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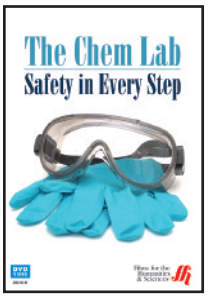

Instructor's Guide

THE CHEM LAB: SAFETY IN EVERY STEP

Introduction

This instructor's guide provides information to help you get the most out of *The Chem Lab: Safety in Every Step*. The contents of the guide will allow you to prepare your students before they use the program, assist them as they navigate through the program, and present follow-up activities to reinforce the program's key learning points.

The Chem Lab is a 25-minute video targeted to students in grades 9-12 and first-year college students. Its content is appropriate to such curriculum areas as Science Education and Technology Education.

Learning Objectives

After watching this video program, students will be able to:

- Identify the risks and potential hazards present in a chemistry lab.
- Demonstrate an understanding of hazardous terms and warning signs and the proper storage and handling of chemicals and materials.
- Identify what CLIPs and MSDSes are and what information they contain.
- Explain the danger of incompatible chemicals in the chem lab.
- Explain the importance of the issue of chemical waste, how to reduce it, and how to practice green (sustainable) chemistry.
- Explain what safety gear and equipment provides protection from hazards in a chemistry lab.
- Understand what to do and what not to do in the chem lab in order to conduct oneself responsibly and properly.
- Describe what to do in case an emergency or accident does occur.

Educational Standards

The Chem Lab: Safety in Every Step correlates with the following National Standards: the National Science Education Standards developed by the National Academies of Science and Project 2061 Benchmarks for Science Literacy from the American Association for the Advancement of Science; and the National Education Technology Standards from the National Education Technology Standards Project. The content is aligned with the following educational standards and benchmarks from these organizations.

Science Education Program Standard A

All elements of the K-12 science program must be consistent with the other National Science Education Standards and with one another and developed within and across grade levels to meet a clearly stated set of goals.

- In an effective science program, a set of clear goals and expectations for students must be used to guide the design, implementation, and assessment of all elements of the science program.
- Curriculum frameworks should be used to guide the selection and development of units and courses of study.
- Teaching practices need to be consistent with the goals and curriculum frameworks.
- Assessment policies and practices should be aligned with the goals, student expectations, and curriculum frameworks.
- Support systems and formal and informal expectations of teachers must be aligned with the goals, student expectations, and curriculum frameworks.
- Responsibility needs to be clearly defined for determining, supporting, maintaining, and upgrading all elements of the science program.

Science Education Program Standard B

The program of study in science for all students should be developmentally appropriate, interesting, and relevant to students' lives; emphasize student understanding through inquiry; and be connected with other school subjects.

- The program of study should include all of the content standards.
- Science content must be embedded in a variety of curriculum patterns that are developmentally appropriate, interesting, and relevant to students' lives.
- The program of study must emphasize student understanding through inquiry.
- The program of study in science should connect to other school subjects.

Science Education Program Standard D

The K-12 science program must give students access to appropriate and sufficient resources, including quality teachers, time, materials and equipment, adequate and safe space, and the community.

- The most important resource is professional teachers.
- Time is a major resource in a science program.
- Conducting scientific inquiry requires that students have easy, equitable, and frequent opportunities to use a wide range of equipment, materials, supplies, and other resources for experimentation and direct investigation of phenomena.

- Collaborative inquiry requires adequate and safe space.
- Good science programs require access to the world beyond the classroom.

Technology Standards

The activities in this guide were created in compliance with the following National Education Technology Standards from the National Education Technology Standards Project. The content has been aligned with the following educational standards and benchmarks:

- Be proficient in the use of technology.
- Use technology tools to enhance learning, increase productivity, and promote creativity.
- Use productivity tools to collaborate in constructing technology-enhanced models, prepare publications, and produce other creative works.
- Use telecommunications to collaborate, publish, and interact with peers, experts, and other audiences.
- Use a variety of media and formats to communicate information and ideas effectively to multiple audiences.
- Use technology to locate, evaluate, and collect information from a variety of sources.

The National Education Technology Standards, reprinted with permission from the International Society for Technology Education.

State Standards

This program correlates with the following State Standards: the Connecticut State Department of Education Core Science Curriculum Framework's standards on Core Scientific Inquiry, Literacy and Numeracy, and Core Themes, Content Standards and Expected Performances.

Connecticut State Department of Education Core Science Curriculum Framework

Grades 9-10 Core Scientific Inquiry, Literacy and Numeracy

D INQ.1 Identify questions that can be answered through scientific investigation.

D INQ.2 Read, interpret and examine the credibility and validity of scientific claims in different sources of information.

D INQ.3 Formulate a testable hypothesis and demonstrate logical connections between the scientific concepts guiding the hypothesis and the design of the experiment.

D INQ.4 Design and conduct appropriate types of scientific investigations to answer different questions.

D INQ.5 Identify independent and dependent variables, including those that are kept constant and those used as controls.

D INQ.6 Use appropriate tools and techniques to make observations and gather data.

D INQ.7 Assess the reliability of the data that was generated in the investigation.

D INQ.8 Use mathematical operations to analyze and interpret data, and present relationships between variables in appropriate forms.

D INQ.9 Articulate conclusions and explanations based on research data, and assess results based on the design of the investigation.

D INQ.10 Communicate about science in different formats, using relevant science vocabulary, supporting evidence and clear logic.

Core Themes, Content Standards and Expected Performances

Strand II: Chemical Structures and Properties

D18 Explain the short- and long-term impacts of landfills and incineration of waste materials on the quality of the environment.

Strand III: Global Interdependence

D24 Explain how the accumulation of mercury, phosphates and nitrates affects the quality of water and the organisms that live in rivers, lakes and oceans.

D25 Explain how land development, transportation options and consumption of resources may affect the environment.

D26 Describe human efforts to reduce the consumption of raw materials and improve air and water quality.

Program Summary

"Maximize your knowledge and minimize your risk!" That's the primary message of *The Chem Lab: Safety in Every Step.* This video program provides an informative introduction to the chemistry laboratory in order to show high school and first-year college students how to conduct themselves in a safe and professional manner. Familiarity with the properties and safe handling of all materials used in the lab is stressed, including how to store and dispose of hazardous waste, chemicals, and materials. Proper use of safety gear and equipment is explained, and steps to follow in case of a lab emergency are discussed.

Main Topics

Topic 1: Acquire Knowledge

The program begins with an introduction to the chemistry lab, including its risks and hazards. Topics covered include the importance of understanding hazardous terms, warning signs, CLIPs, and MSDSes, and how to properly store and handle chemicals and materials.

Topic 2: Proper Safety Gear and Equipment

Viewers gain an understanding of both the safety gear to wear and the safety equipment to use in a chemistry lab. Electrical safety considerations are also presented.

Topic 3: Proper Conduct

This section focuses on the importance of a commitment to safety in the chemistry lab to dramatically reduce the likelihood of an accident. DOs and DON'Ts present clear rules of conduct to viewers.

Topic 4: In Case of Emergency…

The program wraps up by highlighting what to do if, despite best efforts, an emergency or accident does occur in the chem lab.

Fast Facts

- An accident has been reported about a chemical waste bottle that burst unexpectedly in a chem lab. The cause was due to incompatible chemicals and improper rinsing of the container. Although the bottle had originally held methanol, it was not thoroughly rinsed prior to 2L of nitric acid waste being added to it. After 12-16 hours, the combination of the two created carbon dioxide that resulted in the rupture of the container. Luckily, the accident occurred under a fume hood.

- It is possible to be chemically burned even when wearing safety goggles (as the chemical can potentially seep past the seal). That's why it is recommended that fume hood sashes be lowered as far down as possible during an experiment, and only raised when an experiment is being set up or removed. A sash break is an additional safety feature, as it prevents the sash from being accidentally raised more than the desired height.

- New Jersey has developed a Right to Know Hazardous Substance List (RTKHSL), which contains over 2,455 hazardous substances, including 1,407 substances from the Special Health Hazard Substance List (SHHSL), which are deemed to be a health hazard (carcinogen, mutagen, teratogen, corrosive, flammable, or reactive).

- Never pipette by mouth, as although the liquid may only be water, the glassware itself may contain dangerous chemical residue. Even a disposable pipette is not safe, as you can never be 100% certain that someone did not accidentally use it, rinse it, and put it back for reuse.

- Although at home, you may be tempted to sniff some food in your fridge to see if it's still good, NEVER do the same in a chemistry lab. Even just a whiff of some chemicals could be enough for a harmful exposure — especially a chemical that specifically says it should be used in a fume hood.

- You may know where the Material Safety Data Sheets are kept, but do you know how to find the specific sheet you need? You can search by a substance's chemical name, IUPAC (International Union of Pure and Applied Chemistry) name, trade name, or product name. You can also use the chemical's common name (or synonym, which is often provided). Alternately, you can locate an MSDS by its molecular formula, its CAS (Chemical Abstracts Service) registry number, its manufacturer name, or its four-digit US Defense Department NSN.

- Chemical information is not a new thing. Although Section 2 of the MSDS was the last Section developed, as it only affected a few industries, such as paint, other sections were developed based on information from centuries ago. The earliest descriptions can be dated back to over 4,000 years ago, when Egyptians wrote on tomb walls or papyrus records, and include pharmaceutical descriptions of the materials used as well as names, storage and application procedures, and warnings against improper use and application.

- The rate of accidents occurring in high school and college chem labs can be as much as 1,000 times higher than those occurring at chemical companies such as Dow or DuPont.

- The world's last documented case of smallpox resulted in 1978 from a lab accident. The virus escaped from a lab at the University of Birmingham in England and killed a photographer who contracted it.

- In case of a bench-top fire, remember to notify, evacuate, and isolate. Notify other occupants of the immediate space (yell to the rest of the lab and the instructor), notify the rest of the building by pulling the fire alarm, and notify the police or fire department by calling 911. Evacuate the immediate area, the lab, and the building. And isolate the fire by lowering the hood sash and closing the lab and hall doors. Only extinguish the fire if it is safe to do so with the appropriate fire extinguisher.

Vocabulary Terms

acid: A compound usually having a sour taste and capable of neutralizing alkalis and reddening blue litmus paper, containing hydrogen that can be replaced by a metal or a member of an electropositive group to form a salt, or containing an atom that can accept a pair of electrons from a base.

anesthetic: An agent that causes loss of sensation with or without the loss of consciousness.

anhydride: An oxide or compound that, when combined with water, gives an acid or base.

aqueous: A water-based solution.

asphyxiant: A vapor or gas that can cause unconsciousness or death by suffocation (lack of oxygen). Asphyxiation is one of the principal potential hazards of working in confined spaces.

asymptomatic: Neither causing nor exhibiting symptoms.

baffle: A deflector or barrier in a fume hood to protect the user from heat.

base: A compound that reacts with an acid to form a salt, as ammonia, calcium hydroxide, or certain nitrogen-containing organic compounds. It neutralizes acid and turns red litmus paper blue.

bronchitis: Inflammation of the bronchial tubes in the lungs.

carcinogen: A substance determined to be cancer-producing or potentially cancer-producing by OSHA, the International Agency for Research on Cancer, or the National Toxicology Program.

Chemical Laboratory Information Profile (CLIP): A profile that lists a chemical's physical properties, harmful properties, exposure limits, reactivity risks, and what symptoms to watch out for in case of unsafe exposure to it.

combustible: A term used by the National Fire Protection Agency (NFPA), DOT, and others to classify certain liquids that will burn, on a basis of flash points. Both NFPA and DOT generally define combustible liquids as having a flash point of 100°F (37.8°C) or higher.

corrosive: A chemical that has a pH less than 2, or greater than 12.5, or that causes visible destruction of, or irreversible alternations in, living tissue by chemical action at the site of contact; or in the case of leakage from its packaging, a liquid that has a severe corrosion rate on steel.

cutaneous: Pertaining to the skin.

dermal: Used on or applied to the skin.

dermatitis: Inflammation of the skin.

dyspnea: A sense of difficulty in breathing; shortness of breath.

epistaxis: Nosebleed; hemorrhage from the nose.

explosive: A material that can undergo a rapid violent change such as a sudden, almost instantaneous release of pressure, gas, and heat.

flammable: Describes any solid, liquid, vapor, or gas that will ignite easily and burn rapidly. A flammable liquid is defined by NFPA and DOT as a liquid with a flash point below 100°F (37.8°C).

flash point: Lowest temperature at which a flammable liquid gives off sufficient vapors to form a flammable mixture with air.

gastroenteritis: Inflammation of the stomach and intestines.

green chemistry (sustainable chemistry): A chemical philosophy encouraging the design of products and processes that reduce or eliminate the use and generation of hazardous substances.

ground fault circuit interrupter (GFCI): A device that detects a ground fault and shuts off power to that circuit in a fraction of a second.

Immediately Dangerous to Life and Health (IDLH): An atmosphere that poses an immediate threat to life, would cause irreversible adverse health effects, or would impair an individual's ability to escape from a dangerous atmosphere.

inflammation: A series of reactions produced in the tissues by an irritant, injury, or infection characterized by redness and swelling caused by an influx of blood and fluids.

ingestion: The taking in of a substance through the mouth.

inhalation: The breathing in of a substance in the form of a gas, vapor, fume, mist, or dust.

irritant: A chemical that causes a reversible inflammatory effect on living tissue by chemical action at the site of contact.

laboratory: A facility that provides controlled conditions in which scientific research, experiments, and measurements may be performed.

lacrimation: Secretion and discharge of tears.

lesion: Abnormal change, injury, or damage to tissue or to an organ.

malaise: A feeling of general discomfort, distress, or uneasiness; an out-of-sorts feeling.

Material Safety Data Sheet (MSDS): An informational sheet on a material that provides proper procedures for handling or working with it. It includes its general physical properties — such as its melting, boiling, and flash points — and also important information about its toxicity or reactivity, how to store and dispose of it properly, what safety gear you should wear when dealing with it, and the first aid measures to take if it spills or an accident occurs while handling it.

nausea: Tendency to vomit, feeling of sickness in the stomach.

nystagmus: Spastic, involuntary motion of the eyeballs in a horizontal, rotary, or vertical direction.

oxidation: A reaction in which a substance combines with oxygen or a reaction in which electrons are transferred (as in an oxidation-reduction reaction).

personal protective equipment (PPE): Safety gear.

pH: The value that represents the acidity or alkalinity of an aqueous solution.

phlegm: Thick mucus from the respiratory passages.

prostration: Physical exhaustion and incapacitation.

pyrophoric: A chemical substance that will ignite spontaneously in air at or below a temperature of 130°F (54.4°C).

respiratory system: The lungs and air passages (trachea or "windpipe," larynx, mouth, and nose), as well as the associated nervous and circulatory supply.

sensitization: An immune response in which initial exposure causes little or no response but subsequent exposure elicits elevated response due to an immune or allergic response.

spasm: An involuntary, convulsive muscular contraction.

stupor: Partial or nearly complete unconsciousness.

subcutaneous: Beneath the skin.

systemic: Affecting the entire body.

tachycardia: Excessively rapid heartbeat. Pulse rate above 100.

target organ effects: Chemically caused effects upon organs and systems such as the liver, kidneys, nervous system, lungs, skin, and eyes from exposure to a material.

Threshold Limit Value (TLV): A term used by the American Conference of Governmental Industrial Hygienists (ACGIH) to express the airborne exposure level to a chemical or physical hazard to which nearly all persons can be exposed day after day without adverse effects.

tinnitus: A ringing sound in the ears.

toxic: Poisonous.

urticaria: Elevated, itching, white patches; hives.

vertigo: A feeling of revolving in space; dizziness, giddiness.

viscosity: The internal resistance to flow exhibited by a fluid.

Pre-Program Discussion Questions

1. What do you think is important to understand before conducting an experiment in a chemistry lab?

2. Why is the issue of chemical waste important? How do you think our school can reduce its contribution to the amount of chemical waste released into the environment?

3. What do you think is important to consider when disposing of empty containers in the lab?

4. What safety gear do you think should be worn in the lab and why?

5. What safety equipment do we have in and around the chem lab? Identify and explain the use of this equipment, including both specialized and general equipment.

Post-Program Discussion Questions

1. What information should be displayed on a chemical container?

2. What is a CLIP? What is an MSDS? What's the difference between them?

3. What kinds of chemicals must not be stored together? Why do you think that is so?

4. What safety considerations must you keep in mind when working with compressed gas cylinders?

5. What is "green chemistry"? Why is it important?

Individual Student Projects

- Create a poster of a large double-cabinet. Show and label each section of the cabinet with chemicals and materials that are properly stored, but include sections that have *incompatible* chemicals or materials in them. Then, present your poster to the class, and ask the students to identify the problematic sections in it. After all presentations have been made, mark the problems with a large red X on the poster and write the list of incompatible chemicals and materials at the bottom of the poster. Display the posters around the lab.

- Research school, county, and state guidelines regarding hazardous waste disposal limits and recycling policies. Then, write a paper that explains the various policies, and discuss what more you think could be done at each level.

- Create a chemical fume hood user's guide. Include all important safety considerations to follow to prevent accidents, as well as what to do in case an accident does occur. Don't forget to include proper care and maintenance procedures.

Group Activities

- Divide the class in half. Ask each group to create a live presentation or make a video that depicts either the DOs or the DON'Ts of conduct in a lab. SAFETY WARNING: For the DON'Ts, ensure that the behavior is simulated, not real. Then, as a class, write up a safety contract to use throughout the year.

- In small groups, read the instructions for the following safety equipment:
  - — fire extinguisher
  - — eye wash fountain
  - — chemical spill kit
  - — fire blanket
  - — safety shower

  Then, simulate the steps, in order, for its proper use. Rotate so each group gets a chance to practice at each station.

- Divide the class into small groups, and assign each group an accident situation:
  - — chemical spill on the floor
  - — exploding beaker
  - — fire in a chemical hood
  - — electric shock
  - — bleeding resulting from being cut by a chemical beaker glass shard
  - — chemical splash in the eye
  - — chemical trapped under faulty glove
  - — exploding gas canister
  - — poisoning
  - — vapor release

  Ask each group to simulate the situation (either in a video or a live presentation to the class) to show the exact steps to follow in that situation, including what safety equipment to use, and what evacuation and notification procedures to follow.

Internet Activities

- Using the Internet and the library, create a spreadsheet that lists a column of hazardous raw materials and chemicals, a separate column of an alternative chemical substitute to contribute to a greener environment, and the benefits of using the "green" alternatives.

- Research accidents that have occurred in chem labs around the country. What kinds are most prevalent, and why? What measures have been taken to prevent such occurrences from happening again?

- What are CLIPs and MSDSes? What information do they contain, how have they evolved over time, and what events sparked the changes? How do you think they could change in the future, and why?

Assessment Questions

1. Matching exercise: Match each hazardous term with its corresponding description:

1. Anesthetic	6. Flammable
2. Asphyxiant	7. Irritant
3. Combustible	8. Pyrophoric
4. Corrosive	9. Toxic
5. Explosive	

(a) A solid, liquid, vapor, or gas that will ignite easily and burn rapidly, or specifically, a liquid with a flash point below 100°F (37.8°C).
(b) Poisonous.
(c) A vapor or gas that can cause unconsciousness or death by suffocation (lack of oxygen).
(d) An agent that causes loss of sensation with or without the loss of consciousness.
(e) A liquid that will burn and has a flash point of 100°F (37.8°C) or higher.
(f) A chemical substance that will ignite spontaneously in air at or below a temperature of 130°F (54.4°C).
(g) A material that can undergo a rapid violent change such as a sudden, almost instantaneous release of pressure, gas, and heat.
(h) A chemical that causes a reversible inflammatory effect on living tissue by chemical action at the site of contact.
(i). A chemical that has a pH less than 2, or greater than 12.5, or that causes visible destruction of, or irreversible alternations in, living tissue by chemical action at the site of contact.

2. A(n) [**CLIP/MSDS**] provides the proper procedures for handling or working with a particular substance. It includes its general physical properties — such as its melting, boiling, and flash points — and also important information about its toxicity or reactivity, how to store and dispose of it properly, what safety gear you should wear when dealing with it, and the first aid measures to take if it spills or an accident occurs while handling it. A(n) [**CLIP/MSDS**] lists its physical properties and harmful properties, its exposure limits and reactivity risks, and what symptoms you should watch out for in case of unsafe exposure to it.

3. Which of the following may be safely stored with oxidizers? (Select the best answer.)

(a) Fuels	(b) Mineral acids
(c) Combustible materials	(d) All of the above
(e) None of the above	

4. Which of the following is correct? (Select all that apply.)
(a) All flammable and combustible liquid containers must be stored below eye level.
(b) All flammable and combustible liquid containers must be clearly labeled and sealed.
(c) All flammable and combustible liquid containers must be stored in fireproof cabinets.
(d) All glass bottles and hazardous chemicals must be stored above eye level.

5. True or False: Rubber gloves and aprons always protect your skin from irritation and chemical burns.

6. Which of the following is a correct statement about the proper use and storage of a compressed gas cylinder? (Select all that apply.)
   (a) Check to see if it is marked as full, in service, or empty.
   (b) You may use a cylinder with unidentified contents, as long as it is full.
   (c) It should be stored upright.
   (d) It should be stored on its side.
   (e) It should be attached with a cord to a permanent building fixture.
   (f) Always refer to the manual for how to use and turn off a gas cylinder prior to using it.
   (g) Check the cylinder's label for precautions to take when working with that particular gas.

7. Chemicals and materials should be clearly identified and properly labeled with what information? (Select all correct answers.)
   (a) chemical name
   (b) chemical type (such as acid, base, oxidizer, etc.)
   (c) manufacturer
   (d) date received or prepared
   (e) potential hazards

8. When working with a chemical fume hood, always keep the materials at least how many inches behind the face of the hood?
   (a) 1″ (b) 2″
   (c) 4″ (d) 6″
   (e) 8″ (f) 10″

9. True or False: All electrical equipment with exposed metal parts should have grounded plugs, and in some cases, ground fault circuit interrupters (GFCIs).

10. Which of the following is a true statement about proper conduct in a lab?
    (a) Do not work alone on an experiment unless you have explicit permission to do so.
    (b) Do not leave your experiment unattended unless you have explicit permission to do so.
    (c) Both (a) and (b).
    (d) Neither (a) nor (b).

11. A [**pre-lab / safety contract**] is a report that shows that you have reviewed the experiment, and for which you write up the title, purpose, objectives, procedures, and precautions, in order to show your commitment to safety and acknowledge your accountability for your actions at all times. A [**pre-lab / safety contract**] is a detailed listing of all of the rules of the laboratory, which you'll review and sign to show your commitment to safety and acknowledge your accountability for your actions at all times.

Assessment Questions Answer Key

1. Matching exercise: Match each hazardous term with its corresponding description:

1. Anesthetic
2. Asphyxiant
3. Combustible
4. Corrosive
5. Explosive
6. Flammable
7. Irritant
8. Pyrophoric
9. Toxic

(a) A solid, liquid, vapor, or gas that will ignite easily and burn rapidly, or specifically, a liquid with a flash point below 100°F (37.8°C).
(b) Poisonous.
(c) A vapor or gas that can cause unconsciousness or death by suffocation (lack of oxygen).
(d) An agent that causes loss of sensation with or without the loss of consciousness.
(e) A liquid that will burn and has a flash point of 100°F (37.8°C) or higher.
(f) A chemical substance that will ignite spontaneously in air at or below a temperature of 130°F (54.4°C).
(g) A material that can undergo a rapid violent change such as a sudden, almost instantaneous release of pressure, gas, and heat.
(h) A chemical that causes a reversible inflammatory effect on living tissue by chemical action at the site of contact.
(i) A chemical that has a pH less than 2, or greater than 12.5, or that causes visible destruction of, or irreversible alternations in, living tissue by chemical action at the site of contact.

A. The correct answers are: 1(d); 2(c); 3(e); 4(i); 5(g); 6(a); 7(h); 8(f); 9(b).

2. A(n) [CLIP/MSDS**] provides the proper procedures for handling or working with a particular substance. It includes its general physical properties — such as its melting, boiling, and flash points — and also important information about its toxicity or reactivity, how to store and dispose of it properly, what safety gear you should wear when dealing with it, and the first aid measures to take if it spills or an accident occurs while handling it. A(n) [**CLIP/MSDS**] lists its physical properties and harmful properties, its exposure limits and reactivity risks, and what symptoms you should watch out for in case of unsafe exposure to it.**

A. An **MSDS** provides the proper procedures for handling or working with a particular substance. It includes its general physical properties — such as its melting, boiling, and flash points — and also important information about its toxicity or reactivity, how to store and dispose of it properly, what safety gear you should wear when dealing with it, and the first aid measures to take if it spills or an accident occurs while handling it. A **CLIP** lists its physical properties and harmful properties, its exposure limits and reactivity risks, and what symptoms you should watch out for in case of unsafe exposure to it.

3. Which of the following may be safely stored with oxidizers? (Select the best answer.)

(a) Fuels
(b) Mineral acids
(c) Combustible materials
(d) All of the above
(e) None of the above

A. The correct answer is (e). (a), (b), and (c) are all incompatible with oxidizers, and as such should be stored separately from them.

4. Which of the following is correct? (Select all that apply.)

(a) All flammable and combustible liquid containers must be stored below eye level.
(b) All flammable and combustible liquid containers must be clearly labeled and sealed.
(c) All flammable and combustible liquid containers must be stored in fireproof cabinets.
(d) All glass bottles and hazardous chemicals must be stored above eye level.

A. The correct answers are (a), (b), and (c). (d) is not correct because these items should be stored below eye level, not above it.

5. True or False: Rubber gloves and aprons always protect your skin from irritation and chemical burns.

A. This statement is false. No glove material is completely impermeable, and it is possible for chemicals to sneak through seams, tears, punctures, or imperfections in the gloves or apron, and cause a potentially worse problem of trapping the chemical next to the skin. That is why they must be thoroughly checked for imperfections each and every time prior to use, and harsh chemicals should only be touched at the minimum to limit exposure.

6. Which of the following is a correct statement about the proper use and storage of a compressed gas cylinder? (Select all that apply.)

(a) Check to see if it is marked as full, in service, or empty.
(b) You may use a cylinder with unidentified contents, as long as it is full.
(c) It should be stored upright.
(d) It should be stored on its side.
(e) It should be attached with a cord to a permanent building fixture.
(f) Always refer to the manual for how to use and turn off a gas cylinder prior to using it.
(g) Check the cylinder's label for precautions to take when working with that particular gas.

A. The correct answers are (a), (c), (f), and (g). (b) is incorrect because you should never use a cylinder with unidentified contents; (d) is incorrect because a cylinder should never be stored on its side; and (e) is incorrect because it should be connected by two brackets, chains, or straps to a permanent building fixture.

7. Chemicals and materials should be clearly identified and properly labeled with what information? (Select all correct answers.)

(a) chemical name
(b) chemical type (such as acid, base, oxidizer, etc.)
(c) manufacturer
(d) date received or prepared
(e) potential hazards

A. All of these are correct.

8. When working with a chemical fume hood, always keep the materials at least how many inches behind the face of the hood?

(a) 1″
(b) 2″
(c) 4″
(d) 6″
(e) 8″
(f) 10″

A. The correct answer is (d).

9. True or False: All electrical equipment with exposed metal parts should have grounded plugs, and in some cases, ground fault circuit interrupters (GFCIs).

A. This statement is true.

10. Which of the following is a true statement about proper conduct in a lab?

(a) Do not work alone on an experiment unless you have explicit permission to do so.
(b) Do not leave your experiment unattended unless you have explicit permission to do so.
(c) Both (a) and (b).
(d) Neither (a) nor (b).

A. The correct answer is (c).

11. A [pre-lab / safety contract**] is a report that shows that you have reviewed the experiment, and for which you write up the title, purpose, objectives, procedures, and precautions, in order to show your commitment to safety and acknowledge your accountability for your actions at all times. A [**pre-lab / safety contract**] is a detailed listing of all of the rules of the laboratory, which you'll review and sign to show your commitment to safety and acknowledge your accountability for your actions at all times.**

A. A **pre-lab** is a report that shows that you have reviewed the experiment, and for which you write up the title, purpose, objectives, procedures, and precautions, in order to show your commitment to safety and acknowledge your accountability for your actions at all times. A **safety contract** is a detailed listing of all of the rules of the laboratory, which you'll review and sign to show your commitment to safety and acknowledge your accountability for your actions at all times.

Additional Resources

Science Lab Safety

- **VHS/DVD**
- **Preview clip online**
- **Closed captioned**
- **Correlates to National Science Education Standards**
- **Order # 8439, call 1-800-257-512**

Many students do not realize how hazardous the lab can be. Safety awareness in the laboratory is essential. This engaging and entertaining program teaches students how to recognize hazards, prevent accidents, and cope with emergencies. The proper way to extinguish a fire is demonstrated, along with first aid for acid burns and electric shock. A Cambridge Educational Production. (19 minutes) © 1998

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National Science Teachers Association

www.nsta.org