UNIT I
Materials

Experiment 1

AIM

To study the different parts of a simple (dissecting) microscope.

THEORY

The human eye cannot distinguish objects smaller than 0.1 mm. Hence, we cannot observe cells, tissues, and minute organisms through naked eyes. Before the invention of microscope, biologists used lenses that could magnify minute objects only up to some extent. Subsequently scientists started using combination of lenses that led to the invention of microscope. Microscopes are instruments designed to produce magnified visuals of smaller objects.

The simple microscope, also known as dissecting microscope, has a single lens system through which the image of an object is seen. The simple microscope is infact a magnifying lens mounted on a metallic frame in such a way that lens can be mechanically moved up and down or sideways to get a magnified view of the object under observation. Its principle is not different from an ordinary lens used by a watch repairer.

MATERIALS REQUIRED

A simple (dissecting) microscope, permanent slides of plant (or animal) materials, parts of plants (or small insects), a slide, forceps, and a needle.

DESCRIPTION

A simple (dissecting) microscope (Fig. 1.1) consists of the following parts.

1. Base – It is the basal part that is bifurcated and supports the weight of the microscope. It is generally horse-shoe shaped and is made of metal.
2. Stand – It is a short, hollow cylindrical rod fixed to the base. Another small cylindrical rod called vertical limb fits into the stand, at the other end. The vertical limb can be moved up and down, with the help of an adjustment knob attached to the upper end of the stand.

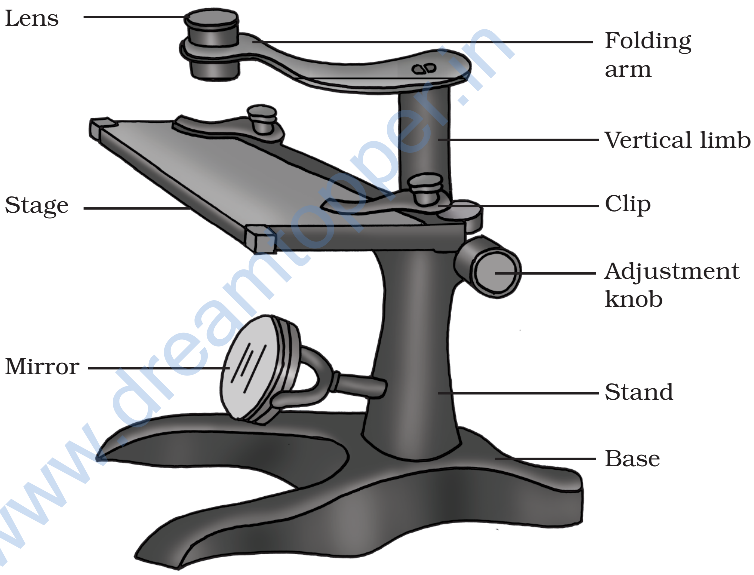


Fig. 1.1 : *A simple (dissecting) microscope*

3. Folding arm – To the upper end of vertical limb, a flat horizontal folding arm is attached. This can move sideways.
4. Stage – It is a rectangular glass plate fitted with a pair of clips on its upper surface. The clips are used to hold the object or slide on the stage.
5. Mirror – A movable plano-concave mirror is attached to the stand below the stage for reflecting light onto the stage.
6. Lens – A simple convex lens (known as eye piece) is mounted on the folded arm. The magnification of a dissecting microscope depends on the magnification of the lens which is normally 5X, 10X or 20X. ('X' denotes the number of times a lens magnifies an object).

PROCEDURE

1. Clean the stage, lens and mirror with a soft and dry cloth or with a tissue paper.
2. Place a permanent slide or a slide with an object mounted on it on the stage.
3. Adjust the mirror to get maximum (reflected) light on to the object.
4. Align the microscope lens over the object under observation.
5. Rotate the adjustment knob to bring the object to clear focus.

PRECAUTIONS

- Keep the microscope in its box after use.
- Clean the lens and mirror with a lens cleaning solution. Always wipe the lens and mirror with a piece of silk cloth.
- Always carry the microscope in an upright position. Use both your hands to hold it.
- Clean the stage properly before placing the slide.
- Take care to prevent the microscope lens coming in contact with the slide or an object.

NOTE FOR THE TEACHER

- A dissecting microscope is used to observe whole mounts of small organisms, parts of plants or animals and for dissecting small organisms.
- It is important to acquaint the students with the precautions to be adhered to while handling a microscope before they proceed for using it.
- It is advised to mount a suitable material on a slide and demonstrate to students.

QUESTIONS

- What is the magnification of the simple microscope you have used?
- Why is a simple microscope also called a dissecting microscope?
- Which type of mirror is fitted in the simple microscope? What is its function?

Experiment 2

Aim

To study the different parts of a compound microscope.

Theory

A compound microscope uses a combination of simple lenses in the objective and the eye piece. It offers a much higher magnification of an object than the simple microscope.

Materials Required

A compound microscope and permanent slides.

Description

The compound microscope (Fig. 2.1) consists of the following parts–

1. Base – It is the basal part that is bifurcated and supports the weight of the microscope. It is made of a metal.
2. Arm – It is curved and supports the body tube, knobs for coarse and fine adjustments, stage and mirror. It is used for holding the microscope. The arm is attached to the base by an inclination joint.
3. Body tube – It is a hollow tube attached to the upper end of the arm. It has the eye piece at the upper end and a circular, movable metallic ring called nose piece at the lower end. Objective lenses are screwed

into the grooves present beneath the nose piece. Usually two objective lenses of 10X (low power) and 40X (high power) magnification are provided.

4. Stage – It is a rectangular platform attached to the lower end of the arm. There is a hole at the centre of the stage which allows light from

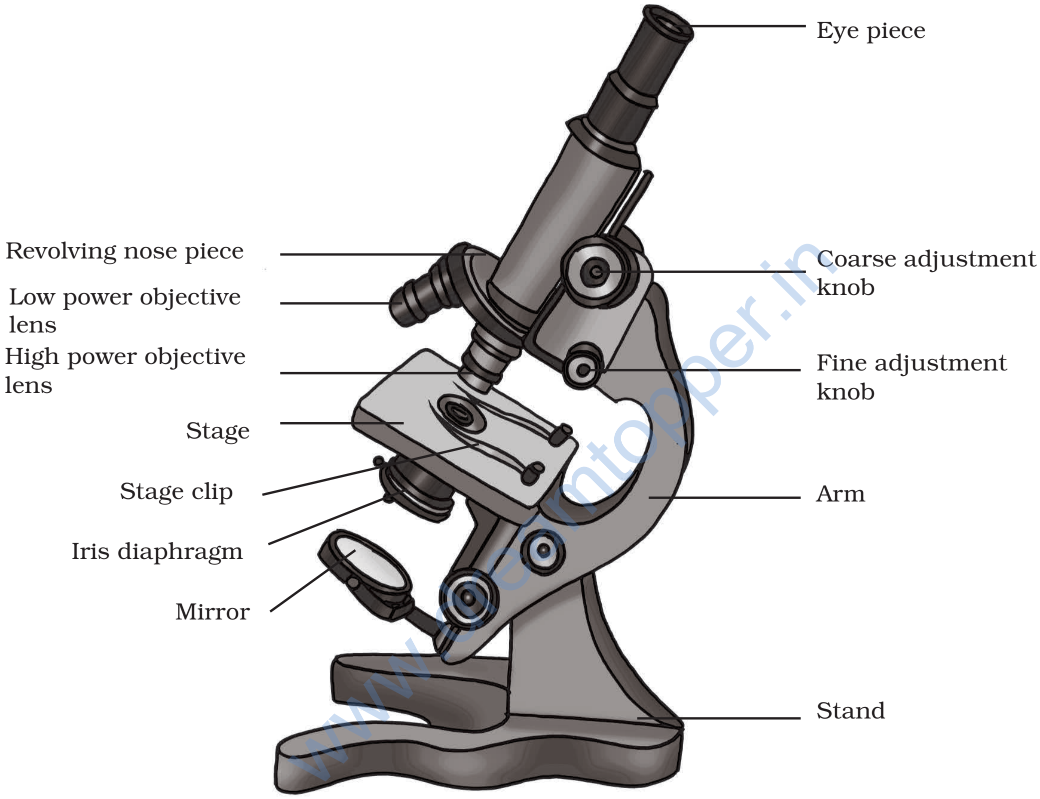


Fig. 2.1 : *A compound microscope*

the mirror to pass through it and to fall on mounted slide. A pair of clips is provided to hold the slide firmly on the stage.

5. Diaphragm – It is present below the stage and is used for adjusting the intensity of light.
6. Coarse adjustment knob – It is attached to the arm and it moves the body tube up and down for focusing the object.
7. Fine adjustment knob – It is attached to the arm and moves the body tube up and down very slowly. The fine adjustment is very essential for fine focusing of object, particularly in high power.
8. Mirror – A plano-concave adjustable mirror is fitted below the stage to reflect light onto the objective.

PROCEDURE

1. The microscope should be placed safely on the working table with the arm facing yourself.
2. Clean the eye piece, objectives, and the mirror with a soft and dry silk cloth.
3. Rotate the nose-piece slowly till it clicks in position to bring the low power objective in line with the body tube.
4. Adjust the diaphragm for allowing optimum light to pass on to the stage.
5. Observe through the eye piece. Tilt and turn the mirror towards the light source and adjust its position till the microscopic field appears bright.
6. Place the slide on the stage and move it so as to view the object on the slide.
7. Move the body tube with the help of coarse adjustment knob until the image of the object is seen. Sharpen the focus with the help of fine adjustment knob.
8. For viewing the object under high power turn the nose piece to high power objective after the object is focused under low power. Using the fine adjustment knob, focus the object.

PRECAUTIONS

- While carrying the microscope, hold its arm with one hand and support the base with the other [see Fig. 2.2(a)].
- Place the microscope with its arm facing yourself [see Fig. 2.2(b)].
- Do not tilt the microscope, keep it in upright position [see Fig. 2.2(c)].
- Do not use coarse adjustment when viewing through high power objective [see Fig. 2.2(d)]. The slide may break.
- Use a tissue paper (or clean silk or muslin cloth) for cleaning lenses and mirror [Fig. 2.2(e)].
- Place the microscope gently on the working table about 15 cm away from the edge of the table to prevent its accidental fall [Fig. 2.2(f)].
- Do not allow direct sun-rays to strike the mirror. Use plane mirror for natural day light and concave mirror for artificial light.
- After use, lower the body tube and keep the microscope in its box.

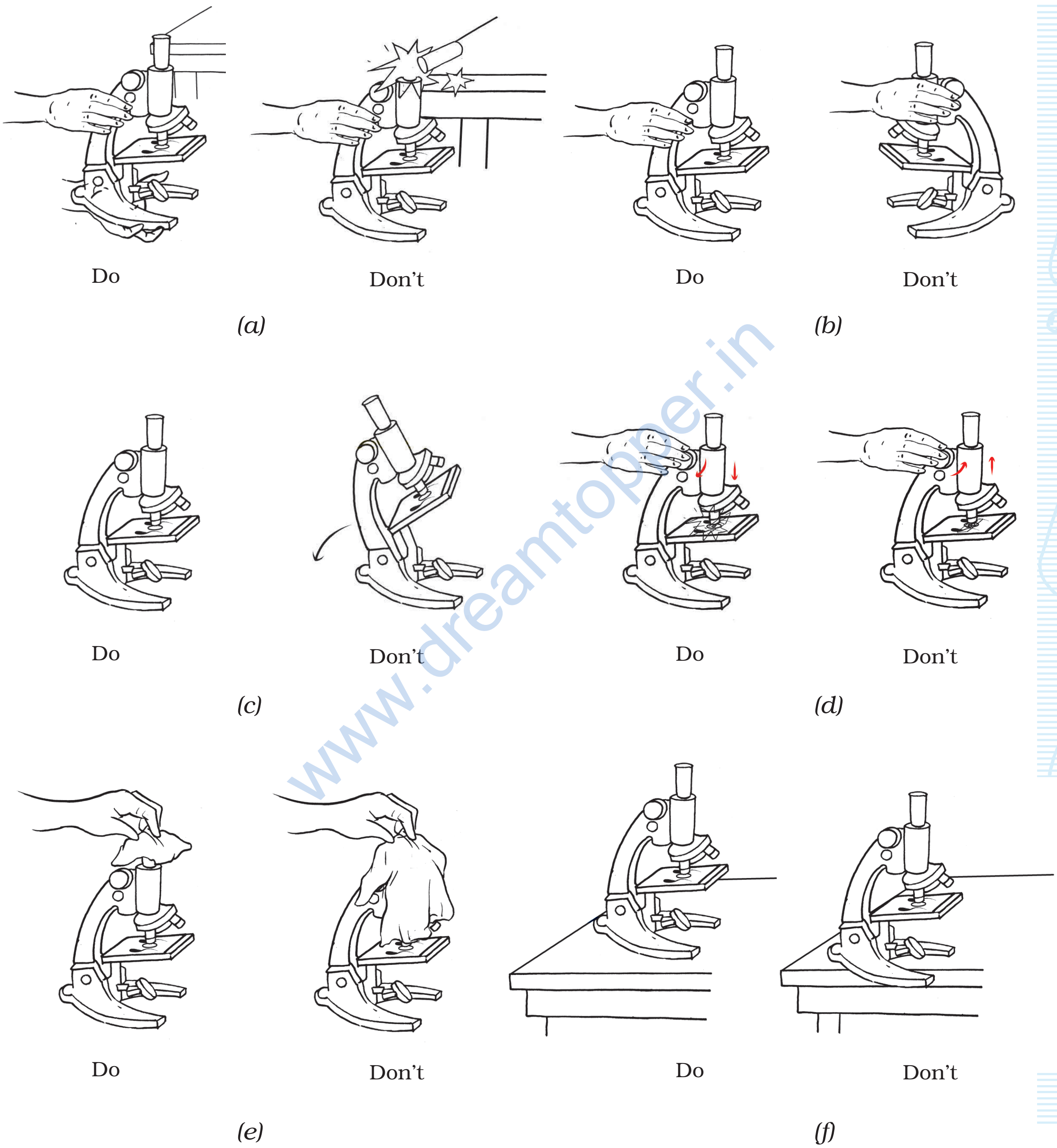


Fig. 2.2 : *Handling of a compound microscope*

NOTE FOR THE TEACHER

- It is important to acquaint the students with the precautions to be followed for handling a microscope before they proceed to use it.
- Magnification of lenses is often written on the surface of the objectives and eye pieces. It denotes the number of times the object is magnified. In a compound microscope, generally an eye piece is 10X or 15X and an objective is 10X and 40X or 45X. The magnification (*M*) of a compound microscope is the product of magnification of eye piece lens and that of objective lens. For example, the magnification of a compound microscope with 10X eye piece and 40X objective is 10×40, that is 400.

QUESTIONS

- What will be the magnification of a microscope when 15X eye piece and 40X objective are used?
- Why is it suggested not to reflect the sunlight directly into the body tube of the microscope?
- What is the difference between a simple (dissecting) and compound microscope?
- What is the function of an adjustment knob in a microscope?
- Which of the following part supports the weight of microscope?

  (a) arm (b) stage (c) body tube (d) base.
- Name the part of a microscope with which objective lenses are fitted?

  (a) nose piece (b) diaphragm (c) stage (d) arm.
- What holds the slide firmly on the stage of a microscope?

  (a) diaphragm (b) clips (c) nose piece (d) objective.
- Which of the following regulates the intensity of illumination in a compound microscope.

  (a) diaphragm (b) body tube (c) stage (d) mirror.

Experiment 3

AIM

To determine the density of a liquid (other than water) by using a spring balance and a measuring cylinder.

THEORY

The density (ρ) of a given substance is the mass of its unit volume. For a substance of mass M and volume V, the density is given by the ratio:

$$\rho = \frac{M}{V}$$

In this experiment the density of a liquid will be determined by finding the mass of its known volume.

MATERIALS REQUIRED

A spring balance (0 – 500 g), measuring cylinder (100 mL), polythene bag according to the size of the measuring cylinder, and the given liquid (kerosene, turpentine oil or any other).

PROCEDURE

1. Find the range and least count of the spring balance and the measuring cylinder. (**Hint:** To determine the least count of a spring balance or a

measuring cylinder, note the value of the physical quantity measured by it between any of its two adjacent numerically marked divisions. Dividing this value by the number of smaller divisions between them gives the least count of the device.)

2. Hold the spring balance vertically and ensure that its pointer is at zero mark. Place the empty cylinder in a polythene bag and suspend it from the spring balance as shown in Fig. 3.1. Note the reading, M_1 of spring balance.
3. Place the measuring cylinder on a horizontal surface like a table. Pour the given liquid (whose density is to be determined) in the measuring cylinder. Note the volume, V, of the liquid (Fig. 3.2).
4. Put the liquid-filled cylinder in the polythene bag and again suspend it from the spring balance. Note the reading, M_2, of the spring balance.

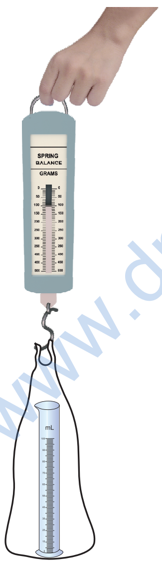


Fig. 3.1 : *Measurement of mass of a measuring cylinder using a spring balance*

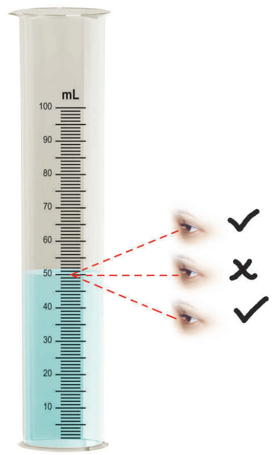


Fig. 3.2 : *Measurement of volume of given liquid*

Observations

(i) Range of the spring balance = ______ g

(ii) Least count of the spring balance = ______ g

(iii) Range of the measuring cylinder = ______ mL

(iv) Least count of the measuring cylinder = ______ mL

(v) Mass (M) of the given liquid:

- (i) Mass of the empty cylinder in the polythene bag, M_1 = ______ g
- (ii) Mass of the liquid-filled cylinder (in the bag) M_2 = ______ g
- (iii) Mass of the liquid, M (= $M_2 - M_1$) = ______ g
- (vi) Volume of the given liquid, V = ______ mL

Calculations

Volume of the given liquid V = ______ mL

Mass of the given liquid M = ______ g

Density of the liquid $\rho = \frac{M}{V}$ = ______ g/mL

= ______ kg/m^3 (1kg/m^3 = 0.001 g/mL)

Results and Discussion

The density of the given liquid is _______ kg/m^3.

Find the standard value of density of the given liquid and compare it with the observed result (see Appendix – C).

Precautions

- The measuring cylinder must be clean and dry.
- The measuring cylinder should be placed on a horizontal surface while measuring volume of the given liquid.
- While observing the liquid meniscus the line-of-sight should be at the same horizontal level as that of the lowest meniscus.
- There should be no air bubble in the liquid while measuring its volume.
- The spring balance should be held vertical while taking measurement.
- Before making use of spring balance it must be ensured that its pointer is at the zero mark.
- The readings of the spring balance should be noted only when its pointer comes to rest.

Sources of Error

- The graduations marked on the measuring cylinder and on spring balance may not be evenly spaced.
- A spring balance is primarily meant for measuring the weight (force) of a body. However in laboratories, a spring balance is often used to measure the mass of a body. It should be remembered that the

calibration of spring balance scale is done at the place of its manufacture and depends on the value of acceleration due to gravity (g) at that place. Therefore, if a spring balance is used to measure mass at any other place where the value of g is different, an error in the measurement of mass will appear.

QUESTIONS

- A spring balance calibrated in newton, reads 19.6 N. What will be its mass in grams at your place?
- You are given two measuring cylinders of least count 1.0 mL and 2.5 mL, respectively. Which one will you prefer to determine the density more accurately?
- Write two precautions that you will observe while measuring the volume of a liquid with the help of a measuring cylinder.
- Two bottles of equal volume are filled with glycerine and water respectively. Which of the bottle will be heavier? Give reason for your answer.
- Why is the density of water at 80 °C less than its density at 30 °C?

Experiment 4

AIM

To determine the density of a non-porous solid (insoluble and denser than water) by using a spring balance and a measuring cylinder.

THEORY

The density (ρ) of a given substance is the mass of its unit volume. For a substance of mass M and volume V, the density is given by the ratio:

$$\rho = \frac{M}{V}$$

MATERIALS REQUIRED

A spring balance (0 – 500 g), measuring cylinder (100 or 200 mL), a piece of thread, water, and a small piece of experimental solid.

PROCEDURE

1. Find the range and least count of the spring balance and the measuring cylinder (Explained in Experiment 3).
2. For finding the mass of the given solid, suspend it from the spring balance with the help of thread (Fig. 4.1). Note the reading of the spring balance.

3. Place the measuring cylinder on a horizontal surface like a table-top and fill it with water, say, up to the half of its range. Note the reading of the water meniscus as the *initial* volume.
4. Tie the given solid with a thread and lower it slowly in water in the measuring cylinder. What happens to the level of water in the cylinder? Let the solid to immerse completely in the water. Next, note the reading of water meniscus as the final volume (Fig. 4.2).

Fig. 4.1 *: Measuring of mass of solid using spring balance*

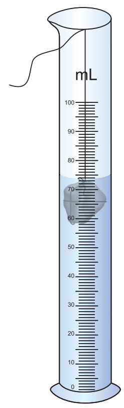


Fig. 4.2 : *Determination of volume of a non-porous solid*

5. Take out the solid from the measuring cylinder. Dry it and repeat the activity by taking different initial volume of water in the cylinder. In each case note the initial and final readings of water meniscus.

Observations and Calculations

(i) Range of spring balance = _____ g

(ii) Least count of the spring balance = _____ g

(iii) Range of the measuring cylinder = _____ mL

(iv) Least count of the measuring cylinder = _____ mL

(v) Mass (M) of the given solid = _____ g

(vi) Volume (V) of the given solid–

Sl. No.	Initial Reading of water meniscus, V_1	Final Reading water meniscus, V_2	Volume of Solid $V = V_2 - V_1$	Mean value of volume of solids
	(mL)	(mL)	(mL)	V (mL)
1.				
2.				
3.				
4.				

Density of the solid ($\rho = \frac{M}{V}$) = _____ g/mL= _____ kg/m^3

(1 kg/m^3 = 0.001g/mL.)

Results and Discussion

The density (ρ) of the given solid is ______ kg/m^3.
Find the standard value of density of the given solid and compare it with the observed result (see Appendix – B).

Precautions

- The measuring cylinder must be dry and clean.
- The measuring cylinder should be placed on a horizontal surface while reading the water meniscus.
- While observing the liquid meniscus the line-of-sight should be at the same horizontal level as that of the lowest meniscus.
- There should be no air bubble in the liquid while measuring its volume.
- The spring balance should be held verical while taking measurement.
- Before making use of spring balance it must be ensured that its pointer is at the zero mark.
- The readings of the spring balance should be noted only when its pointer comes to rest.
- The solid piece should be wiped with a dry cloth before repeating the activity.

Sources of Error

- The graduations marked on the measuring cylinder and on spring balance may not be uniform and evenly spaced.
- A spring balance is primarily meant for measuring the weight (force) of an object. However in laboratories, a spring balance is often used to measure the mass of an object. It should be remembered that the calibration of spring balance scale is done at the place of its manufacture and depends on the value of acceleration due to gravity (g) at that place. Therefore, if a spring balance is used to measure mass at any other place where the value of g is different, an error in the measurement of mass will appear.

NOTE FOR THE TEACHER

- The method describe above is useful for small solid objects. In case of larger objects, one should make use of an overflow can rather than measuring cylinder.
- This method is only useful for non-porous and water insoluble solid objects. Therefore it is advised to use a metallic solid.
- Some error in the measurement of volume of the solid piece may occur even if it has meagre porosity.
- The density of solid should be more than the density of water so that the solid can sink in water. If the density of solid is less than the density of water then a sinker can be used to perform the experiment.
- Earlier Experiment titled "*To determine the density of a liquid (other than water) by using a spring balance and a measuring cylinder*" also uses a spring balance. It is therefore advised that students may perorm the earlier experiment first to be aware of the instruments used in this experiment.

QUESTIONS

- Can you determine the density of a porous solid by using a spring balance and a measuring cylinder? Give reasons in support of your answer.
- How the presence of an air bubble in the liquid taken in the measuring cylinder can affect the volume of the solid?
- Density of sealing wax is 1.8 g/cm^3. Express it in kg/m^3.
- A metal cylinder is melted and the whole mass is cast in the shape of a cube. What happens to its density? Give reasons.
- At which temperature is the density of water maximum?

Experiment 5

AIM

To show that gases are readily compressible and liquids are not.

THEORY

The density of gases varies considerably with pressure but not for liquids. That is, gases are readily compressible while liquids are not. In this experiment we shall use a plastic syringe to demonstrate it.

MATERIALS REQUIRED

A plastic syringe of maximum available size (such as 25 mL or 50 mL) without needle, water, some other liquids such as mustard oil, kerosene, and fruit juice etc.

PROCEDURE

1. Hold the cylinder of a plastic syringe of maximum available size in one of your hand.
2. Insert the piston into the syringe cylinder and bring it to a certain level inside the syringe cylinder. In this situation air (gas) is inside the syringe. Note and record the reading of the piston in the syringe. This is your initial reading.
3. Close (or plug) the outlet nozzle of the syringe strongly by one of the finger of the same hand holding the syringe cylinder.

4. Apply a little force on the piston to push it in the syringe cylinder (that is to compress the air). Are you able to push it (Fig. 5.1)?
5. Keep on applying the force on the piston to push it further inside the syringe cylinder. Do you find that after some attempts, the piston stops pushing in further? Are you able to further compress the air inside the syringe? Note and record the reading of the piston in the syringe cylinder. This is the final piston reading.
6. Take out the piston from the syringe and unplug the nozzle.
7. Fill the syringe cylinder with water. Insert the piston into the syringe cylinder. Slowly push it inside the cylinder to allow the air pass through the nozzle of the syringe. Ensure that there is no air bubble inside the cylinder. Note the reading of the piston in the syringe. This is your initial reading for water inside the syringe.

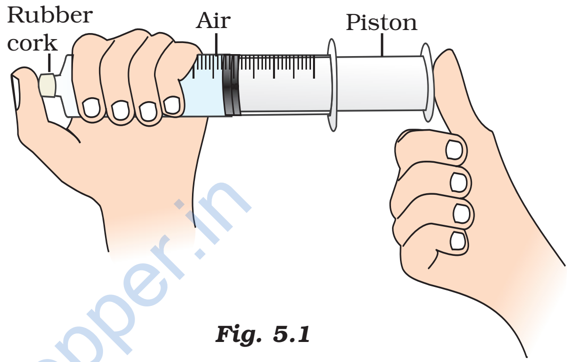


Fig. 5.1

8. Again close (or plug) the nozzle of the syringe strongly.
9. Apply force on the piston to push it in (or to compress the water inside). What do you observe? Does the water compress? Note and record the final reading.
10. Repeat the experiment with other liquids. Record observations.

Observations

Sl. No.	Material	Initial reading of piston in syringe	Final reading of piston in syringe
1.	Air		
2.	Water		
3.	Oil		
4.			

Results and Discussion

Infer from your observations that the gases are readily compressible while liquids are not. This shows that gases have more vacant space between the constituent particles.

Precautions and Sources of Error

- Use a cloth to safely and tightly close or plug the nozzle of the syringe cylinder.
- The motion of piston inside the syringe cylinder must be tight otherwise air (or liquid) may leak from the gas-piston boundary (or liquid-piston boundary).
- The needle of the syringe must not be used as it may hurt.

Questions

- What do you conclude about the inter-particle space in case of liquids and gases?
- Was it easy to compress gas (air)? What happened when you released pressure on the piston?
- What do you think which is present between the particles of air?
- Where do you come across the phenomenon of compressibility of gases and liquids in daily life?

Experiment 6

AIM

To study the changes in state of sublimate solids on heating.

THEORY

A change in state directly from solid to gas on heating without changing into liquid state, or vice-versa is called sublimation. That is,

$$\text{Solid} \underset{\text{cool}}{\overset{\text{heat}}{\rightleftharpoons}} \text{Vapour (gas)}$$

MATERIALS REQUIRED

Ammonium chloride (or camphor or naphthalene or iodine or any other sublimable solid), china dish, funnel, cotton plug, burner, tripod stand, and a wire gauge,

PROCEDURE

1. Take powdered sublimable solid in a china dish.
2. Put an inverted funnel over the china dish.
3. Insert a cotton plug on the stem of the funnel.
4. Put china dish over the wire gauge on the tripod stand.
5. Heat the china dish slowly with the help of a burner.

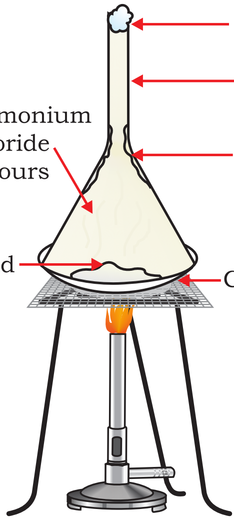


Fig. 6.1 : *Sublimation of ammonium chloride*

6. Cover the outer surface of the funnel with wet cotton to sublime the vapours quickly.

OBSERVATIONS

A sublimable solid on heating directly get converted into vapours, that sublimes back on cooling directly into solid again on the walls of the funnel.

RESULTS AND DISCUSSION

A sublimable solid on heating directly converts into gaseous state. How? Is it because of the high vapour pressure of the liquid state of the solid. The liquid state is practically non-existant.

PRECAUTIONS

- Heat the sample carefully.
- Take care in plugging the stem of the funnel securely with cotton.
- The size of the mouth of the funnel and china dish should be comparable.
- Do not remove the funnel when hot.

Note for the Teacher

- Moth repellent balls are easily available which can be crushed and can also be used as a sample in this experiment.

Questions

- In your view, what could be the reason for direct conversion of some solids to vapours and vice-versa?
- In the above experiment, you have observed conversion of solid to vapours. Is this a physical or a chemical change?
- Could you think of some applications of this change in daily life?

Experiment 7

AIM

To study the process of evaporation.

THEORY

Particles of matter are always moving and are never at rest. At a given temperature in any gas, liquid or solid, there are particles with different amount of kinetic energies. In the case of liquids, a small fraction of particles at the surface, having higher kinetic energy than the bulk is able to break away from the forces of attraction of other particles and gets converted into vapour. This phenomenon of change of a liquid into vapours (gases) at any temperature below its boiling point is called evaporation.

MATERIALS REQUIRED

Water, china dish, tripod stand, burner, and spirit.

PROCEDURE

1. Take about 50 mL tap water in a china dish.
2. Heat the china dish slowly with the help of burner.
3. Observe how the contents in the china dish disappear with time.
4. Continue heating untill all the water evaporates.
5. Repeat the experiment taking spirit as a sample.

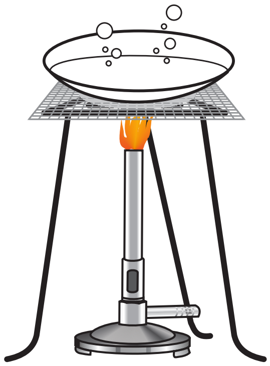


Fig. 7.1 : Evaporation of water

6. Take about 10 to 15 mL spirit in a china dish and mark its level.
7. Keep it for some time. **Do not heat it**.
8. Observe the contents in the china dish and continue observing till all the spirit evaporates.

OBSERVATIONS

Water evaporates on heating whereas spirit evaporates at room temperature.

RESULTS AND DISCUSSION

Some solvents evaporate even at room temperature. The tendency of the liquid to vapourise depends on the nature of the liquid through the molecule-molecule (intermolecular) interaction in the bulk of the liquid.

NOTE FOR THE TEACHER

- A container containing spirit must never be heated directly on a flame. Instead a water bath may be used, if required.
- The solvents which evaporate fast at room temperature are called 'highly volatile' solvents. Examples of highly volatile solvents are ether, acetone, petroleum ether, benzene etc.

QUESTIONS

- How is the crystallisation of sugar from its solution related to the above phenomenon?
- How would the presence of sodium chloride in water effect its evaporation tendency?
- Do you think that the process of evaporation increases if the surface area of a container containing the solvent increases?
- Will an increase of temperature effect the rate of evaporation? Justify your answer.
- On a rainyday, the rate of evaporation decreases. Why?
- Amongst evaporation and condensation which process is more indisciplined? Justify your answer.

Experiment 8

Aim

To determine the boiling point of water and melting point of ice.

Theory

The temperature at which a solid changes into its liquid state is known as its melting point. Once a solid attains its melting temperature, the temperature remains same until the entire solid converts into liquid.

The temperature at which a liquid changes into its vapour state is known as its boiling point. Once a liquid attains its boiling point, the temperature remains same until all the liquid changes into its vapour.

Materials Required

Round bottom flask (250 mL), a double bored cork, beaker (100 mL), thermometer (–10 °C – 110 °C), stop-watch (or a stop-clock), spirit lamp (or gas burner), tripod stand with wire gauze, spring balance, a glass tube, a polythene bag, laboratory stand, water, crushed ice, and thread.

Procedure

A. Determination of boiling point of water.

1. Note the range and the least count of the thermometer.

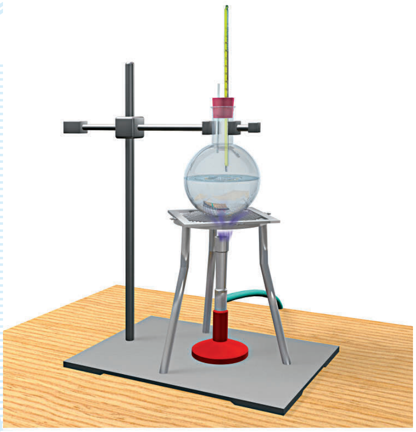


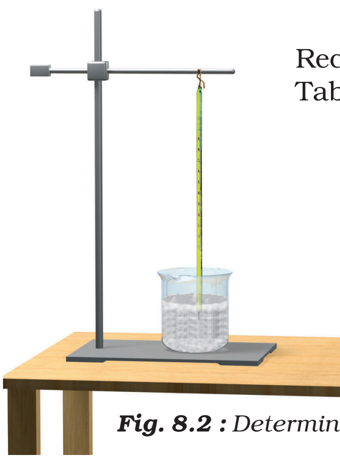
Fig. 8.1 : Determination of Boiling point of water

2. Take about 150 mL water in the round bottom flask and close its mouth with a two-holded stopper. Fix the thermometer through one of the holes in the cork and a glass tube through the other [Fig. 8.1]. Make sure that the bulb of thermometer hangs in air and is not in contact with water in the flask.
3. Place wire gauze on a tripod stand and keep the flask over it. Start heating the water with a spirit lamp or a gas burner.
4. Switch on the stop-watch (or stop-clock) and note the reading of the thermometer after fixed intervals of time, say after every two minutes. Once the temperature rises above 80 °C, the time interval to read the thermometer should be reduced, say to one minute.
5. Continue recording the thermometer readings for 4-5 minutes even after the water in the flask begins to boil.

B. Determination of melting point of ice.

1. Take a beaker and fill it up to half with crushed ice.
2. Insert the bulb of the thermometer into the ice and let it stand in a vertical position (Fig. 8.2).
3. Switch on the stop-watch or the stop-clock and note the reading of thermometer and the state of ice in the beaker after every one minute till the whole of ice melts.
4. Continue recording the temperature till the temperature of the water so formed rises up to 2 – 3 °C.

OBSERVATIONS AND CALCULATIONS



Record your observations on heating of water in Table 1 and those on melting of ice in Table 2.

Fig. 8.2 : Determination of melting point of ice

A. Table 1: Observations for Heating of Water

Sl.No.	Time (minute)	Temperature of water (°C)
1.		
2.		
3.		

B. Table 2: Observations for Melting of Ice

Sl. No.	State of the ice solid/partly solid/partly liquid/liquid	Time (minute)	Temperature (°C)
1.			
2.			
3.			

Results and Discussion

Study the observations recorded in Table 1 and find the temperature that remains constant even when the water begins to boil. Infer the boiling point of water. Study the observations recorded in Table 2 and find the temperature that remains constant as long as the ice gets converted into water. Infer the melting point of ice.

Precautions

A. Determination of boiling point of water

- Thermometer in the flask should be fixed in a manner that its bulb does not touch the water surface in the flask.
- Recording of temperature and time should be done simultaneously.

B. Determination of melting point of ice

- The bulb of the thermometer should be completely inside the crushed ice.
- The thermometer should not touch the wall of the beaker.
- Recording of temperature and time should be done simultaneously.

Note for the teacher

- The boiling point of water under standard conditions is taken as 100°C. However, it may differ due to impurities in water and atmospheric pressure.
- The melting point of pure ice under standard conditions is taken as 0°C. However, it may change due to impurities in ice and atmospheric pressure.

Questions

- Why is the bulb of thermometer kept above the surface of water while determining the boiling point of water?
- Why does the temperature remain unchanged until the entire solid changes into liquid even if we are heating the solid?
- Why do we fix a two holed-cork in the round bottom flask while determining the boiling point of water?

Experiment 9

AIM

To prepare a saturated solution of common salt in distilled water and to determine its solubility at room temperature.

THEORY

A solution in which no more solute dissolves in the given solvent at a particular temperature is a saturated solution. The solubility of a substance in a saturated solution is defined as the mass of solute dissolved in 100 g of solvent. In this experiment we shall prepare a saturated solution of common salt in water at room temperature and then will determine its solubility.

MATERIALS REQUIRED

Common salt or sugar, distilled water, three beakers (250 mL), stirring rod, filter paper, funnel, china dish, watch glass, tripod stand, burner, spring balance (0 g – 250 g, preferably having least count of 1 g), a polythene bag, a measuring cylinder (100 mL), and a thermometer (–10 °C – 110 °C).

PROCEDURE

1. Hang the thermometer freely in the room. Note and record its reading to find the room temperature.

A. Preparation of saturated solution

1. Using a measuring cylinder take 100 mL distilled water in a 250 mL beaker. Dry the measuring cylinder after use.
2. Dissolve some common salt in distilled water with the help of a stirring rod.
3. Warm the solution slightly and keep on adding common salt in the solution with constant stirring till no more common salt dissolves in it.
4. Stop warming the solution and allow the beaker to cool till it comes to the room temperature.
5. Filter the solution into another beaker in order to separate undissolved salt, if any. The filtered solution is the saturated solution of sodium chloride (common salt) in distilled water at room temperature.

B. Determination of Solubility

(i) Density Method

1. Determine the mass of the third beaker of 250 mL. (See Experiment 3 for details), using a spring balance and a polythene bag.
2. Pour 100 mL of prepared saturated solution in the weighed beaker, using the measuring cylinder.
3. Determine the mass of the beaker containing saturated solution (using a spring balance and a polythene bag).
4. Find the mass of the 100 mL of saturated solution.

(ii) Evaporation Method

1. Determine the mass of the china dish, using a spring balance and a polythene bag.
2. Using the measuring cylinder, take 25 mL of prepared saturated solution in a china dish.
3. Heat the china dish until all the water (solvent) evaporates out. The dish will now contain only the solute (common salt).
4. Stop heating the china dish and allow it to cool.
5. Determine the mass of the china dish containing the solute, using the spring balance and polythene bag.
6. Find the mass of solute that was dissolved in 25 mL saturated solution.

Observations and Calculations

Room temperature = _____ °C = _____ K.

(i) Determination of solubility by Density Method

Mass of empty beaker, m_1 = _____ g

Mass of the beaker containing 100 mL of prepared saturated solution, m_2 = _____ g

Mass of 100 mL of saturated solution, m_3 = _____ g

$(m_3 = m_2 - m_1)$

Density of distilled water, ρ (given) = _____ 1 g/mL

Mass of 100 mL distilled water (= $\rho \times 100$ mL) = 100 g

Mass of the solute (common salt) in 100 mL of distilled water, $m = m_3 - 100$ g = _____ g.

Solubility of common salt, m g per 100 g of distilled water

= _____ g per 100 g of distilled water.

(ii) Determination of solubility by Evaporation Method

Mass of empty china dish, m_1 = _____ g

Mass of china dish and common salt, m_2 = _____ g

Mass of salt in 25 mL of prepared saturated solution, $m_3 = (m_2 - m_1)$

= _____ g

Density of distilled water, ρ (given) = 1 g/mL

Mass of 25 mL distilled water (= $\rho \times 25$ mL) = 25 g.

25 mL (or 25 g) of distilled water dissolves m_3 g of common salt to prepare a saturated solution. Thus the 100 mL (or 100 g) of distilled water would require $\frac{m_3 \times 100}{25}$ g of common salt to get a saturated solution at room temperature.

Solubility of common salt, m g per 100 g of distilled water

$= \frac{m_3 \times 100}{25}$ g per 100 g of distilled water

= ___ g per 100 g of distilled water.

RESULTS

Compare the solubility of common salt in distilled water to form a saturated solution at room temperature obtained by density and evaporation methods. Using density method the solubility of common salt in a saturated solution at room temperature (___ °C or ___ K) is ______ g per 100 g of distilled water.

Using evaporation method the solubility of common salt in a saturated solution at room temperature (___ °C or ___ K) is ______ g per 100 g of distilled water.

Precautions and Sources of Error

- The spring balance should be held vertical while taking measurements.
- Before making use of the spring balance it must be ensured that its pointer is at zero mark. If not then ask your teacher to help.
- The readings of the spring balance should be noted only when its pointer comes to rest.
- The measuring cylinder should be placed on a horizontal surface while measuring the volume of the distilled water and solution.
- While preparing the saturated solution, the warming of the solution should be slow and to a temperature slightly (2 °C to 5 °C) more than the room temperature. Similarly the cooling of solution must also be slow.
- While performing evaporation method, heating of saturated solution must be stopped as soon as all the water evaporates from the solution.

Note for the Teacher

- In place of common salt, some students may be suggested to perform this experiment with sugar.
- Experiment 3 and 4 explains a simple method to find the mass of a measuring cylinder using a spring balance and a polythene bag. Since in this experiment too a beaker and a china dish (empty as well as filled) are to be weighed, it is therefore suggested that students may be asked to perform either of experiment 3 and 4 first.
- If the spring balance is not sufficiently sensitive, students may be suggested to use a physical balance. However a physical balance might be new equipment for them, it is advised to kindly guide them in making use of a physical balance to weigh the objects more accurately.
- In case, if distilled water is not available, the experiment may be performed with filtered water or drinking water. Its density may be assumed as 1 g/mL.
- If students find it lengthy to determine the solubility using both density and evaporation methods, suggest them to perform only one method.

Questions

- How does the solubility of a solute in solvent change with an increase in temperature?
- What is a supersaturated solution in your opinion?
- How can a supersaturated solution of salt in water be prepared?
- What will happen if a saturated salt solution prepared at high temperature is (i) cooled slowly? (ii) cooled suddenly?
- Would the solubility of sodium chloride (common salt) in water increase or decrease in presence of water sample containing magnesium/calcium chloride? Give explanation.

Experiment 10

AIM

To prepare a solution of common salt of 10% composition by mass.

THEORY

The concentration of a solution is the amount of solute present in a given amount (mass or volume) of the solution. Mass percent concentration is defined as a mass (g) of the solute per 100 g mass of the solution. A 10% solution by mass means, 10 g of solute dissolved in 90 g of solvent to result into 100 g of solution.

MATERIALS REQUIRED

Common salt, distilled water, watch glass, stirring rod, physical balance, measuring cylinder (100 mL), and a beaker (250 mL).

PROCEDURE

1. Calculate the volume of solvent (distilled water) and mass of solute (sodium chloride or common salt) required to prepare 100 g of 10% by mass solution. This may be done as follows–

   10 g solute is required for 100 g solution (distilled water + salt). Thus the amount of water required would be 100 g – 10 g = 90 g. Since the density of distilled water is 1 g/mL, therefore the volume of distilled water (required to prepare 100 g of 10% by mass solution with 10 g of common salt) is 90 mL.

2. Weigh an empty watch glass on a physical balance. Also weigh 10 g of sodium chloride (common salt) on the watch glass now.
3. Take 90 mL (90 g) of distilled water in a 250 mL beaker with the help of a measuring cylinder.
4. Transfer 10 g of salt from the watch glass to the beaker containing 90 mL distilled water.
5. Stir the solution untill all the salt dissolve in it.

Observations and Calculations

(i)	Mass of empty watch glass (m_1)	= _____ g
(ii)	Mass of watch glass + sodium chloride (m_1 + 10 g)	= _____ g
(iii)	Mass of sodium chloride (common salt)	= 10 g.

Results and Discussion

The concentration of prepared solution is 10% by mass of common salt in water. This way of expressing concentration is one amongst many.

Precautions and Sources of Error

- Use of physical balance must be done with all precautions. Ask your teacher acquaint you with the working of a physical balance.
- The readings of the physical balance should be taken only when its pointer comes to rest.
- The measuring cylinder should be placed on a horizontal surface while measuring the volume of the distilled water and solution.

Note for the Teacher

- In place of common salt, some students may be suggested to perform this experiment with sugar.
- This experiments requires to use a physical balance to weigh 10 g of common salt or sugar using a watch glass. A physical balance is a sophisticated equipment. It is suggested to acquaint students with the working of a physical balance. They may be asked to practice with this balance before performing this experiment.
- In case, if distilled water is not available, the experiment may be performed with filtered water or drinking water. Its density may be assumed as 1 g/mL at the experimental temperature.

QUESTIONS

- Why should the density of a 10% common salt be more than the density of pure water at a specified temperature? Offer qualitative explanation.
- A student is asked to prepare 250 mL sugar solution 15% by mass concentration. How much amount of sugar and water should be taken for preparation of the solution?
- If 50 mL of water is added to the above solution. What will be the change in the mass percentage of the solute?
- 830 g of salt solution contains 50 g of common salt in it. Calculate its concentration in terms of mass percentage?

Experiment 11

AIM

To separate the components of a mixture of sand, common salt and ammonium chloride.

THEORY

Sand, common salt, and ammonium chloride form a heterogeneous mixture and can be separated easily by physical methods of separation. By selecting the right order of methods of separation, the three can be easily separated:

(i) ammonium chloride sublimes on heating;

(ii) sand is insoluble in water; and

(iii) common salt can be recovered by evaporation of its aqueous solution.

MATERIALS REQUIRED

A china dish, a funnel, a beaker (250 mL), a cotton plug, burner, tripod stand, wire gauge, sand, common salt, ammonium chloride, water, and filter paper.

PROCEDURE

1. Take mixture of ammonium chloride, sand and common salt in a china dish.

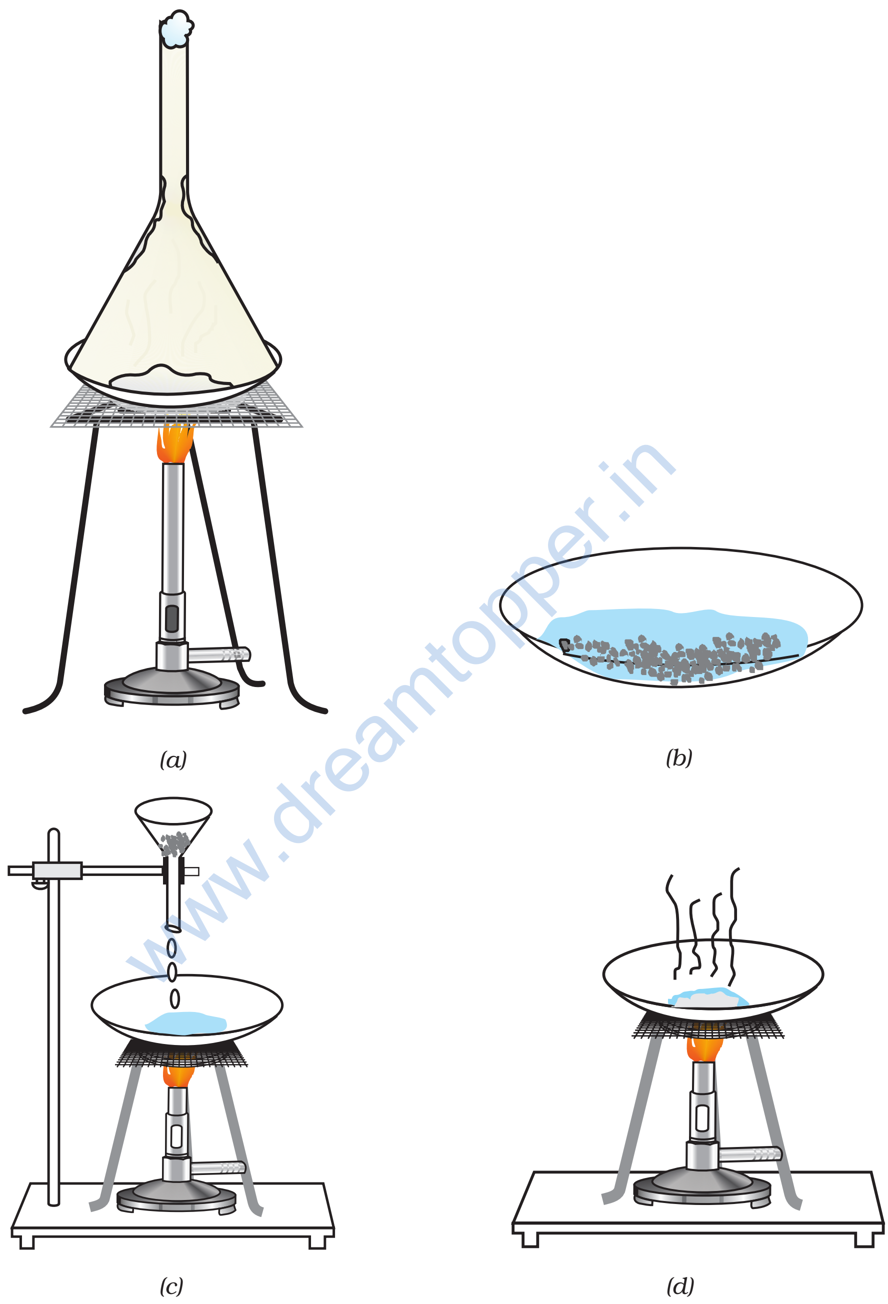


Fig. 11.1 : *Separation of components of a mixture of ammonium chloride, sand and common salt. (a) Separation of ammonium chloride by sublimation; (b) Residue containing sand and common salt dissolved in water; (c) Separation of sand by filtration; and (d) Obtaining common salt by evaporation*

2. Set up a sublimation apparatus as shown in Fig. 11.1(a).
3. Heat the mixture. Ammonium chloride will be separated on the walls of the inverted funnel.
4. The residue left behind in the china dish contains sand and common salt.
5. Dissolve this residue mixture in water. Common salt will dissolve but sand will not [Fig. 11.1(b)].
6. Filter the sand from the mixture using a filter paper [Fig. 11.1(c)].
7. Sand is separated as residue and the filterate is salt solution in water.
8. Heat the filterate (salt solution) to evaporate the water and to get the dry sample of common salt [Fig. 11.1(d)].

Results and Discussion

Using methods of separation sequentially, ammonium chloride, sand and common salt have been separated from their mixture.

Precautions

- Sublimation process should be carried out carefully.
- Take care while filtering so that the filter paper does not tear off.

Note for the Teacher

- If soil is taken instead of sand for formation of mixture, it will form colloidal solution and clear filterate may not be obtained.
- As in the laboratory the sublimation apparatus is not air tight, recovery of ammonium chloride will not be 100%.
- The outer surface of funnel must be covered with wet cotton to separate sublimation product (ammonium chloride in this case) easily.
- To make the process of separation easily workable, it is desired that one water soluble component be separated by a process other than solubility and that is sublimation in this experiement.

QUESTIONS

- If in the first step the mixture had been dissolved in water what would have been the difficulty in separation.
- Instead of common salt if one component in the given mixture is sulphur, how would you carry out separation process then?
- Can the two components of a mixture that are soluble in water be separated by any technique? Justify your answer.

Experiment 12

AIM

To prepare solutions of various substances and to identify them as true solutions and suspensions.

THEORY

A true solution is a homogeneous mixture of two or more substances. The solute and solvent particles can not be observed by the naked eye as they are very small (of the order of 1nm). A suspension is a hetrogeneous mixture of two or more substances. The solute particles of a suspension are often visible by the naked eyes as the size of particles is more than 0.1 mm.

MATERIALS REQUIRED

Powder samples of sodium chloride (or common salt), sugar, baking soda, chalk powder, sand, and sulphur etc., a beaker (250 mL), water, and a glass stirrer rod.

PROCEDURE

1. Take a small amount of a solid sample as solute.
2. Dissolve it in 100 mL water taken in a beaker with the help of a glass stirrer rod. Stir the mixture for some time.
3. Allow it to stand for some time.

4. Observe and record whether the mixture formed is homogeneous or heterogeneous.
5. Repeat the experiment for different solid solutes.

OBSERVATIONS

Sl. No.	Solute	Homogenous or heterogeneous	Type of mixture formed (true solution or suspension)
1.			
2.			
3.			
4.			

RESULTS AND DISCUSSION

(a) Samples ___________, ___________, ___________, form true solution in water. Which are homogeneous.

(b) Samples ___________, ___________ form suspension in water.

NOTE FOR THE TEACHER

- Students may be provided fine powder samples.
- If a light beam from a torch is passed through suspensions, scattering of light may also be observed.

QUESTIONS

- Why are the particles of a true solution not visible to naked eye?
- What is the order of the size of a particle that can be seen by naked eyes?
- What different techniques of seperation can be employed for separation of components of homogeneous and heterogeneous mixture?
- What will be your observation, when a beam of light is passed through a true solution and through a suspension respectively?

Experiment 13

Aim

To prepare a colloidal solution of sulphur and differentiate it from a true solution or from a suspension on the basis of transparency and filtration.

Theory

A collodial solution of sulphur in water can be obtained by the oxidation of hydrogen sulphide by nitric acid.

$$H_2S\ (aq) + 2HNO_3\ (aq) \longrightarrow 2H_2O\ (l) + S\ (s) + 2NO_2\ (g)$$

A true solution is homogenous and transparent. It can be completely filtered through a filter paper. It remains stable on standing.

A colloidol solution is heterogenous, it appears translucent. It can be filtered completely through filter paper. Here solute particles do not easily settle down on standing.

A suspension is heterogenous mixture. The particles of a suspension are visible to the naked eye. They settle down on standing and can be separated by filtration.

Materials Required

Kipp's apparatus to get hydrogen sulphide gas, concentrated nitric acid, common salt, chalk powder, funnel, four boiling tubes, glass rod, test tube stand, and filter paper.

Procedure

(i) Preparation of Colloidal Solution of Sulphur

1. Take about 20 mL distilled water in a boiling tube and pass H_2S gas through it for about 5 minutes. The solution would smell like a rotten egg.

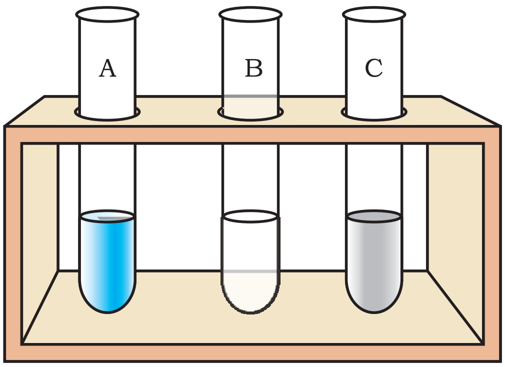


Fig. 13.1

2. Add few drops of concentrated nitric acid in it. Stir the solution. Continue adding few more drops of nitric acid untill solution becomes milky.
3. Transfer the contents into a another clean boiling tube. Label this boiling tube as tube A.

(ii) Preparation of True Solution

4. Take about 20 mL distilled water in a clean boiling tube.
5. Add approximately 1- 2 g of sodium chloride (or common salt) into it.
6. Stir the solution till it becomes clear. Label this boiling tube as tube B.

(iii) Preparation of suspension

7. Take about 20 mL of distilled water in another clean boiling tube.
8. Add approximately 1- 2 g of powdered chalk into it.
9. Stir the mixture with the help of glass rod. Label this boiling tube as tube C.

Observations

Sl.No.	Experiment	Boiling tube	Inference
1.	**Transparency**	A	
	Observe the contents of	B	
	different boiling tubes	C	
2.	**Filtration**		
	Filter the contents of	A	
	different tubes through	B	
	an ordinary filter paper	C	

Results and Discussion

Colloidal and suspension are heterogenous mixtures where as true solutions are homogenous mixtures. They differ form each other only on the basis of their particle size.

Note for the teacher

- Arrangement for the preparation of H_2S gas may be done in advance in the laboratory using the Kipp's apparatus. It requires ferrous sulphide and conc. sulphuric acid.
- When sulphur is formed by an insitu reaction the particle size is in the colloidal range as particles of sulphur remain aggregate in water, forming a colloidal solution.
- Sulphur can form true solution in carbon tetrachloride or carbon disulphide solvent.
- A suspension of sulphur can be formed in water by mixing sulphur powder in distilled water.
- Colloidal solution of sulphur can also be obtained by adding dil. HCl or conc. H_2SO_4 to sodium thiosulphate solution

$$\underset{\substack{\text{(sodium thiosulphate}\\ \text{or hypo solution)}}}{Na_2S_2O_3} + 2HCl \rightarrow 2NaCl + SO_2 + \underset{\substack{\text{(colloidal}\\ \text{sulphur)}}}{S} + H_2O$$

Questions

- What will be the effect of passing light through colloidal solution of sulphur?
- What is the difference in the particle size of colloid, true solution and suspension.
- Classify the following as a true solution, as a suspension, or as a colloid: (i) milk; (ii) $CuSO_4$ solution; (iii) jam; (iv) gum; (v) soil in water; and (vi) sand in water

Experiment 14

AIM

To study the process of separation of a mixture of two immiscible liquids.

THEORY

The separation of two immiscible liquids by a separating funnel depends on the difference in their densities. A less denser liquid floats over a liquid whose density is more.

MATERIALS REQUIRED

Separating funnel (250 mL)(with its stop-cock), two beakers (250 mL), and two immiscible liquids such as water and kerosene.

PROCEDURE

1. Take a mixture of two immiscible liquids (say water and kerosene) in a separating funnel (Fig. 14.1).
2. Allow it to stand for some time.
3. The mixture separates into two liquid layers according to their densities.
4. Collect the lower layer carefully in a beaker by opening the stop-cock of the separating funnel.
5. Similarly collect the upper layer in another beaker.

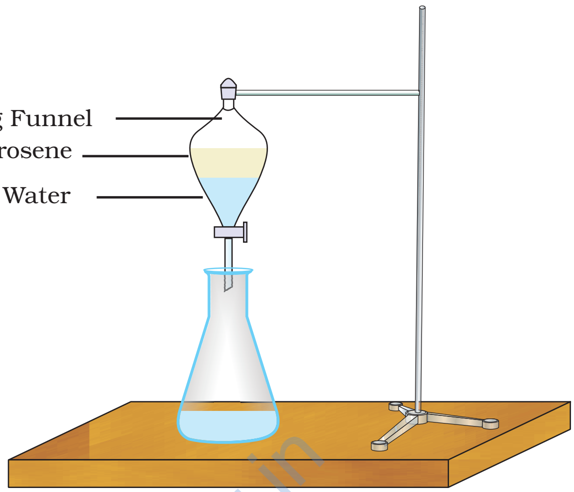


Fig. 14.1 : *Separation of immiscible liquids*

Results and Discussion

Water and kerosene are immiscible and can be separated by using separating funnel. Miscibility and immiscibility of liquid pairs depends upon the effectiveness of intermolecular interaction.

Note for the Teacher

- It is essential to remove the lid of the separating funnel while opening the stop cock of the separating funnel.
- In order to get the two components in pure form, it is advisable to discard a part of the mixture at the junction of the two layers.

Questions

- Arrange the two liquids used in the above experiment according to the increasing order of their densities?
- Think of a technique that you can use to separate the above immiscible liquids if separating funnel is not available?
- Is the mixture used in the above experiment heterogenous or homogenous in nature?
- Which of the two sea water or pure water has got higher density?
- Can there be any way of varifying that lower layer in the separating funnel is water layer. Explain either way.

Experiment 15

Aim

To separate a mixture of two miscible liquids by simple distillation.

Theory

The separation of two miscible liquids (having at least a difference in their boiling points of 25 K) can be separated by a simple distillation method. Distillation depends on the difference in their boiling points. The liquid which has lower boiling point evaporates first and faster than the liquid which has a higher boiling point.

Materials Required

Mixture of two miscible liquids (water and acetone), measuring cylinder, a round bottom flask (250 mL), thermometer (-10 °C - 110 °C), condenser, two beakers (250 mL), burner, tripod stand, and a wire gauge.

Procedure

1. Take a mixture of 50 mL water and 50 mL acetone in a round bottom flask.
2. Arrange the apparatus as shown in the Fig. 15.1.
3. Heat the mixture of acetone and water slowly and carefully monitor the rise in temperature.

4. Observe and note the temperature at which the first component of the mixture distils out, that is, vapours get cooled and collected in a beaker kept at the other end of the condenser.
5. Continue heating and similarly observe and note the temperature at which the second component distills out.

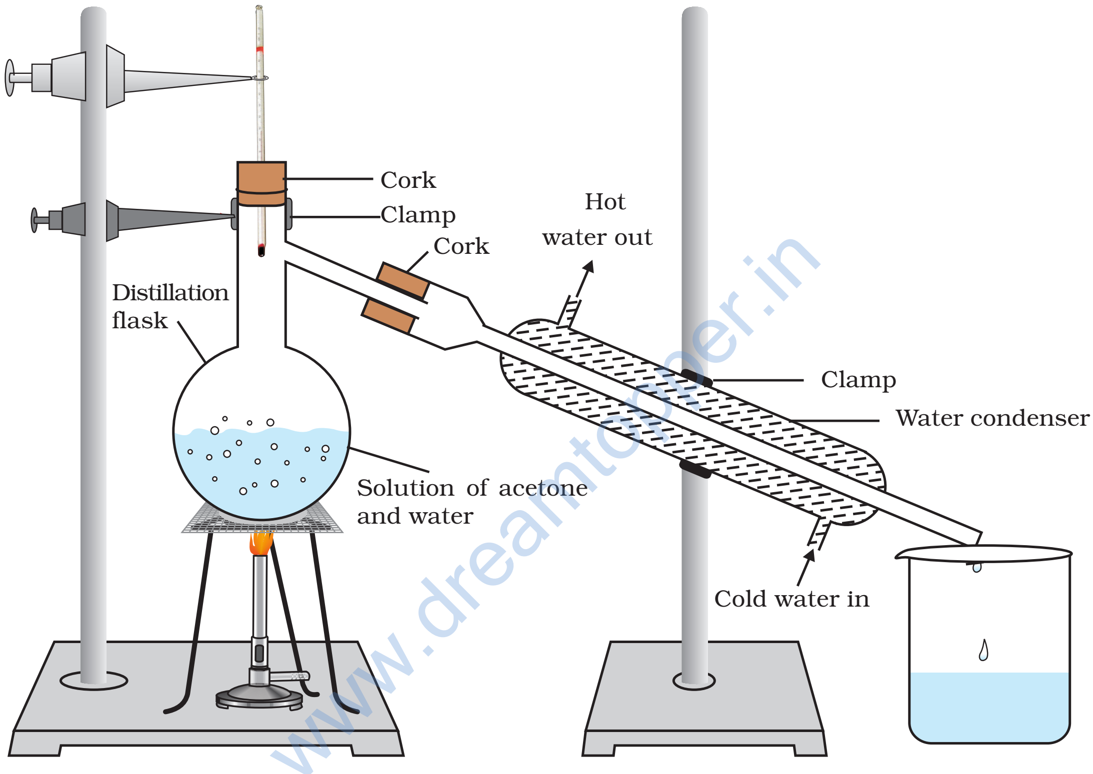


Fig. 15.1 : *Laboratory apparatus for distillation*

OBSERVATIONS

	Component I	Component II
Temperature Name of the component		

Results and Discussion

The two components of the miscible liquids are separated by distillation. The difference in the boiling points of the liquids depend upon the attraction between the particles of the liquid.

Note for the Teacher

- The intermediate fraction may be rejected as it may contain both the components.
- For distillation, in place of round bottom flask and condenser, a distillation apparatus is easy to use.
- The process of distillation can be stopped after the separation of first component, as the second component of the mixture is left in the round bottomed flask.
- A discussion on the difference between bottled mineral water and distilled water may be initiated in the class room.

Questions

- In the above experiment you have found the boiling points of water and acetone. Use this information to arrange acetone and water in the order of (i) increasing force of attraction between the particles of water (water-water); particles of acetone (acetone-acetone); and (ii) increasing densities.
- You are provided with a mixture of methanol and ethanol having boiling points 61 °C and 78 °C respectively. Can you separate the two components by simple distillation method? Explain.
- You are given a sample of tap water, suggest a technique for obtaining pure and salt free water (distilled water) from it?
- What is the natural technique of obtaining distilled water from the nature?
- What is the utility of acetone in daily life?

Experiment 16

Aim

To differentiate between a mixture (containing two components) and a pure compound.

Theory

The components of a mixture retain their individual properties. In a mixture these components can have any ratio while components of a mixture lose their individual properties once the compound is formed. Ratio of components in a compound is fixed. Merely mixing two components is a physical change and converting these into a compound is a chemical change.

Materials Required

Sulphur powder, iron filings, dil. hydrochloric acid (or dil. sulphuric acid), lead acetate solution, carbon disulphide solvent, a bar magnet, two beaker (100 mL), three test tubes, china dish, watch glass, glass rod, filter paper, tripod stand, burner, wire gauge, splinter (or candle), and a mortor and pestle.

Procedure

1. Take iron fillings (5.6 g) and sulphur powder (3.2 g) in a beaker. Mix them properly. Label this mixture as A.

2. Take half of this mixture A in a china dish and heat it slowly with constant stirring untill black mass is formed.
3. Cool the contents of china dish.
4. Grind the black mass with the help of mortar and pestle and put it in another beaker and mark it as B.
5. Perform various tests (as suggested in the table below) with samples A and B and record your observations.

OBSERVATIONS

Sl. No.	Experiment	Observation with sample		Inference
		A	B	
1.	**Magnet test** Move a magnet over the sample A and powdered black mass in sample B several times.			
2.	**Gas test** Take a small amount of mixture from sample A in a test tube and add 5 mL dil. hydrochloric acid or dil. H_2SO_4 carefully. Test the evolved gas by (a) bring a burning splinter or lighted candle near the mouth of the test tube; (b) bring a filter paper dipped in lead acetate solution near the mouth of the test tube. Repeat the same test with sample B.			
3.	**Solubility test** Take a pinch of A and B in test tubes. Add 5 mL carbon disulpide (CS_2) and shake the mixture. Filter the solution.			

PRECAUTIONS

- Do not inhale hydrogen sulphide gas as it a poisonous gas.
- Carbon disulphide is inflammable, so keep it away form the flame.

Note for the Teacher

- In order to simplify the performance part of this experiment, it is suggested that 5.6 g of iron filings and 3.2 g of sulphur powder may be provided to the students.
- It is important to maintain the proper stoichiometry in the reaction of iron with sulphur. In case of excess iron the product will be attracted towards magnet.
- A mixture containing iron and sulphur shows the properties of both its contituents. Iron filings are attracted towards a bar magnet and react with dil. hydrochloric acid or dil. sulphuric acid to liberate hydrogen. Hydrogen burns with the pop sound at the mouth of the test tube. This reaction is highly exothermic and therefore, must be performed carefully.

$$2Fe\ (s) + 6HCl\ (aq) \longrightarrow 2FeCl_3\ (aq) + 3H_2\ (g);$$

$$2Fe\ (s) + 3H_2SO_4\ (aq) \longrightarrow Fe_2(SO_4)_3\ (aq) + 3H_2\ (g);$$

Sulphur is soluble in non polar solvent like carbon disulphide (CS_2). The compound iron sulphide (FeS) is formed on heating iron (Fe) and sulphur (S).

$$Fe\ (s) + S\ (s) \xrightarrow{heat} FeS\ (s)$$

Iron sulphide reacts with dilute hydrochloric acid forms hydrogen sulphide (H_2S) gas which turns lead acetate paper into shiny black. Iron sulphide is insoluble in carbon disulphide solvent.

$$2FeS\ (s) + 2HCl\ (aq) \longrightarrow 2FeCl_2\ (aq) + H_2S\ (g);$$

$$2FeS\ (s) + H_2SO_4\ (aq) \longrightarrow 2FeSO_4\ (aq) + H_2S\ (g);$$

$$(CH_3COO)_2\ Pb\ (aq) + H_2S\ (g) \longrightarrow \underset{(Black)}{PbS\ (s)} + 2CH_3COOH\ (aq).$$

Questions

- How would you proceed to test that a mixture of NH_4Cl and $CuSO_4$ give test for NH_4^+, Cl^-, Cu^{2+} and SO_4^{2-} ions?
- Which one is the more appropriate statement amongst the following and Why? (i) Air is an oxidising agent; (ii) Oxygen of the air is an oxidising agent.
- Why does brass react with dilute hydrochloric acid and is corroded in rainy season to form $CuCO_3$. $Cu(OH)_2$?

Experiment 17

AIM

To verify the law of conservation of mass in a chemical reaction.

THEORY

Law of conservation of mass states that the mass remains conserved during a chemical reaction. In this experiment we shall verify the law of conservation of mass using a precipitation reaction. This reaction is considered as the simplest method to verify this law.

MATERIALS REQUIRED

Barium chloride ($BaCl_2.2H_2O$), sodium sulphate ($Na_2SO_4.10H_2O$), distilled water, two beakers (150 mL), one beaker (250 mL), physical balance, spring balance (0 – 500 g) and a polythene bag, two watch glasses of known masses, and a glass stirrer.

PROCEDURE

1. Pour 100 mL distilled water in two beakers (150 mL).
2. Using the physical balance and a watch glass of known mass, weigh 7.2 g of $BaCl_2.2H_2O$ and dissolve it in a beaker (150 mL) containing 100 mL distilled water.
3. Similarly, weigh 16.1 g of $Na_2SO_4.10H_2O$ in another watch glass of known mass and dissolve it in another beaker (150 mL) containing 100 mL distilled water.

4. Take the third beaker (250 mL) and weigh it using a spring balance and polythene bag (see Experiment no. 3 for details).
5. Mix both solutions of 150 mL beakers in the third beaker (250 mL). Mix the contents using a glass stirrer.
6. On mixing white precipitate of $BaSO_4$ appears due to precipitation reaction.
7. Weigh the beaker containing the reaction mixture again to determine the mass of the precipitation reaction products.
8. Compare the masses of before and after the chemical reaction.

Observations

(i)	Mass of 100 mL distilled water (The density of distilled water is 1 g/mL.)	= 100.0 g
(ii)	Mass of $BaCl_2.2H_2O$	= 7.2 g
(iii)	Mass of $BaCl_2$ solution	= 107.2 g
(iv)	Mass of $Na_2SO_4.10H_2O$	= 16.1 g
(v)	Mass of Na_2SO_4 solution	= 116.1 g
(vi)	Total Mass of reactants (solutions of $BaCl_2$ and Na_2SO_4)	= 223.3 g
(vii)	Mass of empty 250 mL beaker, m_1	= _____ g
(viii)	Initial mass of reaction mixture and empty beaker (before the precipitation), $m_2 = (m_1 + 223.3\text{ g})$	= _____ g
(ix)	Final mass of reaction mixture in the beaker after the precipitation, m_3	= _____ g.

Results and Discussion

Compare the initial mass (m_2) of the reaction mixture (before the precipitation) with the final mass (m_3) of the reaction mixture (after the precipitation). Are they same? If the two masses are same within the reasonable limits, then the law of conservation of mass stands verified. The verification of the law rests on accurate mass measurements in the laboratory.

The chemical reaction involved is

$$BaCl_2\,(aq) + Na_2SO_4\,(aq) \longrightarrow \underset{\text{White precipitate}}{BaSO_4\,(s)} + 2NaCl\,(aq)$$

and more precisely

$$Ba^{2+}\,(aq) + SO_4^{2-}\,(aq) \longrightarrow BaSO_4\,(s)$$

PRECAUTIONS

- The spring balance should be held vertical while taking measurements.
- Before making use of the spring balance it must be ensured that its pointer is at zero mark. If not then ask your teacher to help.
- The readings of the spring balance should be noted only when its pointer comes to rest.
- Mixing of barium chloride and sodium sulphate solutions be done slowly with constant stirring.

NOTE FOR THE TEACHER

A physical balance is a sophisticated equipment. It is advised that students may be trained to use a physical balance and they must be properly supervised while they use the physical balance. This experiment involves several weighings that may take lot of time. In case if the weighing measurements takes lot of time, the required quantities of barium chloride and sodium sulphate may be provided to the students on two separate watch glasses. This will facilitate students to concentrate on the reaction dynamics rather than on the weighing skills.

QUESTIONS

- What are the other precipitation reactions that can be conveniently studied in the laboratory to verify this law?
- How can the law be verified by studying combination reaction? Suggest a procedure for the same.