ranges deemed typical (**Figure 4.1**). The student may worry that the measurement indicates a health issue.

GUIDELINES FOR STUDYING HUMANS

Science fair projects often involve human research participants. Teachers need to ensure that participants are safe, that they are treated with respect and dignity, and that the information they provide will be kept confidential.

These ethical safeguards are primarily the responsibility of the student researchers and their supervisors.

http://ethics.youthscience.ca/human-participation

Figure 4.1 We come in all shapes and sizes, even at the same age

ASSESS THE RISKS

The teacher should check the medical information kept in the school office to identify students with specific physical limitations such as a previous injury or asthma triggered by exertion.

Before asking students to exercise or move in a particular way, it is wise to survey students to better understand if they have been asked to complete such tasks before. Physical injury can result from a fall or strain if the action is unfamiliar to a student. As students gain confidence in their ability to complete a particular task, they may pose questions as part of the inquiry process. This can lead them to choose unanticipated actions that could lead to injury. For example, a fall caused by dizziness from twirling or tripping can lead to bruises and sprains. Overexertion is another factor that can lead to physical distress.

Children who are new to class or those who do not have close classroom friends may be at greater risk than other students during "studying ourselves" activities, given their lack of peer support. It is very important that teachers be sensitive to all children who may be exposed to emotional stresses.

TALK TO A HEALTH CARE PROVIDER

A student concerned with their biological data (such as heart rate, irregular heart rate, or difficulty finding a heart rate) can seek confirmation with a health care provider.

MAKE SAFETY PLANS

Physical Safety

Students can measure heart rate or breathing rate with the help of a partner. Students should be gentle when touching a peer and respectful when observing a physical action. Allowing self-selection of groupings may be prudent so that students can limit peer contact.

The teacher should explain to students that variations in human physiology result in a range of physical performance. Heart size and muscle tone not only vary from person to person, but also change over time. Students should consider where they are in their growth process. No one in the class should be singled out for not having "average" measurements. Students could be allowed to opt out of an activity. They can observe or "spot" other members of the class. There are usually some students in a class who are excused from physical activity.

Students should be reminded that humans show a great deal of diversity so they should expect to observe a wide range of results. There may be some value given to a particular level of performance (such as speed), so the teacher should balance this by valuing a performance at the opposite end of the scale (slower movement allows for greater opportunity to observe the surroundings and avoid obstacles).

Students should also be aware that readings made in school may be inaccurate because of noise and variable expertise. Learners discovering aspects of how their body works can make inaccurate measurements and conclude that there is a medical problem where none exists. For example, when students measure heart rate they may start or stop counting too soon, adding or missing beats, and record a pulse rate that is unrealistic.

As always when students work closely together, hygiene (Classroom Hygiene in Section 3.4) and space (Section 3.1, The Nature of the Space for Learning) should be considered. Additional considerations are needed if the activity is outdoors (Section 4.4.1, Nature Study).

Emotional Safety

"Studying ourselves" activities may prompt surprising responses from students, particularly during periods of accelerated growth. Students

should be reminded that a safe environment includes emotional safety. All students have the right to be emotionally safe, and to be treated with respect and dignity. Teachers should look out for bullying, and follow school board reporting procedures if there is a suspicion that bullying is taking place. Concerns about bullying must be directly addressed by training students to recognize and prevent bullying. For example, wall charts could be created showing completed sentence stems such as "I know that physical/verbal/…. bullying is happening when …" It might also be wise to prohibit the use of smart phones during "studying ourselves" activities.

Comprehensive information on bullying is provided on the Ontario Ministry of Education web site. One of the resources on this site, *Bullying: We Can All Help Stop It—A Guide for Parents of Elementary and Secondary School Students*, Spring 2013, describes the different forms of bullying:

- ***physical***—hitting, shoving, damaging or stealing property
- ***verbal***—name calling, mocking, or making sexist, racist, or homophobic comments
- ***social***—excluding others from a group or spreading gossip or rumours about them
- ***written***—writing notes or signs that are hurtful or insulting
- ***electronic (commonly known as cyber-bullying)***—spreading rumours and hurtful comments through the use of e-mail, cell phones (enabling text messaging), and on social media sites.

http://www.edu.gov.on.ca/eng/multi/english/BullyingEN.pdf

PHYSICAL ACTIVITY

Sedentary time can be replaced by physical activity as part of science and technology learning. Allow students to select an action where possible.

Suitable activities include running (aerobic exercise), big arm movement (range of motion, flexibility), lifting (anaerobic exercise), and jumping (high-impact weight-bearing exercise).

http://www.healthycanadians.gc.ca/kids-enfants/physical-physique/tips-conseils-eng.php

4.2.1 Investigating Materials and Simple Machines

The curriculum asks students to probe the properties of materials by testing them in different ways. For this, students have to carefully plan their investigation, purposefully select appropriate tools, and use them safely. When students design, build, and test their own constructions, they use their understanding of materials, tools, and simple machines. Safe investigation of materials and simple machines is an important start for more advanced work in science and technology.

Technological problem solving is a dynamic process that involves the use of many different tools. The best way to ensure safety is for students to know the correct way to use tools, and to use personal protective equipment as required. Students should have the opportunity to use a variety of different hand tools and power tools. Power tools facilitate accurate cutting and drilling regardless of operator strength or dexterity.

The ***Making Safety Plans*** portion of this section has a particular focus on the hazards, risks, and safe handling of three power tools: the scroll saw, the drill press, and the band saw.

- The scroll saw can produce straight, curved, and interior cuts on softwood up to 5 cm in diameter.
- The drill press is able to penetrate wood and most rigid plastics. It can create holes of various diameters and depths at preset angles. This machine allows for a smooth operation requiring little strength or dexterity of the operator while hands are away from the work.
- The bandsaw is most commonly used to re-saw boards to various lengths and thicknesses and to make curved or straight cuts. Guides allow for precise cutting. The continuous cutting blade reduces time and produces edges that need little finishing.

WOODWORKING SAFETY

The Canadian Centre for Occupational Health and Safety provides general safety information on using woodworking machines.

http://www.ccohs.ca/oshanswers/safety_haz/woodwork/gen_safe.html

IDENTIFY THE HAZARDS

All hand and power tools have the potential to cause physical damage. Many have sharp points or edges that can cause puncture wounds, cuts, and scratches. With others there is a danger of impact, or flying projectiles. Others generate heat that could cause burns.

The scroll saw and drill press both pose ***cutting***, ***projectile***, and ***entanglement hazards***. The bandsaw poses a cutting hazard. Appropriate risk management steps must be taken to avoid injury.

ASSESS THE RISKS

Hands-on activities introduce an element of risk. Most of these risks, however, can be reduced with appropriate training and careful planning. When assessing the risks, it is important to consider:

- the appropriateness of the activity for the maturity and skill level of the students;
- whether the selected tools are appropriate for the materials chosen (for example, is a high temperature glue gun required to join the materials?);
- the training of the teacher (See Section 1.1, in which training is recommended in selection and use of materials and equipment, safer alternatives, tool use, and procedures to follow in case of an accident or unexpected outcome.);
- students' observed care and concern for their own safety and for the safety of other people, demonstrating their understanding of safety rules and procedures (outlined in Chapters 3 and 4 of this resource);
- students' skills in using the tools and materials safely;
- the physical layout of the workspace, including the ratio of equipment to student and the amount of space between pieces of equipment; and
- the accommodations that are in place for students with special needs, such as
    - providing a lower work surface for a student in a wheelchair,
    - ensuring that clothing, jewellery, or accoutrements worn for religious reasons are safely secured, and
    - supplying visual cues for English language learners.

MAKE SAFETY PLANS

Implementing an appropriate safety plan can reduce the hazards and risks associated with a science and technology program. The plan should incorporate the selection and use of equipment and materials, the nature of the activity, the workspace in which the activities take

place, and any special instructions for the students.

Equipment and Materials

- Materials and tools should be kept in secure storage facilities when not in use.
- Power tools must have a lock-out switch to turn off power to the machines.
- Safety rules should be posted at each power tool.
- Hazardous materials such as pressure-treated wood must not be used.
- Appropriate personal protective equipment must always be available and easily accessible to all students. Impact-resistant safety glasses are often adequate for technology activities, although splash-resistant goggles may occasionally be required. Ensure that eye protection fits correctly. A full face shield may be more appropriate for younger students especially if there is a risk of flying debris.

The Nature of the Activity

- Safer alternative activities should be designed if students can use simpler tools and materials to address the technology expectations.
- The PPE available must be appropriate for the activity. For example, dust masks should be available for students with dust sensitivity and allergies.

Workspace

- Students working with tools and materials in classrooms must have sufficient and uncrowded work space.
- If power tools are being used there must be procedures in place to control crowding around machines.

Special Instructions

- Students must be trained in the proper handling of the specific tools for the activity.
- Safety precautions must be included in pre-activity instructions to students.
- The teacher should model specific skills and behaviour, such as the correct use of a mitre box or the consistent wearing of safety glasses.

Proper Use of Hand Tools, Power Tools, and Bonding Agents

HAND TOOLS

There are several hand tools that are commonly used in technological problem solving, and each requires that students learn to use them safely and effectively. Appropriate PPE should always be worn and loose clothing, hair, and jewellery should be secured. **Table 4.5** lists some common hand tools.

Table 4.5 — Hand Tools

Tool	*Uses*	*Tips for Safe Use*
Mitre box or bench hook 	• holds wood securely while it is being cut or drilled • provides increased safety by securing work • allows students to keep their free hand away from a saw or drill bit	• Clamp mitre box securely to table using a C or F clamp. • Wood should fit securely into the holder on the mitre box. • Mitre box has guides for making cuts at different angles. If these guides are worn, the mitre box should be replaced.
C or F clamps 	• to secure equipment or work to a work surface (e.g., table top) • to join two pieces of material, e.g., to let glue dry	• Place the object or objects to be clamped on a flat, stable work surface. • Place the clamp so that all objects/surfaces to be clamped are between the pressure pads of the clamp. • Slowly turn the handle of the clamp screw until the pressure pads secure the materials with the desired force. • To avoid damage to the materials being clamped or to the surface to which materials are being clamped, do not over-tighten the clamp. • Keep fingers away from pressure pads as the clamp is being tightened.
Saws (e.g. junior hacksaws*) 	• cutting small wood (e.g., balsa)	• Ensure that the blade of the saw is straight, and the teeth are sharp and undamaged. • Remove screws and nails from old material before cutting. • Fasten the work securely with clamps before cutting. • Keep hands away from the teeth of the blade. • When completing a cut, support the waste side to prevent wood from falling. • Carry the saw with the toe (the end away from the handle) toward the floor.
Hand drill 	• drilling holes for axles, dowelling, pilot holes, or fulcrums	• Use pistol-grip hand drills that have no open gears. • Fasten the work securely with clamps before drilling. • Ensure that the bit is centred in the chuck and tightened before operating the drill. • Before drilling into slippery materials, place masking tape over the intended drilling location, or mark the spot with an awl, if available. • Never drill through cloth or other soft materials that will twist around the bit.

* Junior hacksaws are ideal for use with primary (1–3) and junior (4–6) grades.

POWER TOOLS

The Ontario curriculum document specifies that "Teachers supervising students using power equipment such as drills, sanders, and saws need to have specialized training in handling such tools" (*Ontario Curriculum, Science and Technology 2007, revised, p. 30*). Although power tools are not required to address the curriculum expectations, they can increase the students' level of engagement by providing a "real-world" context. Such an experiential learning opportunity can lead students toward various high school and career program choices.

Teachers should always follow their school board policies and procedures regarding the use of power tools in their classroom. Power tools are generally not recommended below Grade 7. School boards determine the specialized training required for power tools and what power tools are acceptable for use in their schools. For all power tools, students must also receive proper training and show competence in using the machine.

Operators and observers should follow these general safety instructions when power tools are used:

- Wear appropriate PPE (i.e., impact resistant safety glasses and, if necessary, dust masks);
- Secure loose clothing, hair, and jewellery. Clothing (such as a hijab) or other items worn for religious reasons may be worn, but should be secured so that there are no loose ends that may become entangled with a tool;
- Ensure that the workspace is clean and clear;
- Inspect material for knots or foreign objects, such as metal or stones, which could affect the smooth operation of the machine.
- Before making any adjustments to the machine, ensure that it is shut off and locked out;
- Keep hands away from sharp edges and tools;
- Use a dust extraction system to reduce the quantity of airborne dust fibres, when power sanders or electric saws (such as band saws) are in use;
- Students not using the machine must stand at least 1 m away from the machine and the operator;
- Turn the machine off and wait for it to come to a full stop before removing work or leaving the machine; and
- Remove the waste with a brush and leave workspace clean for the next operator.

POWER TOOL SAFETY

The Canadian Centre for Occupational Health and Safety provides information on the safe and effective use of a variety of woodworking machines.

http://www.ccohs.ca/oshanswers/safety_haz/woodwork/

Drill press: http://www.ccohs.ca/oshanswers/safety_haz/metalworking/drillpresses.html

Band saw: http://www.ccohs.ca/oshanswers/safety_haz/woodwork/band_saw.html

It is not usually necessary to wear gloves or an apron for skin protection, as long as tools are used properly. Gloves can often make it difficult to handle tools and materials.

Hearing protection is also unlikely to be needed in an elementary science and technology classroom. Power tools increase noise, but it is unlikely to be at a level that would pose problems. In addition, the use of hearing protection impairs the ability of students to hear those around them or instructions from the teacher. Teachers should consult their school board's health and safety officer if the volume of sound could be an issue in the classroom.

Table 4.6 — Power Tools

Tool	*Uses*	*Tips for Safe Use*
Scroll saw 	• making intricate or detailed cuts (cuts tighter curves than a band saw) • making interior cuts through a pilot hole (the blade is not a continuous loop)	• Check that all guards are in place and working properly before starting the machine. • Use the correct type of blade for the work being completed. • Make certain that the table is secured in the proper position. • Set the lower guide assembly to rest on top of the material to be cut. • Adjust the blade tension before beginning. • Keep your hands to the side of blade and out of cutting path of blade. • Feed the material slowly, following the marked line with the blade. • Avoid turning material too quickly. Do not force the material. • Stop the machine if excessive vibration occurs. Reset the hold down. • If the blade bends or breaks, shut the machine off and wait for it to stop before changing the blade. • Upon completion, shut the machine off. Wait for it to stop then remove the waste. • Leave the workspace clean for the next operator.
Drill press 	• making accurate holes in wood or other suitable materials with little effort	• Ensure that all necessary aids (e.g., hold downs, clamps) are available for use when necessary. • Check that a secured fence/guard or vise is in place when needed. • Set the belt to low speed (appropriate for Grades 7 and 8). • Select the proper size and type of drill bit. • Secure the drill bit in the chuck, making certain that it is centred between all three jaws. Using the chuck key to tighten it. • Remove the chuck key from the chuck. • Ensure that the chip shield is in place. • Adjust and secure the table height. • Set the depth gauge if needed. • Use a flat piece of scrap material beneath the wood being drilled. • Keep well back from all moving parts. • Secure material on the table or in a vise so that it will not move or spin with the turning force of the bit. (This feature makes a drill press safer than a hand-held drill.) • Pull down on the feed lever at a moderate pace to avoid breaking the drill bit. • Release the feed lever by slowly bringing it back to its starting point. • Drill bits can become very hot because of friction when drilling. Do not touch the bit after drilling. • Stop drilling if you see smoke or scorching at the work piece. Retract the bit slowly. • Do not reach behind a rotating bit.

Table 4.6 continued — Power Tools

Tool	*Uses*	*Tips for Safe Use*
Band saw* 	• cutting irregular shapes, curved shapes, or straight lines while producing little sawdust	• Use in conjunction with a dust extraction system to minimize the risk of inhaling small dust particles. • Ensure that push sticks are available for use when necessary. • Set and lock the blade guard 1/4" (~6 mm) above the surface of the material to be cut. • All pulleys, belts, and wheels should be securely covered. • Clearly mark out on the material the cut-out design in pencil. Plan out the order in which you will make the cuts, including relief cuts. • Position your hands on either side of cutting path of the blade. Do not push material into the blade with hands or fingers aligned with the blade. • Use push sticks for smaller pieces of material or whenever safe hand placement is compromised. • Make relief cuts to reduce the risk of snapping a blade or pulling it off of the wheel. • Avoid excessive twisting of the blade and backing out of cuts. • Feed the material into the blade at a rate that does not stress the blade or cause scorching. • The width of the blade will determine the limits of the radius you may cut. Do not attempt to cut a radius too small for the blade size you are using. • If a blade breaks switch the machine off and stand back. Consult with the teacher as to the causes of breakage.

* Unique bandsaw set-ups and operations like ripping, bevelling, mitre cuts, pattern cutting, or use of material other than wood can present a different set of risks. Further research into appropriate set-up and techniques for your specific machine should be done before safely attempting these types of operations.

Three common power tools—the scroll saw, drill press, and band saw —are generally accepted for use by school boards that allow students to use power tools. **Table 4.6** lists specific tips for their safe use in the classroom.

At the end of class, sawdust around tables and on floors should be carefully swept up and disposed of in the organic waste bin or regular garbage.

BONDING AGENTS

Regular carpenter's glue (yellow glue) is a satisfactory adhesive for most elementary school technology projects involving wood. White glue is very similar and can also be used, although yellow glue has higher initial grip. Both glues are non-toxic and, when dried, have the same strength.

Many liquid adhesives give off toxic fumes and also act as skin irritants. Students should not use "super" glues, contact cement, or spray adhesives. In addition, adhesives for joining plastics (such as Plexweld) give off toxic fumes, and have been identified as carcinogenic, so they should not be used in any elementary science and technology program.

Table 4.7 describes some common bonding tools used in elementary school technology classes.

Table 4.7 — Bonding Tools

Tool	*Uses*	*Tips for Safe Use*
Hot glue gun 	• joining different materials—such as fabric, plastic, and wood—quickly and easily (although carpenter's glue and white glue make stronger bonds)	• Wear eye protection (e.g., chemical splash goggles). • Glue gun burns can be very painful. Students should use only low-temperature glue guns, and should be closely supervised. Have cold water available nearby in case of burns. • Ensure that the work area is not cluttered. • Place glue gun on a protective mat made of wood, cardboard, masonite, or other suitable material when not in use. • Keep fingers away from the tip, and away from the area of the work where the hot glue will be applied.
Soldering gun 	• joining wires together to form a strong mechanical bond with good electrical conductivity • preferable to a soldering iron in elementary schools because heat is only generated when the trigger is depressed	• Wear eye protection (e.g., chemical splash goggles). • Ensure that the work area is not cluttered. • Work on a non-flammable or heat-resistant surface. • Inspect the soldering tool to ensure that wires and plugs are in good working order. • Use only lead-free solder. • Soldering should be done in an area with very good ventilation. • Although it may take a few minutes to heat up when the trigger is squeezed, never touch the tip of the soldering gun. • Return the soldering gun to its stand when not in use. • Turn the power off when you are done with it.

4.2.2 Investigating Forces and Motion

Students from kindergarten to Grade 8 are expected to examine forces acting on and through structures. Students explore mechanisms that control, magnify, and change the direction of force. These mechanisms employ one or more simple machines:

- lever;
- pulley;
- inclined plane;
- wheel-and-axle;
- screw; and
- wedge.

Consider the hazards and risks carefully, when students are exploring machines.

IDENTIFY THE HAZARDS

Working with structures and tools often involves using a load that, if dropped, could cause harm.

Some simple machines, such as wheel-and-axles and pulleys, may use elastics or string to transfer forces. These can break under load, resulting in objects being projected across the room. Other machines, such as levers, can also accidentally launch projectiles in the classroom. Such projectiles pose an ***impact hazard***.

Mechanisms and tools usually involve moving parts. For example, gears and pulley systems pose a ***pinch hazard*** for fingers. Moving parts, depending on the force involved, can result in an impact hazard.

In Grades 7 and 8, students explore hydraulics and pneumatics. Any fluid under pressure poses potential ***spray hazards*** to eyes and ears.

ASSESS THE RISKS

Working with forces, mechanisms, and loads poses a risk to students in the immediate vicinity. However, depending on the size of the force,

there may also be considerable risk to students who are further away, particularly from projectiles. Personal protective equipment (PPE), therefore, should be worn by everybody in the vicinity. Limiting the size of load, the type of projectile, and the amount of force applied to a mechanism can reduce the size of the "hazard zone." Whenever possible, activities should be designed so that eye protection is not needed.

MAKE SAFETY PLANS

General Safety Precautions

The teacher should:

- identify hazard zones where heavy objects, loads, or projectiles may land, and make sure that students are kept clear of these areas;
- indicate hazard zones by taping off the area and use cardboard boxes or cushions to break the fall of heavy objects or loads;
- always test a mechanism before permitting students to use it, to ensure that materials are adequately durable and to determine the size of the hazard zone required;
- ensure that mechanisms have a sturdy base and, if attached to a structure, a strong and secure support that can safely support the load that will be used;
- ensure that gears are securely fastened to a scaffold or mount;
- choose testing surfaces (such as acrylic sheets for ramps) and scaffolds that will not bend prior to or during the activity; and
- make sure that ramps are sturdy enough to withstand the required load, and securely clamped to desks or other scaffolds to prevent them from slipping or falling.

Students should:

- wear eye protection in the form of impact-resistant safety glasses with side protection or goggles when constructing and testing structures and mechanisms, and when applying loads to them;
- limit the size of loads being used to test structures and mechanisms to prevent structural failure;
- use pulleys with deep enough grooves to accommodate the thickness of string being used;
- keep fingers clear of gears and away from pulleys that are under

load (pinching hazard!); and
- if projectiles are required, use small rounded objects (for example, sponge balls, small balls of modelling clay) and clear the path for the projectiles both before and during launches.

Safety Precautions for Working with Fluids (Hydraulics and Pneumatics)

Students should:

- wear eye protection any time a fluid is under pressure or forces are being exerted on a closed fluid (for example, when compressing air or water in a syringe);
- never point a syringe at the face of a nearby student;
- ensure that rubber tubing is securely attached to syringes (Tubing should fit over the tip of the syringe with some resistance, forming a tight seal.); and
- never push on both ends of a closed hydraulic or pneumatic system. Pressurized fluid can escape with considerable force if a rupture occurs.

4.2.3 Designing, Building, and Testing Constructions

Throughout the Understanding Structures and Mechanisms strand of the Grades 1–8 Science and Technology curriculum, students are required to design and build structures. In some cases, they are asked to test their constructions to evaluate how well they fit the design criteria. In the process of designing and building, students use hand and power tools. Students need specialized safety instruction on the use of tools to maintain a safe classroom. The teacher should keep careful attendance when giving specialized safety instruction to ensure that all students have the necessary information.

IDENTIFY THE HAZARDS

Part of the design process may involve building scale models or prototypes. Students may need to use tools that are unfamiliar to them, and so require new skills if they are to use the tools competently. When using tools and materials, there are contact and burn hazards, irritant hazards, slip and trip hazards, and mechanical hazards.

Contact and burn hazards can produce mild or severe injuries and are a direct result of touching materials. Cuts, burns, bruises, and abrasions can be the result of coming into contact with a moving object, an object with a sharp surface, or a heavy material. Injuries from a tool include cuts from blades or scissors, bruising from pinch points at the joints of scissors and pliers, and burns from the nozzle of a hot glue gun, hot plate, or kettle. (See Section 4.3.3 Heating and Burning.)

Irritant hazards stem from dust produced during finishing of materials or in the material itself (such as sawdust and plaster of Paris). Dust may cause irritation to the upper respiratory tract.

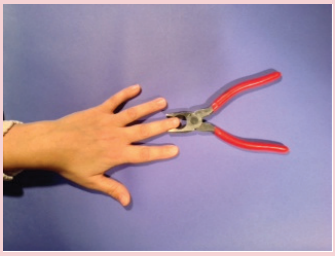
Slip and trip hazards arise from poor storage/management of materials and equipment, and/or cramped working space. Slip hazards can come from liquid or powder spills whereas trip hazards are from a variety of materials (such as power cords, lumber, boxes) at floor level.

Tools

Hand tools and power tools, which incorporate simple machines, are employed because they offer the user a controlled way to apply significant forces to manipulate and cut materials. The forces produced by these tools create ***mechanical hazards*** and may cause injuries. Three common mechanical hazards are pinch point hazards, cutting hazards, and projectile hazards.

FIGURE 4.2

Many simple machines pose a pinch point hazard



Pinch point hazards exist when a body part can be caught between moving parts of a machine, or between a machine and a material that is being worked. Examples include using pliers or machines with gears, working with hinges, lifting heavy materials, and closing containers (**Figure 4.2**).

Cutting hazards are present when using tools with sharp edges and teeth, or sharp points or ends such as nails or awls. Never place a finger on the line of cut!

Projectile hazards can cause hand, eye, and finger injuries when:

- materials come loose as a result of improper clamping;
- drill bits and saw blades snap and break due to excess pressure; or
- materials are broken or dislodged by being hammered with unnecessary force.

ASSESS THE RISKS

The teacher is responsible for providing a safe workspace and equipment. The risks associated with both should be considered in a program in which students use tools and/or machines.

Workspace

- Cluttered space or jostling can lead to injury from falls or cuts.
- Wood dust left on the floor creates a slippery surface that can cause falls.
- Students with dust allergies should have options such as an activity that does not create sawdust.
- Store materials and equipment safely. Objects left on floors or above upper cabinets can fall on or trip students or teachers.

Equipment

- Equipment should be regularly inspected and adjusted to minimize the risk of parts becoming loose and injuring a student's hands or eyes.
- PPE should be available for a whole class, and should be clean and in good working order. Clean goggles are particularly important: without them, students risk eye injury from airborne materials or parts.
- Power tools such as drills and jigsaws, whether operated by 110V AC supply or rechargeable batteries, should only be used by responsible older students who have been trained in their safe use.
- For a thorough description of electrical risks, see 4.3.4 Using Electrical Energy.
- If a machine is protected with a keyed power lock-out, store the key where students cannot obtain it. The key should never be left in an accessible place providing an opportunity for students or supply teachers to turn on machine power.
- Machine inspections should be tracked and filed as components of a safety program.

MAKE SAFETY PLANS

Using tools and machines at the elementary level may appear to pose a high level of risk. However, the care that most elementary school teachers practice regarding safety in their daily routines is sufficient for handling tools and machines. Consistently planning for safety, while teaching and modelling safe behaviour, will enable the teacher to extend student opportunities and learning through the use of tools and machines. Teaching for safety includes:

- posting evidence of a taught and practiced safety plan (tests, anchor charts, posters, etc.);
- establishing protocols for the safe use of tools and machines, such as
    - tool use restricted to students with a proven safety record,
    - no tool use without a teacher (not a supply teacher) present,
    - adherence to set-up and operation instructions and as in machine manuals,
    - safety glasses or splash goggles worn at all times, and
    - all drilled/cut materials clamped;
- selecting tools appropriate for the size and dexterity of students to

avoid muscle strain or hand injury;
- making appropriate materials available, for example
    - no solvents or glue-based lumber (such as MDF [medium-density fibreboard] or pressure-treated wood)
    - cautious use of materials that would place students at risk when using machines (such as tin, rubber, boards with splinters); and
- storing tools, materials, and products securely, in a location that is accessible to staff. Ideally, tools will be stored in lockable storage cabinets.

4.3.1 Using Specialized Equipment

IDENTIFY THE HAZARDS

The Matter and Energy strand involves the use of equipment that might be unfamiliar to students. Table 4.8 lists some of the typical equipment used in a program focussing on student inquiry.

Table 4.8 — Specialized Equipment Hazards

Grades	*Suitable equipment*	*Possible hazard*
1–3 Primary	ruler, small alcohol thermometer, two-pan balance, measuring cups, magnifying glass, garlic press, gardening tools	cuts from sharp edges on broken objects; pinched fingers
4–6 Junior	glass beakers, hand tools, test tubes, test-tube holders, vials, droppers, dropper bottles, spring scale, glass prisms, mirrors, lenses, dry cells, conducting wires, glue gun, small scissors	cuts from sharp edges on broken objects, glass shards, or rusty metal edges; frayed cords; pinched fingers
7–8 Intermediate	Erlenmeyer flask, graduated cylinder, power tools, hot plate, retort stand, clamps, microscope slides, cover slips, triple beam balance, hydrometer, evaporating dish, scalpel blade, displacement can, electronic scale, wire mesh, funnel, forceps, long thermometer	cuts from blades, broken glass, ceramic shards, or rusty metal edges; electric shock from frayed electrical cords

Glassware has the potential to cause harm. Science investigations often involve specialized glassware that can break, creating sharp pieces that can cut skin or damage an eye.

Measuring instruments, such as a ruler or metre stick, are hazardous when misused.

Optical instruments such as magnifying glasses, mirrors, lenses, binoculars, and microscopes may all pose a hazard of eye damage if directed at the Sun. Direct sunlight—particularly when focussed through a lens—can permanently damage the retina without pain.

Microscopes that use electric light sources are a possible electrical hazard when being plugged in, as they may cause an electrical shock. Heat sources such as kettles are a burn hazard, as are the materials and objects that are heated.

ASSESS THE RISKS

Much of the risk related to the use of science and technology equipment in classrooms is related to sharp objects, including broken glass. Teachers should consider their students' ages and their development of fine motor skills. Not all children develop these skills at the same time so it is important to be aware of the skill level of each member of the class.

Different pieces of glassware serve distinct purposes, so students may use several glass items in one activity. The more pieces of glassware there are on the work surfaces, the greater the chance that one could be knocked off and break. Proper handling of glass objects reduces the risk of breakage. Even with on-task behaviour, however, equipment can be jostled or dropped. Glassware can break and flying shards can damage an unprotected eye.

Risks of burn injuries can be reduced by ensuring that students—at least in the younger grades—do not touch hot objects.

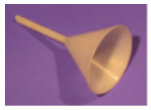
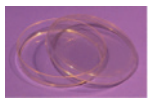
MAKE SAFETY PLANS

General safety precautions include showing students how to use the appropriate equipment properly. Managing how students act toward each other (for example, not allowing play fighting) also contributes to a safe classroom environment. Finally, being aware that accidents can happen, and being prepared to deal with them quickly and calmly, reduces the chances of injury.

Selecting Equipment

The teacher should consider the purpose of the equipment selected. Plastic options can better survive a fall than glass, but are not suitable for investigations that involve heating (**Table 4.9**).

Table 4.9 — Guide to Glassware and its Alternatives

Glassware	*Description*	*Purpose*	*Safer option*	*Laboratory option*
Beaker 	• container for liquids with a spout for pouring	• temporary storage of liquids • pouring liquids • holding water for a water bath	• plastic (polypropylene) beaker • measuring cup • triangular beaker (easier to grasp)	• heat-resistant glass • graduated (showing limited measurement lines)
Erlenmeyer flask 	• container with narrow neck (allows for clamping)	• mixing materials by swirling contents	• plastic (polypropylene) Erlenmeyer flask • flask with screw-on cap	• heat-resistant glass • limited graduation lines
Funnel 	• pouring aid with a narrow neck	• minimizing spillage when pouring liquids into another container • filtering, by placing a filter paper in a funnel to separate solid matter from a solid–liquid mixture	• plastic funnel	• ceramic or glass funnel for hot liquids
Petri dish 	• small, flat, transparent dish and lid	• holding material to be viewed under a microscope or magnifying glass • as an evaporating dish, to allow water to evaporate from a mixture	• plastic (polystyrene) dish with lid	• glass dish with lid can be heated
Dropper bottle 	• small bottle with a fitted dropper	• dispensing liquids one drop at a time	• plastic (polypropylene) dropper bottles	• plastic bottles are squeezable; glass bottles are not
Graduated cylinder 	• tall, narrow, transparent container with many graduation marks	• accurate measurement of volumes	• plastic graduated cylinder (polymethylpentene, polyproplyene, or polystyrene)	• glass graduated cylinder shows concave meniscus

The wide variety of thermometers available gives many options to meet the students' needs and skill levels. Small thermometers braced with a plastic or metal backing suit younger learners. Digital thermometers can be used in a variety of situations, but may have a limited temperature range. Long glass thermometers can be used by more mature students for experiments that involve heat. Students should not use these measuring instruments as stirring tools. If the column in a thermometer is broken, the thermometer will not give an accurate reading and should not be used.

Triangular beakers are easier to hold and pour. Small spouts require attention to fine motor skills. Small hands can handle small containers more easily than larger ones.

Some plastic containers are translucent as opposed to clear. Glass containers generally allow more precise observations.

Although a beaker or flask has some graduation lines to allow some fluid measurement, graduated cylinders have more markings and are a better choice for accurate measurement. Both glass and plastic graduated cylinders are available.

Funnels direct liquid into a container. The size of the neck will affect the rate of fluid flow.

Plastic dropper bottles are suitable for dispensing small volumes of most liquids, but should not be used for long-term storage.

Making a wet mount for viewing under a microscope can involve the use of a glass slide and cover slip. Glass cover slips are quite sharp and break easily. Plastic cover slips are a good alternative. Plastic depression slides are a better choice for viewing a wet sample of microorganisms. Heat from the light source will compromise these specimens.

Demonstrating Proper Use of Equipment

Students should be introduced to the proper use of science and technology equipment. They should learn how to hold or position glassware so that it is stable, and how to pour liquids. It is important to watch students as they hold and use new equipment, and support them as they learn to manage these new items properly. The teacher could post diagrams or photos showing proper handling techniques at

the work stations. Practice sessions with safe substances, such as water, reinforce effective techniques.

Students should be warned of the hazard if the Sun is viewed directly. The teacher should demonstrate the safe and effective use of optical instruments. Students must be told to avoid direct sunlight when illuminating a specimen in a microscope with a mirror using ambient light.

Microscopes with electrical cords should be plugged in carefully, and unplugged by pulling on the plug, not the cord. Electrical cords must be kept up off the floor to avoid tripping hazards. Refer to section 4.3.4, Using Electrical Energy, for more information.

BE SOLAR AWARE

Direct viewing of the Sun can damage the retina and lead to blindness.

Optical instruments must never be pointed toward the Sun.

Do not direct sunlight to an optical device or eye.

Dealing with Unexpected Breakage

Although helpful students may try to pick up broken glass, fragments can cause cuts and should be handled only by teachers.

Each classroom should have a clearly marked Broken Glass disposal bin. The teacher should wear protective eyewear and nitrile gloves when cleaning up broken glass. Nitrile gloves are resistant to puncture. A small hand broom and dustpan should be used to brush up smaller pieces. A vacuum cleaner will pick up the smallest pieces. Finally, a damp paper towel wiped around the impact site will collect glass dust. The bottoms of shoes should be checked for stray shards and wiped with a damp paper towel. This paper towel goes in the normal garbage, not the broken glass bin.

Using Heat Sources and Hot Objects

Teachers must ensure that all activities involving heating take place under close supervision. Hot objects should only be handled by the teacher. For example, if it is ever necessary to carry very hot water around the classroom, it should be carried by an adult and in a closed container such as a kettle or Thermos flask.

Students should be warned about the dangers of burns from hot liquids and equipment that has been heated, such as ring clamps, glassware, and hot plates. Information about heat sources and their proper use is provided in Section 4.3.3.

4.3.2 Chemicals

Student activities that support science and technology understanding involve the use of a variety of materials. Although the curriculum documents suggest some specific chemicals, teachers can select the substances used in class within the purchasing guidelines of the employer. Any worker using controlled substances must be trained in the Workplace Hazardous Materials Information System (WHMIS) (Section 2.4). Other commonly used materials are labelled using Consumer Products symbols (see Section 2.5). All teachers should be aware of these two systems of information. Students should recognize WHMIS warning symbols on containers of hazardous chemicals. Students should also be aware that not all containers of hazardous chemicals—particularly household chemicals—have WHMIS labels.

IDENTIFY THE HAZARDS

Chemical substances can be hazardous. Symbols on the supplier label and the MSDS material or original packaging provide information about a particular material. Refer back to Sections 2.4 and 2.5 for detailed information regarding WHMIS and Consumer Product symbols. Chemical storage is addressed in Section 3.3.

An unlabelled container is most likely the greatest threat in a classroom. A clear, colourless liquid looks like water but could be a corrosive acid or some other chemical. A beaker with white crystals could be sugar but it could be calcium chloride or an even more hazardous substance.

Related to this is the reuse of containers, especially drink bottles, during science and technology activities. A drink bottle with a clear, colourless liquid looks like water, and may be tempting to a thirsty student.

ASSESS THE RISKS

Students working with chemicals can be harmed if they handle or come into direct contact with hazardous chemicals—either intentionally or accidentally.

Concentrated solutions and pure substances pose increased risks to whoever prepares materials for the class. These risks include

irritation or damage to the skin, eyes, or respiratory system, and severe gastrointestinal damage if swallowed. Chemicals are much safer to use when in dilute solutions.

MAKE SAFETY PLANS

There are two types of precautions that need to be considered: teacher precautions when preparing for activities, and student (and teacher) precautions during classroom learning.

Teacher Preparation Precautions

When preparing for an activity that involves potentially dangerous chemicals, or breakable labware, the teacher should follow these precautions:

- Work in an uncluttered working space with good sightlines. This reduces the chance of spills and accidental bumps.
- Store hazardous substances in appropriate safe storage facilities. (See Section 3.3.)
- Use extra caution when working with concentrated materials. Stock chemicals should be stored in a locked cupboard or room and away from heat sources. (See Section 3.3.)
- Use appropriate personal protective equipment (PPE) such as chemical safety goggles, gloves, and apron or lab coat. (See Section 3.3.) Chemical safety goggles protect the eyes from splashing liquids and broken glass. Gloves protect skin from spills. An apron or lab coat protects clothing from spills.
- Design activities to minimize risk: select safe materials that are appropriate to the grade level (**Table 4.10**), prepare solutions with low concentrations for student use, and use small quantities.
    - When selecting materials for a demonstration or student investigation, always look for safer alternatives (**Table 4.11**). Making a saturated solution does not require the use of a hazardous substance; it can be made using sugar (sucrose).
    - Reduce the concentration of materials used. Vinegar is a relatively safe substance, but some people with sensitive skin can experience irritation. Dilute vinegar with water to reduce the potential for adverse effects.
    - Plan to use the smallest possible quantities of materials. Use spot plates or other smaller containers. This reduces the severity of spills (**Figure 4.3**).

FIGURE 4.3

A spot plate allows minimal material to be used to observe a chemical reaction.

- Label containers with the name of the material and handling information. Disposal instructions can help at the end of the activity.
- Do not use food-grade containers for investigations in class.
- Be prepared for small spills. They can be contained and cleaned up if the spilled material is not seriously hazardous. If the hazard is significant, call for assistance.

Table 4.10 — Grade-Appropriate Materials

Grades	*Suggested materials*
1–3 Primary	food colouring, baby oil, sand, borax, bubble fluid, water, clay, peat moss, potting soil, white glue, carpenter's glue
4–6 Junior	materials listed above plus: plaster of Paris, modelling clay, glue sticks (for low-temperature glue gun), 3% hydrogen peroxide solution, sucrose (white sugar), sodium chloride (table salt), glycerine
7–8 Intermediate	materials listed above plus: dilute acid, dilute base, iodine solution, methylene blue indicator, glucose, dextrose, bromothymol blue (indicator), potassium aluminium sulfate (alum)

Table 4.11 — Selecting Safer Materials

Substance	*Potential hazard*	*Safer alternative*	*Sample activity*
Commercial acid–base indicator solution such as bromothymol blue	toxic	cabbage juice (Cut a raw red cabbage into tiny bits, add hot water, and filter out the cabbage bits.)	determining the pH of an environment or substance
Vegetable oil	difficult to completely clean from containers	glycerine	comparing the characteristics of various liquids
Road salt (calcium chloride)	an eye irritant	table salt (sodium chloride)	reducing the temperature and melting ice
Copper (II) sulfate	an eye and skin irritant	white sugar (sucrose) or table salt (sodium chloride)	making a supersaturated solution to grow crystals
Hydrochloric acid	corrosive and irritating to eyes and skin	vinegar (5% acetic acid)	removing the shell from a chicken egg to show diffusion
Iodine in alcohol solution	flammable	Lugol's iodine solution (water based)	Staining plant cells to show starch

Classroom Activity Precautions

When the preparation is complete and the activity is about to begin, the teacher should follow these precautions:

- Before starting, review the sightlines and clutter that can interfere with safe activity. With students, review specific cautions regarding behaviour and skills. This includes the need for students to alert the teacher to any spill.
- Have appropriate PPE for student use during the investigation. Make sure that students wear their PPE properly as they complete the work. Model this behaviour by wearing appropriate PPE during class time.
- Have a plan for the distribution of materials. This can be done with a selection of small dropper bottles or other small container to use at the work stations. Alternatively, set up and supply the work stations before students begin their laboratory work.
- When multiple containers are used, each container at the student stations must have a label that indicates the material inside. A common mistake is the mix-up of unlabelled material.
- To reduce traffic in the classroom, have sufficient equipment and materials at the students' workstations for all trials of the activity, so that the students need not go back and forth to the sink or supply area.
- Review disposal procedures with students before starting the activity. Once the activity is complete, the materials should be collected for safe disposal.

4.3.3 Heating and Burning

Heat is a fundamental form of energy that drives natural phenomena such as the water cycle and weather. Heat also affects solids, liquids, and gases in our everyday lives. In addition to causing changes of state, heat can activate common chemical changes that are the basis of cooking. To observe or control these changes, both teacher and students need to consider the hazards related to heat sources.

IDENTIFY THE HAZARDS

There are four hazards associated with heating and burning to consider: burn hazards, fire hazards, explosion hazards, and projectile hazards.

Handling and touching hot materials presents a ***burn hazard***. Primary burn hazards come directly from heat sources like the surface of hot plates and incandescent bulbs, candles and tea lights, and steam and boiling water from electric kettles. Primary burn hazards are often visible, either directly, because of a flame, or indirectly in the case of a hot plate, because an indicator light is on. Secondary burn hazards are present when the heat sources are in contact with equipment. Secondary burn hazards—items such as test tubes, beakers, and ring clamps that have been heated—may not appear to be hot, but can still be hot enough to cause a burn.

Combustibles such as paper are ***fire hazards*** when open flames or high heat is present. Loose clothing, hanging headphone wires, long hair, and other accessories are also hazards near open flames and heat sources. A fire is a significant hazard to everyone in the classroom, and can cause significant damage to infrastructure.

Generating heat quickly is an ***explosion hazard***. If heat is generated quickly, it will not have time to dissipate. A build-up of heat may cause a container such as a test tube or beaker to explode, or cause material in a test tube or beaker to be ejected. An explosion hazard is both a burn hazard and a fire hazard. In addition, an explosion hazard is a ***projectile hazard***. Projectiles can include shards of glass, or materials that were in the test tube or beaker.

CAUTION

The frequency and severity of accidents when the inappropriate heat sources listed are used suggest that their risks outweigh their benefits, especially in elementary schools. For this reason, most school boards have banned the use of these sources of heat. Regardless of the experience one has in using these sources of heat in common contexts such as camping, teachers should refrain from using these heat sources in schools.

Bunsen burners are not recommended for use in Grades 1–6. Safer sources of heat can be used to address the curriculum expectations related to the study of energy and heat transfer.

ASSESS THE RISKS

To assess the risks associated with burn hazards, the teacher should first consider the characteristics of the learners. (See Section 3.2.) For example, hot water from a kettle is a significant risk to primary-aged children because of their height and readiness to handle equipment. The risk to older students may be lower since they are likely taller, so spills and splashes are less likely to reach students' faces.

In the event of a fire, everyone in the classroom is at risk of injury from smoke inhalation and/or burns.

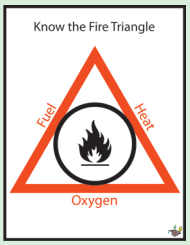
MAKE SAFETY PLANS

General Safety Precautions

The teacher should follow the following precautions:

- Review school procedures for fire before planning any activity involving an open flame.
- Use hot plates instead of open flames whenever possible.
- Ensure that a Type 2A-10BC fire extinguisher is available and placed near an exit whenever an open flame is used and there is a risk of fire. Keep a bucket of sand near the flame. Pour sand on a small fire to smother the flames.
- De-clutter work areas prior to beginning an activity to reduce the risk that fuel such as paper will catch fire.
- Ensure that students tie back hair, remove dangling objects such as jewellery or wires, and secure loose clothing. Jewellery that cannot be removed and that presents a safety concern (such as medical alert identification, religious requirement jewellery) must be taped, securely covered, or tucked out of the way.
- Any object to be heated (such as a beaker of water on a hot plate) should first be clamped to a retort stand to avoid the object being accidentally knocked over.
- Metal equipment such as retort stands, metal bases, and ring clamps are very heavy. Students and teachers must wear appropriate footwear during investigations with equipment. Also, when students are heating or burning materials in the classroom, they must be able to move safely in the event of an accident.
- Everyone in the room should wear appropriate PPE such as

THE FIRE TRIANGLE



Three conditions need to be in place for a fire to start: a heat source, fuel, and oxygen. To reduce the risk of fire, follow these three procedures:

- Use the safest and lowest-temperature heat source.
- Eliminate fuel sources such as paper.
- Understand the reactions of chemicals you use. Some chemicals release oxygen when heated.

FIRE EXTINGUISHERS AND THEIR USE

Class	*To Fight Fires Involving*
A	Wood, paper, cloth
B	Flammable liquids
C	Electrical equipment
D	Metals

goggles. Remind students to stand up when using sources of heat for increased agility to avoid injury in the event of an accident.
- Use the lowest temperature heat source possible for the activity (**Table 4.12**).

Ways of Heating

Appropriate sources of heat: candles and tea lights; hot water from a tap or kettle; Bunsen burner; microwave oven; hot plate; hair dryer. When the risks are understood, and appropriate precautions are taken, these heat sources can be safe.

Inappropriate sources of heat: alcohol burner; camping stove; portable bottled-gas burner; hot-air paint stripper.

Heating Using a Water Bath

A water bath is an effective way to heat both solids and liquids. The solid or liquid sample is placed in a smaller container (such as a test tube) that is then placed in a larger piece of equipment (such as a beaker) containing hot water. The heat is slowly and safely transferred from the hot water in the large container to the sample in the small container. In general, when heating:

- wear goggles;
- use a test-tube holder;
- fill the test-tube to no more than a one-quarter of its volume;
- monitor the temperature of the water with a thermometer; and
- place the test-tube in a beaker of hot water if it only has to be warmed. If necessary, place the beaker on a hot plate (**Figure 4.4**) Samples can be cooled in a similar way, but with ice water in the beaker instead of hot water.

FIGURE 4.4

A hot water bath

Measuring Temperature

Obtaining temperature data from investigations may involve increased activity near heat sources and hot water. Following these tips will help the teacher to minimize the risk:

- supervise students closely;
- remind students to remain standing;
- never put a thermometer into an open flame. Overheating may cause the thermometer to break; and
- be mindful of how heat might affect other parts of a thermometer. If using a digital thermometer connected to a data logger or computer, keep the wires away from the heat source.

Table 4.12 — Proper Use of Heat Sources

Appropriate heat source	*Dos*	*Don'ts*
Candles and tea lights	• Stand the candle/tea light in a layer of sand inside a metal tray (e.g., baking tray). • Support candles in a candle holder. • If matches are used, ensure that they are extinguished before disposing of them.	• Do not use tall candles; they are unstable.
Hot water from a tap or kettle	• Hot water is a good heat source for elementary school programs. • It should be carried in a closed container such as a kettle or Thermos flask only by an adult.	• Students should not move containers of hot water around the classroom to reduce the risk of scalding.
Bunsen burner 	• Teachers must always check their own school board policies and procedures regarding the use of open flames in classrooms. • Teachers must receive specific instruction on the safe use of Bunsen burners prior to using them with their students. • Students must then receive similar instruction—including thorough fire-safety instruction—and be carefully supervised when using these heat sources. • Bunsen burners and the gas supply must be adequately maintained (e.g., no blockages in the supply jet and rubber tubing). • Adjust the oxygen supply to show a yellow flame if a burner is lit but not in use.	• Bunsen burners should not be used with students in Grades 1–6. • Burners should only be lit with a flint lighter; never use a match or butane lighter. • Do not leave open flames unattended.
Microwave oven	• Designate a particular oven for lab use only and not for food preparation. • Give students appropriate training to enable them to use the oven routinely for activities.	• Water alone should not be heated in a microwave oven as steam can become trapped and superheated; avoid this hazard by placing a wooden stir stick in the water. • Do not place metal in a microwave.
Hot plate	• Place hot plates where they cannot be accidentally knocked, at an appropriate height for use by students. • Ensure that electrical cords are tucked out of the way so they are not a tripping hazard. • Switch off hot plates immediately after use. • Place a "May be hot!" sign in front of a recently used hot plate. • Stabilize objects being heated on a hot plate using a ring clamp and retort stand.	• Do not overload electrical circuits when using a number of hot plates at the same time. • Do not use extension cords or receptacle/plug multipliers with hot plates. • Do not use hot plates designed for camp or home use; use laboratory-rated hot plates.
Hair dryer	• Use it for filling hot air balloons and for drying materials.	• Do not use hair dryers around water and water sources.

If a student experiences a minor burn, the affected area should be immediately flushed with cool/cold water for 10–15 minutes to stop the burning process and cool the area. School board procedures must always be followed. This may require contacting someone with First Aid training or seeking medical attention.

MERCURY IN THE CLASSROOM

Many school boards have banned mercury from their schools because of the extremely hazardous nature of the substance.

Teachers should contact the Science and Technology department or the Health and Safety department if any equipment or vessel appears to contain mercury.

Appropriate equipment for measuring temperature includes alcohol thermometers, liquid crystal strips, digital thermometers and probes, and infrared thermometers. Mercury thermometers should not be used. The risk of mercury spills and cost of mercury clean-ups outweighs the benefits of using mercury thermometers.

4.3.4 Using Electrical Energy

The ability to harness and control electrical energy has had profound influences on modern life. Students use electricity in almost every aspect of their lives. In the Science and Technology program, students study electrical energy to understand its properties and its transformations into other forms of energy. Both the teacher and students will need to consider hazards related to electricity from various sources, and the safe use of electrical equipment.

DONATED EQUIPMENT

Some school boards have policies preventing the use of equipment that is donated or brought in from home. Check to see if this is the case for your school.

Electrical energy is delivered in two forms: as direct current (DC) and as alternating current (AC). Typically, direct current is delivered in batteries (more accurately called cells). This source of electrical energy is portable. The form of electricity that is used in schools and homes to power most electrical devices is 110V AC.

A specialized piece of science equipment called a low-voltage power supply connects to the 110V AC outlet. It converts the alternating current to low-voltage direct current, so batteries are not required. A low-voltage power supply, therefore, has components that present the hazards of both direct current and 110V AC, explained below.

IDENTIFY THE HAZARDS

Using Electrical Equipment

There are several hazards inherent in using electricity: burn and shock hazards, chemical exposure hazards, and explosion hazards.

Burns and electric shocks can occur when batteries are short-circuited. This occurs when the positive and negative terminal are connected directly by a wire or piece of metal. This can generate a lot of heat quickly and cause burns. The current can also arc through the air between the terminal and your skin causing a small burn and a shock. A short-circuit in equipment powered by 110V AC can generate serious burns and shocks leading to death.

Batteries are hermetically sealed and usually pose little ***chemical exposure hazar***d. When the seal is broken, however, the chemicals inside the batteries, called electrolytes, can leak and can cause irritation

INAPPROPRIATE BATTERIES

Car batteries and similar large batteries are not appropriate for elementary classrooms. Small "coin" or "button" batteries (such as those used in watches) are also unsuitable and may even be dangerous in younger grades since they can so easily be swallowed (**Figure 4.5**). Lithium-based batteries should not be used because of their ability to discharge rapidly if short circuited, creating heat and fire hazards.

Figure 4.5 A coin battery

to eyes and skin. Batteries should never be heated or put in the mouth. If allowed to discharge quickly—for instance through a short circuit—wires and batteries can get very hot. The heat generated can damage a plastic battery box and burn skin.

Infrequently, batteries ***explode*** due to faults or overheating.

Building Circuits

When students build and switch on circuits, the hazards listed above are present. During the process of building circuits and testing circuits, there are additional hazards that depend on the components and tools used, and on the purpose of the circuit. General hazards associated with using tools can be found in Section 4.2.3. If the students' circuits result in motion (such as moving robots, electric cars, or fans) then there may be a hazard from the moving parts: circuits may be inadvertently closed when students are unprepared, or sudden motion may startle students.

ASSESS THE RISKS

Using Electrical Equipment

When electrical equipment is in safe working order and used properly, it poses little risk to teachers or students. The presence of water increases the risk of shock hazards. This increased risk is present during activities involving liquids and electricity (such as heating water on a hot plate or using a digital probe to measure the temperature of water).

Building Circuits

When students are given electrical components to build circuits, they may build circuits incorrectly. There is a risk that a short circuit could cause a burn or electric shock. Circuits should be checked by the teacher before being switched on.

When students forget to include a switch in their circuit, or turn on a circuit without the teacher's permission, then unexpectedly moving parts may pose a hazard.

MAKE SAFETY PLANS

When students are experimenting with electricity, only low-voltage sources should be used (under 12V). Students should never experiment using AC electrical energy.

Using Electrical Equipment

Students should be taught how to handle equipment properly, to ensure safe use:

- never handle or use electrical equipment around water or with wet hands;
- always unplug equipment by holding the plug, not by pulling on the cord; (Young children should not plug in and unplug electrical cords.)
- never put fingers, wires, pencils, or other objects into electrical outlets;
- keep electrical cords away from where people could trip on them; and
- do not connect power bars or extension cords to each other.

Teachers should visually inspect and test equipment prior to use. Equipment that is not working properly, that is not adequately certified or that has any of the following faults should be removed from use and either repaired or discarded:

- loose connections;
- damaged plugs; (Most electrical equipment has three prongs: the third, rounded prong is for grounding. Double-insulated equipment has a plug with one small and one larger prong that only fits into modern electrical outlets one way.)
- frayed or damaged cords;
- loose or damaged casings on equipment; and
- signs of overheating: smoke, hot wires or connections, discoloured or melted plastic.

SAFETY CERTIFICATION

Every piece of classroom equipment using AC should be certified as safe. The most common certifications are CSA or UL.

Building Circuits

Dry cell batteries are a cheap and safe electrical power supply for students building circuits. It is not possible to receive an electric shock through the skin from a 1.5V battery, unless a great many of them are joined together in series.

Regular single-use batteries are generally safe and easy to use. Students

should not touch batteries that have a white crust around either terminal.

Alkaline batteries are the most common type of dry cell battery. They do not contain hazardous chemicals such as lead, cadmium, or mercury. Alkaline 1.5V C or D batteries are ideal because they have a long life and can be stored at room temperature. (Refer to the storage information below.)

Before using batteries, students should be instructed to:

- inspect batteries to ensure that they are not cracked or leaking; and
- connect no more than three batteries in series. (Any more in series can create enough heat or shock to cause injury.)

When building a circuit, students should:

- maintain a neat working area;
- use PPE (such as impact-resistant safety glasses/ goggles when small parts and tools are being used) as instructed by the teacher;
- ensure that they have included a switch to control their power source;
- ensure that they have included a load (buzzers or small lights with an appropriate wattage), so that short-circuits are not created;
- never leave circuits—open or closed—unattended; and
- ask the teacher to inspect completed circuits before closing switches to activate their circuits.

Battery Storage

For long term storage, batteries should be removed from equipment. Batteries should be stored in such a way that their terminals cannot touch each other and short circuit. One way to prevent this is to place electrical tape on the battery terminals, thus preventing contact between the batteries. Batteries should not be stored in airtight containers due to the slow release of gases, such as hydrogen, that can pose a fire hazard.

Battery Disposal

When dry cell batteries have been used up, they should be properly disposed. Most municipalities in Ontario have battery recycling, and school boards may have a process in place for proper disposal. Used batteries should not be put into the general waste that goes to landfill.

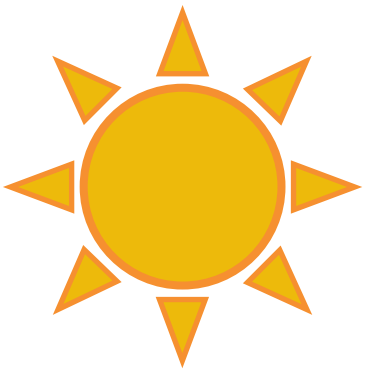
Rechargeable Batteries

Rechargeable batteries can be used over and over again and are widely used to power portable equipment. They should NOT be used by students to design and test different circuits as they can get dangerously hot. A teacher should always supervise the recharging, using only the charger designed for the particular rechargeable battery. Special low voltage supply packs of these batteries for use with rechargeable cells are available. These have devices to prevent overcharging and charging the wrong way, and to limit any short circuit currents. The use of such packs is strongly recommended. High-capacity battery chargers should not be used in elementary classrooms.

4.4.1 Nature Study

Real-world learning in a natural environment lies just beyond the school doors. Accessing this rich experience should start with planning for safety. Given that the teacher will be working outside the confines of the classroom and that the activity will probably take place in a larger, less familiar, and less structured environment, the activity needs to be planned ahead.

IDENTIFY THE HAZARDS



Teachers should assess the area for the nature study before taking students there. A course of action should be planned that takes into account all foreseeable hazards, such as the following:

- ***Animal hazards***: biting or stinging insects; raccoon feces contaminated with Baylisascaris procyonis; poisonous reptiles; Deermouse urine (which can carry Hantavirus); deer ticks (which can carry Lyme disease)
- ***Location hazards***: uneven or slippery ground; dangerous trash; poisonous vegetation (see 4.1.3 Studying Plants); vehicular traffic; poor sightlines; steep or slippery slopes; deep or fast-flowing water
- ***Weather hazards***: sunburn; heat stress; hypothermia (Consult school board policy/guidelines, if available.)

Inadequate or inappropriate clothing and footwear may also be a hazard.

As a rule, students should not approach any wildlife—living or dead.

ASSESS THE RISKS

The best plan for mitigating risk is a program that introduces outdoor learning over time. Through numerous experiences, students can get to know what is expected of them and how to behave during outdoor lessons. These "trips" can start with something as simple and safe as going into the school-yard. Teachers become aware of potential risks and mitigate them in familiar surroundings before going out to less familiar territory. Students should by then have reviewed and practiced a safety plan that includes:

- Partners: who it is and what the rules are regarding keeping close
- Boundaries: the area limits and what to do if accidentally lost
- Signals: for calling back, gathering, and emergencies (for example, three blows on a whistle)
- Appropriate responses: what to do if the unexpected happens (such as contact with strangers or wildlife)

OUTDOOR MOTTO

"Take nothing but pictures; leave nothing but footprints."

MAKE SAFETY PLANS

The plans should include:

- making administrators/parent/guardians aware of the excursion and safety plans;
- implementing a buddy system in which every student is specifically paired with another student;
- grouping a few buddy pairs together and assigning an adult supervisor so that students know who is in their group and who their supervisor is;
- assessing the area prior to the visit;
- ensuring that students are adequately prepared for the weather and the terrain (hats, long pants, sturdy footwear, raingear);
- planning for an emergency (carrying epinephrine autoinjectors, cell phones, first aid kit, medical information, and so on);
- having enough supervisors present (all of whom know for what and for whom they are responsible) should one need to leave;
- establishing and clearly communicating expectations and consequences before going out;
- reviewing "Make Safety Plans" in Section 4.1.4 Studying Animals; and
- requesting information from parents/guardians about any student allergies or special care. (Consider allergies to bee stings or other insect bites and what the teacher is required to do about them.)

REDUCING RISK

To lower the risk of being affected by poisonous plants and ticks, wear long pants and stay on the trails.

4.4.2 Investigating Rocks and Minerals

In the Understanding Earth and Space Systems strand students are introduced to the many ways in which rocks and minerals are used in their daily lives, and how society's use affects the environment. In discovering, investigating, testing, and comparing the unique physical properties of rocks and minerals it is important for students to incorporate safety into their explorations.

IDENTIFY THE HAZARDS

Injuries from using a tool include cuts from tweezers or bruising from a hammer when chipping samples.

Improper use of materials could include throwing rocks or other objects. Safe classroom conduct must be established before handing out materials to students. Students must be aware that using materials as a projectile will not be tolerated. Such behaviour poses a risk of severe harm to others. In addition, students are to use scratch and streak test materials only for the purpose for which they are intended.

Exploring unsafe places, including construction sites and caves, poses a hazard to teachers and students collecting and investigating rocks. When investigating outdoor environments, review safety rules with students. These visits must be only be undertaken with school administration approval, parental permission, and adult supervision.

Chemical burns may result from the improper selection or use of solutions. Limestone and vinegar illustrate the effect of acid precipitation on rocks. Concentrated solutions should never be used. Vinegar is a safer alternative to laboratory acid.

ASSESS THE RISKS

In exploring the natural world, there many potential risks to students and teachers. For example, rain or low temperatures may cause outdoor exploration areas to be slippery and inaccessible. The students' maturity should certainly be considered prior to organizing a rock-collecting expedition.

MAKE SAFETY PLANS

The teacher should ensure that students use the physical space, tools, and materials in a safe manner.

Personal Protective Equipment (PPE)

When conducting investigations such as chipping samples, all participant and observers should wear personal protective equipment: eye protection and gloves. When using chemicals, such as vinegar, eye protection must be worn. Safety gloves (such as leather gloves) must be worn when investigating rock samples in the outdoors.

Uncluttered Work Stations

Students' should keep their work stations uncluttered when examining and testing rocks and minerals. Objects that fall on the floor may be a potential tripping hazard. Students should clear their work station and floor area before and after all activities.

Clothing and Footwear

When conducting outdoor investigations, students must wear appropriate and protective clothing and footwear. Some industrial site visits, such as quarries, may require specific protective footwear and clothing. On hot days, hats, sunscreen, and long-sleeved clothing may be necessary. On cold days, students should dress in several layers.

Respecting the Physical Environment

During outdoor investigations, students should avoid damaging the physical environment that is home to animals and plants. Students should not remove fossils, minerals, or rocks from natural outdoor sites without the teacher's permission.

4.4.3 Rocketry

Model rocketry can be an engaging and interesting activity that involves students in the study of:

- technologies related to space travel;
- forces; and
- mathematics.

If the students design or use pneumatically powered rockets or commercially purchased rockets, they must follow well-defined safety procedures to ensure safety for all participants and bystanders.

IDENTIFY THE HAZARDS

Launching model rockets involves forces that can be dangerous to anybody in the vicinity of the launch. A launched rocket is a projectile and there is a danger from escaping gases. In addition, commercially purchased rocket motors pose a burn risk when ignited. Because of all these hazards, extreme caution must be taken when launching a rocket.

ASSESS THE RISKS

Depending on the power of the rocket being launched, anybody in the immediate vicinity of a launch could be endangered. Crowd control is essential to ensure the safety of students and staff, as well as other bystanders in the area.

MAKE SAFETY PLANS

Novice rocket builders should begin with pneumatically powered "bottle rockets" or use only simple commercially available rocket kits. Safe launch procedures include the following precautions:

- Always use a remote firing system for any type of rocket;
- For "bottle rockets" using compressed air, only rocket motors and reloads of the type approved by Natural Resources Canada, Explosives Regulatory Division (NRC/ERD) should be used;
- Launch from a flat, stable piece of ground, away from any flammables or buildings, trees, power lines, roads, or other obstructions;

- Keep spectators well back from the launch site;
- Provide all spectators with impact-resistant safety glasses and encourage them to wear them; and
- Incorporate a recovery system into rockets powered by a purchased rocket engine to prevent free fall.

The Canadian Association of Rocketry provides a more complete listing of safety rules for building and launching model rockets (*www.canadianrocketry.org/model_safety_code.php*).

ROCKET BY-LAWS

Be aware of local by-laws concerning the launching of model rockets. Many municipalities do not allow the launch of rockets from public properties such as school yards or parks. Always seek permission from the landowner before arranging a launch.

References

A. Books and publications referred to in preparing this resource

CODE, Council of Ontario Directors of Education, *Student Safety in Elementary Science and Technology Grades 7 and 8: A Resource for School Administrators*, June 2013

CODE, Council of Ontario Directors of Education, *Student Safety: A Guide for Supervisory Officers, Principals and Vice-Principals*, June 2013

CODE, Council of Ontario Directors of Education, *Student Safety in Secondary Science Education Grades 9-12: A Resource for School Administrators*, June 2013

Council of Ministers of Education, Canada, *Common Framework of Science Learning Outcomes, K to 12: Pan-Canadian Protocol For Collaboration On School Curriculum*, 1997

National Science Teachers Association (NSTA), *Exploring Safely: A Guide for Elementary Teachers*, 2002

National Science Teachers Association (NSTA), *Inquiring Safely: A Guide for Middle School Teachers*, 2003

Ontario College of Teachers, Professional Advisory, *Safety in Learning Environments: A Shared Responsibility*, April 4, 2013

Ontario Ministry of Education, *Caring and Safe Schools in Ontario: Supporting Students with Special Education Needs Through Progressive Discipline, Kindergarten to Grade 12*, 2010

Ontario Ministry of Education, *Learning for All – A guide to Effective Assessment and Instruction for All Students, Kindergarten to Grade 12*, 2011

Ontario Ministry of Education, *Equity and Inclusive Education in Ontario Schools: Guidelines for Policy Development and Implementation*, 2009

Ontario Ministry of Education, *Supporting English Language Learners: A practical guide for Ontario educators, Grades 1 to 8*, 2008

Ontario Ministry of Education, *The Ontario Curriculum Grades 1–8: Science and Technology, 2007* Revised

Ontario Ministry of Education, T*he Ontario Curriculum Grades 9 and 10: Science, 2008* Revised

Science Teachers' Association of Ontario (STAO), *Be Safe!, Second Edition*, 2006

Science Teachers' Association of Ontario (STAO), *Safe ON Science*, 2010

B. Web sites consulted in preparing this resource

Canadian Association of Rocketry - Model Rocket Safety Code: http://www.canadianrocketry.org/model_safety_code.php

Canadian Standards Association, Occupational Health and Safety Standards and Guidelines, Personal Protective Equipment: http://ohs.csa.ca/standards/Personal_Protective/index.asp

Centers for Disease Control and Prevention, Reptiles, Amphibians, and Salmonella: http://www.cdc.gov/features/salmonellafrogturtle/

Government of Canada

Canadian Centre for Occupational Health and Safety, Consumer Products: http://www.ccohs.ca/teach_tools/chem_hazards/symbols.html

Canadian Centre for Occupational Health and Safety, Metalworking Machines — Drill Presses: http://www.ccohs.ca/oshanswers/safety_haz/metalworking/drillpresses.html

Canadian Centre for Occupational Health and Safety, Woodworking Machines — General Safety Tips: http://www.ccohs.ca/oshanswers/safety_haz/woodwork/gen_safe.html

Canadian Poisonous Plants Information System: http://www.cbif.gc.ca/pls/pp/poison?p_x=px

Children and Physical Activity: http://www.healthycanadians.gc.ca kids-enfants/physical-physique/tips-conseils-eng.php

Health Canada, Supplier Labels: http://www.hc-sc.gc.ca/ewh-semt occup-travail/whmis-simdut/supplier-fournisseur-eng.php

Health Canada, Consumer Product Safety, Chromated Copper Arsenate (CCA) Treated Wood: http://www.hc-sc.gc.ca/cps-spc/pubs/pest/_fact-fiche/cca-acc/index-eng.php

Health Canada, Consumer Product Safety, Consumer Chemicals and Containers Regulations, 2011, Hazard Symbols: http://www.hc-sc.gc.ca/cps-spc/legislation/acts-lois/hazard-symbol-danger-eng.php

Canadian Centre for Occupational Health and Safety, Globally Harmonized System of Classification and Labelling of Chemicals (GHS): http://www.ccohs.ca/oshanswers/chemicals/ghs.html

Health Canada —The Benefits of Hand Washing: http://www.hc-sc gc.ca/hl-vs/iyh-vsv/diseases-maladies/hands-mains-eng.php

Government of Ontario

Education Act, O. Reg 298: http://www.e-laws.gov.on.ca/html/regs english/elaws_regs_900298_e.htm

Environmental Protection Act (EPA): http://www.e-laws.gov.on.ca html/statutes/english/elaws_statutes_90e19_e.htm

Occupational Health and Safety Act (OHSA): http://www.e-laws.gov on.ca/html/statutes/english/elaws_statutes_90o01_e.htm

Ontario Ministry of Education: http://www.edu.gov.on.ca/

Bullying We Can All Help Stop It, A Guide for Parents of Elementary and Secondary School Students, Spring 2013: http://www.edu.gov. on.ca/eng/multi/english/BullyingEN.pdf

Healthy Schools, Sabrina's Law: http://www.edu.gov.on.ca/eng/ healthyschools/anaphylaxis.html

Sabrina's Law Questions and Answers: http://www.edu.gov.on.ca/eng healthyschools/bill3qanda.html

The Ontario Curriculum Grades 1–8, Health and Physical Education, Interim Edition 2010, Revised: http://www.edu.gov.on.ca/eng/ curriculum/elementary/healthcurr18.pdf

Ontario Ministry of Labour

Health & Safety at Work, "Prevention Starts Here": http://www.labour.gov.on.ca/english/hs/pubs/poster_prevention.php

Occupational Health and Safety Act, Workplace Hazardous Materials Information System (WHMIS): http://www.e-laws.gov.on.ca/html/ regs/english/elaws_regs_900860_e.htm#BK0

Workplace Hazardous Materials Information System (WHMIS): A Guide to the Legislation: http://www.labour.gov.on.ca/english/hs/ pubs/whmis/index.php

WHMIS and the Employer: http://www.labour.gov.on.ca/english/hs/pubs/whmis/whmis_4.php

WHMIS and the Supplier: http://www.labour.gov.on.ca/english/hs/pubs/whmis/whmis_3.php

Ontario Ministry of Community Safety & Correctional Services

Office of the Fire Marshall: http://www.mcscs.jus.gov.on.ca/english FireMarshal/OFMLanding/OFM_main.html

Other Canadian Resources

Canadian Pediatric Society, Healthy Active Living: Physical activity guidelines for children and adolescents: http://www.cps.ca/documents/position/physical-activity-guidelines

Ontario Nature, Field Trip: Poisonous Plants: http://onnaturemagazine.com/field-trip-poisonous-plants.html

Ontario Poison Centre: http://www.ontariopoisoncentre.com/ontariopoisoncentre/default.asp

SickKids: http://www.sickkids.ca/aboutsickkids/contact-us/index.html

Science Teachers' Association of Ontario (STAO), Fire Safety Resource: http://stao.ca/res2/fireintro.php

Toronto Public Health, *Assessing Urban Impacted Soil for Urban Gardening: Decision Support Tool -Technical Report and Rationale*, May, 2011: http://tcgn.ca/wiki/uploads/DonationsTradesSharing/urban_gardening_assessment.pdf

Toronto Public Health, *Guide to Soil Testing in Urban Gardens*, October 2013: http://www1.toronto.ca/staticfiles/City%20Of%20Toronto/Toronto%20Public%20Health/Healthy%20Public%20Policy/Environmental%20Pollutants/Files/PDF/guide_for_soil_testing_2013.pdf

University of Guelph Laboratory Services, Agriculture and Food Laboratory: http://www.guelphlabservices.com/AFL/index.aspx

Weedinfo, Weed Database: http://www.weedinfo.ca/

Youth Science Canada, Human Participation: http://ethics youthscience.ca/human-participation

International Sources

U.S. Environmental Protection Agency, Pesticides: Regulating Pesticides, *Chromated Copper Arsenate (CCA): Consumer Safety Information Sheet: Inorganic Arsenical Pressure-Treated Wood*: http://www.epa.gov/oppad001/reregistration/cca/cca_consumer_safety.htm