

Safety Discussion

Responsibilities	First Aid
MSDS Sheets	Working with Flames
Compound Identification	Chemical Emergencies
Hazards	Waste Disposal
NFPA Diamond	Personal Protection
Responsible Agencies	Safety with Chemicals
Manufacturers' Labels	Glassware
Pregnancy Precautions	Eating, Drinking & Smoking

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Your Responsibility



- You and the University are both responsible for your personal safety.
- The university is responsible for providing you a safe laboratory environment, giving you instruction in proper procedures, training you about potential hazards in the laboratory, and giving you safe practices to follow.
- You will be given laboratory safety instruction by your instructor and required to study safety materials such as this lecture and the appropriate sections in your laboratory textbook. You are responsible for following procedures and safety practices carefully.

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- Your instructor expects you to work safely, using the safety instruction you receive as your guide
- You should immediately report any unsafe working condition to your instructor
- Your instructor would like to correct any safety problem in the lab as quickly as possible.

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Material Safety Data Sheets (MSDS)

A Material Safety Data Sheet (MSDS) is a multi-page document, provided by the manufacturer, that contains the following information about a chemical.

- Product or chemical identification (name and CAS number)
- Hazardous ingredients, if a mixture of chemicals
- Physical data, such as boiling point or melting point
- Flammability and explosion danger
- Reactivity data (hazards of mixing with other chemicals)
- Health hazards (toxicity)
- First aid and emergency information (safe handling procedures)
- Measures to control exposure (personal protective equipment)
- Spill handling procedures
- Special procedures, such as waste disposal



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An MSDS sheet can be intimidating, but please be aware:

- ❖ Your instructor has made every attempt to keep your exposure to hazardous chemicals low
- ❖ The experiments have been designed to eliminate as many hazards as is feasible
- ❖ Some hazards are inevitable in a chemistry laboratory, but with appropriate facilities and instruction they should not be considered threatening
- ❖ You should know how to access the MSDS of a given chemical.

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Compound Identification

CAS Number



One of the first pieces of information you will find in an MSDS sheet is the name of the chemical. Often a chemical will have more than one appropriate name. For instance, all of the following are names given for acetone: acetone, dimethyl ketone, 2-propanone

In addition, a chemical may have yet different names in other languages (German, French, etc.)

To avoid the problem of what to correctly name a chemical, the Chemical Abstracts Service (CAS) assigns a unique number, the CAS Number, to each compound. You will find this universal number in the MSDS along with the names.

This number allows an easy computer search for information about a compound. Emergency personnel can readily access safety information with this number, and chemists can use it to find literature articles and to order the compound.

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Basic Hazards



- ✓ Flammable: chemicals will ignite and burn
- ✓ Corrosive or caustic: chemicals will cause damage (immediate burns) to your skin:
 - ‡ Corrosive: usually applies to acids
 - ‡ Caustic: usually applies to bases
- ✓ Strong oxidizers: may cause a fire when they come in contact with other chemicals and are extremely reactive
- ✓ Volatile compounds: readily evaporate (form a vapor) when left in an open container. The vapor could be flammable or toxic

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TOXICITY



The MSDS gives information about toxicity.

- ❖ Toxicity: relates to the adverse effects of a chemical on a living system
- ❖ There are two types of toxicity:
 - ❑ **Acute Toxicity:** the chemical has a rapid bodily absorption and exerts its effect during a single exposure.
 - ❑ **Chronic Toxicity:** the chemical exerts its effect because of repeated exposure over period of time (days, months, years); and the exposures may be cumulative.

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Special MSDS Toxicity Terms

Toxic compounds often have specific actions:

- Carcinogen: cause cancer
- Teratogen: cause birth defects
- Hepatotoxic: cause liver damage
- Nephrotoxic: cause kidney damage
- Neurotoxic: Damage the nervous system
- Hematopoietic: Damages blood cells and bone marrow



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Special MSDS Toxicity Terms

- Sensitizer: cause allergic reaction
- Irritant: causes inflammation of the skin, or mucous membranes, or lungs
- Lachrymator: cause tears and eye irritation.

! The compounds with above type of effects are avoided in our experiments

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Common Routes of Exposure



- Inhalation

This is the most common mode of exposure. Chemical vapors, gases, aerosols, mists or dust can be absorbed through the mucous membranes of the mouth, nose, throat or lungs, ... and a neighbor could be responsible.

- Skin and Eye Contact

You may think of the skin as barrier, but chemicals can penetrate the skin. Such contact may be indirect such as when you adjust your glasses while wearing dirty gloves and then later adjust your glasses with gloves off. Contact with items that others have used or touched is also possible.

Eye exposure can be indirect through vapors, or direct via a splash (when not wearing goggles), or by touching your eye while your hand or glove is contaminated by a chemical.

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- Ingestion

Ingestion is usually by accident. It is avoided by never eating or drinking in the laboratory, and by cleanliness practices, such as washing your hands after working with chemicals. Always wash your hands when you leave the lab. Do not place your fingers in your mouth when working with chemicals.

- Injection

This can occur by skin puncture with a dirty piece of glassware or apparatus. Breaking a piece of glassware is a common route; chemicals can enter through a cut.

Remember that chemicals, no matter how hazardous, are not able to harm you unless you receive an exposure.

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MSDS Exposure Terms



- **LD50:** Lethal Dose, 50% mortality, mg/kg
When this amount of chemical is taken in (contact or ingestion) 50% of the test subjects (usually mice) die. (mg/kg = mg of substance per kg body weight)
- **TLV:** Threshold Limit Value mg/m³ (ppm)
The amount a worker may be exposed to in the work environment daily over a lifetime with no ill effects (m³ is a volume of air space in the room)
- **PEL:** Permissible Exposure Limit mg/m³ (ppm)
A legal standard of exposure in the workplace. This value may not be exceeded.
- **STEL:** Short Term Exposure Limit mg/m³ (ppm)
This value may not be exceeded for a single short term exposure.

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NFPA Diamond



The national fire protection association has developed a hazard-warning symbol called the NFPA Diamond.

The type of hazard (flammability, health, reactivity) is indicated by color and location.

Hazards are rated from 0 (very low) to 4 (extreme) in each category, with a provision for indicating any special hazards.

The NFPA Diamond is usually abbreviated in the MSDS sheets, and is placed on reagent bottles by many of the manufacturers.

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HAZARD LEVEL

0 very low
1 slight
2 moderate
3 severe
4 extreme

NFPA DIAMOND
NATIONAL FIRE PROTECTION ASSOCIATION

FLAMMABILITY

HEALTH 4 3 2 REACTIVITY

SPECIAL

MSDS FORMS ABBREVIATE THE DIAMOND:
NFPA 704M RATING : 4-3-2

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Special Hazards

These are placed in the white area of the NFPA triangle

- ❖ OX: oxidizer
- ❖ ACID: acid
- ❖ ALK: alkali (base)
- ❖ COR: corrosive
- ❖ ~~W~~: use no water
- ❖  radioactive

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Responsible Agencies

- OSHA Occupational Safe Health Administration
The primary federal agency that oversees workplace safety.
- EPA US Environmental Protection Agency
The federal agency that regulates pollution and waste disposal issues.



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Manufacturer's Bottle Labels

- When using a chemical from the manufacturer's original container, note that the label on the container is required to specify known hazards, and the most important information from the MSDS sheet.
- Chemicals distributed prior to 1985, however, may not include these hazard warnings.
- The label of a chemical includes:
 - The name of the product,
 - The name and address of the manufacturer
 - The physical and health hazards,
 - The NFPA diamond



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FACSIMILE CHEMICAL LABEL
BARCODES OMITTED FROM LEFT SIDE OF LABEL

<p style="text-align: center; font-size: small;">BAKER'S A.F.T. DATA™ System HEALTH FLAMMABILITY REACTIVITY CONTACT</p> <table border="1" style="margin: auto; border-collapse: collapse; text-align: center;"> <tr> <td style="width: 25px; height: 25px; border: 1px solid black;">1</td> <td style="width: 25px; height: 25px; border: 1px solid black;">4</td> <td style="width: 25px; height: 25px; border: 1px solid black;">2</td> <td style="width: 25px; height: 25px; border: 1px solid black;">1</td> </tr> <tr> <td style="font-size: x-small;">SLIGHT</td> <td style="font-size: x-small;">EXTREME</td> <td style="font-size: x-small;">MODERATE</td> <td style="font-size: x-small;">SLIGHT</td> </tr> <tr> <td colspan="4" style="font-size: x-small;">LABORATORY PROTECTIVE EQUIPMENT</td> </tr> </table> <div style="display: flex; justify-content: space-around; font-size: x-small; margin-top: 5px;"> <div style="text-align: center;"> GOGGLES</div> <div style="text-align: center;"> LAB COAT</div> <div style="text-align: center;"> VENT HOOD</div> <div style="text-align: center;"> PROPER GLOVES</div> <div style="text-align: center;"> EYE WASH</div> </div> <p style="text-align: center; font-weight: bold; font-size: small;">DANGER! CAUSES IRRITATION EXTREMELY FLAMMABLE HARMFUL IF SWALLOWED OR INHALED</p> <p style="font-size: x-small;">Keep away from heat, sparks, flame. Avoid contact with eyes, skin, clothing. Avoid breathing vapors. Keep in tightly closed container. Use with adequate ventilation. Wash thoroughly after handling. In case of fire, use alcohol foam, dry chemical, carbon dioxide - water may be ineffective. In case of spill, soak up with sand or earth. Flush spill area with water. FIRST AID: CALL A PHYSICIAN. If swallowed, if conscious give large amounts of water. Induce vomiting. If inhaled, remove to fresh air. If not breathing, give artificial respiration. If breathing is difficult, give oxygen. In case of contact, immediately flush eyes with plenty of water for at least 15 minutes. Flush skin with water. TARGET ORGANS: respiratory system, lungs, eyes, skin, central nervous system.</p> <div style="display: flex; align-items: center; font-size: x-small;"> <div style="margin-right: 5px;"></div> <div> <p>FLASH POINT: -19°C (MP) (Closed Cup)</p> <p>DOT Name: Acetone UN 1060</p> <p>CAS No.: 67-64-1</p> <p>J.T. Baker SOLUSO RE solvent is recommended for spills of this product.</p> <p>Made in U.S.A.</p> </div> <div style="margin-left: 5px; text-align: right;"> </div> </div> <p style="font-size: x-small;">© J.T. Baker Inc. Phillipsburg, NJ 08995 USA. PH (201) 899-2150</p>	1	4	2	1	SLIGHT	EXTREME	MODERATE	SLIGHT	LABORATORY PROTECTIVE EQUIPMENT				<p style="text-align: center; font-size: large;">1 L 9006-02</p> <p style="text-align: center; font-size: x-large; font-weight: bold;">Acetone</p> <p style="text-align: center; font-size: small;">‘BAKER ANALYZED’® Reagent (CH₃)₂CO FW 58.08</p> <div style="background-color: #4a7ebb; color: white; padding: 5px; text-align: center; font-weight: bold; font-size: small;">‘BAKER ANALYZED’®</div> <p style="font-weight: bold; font-size: small;">ACTUAL ANALYSIS, LOT C05620</p> <table style="font-size: x-small; border-collapse: collapse;"> <tr> <td colspan="2">Meets ACS Specifications</td> </tr> <tr> <td>Assay (C₂H₆O) (by GC, corrected for water)</td> <td style="text-align: right;">99.7 %</td> </tr> <tr> <td>Color (APHA)</td> <td style="text-align: right;">< 5</td> </tr> <tr> <td>Density (g/ml) at 25°C</td> <td style="text-align: right;">0.7840</td> </tr> <tr> <td>Residue after Evaporation</td> <td style="text-align: right;">0.0001 %</td> </tr> <tr> <td>Solubility in H₂O</td> <td style="text-align: right;">Passes Test</td> </tr> <tr> <td>Thiobarbituric Acid (meq/g)</td> <td style="text-align: right;">0.0001</td> </tr> <tr> <td>Aldehyde (as HC HO)</td> <td style="text-align: right;">0.001 %</td> </tr> <tr> <td>Isopropyl Alcohol (C₃H₈OH) (by GC)</td> <td style="text-align: right;">< 0.01 %</td> </tr> <tr> <td>Methanol (C₁H₄OH) (by GC)</td> <td style="text-align: right;">0.02 %</td> </tr> <tr> <td>Substance Reducing Permanganate</td> <td style="text-align: right;">Passes Test</td> </tr> <tr> <td>Water (H₂O) (by Karl Fischer tit)</td> <td style="text-align: right;">0.08 %</td> </tr> <tr> <td colspan="2">Trace Impurities (in ppm)</td> </tr> <tr> <td>Copper (Cu)</td> <td style="text-align: right;">< 0.004</td> </tr> <tr> <td>Heavy Metals (as Pb)</td> <td style="text-align: right;">0.2</td> </tr> <tr> <td>Iron (Fe)</td> <td style="text-align: right;">0.01</td> </tr> <tr> <td>Nickel (Ni)</td> <td style="text-align: right;">< 0.008</td> </tr> </table>	Meets ACS Specifications		Assay (C ₂ H ₆ O) (by GC, corrected for water)	99.7 %	Color (APHA)	< 5	Density (g/ml) at 25°C	0.7840	Residue after Evaporation	0.0001 %	Solubility in H ₂ O	Passes Test	Thiobarbituric Acid (meq/g)	0.0001	Aldehyde (as HC HO)	0.001 %	Isopropyl Alcohol (C ₃ H ₈ OH) (by GC)	< 0.01 %	Methanol (C ₁ H ₄ OH) (by GC)	0.02 %	Substance Reducing Permanganate	Passes Test	Water (H ₂ O) (by Karl Fischer tit)	0.08 %	Trace Impurities (in ppm)		Copper (Cu)	< 0.004	Heavy Metals (as Pb)	0.2	Iron (Fe)	0.01	Nickel (Ni)	< 0.008
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Modifications by Manufacturers

Some manufacturers have adapted the NFPA Diamond to their own use and modified the special hazards (white) area to specify contact hazard, which is also given a numerical rating.

Under some circumstances two other colors are used in the modified area.

Orange: for general chemicals

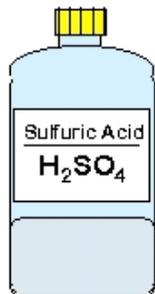
Green: for inert gases

Some companies add stripes to the color coding to further differentiate hazards.

CONCENTRATED ACID AND BASES

Manufacturer's containers of concentrated acids and bases have color-coded caps to avoid confusion.

color-coded cap



sulfuric acid



nitric acid



acetic acid



hydrochloric acid



ammonia



phosphoric acid

Many toxic and corrosive organic liquids have a bright international orange cap.

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Pregnancy



If you are pregnant or planning to become pregnant, you'd better to take this class at another time.

Although the lab is planned to be as safe as we can make it, there will undoubtedly be some inadvertent exposure to chemicals.

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First Aid

- There is a first aid station in the lab, and a variety of bandages will be found there.
- You must report all injuries to your instructor

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Simple First Aid

- Acid or Base Burns
Rinse the affected area with copious quantities of water for at least 15 minutes. Bases have a slippery feeling (like soap), acids cause a “non-skid” feeling and may burn. Rinse until skin returns to normal.
- Minor Cuts
Wash the wound well with water. If necessary apply pressure to stop the flow of blood. Apply a bandage if appropriate.
- Minor Burns
Immerse the burned area in cold water until the pain is alleviated. Salves are discouraged.
- Accidental Ingestion
Call the local poison control center for advice. Do not drink anything unless instructed.

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Working with Flames

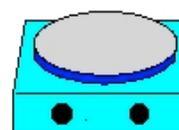
25



FIRE SAFETY

There will be no unauthorized use of flames in the laboratory.

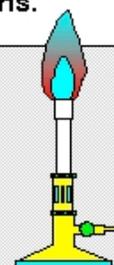
Many of the solvents used in this lab are flammable and will burn. Avoid flames.



Hotplates will be used for most heating operations.

GLASSWORKING

A special area is provided in an adjacent room where flames may be used to bend tubing or perform other glass work.



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Fire Extinguishers



There are several classes of fire extinguishers, that are designated for specific uses by letter:

- **A** Ordinary combustibles: wood, paper, cloth, some plastics--water.
- **B** Flammable and combustible liquids, fats, and oils--carbon dioxide.
- **C** Energized electrical equipment--dry powder.
- **D** Combustible metals--dry granule formulation.

The class B extinguisher is the one most commonly used in organic lab

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Carbon Dioxide Fire Extinguishers

Type B

Learn the location of the fire extinguisher(s) nearest to your position in the laboratory.

- A pin must be pulled in order to operate the extinguisher.
- After pulling the pin, aim the nozzle at the base of the fire.
- Squeeze the handle
- Sweep back and forth.

Once a fire extinguisher has been used, you should report its use, so that it can be recharged.



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Fire Procedures



- **Small Fires**
 - Alert people in the laboratory.
 - Make sure you have a clear exit path.
 - Avoid smoke or fumes.
 - Smother fire or use correct extinguisher.
 - If the fire will not extinguish, evacuate the area.
- **Major Fires**
 - Alert people to evacuate.
 - Notify instructor to summon help.
 - Avoid flames, smoke or fumes.
 - Make sure you have a clear exit path at all times.
 - Close all doors to confine the fire.
 - Exit building through the stairway, do not use the elevators.

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Chemical Emergencies

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Chemical Spills

- It is your responsibility to clean up any chemicals that you spill. If necessary, ask the instructor for guidance.
- For acids and aqueous solutions, sponges and paper towels are provided.
- For small chemical spills, consult your instructor.

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Safety Showers



Learn the location of the safety shower(s) nearest to your position in the laboratory.

These showers are to be used if:

you spill chemicals on your clothes or person

Your clothing or hair is on fire

Pull the handling handle down to operate the shower.

Remove any clothing which has absorbed a hazardous chemical. Also check your shoes.

The shower will not turn itself off. Push the handle up when you are done.

Seek medical attention if you have chemical burns.

Do not play with the shower. There are no floor drains and the water must be mopped up.

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Eyewash Fountains



- Learn the location of the nearest eyewash fountains.
- Eyewash fountains are used if you splash a chemical in your eyes.
- Rinse for at least 10-15 minutes.
- Any water on the floor will have to be mopped up, there are no floor drains.



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Protective Work Practices

- Never allow chemicals to touch your skin or hands.
- Wash your hands frequently
 - After handling chemicals
 - After removing gloves
 - Before you leave the lab
- Use good housekeeping
 - Wash your benchtop before and after working
 - Return chemicals to their proper storage
 - Clean up any spills
 - Remove gloves, goggles and lab coat before you leave
- Understand the hazards of your work
- Never work alone in the lab

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When Can You Work?

- For your own safety, you should never work alone in the laboratory. If you are injured there will be no one to help you or to call for emergency help.
- You should never work alone in the lab.
- Remember, there will be no make-up lab for your missed one.

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Waste Disposal

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Chemical Waste Disposal Containers

- All wastes are collected in containers located in the waste disposal area.
- After collection, wastes are disposed of in accordance with federal and local regulations.
- All the waste containers should be labeled for the types of waste.

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Wastes

- **Halogenated Waste**
 - A halogen is a Group VII element.
 - Any chemical compound containing any of these elements is an halogenated compound.
 - Organic liquids (or liquid mixture) which contain halogenated compounds should be placed in this waste container.
 - It costs more to process halogenated waste because more rigorous (and costly) procedures are required to prevent the formation of acidic gases (HCl, HBr, etc.)
- **Non-Halogenated Waste**
 - Organic liquids (or liquid mixtures) which do not contain any halogens may be placed in this container for disposal.

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- Trash (Non-Hazardous Solid Wastes)
 - Paper, corks, and other non-hazardous substances may be placed in the trash containers.
 - Do not, however, place any glass (broken or not) in the trash containers.
- Broken glass waste
 - Any glass or broken glass waste must be placed in the special cardboard box containers provided.
 - Do not place paper or garbage in these containers.

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Personal Protection

- The most common type of exposure in the lab is the inhalation of chemical vapors.
 - To protect yourself from vapors, always work with chemicals in a hood.
- The second most common type of exposure is to the eyes and skin.
 - Always wear goggles to protect your eyes.
- Chemically resistant gloves will protect you from the most common type of skin exposure.

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Laboratory Coats

- If you wish you may also purchase a white lab coat, or an apron, to protect you from chemical spills.
- Be sure the sleeves are not too long or they may get in the way of your work causing a hazard.



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Eyeglasses

- Ordinary eye glasses (even if hardened) do not provide adequate protection to your eyes.
- If you wear glasses, the goggles will fit over them.
- Contact lenses may be worn in the laboratory, but you must also wear approved safety goggles.

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Eyewash Fountains



- Sink-Based
 - The sink-based eye wash fountain is placed near the sinks and is connected with a flexible hose.
 - Pick it up, remove the cap, and point it at your face as you lean over the sink.
 - Squeeze the handle on the side to start the water flowing so that it floods your entire face and both eyes. Rinse for 10 to 15 minutes.

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Closed-Toe Shoes

- You must wear closed-toe shoes in the laboratory
 - Open-toed sandals are not permitted.
 - Bare feet are not permitted.
- No shorts: You may not wear shorts in the laboratory

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Avoid Contamination of Chemicals

- Do not put chemicals back into reagent bottles.
 - Returning an unused chemical to a container risks contamination. Take only the amount you need. Extra material must be placed in the appropriate chemical waste container.
- Take only as much as you need.
 - Whenever possible, share excess material with a neighbor, but do not return it to the original container.

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Safety with Chemicals

- Don't use any unlabelled chemicals.
 - An unlabelled chemical could be hazardous, toxic, or react in an unexpected fashion when mixed with other chemicals.
- Use chemicals only as directed and for their intended purposes.

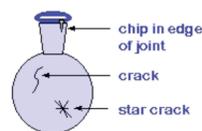
46

Personal Safety with Chemicals

- Avoid direct contact with any chemical
- Keep laboratory chemicals off your hands, face and clothing (including your shoes).
- Never smell, inhale or taste laboratory chemicals. Be sure there is adequate ventilation.
- Wash your hands thoroughly with soap and water after handling any chemicals, especially when you leave the laboratory.

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Glassware



- Always check your glassware for imperfections before use.
- Glassware that has imperfections or damage may break when heated or evacuated.
- Star cracks are formed when two flasks bump against one another. Any one of the lines in a star crack may extend.
- Joints which have chips that extend into the ground portion may leak when heated.

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Eating, Drinking & Smoking

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Toxicity

- No eating or drinking will be allowed in the laboratory
- Do not bring any food or drink into the lab, there is always a risk of contamination with toxic chemicals.



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No drinking in the lab



- It is not considered safe to drink water from any source in the laboratory.
- An experiment could back up and contaminate the supply lines.
- You may eat or drink in the hallway outside of the laboratory.
- Be sure you wash your hands well before eating or drinking, your hands may be contaminated with chemicals.

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No Smoking

- Smoking is not allowed in any of the chemistry laboratories.



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