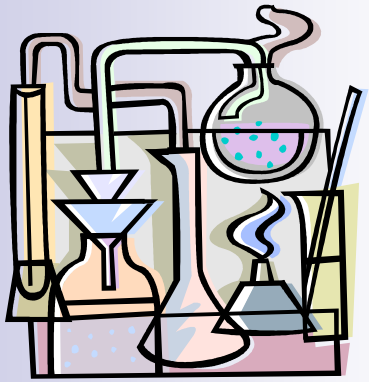
Chemical Laboratory Safety



Orientation

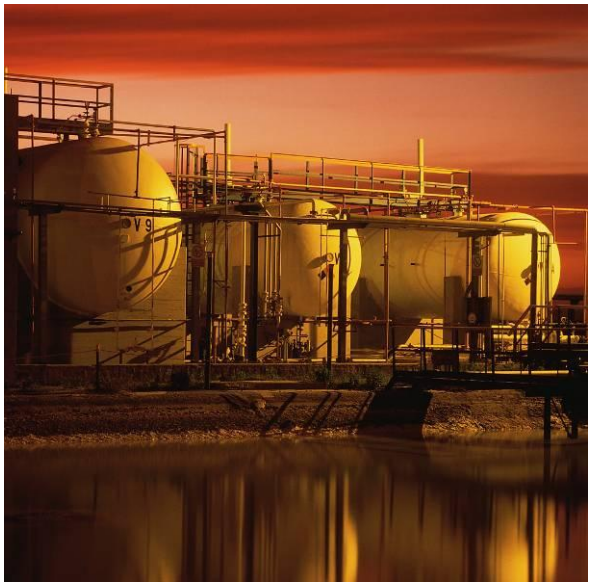
Fundamentals of

Chemical Laboratory Safety

Chemical Safety Video (21mins)
Chem. Safety Video1 (7mins)
Chem. Safety Video2 (7mins)
Chem. Safety Video3 (7mins)
Chem. Safety Video4 (4mins)

Why worry about chemical safety?

- **Chemicals used everyday in laboratories can be hazardous.**

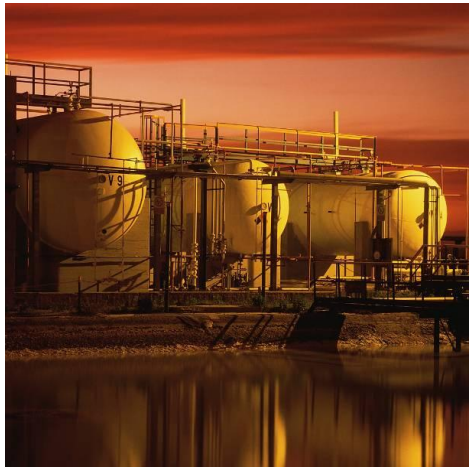


Why worry about chemical safety?

- **Accident prevention is a collective responsibility that requires the full cooperation of everyone in the lab.**

Why worry about chemical safety?

- **Doing things safely is not merely the right way to work --- it is the ONLY way.**



University lab chemical accidents

Incident – Chemical

- **Fire and one death –** t-butyl lithium + pentane
- **Dartmouth, wrong gloves –** methyl mercury
- **Wroclaw Poland, explosion –** dry perchlorates
- **Australia, skin absorption –** hydrofluoric acid
- **Okazaki Japan, explosion –** peroxide by-products in synthesis
- **OSU, US cylinder explosion –** liquid nitrogen cylinder
- **Material science engineering lab explosion –** nitric acid + ethanol explosion

Laboratory Protocol

- Conduct in the Laboratory
  - Do not engage in any unauthorized activity (e.g. practical jokes, unapproved experiments, running around) in the laboratory.
  - The use of personal audio or video equipment is prohibited in the laboratory.
  - Do not sit on laboratory working areas or the sinks.
  - Know emergency procedures.

Personal Protection

- Always wear appropriate personal protective equipment.
  - Chemical splash goggles
  - Chemical resistant apron
  - Shoes that adequately cover the whole feet
  - Disposable gloves
  - Face mask (NOT surgical mask)

Laboratory Protocol

- General Work Procedure
  - Never work in the laboratory alone or unsupervised.
  - Be careful when handling hot glassware and apparatus in the laboratory. Hot glassware looks just like cold glassware.
  - Never pipette by mouth. Always use a pipette aid or suction bulb.
  - Never remove chemicals from the laboratory without proper authorization.
  - Immediately report any spills, accidents or injuries to your teacher.

Laboratory Protocol

- General Work Procedure
  - Make sure no flammable solvents are in the surrounding area when igniting a flame.
  - Turn off all heating apparatus, gas valves, burners and water faucets when not in use.
  - Coats, bags and other personal items must be placed in designated areas, not on the top of the working areas or the aisle ways.

Laboratory Protocol

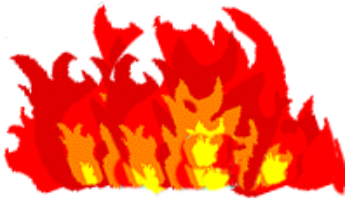
- Housekeeping
  - Never place materials, especially chemicals, on the floor, even temporarily.
  - Keep workspaces and storage areas clear of broken glassware, leftover chemicals, and unnecessary materials.
  - Never block access to exits or emergency equipment.
  - Inspect all equipment for damage (cracks, defects, etc.) prior to use.

Laboratory Protocol

- Hygiene practices
  - Keep your hands away from your face, eyes, mouth and body while using chemicals.
  - Food and drinks are not allowed inside the laboratory.
  - Wash hands after removing gloves and before leaving the laboratory.

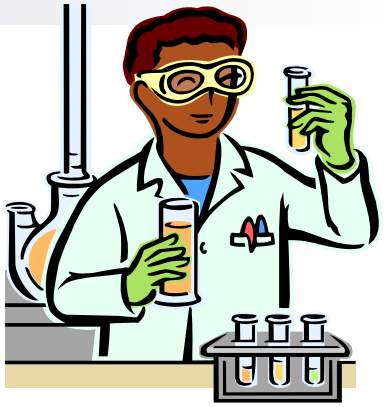
Laboratory Protocol

- Emergency Procedure
  - Know the location of all the exits and follow the emergency plan as explained by the teacher.



  - Know the location of and know how to operate the following:
    - Fire extinguishers, Fire blankets
    - Alarm systems with pull stations
    - Eye washes, deluge safety showers
    - First aid kits

Laboratory Protocol



- Chemical Handling
  - Check the label to verify if it is the correct substance before using it.
  - Always use a spatula to remove a solid reagent from a container.
  - Hold containers away from the body when transferring a chemical or solution from one container to another.
  - Weigh out only the amount of chemical that you need. Never return the excess to its original container.

Laboratory Protocol

- Waste Disposal
  - Never pour chemical waste into the sink drains.
  - Place chemicals waste in appropriately labeled waste containers.
  - Properly dispose of broken glassware and other sharp objects (e.g., syringe needles) immediately in designated containers.
  - Paper products that do not contain chemicals can be placed in the waste baskets.

Types of lab hazards:

chemical toxicity

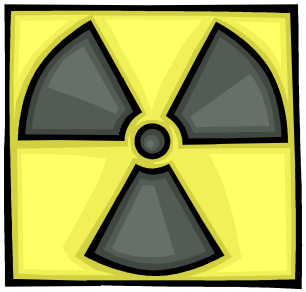
fire / explosion

physical hazards

biohazards

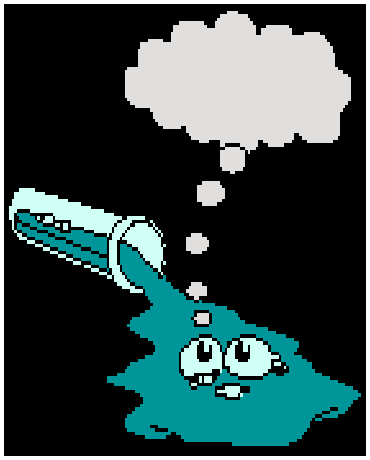
radiation

special substances



Guide to Chemical Hazards

- **Chemical Laboratory Hazards**
- **Chemical hazards**
  - – dusts, fumes, mists, vapors, gases
- **Physical hazards**
  - – fire, electrical, radiation, pressure vibration, temperatures, noise
- **Ergonomic hazards**
  - – repetitive motion (pipetting), lifting, work areas (computers, instruments)
- **Biological hazards**
  - – pathogens, blood or body fluids



Basic Concepts on Toxicity

- All chemicals have the capacity to be toxic
- All chemicals act in the body according to the principles of chemistry, physics and biology
- Natural chemicals are not inherently harmless
- Synthetic chemicals are not inherently hazardous

Chemical Toxicity

Acute (short term, poisons, asthmagens)

cyanide

Strychnine

Chronic (long term, carcinogens, reproductive)

vinyl chloride (liver cancer)

asbestos (mesotheloma, lung cancer)

thalidomide (developmental birth defects)

Chemical Toxicity

- **Toxicity depends on**
  - **concentration (dose)**
  - **frequency**
  - **duration**
  - **route of exposure**

"Dose makes the poison.

All substances have the potential to harm."

Paracelsus ~1500 AD

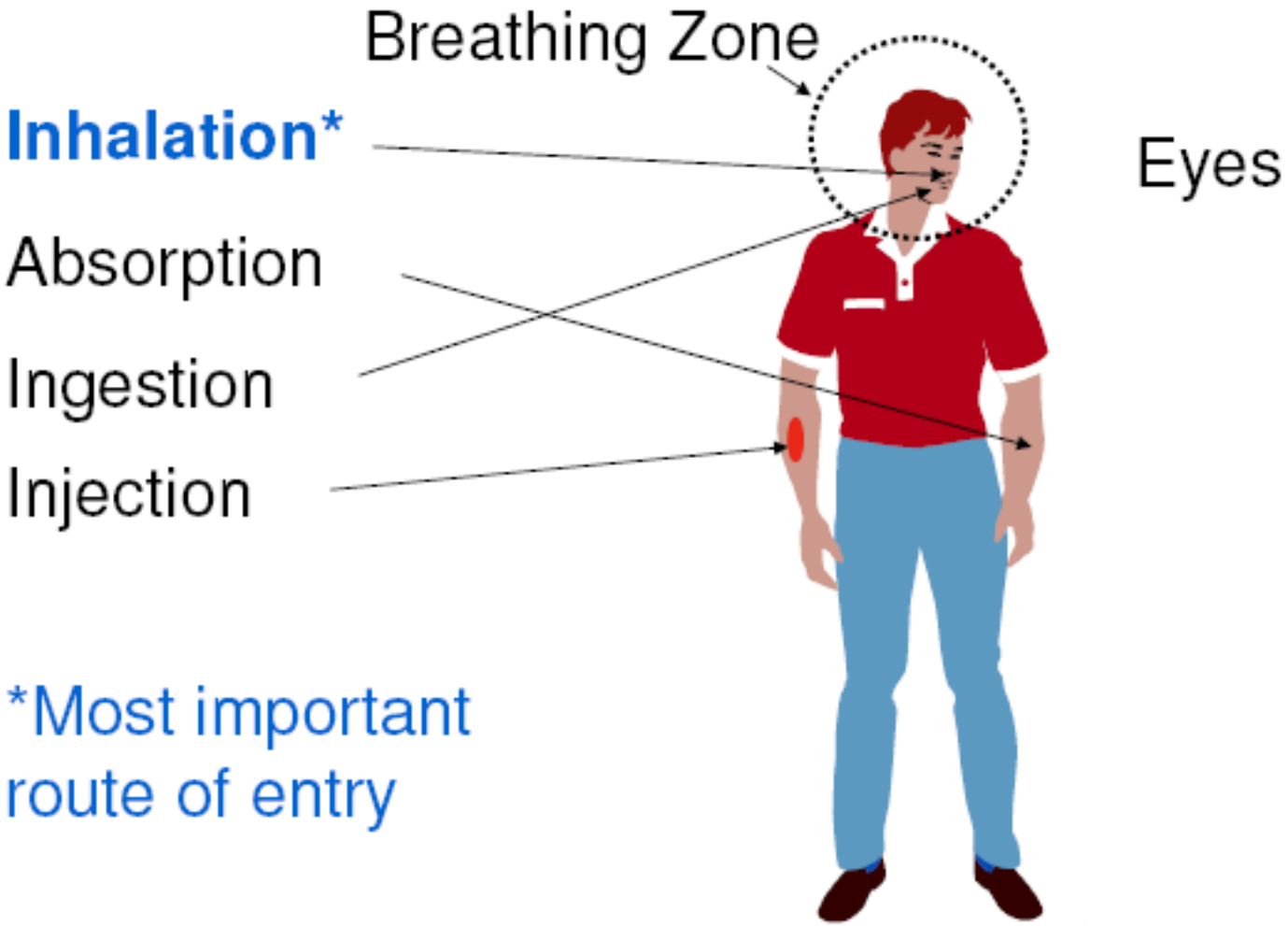
300 mg aspirin = safe

3000 mg aspirin = toxic

Chemical Toxicity

- **Particularly Hazardous Substances**
  - **Chemical Carcinogens**
  - **Reproductive & Developmental Toxins**
  - **Highly Toxic Chemicals**

Routes of Exposure



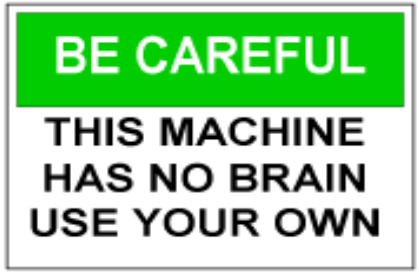
*Most important route of entry

Fire and Explosion Hazards

- Flammable solvents
- Pyrophorics
- Spontaneous combustion

Physical and Ergonomic Hazards

- **Moving unguarded parts, pinches**
  - **vacuum pump belts**
- **Broken glassware and sharps, cuts**
- **Pressure apparatus**
- **Vacuum containers**
- **Dewar flasks**
- **Cryogenics**
- **High voltage equipment**
- **Computer workstations**
- **Slips, trips & falls**



BioHazards

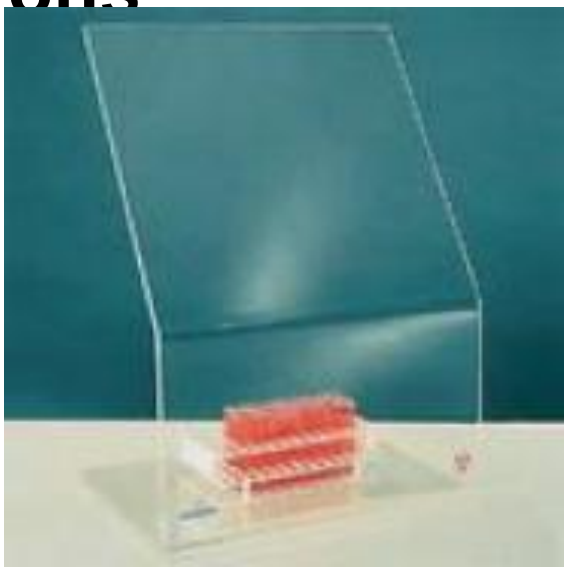
- **Blood borne pathogens**
  - **AIDS, HIV, Hepatitis, clinical chemistry labs**
- **Recombinant DNA**
  - **Genetic engineering, cloning**

- **Work with animals**
  - **Zoonosis, diseases from animals**

Radiation Hazards

Ionizing Radiation

alpha α, beta β, gamma γ, X-rays, neutrons



Radioactive isotopes

tritium (H-3), carbon (C-14), sulfur (S-35), phosphorus (P-32/33), iodine (I-135)

Special Chemical Substances

Controlled Substances:

regulated drugs, psychotropic (hallucinogenic) substances, heroin

Chemical Surety (Warfare) Agents:

nerve gas, phosgene, riot control agents

Chemical Hazards & Symbols

- Flammable  

Irritant 
- Explosive  

Corrosive  

- Toxic/Poison 
Environmental 

Chemical Hazard Definitions

- **Flammable** – Any substance that will burn if exposed to an open flame.

- **Explosive** – A substance that may explode if exposed to heat or flame.

Chemical Hazard Definitions

- **Toxic/Poison** – A substance that can lead to death if inhaled, ingested, or absorbed by the skin.

- **Corrosive** – A substance that can destroy or burn living tissue and can eat away at other materials.

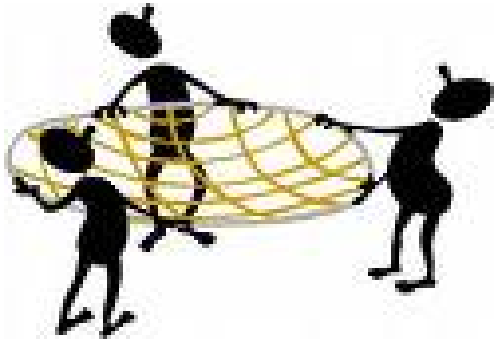
Chemical Hazard Definitions

- **Irritant** - A substance that causes inflammation upon contact with skin or mucous membranes.

- **Environmental** - Substances that are harmful to the environment. They must be disposed of properly, not washed down the drain.

Emergency Procedures

- Before you help another person, evaluate the potential danger to yourself. If you try to help and are injured, you cannot be of much further help to someone.

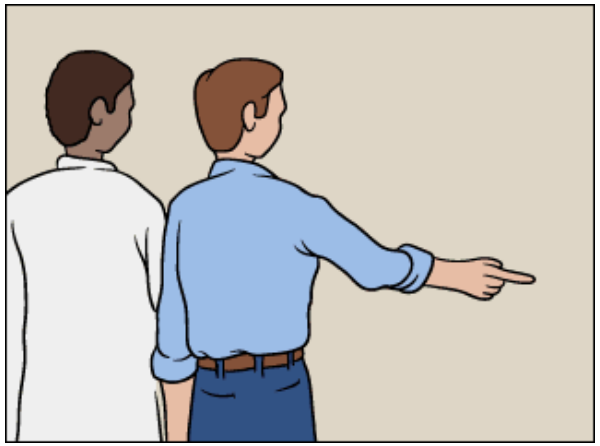


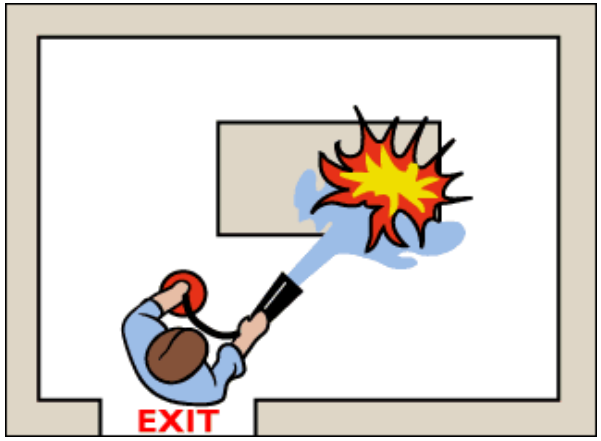
Emergency Procedures

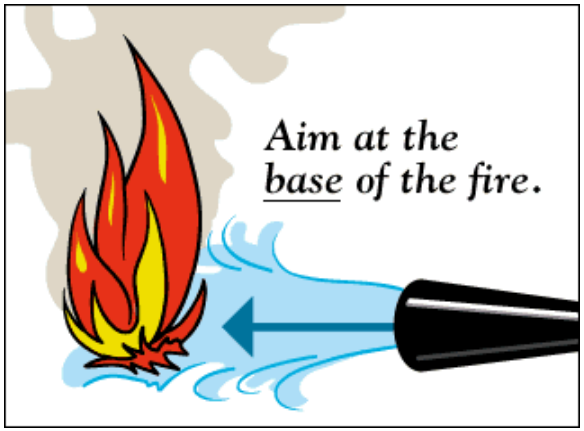
- Report the nature and location of the emergency to your teacher and, if necessary, to the appropriate fire or medical facility.
- Do not move any injured individuals unless they are in immediate danger from chemical exposure.
- Tell others in the area about the nature of the emergency.

Fire Safety

- The best way to fight a fire is to prevent it.
- In case of fire,







WHAT TO DO IF SOMEONE CATCHES ON FIRE

If *you* should catch on fire:

STOP - where you are
DROP - to the floor
ROLL - around on the floor

This smothers the flames, possibly saving your life.

Remember STOP, DROP and ROLL

If a *classmate* catches on fire:

Smother flames by grabbing a blanket or rug
Wrap them in it.
Could save them from serious burns or death.

WHEN NOT TO FIGHT A FIRE

Don’t fight a fire, when:

- It is bigger than a waste paper bin
- One extinguisher is not enough
- The fire is spreading beyond the spot where it started
- Smoke is affecting your breathing
- You can't fight the fire with your back to an escape exit
- The fire can block your only escape
- You don't have adequate fire-fighting equipment

DON'T FIGHT THE FIRE YOURSELF

CALL FOR HELP

Remember

When…

- The extinguisher runs out of agent

- Your path of escape is threatened

- The extinguisher proves to be ineffective

- You are no longer be able to safely fight the fire

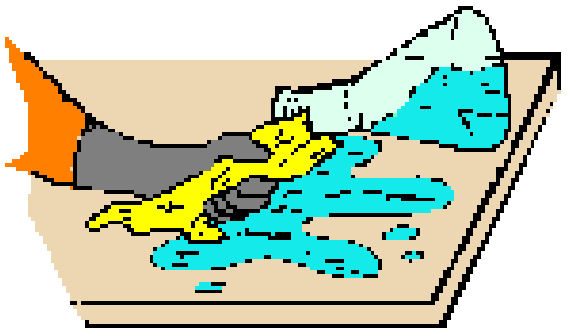
…LEAVE THE AREA IMMEDIATELY!

Chemicals on Skin, Clothing and Eyes

- Any chemical spill on a person should be washed off immediately and thoroughly using the safety shower.
- Launder contaminated clothes separately from other clothing or discard, as recommended in the MSDS.
- Any chemical contacting one's eyes should be immediately and thoroughly rinsed out using the safety eyewash.

Spill Cleanup

- Clean up all spills promptly, efficiently and properly.
- Absorb excess, surround area with absorbent material.
- Wear appropriate PPE.
- Use forceps, etc., to pickup broken glassware, etc.
- Work from outer edge toward center to cleanup
- Do not dry sweep



Spill Cleanup

- Clean spill area with soap & water, specific solvent or neutralizing material (if known).
- Collect contaminated absorbent, gloves, residues in plastic bag(s).
- Label, with chemical name if possible, and dispose of waste properly.

Material Safety Data Sheet

1. Material Identification

   – Identity of organization or company creating the MSDS and date of issue

   – Material's identity; includes both common and chemical names

2. Ingredients and Hazards

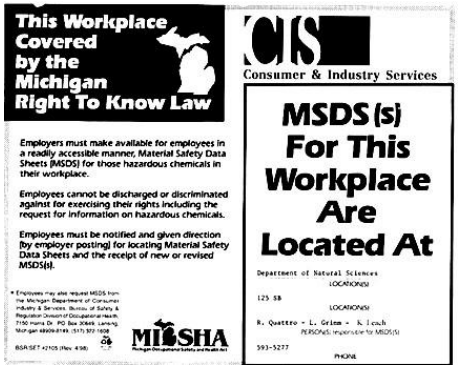
   – The products individual hazardous chemicals and their relative percentage of concentration

      • Level of hazard

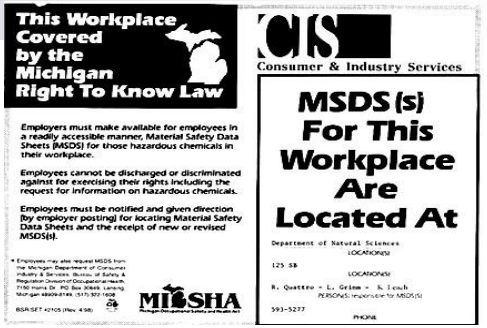
         – Danger: severe hazard

         – Warning: intermediate hazard

         – Caution: moderate hazard



Material Safety Data Sheet



3. Physical Data

   – Boiling point, solubility, specific gravity, melting point, molecular mass, color and appearance.

4. Fire and Explosion Data

   – Dangers if the material is exposed to other chemicals, air or water.

5. Reactivity Data

   – Conditions and chemical characteristics that could cause the material to catch on fire or explode.

   – Flash points, upper and lower explosive limits

Material Safety Data Sheet

6. Health Hazard Data
   – Routes of entry into the body; inhalation, skin absorption, etc.
   – Acute and chronic effects
   – Specific risks: carcinogen, teratogen, etc.
   – Exposure limits
   – Emergency and first aid procedures
   – Precautions and safety equipment needed to work safely with the material

Material Safety Data Sheet

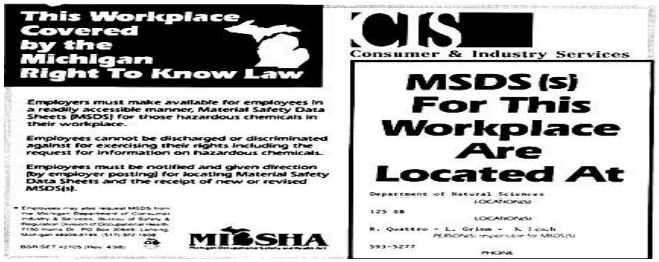
7. Spill, Leak and Disposal Procedures
   – Precautions and safety equipment required in case of an accident.
8. Special Protection Information
   – Methods for reducing exposure to a particularly hazardous chemical.
   – Ventilation, special breathing apparatus, protective clothing.
9. Special Precautions and Comments
   – Safe storage and handling
   – Types of containers, labels and storage conditions
   – Policies for transporting the chemical

MSDS Terminology

- Poison — Material that has toxic effects on the system.
- Toxin — Material that is poisonous to the system.
- Acute — Rapid onset of toxic effect after exposure.
- Chronic — Toxic effect noted over time.
- Cumulative — Toxin builds up in body.
- Carcinogen — Material that causes cancer
- Mutagen — Material that causes genetic mutation
- Teratogen — Material that causes birth defects
- Caustic — Material that causes chemical burns or eats away at equipment

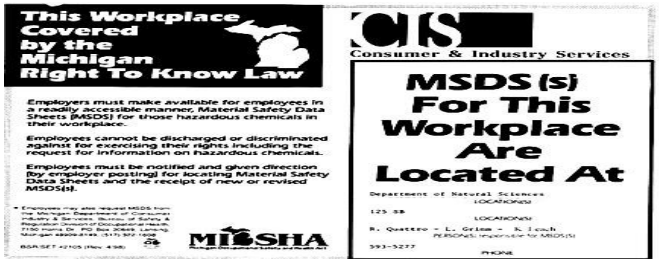
MSDS
Material Safety Data Sheet

MSDS Terminology



- Corrosive — Same as caustic, but usually used to describe equipment destruction.
- Lacrymator — Material causes irritation of the eyes, skin or respiratory system
- Flammable — Material that burns
- Inflammable — Material that burns
- Combustible — Material that burns

MSDS Terminology



- Explosive — Material that may explode under certain conditions, ex: exposure to air, water, etc.
- Oxidizer — Material that causes other substances to burn
- Peroxide former — Material that forms explosive peroxides when exposed to air
- Flash point — Lowest temperature at which a vapor given off by a material will ignite.

Purpose of Laboratory Chemical Safety

- **Protect the worker**
- **Safeguard the environment**
- **Comply with regulations**
- **Support the conduct of the studies**

Learning to work safely in the laboratory is as important as learning the chemical concepts and techniques involved in each experiment.

Have a safe semester!