Instructions and Guidelines for Chemical Storage and Handling

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Introduction

The correct method for storing chemicals in a laboratory has always been of paramount importance. Many incidents in laboratories, such as explosions or fires, stem from a lack of attention to specific guidelines regarding the storage of chemicals.

To properly store and handle chemicals in the laboratory, one must first gather information on safety protocols related to the handling and storage of these chemicals from the manufacturer or supplier organization. Then, in accordance with global standard practices and full adherence to safety recommendations, the proper measures for storing and working with chemicals in the laboratory should be implemented.

The hazards that arise from exposure to chemicals can be categorized into two main types: **health hazards** and **physical hazards**. Health hazards can lead to illnesses, while physical hazards relate to the flammability, explosiveness, or reactivity of chemical compounds.

When storing chemicals, attention must be paid to the conditions of the storage area, the method of organizing the chemicals, the types of storage containers, and additional recommendations.

Chemical Incompatibility Hazards

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Chemicals that are stored improperly next to each other may react and produce hazardous products.

Sometimes, improper storage of chemicals not only leads to contamination but also results in material waste and a decrease in the properties and effects of the chemicals.

By following the guidelines below, the hazards arising from chemical incompatibility can be eliminated:

- **Avoid storing acids near bases or reactive metals** such as sodium, potassium, and magnesium.
- **Avoid storing oxidizing solids or acids** in proximity to organic acids and flammable materials.
- **Do not store materials that react with water** near sinks or close to aqueous solutions.
- **Keep acids away from substances that produce toxic gases** upon contact with them (e.g., sodium cyanide, iron sulfide).

By adhering to these safety precautions, the risks associated with chemical incompatibility can be significantly minimized, ensuring a safer laboratory environment.

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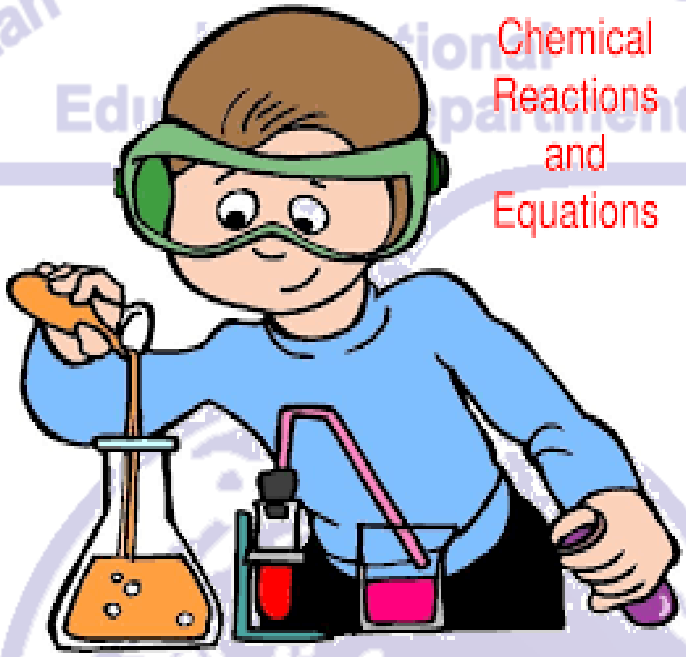
The table below lists several chemicals that are incompatible and should not be stored near each other:



Chemicals	Incompatible with

Acetic Acid	• Oxidizing agents such as:
	  ○ Chromic Acid
	  ○ Nitric Acid
	  ○ Hydroxyl Compounds
	  ○ Ethylene Glycol
	  ○ Perchloric Acid
	  ○ Peroxides
	  ○ Permanganates

Acetone	• Nitric Acid • Sulfuric Acid • Other Oxidizing Agents
Acetylene	• Chlorine • Bromine • Copper • Fluorine • Silver • Mercury

Alkali and Alkaline Earth Metals such as: Aluminum Powder, Magnesium, Calcium, Lithium, Sodium, Potassium	• Water • Carbon Tetrachloride • Other Chlorinated Hydrocarbon Compounds • Carbon Dioxide • Halogens
Anhydrous Ammonia	• Mercury (e.g., in mercury barometers) • Chlorine • Calcium Hypochlorite • Iodine • Bromine • Hydrofluoric Acid
Ammonium Nitrate	• Acids • Metal Powders • Flammable Solutions • Chlorates • Nitrites • Sulfur • Fine Organic Compounds or Flammable Materials
Aniline	• Nitric Acid • Hydrogen Peroxide
Arsenic Compounds	• Reducing Agents
Azides, Cyanides, Sulfides	• Acids
Bromine	• Refer to chlorinated compounds
Calcium Oxide	• Water
Activated Carbon	• Calcium Hypochlorite • Other Oxidizing Agents
Chlorates, Perchlorates	• Ammonium Salts • Acids • Metal Powders • Sulfur • Fine Organic Materials or Flammable Substances
Hydrocyanic Acid (Hydrogen Cyanide)	• Alkalis
Hydrofluoric Acid	• Potassium Permanganate • Sulfuric Acid
Hydrogen Sulfide	• Metallic Oxides • Copper Powder • Oxidizing Agents

Chlorine	• Ammonia • Acetylene • Butadiene • Butane • Methane • Propane (or other gases derived from oil) • Hydrogen • Calcium Carbide • Benzene • Metal Powders • Turpentine
Chlorine Dioxide (ClO_2)	• Ammonia • Methane • Phosphine (PH_3) • Hydrogen Sulfide
Chromic Acid (Chromium Trioxide)	• Acetic Acid • Naphthalene • Camphor • Glycerol • Alcohols • Flammable Solutions
Copper	• Acetylene • Hydrogen Peroxide
Flammable Solutions	• Ammonium Nitrate • Chromic Acid (CrO_2H_4) • Hydrogen Peroxide • Nitric Acid • Sodium Peroxide • Halogens
Hydrocarbons such as: Butane, Propane, Gasoline	• Fluorine • Chlorine • Bromine • Chromic Acid • Sodium Peroxide • Other Oxidizing Agents
Hypochlorites	• Acids • Activated Carbon • Ammonia
Iodine	• Acetylene • Ammonia (gas or aqueous solution) • Hydrogen

Mercury	• Acetylene • Fulminic Acid • Ammonia
Nitrates	• Metallic And Non-Metallic Powders • Metallic Sulfides • Flammable Solutions
Nitric Acid	• Acetic Acid • Aniline • Formic Acid • Hydrocyanic Acid • Hydrogen Sulfide • Flammable Gases And Solutions • Copper • Brass Alloy • Heavy Metals • Alkalis
Nitrites	• Ammonium Salts • Amides • Phosphides • Reducing Agents
Nitroparaffins	• Acids • Bases • Amines • Halides
Oxalic Acid	• Silver • Chlorites • Urea
Oxygen	• Oils • Grease • Hydrogen • Other Reducing Agents Including Flammable Gases, Solutions, And Solids
Phosphorus (White)	• Air • Oxygen • Alkalis • Halogens • Halogen Oxides • Oxidizing Agents
Potassium	• Tetrachloride Chlorine • Carbon Dioxide • Water

Perchloric Acid	• Reducing Agents Such As Acetic Anhydride, Bismuth And Its Alloys, Alcohols, Paper, Wool, Grease, Oils
Potassium Permanganate	• Glycerol • Ethylene Glycol • Benzaldehyde • Other Reducing Agents • Sulfuric Acid
Sodium	• Tetrachloride • Carbon • Carbon Dioxide • Water
Sodium Peroxide	• Ethanol • Methanol • Glacial Acetic Acid • Acetic Anhydride • Benzaldehyde • Carbon Disulfide • Glycerin • Ethylene Glycol • Acetyl Acetate • Methyl Acetate • Furfural
Sulfuric Acid	• Permanganates • Water • Aqueous Solutions • Reducing Agents • Chlorates • Perchlorates • Nitric Acid

Important Points to Consider While Working with Chemicals

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- Health and safety guidelines for working with chemicals must be studied thoroughly.
- The MSDS (Material Safety Data Sheet) for chemicals should be studied precisely and completely.
- Be fully aware of the protocol and methods specific to the laboratory work.
- Avoid inhaling, touching, or tasting the chemical, especially unknown chemicals.
- Use only the chemicals specified in the guidelines and only in the stated amounts.
- In case of chemical splashes on skin, face, or eyes, rinse immediately with plenty of water and inform the laboratory supervisor.
- Avoid heating flammable liquids with direct flames.
- To save costs and minimize solvent use and waste production, use the minimum amount of the necessary substance.
- Labeling information on containers holding chemicals is essential to prevent waste, environmental damage, and time loss.
- Use a pipette filler for filling pipettes, and avoid sucking the pipette with your mouth, even for filling water.

- Use a fume hood and a mask when using chemicals that produce vapors or in situations where you suspect that a gas will be released during a reaction.

How to Store Chemicals

A: Conditions for Storage

- It is recommended to store chemicals in locked cabinets or on sturdy shelves with edges approximately 1.5 cm high to prevent chemicals from falling.
- The shelves should be securely attached to the walls and floor of the laboratory.
- All storage areas for chemicals must be locked.

- Store chemicals outside the presence (area) of students and users.
- The storage area for chemicals should have adequate ventilation.
- Flammable and corrosive materials should be kept in special fireproof and corrosion-resistant cabinets equipped with proper ventilation, away from oxidizing agents.

B: Organizing Chemicals

- Organize chemicals based on their type and composition.
- Sort each category of compounds alphabetically.
- Acids should be stored in a dedicated acid cabinet. Nitric acid must be stored alone unless a separate compartment is provided in the cabinet for it.
- Highly toxic chemicals should be stored in a dedicated cabinet for toxic materials, with clear labeling indicating their toxicity.
- Foul-smelling and volatile chemicals should be kept in cabinets equipped with ventilation systems.
- Flammable materials should be stored like flammable liquids. Water-sensitive chemicals should be stored in a waterproof, dry, and cool cabinet, away from other chemicals.

C. Do's and Don'ts for Storing Chemicals

- Large and heavy chemical containers, as well as liquids, should not be stored on higher shelves.
- Chemicals should not be placed at the top of cabinets.
- Chemicals should not be stored on the laboratory floor, even temporarily.

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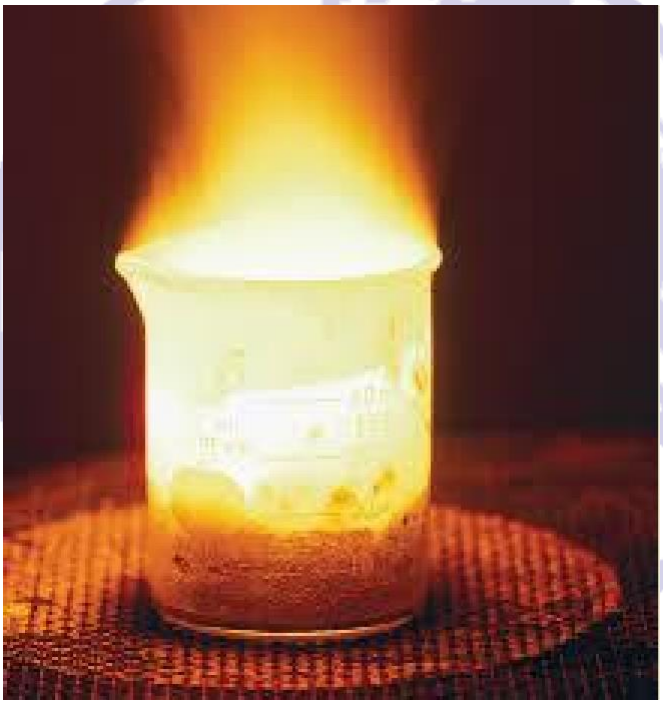
- No chemicals should be kept on benches or under the laboratory hood, except when in use.
- Hazardous liquids or materials should not be stored on shelves above eye level.
- Chemicals should not be stored next to food or beverages.
- Chemicals should not be stored in the personal refrigerators of staff, even temporarily.
- Chemicals should not be exposed to direct heat, sunlight, or highly variable temperatures.
- Avoid accumulating excess chemicals in the laboratory.
- All chemicals must have the necessary informational labels.
- Safety Data Sheets (MSDS) for all chemicals should be readily available.
- The handling and transport of chemicals must be carried out according to the guidelines.
- Chemical containers should be stored in locations where there is no likelihood of people coming into contact with them.
- Use corrosion-resistant shelving with protective edges and load-bearing capacity for chemicals, and keep them away from heat sources and direct sunlight.

- Oxidizing acids must be stored separately from organic acids.
- Acids should be kept separate from alkalis, cyanides, and sulfides.
- Alkalis should be stored in a dry place.
- Reactive materials should be kept away from heat, impact, and friction.
- Compressed gases, both oxidizing and non-oxidizing, should be stored separately.
- Toxic materials should be stored in appropriate locations with adequate ventilation.
- Non-volatile and non-reactive solids should be stored in cabinets or open shelves with protective edges.
- Corrosive materials should be kept cool and at a temperature above their freezing point, as substances like acetic acid, which may freeze at relatively high temperatures, can break their containers and leak out when the temperature rises above the freezing point.
- There should be specific procedures for dealing with chemical spills, and necessary equipment should include protective eyewear, skin, and respiratory coverings, chemical-resistant gloves, absorbent or neutralizing materials, plastic bags, and brooms and dustpans.

- Chemical solvent waste must be segregated according to guidelines and collected in suitable, leak-resistant containers that are labeled with the chemical information. These containers should be stored away from heat, sparks, flames, and direct sunlight, in a well-ventilated area.

- In laboratories that work with flammable materials, if a refrigerator or freezer is present, it must be certified by the relevant specialists to ensure that there is no risk of sparks or fire hazards.



D: Suitable Containers for Storing Chemicals

- **Materials for which even a small amount of their vapors can be fatal**, such as **hydrogen cyanide, cyanogen, and parathion**, must be stored in high-pressure metal cylinders. These cylinders should be protected from physical damage and kept in a cool, well-ventilated area, away from any flammable substances.

- **Liquid materials such as concentrated acids that are sensitive to light** should be stored in dark-colored glass bottles or jars, or in metal containers (coated or uncoated) kept in a well-ventilated area.
- **Humidity-absorbing materials**, such as **sodium hydroxide**, should be stored in **plastic bottles** that are impermeable to water and tightly sealed.
- **Radioactive materials** should be stored in **lead containers** and in environments that are completely impermeable. **personal protective** equipment should be used to guard against radiation from these materials.
- Sometimes, it is necessary to store corrosive or toxic liquids in special containers; for example, **hydrofluoric acid** must be stored in a tightly closed container made from either Polyethylene, Fluorocarbon, or Lead, and cool dry place away from other chemicals or materials.

- Volatile liquids that produce toxic vapors, such as **alcohol, ether, benzene, and concentrated acids**, should always be stored **under a fume hood**, and any handling of these materials should also be done under the hood.
- **Avoid** pouring **strong and concentrated alkaline solutions** into containers like **ceramic crucibles, porcelain capsules, etc.**, as these strong alkaline solutions can corrode these containers, while they are often resistant to acidic solutions.
- **Never** bring a flame close to a container that holds **volatile and flammable materials** such as **alcohol, ether, benzene, carbon sulfide, etc.** Instead, always keep such materials away from any flame, electrical sparks, and even cigarette smoke.

- **Corrosive materials** can damage their containers and spread in the storage area. Common examples of corrosive materials include strong acids and strong bases. Some of them are volatile, and others react violently with moisture, organic materials, and other chemicals.

  Glass containers holding corrosive substances should be placed inside another container and stored in a well-ventilated area. The secondary container can be made of plastic or a similar material. In addition to preventing leaks and spills of corrosive substances, the secondary container also helps prevent corrosion of other metal equipment.

- Avoid heating glass containers, especially those like Erlenmeyer flasks and beakers, over an open flame from a Bunsen burner or alcohol lamp, as the flame's temperature may not distribute evenly throughout the container, causing it to crack. To prevent this, use a heat-resistant mesh.

- Immediately after use, close the lids of glass containers for flammable organic materials and ensure they are not used near flames.

- Chemical materials with high flammability and reactivity should be stored at least 15 meters away from other substances.

- Storing flammable materials in open containers or cans and barrels that leak is prohibited.
- The material of the container should be selected to resist **moisture penetration and the effects of heat**.
- **Never** use food containers to store chemicals.
- Make sure that the lids of all containers holding chemicals are properly sealed. After each use, before placing the container with the chemical on the shelf, clean the outer surfaces with a paper towel and dispose of the towel carefully in an appropriate waste bin.

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