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SOLUTIONS BOOK

CLASS 9

Science · Exploration

CHAPTER 5

Exploring Mixtures and their Separation

Complete Questions and Activities Solutions

In-text Questions | Revise, Reflect, Refine | The Journey Beyond

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Every question is followed by its answer. Question numbers above are clickable and the PDF bookmarks panel lets you jump to any exercise set or question. Figures are reproduced from the NCERT textbook (© NCERT) for educational use.

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5.1

CLASS 9 SCIENCE · CHAPTER 5

In-text Questions

Solutions · 55 questions

Directions (Questions 1–55): These are the questions that appear inside the chapter (Think It Over, activities, Pause and Ponder, Think as a Scientist, Ready to Go Beyond and other in-text questions), numbered in the order in which they appear. Many are open-ended or activity-based; model answers based on the chapter are given, and you may add examples from your own surroundings.

QUESTION 1 *Think It Over · p. 72*

Why do suspended particles settle in muddy water over time but not in milk?

ANSWER

Muddy water is a suspension, whereas milk is a colloid. The difference lies in the size of the particles.

a Muddy water (suspension)

- The particles of mud are large (more than 1000 nm in diameter) and can be seen with the naked eye.
- Being heavy, they are pulled down by gravity and slowly settle at the bottom, leaving clearer water above.

b Milk (colloid)

- The particles in milk are much smaller (1–1000 nm) and remain uniformly dispersed throughout the liquid.
- Unlike the particles of a suspension, the particles of a colloid do not settle over time. Proteins in milk also act as emulsifying agents and keep it stable.

Therefore, large mud particles settle under gravity, but the tiny particles in milk stay dispersed and do not settle.

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QUESTION 2 *Think It Over · p. 72*

How is evaporation different from boiling?

ANSWER

In both processes a liquid changes into vapour, but they differ in where, when and how fast this happens.

Point	Evaporation	Boiling
Where it occurs	Only at the surface of the liquid	Throughout the liquid; bubbles of vapour form inside
Temperature	At any temperature below the boiling point	Only at a fixed temperature, the boiling point
Speed	Slow and gradual	Rapid
Heating	Does not need continuous heating; heat is taken from the surroundings	Needs continuous heating
Example	Wet clothes drying; salt left behind when salt solution dries	Water bubbling in a kettle or in a distillation flask

Therefore, evaporation is a slow surface process at any temperature, whereas boiling is rapid vaporisation throughout the liquid at its boiling point.

QUESTION 3 *Think It Over · p. 72*

Why do you see bright rays of sunlight when it passes through small gaps between the leaves of a dense tree?

ANSWER

We see the rays because of the Tyndall effect, the scattering of light by particles.

- The air around a tree contains tiny particles such as dust, smoke and fine water droplets.
- When sunlight passes through the small gaps between the leaves, these particles scatter (spread) the light in all directions, so the path of the beam becomes visible as bright rays.
- The same thing happened with the laser beam in the suspension (B) and the colloid (C) of Activity 5.1. A transparent solution does not scatter light, so its beam path is not visible.

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Therefore, bright rays are seen because dust and water droplets in the air scatter sunlight (Tyndall effect).

QUESTION 4 *Section 5.1 · p. 73*

Is the mixture of oil and water homogeneous or heterogeneous? Can you think of some other heterogeneous mixtures?

ANSWER

The mixture of oil and water is heterogeneous.

a Why it is heterogeneous

- Oil and water do not mix; they form two separate layers with the oil floating on the water.
- Its composition is not uniform throughout, which is the mark of a heterogeneous mixture.

b Other heterogeneous mixtures

- Sand and water; chalk powder and water; muddy water.
- Sawdust or tea leaves in water; iron filings and sulfur.
- Smoke, fog and dust in air (heterogeneous mixtures with a gas as one component).

Therefore, oil and water form a heterogeneous mixture because they stay as two separate layers.

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QUESTION 5 *Activity 5.1 · p. 73*

Divide the class into three groups — A, B and C. Group A: one spatula of common salt in 50 mL of water. Group B: one spatula of chalk powder in 50 mL of water. Group C: a few drops of milk in 50 mL of water. Stir each well and label A, B and C.
4. Are the particles visible in each mixture? Record your observations.
5. Direct the light from a laser pointer through the beakers (Fig. 5.3) and observe it from the side, perpendicular to the beam. Record your observations.
6. Predict what you would observe in each beaker if you leave them undisturbed for a few minutes.

ANSWER

The three beakers hold three different kinds of mixture: a solution (A), a suspension (B) and a colloid (C). Their observations differ.

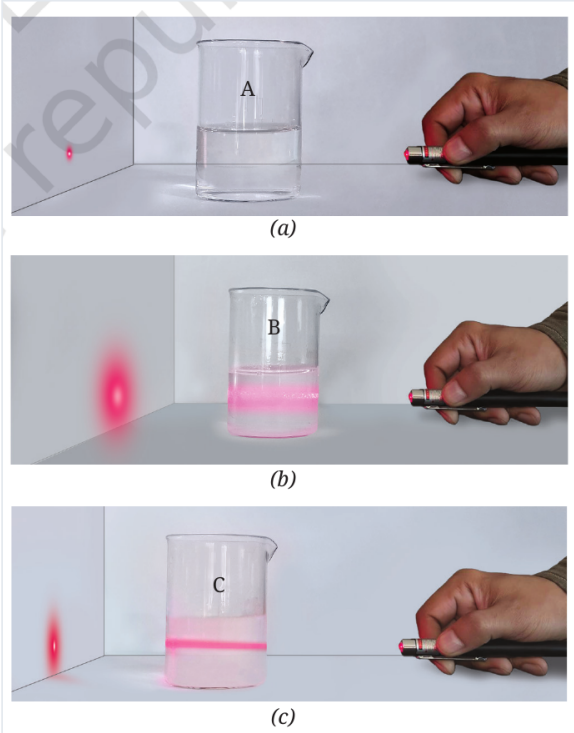


Fig. 5.3. Passing laser light through (a) salt and water, (b) chalk powder and water, and (c) milk and water

Beaker	Particles visible?	Path of laser beam	Prediction (a few minutes)	Mixture type
A: salt + water	No; clear and transparent	Not visible; no scattering	No change; stays clear	Solution

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Beaker	Particles visible?	Path of laser beam	Prediction (a few minutes)	Mixture type
B: chalk powder + water	Yes; chalk particles are visible, mixture is cloudy	Visible; light is scattered	Chalk settles at the bottom	Suspension
C: milk + water	Individual particles not visible; looks uniformly milky	Visible; light is scattered	Does not settle; stays uniform	Colloid

Therefore, only B and C scatter the laser beam, and only B settles on standing.

QUESTION 6 *Activity 5.1 · p. 74*

7. Set up a filtration apparatus and filter each mixture separately. Is there any residue left on the filter paper?
8. Based on your observations, do you think these are the same types of mixtures or are they different?

ANSWER

Filtration shows which particles are large enough to be held back by the filter paper.

Mixture	Residue on filter paper?	Conclusion
A: salt and water	No residue; the clear liquid passes through	Solution
B: chalk powder and water	Yes; white chalk is left on the filter paper	Suspension
C: milk and water	No visible residue; the milky liquid passes through	Colloid

a **Are they the same type?**

- No, they are different types of mixtures. A is a solution, B is a suspension and C is a colloid.
- They differ in particle size, in settling, in the Tyndall effect and in separation by filtration.

Therefore, the three mixtures are of different types: solution (A), suspension (B) and colloid (C).

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QUESTION 7 *Section 5.2 · p. 74*

In what proportion are a solute and a solvent present in a solution? Can these be expressed quantitatively?

ANSWER

Yes. The proportion is expressed as the concentration of the solution, usually as a percentage.

- Concentration is the amount of solute dissolved in a given amount of solvent or solution.
- The chapter uses three percentage methods, given below.

Method	Meaning	Formula	Used for
Mass by mass (% m/m)	Grams of solute in 100 g of solution	(Mass of solute ÷ Mass of solution) × 100	Homogeneous and heterogeneous mixtures; labels of packaged foods
Mass by volume (% m/v)	Grams of solute in 100 mL of solution	(Mass of solute ÷ Volume of solution) × 100	Medicines and laboratories, where measuring volume is easier
Volume by volume (% v/v)	mL of solute in 100 mL of solution	(Volume of solute ÷ Volume of solution) × 100	Two miscible liquids, e.g. perfumes, vinegar

Therefore, the proportion of solute in a solution can be expressed quantitatively as its concentration.

QUESTION 8 *Section 5.2.1 · p. 74*

When farmers spray pesticides on their crops, they must mix the right amount of pesticide with a fixed amount of water to prepare a solution. If they do not do so, what is likely to happen?

ANSWER

Both too little and too much pesticide are harmful, so the proportion must be correct.

- Too little pesticide may not protect the crops.

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- Too much pesticide can damage the crops, the soil and the environment.

Therefore, the pesticide and water must be mixed in the right proportion (concentration).

QUESTION 9 *Section 5.2.1 · p. 74*

Can you think of other such examples? (where the right proportion is essential when preparing a solution)

ANSWER

Many everyday and professional activities depend on the right concentration. Some examples are given below.

- Oral Rehydration Solution (ORS): specified amounts of salt and sugar in a fixed amount of water; otherwise it is not ORS.
- Hospital drips: 0.9 % m/v saline and 5 % m/v glucose solutions.
- Medicines and syrups, where the dose depends on the concentration.
- Vinegar for food, with about 5 % v/v acetic acid.
- Making a cup of tea or sherbet: too much or too little sugar changes the taste.
- Diluting an orange juice concentrate with water before serving.

Therefore, correct proportions matter in medicine, agriculture, food and daily life.

QUESTION 10 *Section 5.2.2 · p. 74*

Collect some commercial packaged products (Fig. 5.4) and note down the information given for each item.

ANSWER

Packaged products state their composition. The three products shown in Fig. 5.4 are summarised below; you can add products from your own home.

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Product (Fig. 5.4)	Information given on the pack	How concentration is expressed
Milk powder	Average per 100 g: fat 26 g, sugars 49 g, fibre 0 g, protein 15.5 g, sodium 0.8 g	Mass by mass (% m/m), i.e. grams per 100 g
Glucose intravenous infusion	5 % w/v; each 500 mL bottle contains 25 g glucose	Mass by volume (% m/v)
White vinegar	5 % v/v acetic acid; 100 mL pack	Volume by volume (% v/v)
Saline drip (Fig. 5.5)	0.9 % m/v sodium chloride; 100 mL bottle contains 0.9 g	Mass by volume (% m/v)

- Check: 25 g in 500 mL is 5 g in 100 mL, so the glucose infusion is 5 % m/v.
- Look for the same kind of information on juice packs, medicines or cosmetics at home and note which method each uses.

Therefore, % m/m, % m/v and % v/v are all used on commercial products.

QUESTION 11 *Example 5.1 · p. 75*

If 10 g of salt is dissolved in 90 g of water, calculate the mass by mass percentage of the solution formed.

ANSWER

Mass by mass percentage = (Mass of solute ÷ Mass of solution) × 100

Step	Working
Mass of solute (salt)	10 g
Mass of solvent (water)	90 g
Mass of solution	10 g + 90 g = 100 g
Mass by mass percentage	(10 g ÷ 100 g) × 100 = 10 % m/m
Check	10 g of salt in every 100 g of solution, so 10 %

Therefore, the concentration of the salt solution is 10 % m/m.

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QUESTION 12 *Example 5.2 · p. 75*

If 5 g of glucose is dissolved in water to make 100 mL of solution, calculate its concentration in mass by volume percentage.

ANSWER

Mass by volume percentage = (Mass of solute ÷ Volume of solution) × 100

Step	Working
Mass of glucose (solute)	5 g
Volume of solution	100 mL
Mass by volume percentage	(5 g ÷ 100 mL) × 100 = 5 % m/v
Check	5 g of glucose in 100 mL, so 5 % m/v

Therefore, the glucose solution is 5 % m/v.

QUESTION 13 *Example 5.3 · p. 76*

If 1 mL of a liquid pesticide is mixed with a sufficient amount of water to form 100 mL of a pesticide spray for rice crop, calculate its volume by volume percentage.

ANSWER

Volume by volume percentage = (Volume of solute ÷ Volume of solution) × 100

Step	Working
Volume of pesticide (solute)	1 mL
Total volume of solution	100 mL
Volume by volume percentage	(1 mL ÷ 100 mL) × 100 = 1 % v/v
Check	1 mL of pesticide in 100 mL of spray, so 1 % v/v

Therefore, the pesticide spray is 1 % v/v.

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QUESTION 14 *Pause and Ponder 1 · p. 76*

A common talcum powder contains 4 % m/m zinc oxide, which acts as an antiseptic. How much zinc oxide is present in 300 g of the talcum powder?

ANSWER

4 % m/m means 4 g of zinc oxide in every 100 g of talcum powder.

Step	Working
Given	Concentration = 4 % m/m; mass of powder = 300 g
Formula	Mass of solute = (% m/m ÷ 100) × Mass of mixture
Calculation	Mass of zinc oxide = (4 ÷ 100) × 300 g = 12 g
Check	(12 g ÷ 300 g) × 100 = 4 %

Therefore, 300 g of talcum powder contains 12 g of zinc oxide.

QUESTION 15 *Pause and Ponder 2 · p. 76*

Your mother gives you a bottle of orange juice concentrate to mix with water and serve it to your visiting friends. She asks you to mix two tablespoons of the concentrate with water in a glass tumbler. If each tablespoon measures 15 mL and you make 150 mL of juice per person, what is the % v/v of orange juice concentrate in the mixture you prepared?

ANSWER

The concentrate is the solute and the final juice is the solution.

Step	Working
Volume of concentrate (solute)	2 × 15 mL = 30 mL
Volume of juice (solution)	150 mL
Volume by volume percentage	(30 mL ÷ 150 mL) × 100 = 20 % v/v

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Step	Working
Check	Water added = 150 − 30 = 120 mL; 30 mL is one-fifth of 150 mL, i.e. 20 %

Therefore, the juice is 20 % v/v orange juice concentrate.

QUESTION 16 *Pause and Ponder 3 · p. 76*

Vinegar, used as a food preservative and additive, contains 5 % v/v acetic acid. Glacial acetic acid is a liquid, i.e., 100 % acetic acid. If you want to make vinegar from glacial acetic acid, how would you proceed?

ANSWER

5 % v/v means 5 mL of acetic acid in every 100 mL of vinegar. So the glacial acetic acid must be diluted 20 times.

Step	Working
1. Measure the acid	Measure 5 mL of glacial acetic acid with a measuring cylinder (under adult supervision; it is corrosive)
2. Dilute	Pour it into some water in a beaker (add acid to water), mix, then add more water until the total volume is 100 mL
3. Mix	Stir well to get a uniform solution
Check	(5 mL ÷ 100 mL) × 100 = 5 % v/v
Larger batch	50 mL of glacial acetic acid made up to 1 litre with water also gives 5 % v/v

Therefore, dilute 5 mL of glacial acetic acid with water to make 100 mL of solution to get 5 % v/v vinegar.

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QUESTION 17 *Section 5.2.3 · p. 76*

A solution that cannot dissolve any more solute at that temperature is called a saturated solution. Why do we mention the temperature?

ANSWER

Solubility depends on temperature, so a solution that is saturated at one temperature need not be saturated at another.

- For a solid solute in a liquid solvent, solubility generally increases with temperature.
- For a gas dissolved in a liquid, solubility generally decreases as the temperature rises.
- Solubility is the maximum amount of solute that dissolves in a fixed quantity of solvent (100 mL or 100 g) at a given temperature; it is an important property used to separate substances from mixtures.

Therefore, the temperature is mentioned because solubility changes with temperature.

QUESTION 18 *Activity 5.2 · p. 77*

Based on the information from the above graph (Fig. 5.6), predict which of the two compounds, 'A' or 'B', will dissolve more in a given amount of water at a given temperature?

ANSWER

Compound 'B' will dissolve more.

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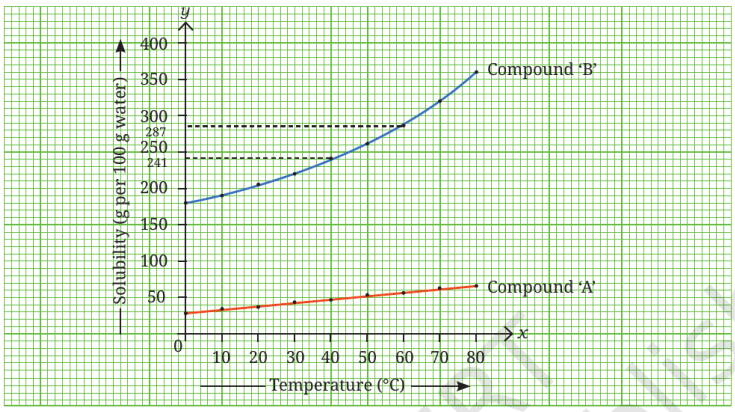


Fig. 5.6: Solubility curves of compounds 'A' and 'B' in water

- The curve of B lies far above the curve of A at every temperature shown (10 °C to 80 °C).
- For example, the solubility of B is 241 g per 100 g of water at 40 °C, and 287 g at 60 °C, whereas the curve of A stays at a small fraction of these values.

Therefore, compound B dissolves more than compound A in a given amount of water at any given temperature.

QUESTION 19 *Activity 5.2 · p. 77*

Observe Fig. 5.6 and fill in the blanks of the following statements:
(i) The solubility of compound 'A' in water at 20 °C is _____ (less than/more than/similar to) its solubility at 60 °C.
(ii) The solubility of compound 'B' at 20 °C is _____ (less than/more than/similar to) its solubility at 60 °C.
(iii) The solubility of _____ increases more than that of _____ with an increase in the temperature.

ANSWER

Both curves rise as the temperature rises, but the curve of B rises much more steeply.

Part	Answer	Reason from the graph
(i)	**less than**	The curve of A rises slowly, so at 20 °C it is lower than at 60 °C
(ii)	**less than**	The curve of B rises steeply; at 60 °C it is 287 g per 100 g of water, higher than at 20 °C

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Part	Answer	Reason from the graph
(iii)	The solubility of **compound B** increases more than that of **compound A**	B gains far more solute per 100 g of water for the same rise in temperature

Therefore, A: less than; B: less than; and the solubility of B increases more than that of A.

QUESTION 20 *Activity 5.2 · p. 77*

What do you think will happen if you make a saturated solution at a higher temperature and cool it slowly?
(Example from Section 5.3.1: a saturated solution of compound 'B' at 60 °C is prepared by dissolving 287 g of B in 100 g of water. What will happen if you gradually cool it to 40 °C?)

ANSWER

The excess solute will separate out as a pure solid, often as crystals.

Step	Working
Dissolved at 60 °C	287 g of B in 100 g of water (saturated)
Solubility at 40 °C (Fig. 5.6)	241 g per 100 g of water
Solid that separates	287 g − 241 g = 46 g of B comes out as crystals
Left in solution	241 g of B stays dissolved (saturated at 40 °C)

- On cooling, the solubility decreases, so the solution can no longer hold all the dissolved solute.
- A crystal is a solid made up of particles arranged in a regular geometric pattern. Slow cooling gives larger, well-shaped crystals.

Therefore, on slow cooling, the extra solute separates as crystals (46 g of B in the example). This is the principle of crystallization.

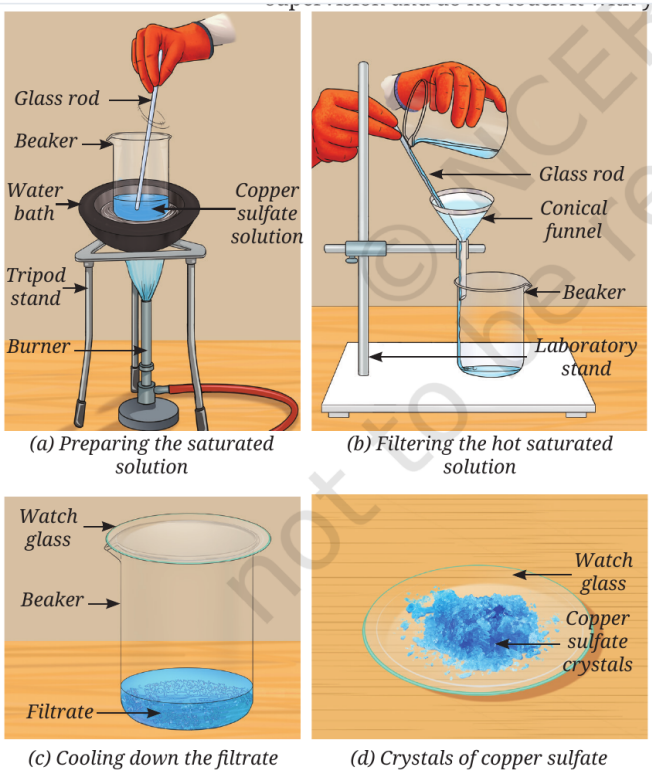
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QUESTION 21 *Activity 5.3 · p. 78*

Try creating your own crystals. Activity 5.3: Let us prepare — collect a sample of copper sulfate (blue vitriol); take 1 g in a 100 mL beaker with 25 mL of water and a drop of dilute sulfuric acid, heat in a water bath, make a saturated solution, filter it hot, cool slowly, then filter, rinse and dry the crystals (Fig. 5.8).

ANSWER

The activity makes crystals of copper sulfate by crystallization. Each step has a reason.



(a) Preparing the saturated solution (b) Filtering the hot saturated solution

(c) Cooling down the filtrate (d) Crystals of copper sulfate

Fig. 5.8: Steps involved in the process of crystallization

Step	Why it is done
Dissolve 1 g of copper sulfate in 25 mL of water; add a drop of dilute sulfuric acid; heat in a water bath while stirring	Heating helps the solid dissolve; sulfuric acid helps in making pure crystals by preventing unwanted reactions
Keep adding copper sulfate until no more dissolves	To get a saturated solution
Filter the hot solution and cover the filtrate with a watch glass	To remove insoluble impurities

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Step	Why it is done
Cool slowly without disturbing	Gives the particles time to come together, forming larger, shiny, well-shaped blue crystals
Filter the crystals, rinse with cold water, dry on a watch glass	To collect the pure crystals

a Result and safety

- Result: blue-coloured, shiny, well-shaped crystals of copper sulfate (Fig. 5.8d).
- Safety: copper sulfate is toxic. Work under adult supervision, do not touch it with bare hands, and let the teacher add the drop of sulfuric acid.
- If copper sulfate is unavailable, common salt can be used, but its solubility changes very little with temperature (Table 5.4), so crystals come mainly by evaporation.

Therefore, slow cooling of a hot saturated solution gives large, pure crystals.

QUESTION 22 *Section 5.3.1 · p. 79*

You may also try: 1. Place 1–2 mL of the saturated copper sulfate solution on a small glass plate or a lamination sheet. 2. Leave it for some time. What do you observe? Did you get crystals? If yes, is this a good way to experiment? Explain.

ANSWER

Yes, crystals of copper sulfate are obtained, but they are small.

a Observation

- The thin layer of solution has a large surface and evaporates quickly. Small blue crystals appear as the water goes away.

b Is it a good way to experiment?

- It is quick, needs very little chemical and shows crystals easily, so it is good for a rapid demonstration.
- But it is not good for good crystals: fast evaporation gives many small, poorly shaped crystals, and the impurities are not removed because the solution is not filtered or cooled slowly.

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Therefore, it shows crystal formation quickly, but slow cooling of a filtered solution is better for large, pure crystals.

QUESTION 23 *Think as a Scientist · p. 79*

If a hot, saturated solution of copper sulfate is cooled rapidly in ice-cold water, smaller and less well-formed crystals will form than if it is cooled slowly at room temperature. How would you design and perform an experiment to test this hypothesis? Hint: Prepare a hot saturated solution of copper sulfate and divide it into two equal parts.

ANSWER

The experiment compares two equal parts of the same solution that differ only in the rate of cooling.

Item	Plan
Hypothesis	Rapid cooling gives smaller, less well-formed crystals than slow cooling
Preparation	Make a hot saturated copper sulfate solution as in Activity 5.3 and filter it hot
Divide	Pour equal volumes into two identical beakers, X and Y, at the same starting temperature
Beaker X	Place in ice-cold water (rapid cooling)
Beaker Y	Cover with a watch glass and leave undisturbed at room temperature (slow cooling)
Kept the same	Solution, volume, beaker type, starting temperature and time
Observation	Filter and dry the crystals from each beaker; compare size and shape using a magnifying glass
Expected result	X: small, less well-formed crystals; Y: larger, well-shaped crystals, which supports the hypothesis

- Only one factor (the cooling rate) is changed, so any difference in the crystals is due to it.

Therefore, slow cooling should produce larger, better crystals than rapid cooling.

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QUESTION 24 *Pause and Ponder 4 · p. 79*

Refer to the solubility curves given in Activity 5.2. If equal masses of hot, saturated solutions of compounds ‘A’ and ‘B’ are cooled from 80 °C to 60 °C, which solution is likely to deposit more solid?

ANSWER

The solution of compound ‘B’ will deposit more solid.

- The amount that crystallises is the fall in solubility between 80 °C and 60 °C.
- In Fig. 5.6 the curve of B falls steeply over this range (about 70–80 g per 100 g of water), whereas the curve of A is nearly flat (only about 10 g per 100 g of water).

Therefore, B deposits more solid because its solubility changes much more with temperature.

QUESTION 25 *Pause and Ponder 5 · p. 79*

Will there be any change in the size of common salt crystals if the rate of evaporation is increased or decreased? Explain.

ANSWER

Yes, the size of the crystals changes with the rate of evaporation.

Rate of evaporation	Crystals formed	Reason
Increased (fast)	Smaller crystals, less regular	Salt separates quickly; particles get little time to arrange themselves
Decreased (slow)	Larger, better-shaped crystals	Particles have time to join the growing crystals in a regular pattern

- This is why salt from sea water is crystallised by evaporation (Activity 5.4): the solubility of common salt hardly changes with temperature, so cooling would give very little salt.

Therefore, slower evaporation gives larger salt crystals and faster evaporation gives smaller ones.

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QUESTION 26 *Activity 5.4 · p. 79*

Observe Fig. 5.9, it shows how salt crystals are obtained from seawater. Can you describe the process in your own words? (Seawater → Saturated solution → Salt crystals)

ANSWER

Salt is obtained from seawater by evaporating the water until the brine is saturated and salt crystallises.

Stage (Fig. 5.9)	What happens
Seawater	Sea water is collected in shallow open pans so that the sun and wind can evaporate the water
Saturated solution	As water evaporates, the salt solution becomes more concentrated until it is saturated (it cannot dissolve more salt)
Salt crystals	On further evaporation, the salt separates as crystals, which are collected and dried

- India’s coastal communities used this ancient method: the *karkatch* salt was made by evaporation of sea water, and the *panga* salt by boiling concentrated sea brines. Crystals of different sizes were produced.

Therefore, seawater gives salt crystals through evaporation, saturation and crystallization.

QUESTION 27 *Ready to Go Beyond · p. 79*

Have you visited a place where large crystal deposits can be observed in nature?

ANSWER

This is an open question; the answer depends on the places you have visited.

- The chapter says that large natural crystals are found in mines, caves and even within the Earth’s crust.

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- An example from the chapter is the Mawsmai Cave in Sohra (Cherrapunji), known for its natural formations (Fig. 5.10a). Quartz (Fig. 5.10b) is another beautiful natural crystal.
- Write the name of the place you visited and what the crystals looked like.

Therefore, crystals occur naturally in caves, mines and rocks, for example in Mawsmai Cave and as quartz.

QUESTION 28 *Section 5.3.2 · p. 80*

When we allow a solvent to evaporate to get a solute, such as salt from a salt solution, the solvent disappears. However, we may also want to recover the solvent. What should we do then?

ANSWER

To recover the solvent, we use distillation instead of simple evaporation.

- Heat the solution so that the solvent vaporises.
- Pass the vapour through a condenser, where it is cooled and turns back into pure liquid (the distillate), which is collected in a separate vessel.
- The dissolved solid (for example salt) remains in the distillation flask.

Therefore, the solvent can be recovered by distillation (evaporation followed by condensation).

QUESTION 29 *Section 5.3.2 · p. 80*

A student accidentally mixed acetone and water, two miscible liquids. How can we separate the two miscible liquids? Is it possible to separate the mixture of two miscible liquids by evaporation and obtain both the liquids?

ANSWER

The mixture can be separated by distillation. Evaporation alone cannot give both liquids.

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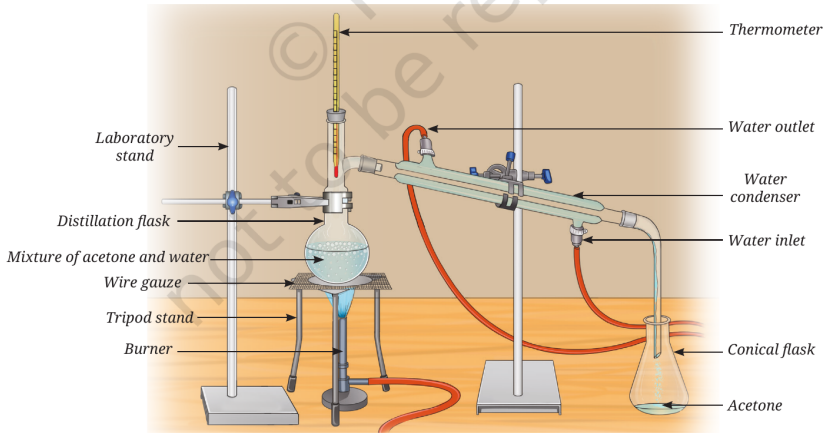


Fig. 5.12: Distillation set-up

a By distillation

- Acetone boils at about 56 °C and water at 100 °C, so acetone vaporises first.
- Its vapour is cooled in the water condenser and collected as pure acetone in the conical flask; water stays in the distillation flask.

b By evaporation

- No. On evaporation the vapours escape into the air, so the liquids are lost and are not collected.

Therefore, distillation separates acetone and water and gives both liquids, while evaporation does not.

QUESTION 30 *Activity 5.5 · p. 82*

5. Observe the paper as the water rises through the paper. What do you notice?
6. As the water rises, the ink starts to separate into different colour spots. What can you infer from this?

ANSWER

Paper chromatography separates the coloured substances in the ink.

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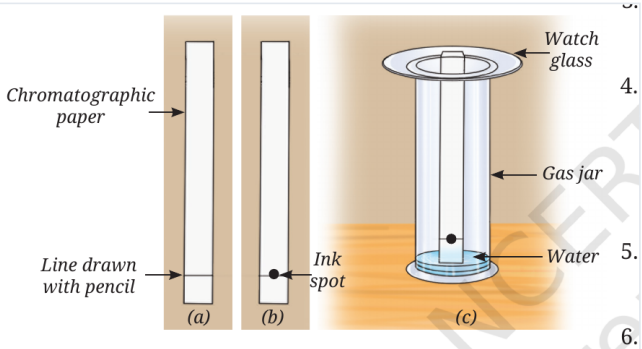


Fig. 5.15: Paper chromatography

a What we notice

- Water rises up the paper strip and carries the ink spot with it.
- The black ink spreads and separates into different coloured spots at different heights.

b What we infer

- Black ink is not a single colour; it is a mixture of different coloured substances.
- Its components move at different speeds because they interact differently with the solvent and the paper.

Therefore, black ink is a mixture of different coloured substances that can be separated by paper chromatography.

QUESTION 31 *Section 5.3.3 · p. 82*

Similarly, you can separate different pigments present in the green extract of spinach leaves or coloured pigments from the flower petals. Will water work as a solvent in every case?

ANSWER

No, water will not work as a solvent in every case.

- The solvent must carry the substances up the paper. Some pigments do not dissolve or move well in water.
- In such cases a different solvent, such as alcohol, or a mixture of solvents is used.

Therefore, the solvent is chosen according to the substances to be separated; it need not be water.

NCERT ARCHIVE

QUESTION 32 *Pause and Ponder 6 · p. 82*

State whether the following statements are True or False. Also, correct the False statements.
(i) Salt can be separated from a salt solution by evaporation or distillation.
(ii) Distillation can be used for separation of two liquids even when these have the same boiling point.
(iii) In paper chromatography, the solvent level should be above the sample spot at the beginning of the experiment.
(iv) Evaporation and crystallization are the same processes.

ANSWER

Each statement is judged using what was learnt about evaporation, distillation, chromatography and crystallization.

Part	Answer	Correction / reason
(i)	**True**	On evaporation the solvent goes away and the salt is left behind; in distillation the water is collected and the salt remains in the flask
(ii)	**False**	Distillation separates two liquids only if their boiling points differ (by at least about 25 °C). Liquids with the same boiling point vaporise together and cannot be separated by it
(iii)	**False**	The solvent level should be below the sample spot at the start; otherwise the spot would dissolve in the solvent instead of being carried up the paper
(iv)	**False**	Evaporation is the escape of the solvent as vapour, leaving the solute. Crystallization is the formation of pure crystals from a saturated solution, usually on slow cooling, and relies on the change of solubility with temperature

Therefore, only statement (i) is True; (ii), (iii) and (iv) are False and are corrected above.

NCERT ARCHIVE

QUESTION 33 *Activity 5.6 · p. 83*

Pour a mixture of 5 mL mustard oil and 20 mL water into a 50 mL separating funnel. Let it stand undisturbed. What do you observe? You will see the formation of two separate layers of mustard oil and water (Fig. 5.16). The yellow-coloured mustard oil forms the upper layer and water forms the lower layer. Can you explain why?

ANSWER

Two separate layers form, with mustard oil on top and water below, because the oil is less dense than water.

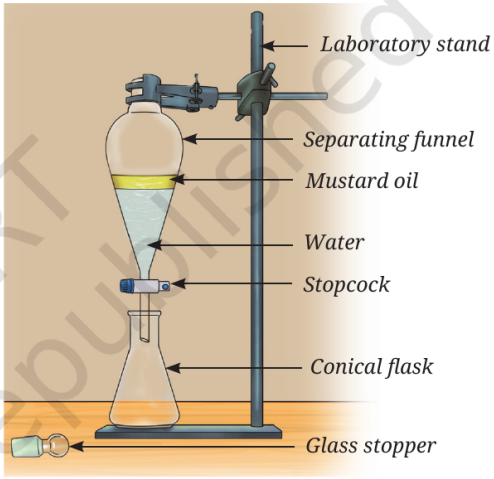


Fig. 5.16: Separation of immiscible liquids

a Explanation

- Oil and water are immiscible; they do not mix, so they form two layers.
- Water is denser, so it settles at the bottom; the lighter mustard oil floats on top.

b Separating the layers (steps 4–7)

- Open the stopcock slowly and collect the lower layer of water in a container.
- Close the stopcock when the water is almost fully drained.
- Collect and discard the small portion in between that may contain both liquids.
- Open the stopcock again and collect the oil separately.

Therefore, the layers form because of the difference in density, and a separating funnel separates them.

NCERT ARCHIVE

QUESTION 34 *Section 5.4.1 · p. 83*

Can you think of any heterogeneous mixtures with a gas as one of the components?

ANSWER

Yes. Most mixtures of gases are homogeneous, but mixtures of a gas with solid or liquid particles are heterogeneous.

- Smoke: solid particles suspended in air.
- Fog: tiny liquid water droplets present in air.
- Dust in the air.
- Clouds: tiny water droplets or ice crystals floating in the air.

Therefore, smoke, fog, dust and clouds are heterogeneous mixtures with a gas as one component.

QUESTION 35 *What if ... · p. 83*

What if two immiscible liquids of the same density are mixed in a separating funnel, how will the layers form?

ANSWER

No clear upper and lower layers would form.

- Layers form because one liquid is lighter and floats on the denser one.
- If both have the same density, neither floats above nor sinks below the other, so they would stay as droplets or blobs of one in the other instead of settling into two layers.
- A separating funnel could not then separate them, because there would be no clear lower layer to drain out.

Therefore, immiscible liquids of equal density would not separate into distinct layers.

NCERT ARCHIVE

QUESTION 36 *Activity 5.7 · p. 84*

Heat a mixture of crushed camphor and sand in a china dish covered with an inverted funnel plugged with cotton (Fig. 5.17). Observe the inner wall of the funnel carefully. Do you notice any solid deposits?

ANSWER

Yes, white solid deposits of camphor form on the inner wall of the funnel.

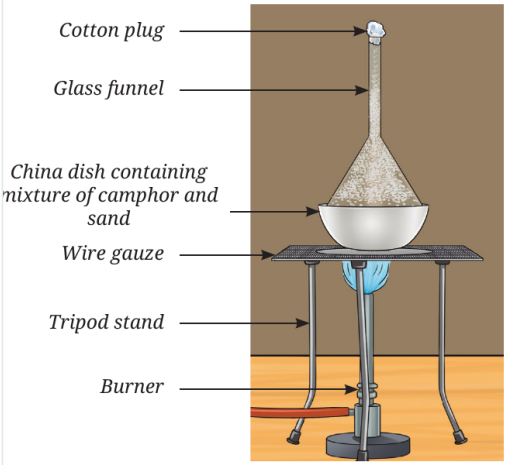


Fig. 5.17: Sublimation of camphor

- On gentle heating (below its melting point) camphor changes directly from solid to vapour, without becoming liquid. This is sublimation.
- The vapour cools on the inner wall of the funnel and changes directly back into solid camphor. This is deposition.
- Sand does not sublime, so it remains in the china dish.

Therefore, camphor sublimes and is separated from sand, which stays behind.

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QUESTION 37 *Section 5.4.2 · p. 84*

Can you think of any other mixtures where sublimation can be used to separate the components?

ANSWER

Sublimation can separate a mixture in which only one component sublimes on heating.

- Naphthalene and sand (mentioned in the chapter).
- Ammonium chloride and common salt or sand, since ammonium chloride sublimes and the other substance does not.
- Any solid that sublimes mixed with a non-subliming solid.

Therefore, sublimation separates a sublimable solid from a non-sublimable one.

QUESTION 38 *Section 5.4.2 · p. 84*

Is it possible to dissolve one metal in another?

ANSWER

Yes, but not at room temperature.

- Metals do not dissolve into each other at room temperature.
- When metals are melted at high temperature, they can mix to form a solution. On cooling it solidifies into a new material that looks like a single metal.
- A homogeneous mixture of two or more metals, or a metal and a non-metal, is called an alloy. Physical methods cannot separate its components.

Alloy	Composition (approximate, from the chapter)
Brass	About 80 % copper and 20 % zinc
Bronze	About 80 % copper and 20 % tin
Stainless steel	Mainly iron with carbon (0.03–0.8 %), chromium (16–18 %), nickel (10–14 %) and molybdenum (2–3 %)

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Therefore, metals can be dissolved in one another by melting them, forming alloys.

QUESTION 39 *Pause and Ponder 7 · p. 84*

Why do immiscible liquids form two separate layers in a separating funnel?

ANSWER

Immiscible liquids do not mix with each other and have different densities.

- Because they do not mix, they cannot form a uniform solution.
- The denser liquid (e.g. water) settles at the bottom, and the less dense liquid (e.g. oil) floats on it, giving two layers.

Therefore, immiscibility and the difference in density make the liquids form two separate layers.

QUESTION 40 *Pause and Ponder 8 · p. 84*

Is sublimation different from evaporation? Justify.

ANSWER

Yes, sublimation is different from evaporation.

Point	Sublimation	Evaporation
Change	Solid changes directly into vapour, without passing through the liquid state	Liquid changes into vapour
Cooling	Vapour changes directly back into a solid (deposition)	Vapour condenses into a liquid
Example	Camphor, naphthalene, dry ice	Water drying from a wet cloth
Use in separation	Separates a sublimable solid from a non-sublimable solid	Separates a dissolved solid from its solvent

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Therefore, sublimation involves solid → vapour, whereas evaporation involves liquid → vapour.

QUESTION 41 *Section 5.4.3 · p. 85*

If the muddy water is still not clear even after keeping for some time, how can it be cleaned?

ANSWER

Filtration alone is not always enough for very small particles, so centrifugation and/or coagulation is used.

a Coagulation (using alum)

- Add powdered alum (*fitkari*) to the muddy water and stir.
- The alum makes the fine suspended particles clump together into larger lumps.
- These lumps settle by gravity and the clear water is separated by decantation or filtration.

b Centrifugation

- Spin the muddy water at high speed in a centrifuge; the heavier particles move outwards and settle at the bottom of the tube, and the lighter liquid stays at the top.

Therefore, muddy water that stays cloudy can be cleaned by coagulation with alum, followed by decantation or filtration, or by centrifugation.

QUESTION 42 *Section 5.4.3 A · p. 85*

Choose a partner. Then, cross your arms and hold each other's hands as shown in Fig. 5.18. Now spin around together. Do you feel as if you are being pulled outwards?

ANSWER

Yes, we feel pulled outwards while spinning.

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- A body moving in a circle seems to be pushed outwards. This outward force is called the centrifugal force.
- A similar force acts in centrifugation. When a mixture in a tube is spun at high speed, the heavier particles move outwards and settle at the bottom of the tube, while the lighter liquid remains at the top.

Therefore, spinning produces an outward pull, and the same effect is used to separate mixtures by centrifugation.

QUESTION 43 *Threads of Curiosity · p. 85*

The spinning game is a folk dance called phugadi in Marathi and kikli in Punjabi. What is this called in your local language?

ANSWER

This depends on your own language and region.

- The chapter gives *phugadi* (Marathi) and *kikli* (Punjabi).
- Ask elders at home or in your neighbourhood and write the name used in your language.

Therefore, write the local name of this spinning game as told by your family or neighbours.

QUESTION 44 *Bridging Science and Society · p. 86*

Find out more about such simple technological inventions that improve access to medical care in remote places.

ANSWER

This is a research activity. The chapter's own example is the paperfuge.

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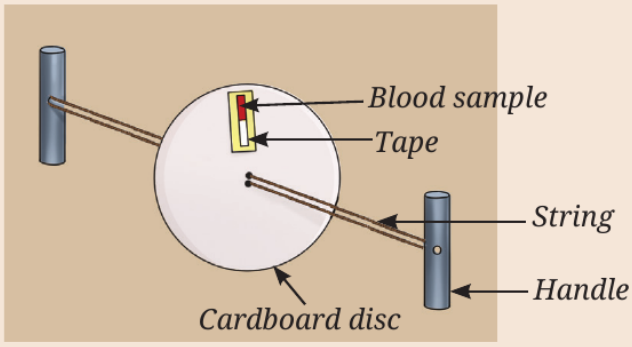


Fig. 5.20: Paperfuge

- **Paperfuge:** a simple hand-powered device that uses ideas from a common toy. It spins blood samples at very high speed without electricity, separating heavier components from lighter ones like a laboratory centrifuge. It can help detect diseases like malaria and anaemia in remote areas.
- Look for other low-cost inventions, for example a paper-based microscope (Foldscope), solar-powered vaccine refrigerators, or health services through mobile phones.
- For each invention, write who made it, how it works and how it helps people in remote places.

Therefore, simple, low-cost devices such as the paperfuge can bring medical tests to remote places.

QUESTION 45 *Activity 5.8 · p. 86*

Make your own centrifuge with a cardboard disc and thick thread. You will be able to see how the heavier particles move outwards. Which mixture would you like to separate using this mini centrifuge?

ANSWER

A cardboard disc and thread work like the paperfuge shown in Fig. 5.20.

a How to make and use it

- Take a cardboard disc and make two holes near the centre. Pass a thick thread through the holes and tie the ends so that it forms a loop, with a handle at each end.
- Fix a small sealed sample of the mixture near the edge of the disc with tape.

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- Twist the thread by spinning the disc, then pull the handles apart and let go repeatedly so that the disc spins very fast.

b Choice of mixture and result

- Mixture to try: muddy water or chalk powder in water, which is a suspension, in a small sealed transparent container.
- Result: the heavier particles move outwards and settle at the outer end of the sample, while the lighter liquid remains near the centre.

Therefore, a home-made centrifuge shows that heavier particles move outwards when a mixture is spun.

QUESTION 46 *Section 5.4.3 B · p. 86*

Can you think of any other coagulation processes used in everyday life?

ANSWER

Coagulation is the clumping together of tiny particles into larger lumps.

- Making cheese (*paneer*) from milk: lemon juice or vinegar acts as the coagulant and coagulates the milk proteins (chapter example).
- Clotting of blood, when it coagulates after an injury.
- Purification of water with alum in water and sewage treatment plants, where sedimentation, coagulation and filtration are used.
- Making curd-like products such as tofu from soya milk by adding a coagulant, and coagulating rubber latex with acid.

Therefore, paneer making, blood clotting and water purification are everyday examples of coagulation.

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QUESTION 47 *Section 5.4.4 · p. 86*

If the components of blood can be separated by centrifugation and the blood coagulates, is it a suspension? However, we cannot see blood cells with the naked eye. Is it a solution?

ANSWER

Blood is neither a solution nor a true suspension. It is a colloid.

Possibility	Why it does not fit
A solution?	The blood cells are not dissolved; blood can be separated by centrifugation and scatters light, so it is not a true solution
A suspension?	The cells cannot be seen with the naked eye, and they stay evenly dispersed instead of settling on their own

- Particles of a colloid (1–1000 nm) are larger than those of a solution and smaller than those of a suspension.
- Other colloids are milk, tomato sauce and ice cream.

Therefore, blood is a colloid.

QUESTION 48 *Donate Blood · p. 87*

Do you know your blood group? Find out!

ANSWER

This is a personal fact, so the answer is different for each student.

- Blood groups are named A, B, AB and O (each can be positive or negative).
- You can find yours from a medical report or blood donor card, by asking your parents or doctor, or by a blood test at a clinic or blood bank.
- The chapter notes that donated blood is tested and its blood group identified before it is separated into plasma, platelets, white and red blood cells.

Therefore, find your blood group from a medical record or a blood test and write it down.

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QUESTION 49 *Section 5.4.4 · p. 87*

Let us try to understand what colloids are. How are they different from solutions and suspensions? Can you think of some other substances that could be colloids?

ANSWER

Solutions, suspensions and colloids differ mainly in the size of their particles.

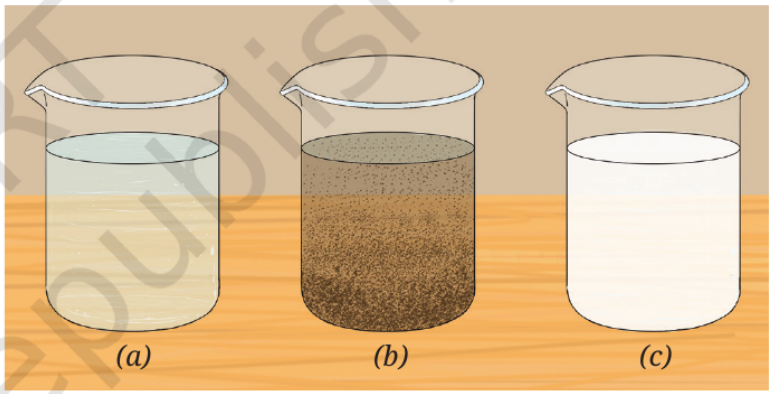


Fig. 5.23: (a) Solution, (b) suspension, and (c) colloid

Point	Solution	Colloid	Suspension
Particle size	Less than 1 nm	1–1000 nm	More than 1000 nm
Settling	Does not settle	Does not settle; evenly dispersed	Settles on standing
Tyndall effect	No scattering of light	Scatters light	Scatters light

a Other colloids

- Milk, blood, tomato sauce and ice cream (chapter examples).
- Butter, body lotion, cold cream and vanishing cream (emulsions), and smoke, fog and clouds.

Therefore, a colloid has particles of intermediate size; it does not settle and it scatters light.

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QUESTION 50 *Section 5.5 · p. 87*

Let us go back to Activity 5.1. What happened to the thin beam of laser light when it was passed through the beakers containing the mixtures?

ANSWER

The beam behaved differently in the three beakers.

Beaker	Beam of light	Reason
A: salt solution	Path of the beam not visible	The particles of a solution are too small to scatter light
B: chalk suspension	Path of the beam visible	The particles scatter (spread) the light
C: milk (colloid)	Path of the beam visible	The particles scatter the light, even though the mixture appears homogeneous

Therefore, light is scattered by the suspension and the colloid but not by the solution.

QUESTION 51 *Section 5.5 · pp. 87–88*

Have you ever observed light scattering by particles in your surroundings? … This effect can also be observed when a fine beam of light enters a dark room through a small hole. … You might have also observed this phenomenon in the floodlights in a sports stadium (Fig. 5.24). Think of some more examples!

ANSWER

The scattering of light by particles is the Tyndall effect. It is seen whenever a beam of light passes through air or liquid that contains small particles.

- A fine beam of sunlight entering a dark room through a small hole shows its path because of dust and smoke in the air.
- Floodlights in a sports stadium, as in Fig. 5.24.
- Headlights of a vehicle or a torch beam in fog, mist or smoke.

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- Sunlight passing through the leaves of a dense tree or through a window in a dusty room.
- A beam of light from a projector in a dark cinema hall.

Therefore, the Tyndall effect is seen wherever light passes through air containing dust, smoke or water droplets.

QUESTION 52 *Pause and Ponder 9 · p. 88*

Clouds are made up of tiny water droplets or ice crystals floating in the air. Based on what you know about solutions, suspensions and colloids, what type of mixture do you think clouds are and why?

ANSWER

Clouds are a colloid.

- Tiny droplets or ice crystals (dispersed phase) are spread throughout the air (dispersion medium).
- The droplets do not settle quickly, like the particles in a colloid, and they scatter light, which is why clouds look white.
- It is not a solution because it is not a uniform mixture of dissolved particles, and it is not a true suspension because the particles stay floating instead of settling out.

Therefore, clouds are a colloid of water droplets or ice crystals in air.

QUESTION 53 *Pause and Ponder 10 · p. 88*

Why do cities with a lot of smoke and dust in the air often look hazy?

ANSWER

The haze is caused by the scattering of light.

- Smoke and dust particles floating in the air scatter the sunlight in all directions (Tyndall effect).
- The scattered light makes the air look dull and cloudy and reduces how clearly distant objects can be seen.

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Therefore, smoke and dust in the air scatter light, so the city looks hazy.

QUESTION 54 *Activity 5.9 · p. 88*

Complete Table 5.1 and review what you have learnt about solutions, suspensions and colloids.
Table 5.1: Properties of different types of mixtures — 1. Nature (homogeneous/heterogeneous); 2. Particle size; 3. Visibility; 4. Separation by filtration; 5. Settling; 6. Tyndall effect

ANSWER

The completed Table 5.1 is given below.

S. No.	Property	Solution	Suspension	Colloid
1.	Nature (homogeneous / heterogeneous)	Homogeneous	Heterogeneous	Heterogeneous (appears homogeneous)
2.	Particle size	Less than 1 nm	More than 1000 nm	1–1000 nm
3.	Visibility	Particles not visible; transparent	Particles visible to the naked eye	Particles not visible to the naked eye
4.	Separation by filtration	Cannot be separated	Can be separated; residue stays on the filter paper	Cannot be separated; passes through filter paper
5.	Settling	Does not settle	Settles when left undisturbed	Does not settle
6.	Tyndall effect	Not shown	Shown	Shown

Therefore, solutions, suspensions and colloids differ in particle size, filtration, settling and the Tyndall effect.

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QUESTION 55 *Section 5.6 · p. 89*

We use various properties, such as size, density and solubility to separate mixtures. However, separation is not always simple. Imagine trying to separate all the ingredients in a lemonade once they have been mixed. Can you do it?

ANSWER

It is very difficult to separate all the ingredients of lemonade, because most of them are dissolved together.

- Pulp, seeds or other solid pieces (a suspension) can be removed by filtration.
- Water can be recovered by distillation, leaving sugar and the other dissolved substances in the flask.
- Separating the remaining dissolved substances from one another is hard, since a solution is homogeneous and their properties are not very different.

Therefore, separation is not always simple: some parts of lemonade can be separated, but fully separating all its ingredients is very difficult.

NCERT ARCHIVE

5.2

CLASS 9 SCIENCE · CHAPTER 5

Revise, Reflect, Refine

Solutions · 15 questions

Directions (Questions 1–15): These are the Revise, Reflect, Refine questions at the end of the chapter (pages 90–93). Solutions are worked out step by step, with formulas, calculations and reasons.

QUESTION 1

Which of the following mixtures are correctly classified as homogeneous (Hm) and heterogeneous (Ht)? Choose the correct option.
(i) Air — Hm, Milk — Ht, Sugar solution — Hm, Smoke — Hm
(ii) Brass — Ht, Fog — Ht, Vinegar — Ht, Muddy water — Hm
(iii) Copper sulfate solution — Hm, Salt solution — Hm, Milk — Hm, Bronze — Hm
(iv) Muddy water — Ht, Milk — Ht, Blood — Ht, Brass — Hm

ANSWER

The correct option is (iv).

Option	Verdict	Reason
(i)	Incorrect	Smoke (solid particles in air) is heterogeneous, not homogeneous
(ii)	Incorrect	Brass (an alloy) and vinegar are homogeneous; muddy water is heterogeneous
(iii)	Incorrect	Milk is heterogeneous (a colloid), not homogeneous
(iv)	**Correct**	Muddy water, milk and blood are heterogeneous; brass (an alloy) is homogeneous

Therefore, the correct option is (iv).

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QUESTION 2

Choose the correct options, and explain the reason for the correct and incorrect options. Which among the following mixtures show the Tyndall Effect? A mixture of:
(a) air and dust particles (b) copper sulfate and water (c) starch and water (d) acetone and water
(i) a and b (ii) b and d (iii) a and c (iv) c and d

ANSWER

The correct option is (iii) a and c.

Mixture	Tyndall effect?	Reason
(a) air and dust particles	**Yes**	Dust particles in air scatter light (e.g. a beam of sunlight in a dusty room)
(b) copper sulfate and water	No	A true solution; its particles (less than 1 nm) are too small to scatter light
(c) starch and water	**Yes**	Starch particles are colloidal in size (1–1000 nm) and scatter light
(d) acetone and water	No	A solution of two miscible liquids; it does not scatter light

- Option (i) is wrong because (b) does not show it; (ii) is wrong because neither (b) nor (d) shows it; (iv) is wrong because (d) does not show it.

Therefore, the correct option is (iii): air and dust particles, and starch and water show the Tyndall effect.

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QUESTION 3

A mixture can be categorised as a solution, a suspension, or a colloid, each possessing distinct properties. Utilise the words or phrases provided in the box to fill in the Table 5.2. Words and phrases may be used more than once.
Words and Phrases: Large-sized particles; Particles remain evenly distributed; Small-sized particles (less than 1 nm diameter); Moderate-sized particles (1–1000 nm); Settles down when left undisturbed (more than 1000 nm in diameter); Does not settle down; Scatters light; Separates by filtration; Transparent; Salt solution; Milk; Sand in water; Smoke; Heterogeneous mixture; Cannot be separated by filtration; Mud; Butter; Brass.

ANSWER

The words and phrases are placed under the type of mixture they describe.

	Solution	Suspension	Colloid
Properties	Small-sized particles (less than 1 nm diameter); Particles remain evenly distributed; Does not settle down; Transparent; Cannot be separated by filtration	Large-sized particles; Settles down when left undisturbed (more than 1000 nm in diameter); Heterogeneous mixture; Scatters light; Separates by filtration	Moderate-sized particles (1–1000 nm); Particles remain evenly distributed; Does not settle down; Scatters light; Heterogeneous mixture; Cannot be separated by filtration
Examples	Salt solution; Brass	Sand in water; Mud	Milk; Smoke; Butter

Therefore, Table 5.2 is completed with each phrase placed under the correct type of mixture.

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QUESTION 4

Solve the following problems:
(i) A cake recipe uses dry ingredients, namely 75 g of sugar for 420 g of all-purpose flour and 5 g of sodium hydrogencarbonate. Express the concentration of each component in the mixture using an appropriate method.
(ii) A brass alloy contains 70% copper by mass. Calculate the quantities of copper and zinc present in 120 g of brass.

ANSWER

The dry ingredients are solids, so mass by mass percentage (% m/m) is used.

a (i) Cake mixture

Step	Working
Total mass of mixture	75 g + 420 g + 5 g = 500 g
Sugar	(75 ÷ 500) × 100 = 15 % m/m
All-purpose flour	(420 ÷ 500) × 100 = 84 % m/m
Sodium hydrogencarbonate	(5 ÷ 500) × 100 = 1 % m/m
Check	15 + 84 + 1 = 100 %

b (ii) Brass (taken as copper and zinc)

Step	Working
Mass of copper	(70 ÷ 100) × 120 g = 84 g
Mass of zinc	120 g − 84 g = 36 g (that is 30 % of 120 g)
Check	84 g + 36 g = 120 g

Therefore, (i) sugar 15 %, flour 84 %, sodium hydrogencarbonate 1 % (m/m); (ii) copper 84 g and zinc 36 g.

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QUESTION 5

The label on a cooking oil pack says one litre (910 g). If this oil is mixed with water, will it form a separate layer? If so, which substance will be on top? How will you separate the two layers? Also, draw the diagram of the apparatus used.

ANSWER

Yes, the oil will form a separate layer, and it will be on top.

Point	Working
Density of oil	910 g per 1000 mL = 0.91 g per mL
Density of water	1000 g per litre = 1 g per mL
Comparison	Oil is lighter (less dense) than water and is immiscible with it

a Separation with a separating funnel

- Pour the mixture into a separating funnel and let it stand until two layers form: oil above, water below.
- Open the stopcock slowly and drain the lower layer (water) into a container; close the stopcock when the water is almost fully drained.
- Collect and discard the small mixed portion in between, then drain the oil into another container.

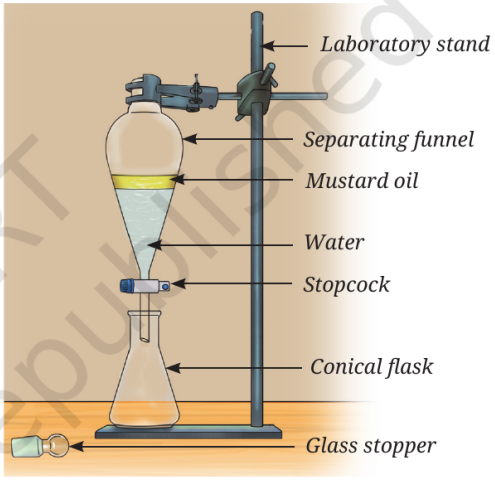


Fig. 5.16: Separation of immiscible liquids

Apparatus used: separating funnel (Fig. 5.16)

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Therefore, oil forms the upper layer and is separated from water with a separating funnel.

QUESTION 6

Assertion (A): Solutions do not exhibit the Tyndall effect.
Reason (R): The particles in solutions are larger than 100 nm, so they cannot scatter light.
Choose the correct option:
(i) Both A and R are true, and R is the correct explanation of A.
(ii) Both A and R are true, but R is not the correct explanation of A.
(iii) A is true, but R is false.
(iv) A is false, but R is true.

ANSWER

The correct option is (iii).

- Assertion A is true: a solution does not scatter light, so the path of a light beam is not visible in it.
- Reason R is false: the particles in a solution are smaller than 1 nm, not larger than 100 nm. Larger particles would scatter light, not prevent scattering.

Therefore, A is true but R is false: option (iii).

QUESTION 7

How would you separate the mixtures given in Table 5.3? Mention the reason for choosing your method. If a mixture cannot be separated, explain why.
Mixtures: Mud from muddy water; Plasma from other components in the blood sample; Naphthalene and sand; Chalk powder and common salt; Common salt and water; Oil from water; Pigments of the flower.

ANSWER

Each mixture is separated by using the property in which its components differ.

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Mixture	Method of separation	Reason for selection
Mud from muddy water	Settling, then decantation or filtration; for fine mud use coagulation with alum or centrifugation	Mud is a suspension; its heavier particles settle, and tiny particles can be made to clump or be spun down
Plasma from other components in the blood sample	Centrifugation	On spinning, heavier blood cells settle at the bottom and the lighter plasma stays on top (Fig. 5.22)
Naphthalene and sand	Sublimation	Naphthalene sublimes on heating, but sand does not
Chalk powder and common salt	Add water, stir and filter; evaporate the filtrate	Salt dissolves in water but chalk does not; chalk stays on the filter paper and salt is got by evaporating the filtrate
Common salt and water	Evaporation or crystallization to get salt; distillation to get water also	Salt is a non-volatile solid dissolved in water; distillation also recovers the water
Oil from water	Separating funnel	Oil and water are immiscible and have different densities
Pigments of the flower	Paper chromatography	Different pigments move at different rates on the paper

- All the mixtures in the table can be separated.

Therefore, a suitable method is chosen from the difference in properties of the components.

QUESTION 8

Two miscible liquids, A and B, are present in a mixture. The boiling point of A is 60 °C and the boiling point of B is 90 °C. Suggest a method to separate them. Also, draw a labelled diagram of the method suggested.

ANSWER

The liquids can be separated by distillation.

- The boiling points differ by 90 °C − 60 °C = 30 °C, which is more than the 25 °C needed for distillation.
- Heat the mixture in the distillation flask. A (lower boiling point) vaporises first, at about 60 °C as shown by the thermometer.

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- Its vapour is cooled in the water condenser and collected as pure liquid in the conical flask; liquid B remains in the distillation flask.

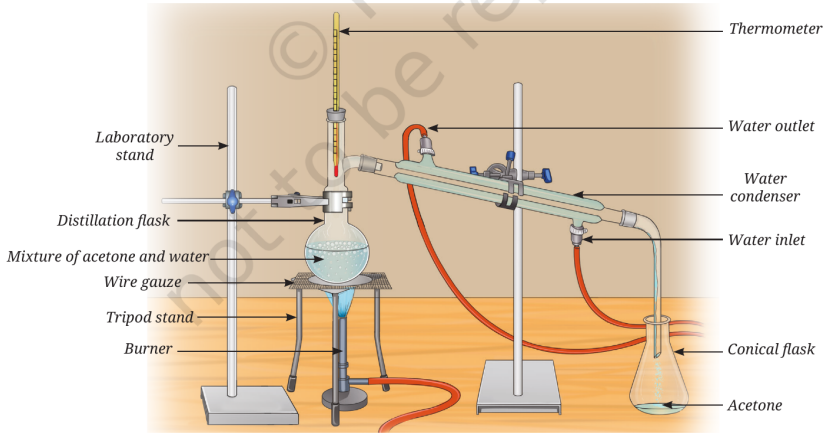


Fig. 5.12: Distillation set-up

Labelled distillation set-up (Fig. 5.12). Here the flask holds the mixture of A and B and the conical flask collects A (the picture labels show acetone and water)

Therefore, simple distillation separates A (collected first) from B.

QUESTION 9

Compare evaporation, crystallization and distillation. In which situation, would you prefer each of these over the others?

ANSWER

All three use heating or a change in temperature, but they have different aims.

Point	Evaporation	Crystallization	Distillation
Principle	The solvent vaporises and goes away	Solubility changes with temperature; a hot saturated solution is cooled slowly	Liquid is vaporised and the vapour is condensed
What we obtain	Solid left behind; the solvent is lost	Pure crystals of the solid	Pure liquid (distillate); solid or other liquid stays in the flask
Prefer when	Only the solid is needed and its solubility changes little with temperature, e.g. salt from sea water	A pure crystalline solid is needed, or a solid has to be purified, e.g. copper sulfate crystals	The solvent has to be recovered, or two miscible liquids with boiling points at least 25 °C apart are to be separated, e.g. acetone and water

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Therefore, use evaporation for the solid, crystallization for pure crystals and distillation to recover liquids.

QUESTION 10

Blood is an example of a colloidal mixture. (i) What would happen if blood behaved like a true suspension inside the body? (ii) In a blood sample, identify the dispersed phase and the dispersion medium.

ANSWER

Blood is a colloid, with particles that stay dispersed and do not settle.

a (i) If blood behaved like a suspension

- The blood cells would not stay evenly dispersed but would settle down, as particles of a suspension do when left undisturbed.
- Blood could then not transport nutrients, gases and hormones evenly to all parts of the body.

b (ii) Dispersed phase and dispersion medium

Term	In blood
Dispersed phase	Blood cells (red blood cells, white blood cells) and platelets
Dispersion medium	Plasma (the liquid part)

Therefore, a suspension-like blood would settle and fail to carry substances; in blood the cells form the dispersed phase and plasma the dispersion medium.

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QUESTION 11

You are given a mixture of sand, common salt and naphthalene (Fig. 5.25a). The Fig. 5.25b depicts various steps used to separate the components of this mixture. Identify and write down the correct sequence of separation techniques.

ANSWER

The correct sequence is Step 1 → Step 3 → Step 2.

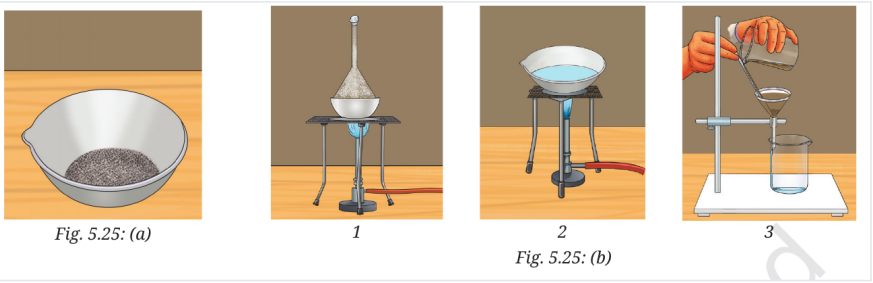


Fig. 5.25: (a)

Fig. 5.25: (b)

Order	Step in Fig. 5.25b	What is separated
First	Step 1: heating with an inverted funnel (sublimation)	Naphthalene sublimes and deposits on the funnel; sand and salt remain in the dish
Second	Step 3: adding water to the residue and filtering	Salt dissolves in water; sand stays on the filter paper as residue
Third	Step 2: heating the filtrate in a dish (evaporation / crystallization)	Water evaporates and common salt is left behind

- Sublimation is done first because naphthalene does not dissolve in water and would otherwise remain mixed with the sand.

Therefore, the sequence is: sublimation (1) → dissolving and filtration (3) → evaporation (2).

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QUESTION 12

Why is distillation an effective method for separating a mixture of water and acetone?

ANSWER

Distillation separates liquids that differ sufficiently in boiling point.

- Water and acetone are miscible, so they cannot be separated with a separating funnel or by filtration.
- Acetone boils at about 56 °C and water at 100 °C, a difference of 44 °C, which is more than the 25 °C needed.
- On heating, acetone vaporises first, is condensed in the condenser and collected as pure liquid, while water remains in the flask.

Therefore, distillation works because acetone and water have very different boiling points.

QUESTION 13

Answer the following questions with the help of the data given in Table 5.4 (solubility of various salts in g per 100 g of water).
(i) What mass of potassium nitrate would be needed to prepare its saturated solution in 50 g of water at 40 °C?
(ii) A student makes a saturated solution of potassium chloride in water at 80 °C and leaves the solution to cool at room temperature (25 °C). What would she observe as the solution cools? Explain.
(iii) What is the effect of a change in temperature on the solubility of salts? Also, compare the changes in the solubility of the four given salts with increasing temperature from 10 °C to 80 °C.

ANSWER

Data from Table 5.4 (g per 100 g of water):

Salt	10 °C	20 °C	30 °C	40 °C	60 °C	80 °C
Potassium nitrate	21	32	45	62	106	167

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Salt	10 °C	20 °C	30 °C	40 °C	60 °C	80 °C
Sodium chloride	36	36	36.3	36.5	37	37
Potassium chloride	35	35	37.4	40	46	54
Ammonium chloride	24	37	41	41	55	66

a (i) Potassium nitrate at 40 °C

Step	Working
Solubility at 40 °C	62 g in 100 g of water
For 50 g of water	(62 ÷ 100) × 50 g = 31 g
Check	31 g in 50 g is 62 g in 100 g

b (ii) Potassium chloride cooled from 80 °C to 25 °C

- Solubility at 80 °C is 54 g per 100 g of water. At 25 °C it is about 36 g (between 35 g at 20 °C and 37.4 g at 30 °C).
- She would observe crystals of potassium chloride separating out (appearing at the bottom) as the solution cools. About 54 − 36 = 18 g per 100 g of water crystallises.
- Reason: the solubility decreases on cooling, so the extra salt can no longer stay dissolved.

c (iii) Effect of temperature on solubility

- The solubility of these solid salts increases with increase in temperature.

Salt	At 10 °C	At 80 °C	Increase	Change
Potassium nitrate	21 g	167 g	146 g	Very large (about 8 times)
Ammonium chloride	24 g	66 g	42 g	Large
Potassium chloride	35 g	54 g	19 g	Moderate
Sodium chloride	36 g	37 g	1 g	Almost no change

Therefore, (i) 31 g; (ii) about 18 g of KCl crystals per 100 g of water form; (iii) solubility rises with temperature, most for potassium nitrate and least for sodium chloride.

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QUESTION 14

Three students, A, B and C, are preparing sugar solutions for an experiment:
• Student A dissolves 20 g of sugar in 80 g of water.
• Student B dissolves 20 g of sugar in 100 g of water.
• Student C dissolves 30 g of sugar in 80 g of water.
(i) Calculate the mass percentage (% m/m) concentration of sugar in each student's solution.
(ii) Whose solution is the most concentrated? Explain why.

ANSWER

Mass of solution = mass of sugar + mass of water; % m/m = (mass of sugar ÷ mass of solution) × 100.

Student	Mass of solution	Working	% m/m
A	20 + 80 = 100 g	(20 ÷ 100) × 100	**20 %**
B	20 + 100 = 120 g	(20 ÷ 120) × 100 = 16.67	**about 16.7 %**
C	30 + 80 = 110 g	(30 ÷ 110) × 100 = 27.27	**about 27.3 %**

a **(ii) Most concentrated**

- Student C's solution is the most concentrated, because it has the greatest mass of sugar per 100 g of solution (about 27.3 g, against 20 g for A and 16.7 g for B).

Therefore, A = 20 %, B ≈ 16.7 %, C ≈ 27.3 % (m/m); Student C's solution is the most concentrated.

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QUESTION 15

Examine Fig. 5.26.
(i) Identify the separation technique marked as 'S'.
(ii) Label the apparatus A, B and C.
(iii) Which of the following mixtures can be separated by the technique identified above? Use the data given in Table 5.5. Mixtures: (a) water — acetone (b) water — salt (c) acetone — alcohol (d) sand — salt (e) alcohol — chloroform (f) alcohol — benzene.
Table 5.5: Boiling points — Water 100 °C, Acetone 56 °C, Alcohol 78 °C, Chloroform 61 °C, Benzene 80 °C.

ANSWER

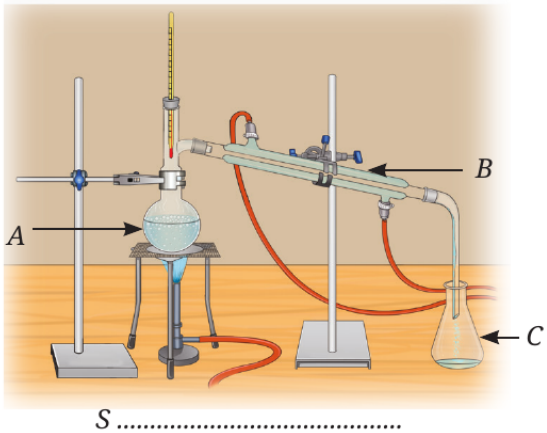


Fig. 5.26

a (i) and (ii) Technique and apparatus

Item	Answer
S	**Distillation**
A	Distillation flask (containing the mixture; fitted with a thermometer)
B	Water condenser
C	Conical flask (receiver for the distillate)

b (iii) Mixtures that can be separated

Mixture	Can it be separated?	Reason
(a) water — acetone	**Yes**	Boiling points 100 °C and 56 °C differ by 44 °C (at least 25 °C)

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Mixture	Can it be separated?	Reason
(b) water — salt	**Yes**	A liquid can be separated from a solution with a dissolved solid; water distils, salt stays
(c) acetone — alcohol	No	56 °C and 78 °C differ by only 22 °C (less than 25 °C)
(d) sand — salt	No	Both are solids; there is no liquid to distil
(e) alcohol — chloroform	No	78 °C and 61 °C differ by only 17 °C
(f) alcohol — benzene	No	78 °C and 80 °C differ by only 2 °C

- Mixtures (c), (e) and (f) have boiling points less than 25 °C apart, so they need fractional distillation instead.

Therefore, S is distillation; A is the distillation flask, B the condenser and C the conical flask; mixtures (a) and (b) can be separated.

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5.3

CLASS 9 SCIENCE · CHAPTER 5

The Journey Beyond

Solutions · 3 questions

Directions (Questions 1–3): These are the questions raised in The Journey Beyond and The Quest Continues ... sections at the end of the chapter (page 93). Model answers are given.

QUESTION 1

Do red leaves also contain green pigments? Investigate it using paper chromatography.

ANSWER

Yes, red leaves usually contain green pigment (chlorophyll) along with red pigments, and paper chromatography can show this.

a Method

- Crush a few red leaves with a little alcohol to get a coloured extract.
- Put a spot of the extract on the pencil line of a strip of chromatography (or filter) paper and let it dry.
- Dip the lower end of the strip in a suitable solvent (such as alcohol, as water may not work) so that the level stays below the spot.
- Remove the strip when the solvent has risen well and note the coloured bands.

b Expected result

- Different pigments move to different heights. A green band shows green pigment is present in the red leaf, hidden by the red colour.
- Compare with the extract of a green leaf run on the same strip.

Therefore, chromatography can reveal green pigment in red leaves by separating the pigments into bands.

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QUESTION 2

If you are camping outdoors and running short on clean water, you can obtain clean water by distillation. Can you think of a set-up with the items available to you?

ANSWER

A simple set-up needs a vessel to boil the water, a cool surface to condense the vapour and a container to collect it.

a **A possible camp set-up**

- Boil the dirty water in a large pot over the fire. Place a small clean cup or bowl in the middle of the pot, floating or resting on a stone, without letting the water splash into it.
- Cover the pot with its lid turned upside down, so that the lowest point of the lid is above the cup.
- Keep the lid cool with cold water or ice. Water vapour condenses on the cool lid and drips into the cup.
- Alternatively, pass the steam from a closed kettle through a tube cooled with cold water into a clean container.
- Take care with the hot pot and steam. The condensed water is free of mud, salts and other dissolved solids left behind in the pot.

Therefore, boiling water and condensing the steam on a cool surface gives clean water by distillation.

QUESTION 3

The Quest Continues … Can we create artificial blood that works just as real blood for all patients?

ANSWER

This is an open question for future research, not one with a fixed answer.

- Blood is a complex colloid. Plasma and the cells (red cells, white cells, platelets) carry nutrients, gases and hormones.

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- At present, no artificial substitute is known that can do all the jobs of real blood for every patient, so donated blood remains essential. Scientists are still working on the problem.
- This is why blood donation is important: the body replaces the donated blood naturally within a few weeks.

Therefore, artificial blood that works for all patients is an open challenge; until then, donated blood saves lives.

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