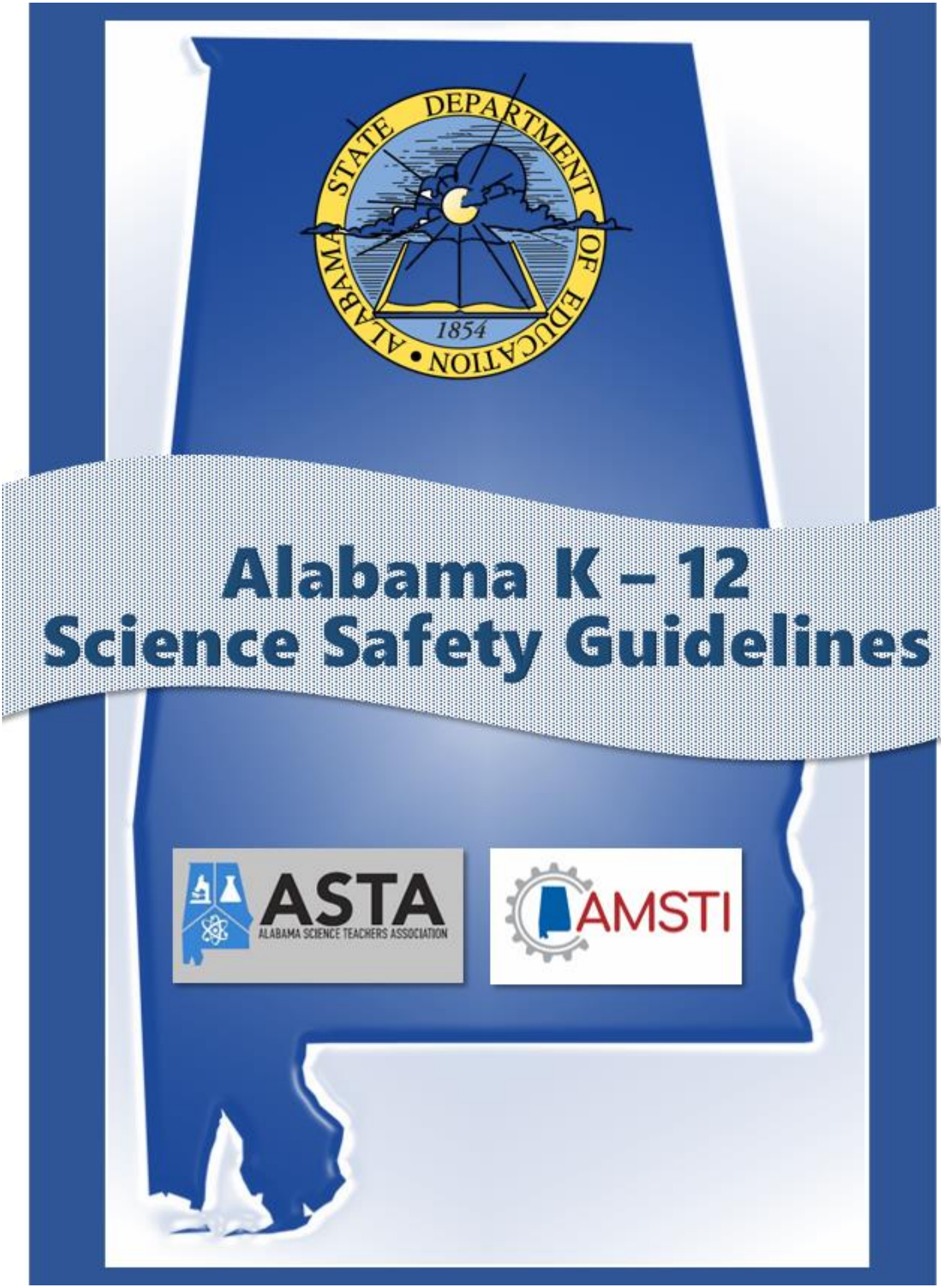
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Alabama K – 12
Science Safety Guidelines
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ALABAMA SCIENCE TEACHERS ASSOCIATION
AMSTI

# Preface

**The Alabama K-12 Science Safety Guidelines 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 preventive actions to avoid or minimize foreseeable hazards and accidents. Science safety in K-12 science classrooms should be considered by all Alabama educators. Everyone is expected to model and display good safety habits at all times and set appropriate safety expectations. By becoming familiar with classroom experiments and always following proper safety procedures, you can prevent or eliminate most classroom accidents. Science experiments are designed with safety in mind; however, accidents can and will happen, which is why everyone should be aware of potential problems and take necessary and appropriate precautions.**

**It is the responsibility of everyone involved in science safety to keep current with new research and changes in the field. Everyone responsible for science safety must continue to educate themselves to keep up with the latest technology, chemical advances, and safety procedures to ensure the safety of all participants.**

# About the Document

**These guidelines have been prepared with the objective of supporting the *2015 Alabama Course of Study (ALCOS) Science* standards and the quality of elementary, middle, and high school science education in Alabama. These guidelines have been developed from sources that are considered to be reliable and that represent knowledgeable viewpoints of science education. No warranty, guarantee, or other form of representation is made by the Alabama Science Teachers Association (ASTA), Alabama Department of Education (ALSDE), Alabama Math, Science, and Technology Initiative (AMSTI), Alabama Science in Motion (AMSTI-ASIM), or by any of their members concerning these guidelines and their use. These entities hereby expressly disclaim any and all liability concerning the use of these guidelines for any purpose. This disclaimer applies to any liability that is, or may be incurred by, or on behalf of the institutions that adopt these guidelines; the faculties, students, or prospective students of those institutions; and any member of the public at large; and includes, but is not limited to, a full disclaimer of all liability that may be incurred with respect to possible inadequate safety procedures taken by any institution.**

# Acknowledgments

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Alabama Science Teachers Association (ASTA), Alabama State Department of Education (ALSDE)
Alabama Math, Science, and Technology Initiative (AMSTI), and Alabama Science in Motion (AMSTI-ASIM)

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# Table of Contents

## PURPOSE

The Alabama K-12 Science Safety Guidelines document is intended to provide valuable information for all Alabama science teachers in preparation for safe experiences. Except for the provisions of federal or Alabama laws or codes, the content of this document does not create requirements applicable to public school districts, nor is it presented as covering all appropriate practices in an Alabama science class. Districts should consider existing policies and procedures, as well as other sources of reference in developing district policies.

# Introduction

As science teachers, our goal is to have a safe, engaging laboratory environment which allows us to provide our students with authentic, hands-on learning opportunities. The three-dimensional nature of our 2015 Alabama Course of Study: Science emphasizes student-centered investigations that foster problem-solving, reasoning, data collection, and discovery. Students in science classrooms are natural scientists and are eager to explore the environment around them. Science teachers have the responsibility of planning safe student-centered investigations that address the three dimensions of scientific and engineering practices, crosscutting concepts, and disciplinary core ideas.

DIMENSION 1: SCIENTIFIC AND ENGINEERING PRACTICES

- Asking questions (for science) and defining problems (for engineering)
- Developing and using models
- Planning and carrying out investigations
- Analyzing and interpreting data
- Using mathematics and computational thinking
- Constructing explanations (for science) and designing solutions (for engineering)
- Engaging in argument from evidence
- Obtaining, evaluating, and communicating information

DIMENSION 2: CROSSCUTTING CONCEPTS

- Patterns
- Cause and effect
- Scale, proportion, and quantity

- Systems and system models
- Energy and matter
- Structure and function
- Stability and change

DIMENSION 3: DISCIPLINARY CORE IDEAS

- **Physical Sciences**
  - ➢ Matter and Its Interactions
  - ➢ Motion and Stability: Forces and Interactions
  - ➢ Energy
  - ➢ Waves and Their Applications in Technologies for Information Transfer
- **Life Sciences**
  - ➢ From Molecules to Organisms: Structures and Processes
  - ➢ Ecosystems: Interactions, Energy, and Dynamics
  - ➢ Heredity: Inheritance and Variation of Traits
  - ➢ Unity and Diversity
- **Earth and Space Sciences**
  - ➢ Earth's Place in the Universe
  - ➢ Earth's Systems
  - ➢ Earth and Human Activity
- **Engineering, Technology, and Applications of Science**
  - ➢ Engineering Design
  - ➢ Links Among Engineering, Technology, Science, and Society

# Who is Responsible for Science Safety?

Safety is the responsibility of teachers, students, administrators and parents. In this section we will outline the role of each group in the safety process.

## THE ADMINISTRATION

School board members, superintendents, supervisors, and principals are responsible for the safety of all school personnel, students, and those who visit the school buildings. Each person involved in an activity must take an interest in his/her own personal safety and the safety of those around him/her. Safe schools share a low frequency of injuries and little to no property damage during a school year. Policies

should be in place in all Alabama school systems to ensure a safe and healthy school environment.

The responsibilities of the administration include:

1. Provide safety training to all school personnel.
2. Provide a safe and effective location for science activities.
3. Provide appropriate safety equipment, including safety goggles and ensure they are in good condition.
4. Provide regular inspections of the lab and safety plan.
5. Develop a Chemical Hygiene Plan for the school system, review it with teachers, and update it each year.
6. Comply with Alabama and federal regulations for disposal of chemicals.
7. Establish a school safety committee and ensure that it meets regularly.
8. Attempt to provide a class size appropriate to laboratory investigations, in keeping with recommendations of professional societies.

## THE TEACHER

Consult your science textbook, the Alabama Math, Science, and Technology Initiative's (AMSTI) teacher guides, the Alabama Science in Motion (AMSTI-ASIM) teacher notes, and resources from other reputable sources for additional safety information available for each lesson, experiment, or investigation you plan to teach and supervise. Safety acknowledgment forms for students and parents to sign are located in all AMSTI teacher guides and on the AMSTI-ASIM website and are available to duplicate as needed. After duplicating the safety agreements, read and discuss the safety rules in class and send home for student and parent signatures at the beginning of each school year. Collect all safety agreements and keep in a file in your classroom (See Appendix A). Teach your students that safety is an important part of science and necessary to prevent accidents and injuries during science activities and experiments. Identify all safe lab practices students should follow and help students gain an awareness of the potential hazards that exist in your K-12 science class.

Potential hazards can be eliminated if you are organized and prepared with appropriate materials and your lesson plans. The key is to be familiar with the procedures and all materials needed for the hands-on activities and/or labs so you will know what to expect. Always perform the experiment before assigning to students and consider the suggestions in this manual to

ensure a safe classroom environment.

Teacher responsibilities include:

1. Teach and post Science Safety Rules with your students in your classroom/lab. Send home, for parent and student signature, a science safety agreement (see Appendix A for an example of a form from National Science Teaching Association (NSTA). Keep a copy of the science safety agreement in the classroom.
2. Observe all safety rules, wear proper personal protective equipment (PPE), and be enthusiastic about safety.
3. Know the properties and hazards associated with each material used in the lab activity before students carry out the procedure.
4. Ensure that all safety equipment is present and in good working condition.
5. Provide and instruct students on the proper use of eye protection and other PPE.
6. Take a "Safety Minute" before each science activity to discuss hazards associated with chemicals/equipment being used.
7. Ensure that all containers are properly labeled.
8. Make sure that all safety rules are obeyed at all times.
9. Promptly clean up or direct the cleanup of spilled chemicals.
10. Dispose of chemical waste properly.
11. Return chemicals to a locked storeroom after use.
12. If a student is injured during science instruction, the injury needs to be reported to the school nurse immediately.
13. Report any accidents or unsafe conditions in writing to your department chairperson, principal, or other appropriate administrator.
14. In the event of an accident, no matter how small, an incident report should be filed. A sample of this form can be found in Appendix B.
15. Comply with procedures in the school system's Chemical Hygiene Plan.

## THE STUDENT

1. Follow your teacher's instructions.
2. Read and understand the safety procedure before beginning the hands-on activity, experiment or investigation. Ask questions if unsure.

3. Be familiar with the properties and hazards of the chemicals and/or materials to be used in the experiment.
4. Obey all safety rules and sign a safety agreement.
5. Know the location of all safety equipment in the lab.
6. Clean your work area immediately after use.

### THE PARENTS

1. Read and discuss the lab safety rules with your child. Sign the safety agreement and return it to your child's teacher.
2. Work with the teachers and administrators at your school to develop a strong safety program.

# Duty of Care

As licensed professionals, teachers are obligated to provide Duty of Care in their classrooms and laboratories. A brochure entitled "Legal Aspects of Duty of Care for Science Teachers" can be found in Appendix C. It is a professional expectation; therefore, science teachers will take any necessary actions to try to prevent an accident from happening. (NSTA Safety Advisory Board 2014a). This process will include the following components:

## Duty of Instruction

- **Duty to Model Safety**- Always model safe lab techniques and proper use of goggles and other PPE prior to and during any lab activity. Require paraprofessionals and other adults in the room to do the same**.**
- **Duty to Warn-** Explicitly and specifically inform students of any potential dangers related to materials, equipment, or technique prior to and during any lab activity.
- **Duty to Notify-** Require students to return a safety agreement form, signed by both student and guardian, which describes lab safety rules and expectations. See Appendix A for a sample.

- **Duty to Review-** Document that students are informed by requiring that pre-lab written responses related to safety concerns are recorded in students' science notebooks/lab reports**.** Teacher lesson plans should reflect safety review for documentation.
- **Duty to Prepare-** Perform demonstrations and lab procedures yourself before doing them with your classes in order to identify any safety precautions that should be taken.

## Duty of Supervision

- **Duty to Monitor-** Actively monitor students, following all professional, legal, and district guidelines, during all lab activities to ensure safe behavior and practices are being followed. Provide an appropriate level of supervision relative to the level of danger or risk involved.
- **Duty to Accommodate-** Provide an appropriate level of supervision relative to the population of participants. The younger the students, or the greater the population of special needs students, the greater the degree of supervision required.
- **Duty to Attend-** Never leave students unattended during a lab activity. In case of an emergency, another adult should be called in to take over the responsibility of the classroom.
- **Duty to Enforce-** Student misbehavior must not be tolerated. Develop a disciplinary policy to follow in the event that unacceptable behavior is observed.

## Duty of Maintenance

- **Duty to Inspect-** Regularly inspect all safety equipment and lab materials to ensure they are working properly. If the equipment is not safe, then do not use it in a science classroom or laboratory setting. See Appendix D for a sample laboratory safety checklist. (Center on Scientific Literacy of the Illinois State Board of Education, 2002).
- **Duty to Inform-** File a written report for maintenance or correction of hazardous conditions or defective equipment with administrators.
- **Duty to Document-** Follow safety guidelines for labeling, storing, and disposing of chemicals according to printed SDSs. Maintain documentation of all inspections, inventories, and requests for maintenance.

## Science Safety Plan

A written science safety plan is an essential part of the school science program. It is suggested that a science safety plan be developed by a team which includes the principal, teachers, school nurse, a firefighter, and a representative from an insurance agency. After initial development, an annual review and assessment of the plan should be made to ensure its effectiveness.

This plan should include safety data sheets for all chemicals that you have in your lab and should be accessible to science teachers, administrators, emergency personnel, students, and parents. Students should also be taught where they are located and how to read them. A copy of the science safety plan should be placed in the science lab as well as the front office or other accessible location.

## State Safety Goggle Law

Teachers should be aware of the state safety goggle law found in the Code of Alabama, 1975, §16-1-7. This law requires local boards of education to provide American National Standard Institute (ANSI) Z87 or Z87.1 coded safety goggles to every student engaged in science experiments. The goggle law can be found on page 8 in the 2015 Alabama Course of Study: Science. According to NSTA, "School boards as the employer are responsible for purchasing and teachers are responsible for selecting eyewear (based on the employer's personal protective equipment (PPE) safety plan) that provides themselves, their students, other school employees, and visitors with the most suitable protection for the hazards and associated risks present in school science activities." See Appendix E for additional information regarding Alabama codes that affect the science laboratory or classroom.

The teacher should model safe practices and wear splash-proof goggles whenever conducting or observing hands-on activities. Students and visitors should also wear goggles to properly protect their eyes during science activities.

## When is Eye Protection Required?

According to the NSTA, eye protection is required for any laboratory or field activity (e.g., setup, hands-on activity, takedown, cleanup, and hand washing). See Appendix F for Federal codes that affect the science laboratory or classroom. Eye protection is required (but not limited to) when there are biological, chemical and/or physical hazards with resulting assessed risks, such as:

- Working with hazardous biological (e.g., bacteria, etc.), chemical (e.g., corrosives, flammables, etc.), or physical (e.g., glassware, electrical equipment, etc.) materials
- Working with materials or equipment under stress, pressure, or force that might cause fragmentation or flying particles
- Doing an activity that generates projectiles, or uses elastic materials under stress (e.g., springs, wires, rubber, glass) or causes collisions
- Creating dust or fumes
- Working with thermal hazards or heating sources (e.g., Bunsen burner, hot plate, etc.)
- Using preserved or live specimens
- Working with meter sticks or other lever systems

Appropriate safety action like selecting and using eye protection (ANSI) Z87 or Z87.1 coded safety goggles must be accompanied by adequate instruction on the hazards of the particular activity (hazards analysis) and on the precautions to be followed to reduce the risk of injury (risk assessment). See Appendix E for additional information regarding Alabama codes that affect the science laboratory or classroom.

***Contact Lens Recommendations:***

Teachers and students can wear contact lenses as long as non-vented chemical splash safety goggles are worn during the activity to protect the eyes.

## Cleaning and Sanitizing Goggles

Goggles can be sanitized or disinfected with soap, chemicals (chlorine or alcohol), or UV light. Goggles may be washed with dishwashing detergent and warm water, then rinsed and allowed to air dry before the next use.

Sanitizing can be accomplished by using a mild solution of 2 teaspoons of bleach per 1 gallon of water; however, stronger solutions are typically recommended to destroy all of the organisms within ten minutes. (½ tablespoon of bleach per pint of water). Please refer to the goggle manufacturer's recommendation before cleaning. UV sanitizers are usually used only in upper grades, but may also be found in an elementary school. The UV sanitizer requires a minimum of five minutes to kill 99% of the bacteria. The UV sanitizer does not remove dirt, debris or chemicals and a safety mechanism must be in place to automatically shut off the UV light source should one of the doors be accidently opened during operation.

# Special Safety Concerns

## Kindergarten through 5th Grade

The Alabama K-12 Science Safety Guidelines 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 preventive actions to avoid or minimize foreseeable hazards and accidents.

Elementary students are naturally inquisitive. Opportunities for hands-on science activities are encouraged and essential for students to acquire critical thinking skills to master the Alabama Science Course of Study standards. Teachers should plan safe and engaging science lessons and provide adequate instruction for science safety prior to each investigation. Each K-5 science teacher should refer to the Alabama Science Course of Study standards related to his/her grade level to determine the appropriate knowledge and direct experiences needed to safely engage students in the practices of science and engineering. As students progress from kindergarten through fifth grade, it is expected for learning experiences to increase in rigor due to opportunities for a variety of investigations. In some cases, students will work in cooperative learning groups to design solutions to real-life problems and by observing phenomena.

Elementary teachers should model and practice good safety habits such as wearing safety goggles when appropriate and discuss any safety concerns before, during, and after each investigation. Safety rules should be posted in the classroom and every student and parent should read, sign, and return a NSTA Elementary Science Safety Form (Appendix A).

## 6th through 8th Grade

Safety is crucial in middle grade science classes because it is often students' first experience with potentially dangerous materials and unfamiliar equipment. This makes requiring safety acknowledgment forms, signed by students and parents, especially important (see Appendix A for a sample form from NSTA). Providing safe science lessons for students in grades 6-8 can also present unique challenges due to the fact that work and storage spaces available to middle grade science teachers vary greatly from school to school.

As students progress from 6th grade through 8th grade, they must engage in activities that involve problem solving and reasoning. They must investigate and verify scientific concepts and principles by analyzing data, and they must learn how to communicate and collaborate. Incorporating hands-on lessons in middle school classrooms is essential for successful development of these skills, and choosing lessons which can be safely conducted is one of the middle school science teacher's greatest responsibilities. (ACS, 2018)

Completing a science safety course is recommended for all Alabama middle school science teachers. NSTA suggests that school districts provide safety training to any K-12 science teacher who is assigned to a classroom, lab, or storeroom where hazardous chemicals are present. In addition, training should occur on an annual basis so teachers can review, discuss, and update the safety program; share experiences and better professional practices; and receive legal updates and other information related to science instruction and safety. (NSTA, 2015) Free safety courses specific to middle school science are available online to make it easier for everyone involved in science safety to continue to educate themselves. Everyone involved in science safety must continue to educate themselves to keep up with the latest technology, chemical advances, and safety procedures for the welfare of students, colleagues, and themselves.

## 9th through 12th Grade

Safety is extremely important in high school science classes due to exposure to potentially hazardous chemicals. To prevent any chemical accidents, high school teachers should model and practice good safety habits such as wearing safety goggles when appropriate and discussing any safety concerns before, during, and after each investigation. Documentation of hazard assessment and safety instruction within a lesson plan is strongly

recommended. Safety rules should be posted in the classroom and every student and parent should read, sign, and return a Science Safety Acknowledgment form. An example of the High School NSTA Science Safety Acknowledgment form can be found in Appendix A and is linked here for your convenience. Not only does it remind the teacher of what safety practices will be relevant within the lesson, but such documentation may be used as evidence of Duty of Care (Stroud and Roy, 2015).

Completing a science safety course is recommended for all Alabama high school science teachers. NSTA suggests that school districts provide safety training to any K-12 science teacher who is assigned to a classroom, lab, or storeroom where hazardous chemicals are present. In addition, training should occur on an annual basis so teachers can review, discuss, and update the safety program; share experiences and better professional practices; and receive legal updates and other information related to science instruction and safety. (NSTA, 2015) Free safety courses specific to high school science are available online from vendors like Flinn Scientific or The Laboratory Safety Institute. Everyone involved in science safety must continue to educate themselves to keep up with the latest technology, chemical advances, and safety procedures for the safety of students, colleagues and themselves.

## CLASS SIZE

The National Science Teaching Association (NSTA) recommends a maximum of 24 students in a laboratory class. The 2015 Alabama Course of Study: Science also states, "to address the safety issue, professional organizations of science teachers recommend that science laboratory classes not exceed 24 students" (p. 8). These students must have immediate access to the teacher. Large class size as a result of increased enrollment or budgetary constraints is an important issue for science teachers, since safety problems increase with larger class size. Not only does the chance of an accident increase as more students move about the room carrying equipment or chemicals, but direct supervision and instruction by the teacher becomes difficult in large classes. The presence of too many students in a lab can also create problems when they have to wait too long for chemicals and equipment or have too much down time. Under these circumstances, boredom sets in and increases the possibility of someone removing safety goggles, engaging in horseplay, or otherwise violating safety rules causing increased risk of an accident. (NSTA, 2014b)

If a teacher believes the laboratory is too crowded for safety, he/she should place the concerns in writing to the department chair, principal, and superintendent. If the situation is not corrected, the teacher may request a liability waiver. If the situation is still not corrected, Steele, Conroy, and Kauffman recommend the teacher make a presentation to the school board to document safety concerns and request corrective action (Steele, Conroy, and Kauffman, 1992).

Science lessons must be given adequate space and time. NSTA recommends no more than 24 students in a space that allows for at least 45 square feet/student in a multi-use laboratory/classroom. (NSTA, 2014b). If science takes place in a dedicated laboratory space, the National Fire Protection Association (NFPA) requires 50 square feet/occupant (note that "occupant" includes students, teachers, and all other occupants) (Stroud and Roy, 2015). In addition, any instructional activities must allow for sufficient time for students to clean up their work area (Kwan, 2002).

Adequate space for secure storage of science materials must also be provided. Approximately 10 square feet/student is recommended to store science equipment, materials and chemicals. (Motz, Biehle, & West, 2007) Flexible shelving, drawers of various sizes, and cabinets are recommended for the range of size and shape of science equipment and materials.

## TEACHER DEMONSTRATION

Occasionally, scientific phenomena are presented to students in the form of teacher demonstrations. Science demonstrations, like any other science investigation, require teachers to conduct a safety review (hazard analysis, risk assessment and safety action to be taken) and a rehearsal of the demonstration before they present it to students. If there is any possibility the demonstration might result in risk of injury to the audience, protection of the audience (in the form of ANSI/ISEA Z87.1 D3 series goggles and a safety shield) is necessary. All science demonstrations should have an educational objective with measurable student outcomes. Demonstrations intended solely to entertain are inappropriate for the educational setting and are more likely to be unnecessarily hazardous (Flinn Scientific, 2018).

## HOME PROJECTS

Laboratory activities or science projects that are assigned for completion at home should be reviewed by teachers to be certain they can be conducted safely and, if applicable, students have the necessary personal protective equipment. Teachers may be held liable if a student or family member is injured by an experiment the student was assigned to complete at home. Teachers should examine the chemicals and procedures used in each lab and substitute less toxic chemicals or less dangerous procedures whenever possible. (NSTA, Duty or Standard of Care).

# Student and Teacher Preparations

### Possible Hazards

Teachers have the sole responsibility for choosing the laboratory activities that are carried out in their instructional spaces and no teacher should have their students perform an activity that they believe is unsafe. Documentation of hazard assessment and safety instruction within a lesson plan is strongly recommended. Not only does it remind the teacher of what safety practices will be relevant within the lesson, but such documentation may be used as evidence of Duty of Care (Stroud and Roy, 2015). Teachers need to look at all hands-on activities with a critical eye. Is there an alternate activity that teaches the same concept but uses a safer procedure?

Students will be expected to observe, characterize properties, describe changes caused by heating or cooling, and analyze changes that occur in chemical reactions. The management of the chemicals is ultimately the responsibility of the teacher and ensures a culture of safety. Some science activity procedures call for household chemicals. Study the product label carefully before using and check the Safety Data Sheets (SDS). The SDS describes the hazards of using the chemical along with storage recommendations, and disposal information.

## Chemical Use in Science Classrooms

A laboratory setting may simply be a classroom with student desks, or it may have tables and/or sinks available. Regardless of the size or the contents, the space should be set up in a way that facilitates classroom activities and laboratory work. Many of the substances used are often common household items; however, once the chemicals are moved to the teaching environment, they should be treated as laboratory chemicals. Students need to know that chemicals used in the science laboratory should never be tasted or consumed. Even though the chemicals are purchased at the store, in the lab they should only be smelled by wafting and under teacher instruction. All household items that are used in a laboratory setting should be labeled, "NOT FOR HUMAN CONSUMPTION." (American Chemical Society, 2018).

Before ordering chemicals, teachers should assess the hazards and physical properties of the chemical using the Safety Data Sheet to consider the following factors:

1. Procurement:

Purchase chemicals following your local education agency (LEA) procedures. The term "chemical" refers to any type of matter, and includes common substances such as sugar, salt, baking soda, cooking oil, water, or sand. Chemicals must be age-appropriate and donated chemicals should never be accepted for classroom use. Only purchase quantities needed, retain Safety Data Sheets (SDSs), and indicate the date received on the container.

As you think about the chemicals you will be using in the science lab, it is important to think about the toxicity of those chemicals in relation to their educational value, and choose chemicals that are the least toxic. You also need to think about the adverse health effects that may arise due to exposure to the chemicals you choose, and realize that the percent of adverse health effects increases as the dose/exposure increases (Flinn, 2018). There are three routes of exposure:

- Inhalation
- Dermal/Skin contact
- Ingestion (remember, this can be unintentional)

These types of exposure can be quantified using the PEL (Permissible Exposure Limit) which is an exposure standard established and enforced by OSHA that specifies the maximum amount or concentration of a chemical to which a worker may be exposed (ACS, 2018). The ACGIH (American Council of Governmental Industrial Hygienists) has also established the TLV (Threshold Limit Values) which denotes the level of exposure that nearly all workers can experience without an unreasonable risk of disease or injury (ACS, 2018). Another

measure of toxicity is the LD50 (Lethal Dose in 50% of subjects-mice or rats) which is measured in mg/kg/day and are classified as follows:

- Highly Toxic LD50 < 250mg/kg
- Moderately Toxic LD50 250-1000mg/kg
- Slightly Toxic LD50 >1000mg/kg
- Non-Toxic LD50 >5000mg/kg

To calculate these values for humans, you would use the following formula:

$$Chemical\ LD50\ \frac{mg}{kg}\ X\ \frac{1g}{1000\ mg}\ X\ \frac{1kg}{2.216\ lb}\ X\ human\ weight\ lb = g\ chemical/individual$$

To reduce our exposure to chemicals that could cause acute (short term) or chronic (long term) health effects, it is important to:

| | |
|---|---|
| Use proper ventilation (fume hood for volatile chemicals) | Be prepared for spill management |
| Always use proper PPE | Plan ahead with the SDS |
| Use proper storage practices | Never use benzene |
| Use proper chemical handling | Never use mercury |
| Use less toxic alternatives | Dispose of older hazardous chemicals |
| Never consume any lab chemicals | Use microscale labs |
| Use the most dilute formaldehyde or formalternate | Never allow students to work with Highly Toxic chemicals |

(Flinn, 2018)

2. Handling and Instruction:

Students must be taught how to handle chemicals safely and must be taught the consequences of incorrect handling. Students will need to wash hands thoroughly with soap and water after handling chemicals. Thorough washing should include washing the wrists, palms, tops of the hands, between all fingers (including the thumbs) and the nail beds.

When chemicals are in use, the teacher assumes a duty of supervision and a duty of instruction during all science investigations. If a student is injured during science instruction, then the injury will need to be reported to the school nurse. (See Appendix B,

Accident/Incident Report). Any activity involving chemicals will require all occupants in the room to wear chemical splash goggles (ANSI Z87 or Z87.1). Goggles will need to be cleaned and either disinfected or sanitized after each use if they are shared. Teachers should model appropriate safety practices by wearing goggles during the science investigation.

3. Substitution:
Can a safer, less hazardous chemical be used instead?

4. Safety:
Are proper safety equipment and PPE available for the safe handling of this chemical?

5. Storage:
Is there a storage location available that meets the safety requirements for this chemical?

6. Disposal:
Can the chemical and any end products be safely disposed of in accordance with the SDS?

7. Emergency Care:
Are safety materials and equipment available to respond in a worst case scenario if the chemical is spilled or splashed on a teacher or student?

Science teachers are responsible for maintaining accurate inventories of all chemicals in their classroom and/or lab. Safety Data Sheets must be printed and kept with the chemicals they describe and must be visible and accessible to everyone using the lab in case of an emergency.

Chemicals that are purchased for use in the classroom are generally non-hazardous by definition; however, proper storage and disposal protocols must be followed for all chemicals.

## Chemical Labeling

Container labels should include the name of the chemical, a list of hazards, and the name of the manufacturer or other responsible party. This label should be firmly attached to the container. If the label is lost or damaged, the chemical should be disposed of appropriately. The date of purchase should be added to the label as soon as the chemical arrives in the

lab. Refer to Appendix G, National Fire Protection Diamond, for an explanation of chemical labeling (NFPA Rating Explanation Guide).

## Chemical Storage

Guidelines for chemical storage:

1. Always store chemicals in a lockable room or cabinet.
2. Avoid the alphabetical storage of chemicals. All chemicals should be stored according to chemical class compatibility. We recommend the Flinn Storage Method which can be found in Appendix H.
3. Use appropriate shelving or cabinets. If you use shelving with metal brackets, inspect the clips and brackets annually for corrosion and replace as needed.
4. Store flammable liquids in approved fire cabinets. (See Appendix E, Flammables Stored Properly).
5. Make sure shelves holding containers are secure. Attach anti-roll lips on shelves to prevent containers from falling off.
6. Do not store chemicals on desks, laboratory benches or fume hoods, on floors or in hallways.
7. Maintain a complete inventory in the room where chemicals are stored, and give a copy to your local fire department.
8. Have spill cleanup supplies (absorbents, neutralizers) in any room used for chemical storage or use.
9. Containers should be dated upon receipt, dated to be disposed where appropriate, and dated when opened.
10. Chemical containers should be periodically checked for rust, corrosion, and leakage.
11. Chemical labels should be readable and free from chemical encrustation.
12. Where possible, storage areas should be planned with two separate exits.

## Disposal of Chemical Wastes

All laboratory work with chemicals eventually produces chemical waste. It is everyone's legal and moral responsibility to minimize the amount of waste produced and to dispose of chemical waste in a fashion that has the least impact on the environment. Depending on what is contained in the waste, some waste must be professionally collected, or can be

deposited in designated landfills, while other waste can be neutralized or discharged in the trash or sewer system.

In 1980 the U.S. Environmental Protection Agency (US EPA) put into effect federal regulations for hazardous waste management system. These regulations were developed to establish a "cradle to grave" system for the management of hazardous wastes from all sources.

Below are some guidelines to help decrease the amount of waste generated:

1. Source reduction- conduct activities that reduce or eliminate the generation of chemical waste. Consider doing microscale labs where appropriate.
2. Recycle- use the waste generated in one lab as reactants for future labs.
3. Treatment--neutralization or other method conducted in the lab as part of an experiment or disposal procedure.
4. Substitute non-toxic substances- minimize the hazard and disposal costs by using less hazardous chemicals.
5. Consider using demonstrations to reduce amounts of waste generated.

For waste that needs disposal, please consult local regulations first, and then check the guidelines below for common lab chemicals that can be disposed of without contractor removal. Flinn Scientific catalog/website is a valuable resource for disposal methods for many types of chemicals (https://www.flinnsci.com/).

A. Neutralization of Strong Acids and Bases: Acids can be neutralized by diluting the acid to 5% concentration or less by adding acid to water. Slowly add 6M sodium hydroxide solution (240g/L of water) until the pH is between 6 and 10. Wash solution down the sanitary sewer using 20 fold water. Bases also need to be diluted to 5% concentration or less, then slowly add 6M hydrochloric acid until the pH is between 6 and 10. Wash solution down the sanitary sewer with 20 fold water. Warning: Usually the neutralization process is very exothermic. An ice bath may be needed for the reaction vessel. Likewise, the dilution/hydration of a concentrated acid/base is exothermic. Any strong acids or bases should first be diluted to a concentration around 1 M or 10%. Remember, always add acid to water. Second, the final product must be near neutral (pH 5-9) before discharge to the drain. Consult the Flinn catalog or website https://www.flinnsci.com/ for instructions.
B. Other soluble waste: Limit quantities of chemicals to a few hundred grams or milliliters. More specific disposal methods for various chemicals can be found on the SDS sheets for each chemical.

***Only dispose of approved liquid waste in a sink that empties into a wastewater treatment facility, not a storm drain, or septic tank system. Failure to comply with this would be in violation of the Clean Water Act. (See Appendix F).*

## Chemical Safety Equipment and Maintenance

For students to conduct investigations in a safe environment, appropriate safety equipment must be in all locations where experiments and demonstrations will take place. If the chemical storage area is separate from the lab area, these safety features must also be present there. Fume hoods and portable safety shields are optional at the middle school level, assuming the chemicals utilized do not warrant the use of these devices. All safety equipment must be properly maintained and tested on a regular basis. (ACS)

A. **Goggles**: Chemical splash safety goggles (ANSI Z87 or Z87.1) are required for all activities involving chemical use. Goggles should be sanitized between each student use with an ultraviolet cabinet (5-15 minutes for sterilization), or chemical disinfectant (dipped and allowed to air dry). (See "Cleaning and Sanitizing Goggles" section below.) Encouraging students to provide their own goggles can eliminate the need for disinfection procedures (See Appendix E, Goggle Law).****Contacts should not be worn in the lab if at all possible; however, if they must be worn, proper chemical splash goggles must be worn at all times.****

B. **Eyewash**: The eyewash station is an essential component of any lab that uses chemicals. Certain chemicals can cause damage within seconds of contact with eyes. ANSI standard Z358.1-1990 is the recommendation that the time required to reach an eyewash should be determined by the hazard. For strong acids or strong caustic chemicals, the eyewash should be located immediately adjacent or within 10 feet of the hazard (ANSI Z.358.1-1990 E 7.4.4). The eyewash should treat both eyes simultaneously; have a gentle flow of water for at least 15 minutes; be accessible within 10 seconds from time of injury; leave both hands free to hold eyelids open; and be accessible for all students. A plumbed eyewash fountain is best. A hand-held spray (either a commercial model or a faucet shower attachment) may supplement but not replace, a plumbed eyewash.

Portable eyewash squeeze bottles are not an acceptable alternative because they can treat only one eye, provide an inadequate supply of water, are susceptible to contamination, and provide a good environment for the growth of microorganisms.
The National Safety Council recommends that all plumbed eyewash fountains be flushed for three minutes a week to reduce the risk of eye infections. Maintenance should be completed weekly and recorded.

C. **Safety Showers**: A safety shower should be available in each laboratory. The safety shower is used to wash hazardous chemicals from the skin and may be used on clothing fires. The Emergency Eyewash and Shower Equipment Standard (ANSI. Z, 358.1-1990) requires that an emergency shower should be located no more than 10 seconds in time nor greater than 100 feet in distance from the site of the emergency. The ANSI recommendation is that the maximum time to reach the shower should be determined by the potential effects of the chemicals being used. For strong acid and strong caustic chemicals, safety showers should be located within 10 to 20 feet of the hazard (ANSI Z.358.1-1990 E4.6.1). The shower should be tested monthly and a record kept.

A hand-held spray may serve as an alternative to a safety shower for middle school settings as long as the chemicals being used are less hazardous.

D. **Fire Extinguishers**: There are 4 classes of fires:
   a. Class A - wood, paper, plastic, cloth
   b. Class B - flammable liquids
   c. Class C - electrical
   d. Class D - combustible metals (Na, K, Mg, etc.)

Water is useful only for Class A fires, the common trash-can fire, and should never be used with Class B, C, or D fires. Multipurpose Class ABC dry chemical fire extinguishers contain monoammonium phosphate and are recommended for use in all classrooms.
Fire extinguishers are not to be used on people. After use, have the fire extinguisher recharged immediately. Signs indicating the location of fire extinguishers should be easily visible.

E. **Fire Blankets**: Fire blankets are made of flame-retardant wool. When wrapping a fire blanket around a person whose clothing is on fire, be careful not to direct flames toward the face. The fire blanket should be stored within 30 feet of the work area.

F. **First-Aid Kits**: First aid kits should be available in the lab; however, first aid should be provided by a trained first aid attendant/school nurse where possible. Emergency phone numbers should be prominently posted. These numbers may include 911, local poison control center, and local hospital or ambulance. Staff should be trained in basic first aid and CPR according to school policy. Disposable gloves should be part of any first-aid kit to prevent the spread of blood-borne pathogens (see Appendix H for examples of gloves appropriate for science laboratory activities). Please consult with your principal on requirements for how to handle first aid at your school.

G. **Evacuation**: An evacuation plan should be in place and practiced several times a year. Each lab should have at least 2 exits. In order to keep aisles clear, students should not sit during lab activities.

H. **Handicap access**: Students with disabilities should receive the level of laboratory experience that is appropriate for the individual student. Students with impaired mobility must have access to safety equipment, utility controls such as faucets and gas jets, restrooms, telephones, doors, and exits. Eye wash fountains and chains on safety showers must be accessible to students with impaired mobility.

I. **Refrigerators**: Food should never be stored in a chemical refrigerator. Chemical refrigerators should be clearly labeled "No Food".

J. **Master Gas and Electrical Shut-off**: It is imperative that you know the location of the master gas and electrical shut-off valves in case of fire or electrical accident. Valves should be clearly labeled, readily accessible and easy to use.

K. **Ventilation: Fume Hood and Exhaust Fans**: Ventilation in any room where chemicals are used or stored is extremely important. An adequate ventilation system will change the room air 4-12 times per hour. All air vented from the lab space should be exhausted outdoors. The exhaust fan is used for the ventilation of the room.

Fume hoods are intended to keep flammable gases, toxic vapors, or noxious odors from entering the general room atmosphere. While most middle school lab activities will not use chemicals that require fume hoods, these guidelines should be followed if prescribed by the SDS.

Additional Rules for Using Fume Hoods:

1. Do not store chemicals in a fume hood.
2. Fume hoods must be inspected for proper operation. Exhaust rates of 60-120 lfpm (linear feet per minute) have been recommended.
3. Keep the sash at its most efficient level.
4. Work as far inside the hood as possible, but keep your head outside the hood.
5. A minimum working distance of 6 inches from the front of the hood is recommended.
6. Locate the hood away from windows, doors, and heavily trafficked areas because drafts can adversely affect the effectiveness of a hood.

## Spill Cleanup

Ensure that you have appropriate materials for cleanup of lab spills. This includes vermiculite/cat litter for most chemical spills and sand for possible metal fires, and a broom and dustpan to sweep up the absorbent.

## Physical Hazards

1. Fire Safety:

Due to the physical hazard, students should not handle heat sources or heated materials, nor should they handle cold items of extreme temperatures such as dry ice. These items should only be handled by adults if they are used in the classroom. A candle with an open flame may be used if absolutely necessary for an investigation. Care should be taken by the adult in handling the candle and the candle should be placed in the center of a metal pie pan filled with wet sand. Open flames should not be left unattended, and upon extinguishing the flame, the candle must be at room temperature or cooler before being discarded. In the middle and high school science lab, great care should be taken to ensure that students are properly trained on the use of the Bunsen burner and other heat sources before conducting the activity.

An ABC fire extinguisher should be located within 75 feet of the classroom or laboratory (in the room near an exit is preferred). Follow school, district, or state policy regarding use of the fire extinguisher. The safety of the students is the top priority: the teacher's primary responsibility in case of a fire is moving the students to safety. If the teacher is uncertain whether a fire can be extinguished with a fire extinguisher, he/she should sound the fire alarm and evacuate. A school district/LEA that requires employees to use a fire extinguisher is required by OSHA to provide those employees with annual training (Stroud and Roy, 2015).

Some science activities require students to examine phenomena with a hand lens. Investigations which take place outdoors should be monitored by the teacher as students use hand lenses to ensure the lens is not focusing sunlight to create fires.

2. Electrical Safety:

Students begin studying the science of electromagnetic force as early as third grade. A unit on electricity should begin with safety instruction, and when students work with electric circuits, teachers must ensure that students do not create short circuits. Lessons which include instructing students how to draw a schematic of a circuit must have the teacher approve the drawing before students connect the parts to ensure students are not creating short circuits or other hazardous electrical connections. Diagrams of unsuccessful, but non-hazardous circuit diagrams should be approved by the teacher so students uncover misconceptions about their diagrams. Students should never handle electric circuits with wet hands. To reduce the likelihood of injuries related to a short circuit, including an open switch in a circuit will enable the circuit to be closed and opened quickly. Students should

wear Personal Protective Equipment (PPE) in the form of safety glasses or chemical splash goggles (ANSI/ISEA Z87 D3) while working with wires or other sharp objects.

Teachers should monitor the area for electrical safety as part of the Duty of Supervision and Duty of Instruction. Extension cords should be used on a temporary basis, and not for more than 90 days. The cords should be covered to prevent tripping and should be commercial extension cords. At the end of the school day, the cords should be disconnected from the electrical receptacle outlets to prevent potential overheating.

Never overload electric receptacles with multi-plug adapters, and never disable grounding plugs. Receptacles near water must be fitted with Ground Fault Circuit Interrupters (GFCI) which should be tested monthly to ensure failure does not occur. Any discrepancies related to electricity should be documented and communicated in writing to the building administrator for correction and repair, and until the repairs are complete, the defective electrical equipment cannot be used.

3. Glassware Safety:

Working with glassware requires specific safety considerations. Before use, glass must be carefully inspected for damage or cracks. Broken glass should be disposed of in a designated "sharps" container. Goggles must always be worn when working with glassware and special care must be taken whenever glassware is heated. Remember that hot glass looks identical to cool glass, so never test glass temperature with bare hands. If a beaker contains hot liquid, allow the solution to cool, then handle using beaker tongs. If a hot plate is being used, never evaporate a substance to dryness and do not use thick-walled glassware or crucibles.

4. Allergens:

Teachers should be aware of any possible student allergies that may be triggered by materials used during a laboratory activity (i.e. peanuts, pollen, sulfur, flour/gluten, baking soda, latex, etc.)

5. Other Physical Hazards:

Other hazards that are not listed above may be found in science activities. These may include projectiles, either by design or unintentionally (such as creating paper gliders, rolling and dropping balls, or use of rubber bands for investigations). If there is a danger of creating projectiles, every occupant in the classroom or laboratory must wear impact goggles or safety glasses.

Physical hazards which could also be considered under Other Physical Hazards may include the following:

- Slipping or falling hazards
- Loud noise hazards
- Choking hazards
- Sharp objects
- Electromagnetic radiation hazards such as bright light, ultraviolet light or laser

The teacher is expected to reduce the likelihood of these hazards and any other hazard not listed above with the cooperation of the building and district administrators, as part of planning and carrying out science instruction.

6. First Aid:

First aid kits should be available in the science lab. First aid should be provided by a trained first aid attendant/school nurse where possible. Emergency phone numbers should be prominently posted. These numbers may include 911, local poison control center, and local hospital or ambulance. Staff should be trained in basic first aid and CPR according to school policy. Disposable nitrile gloves should be part of any first-aid kit to prevent the spread of blood-borne pathogens.

## Biological Hazards

The *2015 Alabama Course of Study: Science* based on the 2012 National Research Council publication, *A Framework for K-12 Science Education: Practices, Crosscutting Concepts and Core Ideas* (National Research Council, 2012), requires kindergarten through high school students to study numerous aspects of living things including structures, behaviors and life cycles. Studying and maintaining living organisms is a crucial component to mastering many grade level standards.

1. Safety Related to Animals:

Any animals maintained in the classroom should be obtained from commercial vendors, and students should not bring pets into the classroom for an extended study. If pets are brought to the classroom for the day, they should be handled only by their owners, preferably the adult owner, and proper care should be provided by the owner during the visit. Wild animals should never be brought to the classroom because some animals such as turtles, snakes, birds, arachnids (spiders, ticks, mites), and other insects may transmit

serious diseases and could behave unpredictably. Students' hands should be cleaned and sanitized before and after handling any animal, and they must be instructed with the exact procedures to follow. (See thorough hand washing procedure in the "Chemical Hazards - Handling" section for further details.) Young students will need to be reminded not to put their fingers or hands on their face or in their mouth after handling animals. Reptiles carry Salmonella, and the same hand washing precautions apply to students who handle bird eggs. Teachers should be aware of student allergies and should determine if an allergy could be triggered by the animal. Personal protective equipment such as eye protection (ANSI/ISEA Z87.1 D3 chemical splash goggles) and hand protection (vinyl or nitrile gloves) may be required in some cases where there are potential hazards and resulting risks (see Appendix D (Ward's, 2019) for examples of gloves appropriate for science laboratory activities).

Teachers are required and are responsible for providing the animal with an appropriate habitat. This includes adequate space and sanitation, protection from adverse conditions, temperature regulation, proper feeding and watering, and provision for offspring. Ensuring an animal has a proper living quarters should also include care to prevent an animal's escape. If this should occur, the principal and head custodian should be notified immediately, and every attempt to search for and recover the missing animal should be made. Animals should be cared for and provisions made over school vacations, power outages, fires, etc. If an animal dies unexpectedly, the teacher should determine the cause of death and dispose of the remains according to state and/or local regulations.

In the event that an animal must be euthanized, the process should be carried out by an adult and never in the presence of students. Euthanasia should be carried out in the most humane manner possible at the end of the learning activity, and animals should never be released to the wild nor given to the students to take home as pets, even with parental consent. Commercial vendors that provide living organisms for educational use also give instructions on how to carry out euthanasia in the most humane manner in the teacher guide.

The National Association of Biology Teachers (NABT) believes the study of organisms, including nonhuman animals, is essential to the understanding of life on Earth. NABT recommends the prudent and responsible use of animals in the life science classroom. NABT believes biology teachers should foster a respect for life. Biology teachers should teach about the interrelationship and interdependence of all things. Classroom experiences that involve nonhuman animals range from observation to dissection. NABT supports these

experiences so long as they are conducted within the long established guidelines of proper care and use of animals, as developed by the scientific and educational community. Vertebrate animals should not be taken from the environment. Vertebrate animals should be used only for observational activities and to teach students proper care and handling. No invasive procedures should be done on living vertebrate animals (NABT, 2019).

When the use of the organism is complete, proper disposal is required. Do not release animals into the environment.

2. Safety Related to Plants:

Before instruction begins with a study of plants, teachers should ascertain whether there are allergies to the plants that will be studied. Excessive pollen can irritate eyes or respiratory tissues. Beans and seeds from the grocery store are safer to handle or germinate. Do not use seeds for gardening since they are coated with chemicals. Students should never eat any part of an unknown plant, including berries and seeds, whether in the classroom or on a field trip. Instruct students on how to understand the difference between edible and inedible plants, vegetables, and fruits.

When students are in the wild, studying plants, they should be instructed to recognize hazardous plants such as poison ivy, poison oak, poison sumac, and stinging nettle. Students should never taste any plant or touch a fungus growing outside in the wild. Some plants are extremely poisonous if eaten such as toadstools, buttercup, and azaleas. Some plants may have been sprayed with insecticides or exposed to animal waste.

Instead of chemical fertilizers, compost or organic fertilizers should be used to fertilize plants. If chemical fertilizers are used, they should be purchased through a science supply company with a purchase order and should be handled by adults, never students. All fertilizers must be labeled and locked in cabinets and Safety Data Sheets (SDS) filed for each. Students should be reminded to wash hands and clean nails well after use of these chemicals. Chemical splash goggles and gloves should be used when handling fertilizers and plant chemicals, and all precautions should be taken for dust hazards. Composting should only be handled outside of the school building and not in the classroom, laboratory, or other indoor instructional space. No chemical pesticides, herbicides, or fungicides should be used in the classroom.

Living things that should never be studied in the science classroom:

- Bacterial or fungal cultures (especially those collected from the environment)
- Stinging insects (bees, wasps, hornets)
- Poisonous spiders
- Venomous snakes
- Exotic species (plant and animal) known to endanger local ecosystems
- Poisonous plants or plants with thorns

3. Microbiology:

Specimens should be obtained from reliable supply companies. Aseptic technique should be followed at all times and proper equipment for sterilization should be available. Disposal of specimen samples is extremely important. They should be destroyed to avoid possible contamination through dry heat, steam, or chemical sterilization.

4. Preserved specimens:

Preserved specimens should be obtained from reputable sources, in a quantity appropriate for one school year. Safety goggles should be worn during all dissection labs.

5. Biotechnology:

Work with DNA is at the core of many of these activities. Spooling, enzymatic digestion, and electrophoresis of this molecule to study its chemical and physical properties, as well as manipulating bacterial cells to introduce new genetic properties, have become commonplace. All samples should be handled carefully and as if they can cause infection. The lab should be off-limits to others during class periods when microorganisms or DNA are being used. All participants should wash their hands with soap and water before and after handling samples. The work surfaces should also be disinfected before and after the lab period.

## ACCIDENT RESPONSE

In the event of an accident, no matter how small, an incident report should be filed with the school administrator. A sample of this form can be found in Appendix B.

## PERSONAL PROTECTION EQUIPMENT

Students should wear the proper personal protection equipment (PPE) for the type of lab that will be conducted. This includes the proper goggles, apron/lab coat, and gloves if required.

**A. Goggles:** Goggles should be appropriate for the lab being performed:

1. Chemical splash goggles: American National Standard Institute (ANSI) Z87 or Z87.1 coded safety goggles should be worn by all participants in the lab classroom when chemicals are involved.
2. Safety glasses: only provide protection from physical impact, not from chemicals, and should only be used in activities where projectiles may be encountered.

**B. Apron/Lab Coat:** Laboratory coats and aprons each have a place in laboratories depending on the hazards involved. Laboratory coats are intended to prevent contact with dirt and the minor chemical splashes or spills encountered in laboratory work. Plastic or rubber aprons provide better protection from corrosion or irritating liquids.

**C. Gloves:** Nitrile gloves are the best choice for most labs in chemistry and biology classes, And they are also good for students with latex allergies. Appendix H outlines the different types of gloves and their uses in the lab (Ward's, 2019).

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# Appendix A- NSTA Science Safety Acknowledgment Forms

http://static.nsta.org/pdfs/SafetyAcknowledgmentForm-ElementarySchool.pdf

Elementary Science Safety Acknowledgment Form

**Note to teachers of science and supervisors/administrators: Safety is the most important part of a science lesson. This includes monitoring student behavior and taking care of lab materials and equipment. The attached safety acknowledgment form is for your use in the elementary classroom and/or laboratory. It should be given to students at the beginning of the school year—after safety training is completed—to help them understand their role in ensuring a safer and more productive science experience.**

**When selecting activities to do with elementary school students, only plan those that use materials for which you have appropriate engineering controls (e.g., ventilation, eyewash station, etc.) and personal protective equipment (e.g., safety goggles, aprons, etc.). Be sure to have storage and disposal procedures in place as per the Safety Data Sheet (SDS), including household substances, such as vinegar, alcohol, and baking soda. Teachers should conduct a hazard analysis and risk assessment and review appropriate safety actions to determine if the activity is feasible or should be altered or eliminated. For more information, visit the NSTA website at www.nsta.org/safety to view and download safety resources. Also seek out your state's safety resources and OSHA regulations.**

**Resources Science Safety Rules; Science Safety: It's Elementary!**

***NSTA would like to thank its Science Safety Advisory Board for developing this resource. Questions or comments about its content should be directed to NSTA at 703-243-7100 or safety@nsta.org.***



***NSTA is committed to providing quality material that promotes the best in inquiry-based science education. However, conditions of actual use may vary, and the safety procedures and practices described in this resource are intended to serve only as a guide. Additional precautionary measures may be required. NSTA and the authors do not warrant or represent that the procedures and practices in this resource meet any safety code or standard of federal, state, or local regulations. NSTA and the authors disclaim any liability for personal injury or demand to property arising out of or relating to the use of this resource, to include any of the recommendations, instructions, or materials contained therein.***

## Elementary Science Safety Acknowledgment Form

***Note to parents/guardians: Please review the following safety acknowledgment with your child and sign in the spaces indicated. If you or your child have any questions, please contact your child's teacher or school administrators.***

**What I need to do to behave responsibly:**

- **Always follow safety operating procedures.**
- **Always wait for the teacher's directions before touching any lab materials.**
- **Listen to and follow all instructions given by the teacher.**
- **Tell the teacher if you see anything that might not be safe, including unsafe behavior.**
- **Behave in a responsible manner in the science classroom and in outdoor settings.**
- **Report any accidents, spills, or broken equipment to the teacher immediately.**
- **Read and follow all warning labels on substances being used.**
- **Be sure your teacher is aware of any allergies you may have.**

**What I need to do for my safety:**

- **Wear personal safety equipment (goggles, gloves, aprons) as indicated by your teacher. When my teacher's safety equipment is on, mine will be on. When my teacher's safety equipment is taken off, I can then take mine off!**
- **Tie back long hair.**
- **Avoid wearing loose sleeves or other clothing that may drag in chemicals or catch on equipment.**
- **Do not wear loose hanging jewelry, especially when working with chemicals or heat sources.**
- **Before touching a hot plate or other heat source, make sure that it is both unplugged and cool.**
- **Never taste, eat, or drink anything in science class.**
- **Avoid touching your eyes, ears, face, or mouth when working with chemicals, plants, or animals.**
- **Never mishandle or mistreat animals.**
- **Make sure any chemical used has a label on the container.**
- **Keep lids on bottles and other containers when not in use.**
- **Dispose of all chemical waste and materials only as directed by my teacher.**
- **Never smell or inhale anything unless the teacher tells you to do so.**

**What I also need to do:**

- **Use science equipment the way you have been taught.**
- **Do not pull out electric plugs by tugging on the cord.**
- **Keep your workplace neat and clean up when the activity is completed.**
- **Keep books, book bags, etc., off the floor and away from the area where the science activity is being performed.**
- **Know the location of all safety equipment, such as the fire blanket, fire extinguisher, first-aid kit, etc., in or near your classroom/laboratory.**
- **Wash your hands with soap and water after science lab activities.**

**Agreement: I have read and understand this form. I was present when these safety guidelines were discussed in class or I discussed them directly with my teacher. I am aware that the laboratory may have hazards that could make it unsafe. I acknowledge that it is important that I follow the above safety procedures to help make it a safer learning environment.**

_____

**(Student Signature) (Date)**

**I have read and reviewed the lab safety rules with my child.**

_____

**(Parent/Guardian Signature) (Date)**

http://static.nsta.org/pdfs/SafetyAcknowledgmentForm-MiddleSchool.pdf

## Middle School Safety Acknowledgment Form

**Note to science teachers and supervisors/administrators: Safety is the most important part of a science lesson. This includes monitoring student behavior and taking care of lab materials and equipment. The attached safety acknowledgment form is for your use in the science classroom, laboratory, and field site. It should be given to students at the beginning of the school year— after safety training is completed—to help them understand their role in ensuring a safer and more productive science experience.**

**When selecting activities for middle school students involving chemicals, only plan to use chemicals for which you have appropriate engineering controls (e.g., ventilation, eyewash station, etc.) and personal protective equipment (e.g., safety goggles, aprons, etc.). Be sure to have storage and disposal procedures in place as set forth in the Safety Data Sheet (SDS). Substitute a less hazardous chemical whenever possible. Teachers should conduct a hazard analysis and risk assessment, and review appropriate safety actions to determine if the activity is feasible or should be altered or eliminated.**

**For more information, visit the NSTA website at www.nsta.org/safety to view and download safety resources. Also seek out your state's safety resources and OSHA regulations.**

**Resources: Safety in The Science Classroom, Lab, and Field**

**Safety Acknowledgment Form for Working With Microorganisms**

***NSTA would like to thank its Science Safety Advisory Board for developing this resource. Questions or comments about its content should be directed to NSTA at 703-243-7100 or safety@nsta.org.***



***NSTA is committed to providing quality material that promotes the best in inquiry-based science education. However, conditions of actual use may vary, and the safety procedures and practices described in this resource are intended to serve only as a guide. Additional precautionary measures may be required. NSTA and the authors do not warrant or represent that the procedures and practices in this resource meet any safety code or standard of federal, state, or local regulations. NSTA and the authors disclaim any liability for personal injury or demand to property arising out of or relating to the use of this resource, to include any of the recommendations, instructions, or materials contained therein.***

## Middle School Safety Acknowledgment Form

***Science is a process of discovering and exploring the natural world. Explorations can occur in the classroom, laboratory, or field. As part of your science instruction, you will conduct many activities and investigations using a variety of materials, equipment, and chemicals. As a result, you may be exposed to biological, chemical, or physical hazards.***

***Safety is the FIRST PRIORITY for students, instructors, and parents. To ensure safer experiences, the following safety operating procedures—based on legal safety standards and better professional safety practices—have been developed for the protection and safety of everyone. Your instructor will provide additional safety procedures for specific situations or settings. The safety operating procedures must be followed at all times.***

***Review these procedures with your instructor and parents/guardians, then sign and get the signature of a parent/guardian. Your signature indicates that you understand the lab can have hazards, and that you have read the safety procedures and agree to follow them at all times. Signatures are required before you can participate in any activity or investigation.***

### Safety Standards for Student Conduct in the Classroom, Laboratory, or Field

- **Conduct yourself in a responsible manner at all times. Inappropriate behavior such as throwing things, and doing unauthorized experiments are prohibited.**
- **Read all lab and safety operating procedures before conducting an activity and follow all verbal and written instructions during the activity or investigation.**
- **Eating, drinking, chewing gum, applying cosmetics (including lip balm), touching contact lenses, or other unsafe activities are not permitted. Food storage is not allowed in the laboratory.**
- **Do not enter or work in the laboratory unless an instructor is present.**
- **Unauthorized and unsupervised activities or investigations are prohibited.**
- **Never enter chemical storage or preparation areas.**
- **Removing chemicals or equipment from the classroom or laboratory is prohibited unless authorized by the instructor.**
- **Do not touch any materials, equipment, etc. for a lab activity until instructed to do so by the teacher.**

### Personal Safety

- **Sanitized indirectly vented, chemical-splash goggles (ANSI/ISEA Z 87+ D3) or safety glasses (ANSI/ISEA Z 87+ D3), as appropriate, should be worn during setup, hands-on activity, and take-down/cleanup unless the instructor specifically states that the activity or demonstration does not require the use of eye protection. Indirectly vented, chemical-splash goggles must be worn whenever you are working with chemicals, a heating source, particulate matter, or glassware. Notify the teacher immediately if your goggles are damaged or do not fit properly.**

- **When an activity requires the use of non-latex laboratory aprons, the apron should be appropriate to the size of the student and the hazard associated with the activity or investigation. The apron may be removed only when the instructor notes it is safe to do so.**
- **Dress appropriately for laboratory work by protecting your body with clothing and shoes. Long hair should be tied back collars tucked in. Avoid wearing loose or baggy clothing and dangling jewelry. Acrylic nails are a safety hazard near heat sources and should not be used. Sandals or open-toe shoes are not to be worn during any lab activities. Refer to pre-lab instructions. If in doubt, ask!**
- **Know the location of and how to operate all safety equipment in the room. This includes eyewash stations, deluge shower, fire extinguishers, fume hood, and the safety blanket. Know the location of emergency master electric and gas shutoffs and exits.**
- **Certain classrooms or laboratories may have living organisms including plants and animals in aquaria or other containers. Students should never handle organisms without approval from your instructor. Wash your hands with soap and water after handling organisms.**
- **When an activity or investigation requires the use of non-latex laboratory gloves for hand protection, the gloves shall be appropriate for the hazard and worn throughout the activity. Cover all cuts, broken skin, or wounds with a waterproof dressing to reduce or prevent exposure. Wash hands thoroughly with soap and water after removing gloves.**
- **Keep hands away from the face at all times. Do not put hands or other objects in or near your mouth or eyes.**
- **All accidents, chemical spills, broken glassware, and injuries (including minor burns) must be reported immediately to the instructor, no matter how trivial they may seem at the time. Follow your instructor's directions for immediate treatment.**

Safety Standards Regarding Chemicals and Lab Equipment

- **Never taste or smell a chemical solution. When checking for odor, waft by sweeping your hand over the container. Avoid inhaling fumes that may be generated during an activity or investigation.**
- **Never fill pipettes by mouth suction; use the suction bulbs or pumps.**
- **Do not force glass tubing into rubber stoppers. Use glycerin as a lubricant and hold the tubing with a towel as you ease the glass into the stopper.**
- **Proper procedures should be followed when using any heating or flame-producing device, especially gas burners. Remove all flammable materials from the area before lighting a match, candle, or Bunsen burner. Never leave a flame unattended.**
- **Never dispense flammable liquids near an open flame or heat source. Avoid facing the open end of a test tube toward yourself or other students when being heated.**
- **Remember that hot glass looks the same as cold glass. After heating, glass remains hot for a very long time. Determine if an object is hot by placing your hand close to the object without touching it. After using a hot plate or working with hot glass, warn**

**others of a possible burning hazard by placing a sign nearby indicating that it may be hot. e**

- **In the event of a fire drill, lockdown, or other emergency during an investigation or activity, turn off all gas burners and electrical equipment. During an evacuation emergency, exit the room as directed. During a lockdown, move out of the line of sight from doors and windows as directed. Lights should be turned off.**
- **Always read the reagent bottle labels twice before you use the reagent to be certain you are using the correct chemical. Do not use any chemicals stored in unlabeled bottles and inform your teacher if a label is missing from a reagent bottle.**
- **Replace the top on any reagent bottle immediately after use and return the reagent to the designated location. Follow the teacher's instructions for carrying chemicals.**
- **Do not return unused chemicals to the reagent container. Follow the instructor's directions for the storage or disposal of these materials.**

Standards for Maintaining a Safer Laboratory Environment

- **To prevent potential cross contamination, backpacks and books are to remain in an area designated by the instructor and should not be brought into the laboratory area.**
- **Never sit or stand on laboratory elevated platforms (e.g., tables, desks, etc.).**
- **Work areas should be kept clean and neat at all times, and cleaned at the end of each laboratory or activity.**
- **Solid chemicals, metals, matches, filter papers, broken glass, and other materials designated by the instructor are to be deposited in the proper waste containers, not in the sink. Follow your instructor's directions for disposal of waste.**
- **Sinks are to be used for the disposal of water and those solutions designated by the instructor. Other solutions must be placed in the designated waste disposal containers.**
- **Glassware is to be washed with hot, soapy water and scrubbed with the appropriate type and size of brush, rinsed, dried, and returned to its original location.**
- **Appropriate eye protection (e.g., safety goggles, safety glasses) is to be worn during setup, hands-on activity or investigation, and take down/cleanup, and until hands can be thoroughly washed with soap and water.**
- **To prevent accidental release, discharge, or injury, handle with extreme caution all projectiles, spring-loaded devices, meter sticks or similar levers, and other physical hazards, such as bare wires, blades, and other sharps. Eye protection must be worn.**
- **Safety Data Sheets (SDSs) contain critical information about hazardous chemicals of which students need to be aware. Your instructor will review the important points on the SDSs for the hazardous chemicals students will be working with and also post the SDSs in the lab for future reference.**

- **Indirectly vented, chemical-splash goggles (ANSI/ISEA Z 87+ D3) or safety glasses (ANSI/ISEA Z 87+ D3), as appropriate, must be worn by all students, teachers, and visitors in the laboratory during work periods INCLUDING SETUP, HANDS-ON ACTIVITY, and TAKE-DOWN/CLEANUP in accordance with legal safety standards and/or better professional practices.** *Indirectly vented, chemical-splash goggles must be worn whenever chemicals, a heating source, particulate matter, or glassware are present.*

WHEN IN DOUBT, WEAR GOGGLES!

*Agreement:*
***I have read the above safety operating procedures and agree to follow them during any science lab, investigation, or activity. By signing this form, I acknowledge that given the biological, chemical or physical hazards, the science classroom, laboratory, or field can be an unsafe place to learn. The safety-operating procedures are developed to help prevent accidents and to ensure my own safety and the safety of my fellow students. I will follow any additional instructions given by my instructor. I understand that I may ask my instructor at any time about the safety operating procedures if they are not clear to me. My failure to follow these science laboratory operating procedures may result in disciplinary action.***

_____

***(Student Signature)*** ***(Date)***

***I have read and reviewed the lab safety rules with my child.***

_____

***(Parent/Guardian Signature)*** ***(Date)***

*Please keep these pages in the front of the laboratory section of your notebook.*

http://static.nsta.org/pdfs/SafetyAcknowledgmentForm-HighSchool.pdf

## High School Safety Acknowledgment Form

Note to science teachers and supervisors/administrators: **Safety is the most important part of a science lesson. This includes monitoring student behavior and taking care of lab materials and equipment. The attached safety acknowledgment form is for your use in the science classroom, laboratory, and field site. It should be given to students at the beginning of the school year— after safety training is completed—to help them understand their role in ensuring a safer and more productive science experience.**

**When selecting activities for high school students involving chemicals, only plan to use chemicals for which you have appropriate engineering controls (e.g., ventilation, eyewash station, etc.) and personal protective equipment (e.g., safety goggles, aprons, etc.). Be sure to have storage and disposal procedures in place as set forth in the Safety Data Sheet (SDS). Substitute a less hazardous chemical whenever possible. Teachers should conduct a hazard analysis and risk assessment, and review appropriate safety actions to determine if the activity is feasible or should be altered or eliminated.**

**For more information, visit the NSTA website at www.nsta.org/safety to view and download safety resources. Also seek out your state's safety resources and OSHA regulations.**

**Resources: Safety in The Science Classroom, Lab, and Field Safety Acknowledgment Form for Working With Microorganisms**

***NSTA would like to thank its Science Safety Advisory Board for developing this resource. Questions or comments about its content should be directed to NSTA at 703-243-7100 or safety@nsta.org.***



***NSTA is committed to providing quality material that promotes the best in inquiry-based science education. However, conditions of actual use may vary, and the safety procedures and practices described in this resource are intended to serve only as a guide. Additional precautionary measures may be required. NSTA and the authors do not warrant or represent that the procedures and practices in this resource meet any safety code or standard of federal, state, or local regulations. NSTA and the authors disclaim any liability for personal injury or demand to property arising out of or relating to the use of this resource, to include any of the recommendations, instructions, or materials contained therein.***

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***Safety is the FIRST PRIORITY for students, instructors, and parents. To ensure safer experiences, the following safety operating procedures—based on legal safety standards and better professional safety practices—have been developed for the protection and safety of everyone. Your instructor will provide additional safety procedures for specific situations or settings. The safety operating procedures must be followed at all times.***

***Review these procedures with your instructor and parents/guardians, then sign and get the signature of a parent/guardian. Your signature indicates that you understand the lab can have hazards, and that you have read the safety procedures and agree to follow them at all times. Signatures are required before you can participate in any activity or investigation.***

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- **Conduct yourself in a responsible manner at all times. Inappropriate behavior such as throwing things, and doing unauthorized experiments are prohibited.**
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- **When an activity requires the use of non-latex laboratory aprons, the apron should be appropriate to the size of the student and the hazard associated with the activity or**

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- **Dress appropriately for laboratory work by protecting your body with clothing and shoes. Long hair should be tied back collars tucked in. Avoid wearing loose or baggy clothing and dangling jewelry. Acrylic nails are a safety hazard near heat sources and should not be used. Sandals or open-toe shoes are not to be worn during any lab activities. Refer to pre-lab instructions. If in doubt, ask!**
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_____

***(Student Signature)*** ***(Date)***

***I have read and reviewed the lab safety rules with my child.***

_____

***(Parent/Guardian Signature)*** ***(Date)***

*Please keep these pages in the front of the laboratory section of your notebook.*

# Appendix B- Accident/Incident Reports

Science Department - Laboratory Accident/Incident Report Form

Supervisor/Investigator Name: _____ Date: _____

**I. Summary of the Incident (to be filled out by the supervisor/investigator after interviewing the students/staff involved)**

**Date and time of incident:** _____ **Place of incident:** _____
**Experiment/activity performed at the time of the incident:** _____
**Persons involved:** _____
**Witnesses:** _____

**Severity of the incident (circle one):**

**(1): simple injury or minor damage** **(2) mild injury or mild damage** **(3) serious injury or major damage**

**Equipment damaged:** _____
**Did the incident result in an injury?** **(Yes)** **(No)**
**If there was an injury, was the nurse contacted?** **(Yes)** **(No)**

**Summary of the incident:** _____

_____

_____

**Immediate actions taken after the incident:** _____

_____

_____

**II. Report by the Person Involved**

**Name:** _____
**Describe how the incident occurred:** _____

_____

_____

**Did you sustain any injuries? If yes, please elaborate:** _____

_____

**Was there any damage to the equipment? If yes, please elaborate:** _____

_____

**Personal protective equipment (PPE) worn during the incident:** _____

_____

**What safety rules had been followed until the incident happened?:** _____

_____

**What casual factors do you think are behind this incident?:** _____

_____

**Additional comments:** _____

_____

**Signature:** _____

**III. Report by the Witness:**

**Name:** _____

**Describe how the incident occurred:** _____

_____

_____

**Additional comments/observations:** _____

_____

**Signature:** _____

**IV. Report by the Supervisor/Investigator:**

**Contributing/casual factors behind the incident:** _____

_____

**Recommendations to prevent the recurrence of similar incidents:** _____

_____

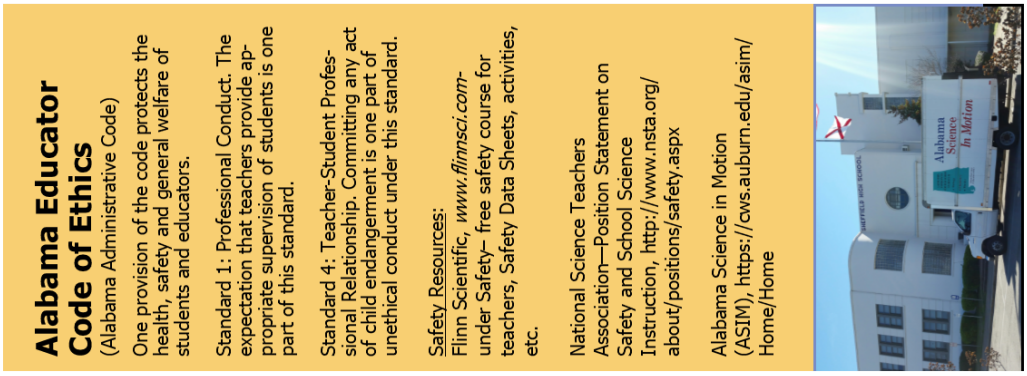
**Additional comments:** _____

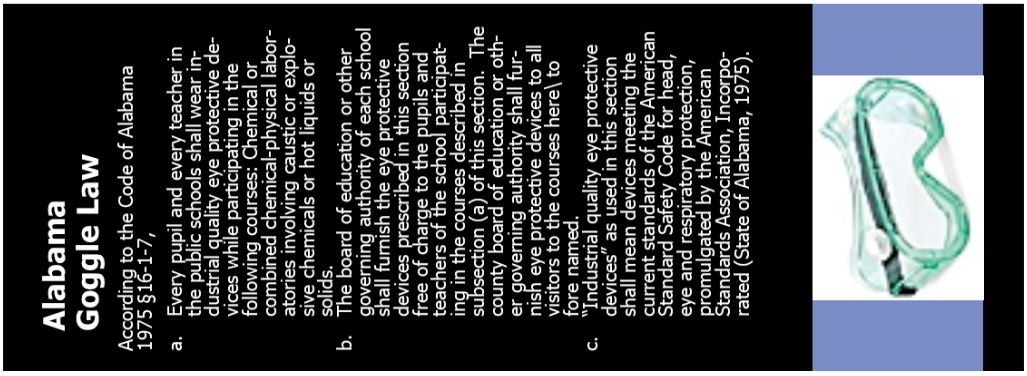
_____

**ATTACH ANY ADDITIONAL RESPONSES, IF NEEDED.**

**Supervisor/investigator signature:** _____

# Appendix C- Legal Aspects of Duty of Care for Science Teachers


## Duty of Care

Duty of Care is defined as "a requirement that a person act toward others and the public with the watchfulness, attention, caution and prudence that a reasonable person in the circumstances would use. If a person's actions do not meet this standard of care, then the acts are considered negligent, and any damages resulting may be claimed in a lawsuit for negligence." (https://dictionary.law.com )

"If a teacher can reasonably foresee the consequences of action or inaction, he or she will be held legally responsible" (Flinn Scientific, 2014).

Duty of care includes duty of supervision, duty of instruction, and duty of maintenance. Never leave students unattended in the lab or classroom. If someone gets hurt, the teacher could be found negligent.

**DO's**

- Do keep a signed safety contract on file for every student.
- Do require every student to pass a lab safety test before they can go into the lab.
- Do be sure that students follow lab directions precisely.
- Do warn students about hazards associated with lab activities every time a lab is conducted.
- Do reinforce safety rules every day.
- Do document every time you cover safety issues with students.
- Do the lab/demo before you do it with students to find and correct potential dangers.
- Do have a written safety plan that is reviewed and updated yearly.
- Do follow recognized professional standards.
  - The Alabama Code of Ethics
  - Position statements adopted by the National Science Teachers Association (NSTA), the National Association of Biology Teachers (NABT), the American Chemical Society (ACS), the Council of State Science Supervisors (CSSS) or the National Science Education Leadership Association (NSELA)

**DON'Ts**

- Don't leave students unattended in the lab or classroom.
- Don't assume that students read the lab and the safety precautions mentioned in the write-up.
- Don't allow students to go into the chemical storage room.
- Don't allow horseplay in the lab.
- Don't allow students in the lab with open-toed shoes, synthetic clothing that can melt to the body, or baggie clothing that can get caught.
- Don't allow students to leave the laboratory without first washing their hands to remove any residual chemicals.
- Don't allow students to perform any unauthorized experiments.
- Don't allow students to eat, drink, or chew gum in the lab because chemicals from the lab bench, hands, and air could be consumed.
- Don't allow students to use faulty or broken equipment.
- Don't perform a lab or demo until you have done the lab/demo yourself, performed a hazard & risk assessment and made changes to improve safety. (Check physical hazards of equipment & procedures, chemical hazards of reactants & products, & health hazards.)

# Appendix D- Laboratory Safety Checklist

***(Please indicate items that do not apply to your classroom with "N/A.")***

1. Teachers should perform periodic assessments of the classroom to ensure that all possible safety precautions are being taken. _____
2. Teachers should design an instructional format that allows students sufficient time to conduct a science activity, to cleanup, and properly store materials and equipment after use. _____
3. Teachers should be a positive role model for students by always practicing appropriate safe behaviors and using necessary personal protective equipment (PPE) (safety goggles, aprons, gloves, etc.). _____
4. The room has no blind spots which cannot be supervised by the teacher. _____
5. Functioning smoke/heat detector and fire extinguisher(s) are in the room. _____
6. All safety equipment, including fire blanket, eyewash station, safety shower, and fire extinguisher are available and in good working condition. _____
7. All PPE (safety goggles, aprons, gloves, etc.) are available, and goggles can be sanitized between student use. _____
8. Safety rules are posted in various locations throughout the lab. _____
9. There is a functioning intercom system to secure aid in an emergency. _____
10. If floors are tile or hardwood, they are covered with a nonskid wax to prevent falls. _____
11. There are enough electrical outlets to prevent the necessity for extension cords. _____
12. Electrical outlets near water faucets have Ground Fault Interrupters (GFI) to prevent electrocution. _____
13. Only three-pronged, grounded electrical outlets are available in the room. _____
14. Electrical outlets are capped when not in use. _____
15. The classroom doors open outward to facilitate emergency exit. _____

16. Occupancy minimum in a dedicated lab is set at 50 square feet per occupant and 45 square feet per occupant in a multi-use classroom/lab. _____

17. Aisles are sufficiently wide to accommodate handicapped student needs (5 ft.). _____

18. The physical organization of the room is sufficiently flexible to allow space to set up, conduct, and store student projects. _____

19. There are no more than 24 students assigned to a teacher when conducting science activities. _____

20. There are sufficient numbers of large tables on which students can conduct science activities. _____

21. There are at least two faucets and sinks in the room for use in conducting science activities. Non-slip drainage mats are placed securely on the floor in front of each sink. _____

22. The room is maintained in a neat, orderly condition. _____

23. A spill clean-up kit is readily available in the lab and chemical storeroom. _____

24. Large and/or heavy items are stored on lower shelves. _____

25. There are SDS's for all chemicals in the lab. _____

26. Student containers are identified with accurate, chemically resistant, temporary labels. _____

27. Student containers are small enough to reduce the potential for serious injury and to prevent the need for disposal of large quantities of waste. _____

28. A system should be developed for the appropriate transport of chemicals and equipment items within and between classrooms and storage areas, that ensures safety. A rolling cart with lips on each shelf is highly recommended. _____

29. Hazardous materials should only be transported through the halls by the teacher. _____

**STORAGE**

30. There is adequate classroom storage space to prevent overcrowding. _____

31. All storage shelves are below adult eye level and have raised front lips to prevent objects from rolling off them onto the floor. _____

32. There is a lockable storage area, or box, for securing valuable, or potentially dangerous, materials. _____

33. Volatile chemicals are stored away from sunlight, heat and electrical sources. _____

34. Synergistically reactive chemicals should be stored away from each other. _____

35. Chemicals with NFPA codes of 3 or greater, in any category, or that are deemed hazardous from the MSDS, should be kept out of the reach of students in appropriate lockable containers. _____

36. Caustic, or dangerous, chemicals should be stored in containers appropriate for their protection. _____

37. Caustic chemicals are kept in appropriate containers which are easily handled. _____

38. Appropriate mild acids or bases are provided to students in small, easily handled containers. _____

39. Storage areas and individual items (chemicals and equipment) are appropriately labeled with permanent ink or electric markers. _____

40. A method for keeping an inventory and checking-in and checking-out of chemicals and equipment is in place. _____

41. Permanent chemicals are completely identified, with the manufacturer's label. _____

42. The date of chemical receipt is noted on the container in order to prevent exceeding the useful shelf life. _____

43. Substances which have lost their identity labels, or for which there is confusion in their labeling, are appropriately disposed of. _____

44. Wood storage cabinets are used instead of metal in order to prevent corroding and hot spots during fires. _____

45. Shelves are deep enough to accommodate the objects placed on them and to prevent dislodging. _____

# Appendix E- Alabama Codes that Affect the Science Laboratory Classroom

- School Safety Audit--§ 16-1-44
- Annual Safety Plan Review--§ 16-1-44
- **Fire Extinguishers: Located, Charged, Tagged**--§ 36-19-2; § 36-19-11
- **Fire Escape--**SFM 482-2-102.01**(d);** SFM 482-2-102.01**(e)**
- **Flammables Stored Properly**--§36-19-2(2)**;** §36-19-11**;** SFM 482-2-102.01(b)
- **Facility Review/Safety--**AAC 290-6-1-.04-10
- **Goggle Law**--§16-1-7

**P. 32 Title 16. Education Laws**
Code of Alabama, 1975, §16-1-7
**Section 16-1-7. Eye protective devices for pupils and teachers participating in certain courses**

**Pp 35-37**
**Section 16-1-7. Eye protective devices for pupils and teachers participating in certain courses.**

**(a) Every pupil and every teacher in the public schools shall wear industrial quality eye protective devices while participating in the following courses:**

**(1) Vocational or industrial arts, shops or laboratories involving experience with:**

**a. Hot molten metals;**

**b. Milling, sawing, turning, shaping, cutting or stamping of any solid materials;**

**c. Heat treatment, tempering or kiln firing of any metal or other materials;**

**d. Gas or electric arc welding;**

**e. Repair or servicing of any vehicle;**

**f. Caustic or explosive materials.**

**(2) Chemical or combined chemical-physical laboratories involving caustic or explosive chemicals or hot liquids or solids.**

**(b) The board of education or other governing authority of each school shall furnish the eye protective devices prescribed in this section free of charge to the pupils and teachers of the school participating in the courses described in subsection (a) of this section. The county board of education or other governing authority shall furnish eye protective devices to all visitors to the courses heretofore named.**

**(c) "Industrial quality eye protective devices" as used in this section shall mean devices meeting the current standards of the American Standard Safety Code for head, eye and respiratory protection, promulgated by the American Standards Association, Incorporated.**

***2015 Alabama Science Course of Study*, p. 8**

**"Teachers should also be aware of the state safety goggle law found in the Code of Alabama, 1975, §16-1-7. This law requires local boards of education to provide American National Standard Institute (ANSI) Z87 or Z87.1 coded safety goggles to every student engaged in science experiments. Teachers are further encouraged to obtain and keep readily available the safety references, Science and Safety—Making the Connection for secondary classrooms and the Science and Safety: It's Elementary! calendar and flip chart.**

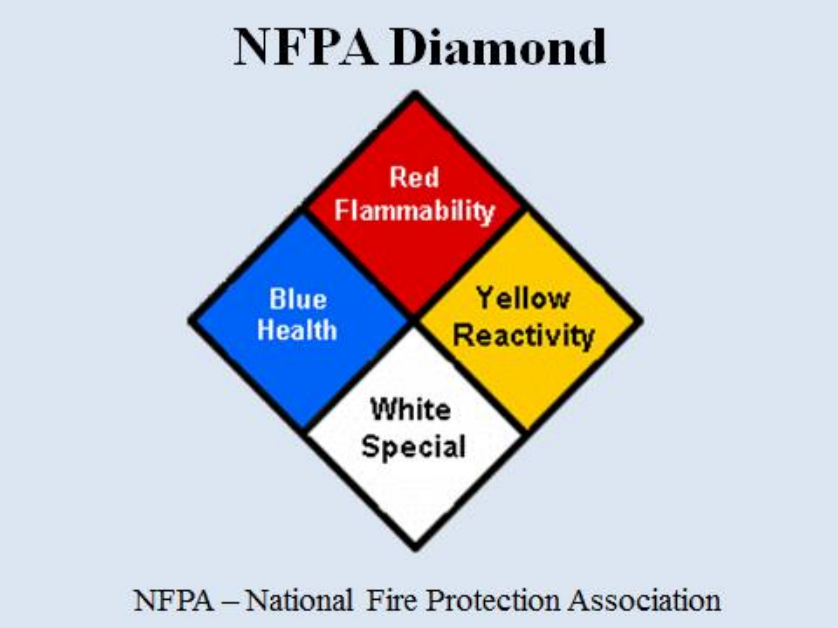
# Appendix F- Federal Codes that Affect the Science Laboratory Classroom

**CFR (Code of Federal Regulations); NFPA (National Fire Protection Act)**

- **Asbestos materials 40 CFR 61 34 CFR 230, 763**
- **Chemicals in Drinking Water Chemicals in drinking water 40 CFR 141, 144**
- **Clean Water Act Control of discharges of hazardous substances 40 CFR 100, 401**
- **Comprehensive Environmental Response, Compensation, and Liabilities Act (CERCLA) Responsibility and compliance for hazardous materials 40 CFR 302, 305, 306**
- **Federal Insecticide, Fungicide and Rodenticide Act (FIFRA) Use of pesticides 40 CFR 150-199**
- **Lead Contamination Control Act Lead in water supplies Public Law 100-572, October 1988**
- **National Fire Protection Association (NFPA) Storage of flammable liquids NFPA Code 30**
- **Protection of life and property in laboratory settings. NFPA Code 45**
- **Life safety, technical standards for fire prevention and safety. NFPA Code 101**
- **Occupational Safety and Health Administration (OSHA) Allowable standards in the workplace. 29 CFR 1910**
- **Occupational exposure to hazardous materials in laboratories 29 CFR 1910.1450**
- **Hazard communication standard 29 CFR 1910.1200**
- **Occupational exposure to bloodborne pathogens 29 CFR 1910.1300**
- **Compressed gas standard 29 CFR 1910.101**
- **Flammable liquids 29 CFR 1910.106**
- **Eye/face protection 29 CFR 1910.133**
- **Respiratory protection 29 CFR 1910.134**
- **Quick drench 29 CFR 1910.151**
- **Portable fire extinguishers 29 CFR 1910.157**
- **Automatic sprinkler systems 29 CFR 1910.159**
- **Record keeping requirements 29 CFR 1910.20**
- **Protection of Stratospheric Ozone Release of freon to the Atmosphere 40 CFR 82**
- **Radioactive Materials Hazardous radioactive materials 10 CFR 19, 20**
- **Resource Conservation and Reauthorization Act (RICRA) Disposal of hazardous materials 40 CFR 241**
- **Superfund Amendments and Reauthorization Act (SARA) Reporting, planning, and training regarding hazardous materials 40 CFR 300**
- **Toxic Substances Act (TOSCA) Chemical information, rules, PCBs 40 CFR 712, 716**

- **Federal Hazardous Materials Transportation Act Transportation, labeling, handling, training, classification, description, marking, packaging, loading, and storage of hazardous chemicals 49 CFR 107-180**
- **Individuals with Disabilities Act 1975; Rehabilitation Act 1973**

# Appendix G- National Fire Protection Diamond




## NFPA Rating Explanation Guide

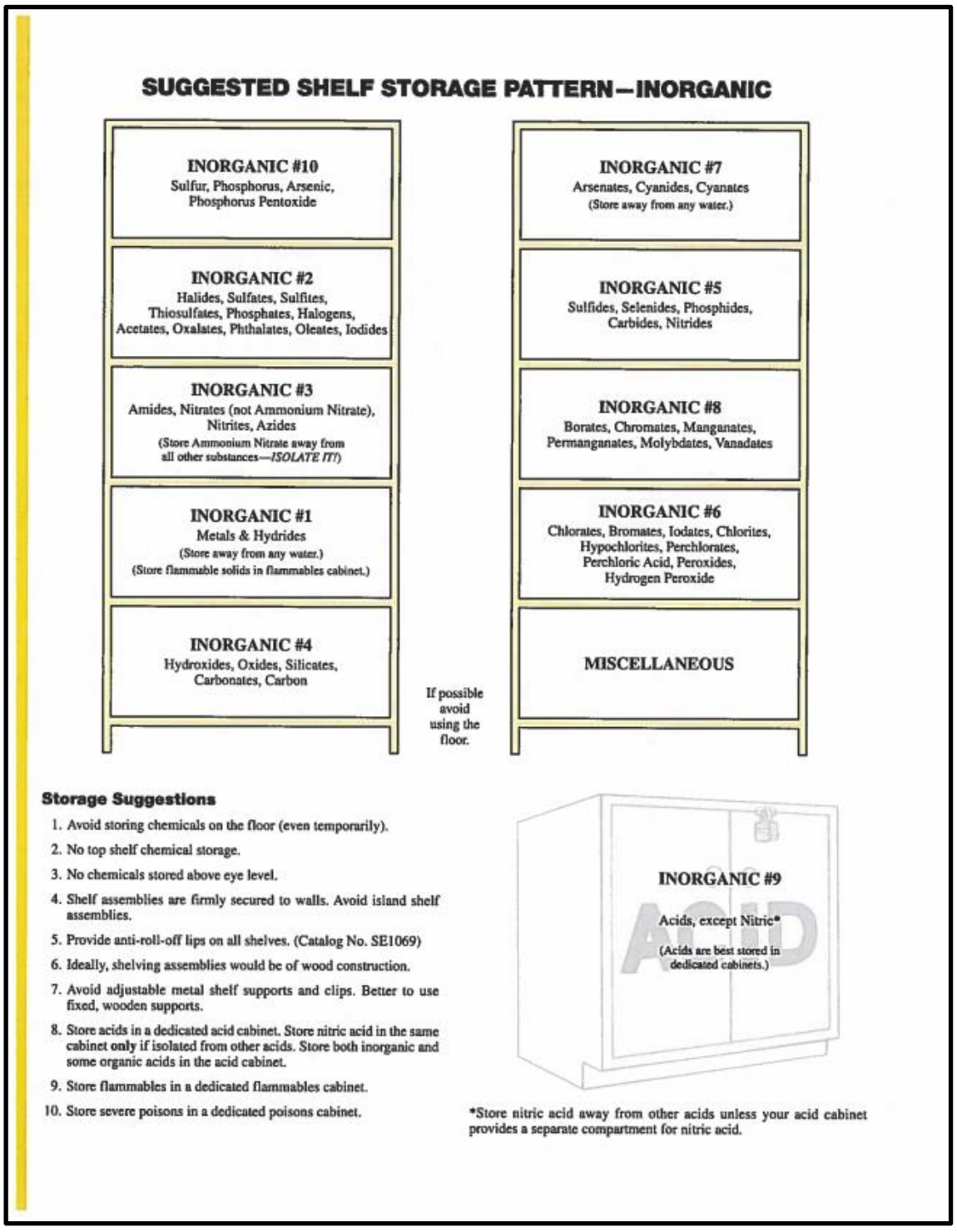
| RATING NUMBER | HEALTH HAZARD | FLAMMABILITY HAZARD | INSTABILITY HAZARD |
|---|---|---|---|
| 4 | Can be lethal | Will vaporize and readily burn at normal temperatures | May explode at normal temperatures and pressures |
| 3 | Can cause serious or permanent injury | Can be ignited under almost all ambient temperatures | May explode at high temperature or shock |
| 2 | Can cause temporary incapacitation or residual injury | Must be heated or high ambient temperature to burn | Violent chemical change at high temperatures or pressures |
| 1 | Can cause significant irritation | Must be preheated before ignition can occur | Normally stable. High temperatures make unstable |
| 0 | No hazard | Will not burn | Stable |

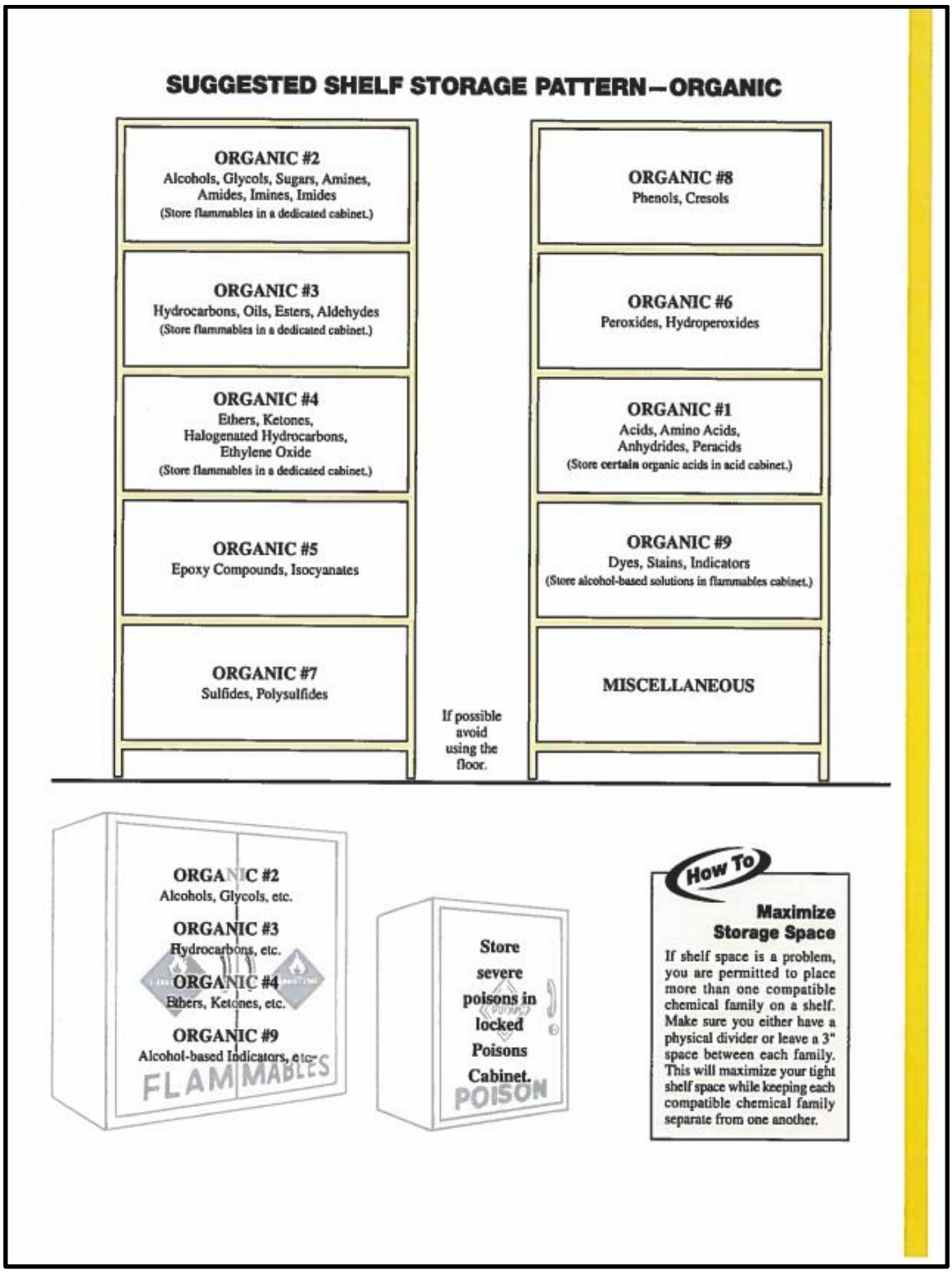
| RATING SYMBOL | SPECIAL HAZARD |
|---|---|
| ALK | Alkaline |
| ACID | Acidic |
| COR | Corrosive |
| OX | Oxidizing |
| ☢ | Radioactive |
| W | Reacts violently or explosively with water |
| W OX | Reacts violently or explosively with water and oxidizing |

*This chart for reference only - For complete specifications consult the NFPA 704 Standard*

# Appendix H- FLINN Recommended Storage for Chemicals

Shelf Storage Pattern




SUGGESTED SHELF STORAGE PATTERN—ORGANIC
ORGANIC #2
Alcohols, Glycols, Sugars, Amines, Amides, Imines, Imides
(Store flammables in a dedicated cabinet.)
ORGANIC #3
Hydrocarbons, Oils, Esters, Aldehydes
(Store flammables in a dedicated cabinet.)
ORGANIC #4
Ethers, Ketones, Halogenated Hydrocarbons, Ethylene Oxide
(Store flammables in a dedicated cabinet.)
ORGANIC #5
Epoxy Compounds, Isocyanates
ORGANIC #7
Sulfides, Polysulfides
ORGANIC #8
Phenols, Cresols
ORGANIC #6
Peroxides, Hydroperoxides
ORGANIC #1
Acids, Amino Acids, Anhydrides, Peracids
(Store certain organic acids in acid cabinet.)
ORGANIC #9
Dyes, Stains, Indicators
(Store alcohol-based solutions in flammables cabinet.)
MISCELLANEOUS
If possible avoid using the floor.
ORGANIC #2
Alcohols, Glycols, etc.
ORGANIC #3
Hydrocarbons, etc.
ORGANIC #4
Ethers, Ketones, etc.
ORGANIC #9
Alcohol-based Indicators, etc.
FLAMMABLES
Store severe poisons in locked Poisons Cabinet.
POISON
How To
Maximize Storage Space
If shelf space is a problem, you are permitted to place more than one compatible chemical family on a shelf. Make sure you either have a physical divider or leave a 3" space between each family. This will maximize your tight shelf space while keeping each compatible chemical family separate from one another.

# Appendix I- Glove Types Appropriate for Science Laboratory Activities

| Glove material | Intended use | Advantages and disadvantages | Example Photos |
|---|---|---|---|
| Latex (natural rubber) | Incidental contact | • Good for biological and water-based materials.<br>• Poor for organic solvents.<br>• Little chemical protection.<br>• Hard to detect puncture holes.<br>• Can cause or trigger latex allergies |  |
| Nitrile | Incidental contact (disposable exam glove)<br><br>Extended contact (thicker reusable glove) | • Excellent general use glove. Good for solvents, oils, greases, and some acids and bases.<br>• Clear indication of tears and breaks.<br>• Good alternative for those with latex allergies. |  |
| Butyl rubber | Extended contact | • Good for ketones and esters.<br>• Poor for gasoline and aliphatic, aromatic, and halogenated hydrocarbons. |  |
| Neoprene | Extended contact | • Good for acids, bases, alcohols, fuels, peroxides, hydrocarbons, and phenols.<br>• Poor for halogenated and aromatic hydrocarbons.<br>• Good for most hazardous chemicals. |  |

| | | | |
|---|---|---|---|
| **Norfoil** | **Extended contact** | • **Good for most hazardous chemicals.**<br>• **Poor fit (Note: Dexterity can be partially regained by using a heavier weight Nitrile glove over the Norfoil/Silver Shield glove.** |  |
| **Viton** | **Extended contact** | • **Good for chlorinated and aromatic solvents.**<br>• **Good resistance to cuts and abrasions.**<br>• **Poor for ketones.**<br>• **Expensive.** |  |
| **Polyvinyl chloride (PVC)** | **Specific use** | • **Good for acids, bases, oils, fats, peroxides, and amines.**<br>• **Good resistance to abrasions.**<br>• **Poor for most organic solvents.** |  |
| **Polyvinyl alcohol (PVA)** | **Specific use** | • **Good for aromatic and chlorinated solvents.**<br>• **Poor for water-based solutions.** |  |
| **Stainless steel**<br><br>**Kevlar**<br><br>**Leather** | **Specific use** | • **Cut-resistant gloves.**<br>• **Sleeves are also available to provide protection to wrists and forearms.**<br>• **(If potential for biological or chemical contamination: wear appropriate disposable gloves on top of your cut-resistant gloves and discard after use).** |  |
| **Cryogenic Resistant Material**<br><br>**Leather** | **Specific use** | • **For use with cryogenic materials.**<br>• **Designed to prevent frostbite. Note: Never dip gloves directly into liquid nitrogen.** |  |