Science and Safety: It's Elementary!

Calendar

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A Note to the Elementary Teacher

With the increasing emphasis on hands-on, minds-on inquiry instruction at all levels in the National Science Education Standards (NSES) and most state frameworks or courses of study, it becomes more incumbent upon elementary teachers who teach science to be as knowledgeable as possible about laboratory safety issues and their own responsibilities. As teacher and role model, you are expected to display good safety habits at all times and to set appropriate safety expectations for your students. Unfortunately, when you increase the amount of inquiry instruction in your classroom, you also increase the likelihood of accident. This document is intended to educate and reassure you, the user, that liability concerns can be minimized when you are knowledgeable of your duties and take appropriate precautions and preventative actions to avoid or minimize foreseeable hazards and accidents.

Answers to Some of Your Most Pressing Questions

As science supervisors/specialists, members of the Council of State Science Supervisors (CSSS) constantly receive questions from teachers and administrators about safety issues, responsibilities, and liability. To address some of these concerns, we have prepared this document—a companion to the secondary-level document, *Science and Safety: Making the Connection*—to answer 10 of the questions asked most often by elementary teachers. The goal is to provide a handy, concise reference with information and a variety of resources in paper, electronic, and Internet accessible forms. It should be clear that this document cannot be comprehensive because of limitations of the format and purpose. Rather, we hope that it incorporates the most important information needed about the topics asked. The inclusion or omission of resources in

this document should not be read as either endorsement or critique of those resources.

Where to Go for More Information

For more information about specific questions in the document as it pertains to a particular locale or state, contact your local or state fire marshal, building commission, health department/poison control center, environmental regulatory and state OSHA agencies, or science specialist at your local or state board of education/education agency. You should also cultivate a working partnership with the most knowledgeable high school science teachers in your district and participate in safety training programs offered by your state science teachers' organization or state/local education agency.

About Us

The Council of State Science Supervisors (CSSS), an organization of state science supervisors/specialists throughout the United States, has a long history of working with other science education organizations and professional groups to improve science education. For more information about CSSS and a printable version of this document, go to *http://csss.enc.org.*

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Disclaimer

The materials contained in this document have been compiled using sources believed to be reliable and to represent the best opinions on the subject. As stated above, the goal of this document is to provide a handy, concise reference that elementary teachers of science, primarily at the K-5 level, can refer to for information and resources on some of the most commonly asked questions that concern teachers of science. The document as a whole does not purport to specify minimal legal standards. No warranty, guarantee, or representation is made by the Council of State Science Supervisors concerning the accuracy or sufficiency of the information contained herein, and the Council assumes no responsibility in connection therewith.

The document is intended to provide basic guidelines for safe practices and facilities. Therefore, it cannot be assumed that ALL necessary warnings and precautionary measures are contained in this document and that other or additional information or measures may not be required. Users of this document should also consult pertinent local, state, and federal laws pertaining to their specific jurisdictions, as well as legal counsel, prior to initiating any safety program. Registered names and trademarks, etc., used in this publication, even without specific indication thereof, are not to be considered unprotected by law.

1. Where can I find a general science safety checklist?

General Items

The following practices should be observed in your science instructional environment.

1. **Have and enforce** a safety contract signed by students and parents.
2. **Identify** medical and allergy problems for each student to foresee potential hazards.
3. **Assess and minimize** barriers for students with disabilities.
4. **Model, post, and enforce** all safety procedures. Display safety posters and the numbers for local poison control centers and emergency agencies.
5. **Know** district and state policies concerning administering first aid and have an adequately stocked first-aid kit accessible at all times.
6. **Report** all injuries, including animal scratches, bites, and allergic reactions, immediately to appropriate personnel.
7. **Be familiar with** your school's fire regulations, evacuation plans, and the location and use of fire fighting equipment.
8. **Post and discuss** emergency escape and notification plans/emergency phone numbers in each space used for science activity.
9. **Make certain** that the following items are easily accessible in elementary classrooms, classrooms with labs, and science resource rooms:
   - appropriate-size chemical splash goggles that are American National Standards Institute (ANSI) Z87 or Z87.1 coded and of type G, H, or K only
   - non-allergenic gloves
   - non-absorbent, chemical-resistant protective aprons
   - eyewash units
   - safety spray hoses/shower
   - ABC tri-class fire extinguisher(s)
   - flame retardant treated fire blanket
10. **Make certain** that you, your students, and all visitors are adequately protected when investigations involving glass (not recommended), heat, chemicals, projectiles, or dust-raising materials are conducted.
11. **Implement** a goggle sanitation plan for goggles used by multiple classes.
12. **Keep** spaces where science activities are conducted uncluttered.
13. **Limit s**ize of student working groups to a number that can safely perform the activity without causing confusion and accidents.
14. **Prepare** records [including Material Safety Data Sheets (MSDS) (See question 5) on all chemicals used] on safety training and laboratory incidents.
15. **Provide** adequate workspace (45 square feet) per student as well as low table sections for wheelchair accessibility that can be supervised by recommended ratio of teacher to student of 1:24.
16. **Do not permit** eating and drinking in any space where science investigations are conducted.
17. **Do not store,** under any circumstances, chemicals and biological specimens in the same refrigerator used for food and beverages.
18. **Do not use** mercury thermometers with elementary students, since their use is inappropriate. Any mercury thermometers still present should be disposed of properly.

Glassware Precautions

19. **Substitute** plasticware for glassware in elementary classrooms, classrooms with labs, and science resource rooms.
20. **Possess** a whiskbroom, dust pan, and disposal container for broken glass when using glassware of any type (not recommended).
21. **Make certain** that students understand they are not to drink from glass/plasticware used for science experiments.

Chemical Precautions

22. **Label** equipment and chemicals adequately with respect to hazards and other needed information.
23. **Store** chemicals in appropriate places: e.g., in secured cabinet or stockroom, at or below eye level, on wooden shelves with a front lip, and without metal supports. Storage space should be kept cool, dry, and locked.
24. **Make certain** that students understand that chemicals must never be mixed "just for fun" or "to see what might happen"; that they should never taste chemicals; and that they should always wash their hands after working with chemicals.

Electrical Precautions

25. **Make certain** that students understand that they must NOT perform experiments with electrical current at home or at school "just for fun or to see what will happen." Only supervised activities directed by the teacher should be done.
26. **Make certain** electrical cords are short and plugged into the nearest socket. Emphasize that students grasp the plug, rather than the cord, when unplugging electrical equipment. Cords also must be in good repair. Do not use extensions.
27. **Be sure** that students' hands and surrounding surfaces are dry before plugging in electrical cords or turning on and off switches and appliances/tools. Water can be a good conductor of electricity.
28. **Make sure** all electrical outlets are Ground-Fault Interrupters (GFIs). Cover outlets when not in use.
29. **Use** only three-prong (grounded) plugs when small electrical tools such as heating elements for terraria and aquaria, hot plates, or small motors are used. Extension cords s**hould not be used**.
30. **Instruct s**tudents never to grasp any electrical device that has just been turned off, since it may be hot after use and result in serious burns.
31. **Make certain** that students understand that connecting only a wire between the terminals of a battery will result in the wire getting hot and possibly causing serious burns.
32. **Remind** students that even non-electrical hand tools such as hammers, screwdrivers, or hand drills slip easily and can produce projectiles or inflict serious cuts. Appropriate safety equipment **should** always **be worn**.

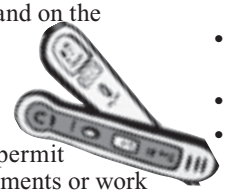
2. Where can I find a checklist of common laboratory operating procedures?

Regulated Safety Rules

- **Know** district, local, and state statutes and regulations regarding animal care, storage of chemicals, and fire safety. Does your district have a written Chemical Hygiene Plan? A district Science Safety Policy?
- **Maintain** Material Safety Data Sheets (MSDS) for all chemical supplies with a second set in the main office; generic chemicals and/or store-bought substances should also be listed in the inventory.
- **Require** the use of American National Standards Institute (ANSI) Z87.1 approved eye protective equipment (typically chemical splash safety goggles—types G, H, or K only), gloves, and aprons during all activities, including demonstrations in which chemicals, glassware, potential projectiles, or heat are used.
- **Dispose** of unwanted chemicals and materials according to state and local regulations.

General Safety Rules

- **Know** the safety hazards before starting an activity; you should do a "dry run" without the students to identify unforeseen hazards.
- **Use** only equipment that is in good working order; inspect equipment before each use.
- **Maintain and have immediate access to** a first-aid kit for emergency treatment (if local and state policies allow), as well as biohazard and chemical spill kits/ materials.
- **Never use** unfamiliar chemicals unless MSDS sheets are consulted first. Consult MSDS and the container label before using chemicals for the first time.
- **Never use** mercury thermometers in elementary classroms/labs.
- **Prevent** contamination by not returning unused chemicals to the original container.
- **Label and date** all storage containers of laboratory chemicals and preserved specimens upon receipt. Properly label all secondary chemical and specimen (set-out) containers.
- **Use** unbreakable plastic equipment whenever possible; **maintain** a separate waste container for broken glass; **sweep up** broken glass with dustpan and brush.
- **Check** with school medical personnel at the beginning of the school year to identify student medical conditions such as allergies, epilepsy, etc., and **be prepared** to take appropriate actions.
- **Check** safety manuals for chemical and plant toxicity before use.
- **Tie back** long hair; **secure** loose clothing and dangling jewelry; **do not permit** open-toed shoes or sandals during lab activity. Clothing should cover upper and lower body.
- **Wear** appropriate protective eyewear for chemical and projectile hazards, as well as appropriate lab aprons and gloves.
- **Never permit** eating and drinking in the science classroom/laboratory.
- **Advise** students not to engage in a laboratory activity unless directed by you, and only after safety procedures are discussed and student "plans of action" (in inquiry) are **reviewed and approved**.
- **Have** students wash hands and clean nails directly after coming into contact with animals, plants, soil and water samples, chemical substances, and laboratory/work surfaces. Hands **should always be washed** upon completion of an inquiry activity.
- **Teach** students to pick up and transport a microscope with one hand under the base and one hand on the arm.



Classroom Management

- **Supervise** students at all times. Do not permit students to conduct unauthorized experiments or work unsupervised. Do not make assignments that require students to perform hazardous experiments at home.
- **Maintain** a clear view of all students at all times. Set up science learning centers for single students or small groups that allow easy observation of students. Periodically update and evaluate safety concerns in the centers.
- **Do not block** access to exits, emergency equipment, and utilities with personal items.
- **Have** students participate in determining classroom rules, laboratory safety procedures, and emergency action plans.
- **Do not tolerate** boisterous conduct (horseplay). **Enforce** established rules and procedures immediately and appropriately.
- **Practice** the procedures and rules yourself before expecting students to follow them, so you can identify unforeseen consequences and avoid liability.
- **Discuss** safety concerns with students prior to each laboratory activity and **monitor** students for compliance.
- **Ensure** that sight-impaired students are made familiar with and always use the same area and equipment. These students should be "buddied" with a student who can read instructions (if Braille forms or a tape recorder are not available) and guide him/her to safety in case of emergency.
- **Model** safety procedures prior to an activity and have students practice the procedures before beginning work.
- **Use** student safety contracts; have students and parents **read and sign**.
- **Have** an established procedure for student accident or injury: e.g., student runner, telephone/intercom, accident/injury report to the principal, etc.
- **Lock** science classrooms, cabinets, prep area doors, etc., when not in use; **do not permit** students in chemical/equipment storage rooms.
- **Turn off** gas and electrical equipment and close open containers during a fire drill. Gas, if available in the classroom, should always be turned off at the master valve when not in use.
- **Have** students report all accidents to the classroom teacher.
- **Have** students check the classroom daily for safety hazards.
- **Use** only age-appropriate activities with students.
- **Have** a designated "broken glass" container, if you use equipment made of glass (NOT recommended).
- **Limit** the size of student working groups to a number that can safely perform the activity without causing confusion and accidents.
- **Display** commercial and/or student-made safety posters and classroom safety rules in the classroom.
- **Do not permit** elementary students to dispense chemicals or handle containers of hot liquids. **Discourage** tasting and smelling. When smelling is required, students **should waft** vapors toward their nose using their hand. They **should never inhale** the vapors directly.
- **Dispose of** all waste chemicals properly. There should be separate containers for each solid. Non-hazardous liquids/solutions should be rinsed down the drain one at a time and flushed with plenty of water.
- **Clean up** spills or ice immediately on tables and floor; take appropriate precautions against contamination as needed.
- **Have** students clean up their work areas at the completion of each day's activity, including sinks and floor.

3. What should I do to prevent accidents and—if an accident occurs—to minimize its effects?

As the adult in the elementary classroom, you are expected to model safety practices at all times. You are also expected to provide appropriate safety instruction before students perform science investigations and experiments. While students explore, you should continually monitor them and the classroom for unsafe practices and situations. Students need to know exactly which behaviors are safe and unsafe, as well as the rationale behind safety instruction appropriate to their intellectual and emotional development.

Safety instruction should be done at the beginning of the year and reinforced throughout the year. Pre-activity instruction should always include some general guidelines for safety and specific instructions and warnings for the current activity. Listed below are some guidelines for your safety instruction to students. The safety instruction you provide should match the scope and intent of the safety/emergency procedures developed for the school and the district.

1. **Post** a short, easy-to-read list of safety rules in the classroom and review it often with your students. Student-made safety posters help remind students of the rules!
2. **Conduct** an investigation/experiment to become familiar with needed safety procedures and any hazards before students are asked to perform it.
3. **Have** students wear appropriate eye protection.
4. **Identify** students' allergies, so that they are not accidentally exposed to allergens such as pet dander, pollen, or peanuts.
5. **Know** how to properly use and have readily accessible approved safety equipment, such as fire extinguishers, eyewashes, and retardant-treated wool fire blankets.
6. **Conduct** regular safety emergency drills that follow posted fire evacuation plans as required by law.
7. **Show** students how to obtain help (e.g., classroom telephone, intercom) should an emergency occur.
8. **Do not leave** students unattended in the classroom unless there is a serious, immediate emergency and a qualified substitute is first obtained.
9. **Keep** the classroom organized and orderly; provide ample space for student investigations/experiments.
10. **Tell** students to report any emergency/accident to you immediately.
11. **Contact** the school nurse (if there is one) and/or the principal immediately during any emergency.
12. **Provide** necessary emergency care (e.g., first aid, CPR) if you are properly trained and permitted to do so by local policy. NEVER dispense any form of medicine to a student.

If an accident occurs, you should act promptly, following approved procedures established by the local school and district. The procedures should list and describe specific actions to be taken for certain emergencies. Like the safety instruction mentioned above, the procedures must match the scope and intent of the safety/emergency procedures developed for the school and district. You should also become aware of all applicable state and local Good Samaritan laws.

Listed below are some general guidelines in the event an accident occurs in your classroom. For all accidents, you should immediately notify the school nurse (if present) and/or the building administrator. **The office** should notify parents and/or 911, depending on the seriousness of the injury.

Chemical

Eye Flush the eye immediately with potable, aerated, 60-90 degree F water at a rate of 3-5 gallons/minute (the American National Safety Institute Standard Z-358.1 applies) for a minimum of 15 minutes. Hold eyelids apart as wide as possible and flush for at least 15 minutes or until emergency personnel arrive.
Skin Flush the area as soon as possible with copious amounts of tepid water from a faucet or drench shower for at least 15 minutes. Do not apply ointments, baking soda, ice, or gauze.
Clothing If the spill is on clothing, drench it with tepid water and cut/remove the clothing as soon as possible to prevent prolonged contact with the skin.
Ingestion Consult the MSDS for appropriate action and, if a poison or corrosive is involved, contact the local poison control center and 911 immediately. Begin appropriate action as directed—as soon as possible. If the student begins to vomit, turn the head so that the stomach contents are not aspirated into the lungs. If the chemical ingested is unknown, save all chemical containers and a small amount of vomitus for analysis by emergency medical personnel.

Fire

Clothing If the student's clothes are on fire, smother flames properly with fire blanket, safety shower, and/or the stop-drop-roll method, whichever is/are most appropriate to the situation. Never use a fire extinguisher above the waist on a student.
Skin If a burn occurs, do NOT apply ointments or ice to the wound. If the burn appears minor, flush with copious amounts of tepid water and apply a moist dressing, bandaging loosely. Anything more serious, do NOT flush with water. Apply a dry dressing and bandage loosely. Keep the student warm to avoid shock.
Materials If materials are on fire, obtain the nearest ABC tri-class fire extinguisher (**A** is for paper, wood, cloth, rubber, or plastics fires; **B** is for burning liquids, gases, or greases; and **C** is for burning electrical equipment) to combat the fire, using the **PASS** technique (**P**ull pin, **A**im at base of fire, **S**queeze handle, and **S**weep side to side). Practice operating a fire extinguisher and using the PASS method **before** the time of need.

Release of Body Fluids

Wear disposable, non-allergenic gloves during cleanup.
Clean up immediately with a pre-made disinfectant or 10% bleach solution.
Wipe up the fluids with paper towels or other absorbent material and dispose of the contaminated material used to clean up the fluids in a labeled biohazard container (or double-bag with plastic bags and label contents of bag as hazardous).
Flood the area after it has been wiped with a solution of 1 cup of liquid chlorine bleach to 1 gallon of fresh water, and allow it to stand for at least 20 minutes.

Cuts

If blood is present, wear disposable, non-allergenic gloves to control bleeding using approved procedures.
If cut is minor, flush with tepid water to wash away any contaminants, sanitize with 3% hydrogen peroxide (drugstore variety), and cover with sterile bandage if no school nurse is available. Otherwise, refer student to the school nurse for proper care in all cases.
If blood is spilled, follow clean-up procedures given above (for body fluids).
If cut is more serious, send immediately for school nurse and notify the office so that parents and emergency services (911— if serious enough) can be called. Apply sterile gauze pads to the wound. If necessary, apply direct pressure to the covered wound to stop bleeding until school nurse or paramedics arrive. Try to keep yourself and your students calm.

4. How should I identify and manage chemicals for use in elementary classrooms?

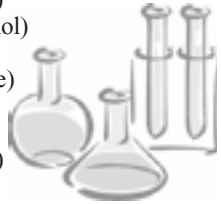
Prior to conducting an experiment or investigation, you should carefully consider the safety of chemicals, materials, and equipment your students will use in the classroom. A high school chemistry teacher, the head of the science department, and the district science supervisor can provide you with important safety information regarding the use of chemicals, materials, and equipment in your classroom. For example, they can help you determine whether the chemicals described in the activity should or should not be used or whether alternative chemicals can be used. They can also provide assistance regarding the identification, procurement, handling, storage, and disposal of chemicals. Refer to your school district and state policies for specific requirements and mandates related to these matters. Do NOT allow students access to chemical storage areas.

The amount and types of chemicals used for science instruction in an elementary classroom should be small in quantity and number. Many of the chemicals can be obtained from the local grocery or drugstore. Be careful to read and follow directions carefully and to use these chemicals only for their intended purpose. Acquire a Material Safety Data Sheet (MSDS) for each chemical. Listed below are some general guidelines for purchasing, labeling, storing, and disposing of chemicals.

Purchasing Chemicals

- **Before purchasing chemicals** from a commercial vendor, obtain and review the MSDS for each chemical. These resources provide important information about the physical properties, toxicity, storage, and handling of the chemical. MSDS are available online at *http://www.msdsonline.com*.
- **MSDS should be kept on file** and easily accessible for all chemicals, whether purchased locally or from chemical supply houses.
- **Whenever possible, use generic chemicals** that are commonly obtained from home, the grocery store, or the drugstore. These chemicals can serve as substitutes for lab-grade chemicals. Some examples include:

  vinegar (acetic acid)
  aluminum foil (aluminum metal)
  vitamin C tablets (ascorbic acid)
  ammonia (ammonium hydroxide, base)
  chalk (calcium carbonate)
  lime (calcium oxide, basic)
  Plaster of Paris (calcium sulfate)
  rubbing alcohol (isopropyl alcohol)
  talc (magnesium silicate)
  baking soda (sodium bicarbonate)
  table salt (sodium chloride)
  table sugar (sucrose)
  Epsom salts (magnesium sulfate)
  starch (corn starch)



- **Limit the quantity** of chemicals purchased to a supply that will last for a specific period of time (e.g., a one-year supply or the chemical shelf-life provided by the manufacturer).
- **Although experienced, upper-elementary teachers may make an exception** at their own discretion, a general rule is that elementary students should not handle anything with a National Fire Protection Association (NFPA) rating in any category over 2. (NFPA ratings are from 0-4, with 0 indicating no hazard and 4 indicating the highest hazard level. See *http://www.nfpa.org* for specific information about the rating system.)

Labeling Chemicals

- **Indicate the name of the chemical manufacturer or supplier** along with the address and telephone number.
- **Include the chemical name/trade name** of the product on the label.
- **Record the date** the chemical was received.
- **Include the appropriate hazard symbol** based on the NFPA rating. (Adhesive backed labels are available in most chemical supply catalogs.)
- **Indicate the strength** of the chemical, especially if it was prepared on-site.
- **Give and highlight** clear and concise emergency or first-aid directions on the label.
- **Use protective coating**, such as clear nail polish or adhesive tape, on labels to prevent stain or corrosion damage during use.

Storing Chemicals

- **Have a separate, locked storage area**—preferably away from the classroom.
- **Use appropriate NFPA warning symbols** to mark storage areas. On the front of the storage cabinet or doorway, you should place an NFPA diamond that shows the **highest** hazard rating in each category of any chemical stored in that cabinet area. This can quickly alert firefighters in an emergency.
- **Maintain a complete inventory** of every chemical in storage.
- **Keep copies of the chemical inventory and all MSDS** in the storage area, with additional copies to the building principal, the district science supervisor, and the local fire marshal.
- **Review and revise** the chemical inventory annually.
- **Use accepted guidelines** (e.g., Flinn at *http://www.flinnsci.com*) to properly separate and store chemicals. Wooden shelving with slide-proof front lips on each shelf are recommended. Uncoated metal supports or brackets should **NOT** be used.
- **Store acids, bases, and flammables** in separate and well-ventilated areas. These chemicals should only be stored in the original manufacturer's container or in an approved safety container.
- **Dispose properly** (see following text) of chemicals with no labels or unreadable labels.

Disposing of Chemicals

- **Use information contained in the MSDS** to properly dispose of chemicals.
- **Follow local and state mandates** for proper disposal of chemicals.
- **Contact** your local/state hazardous waste management agency, state environmental agency, regional Environmental Protection Agency (EPA) office, fire marshal's office, or state department of education to determine if a chemical requires special disposal methods.

5. What protective equipment should be provided in elementary science environments for teacher and student use?

Although the materials used by elementary students may not be as harmful as those used at the secondary level, elementary science teachers should ensure that appropriate protective equipment is provided to prevent injury and clean up spills.

1. Safety goggles

American National Standards Institute (ANSI) coded Z87 or Z87.1 approved chemical splash goggles (only types G, H, or K) should be provided for each student when chemical or projectile hazard is present. These goggles are available in sizes to fit elementary students.

2. Sanitizing material for goggles

Commercial alcohol wipes (not swabs) work well to kill bacteria and some lice (for new, more difficult strains, see your school nurse) that might adhere to goggle straps and rims. Wipe all surfaces that come into contact with the student. Be certain that they are completely dry before use.

3. Non-absorbent, chemical-resistant aprons

Protective aprons should be provided for each student when there is a possibility of spillage or spattering of chemicals or hot water (teacher-dispensed). These aprons are available in sizes to fit elementary students.

4. Safety gloves

Elementary students should wear protective gloves when handling animals, plants, soil samples, or any other materials that might contain harmful micro-organisms or allergens. Wearing gloves may also be appropriate for some chemicals that can cause skin irritation or staining. You should be aware of any student allergy to latex.

5. Eyewash stations

A faucet-type portable eyewash unit (available from several scientific equipment vendors) should be placed on a goose-neck faucet in order to irrigate a student's eye if a chemical or particle (salt, sand) lands in it. Eyewash stations should be placed low enough for elementary students to use and should comply with ANSI Z358.1-1998. Generally, this means they should be within 20–30 steps and 10–15 seconds, relative to their location in the room. These should be activated weekly and tested monthly.

6. Fire extinguishers

You should have adequate numbers of **ABC tri-class fire extinguishers** (**A** is for paper, wood, cloth, rubber, or plastics fires; **B** is for burning liquids, gases, or greases; and **C** is for burning electrical equipment) strategically placed to be within 20-30 steps distance or 10-15 seconds travel time of any location in the room. These should be checked and certified as fully charged and ready for use at least annually. Remember to use the **PASS** method (**P**ull pin, **A**im at base of fire, **S**queeze handle and **S**weep from side to side) method. Be careful never to point at students.

7. Forearm- or foot-operated face/body sprayers

These water sprayers with adequate-length flexible hose should be strategically placed to meet the same rule outlined above (20-30 steps or 10-15 seconds, etc.). They should be used to douse burning clothing or hair.

8. Ground-fault interrupters (GFI) and outlet covers

These should be used on all electrical outlets in an elementary science classroom. The outlet cover guards against objects being "poked" into an outlet. The GFI breaks the circuit when an object or water shorts the circuit, or electricity attempts to ground through a student to a water pipe, preventing electrocution. Outlets should be placed along walls or counters at intervals of 6-8 feet and be capped when not in use.

9. First-aid kit

Where local and state policies permit, have an adequately stocked first-aid kit easily accessible for your use in case of emergency. Check with the school nurse regarding safe contents of the kit. You should be aware of student allergies to first-aid materials.

10. Safety posters

Posters appropriate for elementary students (student-made posters are even better) should be prominently displayed around the room.

In addition to the equipment described above, emergency procedures and telephone numbers should be prominently displayed where they can be consulted quickly in case of accident or emergency. The same is true for proper disposal methods for the following: bacterial growth plates, chemical waste, dead animals (checked by a veterinarian before disposal), animal wastes, dead plants, and spilled liquids.

6. Are there recommended guidelines covering the physical specifications for elementary classrooms, classrooms with labs, and science resource rooms?

The guidelines given below are the ideal in a less-than-ideal world! You should view them as the recommended (some mandated by individual states within their individual building codes) standards that you can strive toward as renovations or new constructions are planned and completed.

- **Provide access** to students with disabilities (Americans with Disabilities Act of 1992).
- **Maintain a storage area/room** for materials and equipment, with locking cabinets and open shelving secured to wall or floor; equivalent to an area of 9.8 square feet per student.
- **Provide floor space** for any room where science investigations are conducted equal to 45 square feet/student or approximately 1100 square feet, as consistent with professional standards (National Science Teachers Association and many state school building codes).
- **Maintain adequate natural light** and/or diffused task lighting (538.2 to 1076.4 lumens per square meter) for all activities.
- **Provide a telephone** or intercom system to notify school medical personnel or school administrator of emergencies and accidents.
- **Provide two classroom exits,** both opening outward and at least 5 feet wide, to accommodate emergency exit for students with disabilities and for equipment carts.
- **Maintain a tri-class ABC fire extinguisher** (**A** is for paper, wood, cloth, rubber, or plastics fires; **B** is for burning liquids, gases, or greases; and **C** is for burning electrical equipment), fire blanket, and eyewash station at a height appropriate to the age and size of students within the classroom. Eyewash stations should be no more than 10 seconds or 20 steps away from any point in the room and should be activated weekly and tested monthly. Check local and state codes for variance from this. You should also provide a face/body sprayer nearby that meets the American National Standards Institute (ANSI) Z358.1-1998 standard.
- **Do not attach tables** to the floor; no more than four students should be at each table.
- **Give each student** 6 feet of horizontal work space, according to NSTA recommendations.
- **Maintain the professional safety ratio** of one teacher to 24 students in the science classroom (NSTA).
- **Maintain good ventilation** and adequate air exchanges to help facilitate student comfort.
- **Provide black laboratory tabletop surfaces** of plastic laminate (good) or epoxy resin (excellent) unaffected by chemicals and heat.
- **Provide floors** with non-skid vinyl tile.
- **Provide capped electrical outlets.** Ground-fault interrupters (GFIs) should be used near sinks and placed at intervals of 6-8 feet around perimeter counters; outlets should be capped when not in use.
- **Provide cut-off valves** for gas, electricity, and water near the teacher's desk, within a lockable cabinet in the demo table, or in an area that is not accessible to students.
- **Provide large sinks,** 16 by 20 inches with mats, and both hot (not scalding) and cold water supply; provide gooseneck faucets on all sinks.
- **Provide space for computers** (one computer per students), laserdisc players, VCRs, TVs, and other electrical equipment on perimeter counters away from sinks and activity centers; outlets (see above) should have GFIs with surge protection.

7. What precautions should I take when using animals in the classroom?

Animals play an important role in the elementary school classroom. The National Science Teachers Association has stated that studying animals in the classroom enables students to develop skills of observation and comparison, a sense of stewardship, and an appreciation for the interrelationships and complexity of life. As a teacher, however, you must be knowledgeable about the proper care of animals used for classroom study and the precautions necessary to ensure your students' safety. You should also have clearly defined learning objectives for using animals in the classroom. Before introducing live animals into the classroom, you should check your school's, district's, or state's policy regarding live organisms.

Animal Care

- **You as the teacher** are responsible for ensuring that living animals receive proper care, which includes proper light, climate control, a correct diet, and sanitary living conditions. Care must be continuous and planned to include weekends and holidays.
- **The comfort and humane treatment** of animals should be of prime concern.
- **Cages must be adequately sized**, cleaned daily, and kept locked in safe, comfortable settings.
- **Water bottles** should be used for all mammals.
- **Waste matter** should be wrapped in newspaper, placed in a plastic bag, and deposited in the trash. Ordinarily, animal wastes are not harmful to the environment, but school staff—including the custodian—should be protected from exposure to these wastes.
- **Animals should be handled minimally** and gently, only after proper directions and demonstrations have been given. Students should wear non-allergenic gloves while handling animals and should wash their hands thoroughly afterward. Sudden movements should be avoided, since they can make animals feel threatened.
- **Allow animals new to the classroom** a few days to adjust to the unaccustomed environment before students handle them. Take precautions when handling new animals for the first time. At first, restrict handling to yourself, or someone familiar with them, and wear heavy gloves until animals become acclimated to their surroundings and handling.
- **Students should never be allowed to tease** animals, throw things in their cages, or disturb them, especially while the animals are eating, sleeping, or birthing.

Animal Precautions

- **Always purchase healthy animals** from reliable sources.
- **Do not allow students to bring wild animals** into the classroom. Wild animals, such as turtles, snakes, birds, arachnids (spiders, ticks, mites), and insects, may transmit serious diseases and behave unpredictably.
- **Discourage students from bringing personal pets** to school. If pets are allowed into the room, they should be handled only by their owners, and provisions should be made for proper care during the visit. Certification by a veterinarian declaring the animal disease-free should be required.
- **Never use poisonous animals** in the classroom. This includes some species of spiders, venomous insects, lizards, and poisonous snakes.
- **Inquire beforehand about potential student allergies** associated with animals. Some students are allergic to the dander produced by guinea pigs, hamsters, and other fur-bearing animals, as well as to mold found in animals' food and bedding. The school nurse should keep an "Epi-pen" handy in case of hyper-allergenic reactions.
- **Pick up rabbits, hamsters, mice, and lab rats** by the scruff of the neck only, with a hand placed under the body for support. If the young are handled, you should remove the mother to another cage, since by nature the mother may be fiercely protective.
- **Do not allow students to insert fingers** into animal cages, since animals may protect themselves by biting, scratching, or kicking.
- **Report animal bites and scratches** immediately to the school's medical authority.
- **Do not allow dead animals** in the room, as the exact cause of death may not be determinable. You should have a veterinarian evaluate any classroom animal that dies unexpectedly.
- **Have a plan** for removal, care, and return of animals during holidays and at the end of the school year.

Experiments with Animals

- **Animals used in the elementary classroom** should most often be invertebrates. It is best practice to order live animals from a reputable science supplier. When you order live animals, be careful regarding date of delivery, since these specimens may be very sensitive to environmental conditions.
- **No experimental procedure that causes pain or discomfort** should be attempted on mammals, birds, reptiles, amphibians, or fish. Vertebrate studies should be restricted to observations of normal functions such as growth, feeding, or life cycles.
- **Student-performed dissections** are not recommended for most elementary students. If you decide to allow mature, advanced, upper-elementary students to perform dissections, only use preserved, lower-order animals (e.g., worms, insects, and crustaceans). In all cases, students must be completely instructed in procedures and safety precautions, and they must be carefully supervised. Students who do not wish to participate in dissections should be allowed alternative methods of instruction, such as the use of multimedia instructional programs.
- **Live bacterial and fungal cultures** should not be used in the elementary science program. If bacterial cultures or molds are displayed, make sure that the container is completely sealed and cannot be opened by students.
- **If pond water is brought** to class, never use contaminated or polluted sources. Be sure that students wash their hands immediately following the activity.
- **Watch for allergic reactions** when studying insects and be aware that some insects bite or sting.
- **Owl pellets** for classroom investigations should be previously sanitized. Check for student allergies to fur and feathers, since these are common contents of owl pellets.
- **If studying chicken bones,** thoroughly remove all traces of meat and soak the bones in a mild bleach solution for at least three days before allowing students to examine them.
- **Students should always wash** their hands carefully after animal investigations.

8. What precautions should I take when using plants in the classroom?

Most elementary classrooms have an assortment of plants for both decorative purposes and learning experiences. Classroom plants can help students understand the needs of living things and can reinforce process skills such as observation, measurement, and classification. Plants are relatively easy to care for, even during weekends or brief vacation times. Even so, there are precautions and safety considerations that you need to know.

Classroom Plants

- **Be sure that students never eat** any part of an unknown plant, including seeds and berries, whether in the classroom or on a field trip. Help students understand the difference between edible and non-edible plants, vegetables, and fruits.

- **Plants that contain toxins** should not be present in classrooms.

  Examples of plants that are toxic when eaten include **azaleas, lantana, delphinium, iris, pokeweed, tansy, hemlock, foxglove, jimsonweed, dieffenbachia, philodendron, caladium, buckeye,** and **belladonna**.

  Examples of plants that have toxic sap include **oleander, poinsettia,** and **trumpet vine.**

  Examples of plants that are poisonous to the touch because of oils include **poison ivy, poison oak,** and **poison sumac**.

  Some plants with edible parts have parts that are inedible and quite toxic, such as **potato leaves** and **sprouts** and **rhubarb leaves**.

  Students should not touch unfamiliar plants.

- **Teach children to avoid touching all mushrooms** they may find outdoors, since many varieties are poisonous.

- **Symptoms of plant poisoning** may include headache, nausea, dizziness, sweating, tightness in the chest, vomiting, skin eruption, itching, or dermatitis. Have the student obtain medical care immediately.

- **You should be able to identify** toxic or poisonous plants to prevent their introduction into the classroom and to ensure that students avoid these species, which are often common to school grounds.

- **Try to ascertain** whether students have allergies to certain plants. Many people are allergic to pollen or mold and exposure to these should be minimized or avoided.

- **Fertilizers or plant chemicals** should be labeled and locked in cabinets and a Material Safety Data Sheet (MSDS) filed for each. Wash hands and clean nails well after use of these chemicals. Goggles and gloves should be used when handling fertilizers and plant chemicals and precautions taken for dust hazard.

- **Be aware of what you burn** in a campfire, since some plants release toxins that can be inhaled into the respiratory system.

- **Always wash hands thoroughly** after handling plants, especially before eating food.

- **Identify the phone number** of your nearest poison control center and post it where it can be easily and quickly obtained.

Experimenting with Plants

- **A common classroom activity** is seed sprouting or planting. Beans and seeds from a grocery store or specifically packaged for sprouting will be safe to handle and germinate. Do not use seeds used for garden or field planting, as they may be coated with chemicals. These seeds usually have a pink, blue, or green stain on their surface. These chemicals may irritate sensitive skin and could be poisonous if eaten.

- **Wash hands thoroughly,** or wear non-allergenic gloves, when working with plants. Plants with thorns or "stickers" should be avoided.

- **If studying soil,** it is safer to use sterilized potting soil. Soil that is dug up from the outside probably contains mold and fungi. If studying soil outdoors, have students use proper tools for digging up and examining the samples, not their bare hands.

- **Be careful if studying aquatic plants** from ponds or marshes. Pond or marsh water may contain contaminants that could cause illness. Try to avoid direct contact with water or mud unless wearing gloves; wash hands thoroughly afterward.

- **Wash all surfaces** thoroughly after plant activities.

- **Try to obtain** plant specimens from reputable scientific suppliers.

9. What safety issues do I need to consider when planning and conducting field trips and field experiences?

There is strong consensus among science and environmental educators that field experiences for elementary-aged students are essential for effective learning. The experiential base provided by a broad range of outdoor investigations and activities can strengthen academic learning and reinforce citizenship skills and personal responsibility. Whether on school grounds or away from the school site, safe and successful field experiences require two major elements: **thorough planning** and **careful implementation**.

Planning

- **Become familiar** with and follow the guidelines for field safety in effect in your school or district.
- **Visit and survey the field site(s)** prior to the actual event and instruct students in advance of any potential challenges (e.g., deep water, allergenic plants, slippery footing).
- **Make sure parents or guardians are fully informed** about the nature of the field experience, appropriate student dress, and other essential information.
- **Be aware of any pertinent medical and physical issues** your students have, such as allergies.
- **Have parents and students sign a safety contract** outlining rules and expectations of student behavior.
- **Process and file** signed parent or guardian permission forms prior to the activity. These should include **contact information** in case of emergency and a copy of each student's **insurance card**. Make sure the permission form is preapproved by the appropriate authority in your school or district. Forms should be carried on the field trip in order to be given to a doctor/hospital in case emergency treatment is required.
- **Arrange for the use of school-sanctioned vehicles and drivers** if transportation is required. School medical and liability insurance is recommended for extended field trips involving students. **Discuss rules of behavior** beforehand and while enroute.
- **Plan for additional adult supervision**. This includes, as a minimum, one (school-approved) adult per every 10 students. Consider assigning specific students to an adult in the group. Adult chaperones should be knowledgeable of all hazards, rules, and emergency procedures in advance.
- **Carry a mobile phone** in case of emergencies and a basic, approved **first-aid kit** for minor abrasions or scratches.
- **Make sure** that students fully understand the activities they will be conducting and any possible hazards to avoid.
- **Ensure that,** for water-related field experiences, at least one adult is trained in water safety techniques including CPR and lifesaving. If the student activity is planned in or on water, U.S. Coast Guard-approved life jackets must be worn.

Implementation

- **Obtain the most current weather forecast** prior to the activity. Be especially aware of the chance for storms or other dangerous weather.
- **Make sure all students** are dressed appropriately for the field experience.
- **Review expectations** of student behavior and on-site precautions with students and chaperones.
- **Reinforce the learning objectives/goals** for the field experience and keep students focused on their purpose(s) or task(s).
- **Group students in pairs (buddies) or teams** to enhance mutual responsibility. Chaperones should assist in keeping students together and focused on the trip's purpose.
- **Keep on the move** at all times, monitoring student activities.
- **Use only plastic containers** when engaged in permitted collecting as part of the activity— avoid glass—and use non-allergenic gloves.
- **Get professional medical help** as soon as possible in the event of an accident.

10. As an elementary teacher, what are my legal responsibilities for science safety?

These materials are targeted at teachers of science in grades K-5. They should help address safety concerns in self-contained as well as departmentalized science programs with a science lab room. The guidelines are not meant to be comprehensive, but rather representative. Consult the references at the back of this document for more complete science safety resources.

Negligence, as defined by the courts today, is conduct that falls below a standard of care **established by law or profession** to protect others from an unreasonable risk of harm, or the failure to exercise due care. In the absence of specific laws or local policies, the standard of care expected is set by the profession; e.g., position statements adopted by the National Science Teachers Association (NSTA), the National Association of Biology Teachers (NABT), the American Chemical Society (ACS), and the Council of State Science Supervisors (CSSS).

The elementary school teacher, just like all science teachers, has three basic duties relating to the modern concept of negligence:

- **duty of instruction;**
- **duty of supervision;** and
- **duty of maintenance**.

Teachers who are knowledgable of their legal responsibilities, exercise good judgment, and take all appropriate precautions to avoid foreseeable hazards should not be apprehensive about guiding student inquiry. The law does not expect you to be clairvoyant. It does expect you to take all reasonable precautions to protect yourself and your students. It is a good idea to document your instruction and precautions taken for each activity done; e.g., an entry labeled "Safety" should be part of all lesson plans where "lab" activities are involved. Failure to perform any duty may result in a teacher and/or school administrator being found liable for damages.

Duty of Instruction includes adequate direction (in writing when appropriate) prior to conducting a science activity, investigation, or field experience that:

- is accurate;
- corresponds to the situation, setting, and developmental level of the students;

- addresses and identifies any foreseeable dangers and risks involved;
- explains proper procedures/techniques to be used; and
- presents comments concerning appropriate/inappropriate conduct in the instructional setting.

Instruction must follow professional and local/state guidelines. Consult your district science curriculum and become familiar with the adopted safety policies and procedures. Does your district have a Science Safety Policy and Chemical Hygiene Plan? Has your school developed a School Science Safety Plan based on district policy? Make sure that the activities, investigations, or field experiences you plan to conduct are appropriate for your grade level. If in any doubt, consult your building administrator, key instructional leader, or district science contact person.

Teachers who set poor examples by not observing proper safety procedures may be liable if students follow these unsafe practices and sustain injury.

Duty of Supervision is defined by professional, legal, and district guidelines to ensure students behave properly in light of any foreseeable risks. Points to remember:

- **do not tolerate misbehavior** of any type;
- **failure to act** or improper action is grounds for liability;
- **the greater the degree** of potential risk, the greater the level of supervision required;
- **the younger the age** of students and/or the greater the degree of inclusion of students requiring a higher level of assistance or attention, the greater the level of supervision necessary; and
- **never leave students unattended**, except in an emergency where the potential harm is greater than the perceived risk to students. Even then, try to minimize risk or transfer responsibility to another authorized person before leaving the room.

When conducting field experiences or investigations that require a high level of attention and supervision, additional responsible adults should be in the instructional setting. These adults should be fully trained in the proper procedures/techniques and knowledgable of foreseeable risks.

Duty of Maintenance includes ensuring a safe environment for students and teachers. This requires that the teacher:

- **never** use defective or inappropriately sized equipment for any reason;
- **file** written reports with responsible administrators for maintenance/correction of potentially hazardous conditions or defective equipment;
- **establish** regular inspection schedules and procedures for checking classroom safety and first aid equipment; and
- **follow** all school and district safety guidelines concerning proper labeling, storage, handling, and disposal of chemicals.

You should keep files of all hazard notifications and maintenance inspections. In the event of an accident, this should minimize or eliminate personal and school liability.

References

The following is a list of general references. It should be obvious that it is not exhaustive. The references provided are for those who are interested in obtaining additional information from primary sources. A much more exhaustive listing of references and resources can be found in two excellent state documents: *Guidebook for Science Safety in Illinois*, available from the Illinois State Center for Educational Innovation and Reform (contact Illinois State Board of Education) and *Maryland Science Safety Manual, K-12*, available from the Maryland Science Supervisors Association (contact the Maryland State Department of Education.) In addition, excellent safety documents in diskette and/or CD-ROM format have been customized for several states based on the Total Science Safety System Software listed below. Contact JaKel, Inc. (jakel @ netins.net) for titles. No implication of endorsement or lack of endorsement should be read into inclusion or omission of any referenced material within this document.

Print Material

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Software

Gerlovich, et al. Total Science Safety System Software. JaKel, Inc., 1998.

Internet Resources

American Association of Law Libraries: www.aallnet.org

American Chemical Society: www.chemistry.org

Centers for Disease Control and Prevention: www.cdc.gov

Chem Lab Safety, Department of Chemistry, University of Nebraska-Lincoln: www.chem.unl.edu/safety

Eisenhower National Clearinghouse: www.enc.org

US Environmental Protection Agency: www.epa.gov

Flinn Scientific, Inc: www.flinnsci.com

Laboratory Chemical Safety Summaries, Howard Hughes Medical Institute: www.hhmi.org/science/labsafe/lcss/index.html

Animals in Education, Humane Society of the United States: www.hsus.org/ace/11368

JaKel, Inc: http://www.netins.net/showcase/jakel

Science Safety, Laboratory Safety Institute: www.labsafety.org

MSDS Online: http://msdsonline.com

National Association of Biology Teachers: www.nabt.org

National Fire Protection Association:www.nfpa.org

Office of Research Services, National Institutes of Health:www.ors.od.nih.gov/service

US Department of Labor, Occupational Safety and Health Administration: http://www.osha.gov

Science and Technology Safety Program, Plymouth (MA) Public Schools: www.plymouthschools.com/Science/Curriculum/LABSAFTY.htm

Office of Environmental Health and Safety, University of Virginia: keats.admin.virginia.edu/home.html

VWR International: http://www.vwrsp.com

Wellesley College Science Center Safety Information, Wellesley College: www.wellesley.edu/ScienceCenter/sciencecenter/safety.html

Eisenhower National Clearinghouse

www.enc.org

Eisenhower Network

www.mathsciencenetwork.org

Appalachia Regional Eisenhower Consortium for Mathematics and Science Education at AEL

www.ael.org/eisen/

Eisenhower Regional Alliance for Mathematics and Science Education

ra.terc.edu

WestEd Eisenhower Regional Consortium for Mathematics and Science Education (WERC)

www.wested.org/werc/

Northwest Eisenhower Regional Consortium for Mathematics and Science

www.nwrel.org/msec/nwerc/

Mid-Atlantic Eisenhower Regional Consortium for Mathematics and Science Education

www.rbs.org

Pacific Mathematics and Science Regional Consortium

www.pacificconsortium.org

Eisenhower Regional Consortium for Mathematics and Science at McREL

www.mcrel.org/erc/

Southeast Eisenhower Regional Consortium for Mathematics and Science Education at SERVE

www.serve.org/Eisenhower/

North Central Eisenhower Mathematics and Science Consortium (NCEMSC) at Learning Point Associates

www.ncrel.org/msc/

Eisenhower Southwest Consortium for the Improvement of Mathematics and Science Teaching (SCIMAST)

www.sedl.org/scimast/