Chemical Safety in High School Laboratory

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Presentation Order

- Introduction
- The Importance of Lab Safety in Schools
- Who is Responsible for Lab Safety in Schools?
- Teacher’s / Instructor’s Viewpoint
- Student’s Viewpoint
- School’s Viewpoint
- What Are the Teacher’s Responsibilities?
- Teachers’ Safety Checklists
- About the Safety Guide and upcoming CD-ROM
Introduction

• Educational institutions have been slower to adopt such safety practices and programs.

• A science program has certain potential dangers. With careful planning, most dangers can be avoided in an activity-oriented science program.
The Importance of Safety

- Safety and health are as important as any other materials taught in high school science curricula.

- New laboratory activities increase the risk incidents, injury, and damage is high.

- Students must be taught what can go wrong, how to prevent such events from occurring, and what to do in case of an emergency.
Who is Responsible for Safety in Schools?

- It is the principal, teacher, and student—each assuming his/her share.

- Safety and health should be an integral part of the planning, preparation, and implementation of any science program.
Teacher’s / Instructor’s Viewpoint

Teachers must instruct their students in the:

- Basic safety practices in science laboratories.

- Basic principles of health hazards found school science laboratories.

- Must provide safety information and training for every stage of experiment planning and be there to observe, supervise, instruct, and correct during the experimentation.

Teachers insure a safe and healthful learning environment for the students.

Student safety training must be done before they start working with chemicals in science laboratories.
Student’s Viewpoint

- They develop attitudes towards safety and acquire habits of assessing hazards and risks when they are young.

- They come from diverse backgrounds and have various levels of preparation.

- They have no previous hands-on-training in handling chemicals or equipment.

- The school science laboratory provides an opportunity to instill good safety attitudes and habits.
The students should learn that safe procedures are part of the way science must be done.

Student safety motivation in any area of education is a critical factor in the learning process.
School’s Viewpoint

- Support for laboratory safety programs is the responsibility of school system administrators.

- No Federal law requires safety and health programs to protect students in schools.

- All safety programs must actively involve the school administrators, supervisors, teachers, and students, and all have the responsibility for safety and health.
What Are the Teacher’s Responsibilities?

Teachers and teacher-aides should **lead by example**:

- Wear personal protective equipment
- Follow and enforce safety rules, procedures, and practices
- Demonstrate safety behavior and promote a culture of safety.
- Be proactive in every aspect of laboratory safety, making safety a priority.
SAFE LAB

School Chemistry Laboratory Safety Guide

NIOSH Publ. # 2007-107
CONTENTS

Teachers’ Safety Checklists

- Upkeep of Laboratory and Equipment (3-steps)
- Recordkeeping (2-steps)
- Safety and Emergency Procedures (8-steps)
- Maintenance of Chemicals (10-steps)
- Preparing for Laboratory Activities (5-steps)
- Ensuring Appropriate Laboratory Conduct (7-steps)
CONTENTS

What Are the Safety Do’s and Don’ts for Students?

- Conduct (5-step checklist)
- General Work Procedure (16-step checklist)
- Housekeeping (9-step checklist)
- Apparel in the Laboratory (8-step checklist)
- Hygiene Practices (6-step checklist)
- Emergency Procedure (4-step checklist)
- Chemical Handling (19-step checklist)
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What Is a Chemical Hygiene Plan?

- Chemical Hygiene Plan Required Elements
- Other Suggested Elements of a Chemical Hygiene Plan

What Is a Material Safety Data Sheet?
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- What Should Be Considered When Purchasing Chemicals *(16-step checklist)*

- What Is a Chemical Tracking System and How Should It Be Set Up?
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How Should Chemical Containers Be Labeled?

- Labeling Basics
- Commercially Packaged Chemicals
- Secondary Containers and Prepared Solutions
- Containers in Immediate Use
- Chemical Waste
- Peroxide-Forming Substance
CONTENTS
How Should Chemicals Be Stored?

- General Rules for Chemical Storage
  - Criteria for Storage Area
  - Organization
  - Chemical Segregation (5-step checklist)
  - Storage Don’ts (8-step checklist)
  - Proper Use of Chemical Storage Containers
Suggested Shelf Storage Pattern

A suggested arrangement of compatible chemical families on shelves in a chemical storage room, suggested by the *Flinn Chemical Catalog/Reference Manual*, is depicted on the following page. However, the list of chemicals below does not mean that these chemicals should be used in a high school laboratory.

- First sort chemicals into organic and inorganic classes.
- Next, separate into the following compatible families.

<table>
<thead>
<tr>
<th>Inorganics</th>
<th>Organics</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Metals, Hydrides</td>
<td>1. Acids, Anhydrides, Peracids</td>
</tr>
<tr>
<td>3. Amides, Azides, Nitrates (except Ammonium nitrate), Nitrites, Nitric acid</td>
<td>3. Aldehydes, Esters, Hydrocarbons</td>
</tr>
<tr>
<td>5. Carbides, Nitrides, Phosphides, Selenides, Sulfides</td>
<td>5. Epoxy compounds, Isocyanates</td>
</tr>
</tbody>
</table>
# Suggested Shelf Storage Pattern for Inorganics

<table>
<thead>
<tr>
<th>Inorganic #10</th>
<th>Inorganic #7</th>
</tr>
</thead>
<tbody>
<tr>
<td>Arsenic, Phosphorous, Phosphorous Pentoxide, Sulfur</td>
<td>Arsenates, Cyanates, Cyanides STORE AWAY FROM WATER</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Inorganic #2</th>
<th>Inorganic #5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Halides, Halogens, Phosphates, Sulfates, Sulfites, Thiosulfates</td>
<td>Carbides, Nitrides, Phosphides, Selenides, Sulfides</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Inorganic #3</th>
<th>Inorganic #8</th>
</tr>
</thead>
<tbody>
<tr>
<td>Amides, Azides, Nitrates, Nitrites EXCEPT Ammonium nitrate - STORE AMMONIUM NITRATE AWAY FROM ALL OTHER SUBSTANCES</td>
<td>Borates, Chromates, Manganates, Permanganates</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Inorganic #1</th>
<th>Inorganic #6</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hydrides, Metals STORE AWAY FROM WATER. STORE ANY FLAMMABLE SOLIDS IN DEDICATED CABINET</td>
<td>Chlorates, Chlorites, Hypochlorites, Hydrogen Peroxide, Perchlorates, Perchloric acid, Peroxides</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Inorganic #4</th>
<th>Miscellaneous</th>
</tr>
</thead>
<tbody>
<tr>
<td>Carbon, Carbonates, Hydroxides, Oxides, Silicates</td>
<td></td>
</tr>
</tbody>
</table>
# Suggested Shelf Storage Pattern for Organics

<table>
<thead>
<tr>
<th>Organic #2</th>
<th>Organic #3</th>
<th>Organic #4</th>
<th>Organic #5</th>
<th>Organic #6</th>
<th>Organic #7</th>
<th>Organic #8</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alcohols, Amides, Amines, Imides, Imines, Glycols</td>
<td>Aldehydes, esters, hydrocarbons</td>
<td>Ethers, Ethylene oxide, Halogenated Hydrocarbons, Ketenes, Ketones</td>
<td>Epoxy compounds, Isocyanates</td>
<td></td>
<td>Nitriles, Polysulfides, Sulfides, Sulfoxides, etc.</td>
<td>Cresols, Phenol</td>
</tr>
</tbody>
</table>

**STORE FLAMMABLES IN A DEDICATED CABINET**

<table>
<thead>
<tr>
<th>Organic #1</th>
<th>Organic #6</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acids, Anhydrides, Peracids</td>
<td>Azides, Hydroperoxides, Peroxides</td>
</tr>
</tbody>
</table>

**STORE CERTAIN ORGANIC ACIDS IN ACID CABINET**

**POISON STORAGE CABINET**
- Toxic substances

**FLAMMABLE STORAGE CABINET**
- **FLAMMABLE ORGANIC #2**
  - Alcohols, Glycols, etc.
- **FLAMMABLE ORGANIC #3**
  - Hydrocarbons, Esters, etc.
- **FLAMMABLE ORGANIC #4**

No storage on the floor.
CONTENTS

- How Should Compressed Gas Cylinders Be Stored, Maintained, and Handled? (20-step checklist)

- What Are Some Strategies to Reduce the Amount and/or Toxicity of Chemical Waste Generated in the Laboratory? (incl. possible safer substitutions)
What Is the Recommended Procedure for Chemical Disposal?

- Storing Chemical Waste
- Proper Disposal of Chemical Waste
  - Disposal Procedure
Provide explanatory and practical information for laboratory safety and health
Appendix A. Common Safety Symbols

![Flammable](image1)  ![Poison](image2)  
*Flammable*  *Poison*

![Explosive](image3)  ![Radioactive](image4)  
*Explosive*  *Radioactive*

![Corrosive](image5)  ![Compressed Gas](image6)  
*Corrosive*  *Compressed Gas*

The above safety symbols may be replaced by the following symbols that are internationally accepted:

![Flammable](image7)  ![Oxidizer](image8)  
*Flammable*  *Oxidizer*

![Explosive](image9)  ![Low Level Hazard](image10)  
*Explosive*  *Low Level Hazard*

![Corrosive](image11)  ![Severe Chronic Hazard](image12)  
*Corrosive*  *Severe Chronic Hazard*

![Poison](image13)  ![Environmental Hazard](image14)  
*Poison*  *Environmental Hazard*
Appendix B. National Fire Protection Association Hazard Labels

The National Fire Protection Association (NFPA) has developed a visual guide (right) for a number of chemicals pertinent to the MSDS. The ANSI/NFPA 704 Hazard Identification system, the NFPA diamond, is a quick visual review of the health hazard, flammability, reactivity, and special hazards a chemical may present.

The diamond is broken into four sections (blue, red, yellow, and white). The symbols and numbers in the four sections indicate the degree of hazard associated with a particular chemical or material.

### Health Hazard (Blue)

<table>
<thead>
<tr>
<th>Number</th>
<th>Symbol</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>4</td>
<td>Danger</td>
<td>May be fatal on short exposure. Specialized protective equipment required</td>
</tr>
<tr>
<td>3</td>
<td>Warning</td>
<td>Corrosive or toxic. Avoid skin contact or inhalation</td>
</tr>
<tr>
<td>2</td>
<td>Warning</td>
<td>May be harmful if inhaled or absorbed</td>
</tr>
<tr>
<td>1</td>
<td>Caution</td>
<td>May be irritating</td>
</tr>
<tr>
<td>0</td>
<td></td>
<td>No unusual hazard</td>
</tr>
</tbody>
</table>

### Flammability (Red)

<table>
<thead>
<tr>
<th>Number</th>
<th>Symbol</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>4</td>
<td>Danger</td>
<td>Flammable gas or extremely flammable liquid</td>
</tr>
<tr>
<td>3</td>
<td>Warning</td>
<td>Combustible liquid flash point below 100 °F</td>
</tr>
<tr>
<td>2</td>
<td>Caution</td>
<td>Combustible liquid flash point of 100 to 200 °F</td>
</tr>
<tr>
<td>1</td>
<td></td>
<td>Combustible if heated</td>
</tr>
<tr>
<td>0</td>
<td></td>
<td>Not combustible</td>
</tr>
</tbody>
</table>
## Appendix C. Substances with Greater Hazardous Nature Than Educational Utility (6-page list)

<table>
<thead>
<tr>
<th>Chemical</th>
<th>CAS Number</th>
<th>Hazard</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acrylonitrile</td>
<td>107–13–1</td>
<td>Flammable (NFPA = 3), reasonably anticipated human carcinogen</td>
</tr>
<tr>
<td>Ammonium chromate</td>
<td>7788–98–9</td>
<td>Oxidizer, known human carcinogen</td>
</tr>
<tr>
<td>Aniline</td>
<td>62–53–3</td>
<td>Combustible, may be fatal if inhaled, ingested, or absorbed through the skin</td>
</tr>
<tr>
<td>Aniline hydrochloride</td>
<td>142–04–1</td>
<td>May be fatal if inhaled, ingested, or absorbed through the skin</td>
</tr>
<tr>
<td>Anthracene</td>
<td>102–12–7</td>
<td>Irritant, may cause an allergic skin reaction</td>
</tr>
</tbody>
</table>
## Appendix D. Substances with a Hazardous Nature, but May Have Potential Educational Utility (4-page list)

<table>
<thead>
<tr>
<th>Chemical</th>
<th>CAS Number</th>
<th>Hazard</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acetamide</td>
<td>60–35–5</td>
<td>Combustible solid</td>
</tr>
<tr>
<td>Aluminum chloride</td>
<td>7446–70–0</td>
<td>Water reactive, corrosive</td>
</tr>
<tr>
<td>Ammonium bichromate</td>
<td>7789–09–5</td>
<td>Oxidizer, corrosive, known human carcinogen</td>
</tr>
<tr>
<td>Ammonium oxalate</td>
<td>1113–38–8</td>
<td>May be fatal if inhaled or ingested</td>
</tr>
<tr>
<td>Ammonium vanadate</td>
<td>7803–55–6</td>
<td>May be fatal if inhaled or ingested</td>
</tr>
<tr>
<td>Antimony</td>
<td>7440–36–0</td>
<td>May be fatal if inhaled, irritant</td>
</tr>
</tbody>
</table>
## Appendix E. Incompatible Chemicals

(3-page list)

<table>
<thead>
<tr>
<th>Chemical</th>
<th>Incompatible with</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acetic acid</td>
<td>Chromic acid, Nitric acid, Peroxides, Permanganates</td>
</tr>
<tr>
<td>Acetic anhydride</td>
<td>Hydroxyl group containing compounds, Ethylene glycol, Perchloric acid</td>
</tr>
<tr>
<td>Acetone</td>
<td>Concentrated Nitric and Sulfuric acid mixtures, Hydrogen peroxide</td>
</tr>
<tr>
<td>Acetylene</td>
<td>Bromine, Chlorine, Copper, Fluorine, Mercury, Silver</td>
</tr>
<tr>
<td>Ammonium nitrate</td>
<td>Acids, Chlorates, Flammable liquids, Nitrates, powdered metals, Sulphur, finely divided organic or combustible materials</td>
</tr>
<tr>
<td>Aniline</td>
<td>Hydrogen peroxide, Nitric acid</td>
</tr>
</tbody>
</table>
Appendix F. Recommended Safety and Emergency Equipment for the Laboratory

- Personal Protective Equipment (5-step checklist)

- Safety and Emergency Equipment (18-step checklist)
Appendix G. How Does a Chemical Enter the Body?

- Dermal Exposure
- Inhalation
- Ingestion
Appendix H. What Are Exposure Limits?

- Exposure Limits
  - *Legally Enforceable Limits*
    - Permissible Exposure Limits (PELs)
  - *Other U.S. Exposure Limits*
    - Threshold Limit Values (TLVs)
    - Recommended Exposure Limits (RELs)
    - Workplace Environmental Exposure Limits (WEELs)
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- Acid/Base Spill
- Mercury Spill
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Appendix K. Sample MSDS (for toluene)

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- Federal Government
- Other

Appendix M. Glossary

Pull-Out/Tear-Out Sheets

- Safety Do’s and Don’ts for Students
- How Should Chemicals Be Stored?
Chemical Safety CD-ROM Version
Under Development
(need reviewers)
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- American Federation of Teachers/AFL-CIO,
- Cincinnati Federation of Teachers
- National Science Teachers Association
- U.S. Environmental Protection Agency,
- Federal OSHA Directorate of Standards and Guidance, Federal OSHA, Region VII.
Availability of School Chemistry Laboratory Safety Guide

- NIOSH Web site
  (run out of printed copies)

- Upcoming CD-ROM copies will be available for free from NIOSH
  By Tel.: 1(800) 356-4674
  Order By FAX: (513) 533-8573

John’s Telephone: (513) 533-8136
John’s E-mail: jpalassis@cdc.gov
Thank You


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<td>12</td>
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