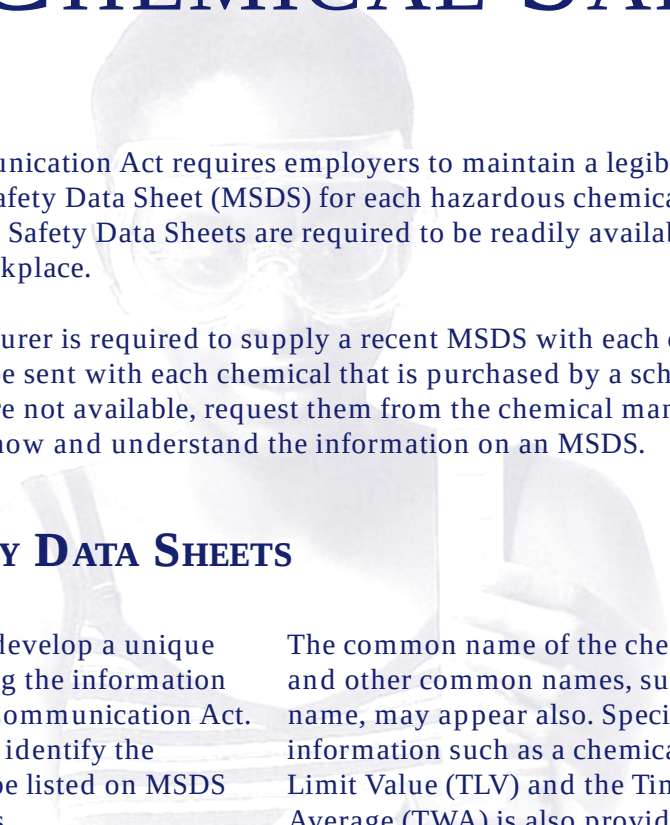


CHEMICAL SAFETY



The Hazard Communication Act requires employers to maintain a legible copy of a current Material Safety Data Sheet (MSDS) for each hazardous chemical they purchase. Material Safety Data Sheets are required to be readily available, on request, to employees at each workplace.

Every chemical manufacturer is required to supply a recent MSDS with each chemical it produces. These should be sent with each chemical that is purchased by a school or school district. If MSDS forms are not available, request them from the chemical manufacturer. Every teacher needs to know and understand the information on an MSDS.

MATERIAL SAFETY DATA SHEETS

Each manufacturer may develop a unique format and style for listing the information required by the Hazard Communication Act. The areas outlined below identify the information that should be listed on MSDS forms for science teachers.

PRODUCT IDENTIFICATION

This section provides the name, address, and telephone number of the manufacturer in case additional information about a chemical is needed. This section also lists an emergency phone number where the manufacturer can be reached in case of an emergency.

HAZARDOUS CHEMICALS

Information about the hazardous chemical is listed in this section. It is important that the user know the exact ingredients of the substance, whether it is an element or a compound, whether the substance is pure, and what percentage of the substance is hazardous. Pure substances will have a Chemical Abstract Service (CAS) number that identifies the substance. The American Chemical Society assigns a different CAS number to each compound and element.

The common name of the chemical is given and other common names, such as a trade name, may appear also. Specific hazardous information such as a chemical's Threshold Limit Value (TLV) and the Time Weighted Average (TWA) is also provided.

The TWA indicates how much a person can be exposed safely to a given chemical, assuming that the person works an eight-hour day, five days a week. The more toxic the compound, the lower the exposure limit.

PHYSICAL DATA

This section provides information about the physical characteristics of a hazardous substance, including the boiling point and specific gravity.

The section may also provide the vapor pressure and vapor density if the chemical is a liquid. When the vapor pressure and vapor density are high and the substance is combustible, a flammability hazard will be indicated. Other physical properties that may be listed in this section include the substance's evaporation rate, solubility in water, its appearance, color, and odor. Some compounds have distinctive odors, such as ammonia or hydrogen sulfide.

FIRE AND EXPLOSION HAZARDS

This section provides information about the flash point of the chemical. The flash point is the minimum temperature at which there are sufficient vapors present to support combustion. Liquids with flash points below 20°C are very hazardous and flammable. Liquids that have low flash points and wide flammability limits are very dangerous.

Many liquids react so rapidly that an explosion occurs along the burning process. Most of these liquids, including gasoline, diethyl ether, and carbon disulfide, will rate “4” (i.e., most flammable) on the National Fire Protection Standards scale.

This section may also provide information about the type of fire extinguisher to use when a particular substance is burning, as well as information about precautions to follow when handling these dangerous materials. Flammables have specific storage requirements and transportation precautions.

HEALTH HAZARDS

This section discusses the several ways a chemical can create health problems. Generally, the first concern a person will have about a hazardous substance is whether it is poisonous. Therefore, it is important to know what concentrations of a given chemical will cause injury to a person.

Almost every chemical will be toxic to humans at some concentration level. In a medical sense, a lethal dose (LD) indicates the percentage of people who have died when exposed to that concentration level of the chemical. For example, LD₅₀ means that 50% of the population receiving that concentration level will likely die.

A second health concern is the corrosiveness of a chemical when it comes into contact with skin. Strong alkaline substances, such as calcium oxide, potassium hydroxide, and sodium phosphate, can cause chemical

burns. Some corrosive chemicals can cause rapid dehydration of the body tissues, such as glacial acetic acid and anhydrous aluminum chloride. Others, such as hydrofluoric acid, cause rapid decomposition of skin, bones, and other body tissues.

A third health hazard that may be listed in this section are carcinogens—i.e., chemicals that cause cancer. Some known carcinogens include organic compounds such as benzene and carbon tetrachloride. Chemicals suspected of being carcinogens include formaldehyde and polychlorinated biphenyls.

FIRE AND EXPLOSION DATA

This section indicates the stability of the substance. High reactivity is commonly associated with unstable compounds. Many highly reactive compounds are explosives, such as picric acid and ammonium perchlorate. Strong oxidants are color-coded yellow.

Compounds that are highly reactive with water will appear in this section, even though they occupy a different quadrant on the National Fire Prevention Standard diamond. Compounds such as sodium hydride react with water to release hydrogen gas. An important feature of this section is the listing of the incompatibility of certain chemicals with other chemicals. This information assists with the storage of chemicals in compatible families.

SPILL AND DISPOSAL PROCEDURES

This section provides valuable information that is difficult to find in other resources—how to handle a chemical spill and how to dispose of chemicals properly. Many MSDS forms will list the Environmental Protection Agency’s hazardous waste number for disposal purposes. Or they may simply state that the chemical must be disposed of in accordance with local, state, and federal environmental regulations.

PROTECTIVE EQUIPMENT

This section lists personal protective equipment that must be used or worn by the teacher and students using the chemical in an experiment.

STORAGE AND HANDLING PROCEDURES

This section provides the user with information about the proper storage and handling of a particular chemical. For example, statements such as “Storage Code: RED—flammable substance; store in cool, well-ventilated areas,” will be found in this section or combined with other sections of the MSDS.

TRANSPORTATION DATA

This is optional information on MSDS forms that lists the Department of Transportation (DOT) class required if the material is to be shipped.

CHEMICAL LABELING

There are no regulations on what a chemical label must look like. However, the Hazard Communication Act does require that all manufacturer’s labels must include

- ☼ the name of the chemical;
- ☼ physical and health hazards associated with the chemical, including the organs it would affect; and
- ☼ the manufacturer’s name and address.

The sample label of Ethyl Ether included in this chapter lists the information required in

ETHYL ETHER		GENERIC CHEMICALS
$C_2H_5OC_2H_5$		1717 Toxic Row
Education Grade		Ether, USA 10059
1000mL  CAS 60-29-7	HIGHLY VOLATILE EXTREMELY FLAMMABLE MAY FORM EXPLOSIVE PEROXIDES HARMFUL IF SWALLOWED OR INHALED MAY CAUSE INJURY TO EYES EFFECTS MAY BE DELAYED STORE AT 77°F (SAMPLE LABEL)	

addition to the NFTA Hazard Code, the chemical formula, and the CAS number. Other items that may be identified on the chemical label include the

- ☼ CAS number that was assigned by the Chemical Abstract Service;
- ☼ chemical formula;
- ☼ molecular weight (for compounds) or atomic weight (for elements);
- ☼ common name of the chemical;
- ☼ purity of the substance;
- ☼ lot number; and
- ☼ supplier’s name and address.

If the chemical is removed and placed in a new container, or if the original label is destroyed, the label of the new container must include

- ☼ the chemical name and its formula, and
- ☼ the physical and health hazards associated with the chemical.

CHEMICAL STORAGE

Safe chemical storage is based on the chemical properties and hazards of the substances that are to be stored. To store chemicals properly, follow these guidelines.

1. Label the container with the name of the chemical, the hazards associated with the chemical, and the manufacturer’s name and address.
2. Store chemicals in compatible families.
3. Locate the chemical storage room in such a way as to minimize injuries to people and damage to the building if an explosion or fire should occur.
4. Ensure that the storage room has two exits and doors that lock.
5. Label the storage room doors “Authorized Personnel Only” or “Hazardous Materials.”

6. Provide the storage room with continuous forced-air ventilation that is vented to the outside and away from air intakes.
7. Ensure that storage cabinets and shelves are resistant to corrosion.
8. Store chemicals in an upright position and no more than two containers deep.
9. Equip shelves with a lip to prevent chemicals from being jarred off the shelf.
10. Store corrosives (acids and bases) in an approved corrosives cabinet.
11. Store flammables in a flammable-approved cabinet.
12. Do not store chemicals above eye-level or on the floor.
13. Store water-reactive chemicals (metals) where they will remain dry.
14. Label safety equipment clearly inside the storeroom.
 - ☞ ABC fire extinguisher
 - ☞ Safety goggles
 - ☞ Fire blanket
 - ☞ Spill kit
 - ☞ First-aid kit
15. Provide the room with adequate lighting.
16. Install smoke detectors.
17. Maintain a chemical inventory.

CHEMICAL DISPOSAL

There are two important steps to take before proceeding with chemical disposal. First, determine how many chemicals are designated for disposal.

Second, remove

- ☞ out-of-date or contaminated chemicals;
- ☞ chemicals without legible labels; and
- ☞ chemicals that are too hazardous for student use.

OPTIONS FOR CHEMICAL DISPOSAL

Contact commercial chemical disposal companies in your area. Many waste disposal companies recycle chemicals and resell them. Other options may be available by contacting

- ☞ other schools in your area, possibly to combine quantities for disposal;
- ☞ industries in the area for assistance with disposal; or
- ☞ institutions of higher education, which might allow you to use their system of disposal.

Chemical disposal companies can properly dispose of chemicals by using one or more of the following methods.

1. Incineration
2. Detonation
3. Open burning
4. Neutralization of acids and bases (final pH range of 5–9)
5. Carbon absorption
6. Oxidation/reduction
7. Precipitation and clarification
8. Biological treatment
9. Land disposal

Do not flush chemicals down sinks. This may adversely affect the water treatment plants in your area by destroying microorganisms essential to the process of water purification.

Texas Education Agency, Science Laboratory Safety and Chemical Waste Disposal for Texas Science Teachers, 1985

MICROSCALE CHEMISTRY

Discussing microscale science techniques may appear out of place in a laboratory safety manual. To the contrary, however, microscale techniques offer a pedagogically sound approach to science laboratory investigations and provide simple solutions to many safety issues.

The primary construct put forth by advocates of microscale chemistry is to instill in educators and students the idea, “If you don’t need that much, then don’t use it.” The purpose is to move away from a “throwaway” mentality. One aspect of microscale chemistry is that it reduces the amount of materials being wasted.

Educators and administrators find microscale chemistry appealing because hazardous waste management is a problem confronting all education institutions. Schools are finding it increasingly difficult to fund the disposal of hazardous waste while attempting to maintain a safe hands-on chemical learning environment. Microscale experiments make it possible to promote critical thinking skills while addressing major safety issues. The advantages of incorporating microscale / small-scale chemistry into the learning environment include

- ✿ a reduction in the cost of chemicals;
- ✿ a reduction of possible fire and explosion danger;
- ✿ a reduction of chemical waste disposal costs;
- ✿ the introduction of experiments in which chemicals once thought to be too expensive or hazardous can be made available with the reduced amounts;
- ✿ the recycling of products for future experiments (plan ahead and use it again);
- ✿ the introduction of smaller, less expensive glassware; and
- ✿ reduced exposure to toxic materials.

SAFETY ADVANTAGES

Using microscale chemistry techniques means that

- ✿ spills are reduced because liquids are dispensed from plastic dropper bottles;
- ✿ accidental glass container breakage is eliminated;
- ✿ air quality is improved because smaller amounts of vapor escape; and
- ✿ fire hazards are virtually eliminated.

Although some of the liquid is lost due to vaporization during both processes, the microscale technique reduces the amount of hazardous organic chemicals that must be recovered and disposed of properly. In addition, this technique represents a responsible step in reducing environmental pollutants.

In the science storeroom, keeping chemicals in smaller containers (approximately 10% of the size used in macroscale) reduces the need for storage space. Packaging and handling represent the greatest costs in purchasing chemicals.

Consider health and fire hazards, storage cost, and disposal cost when buying more chemicals than are needed simply because the cost per milliliter or gram appears to be less in larger quantities.

Byron E. Howell, *Microscale Chemistry Center*, 1999

CHEMICAL SPILLS

If a chemical spill should occur in the laboratory, preparatory room, or classroom, the teacher should take the following actions as quickly as possible to reduce the possibility of injury to a student.

- ✿ Immediately evacuate all students through the exits farthest from the spill. Fumes from a chemical spill can cause severe damage to the body.

- ☼ Immediately help any person to the safety shower who has been splashed with the chemical.
- ☼ Turn on the emergency exhaust fan.
- ☼ Contain the spill, wearing proper protective clothing. Do not allow the spill to trap you.
- ☼ Call for help. The school safety plan include information about agencies or departments in your community that will assist with containment and removal of the chemical.

SPILL CONTROL MATERIALS

There are many types of commercial materials that have been developed for the containment and removal of chemical spills. These range from absorbent pads that quickly absorb chemicals in a liquid state, to porous bags filled with an inert amorphous silicate that absorbs the chemical, to materials that neutralize an acid or a caustic spill.

Spill control materials typically found in public schools include a plastic five-gallon bucket filled with dry sand, vermiculite, or dry clay materials. These do nothing to neutralize a chemical, but they absorb the liquid or contain it in a smaller area. The disadvantage of using sand is that it is heavy and difficult to transport.

Once the chemical has been contained and neutralized, use clean-up equipment made of plastic or polypropylene so that the equipment doesn't react with any of the chemical that remains. Place the contaminated material in plastic bags or containers and mark them appropriately. Inform the custodial staff of the material so that they can dispose of it properly.