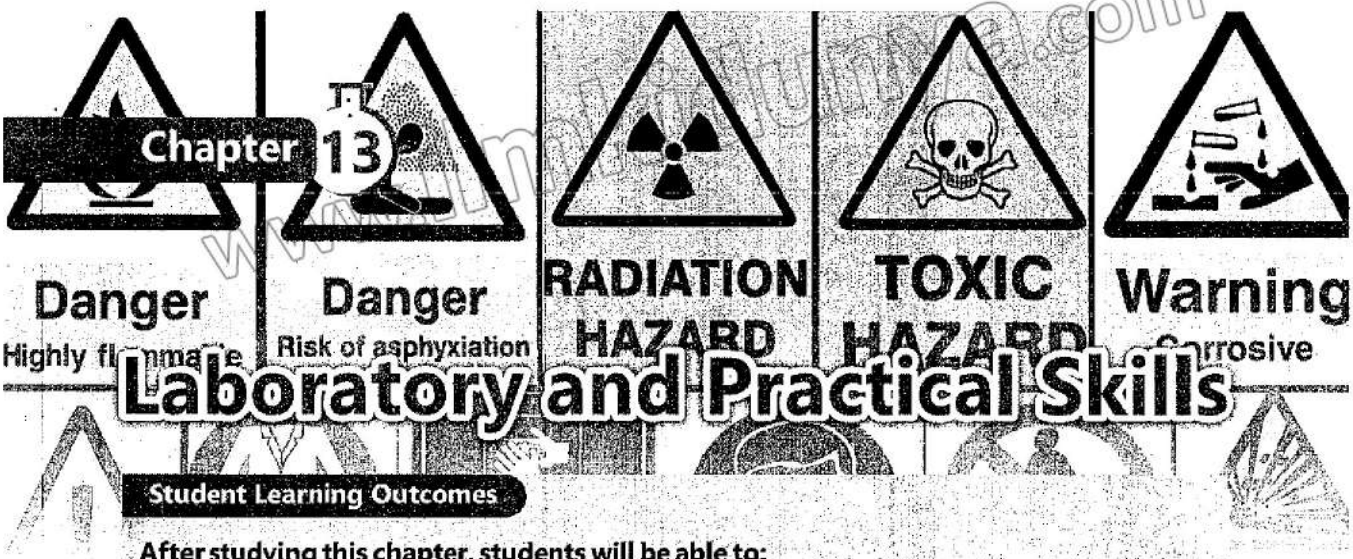

Chapter 13

Laboratory and Practical Skills

Student Learning Outcomes

After studying this chapter, students will be able to:

- Explain, with examples, the types of chemical hazards in the lab and suggest safety precautions. (Types of chemical hazards to be identified: flammable or explosive hazards, corrosive hazards, toxic hazards, reactive hazards, radiation hazards and asphyxiation hazards)
- Recognize the meaning of different chemical hazard signs in the lab and on chemicals.
- Recognize the importance of personal protective equipment (PPE) by correctly identifying the types of PPE needed for different lab activities
- Locate the nearest fire extinguisher and emergency shower.
- Show awareness of emergency procedures in the event of an emergency in the lab.

Introduction

A Chemistry laboratory is a place where a student is trained to observe the physical and chemical characteristics of substances by following definite procedures. Before starting the laboratory work, a student should get himself familiarized with the layout of the laboratory and various fittings provided in the laboratory table as well as the side shelves. Students are expected to conduct themselves in a responsible manner at all times in the lab. They are advised not to work alone in the lab. Experiments should be performed in the presence of lab instructor and other laboratory staff. All equipments should be checked before use whether they are working properly according to the requirements of the experiments. Determine the potential hazards related to any equipment or the experiment before beginning any work. Appropriate safety precautions must be observed at all cost. There must not be any crowding in the lab and students should stick to their work places at a safe distance from each other. Don't bring any food items in the lab. Never taste or smell any compound or a gas. If it is necessary to smell a gas it is always advised to waft the fumes or vapor towards your nose.

Warning signs are displayed when unusual hazards, hazardous materials, hazardous equipment or special conditions are expected. Do not pour chemicals down the drains and do not utilize the sewer for chemical waste disposal. Keep all sink traps and floor drains clean. Laboratory chemical waste can be disposed of in sewer or trash bin if they are non-hazardous materials. Acids and bases are first neutralized followed by sewer disposal. Hazardous waste material is transported to hazardous waste disposal site.

Misuse and mishandling of chemicals may create serious problems for the laboratory workers. A laboratory worker must use the chemicals according to the standard procedures keeping in view the particular hazards and precautions required for the safe use. The chemicals which can create problems for the safety of workers are cleaning agents, disinfectants, solvents, paints, compressed gas cylinders, mineral acids, carcinogenic chemicals etc.

Recognizing hazards which are commonly encountered in the laboratory helps to identify and minimize many of the health and safety problems. Most hazards which we might face while working in the laboratory fall into the following categories.

13.1 Chemical Hazards in the Laboratory

13.1.1 Flammable and Explosive Chemical Hazards

To start working in the laboratory requires great care, responsible behaviour and good attention. It is important to exercise extreme caution while working with delicate instruments, hazardous chemicals and open flames. If flammable and explosive chemicals are not handled in a safe and compliant manner, they can cause acute health problems. These problems may include burns, eye injuries, lung disease and suffocation.

Chemicals that cause a sudden release of pressure, gas and heat when they experience sudden shock are called explosive chemicals. Examples of chemicals which are expected to explode are picric acid, 2,4 -di-nitrophenyl hydrazine, benzoyl peroxide, nitrocellulose etc.

Flammable chemicals or mixtures are those which have a flashpoint around room temperature. Examples of flammable compounds are ethers, methylated spirit, benzene, acetone, petrol etc.

If you ever come across any chemical that you suspect to explode, do not

attempt to move the container to avoid shock. Explosives can cause damage to people, windows, tables etc.

Avoid using a chemical that is hazardous. Look for its alternative. If you must use a potentially dangerous chemical, you must follow the underlying safety instructions.

1. Obtain prior approval from your teacher.
2. Always use smallest quantity of the chemicals.
3. Always conduct experiment in fume hood.
4. Remove all other chemicals and apparatus around you.
5. Inform other people working with you.
6. Always wear safety spectacles, gloves and lab coat.
7. Always keep flammable compounds away from heat source.
8. Pour the flammable liquid very carefully.
9. Properly dispose off any hazardous waste.
10. Do not store flammable liquid in refrigerator.

13.1.2 Corrosive Hazards

Corrosive chemicals attack living tissues when they come in contact with them. They can be in the form of solids, liquids or gases. Such chemicals attack skin, eyes and respiratory tract and in the intestine as well. Whenever you work with corrosive chemicals, wear splash goggles instead of safety glasses and use a face shield.

Safety Precautions

1. Corrosive chemicals must be used in a fume cupboard to avoid breathing corrosive vapours.
2. While mixing concentrated acids with water, always add acid slowly to water and not vice versa.
3. Ensure eye wash and emergency shower is available.
4. Wash the affected area with soap and water and seek medical attention in case of emergency.

Examples of corrosive chemicals are mineral acids including HF, caustic alkalies, acetic acid (glacial) etc.

13.1.3. Toxic Chemical Hazards

A toxic chemical is a poisonous material which is capable of causing serious health problems. Mercury, benzene, chlorine, pesticides, ammonia,

hydrogen cyanide are some examples of toxic chemicals. The following safety instructions may be ensured in case you intend to work with toxic chemicals.

1. Wear gloves, masks or other protective devices.
2. Keep the work area well ventilated.
3. Keep the toxic chemicals in original container.
4. Do not work alone.
5. Wash your hands with soap and water after you finished.
6. Always work in fume hood because toxic vapours can be formed during an experiment.
7. Seek immediate medical and if you think you may have exposed to poisonous substance.

13.1.4. Reactive Chemical Hazards

The reactivity property of chemicals is vital for the production of many chemicals, pharmaceutical and food products which are in our daily use. When chemical reactions are not properly performed, they may cause fires, explosions as they may evolve dangerous gases. These reactions may result to an extreme damage to life and property. Examples of reactive chemicals are calcium hydride, Na, Li, azides, picric acid, $AlCl_3$, benzoyl peroxide etc.

Safety Instructions

1. Handle reactive chemicals with utmost care. Segregate these from other chemicals while storage.
2. Appropriate measures should be taken before performing reactions with reactive chemicals. Utilize shield and heavy gloves.
3. Minimize the quantity required for experiment.
4. Glass equipment must be shielded by wrapping with tape.
5. After use carefully dispose off every dangerous material.

13.1.5. Radiation Hazards

When a person is exposed to a high dose of radiation, it can damage the functioning of tissues and organs and can cause vomiting, radiation burns, hair loss and radiation syndrome.

Radioactive materials that emit alpha and beta particles inflict extreme damage when inhaled or injected. Gamma rays cause external injuries. Medical x-rays produce ionizing radiation which can affect living tissues.

Safety Instructions

1. Keep radioactive sources shielded.
2. Avoid prolonged exposures to the radiation.
3. Stay inside as walls and ceilings can protect you from radiation fall out.
4. Never operate equipment that produces radiation without sufficient training.
5. Wear protective clothing, wear face mask.
6. Avoid contact of the material with bare skin.
7. Monitor exposure to radiation using badges etc.

13.1.6 Asphyxiation Hazards

It is a type of hazard in which a gas or vapour can cause unconscience or death through suffocation.

A sufficient level of oxygen is essential for normal breathing. If this level falls, it can create very dangerous situation. The exposed person has no warning and cannot realize that oxygen level has become low. If the level of oxygen decreases a person can feel rapid breathing, rapid heart rate, nausea and convulsions.

Examples of chemical asphyxiants are hydrogen cyanide, carbon monoxide, nitrogen, argon, helium, methane and carbon dioxide etc.

Safety Instructions

1. Store and use asphyxiant chemicals in well-ventilated areas with plenty of air.
2. Wear a full lab coat, wear glasses and standard gloves, long trousers and closed-toed shoes.
3. Dispose off the waste strictly according to the instructions.
4. If exposed to such chemicals wash the exposed part with running water and seek medical attention.
5. When such a chemical is inhaled, remove the patient from the contaminated area and call appropriately trained person.

Exercise

1. Why flammable liquids are not stored in refrigerator?
2. Can you wear contact lenses in the lab?
3. Under what circumstances explosive chemicals are likely to explode?
4. How will you dispose off acid and alkali waste after the experiment is finished?

13.2 Hazard Signs

A chemistry laboratory is a strict area where rigorous rules must be practised to avoid a chance of a deadly accident. A dangerous situation may arise not only for the individuals working there but for the whole area. In a laboratory there are several hazardous materials, sensitive equipments and specified areas for specific tasks. Proper warning signs ought to be posted on these areas to ensure that every person entering there must understand and act accordingly to maintain laboratory safety.

Several signs and symbols are posted in different areas of the lab and bottles containing hazardous chemicals. These signs indicate that specific precautions must be observed according to the requirement sign posted there. If you see such signs, you must be alert and take extra care to maintain safety in that area.

Fig (13.1): Different Hazard Signs

Exercise

1. What does warning sign "caution" convey the message?
2. Name some explosive chemicals.

13.3 Personal Protective Equipment (PPE) in the Laboratory

Personal protective equipment should be made available to students to face any emergency situation which may arise in the lab. They are also useful to reduce exposures to hazardous chemicals. Proper protective equipment include such items as lab coat, protective glasses, face shields, apron, boots and hearing protection.

13.4 Location of Fire Extinguisher

Chemical laboratories using such materials which are likely to catch fire during experiments must have a portable fire extinguisher. This equipment can quickly be used to control a small fire if it is applied by a student individually. For this purpose all students should be well aware the location where this fire extinguisher is placed. A training session should be held to train all the students to know how to handle and apply this fire extinguisher to extinguish the fire properly without any panic or harm to anybody.

Similarly the facility of a shower should also be made available in the lab whose location and working must be told to everybody working in the lab. In case of fire or any other emergency students should know how to face that emergency situation.

Exercise

1. Should emergency drills be compulsory or optional?

13.5 Emergency Situation in the Lab

Students should make themselves aware of the actions that need to be taken in case of an emergency in a laboratory or if a person is affected. For this purpose periodic drills should be held with compulsory participation. Students should not only been given lectures but involve them practically to handle the emergency situations. During drill firefighting and other equipments must be checked whether they are in proper working order or not.

The following points should be kept in mind to cope with the emergency situation.

1. Stay calm and do not panic.
2. Alert people in the area to evacuate.
3. In case of fire, close doors to confine fire. Use fire extinguisher to put down the fire.
4. In case of chemical emergency adopt safety procedures as mentioned article 13.1.
5. Call and assist emergency staff.

Key Points

1. Working in the laboratory requires care and responsible behaviour. Hazardous chemicals and open flames if not handled properly can cause health problems.
2. Chemicals can suddenly explode due to shock and heat. They require handling them with care.
3. Safety instructions should be followed strictly to avoid any damage due to flammable and explosive chemicals.
4. Corrosive chemicals affect skin, eyes and respiratory tract. To avoid such health problems corrosive chemicals must be handled in fume cupboard.
5. Chemicals are poisonous and cause great harm if not handled according to instructions.
6. Some chemicals are so reactive that they require special care in the laboratory.
7. Radioactive materials can affect living tissues, and organs and cause other health problems. It is important to avoid longer exposure to radiation to stay healthy.
8. Asphyxiant chemicals are extremely lethal because they can cause suffocation. They must be used in well-ventilated places with protected dress.
9. Signs and symbols should be posted in lab, and chemical bottles to let the people know their hazardous nature
10. Personal protection equipment are mandatory before you enter the lab.
11. Students shall know the location and operation of fire extinguisher and shower in the lab.

Exercise

1. Tick (✓) the correct answer.

(i) Safety in the chemistry laboratory is:

(a) the responsibility of the students only
(b) the responsibility of the professor only
(c) the responsibility of the lab incharge only
(d) a shared responsibility

(ii) Accidents often result from:

(a) making mistakes
(b) failure to use common sense
(c) failure to follow instructions
(d) all of the above

(iii) The label "Warning" on a chemical bottle signifies:

(a) that the chemical can cause less serious injury
(b) that the chemical can cause serious injury
(c) that user should be careful when using chemical
(d) that user should open it only in the presence of a teacher

(iv) The label "Corrosive" on a chemical bottle indicates:

(a) that the material is an oxidizing agent
(b) that the material can degrade rapidly upon exposure
(c) that the contact destroys living tissue
(d) that the chemical can explode

(v) Example of highly toxic chemical:

(a) Ethanol (b) Acetic acid
(c) Potassium Cyanide (d) Potassium permanganate

(vi) Example of self-reactive chemical:

(a) Potassium (b) Phenol
(c) Picric acid (d) n-Hexane

(vii) When diluting an acid with water:

(a) do it quickly

(b) do not stir the container

(c) always add acid to water

(d) always add water to acid

(viii) What should you do in case of a fire drill in lab?

(a) run to safety shower

(b) climb into the fume cupboard

(c) close gas values and turn off all equipments

(d) carry chemicals out of the lab

2. Questions for Short Answers

i. Name some corrosive chemicals.

ii. What type of safety precautions are adopted to avoid damage due to explosive chemicals?

iii. What type of damages can reactive chemicals cause?

iv. Indicate two such safety instructions which are required to avoid radiation.

v. Which chemicals can cause suffocation?

vi. Why signs and symbols are posted on lab and chemical bottles?

vii. How fire caused by chemicals should be handled?

viii. Why emergency drills are important to face emergency situations?

3. Constructed Response Questions

i. How will you handle an emergency situation caused by fire due to short circuiting?

ii. What type of reactions should be carried out in fume cupboard?

iii. Put forward at least two suggestions to improve safety in the lab.

iv. Can you identify warning symbols posted for radiation and asphyxiant chemicals?

v. Why sudden shock can cause some chemicals to explode?

4. Descriptive Questions

i. Explain hazards due to explosive and toxic chemicals.

ii. Write down five such common safety instructions which are used to avoid all types of hazards.

iii. Explain the importance of warning signs and symbols to avoid any accident in the lab.

iv. Name some toxic chemicals. Describe the effects of spreading toxic gas in the lab.

v. A student has spilled over a corrosive and explosive chemical due to an accident. Which emergency measures you will take to tackle the situation.

5. Investigative Question

i. A few decades ago, a tanker carrying poisonous chlorine gas leaked and the gas spread over a large area in Lahore. The accident killed a few persons as well as animals. Give some concrete proposals to avoid such an accident in future.