

Chapter 2: Is Matter Around Us Pure?

Complete Study Notes for Exam Preparation

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1. Introduction to Pure Substances {#introduction}

What is Purity?

- **Common understanding:** Pure means having no adulteration
- **Scientific definition:** A pure substance consists of a single type of particle where all constituent particles are the same in their chemical nature

Key Concepts:

- **Pure Substance:** A single form of matter with uniform composition throughout
- **Examples:** Distilled water, pure gold, oxygen gas
- Most matter around us exists as **mixtures** (sea water, soil, minerals, etc.)

Real-world vs Scientific Purity:

Item	Common View	Scientific View
Milk	Pure	Mixture of water, fat, proteins
Salt	Pure	May contain impurities
Mineral Water	Pure	Contains dissolved minerals

2. Mixtures and Their Types {#mixtures}

Definition

A **mixture** contains more than one pure substance and can be separated by physical processes.

Characteristics of Mixtures:

- Composition can vary
- Components retain their individual properties
- Can be separated by physical methods
- No fixed melting or boiling point

Types of Mixtures

2.1 Homogeneous Mixtures

- **Definition:** Mixtures with uniform composition throughout
- **Also called:** Solutions
- **Examples:**
 - Salt dissolved in water
 - Sugar dissolved in water
 - Copper sulphate solution

Diagram: Homogeneous Mixture

[Salt + Water] → [Uniform Solution]

•••	[••••••••••]
○○○	[○○○○○○○○○○○○]
Separate	Mixed uniformly
components	throughout

2.2 Heterogeneous Mixtures

- **Definition:** Mixtures with non-uniform composition and physically distinct parts
- **Examples:**
 - Salt and iron filings
 - Oil and water
 - Salt and sulphur

Diagram: Heterogeneous Mixture

[Oil + Water] → [Separated Layers]

●●●

[●●●●●●●●●●]

○○○

[○○○○○○○○○○○○]

Components

Clearly visible

separate phases

3. Solutions {#solutions}

Definition

A **solution** is a homogeneous mixture of two or more substances.

Components of a Solution:

1. **Solute:** The component that is dissolved (usually present in smaller quantity)
2. **Solvent:** The component that dissolves the solute (usually present in larger quantity)

Types of Solutions:

Type	Example	Solute	Solvent
Solid in Liquid	Sugar water	Sugar (solid)	Water (liquid)
Liquid in Liquid	Tincture of iodine	Iodine (solid)	Alcohol (liquid)
Gas in Liquid	Soda water	CO ₂ (gas)	Water (liquid)
Gas in Gas	Air	Various gases	Nitrogen (major)
Solid in Solid	Alloys (Brass)	Zinc	Copper

Properties of Solutions:

1. **Homogeneous mixture**

2. **Particle size:** $< 1 \text{ nm}$ (10^{-9} m)
3. **Invisible particles:** Cannot be seen with naked eyes
4. **No Tyndall effect:** Do not scatter light
5. **Stable:** Particles do not settle down
6. **Cannot be filtered:** Particles pass through filter paper

Concentration of Solutions

Types Based on Concentration:

1. **Dilute Solution:** Contains relatively less solute
2. **Concentrated Solution:** Contains relatively more solute
3. **Saturated Solution:** Contains maximum amount of solute that can dissolve at given temperature
4. **Unsaturated Solution:** Can dissolve more solute at given temperature

Mathematical Expressions:

1. Mass by Mass Percentage:

$$\text{Mass \%} = (\text{Mass of solute} / \text{Mass of solution}) \times 100$$

2. Mass by Volume Percentage:

$$\text{Mass by Volume \%} = (\text{Mass of solute} / \text{Volume of solution}) \times 100$$

3. Volume by Volume Percentage:

$$\text{Volume \%} = (\text{Volume of solute} / \text{Volume of solution}) \times 100$$

Solubility

- **Definition:** Amount of solute that can dissolve in 100g of solvent at a given temperature
 - **Factors affecting solubility:**
 - Temperature
 - Nature of solute and solvent
 - Pressure (for gases)
-

4. Suspensions {#suspensions}

Definition

A **suspension** is a heterogeneous mixture in which solute particles do not dissolve but remain suspended in the medium.

Properties of Suspensions:

1. **Heterogeneous mixture**
2. **Visible particles:** Can be seen with naked eyes
3. **Shows Tyndall effect:** Particles scatter light
4. **Unstable:** Particles settle down when left undisturbed
5. **Can be filtered:** Particles are retained on filter paper

Examples:

- Chalk powder in water
- Wheat flour in water
- Muddy water

- Paint

Diagram: Suspension

[Large Particles in Liquid]



Particles visible and
will settle down

5. Colloidal Solutions {#colloids}

Definition

A **colloid** is a heterogeneous mixture where particles are uniformly distributed but are intermediate in size between solutions and suspensions.

Components:

1. **Dispersed Phase:** The solute-like component
2. **Dispersion Medium:** The component in which dispersed phase is suspended

Properties of Colloids:

1. **Heterogeneous mixture** (appears homogeneous)
2. **Particle size:** Between 1-100 nm
3. **Invisible individually:** Cannot be seen with naked eyes
4. **Shows Tyndall effect:** Particles scatter light beam

5. **Stable:** Do not settle down

6. **Cannot be filtered:** But can be separated by centrifugation

Tyndall Effect

- **Definition:** Scattering of light by colloidal particles
- **Examples:**
 - Sunlight through forest canopy
 - Car headlights in fog
 - Light beam in dusty room

Diagram: Tyndall Effect

Light Source → [Colloidal Solution] → Scattered Light



Types of Colloids:

Dispersed Phase	Dispersion Medium	Type	Examples
Liquid	Gas	Aerosol	Fog, clouds, mist
Solid	Gas	Aerosol	Smoke, automobile exhaust
Gas	Liquid	Foam	Shaving cream
Liquid	Liquid	Emulsion	Milk, face cream
Solid	Liquid	Sol	Milk of magnesia, mud
Gas	Solid	Foam	Foam rubber, sponge
Liquid	Solid	Gel	Jelly, cheese, butter

Dispersed Phase	Dispersion Medium	Type	Examples
Solid	Solid	Solid Sol	Colored gemstone, milky glass

6. Physical and Chemical Changes {#changes}

Physical Properties

Properties that can be observed without changing the chemical composition:

- Color, hardness, density
- Melting point, boiling point
- State of matter

Physical Changes

- **Definition:** Changes in physical properties without change in chemical composition
- **Examples:**
 - Melting of ice
 - Boiling of water
 - Cutting of paper
 - Dissolving salt in water

Chemical Changes

- **Definition:** Changes involving formation of new substances with different chemical properties
- **Also called:** Chemical reactions
- **Examples:**
 - Burning of paper

- Rusting of iron
- Digestion of food
- Cooking of food

Comparison Table:

Physical Change	Chemical Change
No new substance formed	New substance formed
Reversible	Usually irreversible
Chemical composition unchanged	Chemical composition changed
Only physical properties change	Chemical properties change

7. Pure Substances: Elements and Compounds {#pure-substances}

Classification of Pure Substances

Pure Substances



Elements Compounds

7.1 Elements

Definition by Lavoisier:

An **element** is a basic form of matter that cannot be broken down into simpler substances by chemical reactions.

Classification of Elements:

A. Metals

- Properties:
 - Have lustre (shine)
 - Silvery-grey or golden-yellow color
 - Conduct heat and electricity
 - Ductile (can be drawn into wires)
 - Malleable (can be hammered into sheets)
 - Sonorous (produce ringing sound)
- Examples: Gold, silver, copper, iron, sodium, potassium
- **Special case:** Mercury (only liquid metal at room temperature)

B. Non-metals

- Properties:
 - Display variety of colors
 - Poor conductors of heat and electricity
 - Not lustrous, sonorous, or malleable
 - Brittle in solid state
- Examples: Hydrogen, oxygen, carbon, chlorine, bromine

C. Metalloids

- Properties intermediate between metals and non-metals
- Examples: Boron, silicon, germanium

Important Facts:

- **Total known elements:** More than 100
- **Naturally occurring:** 92 elements
- **Man-made:** Rest are artificial
- **Physical states at room temperature:**
 - Majority: Solid
 - Eleven: Gaseous
 - Two: Liquid (Mercury and Bromine)
 - Gallium and Cesium: Liquid slightly above room temperature (303 K)

7.2 Compounds

Definition:

A **compound** is a substance composed of two or more elements chemically combined in a fixed proportion.

Formation of Compounds:

Example: Iron + Sulphur → Iron Sulphide

- When iron filings and sulphur are simply mixed: **Mixture** (physical change)
- When heated strongly: **Compound** (chemical change)

Properties of Compounds:

1. Fixed composition
2. Uniform throughout
3. Different properties from constituent elements
4. Cannot be separated by physical methods

5. Can only be separated by chemical/electrochemical methods

Comparison: Mixtures vs Compounds

Aspect	Mixtures	Compounds
Formation	Physical mixing	Chemical reaction
Composition	Variable	Fixed
Properties	Shows properties of constituents	Entirely different properties
Separation	Physical methods	Chemical methods only
Energy change	Usually no energy change	Energy absorbed or released

8. Important Formulas and Calculations {#formulas}

Concentration Calculations:

Example 1: Mass by Mass Percentage

Problem: A solution contains 40 g of common salt in 320 g of water. Calculate the mass percentage.

Solution:

- Mass of solute (salt) = 40 g
- Mass of solvent (water) = 320 g
- Mass of solution = $40 + 320 = 360$ g
- Mass percentage = $(40/360) \times 100 = 11.1\%$

Example 2: Solubility Calculation

Problem: At 313 K, potassium nitrate has solubility of 62 g per 100 g water. How much KNO_3 is needed to saturate 50 g water?

Solution:

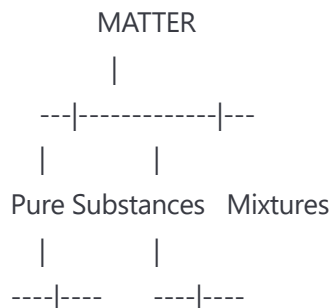
- 100 g water dissolves 62 g KNO_3
- 50 g water will dissolve = $(62 \times 50)/100 = 31 \text{ g } \text{KNO}_3$

Summary of All Mixture Types:

Property	Solution	Suspension	Colloid
Particle size	< 1 nm	> 100 nm	1-100 nm
Visibility	Invisible	Visible	Invisible individually
Tyndall effect	No	Yes	Yes
Stability	Stable	Unstable	Stable
Filtration	Cannot filter	Can filter	Cannot filter
Settling	No settling	Settles down	No settling

9. Key Diagrams for Exam Preparation

Diagram 1: Classification of Matter



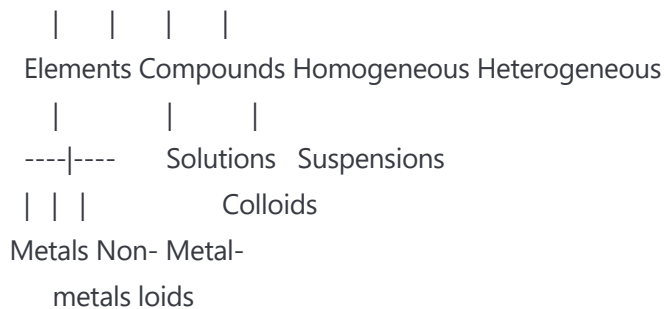


Diagram 2: Particle Size Comparison

Solution	Colloid	Suspension
•	•••	•••••
•••	•••••	•••••••
•	•••	•••••
< 1 nm	1-100 nm	> 100 nm

Diagram 3: Separation Methods

Mixture Type → Separation Method → Result

Solution -----> Evaporation -----> Pure solute + solvent
 → Distillation -----> Separate components

Suspension ---> Filtration -----> Residue + Filtrate
 → Sedimentation ----> Clear liquid + settled particles

Colloid -----> Centrifugation ---> Separated components
 → Coagulation -----> Precipitated particles

10. Experimental Activities Summary

Activity 2.1: Types of Mixtures

Objective: To distinguish between homogeneous and heterogeneous mixtures **Materials:** Water, copper sulphate, potassium permanganate, salt **Observations:**

- Uniform color → Homogeneous mixture
- Non-uniform distribution → Heterogeneous mixture

Activity 2.2: Solution, Suspension, and Colloid

Objective: To identify different types of mixtures based on properties **Tests Applied:**

1. **Visibility test:** Can particles be seen?
2. **Tyndall effect:** Does light beam scatter?
3. **Stability test:** Do particles settle?
4. **Filtration test:** Any residue on filter paper?

Activity 2.3: Concentration and Solubility

Objective: To understand saturated solutions and solubility **Key Learning:** Different substances have different solubilities at the same temperature

Activity 2.4: Elements vs Compounds

Objective: To distinguish between mixture formation and compound formation **Key Results:**

- **Group I** (mixing): Physical change, magnetic properties retained
- **Group II** (heating): Chemical change, new properties developed

11. Important Definitions for Exams

1. **Pure Substance:** Matter consisting of single type of particles with same chemical nature

2. **Mixture:** Matter containing more than one pure substance
 3. **Solution:** Homogeneous mixture of solute and solvent
 4. **Solute:** Component that gets dissolved
 5. **Solvent:** Component that dissolves the solute
 6. **Saturated Solution:** Solution containing maximum amount of solute at given temperature
 7. **Solubility:** Maximum amount of solute that can dissolve in 100g solvent at given temperature
 8. **Suspension:** Heterogeneous mixture with large particles that settle down
 9. **Colloid:** Heterogeneous mixture with intermediate-sized particles
 10. **Tyndall Effect:** Scattering of light by colloidal particles
 11. **Element:** Basic form of matter that cannot be broken down chemically
 12. **Compound:** Substance formed by chemical combination of elements in fixed proportion
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12. Exam-Style Questions and Answers {#practice-questions}

Very Short Answer Questions (1 Mark)

- Q1:** What is the particle size range in a colloidal solution? **A1:** 1-100 nm
- Q2:** Name the effect shown by colloidal solutions when light passes through them. **A2:** Tyndall effect
- Q3:** Give one example of solid in liquid solution. **A3:** Sugar dissolved in water (or salt in water)
- Q4:** What is an alloy? **A4:** A mixture of two or more metals or a metal and non-metal
- Q5:** Name two liquid elements at room temperature. **A5:** Mercury and Bromine

Short Answer Questions (2-3 Marks)

Q6: Distinguish between homogeneous and heterogeneous mixtures with examples. **A6:**

- **Homogeneous mixtures:** Have uniform composition throughout; particles not visible; examples - salt water, sugar water
- **Heterogeneous mixtures:** Have non-uniform composition; distinct phases visible; examples - oil and water, sand and water

Q7: What is meant by concentration of a solution? Write the formula for mass by mass percentage.

A7:

- **Concentration:** Amount of solute present in given amount of solution
- **Formula:** $\text{Mass \%} = (\text{Mass of solute} / \text{Mass of solution}) \times 100$

Q8: Why is a solution considered a homogeneous mixture? **A8:**

- Solution has uniform composition throughout
- All parts have same properties
- Particles are evenly distributed at molecular level
- Cannot distinguish between solute and solvent visually

Long Answer Questions (5 Marks)

Q9: Compare the properties of solutions, suspensions, and colloids. **A9:**

Property	Solution	Suspension	Colloid
Type	Homogeneous	Heterogeneous	Heterogeneous (appears homogeneous)
Particle size	< 1 nm	> 100 nm	1-100 nm
Visibility	Not visible	Visible	Not visible individually
Tyndall effect	No	Yes	Yes
Stability	Stable	Unstable	Stable
Filtration	Cannot be filtered	Can be filtered	Cannot be filtered
Settling	No	Yes	No

Q10: Explain the difference between elements and compounds with examples. **A10: Elements:**

- Basic forms of matter
- Cannot be broken down chemically
- Examples: Gold, oxygen, carbon
- Properties same as pure element

Compounds:

- Formed by chemical combination of elements
- Fixed composition
- Can be broken down into elements chemically
- Properties different from constituent elements
- Examples: Water (H₂O), Common salt (NaCl)

13. Practical Applications and Daily Life Examples

Solutions in Daily Life:

- **Household:** Salt water, sugar water, vinegar
- **Medical:** Saline drip, antiseptic solutions
- **Industrial:** Acids, alkalis for manufacturing

Colloids in Daily Life:

- **Food:** Milk, butter, cheese, whipped cream
- **Cosmetics:** Face cream, toothpaste
- **Others:** Fog, smoke, foams

Separation Techniques Applications:

- **Water purification:** Filtration, sedimentation
 - **Salt production:** Evaporation from sea water
 - **Mining:** Magnetic separation
 - **Food industry:** Various separation methods
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14. Common Exam Mistakes to Avoid

1. **Don't confuse** physical and chemical changes
 2. **Remember** that alloys are mixtures, not compounds
 3. **Understand** that milk is a colloid, not a solution
 4. **Know** the difference between saturated and concentrated solutions
 5. **Remember** Tyndall effect is shown by colloids and suspensions, not solutions
 6. **Don't mix up** solute and solvent definitions
 7. **Be careful** with concentration calculations - check units
-

15. Memory Tips and Mnemonics

For Types of Mixtures:

"Some Cats Sleep"

- **S**olution (homogeneous)
- **C**olloid (appears homogeneous)
- **S**uspension (heterogeneous)

For Separation Methods:

"Every Student Filters Carefully"

- **E**vaporation (for solutions)
- **S**edimentation (for suspensions)
- **F**iltration (for suspensions)
- **C**entrifugation (for colloids)

For Metal Properties:

"**LMDHMS**" - Lustrous, Malleable, Ductile, Hard, Metallic luster, Sonorous

16. Numerical Problems Practice

Problem 1:

Calculate the mass percentage of a solution containing 20g of salt in 180g of water.

Solution:

- Mass of solute = 20g

- Mass of solvent = 180g
- Mass of solution = 20 + 180 = 200g
- Mass % = $(20/200) \times 100 = 10\%$

Problem 2:

At 298K, the solubility of salt is 36g per 100g water. How much salt will dissolve in 250g water?

Solution:

- 100g water dissolves 36g salt
 - 250g water will dissolve = $(36 \times 250)/100 = 90\text{g}$ salt
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17. Important Points for Board Exams

High-Weightage Topics:

1. **Classification of mixtures** (Solutions, suspensions, colloids)
2. **Properties and examples** of each type
3. **Concentration calculations**
4. **Tyndall effect** and its applications
5. **Difference between elements and compounds**
6. **Physical vs chemical changes**
7. **Separation techniques**

Common Board Exam Questions:

- Differentiate between types of mixtures
- Explain Tyndall effect with examples

- Calculate concentration of solutions
- Classify given substances as elements, compounds, or mixtures
- Explain formation of compounds vs mixtures
- Identify physical and chemical changes

Quick Revision Points:

- Solution particles < 1 nm, stable, no Tyndall effect
- Colloid particles 1-100 nm, stable, shows Tyndall effect
- Suspension particles > 100 nm, unstable, shows Tyndall effect
- Elements cannot be broken down chemically
- Compounds have fixed composition and different properties
- Alloys are mixtures of metals
- Mercury and bromine are liquid elements

Remember: Understanding concepts is more important than memorizing. Practice numerical problems and always relate examples to daily life for better retention!