CHEMISTRY LABORATORY SAFETY MANUAL

Be Safe & Enjoy Science

IISER Tirupati

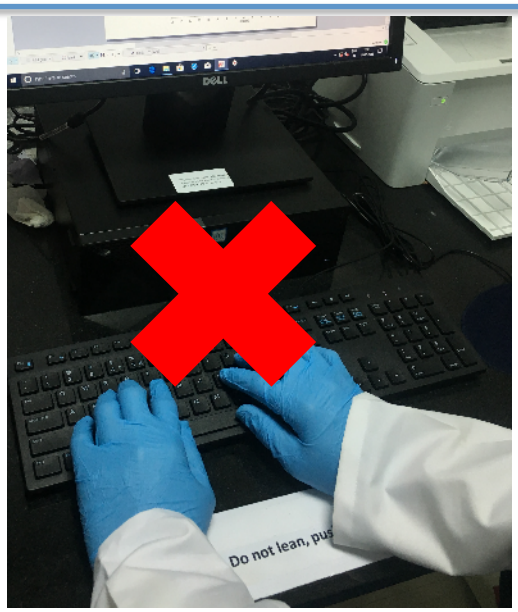
Introduction:

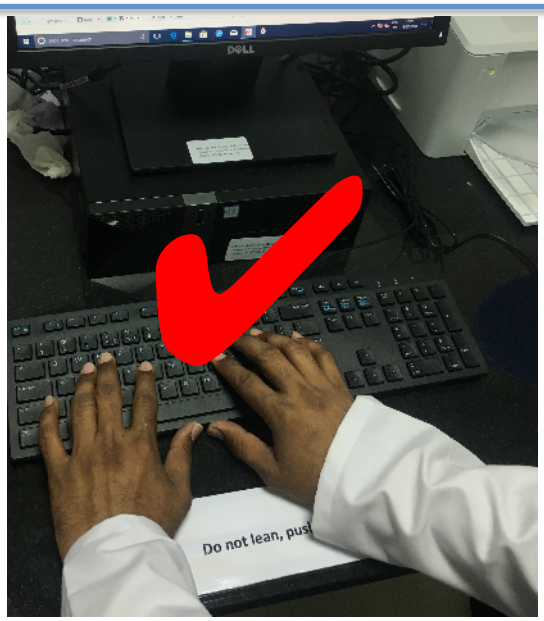
Safety and health considerations are as important as any other materials taught in science curricula. Occupational injury data from industry studies indicate that the injury rate is highest during the initial period of employment and decreases with experience. Working with chemicals poses continuous challenge to one's health and to the environment. The requirements and recommendations of this 'Laboratory Safety manual' will not fully protect you unless you exercise diligence in your daily work, or at least stop periodically to assess your environment. Step back and look carefully at your laboratory environment, looking at it as a first-time visitor would. Does it look safe, neat, and orderly? Are chemicals stored properly? Are you and other personnel taking appropriate precautions? Can you see ways to make the lab safer? You are strongly encouraged to conduct assessment of your laboratory's safety practices at least once in six months (and preferably more frequent). Following certain discipline and working as a responsible human being, one can maintain a total hygiene working with chemicals. Below are few guidelines to ensure maximum safety of the organization (IISER fraternity and its properties) as well as of our society.

1. General Laboratory Protocols

1.1 Basic Rules

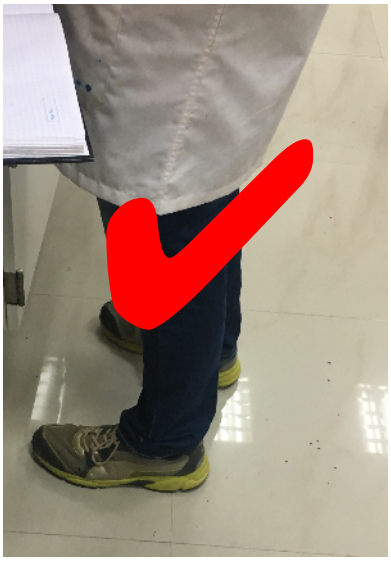
- Safety goggles are mandatory for all the lab workers
- Lab workers should not work alone inside the laboratory
- Lab-coats are not allowed in common areas like cafeteria, restrooms etc.
- Lab worker should be aware of the location and proper operation of laboratory safety equipment
- Know the exits in the laboratory and in the building
- Everyone while working in the lab should wear lab coats and full pants.
- Use of blast shields is strongly recommended while doing potential dangerous reactions (such as dealing with peroxides, diazo-compounds, high pressure vessels, distillation of high boiling substances).
- Gloves shall be worn while working in the lab and should be removed before touching surfaces outside the work area (i.e., doorknobs, computers etc).
- Feet should be covered completely with shoes containing reasonable heel heights.
- Open toe sandals and half pants/shorts should be avoided in the lab.





1.2 Good Personal Habits & Behavior

- Students should act in a professional manner at all times.
- Eating, drinking, gum and tobacco chewing, are not permitted in the laboratory.
- Using mobile phone is strictly prohibited inside the laboratory.
- Ice from the ice machines for laboratory use shall not be used for beverages, food or food storage.
- Do not smell or taste chemicals.
- Skin contact with chemicals should be avoided.
- Hands should be washed thoroughly before leaving the lab.



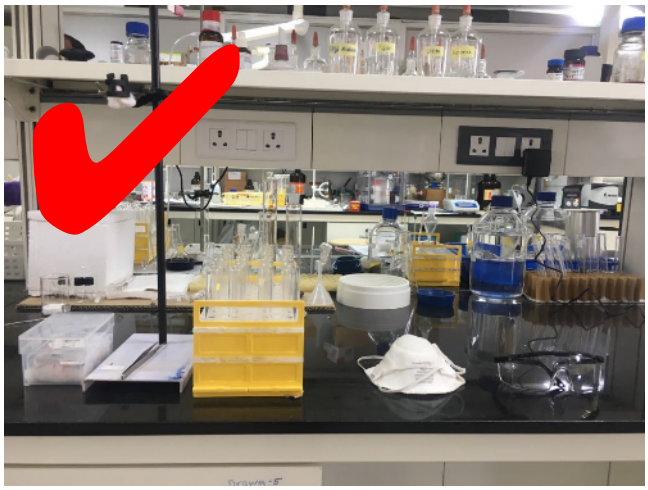
1.3 Housekeeping

- Lab areas are to be kept clean and uncluttered.
- Spills should be cleaned up immediately from work areas and floors.
- Equipment and instrumentation shall be cleaned to remove spillage and contamination before repair or calibration service is requested.
- Personnel must be able to see clearly through the protective glass sashes on fume hoods.
- Clear aisles, exits, and hallways for obstructions leading to slipping or tripping hazards (e.g., boxes, electrical cords or other items on the floor).
- Ensure unblocked access to all of the following:
    - Eyewash/safety showers
    - Electrical panels
    - Fire extinguishers
    - Chemical storage cabinets
    - Fume hoods
    - Waste containers

1.3.1 Possible ways to avoid clutters in Labs

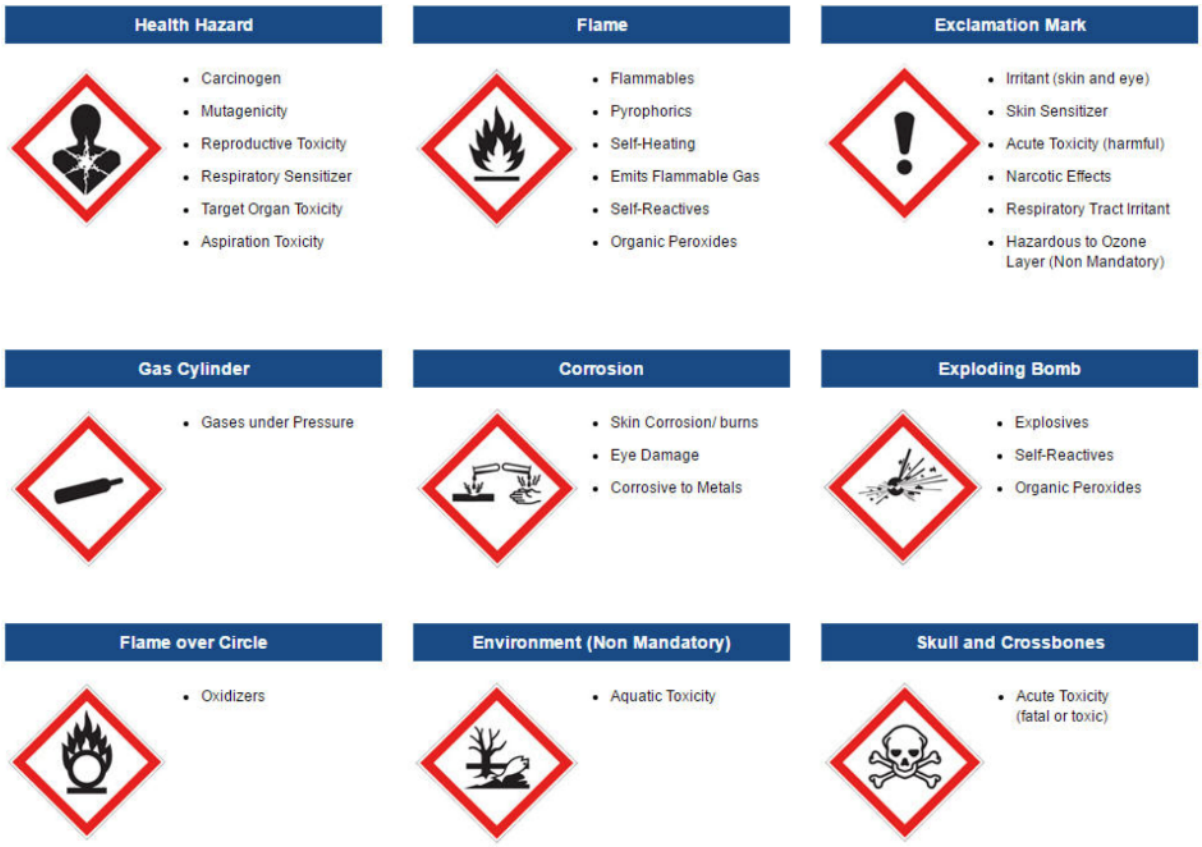
- Laboratories that are cluttered present a variety of safety hazards to researchers, students, and visitors. Some common methods for controlling clutter in laboratories are as follows:
- Properly dispose of chemicals and equipment that are no longer needed
- Do not buy chemicals, solvents or other inventories in bulk unless there is space available to safely store the material.
- Regularly schedule "lab clean-up days"
- Remove clutters from fume hoods, and ensure that they are not used for long-term storage of equipment, chemicals, or supplies that are not regularly used in the fume hood.
- Empty containers of unwanted materials (including trash) on a regular basis, and never allow them to overflow.
- Store excess materials in a neat, secure manner that provides easy access and reduces the potential for falling, collapsing, rolling, or spreading of the material.
- Limit overhead storage to lightweight, non-hazardous items.
- Chemical containers, supplies, and equipment are to be stored away from the edges of benches and shelves.
- Never stack chemical containers directly on top of one another (unless in original boxes that can be safely stacked) and/or with incompatible chemicals (such as acids with bases or flammables with oxidizers).

- Containers holding chemicals should not be stored on the floor. When this is unavoidable, store containers in plastic tubs or other secondary containment.
- Clearly mark bench areas containing radioactive materials with radiation tape and sorbent pads.
- Clean up all spills promptly. Never leave puddles, powders, or unknown materials on floors or work surfaces.
- Daisy-chaining of extension cords and/or power strips is not permitted. Store equipment, chemicals, glassware, and supplies not in regular use away from workstations.
- Do not use leg space beneath benches and desks in a way that prevents proper ergonomic posture.
- Keep personal desk spaces and other araes clean (free of all hazardous research materials).
- Neatly store lab coats and safety glasses away from potential sources of contamination.
- Never store hazardous materials in refrigerators that contain food.
- Only eat or store food in designated areas. Maintain sufficient open space within the laboratory to manage the acquisition and disposition of materials.



1.4 GHS (Globally Harmonized System)

GHS stands for the Globally Harmonized System of Classification and Labelling of Chemicals that defines and classifies the hazards of chemical products, and communicates health and safety information. The goal is that the same set of rules for classifying hazards, and the same format and content for labels and safety data sheets (SDS) will be adopted and used all around the world. It is important that those working with chemicals are aware of all the signs and symbols on the chemical containers.The following is the symbol and related hazard information that are commonly encountered in reseacrh labs.



2. Chemical Procurement & Storage

2.1 Procurement

All material safety data sheets (MSDS) of non-catalogue compounds that are received with shipments to the lab are maintained on file. For regular catalogue items (e.g. Aldrich, Alfa Aesar, TCI etc.) the corresponding supplier home page is consulted.

2.2 Hazardous Chemical Inventory

Each laboratory should annually conduct and document hazardous chemical inventory. While no standardized format is required, the inventory should include, at minimum: the chemical name, container size, and the room number. Unused or unwanted chemicals should be disposed.

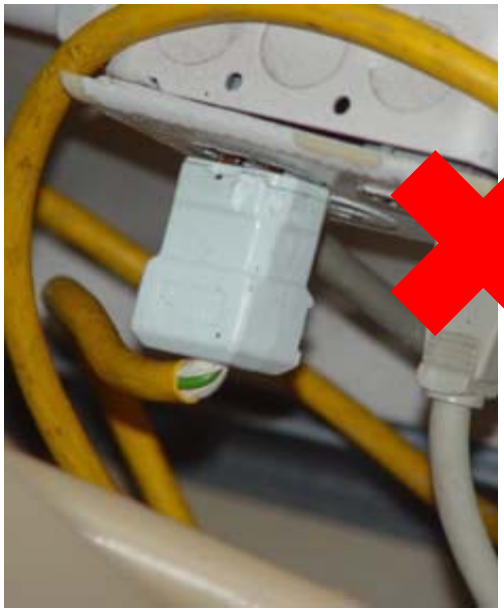
2.3 Storage

- Stored and working amounts of hazardous chemicals shall be kept to a minimum.
- Bulk store (in liters quantity) place for flammables should be away from working laboratory.

- All containers must have a legible and firmly attached label
- Compressed gas cylinder must be supported using straps, chains, or stands
- Acids, bases, flammables, strong reducing and oxidizing agents should be segregated within the laboratory. Water reactive materials must be separated from all other chemicals.


3. Electrical Safety

Electrical equipment and wiring comprises a major part of the laboratory, thus posing a new set of possible laboratory hazards. Periodic laboratory inspections should pay particular attention to electrical safety.




A list of possible wiring hazard are as follows:

- Spliced cables
- Worn-out cables
- Tripping hazards from poorly draped cables near hot plates etc.
- Sliced cables near sinks or other wet locations.

Should you be concerned with high voltage or high current? In fact, it is a bit of both! If the voltage is not high enough, it may be relatively safe to touch an electrical circuit which can deliver high current. On the other hand, if the voltage is very high, but the current that the supply can deliver is very low, you might still be safe. Let us see why!
The electricity is nothing but the flow of charged particles. In most of our everyday life situations, it is the flow of electrons. The electrons flow from a high potential to a lower potential. What happens when you get a shock is that the electricity flows through your body from an electrical circuit carrying a high potential to the ground.

Your body has certain electrical resistance. From the tip of your finger to your feet, it is about 100 kΩ under normal circumstances. However, if you are wet, the resistance can drop to about one kilo-ohm! Thus, if you are touching a 100 V terminal, the current that can flow through your body is about one milliamp under normal conditions. The resultant shock is barely perceptible (See the table below)! However, once the current passes through the body, its resistance decreases and more current starts flowing, which is indeed dangerous. If your body is wet, the initial current can be up to 100 mA, which is indeed fatal! However, if the power supply can deliver a maximum of one milliamp of current, and if it is not faulty, you are very likely safe! If there is some failure in the grounding of the power supply, the resultant current can be lethal! Therefore, do not touch any electrical terminals that look suspicious.

One important thing to note at this point is that once the electricity starts flowing through your body, your resistance will decrease drastically facilitating more current to flow. Given below in a box is a description of how human body responds to various amounts of currents [Source: Fish, R. M. & Geddes, L. A. Conduction of electrical current to and through the human body: a review. Eplasty 9, e44 (2009).]

1 mA	Barely perceptible
16 mA	Maximum current an average man can grasp and "let go"
20 mA	Paralysis of respiratory muscles
100 mA	Ventricular fibrillation threshold
2 Amps	Cardiac standstill and internal organ damage
15/20 Amps	Common fuse or breaker opens circuit*

*Contact with 20 milliamps of current can be fatal. As a frame of reference, a common household circuit breaker may be rated at 15, 20, or 30 amps.

Lethal voltages present in the labs can be identified by the following symbol.

Electricity can kill. Respect it!

4. Fume Hood Safety and Ventilation

General laboratory ventilation shall provide airflow into the laboratory from non-laboratory areas and out to the exterior of the building. Laboratory doors should remain closed, except for exit and entrance. All reactions must be performed within a fume hood. The hood sash should remain closed or at minimal safe height while working in the lab. Ventilation problems or fume hood alarms should be reported to the concerned lab supervisor who shall submit repair requests to facilities maintenance.

5. Waste disposal:

Ensure proper segregation, containment and storage of wastes. Liquid wastes are to be segregated according to halogenated, non-halogenated and aqueous wastes. Solid wastes are to be segregated as silica waste, heavy metals (palladium, Ra-nickel) waste and miscellaneous other contaminated solids wastes such as papers, cottons, gloves, facemask etc. Disposable plastic syringes and plastic chemical containers should be collected separately. Sharp objects like syringe needles and broken glass pieces (Chemically contaminated broken glassware's should be segregated) should be separately collected in appropriate containers. The waste containers should be labeled properly and disposed through an agency. Give special attention to avoid mixing of incompatible wastes to minimize disposal costs.

6. Fire Safety

Fire is the most common safety hazard in any organization. Therefore, it is very essential for everyone to know how to survive a building fire and what to do in case of a fire. The following section briefly explains some common protocols and procedures that may be followed during a fire emergency.

How to Survive a Building Fire

- Go out of the building immediately through the nearest exit.
- Always use stairs, not an elevator
- Close doors from outside in case of severe fire to prevent the fire from spreading
- In case of heavy smoke, crawl low and if possible tie a wet cloth on your nose
- Use a fire extinguisher, if the fire is very small and you know how to use it safely

If you are on fire - Stop, Drop and Roll

If you get trapped:

- Close the door
- Open the windows if safe
- Do not jump out of a tall building
- Signal for help and call 101

Fire Extinguishers:

Fire, depending on its origin, is classified as:

1. Class A: Combustible materials: Wood, paper, furniture etc.
2. Class B: Flammable Liquids
3. Class C: Flammable Gas
4. Class D: Metal Fire
5. Class E: Electrical equipment
6. Class K: Oil, greases

If FIRE occurs:

It may not be necessary to evacuate the building for a small fire. If, however, there is any chance that the fire may endanger others or may cause serious damage, confine or control the fire only if possible.

Use an appropriate extinguisher:

- *Dry Powder (for all type of fire)*: Dry powder containing extinguishers are recommended for putting off all types of fire.
- *CO_2 (for B and C type fire)*: Because the use of dry powder leaves a messy surrounding, CO_2 based extinguishers are often recommended for small fire of chemical origin.
- If fire breaks out close to a flammable gas supply or close to electrical power source, turn off gas supplies and electrical power sources.

Immediately after a fire extinguisher has been used, make a report of it and inform the Safety Officers.

If a solvent in a beaker catches fire, covering the beaker and depriving the fire of oxygen can easily extinguish the fire than using a fire extinguisher on the same beaker, which may cause the solvent to spill, thus increasing the hazard!

If Emergency Occurs: Pull The Fire Alarm And Evacuate The Building.

If there are injured victims, provide the minimum necessary first aid '*Only If You Are Sure That There Is No Danger To Yourself*'. If providing assistance will endanger you, *DO NOT* attempt intervention and move the victim immediately to the nearest hospital. In case of urgency, call:

1. Ambulance - **102**
2. Fire station - **101**
3. Disaster management - **108**
4. A.P. State Emergency Service And Fire Station, Tirupati - **0877 226 0101**

The above list is not complete and there could be many other scenarios, not listed here. In such cases your response should be based on the given scenario.

If CHEMICAL EMERGENCY OCCURS:

Chemical emergencies such as large spills, spills involving highly hazardous or flammable materials, releases of toxic or corrosive gasses or substances should be treated as other types of emergencies. **PULL THE FIRE ALARM AND EVACUATE THE BUILDING.**

The above list is not complete and there could be many other scenarios, not listed here. In such cases your response should be based on the given scenario.

7. Institute Policies regarding Safety

7.1 Safety Audits / Inspections

Safety officers along with few students (on rotation) will visit each laboratory to ensure all the basic safety rules are in place. For chemistry laboratories, the following eight areas have been identified for observing and maintaining safety of highest standard:

1. Safe working practices 2. Safety equipment 3. Fire handling and evacuation process 4. Ventilation of chemical vapor 5. Safety in conducting experiments 6. Laboratory equipment 7. Storage and labeling 8. Disposal of liquid and solid waste.

7.2 Revision of Safety Manual

Safety Manual will be reviewed once in six months or whenever there is a necessity for a certain policy change.

A ***quick run through*** of lab safety rules/policies:

- Report "All" accidents, no matter how minor, to the Supervisor/Safety In-Charge immediately
- Do not work alone in the laboratory.
- Know the location of the (i) "**Emergency Exits** in the lab and instrument room and (ii) **fire extinguishers**.
- Student with medical/Health concerns should seek the advice of a Doctor before attending labs.
- Wear safety goggles and lab coat at all times. If you have spilled chemical in your eyes, flush with water in an eye wash station for 10 to 15 minutes. Use safety shower in case of chemical spillage on body. Notify the incident to Supervisor and Safety In-Charge.
- Always wear full sleeves and a lab coat while working in the lab
- Wear appropriate shoes while working in the lab. Feet must be adequately covered. Open toed shoes or sandals are not permitted in the laboratory.
- Confine long hair whenever working in the laboratory.
- NO tobacco products in the laboratory.

- Ensure safe handling of chemicals by referring to Material Safety Data Sheet (MSDS) or ask the supervisor
- Report all spills especially mercury spill to Supervisor and Safety in Charge.
- Segregate the waste solvents and solid wastes appropriately for proper disposal.
- Do not use broken or chipped glassware and dispose them in the glass disposal box.
- Used syringe needles should be dropped in syringe disposal box, and do not dump waste paper in the broken glass/needle disposal boxes.
- Do not perform unauthorized experiments in the lab.
- Avoid crowding in lab benches (not more than **6** in each work bench)
- Do not use earphones/headphones while working in lab
- Follow all the special instructions and be careful while handling & disposing bio hazardous samples.