CLASS 9 SCIENCE

Chapter 5 Notes

Exploring Mixtures and their Separation

Chapter focus
This chapter explains how mixtures are classified, how concentration and solubility are expressed and how different physical properties are used to separate homogeneous and heterogeneous mixtures. It also compares solutions, suspensions and colloids and explains the Tyndall effect.

1. Classification of Mixtures

Homogeneous mixture	Heterogeneous mixture
Uniform composition throughout.	Non-uniform composition.
Also called a solution when a solute is dissolved in a solvent.	Different components or phases can be distinguished.
Examples: sugar solution, vinegar, aerated drinks.	Examples: sand and water, oil and water, smoke, fog.

- A solution always remains homogeneous.
- Most gas-gas mixtures are homogeneous because gas particles mix freely.
- Smoke, fog and dust in air are heterogeneous mixtures in which a gas is one component.

2. Solutions: Solute and Solvent

- A solution is a homogeneous mixture.
- Solute: the substance that gets dissolved.
- Solvent: the substance that dissolves the solute.
- Example: in sugar solution, sugar is the solute and water is the solvent.

Concentration
The amount of solute dissolved in a given amount of solvent or solution is called the concentration of the solution.

3. Expressing Concentration

Method	Formula	Meaning / use
Mass by mass (% m/m or % w/w)	(Mass of solute ÷ Mass of solution) × 100	Grams of solute in 100 g of solution.
Mass by volume (% m/v or % w/v)	(Mass of solute ÷ Volume of solution) × 100	Grams of solute in 100 mL of solution; common in medicines/labs.
Volume by volume (% v/v)	(Volume of solute ÷ Volume of solution) × 100	mL of liquid solute in 100 mL of solution; useful for miscible liquids.

- Mass of solution = Mass of solute + Mass of solvent.
- Example: 10 g salt + 90 g water gives 100 g solution, so concentration = 10% m/m.
- A 5% m/v glucose solution contains 5 g glucose in 100 mL solution.
- A 1% v/v liquid pesticide solution contains 1 mL pesticide in 100 mL solution.
- A hospital saline drip is commonly 0.9% m/v sodium chloride solution.

4. Solubility and Saturated Solution

- Solubility is the maximum amount of solute that dissolves in a fixed quantity of solvent (100 mL or 100 g) at a given temperature.
- A saturated solution cannot dissolve any more solute at that temperature.
- For most solid solutes in liquid solvents, solubility generally increases as temperature increases.
- For gases dissolved in liquids, solubility generally decreases with increase in temperature.
- A graph of solubility against temperature is called a solubility curve.

Why solubility matters
Differences in solubility at different temperatures can be used to separate and purify substances by crystallization.

5. Separation of Homogeneous Mixtures

Crystallization

- Crystallization is the process of forming crystals from a saturated solution.
- A crystal is a solid whose particles are arranged in a regular geometric pattern.
- The method is based on differences in solubility at different temperatures.
- It can separate two soluble solids when one is present in a small quantity and can also purify solids.
- A hot saturated solution is prepared, insoluble impurities are filtered out and the filtrate is cooled slowly to form crystals.
- Slow cooling generally produces larger, better-shaped crystals than rapid cooling.

Example:
For compound B, solubility falls from 287 g per 100 g water at 60°C to 241 g per 100 g water at 40°C. On cooling, the excess solute separates as crystals.

Distillation

- Distillation separates a homogeneous mixture by vaporising the lower-boiling liquid and then condensing its vapour.
- It can separate two miscible liquids when their boiling points differ by about 25°C or more.
- It can also recover a liquid solvent from a solution containing dissolved solids.
- The vapour passes through a condenser, cools and becomes liquid called the distillate.
- Acetone (boiling point about 56°C) and water (100°C) can be separated by distillation.

Fractional distillation

When components have relatively small differences (less than about 25°C) in boiling points, fractional distillation is used. Crude petroleum is separated into useful fractions such as petroleum gas, petrol, kerosene, diesel, lubricating oil and bitumen.

- The traditional Deg-Bhapka distillation method of Kannauj for preparing Mitti ka Ittar.

Paper Chromatography

- Paper chromatography separates components according to differences in their interactions with the solvent and the paper.
- The solvent rises through the paper and carries substances with it; different components move at different rates.
- The sample spot must initially remain above the solvent level.
- It can separate colours in black ink, food colours and pigments from leaves or flower petals.
- Water is not a suitable solvent in every case; alcohol or a solvent mixture may sometimes be needed.

6. Separation of Heterogeneous Mixtures

Separating Funnel

- Immiscible liquids do not mix and form separate layers.
- A separating funnel separates two immiscible liquids on the basis of difference in density.
- In mustard oil and water, oil forms the upper layer and water the lower layer; the lower layer is drained first through the stopcock.

Sublimation

- Sublimation is the direct change of a solid into vapour below its melting point without passing through the liquid state.
- Deposition is the reverse change: vapour changes directly into solid.
- A sublimable solid can be separated from a non-sublimable solid.
- Example: camphor or naphthalene can be separated from sand. Dry ice also undergoes sublimation.

7. Alloys

- An alloy is a homogeneous mixture of two or more metals, or a metal and a non-metal.
- Its components cannot generally be separated by physical methods.
- Alloys are made to obtain useful properties such as greater strength, rigidity or corrosion resistance.

Alloy	Approximate composition
Brass	80% copper + 20% zinc
Bronze	80% copper + 20% tin
Stainless steel	Iron with carbon, chromium, nickel and molybdenum

8. Suspensions

- A suspension is a heterogeneous mixture in which undissolved solid particles remain suspended in a medium.
- Suspension particles are visible to the naked eye and are larger than particles in solutions.
- They settle when left undisturbed and can generally be separated by filtration.
- Examples: sand in water, sawdust in water and tea leaves in water.

Centrifugation

- Centrifugation involves spinning a mixture at high speed.
- Heavier particles move outward and settle, while the lighter liquid remains above.
- It is used to separate blood components such as red blood cells and plasma and is also used in chemical industries.
- A paperfuge is a simple hand-powered centrifuge that can work without electricity and can assist medical testing in remote areas.

Coagulation

- Coagulation makes very fine suspended particles clump together into larger particles.
- The substance added to cause clumping is called a coagulant.
- Powdered alum (fitkari) acts as a coagulant in muddy water.
- The larger clumps settle by sedimentation and can then be removed by decantation or filtration.
- Paneer formation is also an example of coagulation: lemon juice or vinegar coagulates milk proteins.

9. Colloids

- A colloid is neither a true solution nor a true suspension.
- Its particles remain dispersed and do not settle on standing.
- Examples: blood, milk, tomato sauce and ice cream.
- The solute-like particles form the dispersed phase; the substance in which they are dispersed is the dispersion medium.

10. Solution, Suspension and Colloid - Comparison

Property	Solution	Suspension	Colloid
Nature	Homogeneous	Heterogeneous	Heterogeneous, though it may appear homogeneous
Particle size	Less than 1 nm	More than 1000 nm	1–1000 nm
Visibility	Particles not visible	Particles visible to naked eye	Particles not normally visible to naked eye
Settling	Do not settle	Settle on standing	Do not settle
Filtration	Cannot be separated by ordinary filtration	Can be separated by filtration	Cannot be separated by ordinary filtration
Tyndall effect	Does not show	Shows	Shows

11. Tyndall Effect

- The scattering of light by particles is called the Tyndall effect.
- A beam of light becomes visible when it passes through a suspension or colloid because their particles scatter light.
- A transparent solution does not show the Tyndall effect.
- Examples include visible sunrays in a dusty room and light beams seen through smoke, dust or fog.

12. Emulsions

- An emulsion is a colloid in which both the dispersed phase and dispersion medium are liquids.
- Oil-in-water emulsions: milk and vanishing cream.
- Water-in-oil emulsions: butter, body lotions and cold cream.
- Emulsifying agents help stabilise emulsions; proteins in milk and butter act as emulsifying agents.

13. Choosing the Correct Separation Method

Mixture / situation	Suitable method	Property used
Pure crystals from saturated solution	Crystallization	Difference in solubility with temperature
Acetone + water	Distillation	Large difference in boiling points
Liquids with close boiling points	Fractional distillation	Small differences in boiling points
Colours/pigments in ink or leaves	Paper chromatography	Different rates of movement/interactions
Oil + water	Separating funnel	Immiscibility and density difference
Camphor/naphthalene + sand	Sublimation	One solid sublimes; the other does not
Mud or fine particles in liquid	Centrifugation / coagulation	Density or particle clumping
Large insoluble solid particles + liquid	Filtration	Particle size

14. Important Differences

Processes	Main difference
Evaporation vs crystallization	Evaporation removes solvent to obtain solute; crystallization forms purer, well-defined crystals from a saturated solution.
Evaporation vs distillation	Evaporation normally does not recover the solvent; distillation condenses and recovers the vaporised liquid.
Sublimation vs evaporation	Sublimation is solid → vapour directly; evaporation is liquid → vapour.
Distillation vs fractional distillation	Distillation is suitable for sufficiently different boiling points; fractional distillation is used for closer boiling points.
Suspension vs colloid	Suspension particles are larger and settle; colloidal particles remain dispersed.

15. Key Terms

Term	Meaning
Homogeneous mixture	Mixture having uniform composition throughout.
Heterogeneous mixture	Mixture having non-uniform composition.
Solution	Homogeneous mixture of solute and solvent.
Concentration	Amount of solute in a given amount of solvent or solution.
Solubility	Maximum solute dissolving in a fixed amount of solvent at a given temperature.
Saturated solution	Solution that cannot dissolve more solute at that temperature.
Crystallization	Formation of crystals from a saturated solution.
Distillate	Liquid collected after vapour is condensed during distillation.
Chromatography	Separation based on different movement/interactions of components.
Sublimation	Direct change of solid into vapour.
Deposition	Direct change of vapour into solid.
Centrifugation	High-speed spinning used to separate heavier and lighter components.
Coagulation	Clumping of fine particles by adding a coagulant.
Colloid	Mixture with particles intermediate in size between solution and suspension.
Tyndall effect	Scattering of light by colloidal or suspended particles.

16. Exam-Oriented Self-Check Questions

1. Differentiate between homogeneous and heterogeneous mixtures with examples.
2. Define solute, solvent and solution.
3. Write formulas for % m/m, % m/v and % v/v concentration.
4. What is a saturated solution? Why is temperature mentioned while defining solubility?
5. How does temperature generally affect the solubility of solids and gases in liquids?
6. Explain the principle and uses of crystallization.
7. Why does slow cooling produce better crystals than rapid cooling?
8. Explain distillation. When is it preferred?
9. What is fractional distillation and where is it used?
10. Explain the principle of paper chromatography.
11. Why must the sample spot remain above the solvent level in chromatography?
12. How does a separating funnel separate oil and water?
13. Define sublimation and deposition with examples.
14. What is a suspension? Give two examples.
15. Explain centrifugation and one important use.
16. What is coagulation? How does alum help clean muddy water?
17. What is a colloid? How is it different from a suspension?
18. Define the Tyndall effect. Which types of mixtures show it?
19. Differentiate solution, suspension and colloid on the basis of particle size, settling and filtration.
20. What are emulsions? Give examples of oil-in-water and water-in-oil emulsions.

One-Minute Chapter Summary

Quick revision

Mixtures may be homogeneous or heterogeneous. A solution contains a solute dissolved in a solvent and its concentration can be expressed as % m/m, % m/v or % v/v. Solubility depends on temperature and is used in crystallization. Homogeneous mixtures can be separated using crystallization, distillation and chromatography. Heterogeneous mixtures can be separated using methods such as separating funnel, sublimation, filtration, centrifugation and coagulation. Solutions have particles smaller than 1 nm, colloids 1–1000 nm and suspensions more than 1000 nm. Colloids and suspensions scatter light and show the Tyndall effect.

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