Introduction

A pure substance is a single substance and is made up of one kind of particles. The particles may be either atoms or molecules. A pure substance is uniform or homogeneous throughout because it consists of only one kind of particles. These particles are similar to one another and cannot be separated by physical methods.

Elements and Compounds

The pure substance which is made up of one kind of atoms only is called an element and the pure substance which is made up of one kind of molecules only is called a compound. Examples of elements are hydrogen, carbon, oxygen, sulphur, copper, silver, gold, etc. Examples of compounds are water, alcohol, carbon dioxide, ammonia, sodium chloride, etc.

Types of Elements

Elements can be classified into metals, non-metals and metalloids on the basis of their properties.

- **Metals**
  - Metals are solids at room temperature except mercury, which is a liquid at room temperature.
  - Metals are malleable which means that they can be hammered into thin sheets. Gold and silver are the most malleable metals.
  - Metals are ductile i.e. they can be drawn into thin wires. Gold is most ductile followed by silver, copper and aluminium.
  - Metals are good conductors of heat and electricity Silver is the best conductor and lead is the poorest conductor of heat. Silver is the best conductor of electricity followed by copper, gold, aluminium and tungsten.
  - Metals have lustre i.e, they have shining surfaces. Silver has a shining white surface, gold has yellow and copper has reddish brown.
  - Metals have high tensile strength. Sodium and potassium are quite soft hence have low tensile strength.
  - Metals are generally hard. Sodium and potassium are soft can be cut with a knife.
  - Metals are sonorous i.e. they produce a ringing sound when hit.
  - Metals have generally high densities.
  - Metals have generally high melting and boiling points. Sodium and potassium have low melting points. (371 and 336 K respectively).
  - Gallium and cesium become liquid at slightly higher temperature than room temperature (303 K).
- **Non-Metals**
  - Non-metals are either gases, liquids or solids at room temperature. Bromine is liquid a room temperature. Boron, carbon, sulphur and phosphorus are solids. Hydrogen, oxygen, nitrogen, etc. are gases.
  - Non-metals are brittle. They are not malleable or ductile. They break into pieces when hammered Non-metals are bad conductors of heat and electricity. Graphite an allotropic form of carbon is good conductor of electricity due to its special crystalline structure in which one electron of carbon remains free.
  - Non-metals have no lustre. Solid non-metals have generally dull surfaces. Iodine has a shining lustre and a crystalline structure.
  - Non-metals are generally soft. Diamond, an allotropic form of carbon, is the hardest natural substance known.
  - Non-metals have low tensile strength i.e, they are not strong and their bonds break easily.
  - Non-metals are non-sonorous.
  - Non-metals have comparatively low melting and boiling points except boron, graphite and diamond have high boiling points.
- **Metalloids**

  Elements which have properties of both metals and non-metals are called metalloids or semimetals. Their intermediate conductivity makes them semiconductors. Silicon, germanium,

arsenic, antimony, tellurium are common examples of metalloids.

Compound

- A compound is a pure substance which contains two or more elements combined together in a fixed proportion by mass. e.g. carbon dioxide is always made up of the same two elements, carbon and oxygen combined together in a fixed proportion of 3:8 by mass.
- The properties of a compound are entirely different from the properties of its constituents, e.g. water is a liquid while its constituents are gases. Hydrogen is a combustible gas and oxygen is a supporter of combustion while water is used to extinguish fire.
- The constituents of a compound cannot be separated by physical means. Each compound has a fixed molecular formula, melting point and boiling point. A pure solid compound has a fixed sharp melting point while impure solids have lower melting point than the pure solid. A pure liquid compound has a fixed boiling point while impure liquid has higher boiling point than the pure liquid.
- A compound is homogeneous in nature. Its composition remains same throughout the compound.
- Energy changes are accompanied by formation of compounds. Heat, light or electricity are either evolved or absorbed during formation of a compound.
- Compounds can be classified into inorganic and organic compounds on the basis of their structures.
  They can also be classified into acids, bases and salts on the basis of their properties. Sodium chloride, calcium carbonate, carbon dioxide, sulphuric acid etc. are inorganic compounds. Alcohol, ether, sugar, oils, hydrocarbons, etc. are organic compounds. Sulphuric add, nitric acid, hydrochloric acids are common acids. Sodium hydroxide, potassium hydroxide, ammonium hydroxide, etc. are common bases. Calcium carbonate, zinc sulphate, copper sulphate, ammonium chloride, sodium carbonate, etc. are common examples of salts.

Differences between an element and a compound

	Element	Compound
1.	An element consists of the same kind of atoms.	A compound is composed of different kinds of atoms.
2.	A monoatomic element cannot be split up into its components by physical or chemical methods.	A compound can be split up into its components by chemical methods.
3.	Only limited number of elements are known.	Number of known compounds are quite large.
4.	The property of an element is the property of its atom.	The property of a compound is quite different from that of its constituent atoms.

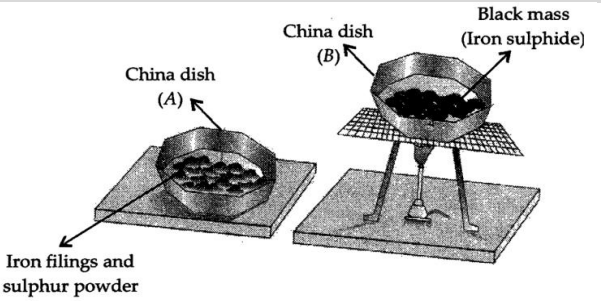
Impure Substances or Mixtures

- A mixture is a substance in which two or more pure substances are mixed in any proportion without any chemical combination. A mixture does not have a definite formula or composition.
- A mixture does not have a fixed melting or boiling point.
- The mixture shows the properties of all its components.
- A mixture can be separated into its components by physical means since they are not chemically bonded.

ACTIVITY CORNER

To distinguish between mixtures and compounds

In two separate china dishes marked (A) and (B), take mixture of nearly 50 g of iron filings and 3 g of powdered sulphur. Keep the dish (A) as such while heat the dish (B) to red hot for some time and then cool it.



- **Observations:**

- In the china dish (A) both iron filings and sulphur powder retain their colour.
  In the dish (B) a black mass will be formed.
- Bring a magnet near the mass present in both the dishes. Iron filings will readily cling to the magnet in dish (A) while this will not happen in dish (B).
- Transfer a small amount of the mass from dish (A) into a glass tube. Add carbon disulphide (liquid) to it and shake for some time. The yellow powder will dissolve leaving behind the iron filings in the tube. Repeat the

same experiment with the mass present in dish (B) also.
Nothing will happen.

- **Conclusion:**

- In the china dish (A), both iron filings and powdered sulphur are in the form of a mixture.
  In the dish (B), a chemical reaction has resulted upon heating and the black mass of iron sulphide is formed. It is a compound.

Iron+ Sulphur $\xrightarrow{\text{Heat}}$ Iron sulphide

- Iron filings present in dish (A) are attracted towards the magnet. Since iron sulphide is a compound, it is not attracted towards the magnet.
- Carbon disulphide has dissolved sulphur present in dish (A) leaving behind iron filings. It will not dissolve iron sulphide present in dish (B).

Differences between a mixture and a compound

Mixture	Compound
1. A mixture is obtained when two or more elements or compounds just mix together without involving the formation of any new compound.	1. Elements react together to form a new compound.
2. A mixture is formed as a result of a physical change.	2. A compound is formed as a result of a chemical change.
3. The constituents of a mixture can be easily separated by physical methods such as filtration, evaporation, distillation, sublimation, extraction with solvents, magnet, etc.	3. The constituents of a mixture cannot be separated by physical methods but can be separated only by chemical or electrochemical reactions.
4. A mixture shows the properties of its constituents.	4. The properties of a compounds are altogether different from those of its constituents.
5. The composition of a mixture is variable, i.e., the constituents of a mixture can be present in any proportion. Therefore, a mixture does not have a fixed formula.	5. The composition of a compound is always fixed, *i.e.,* the constituent elements are always present in a fixed proportion by mass. Therefore, a compound has a definite formula.
6. A mixture does not have a fixed melting point, boiling point, etc.	6. A compound has a fixed melting point, boiling point, etc.
7. A mixture may be homogeneous or heterogeneous.	7. A compound is a homogeneous substance.
8. Energy (in the form of heat or light) is neither absorbed nor evolved during the formation of a mixture.	8. Energy (in the form of heat or light) is either absorbed or evolved during the formation of a compound.

Types of Mixtures

Depending upon the nature of the components of a mixture, mixtures can be classified into homogeneous and heterogeneous mixtures.

Types of Mixtures

	Type of mixture	Homogeneous mixture	Heterogeneous mixture
1.	Gas in gas	Clean air	–
2.	Gas in liquid	Aerated water (water + carbon dioxide + oxygen)	–
3.	Gas in solid	Hydrogen in palladium	–
4.	Liquid in liquid	Alcohol and water	Oil and water
5.	Liquid in solid	Mercury in amalgamated zinc	–
6.	Solid in liquid	Sodium chloride in water	Chalk in water
7.	Solid in solid	Alloys, *e.g.* bronze, brass	Iron filings and sand, gun powder

- **Homogeneous Mixture**

A mixture is called homogeneous if all the components are mixed uniformly and there is no clear boundary of separation between them. The composition of a homogeneous mixture is uniform throughout. The components cannot be seen with naked eyes or under a microscope.

- Air is a homogeneous mixture of a number of gases like oxygen, nitrogen, carbon dioxide, inert gases, etc.

- A solution of alcohol and water is a homogeneous mixture of two liquids.
- An alloy is a homogeneous mixture of two or more metals and non-metals in solid state (Brass is an alloy of zinc and copper).
- A solution of sugar in water is a homogeneous mixture of a solid and a liquid.

- **Heterogeneous Mixture**

  A mixture is called heterogeneous if its composition is not uniform throughout and the components have visible boundaries of separation with them. The components of a heterogeneous mixture can be seen by naked eyes or under a microscope.

  - A mixture of sugar and sand is a heterogeneous mixture of two solids.
  - Oil and water is a heterogeneous mixture of two liquids.
  - Water and chalk powder is a heterogeneous mixture of a solid and a liquid.

ILLUSTRATION

1. How will you justify that water is a compound?

Sol. Water is considered to be a compound due to the following reason:

(a)Water cannot be separated into its constituents i.e., hydrogen and oxygen by physical methods.

(b) Properties of water are entirely different from its constituents hydrogen and oxygen. Hydrogen is combustible while oxygen supports combustion. Water is quite different from the two and it extinguishes fire.

(c) Heat and light are given out when water is formed by burning hydrogen and oxygen.

(d) The composition of water is fixed. Its constituent's hydrogen and oxygen are present in the ratio of 1:8 by mass.

(e) Water has a fixed boiling point of $100^{o}C$ (or 373K) under atmospheric pressure of one atmosphere (or 760 mm).

2. How will you justify that air is mixture and not a compound?

Sol. The justification can be done on the basis of the following points in its support:

(i) The composition of air is not always the same. At high altitudes, the percentage of oxygen decreases. Similarly, in industrial towns, we normally say that the air is more polluted. This means that the percentages of carbon monoxide, sulphur dioxide and other poisonous gases in air has increased.

(ii) The major constituents of air can be easily separated by physical methods such as liquefaction, fractional distillation, etc.

(iii) The different gases present in air do not lose their identities. For example, air supports combustion which means that it contains oxygen. Similarly, air turns lime water milky. This establishes the presence of carbon dioxide in air.

(iv) No energy changes or no chemical reactions occur when the constituents of air tried to be mixed.

All these evidences support the fact that air is a mixture and not a compound.

Physical and Chemical Changes

Two types of changes take place during the formation of compounds and mixtures. A compound is formed as a result of chemical reaction while a mixture is formed only by mixing the constituents without any chemical reaction.

- **Physical Change**
  - Physical change involves a change in physical state of a substance, size and its appearance.
  - No new substances are formed.
  - Change is temporary and can be reversed.
  - No change in the mass or composition of constituents.
  - Not much gain or loss of energy occurs.

  Examples- Dissolving salt or sugar in water, sublimation of iodine, bending a glass tube, etc.

- **Chemical Change**
  - The change in which new substances are formed in a chemical reaction by interacting with other is called a chemical change.

- A chemical change is a permanent change and cannot be reversed to give back substances in original structure.
- The original substances lose their identities and properties.
- Energy changes occur in a chemical reaction.
- The change in mass and composition takes place. Examples- Burning of magnesium in air, rusting of iron, digestion of food, baking of cake, burning of hydrogen in air or oxygen to give water, burning of fuels, ripening of fruits, etc.

Differences between Physical and Chemical Changes

Physical change	Chemical change
1. A physical change brings about changes in physical properties of the substance such as physical state, shape and size, etc. For example, ice (solid) melts to form water (liquid).	1. A chemical change brings about changes in the chemical properties of the substance. For example, iron undergoes rusting to form hydrated iron oxide. The chemical properties of hydrated iron oxide are different from those of iron.
2. There is no change in the chemical composition of the substance during the physical change. Thus, both ice and steam have the same chemical composition (made up of water molecules) as that of liquid water.	2. There is always a change in the chemical composition of the substance during a chemical change. For example, iron and rust have different chemical composition.
3. No new substance is formed in a physical change.	3. A new substance is always formed during a chemical change.
4. Physical changes are temporary and hence are easily reversible.	4. Chemical changes are permanent and hence are irreversible.
5. Small amounts of heat and light energy is usually absorbed or given out during a physical change.	5. Large amounts of heat and light energy are always absorbed or given out in a chemical change.

ILLUSTRATION

3. Why is burning of a candle involves both physical and chemical change?

Sol. When a candle is burnt, the following two changes occur.
1. Melting of wax.
2. Burning of thread and was.
The melting of wax is a physical change whereas the burning of thread and wax is a chemical change. Hence, the burning of a candle involves both physical and chemical change.

Solution

A solution is a homogeneous mixture of two or more non-reacting substances whose composition can be varied within certain limits. The solution which has only two components is called binary solution. A binary solution is made by dissolving one component into another.

- **Components of a Solution**
  - The component which is dissolved is called solute. The solute is present in small amount. Solution may or may not be in the same state of matter as the solute.
  - The medium in which solute is dissolved is called the solvent. The solvent is present in a larger amount. Solution will be in the same state of matter as the solvent.
- **Types of Solution**
  Due to three states of matter nine different types of binary solutions are possible. Three groups of solutions can be formed depending upon the nature of the solvent.
  - Solid solution: The solvent is solid.
  - Liquid solution: The solvent is liquid.
  - Gaseous solution: The solvent is gas.
  The nine types of binary solutions discussed above are summarized in the following table:

Name of solution	Solute	Solvent	Examples
Solid solutions			
1. Solid in solid	Solid	Solid	Alloys like steel, brass, bronze, German silver, solder, etc.
2. Liquid in solid	Liquid	Solid	Hydrated crystals such as blue vitriol (hydrated copper sulphate), dental amalgam (mercury liquid and silver solid).

3. Gas in solid	Gas	Solid	Gases adsorbed over the surface of the metals (such as nickel, palladium, platinum, etc.) under pressure.
Liquid solutions			
4. Solid in liquid	Solid	Liquid	Sugar, common salt or other salts dissolved in water, tincture of iodine.
5. Liquid in liquid	Liquid	Liquid	Mixture of two miscible liquids such as acetone and water, alcohol and water, vinegar (acetic acid and water), etc.
6. Gas in liquid	Gas	Liquid	Aerated drinks. Here, carbon dioxide is dissolved in water under pressure.
Gaseous solutions			
7. Solid in gas	Solid	Gas	Camphor in air or iodine in air.
8. Liquid in gas	Liquid	Gas	Clouds and fog. Here, water drops (liquid) are dispersed in gas (air).
9. Gas in gas	Gas	Gas	Air is a mixture of gases like nitrogen, oxygen, carbon dioxide, inert gases, etc.

- **Properties of Solution**
  - A solution is a homogeneous mixture.
  - The particle size of a solution is very small (< 1 nm or 10^{-9} m) in diameter. So they cannot be seen by naked eye or by ordinary microscope.
  - Due to small size the solute particles do not scatter a beam of light passing through a solution.
  - The solution can pass through a filter paper without separation of solute particles. The solute particles present in a solution do not settle down if solute is kept for a long time shows that solutions are stable.
  - A solution is always transparent in nature. It may be coloured or colourless.
  - The components of a solution do not react chemically with each other.
- **Aqueous and Non-aqueous Solution**
  A solution in which water acts as a solvent is called aqueous solution while the solution; which any other liquid acts as a solvent is called non-aqueous solution. Solution of come-on salt or sugar in water is an aqueous solution. Solution of sulphur in carbon disulphide or solution of iodine in alcohol is non-aqueous solution.
- **Saturated and Unsaturated Solution**
  A solution becomes saturated if no more solute can be dissolved into it at that temperature contains maximum amount of solute which can be dissolved into it and on addition of an more solute to the solution, the solute starts settling at the bottom. The solution in which more solute can be dissolved at the given temperature is called an unsaturated solution. A saturate solution becomes unsaturated on heating because it can dissolve more solute if the temperature is increased.
- **Supersaturated Solution**
  Under certain conditions a solution may temporarily contain more solute than the saturation level at a particular temperature. Such a solution is called supersaturated solution. Super saturate solutions separate out the extra solute by adding a small crystal of solute.
- **Concentrated and Dilute Solution**
  Between the two solutions one which has larger proportion of solute is called concentrated a compared to the one which has lesser proportion of solute. The solution with lesser solute called dilute solution.
- **True Solution**
  The solution in which particles of solute are so thoroughly mixed with the solvent that they cannot be distinguished from each other even under a powerful microscope is called a true solution.

Solubility

The maximum amount of solute in grams that can be dissolved in 100 grams of the solvent at a given temperature to form a saturated solution is called solubility of a solute at that particular temperature.

$$\text{Solubility} = \frac{\text{Weight of solute in saturated solution}}{\text{Weight of solvent in saturated solution}} \times 100$$

To demonstrate that different substances have different solubilities

- Take approximately 50 mL of water each in two separate beakers.
- Add common salt in one beaker and sugar or barium chloride in the second beaker with continuous stirring.
- When no more solute can be dissolved, heat the contents of the beakers.
- Start adding the solute again.

- Is the amount of common salt and sugar or barium chloride that can be dissolved in water at a given temperature, the same?
- What would happen if you were to take a saturated solution at a certain temperature and cool it slowly.
- **Observations:**

- The amounts of common salt, sugar and barium chloride that can be dissolved in water (50 mL) at room temperature are different.
- When a saturated solution at a certain temperature is cooled, the solubility decreases and the amount of the solute which exceeds the solubility at the lower temperature crystallizes out of the solution.

- **Conclusion:** Different substances have different solubilities in a given solvent at the same temperature and, in general, the solubility decreases as the solution is cooled and the extra amount of solute crystallizes out.

- **Effect of Temperature on Solubility**
  - Solubility of solids in liquids increases with increase in temperature and decreases with decrease in temperature.
  - Solubility of solids in liquids remains unaffected by the change in pressure.
  - Solubility of gases in liquids increases with decrease in temperature and decreases with increase in temperature.
  - Solubility of gases in liquids increases on increasing the pressure and decreases on decreasing the pressure.

ILLUSTRATION

4. 2.5 g of a solute are dissolved in 25 g of water to form a saturated solution at 298 K. Find out the solubility of the solute at this temperature.

Sol. Mass of the solute = 2.5 g

Solubility of the solute $= \frac{\text{Wt. of the solute}}{\text{Wt. of the solvent}} \times 100 = \frac{2.5}{25} \times 100 = 10g$

5. (a) What mass of potassium chloride would be needed to forma saturated solution in 50 g of water at 298 K? Given that solubility of the salt is 46/100 g at this temperature.

(b) What will happen if this solution is cooled?

Sol. (a) Mass of potassium chloride in 100 g of water in saturated solution = 46 g

Mass of potassium chloride in 50g of water in saturated solution $= \frac{(46)}{(100)} \times (50) = 23\text{g}$

(b) When the solution is cooled, the solubility of salt in water will decrease. This means that upon cooling, salt will start separating from the solution in crystalline form.

Concentration of Solution

The concentration of a solution may be defined as the amount of solute present in a given amount (mass or volume) of solution and can be expressed in various ways given below.

- **Mass Percentage**
  - The mass of the solute in grams dissolved in 100 grams of solution is called mass by mass percentage.

    Mass by mass percentage can be calculated as:

    $$w/w = \frac{mass\ of\ solute}{mass\ of\ solute + mass\ of\ solvent\ \ (solution)} \times 100$$

  - The mass of the solute in grams dissolved in 100 mL of solution is called mass by volume percentage.

    Mass by volume percentage can be calculated as: $\text{w}/\upsilon = \frac{\text{mass of solute (mL)}}{\text{volume of solution (mL)}} \times 100$

- **Volume Percentage**
  - The volume of the solute in mL dissolved in 100 mL of solution is called volume percentage

    Volume by volume percentage of a solution can be calculated as:

    $$\upsilon/\upsilon = \frac{\text{volume of solute}}{\text{volume of solution}} \times 100$$

- **Parts per Million or Parts per Billion (ppm or ppb)**
  - The ppm unit is used for expressing concentration of trace amounts of substance present in the total amount of solution.
  - Parts per million or parts per billion can be calculated as: $\text{ppm} = \frac{\text{mass of solute}}{\text{mass of solution}} \times 10^6$

    $$\text{ppb} = \frac{\text{mass of solute}}{\text{mass of solution}} \times 10^9$$

- **Molarity**

  It is defined as the number of moles of the solute per litre or per dm^3 of the solution. It is denoted by M.

  $$\text{Molarity(M)} = \frac{\text{Number of moles of solute}}{\text{Number of litres of solution}}$$

- **Molality**
  It is defined as the number of moles of the solute dissolved in kg (1000 g) of the solvent. It is denoted by m.

$$Molarity(m) = \frac{Number\ of\ \ moles\ of\ \ solute}{Number\ of\ \ kilogram\ of\ \ solvent}$$

- **Normality**
  It is defined as the number of gram equivalents of solute present per litre of solution. It is denoted by N.

$$Normality\,(N) = \frac{Number\ of\ \ gram\ equivalents\ of\ \ solute}{Number\ of\ \ litres\ of\ \ solution}$$

ILLUSTRATION

6. A solution contains 40 g of common salt in 320 g of water. Calculate the concentration in terms of (i) mass by mass percentage of the solute (ii) mass by mass percentage of the solvent.

Sol. Mass of common salt (solute) = 40 g
Mass of water (solvent) = 320 g
$\therefore$ Mass of the solution
= Mass of the solute + Mass of the solvent
= 40 + 320 = 360 g
Thus,
(i) mass by mass percentage of the solvent

$$= \frac{\text{Mass of the solute}}{\text{Mass of solution}} \times 100 = \frac{40}{260} \times 100 = 11.1\%$$

(ii) Mass by mass percentage of solvent
= 100 – (mass by mass percentage of solute)
= 100 – 11.1 =88.9%

7. A solution contains 5 mL of alcohol in 70 mL of water. Calculate the volume by volume percentage of the solute.

Sol. Volume of alcohol (solute) = 5 mL
Volume of water (solvent) = 70 mL
$\therefore$ Volume of the solution
= Volume of alcohol + Volume of water
= 5 + 70 = 75 mL
Thus, volume by volume percentage of solute

$$= \frac{\text{Volume of solute}}{\text{Volume of solution}} \times 100 = \frac{5}{75} \times 100 = 6.66\%$$

8. A solution contains 35 g of common salt in 300 g of water. Calculate the concentration of the solution.

Sol. Concentration of solution

$$= \frac{\text{Mass of solute}}{\text{Mass of solution}} \times 100$$

Mass of common salt = 35 g
Mass of water = 300 g
Mass of solution = (300+35) = 335 g
Concentration of solution

$$= \frac{(35)}{(335)} \times 100 = 10.45\%$$

9. A solution with mass of 1.00 kg contains 3 mg of solute. Express this concentration in ppm and ppb.

Sol.

$$\text{ppm} = \frac{\text{mass of solute}}{\text{mass of solution}} \times 10^6$$

$$= \frac{3 \times 10^{-3} g}{1 \times 10^3 g} \times 10^6 = 3\,ppm$$

$$\text{ppb} = \frac{3 \times 10^{-3} g}{1 \times 10^3 g} \times 10^9 = 3 \times 10^3 \text{ ppb}$$

Suspension

A suspension is a heterogeneous mixture in which the solute particles are spread throughout the solvent without dissolving in it. The particle size of a suspension is large (> 100 nm or 10^{-7} m) and can be seen by naked eyes. The solid particles of a suspension settle down when allowed to stand for some time hence suspensions are unstable. The solid particles of a suspension do not pass through a filter paper, they remain on the filter paper as residue. Suspensions are either opaque or translucent.
Few examples of suspension are chalk and water mixture, muddy water, milk of magnesia, lime water, a suspension of calcium hydroxide in water used for white washing, bleaching powder in water, etc.

Colloidal Solution

A colloidal solution is heterogeneous in nature with the particle size between the true solution and suspension. Colloids appear to be homogeneous but actually are heterogeneous.
The particle size lies between 1-100 nm or $10^{7} - 10^{-5}$ cm. Common example of colloids are smoke, ink, blood, milk, jellies, butter, etc.

- **Dispersed Phase and Dispersion Medium**
  The component present in smaller proportion (similar to solute in solutions) which is dispersal in a solvent like medium is called **dispersed phase.** The component present in larger proportion (similar to solvent in solutions) in which dispersed phase is distributed is called **dispersion medium.**

States of Matter

Depending on the states of dispersed phase and dispersion medium eight different types of colloids are possible because gases mix to form homogeneous mixtures.

Common example of colloids

Dispersed phase	Dispersion medium	Type	Examples
1. Solid	Solid	Solid sol	Coloured gemstones, milky glass
2. Solid	Liquid	Sol	Starch sol, muddy water, milk of magnesia, white of an egg, paints, latex, blood plasma, gelatin, etc.
3. Solid	Gas	Solid aerosol Gel	Smoke, dust-storm, automobile exhaust, etc.
4. Liquid	Solid	Emulsion	Jelly, cheese, butter, curd, shoe polish, etc.
5. Liquid	Liquid		Milk, face cream, cod liver oil.
6. Liquid	Gas	Aerosol	Fog, clouds, mist, sprays.
7. Gas	Solid	Solid foam	Pumice stone, foam, rubber (sponge), bread, etc.
8. Gas	Liquid	Foam	Froth, whipped cream, soap lather, shaving

- **Lyophilic and Lyophobic Colloids**
  Depending upon the interaction between dispersed phase and dispersion medium colloids are classified as lyophilic (solvent-loving) and lyophobic (solvent hating) colloids.

- **Lyophilic colloids:** In this type of colloids, the dispersed phase has great attraction towards the dispersion medium. If dispersion medium is separated from dispersed phase, the sol can be reconstituted by simply mixing with the dispersion medium. Hence, they are also called reversible sols. e.g. gum, starch, gelatine and polymers in organic solvents.
- **Lyophobic colloids:** In this type of sols, the dispersed phase has very little affinity for dispersion medium. They require some stabilizing agent to prevent the precipitation of the sol and once precipitated they cannot be reconstituted by simply adding the dispersion medium. Hence they are called irreversible sols. e.g. sols of metals and their insoluble compounds.

- **Multi molecular, Macromolecular and Associated Colloids**
  Based on the type of particles of the dispersed phase, colloids are classified as multi molecular, macromolecular and associated colloids. The colloids in which small molecules aggregate together to attain the size of the colloidal particles are called **multi molecular colloids** e.g. Sulphur (Sg).
  Macromolecules have large sizes, comparable to colloidal particles, the solutions of such molecules are called **macromolecular colloids,** e.g. starch, cellulose, protein, etc.
  The substances which behave as electrolytes at low concentrations and have size smaller than colloidal particles but at higher concentrations the molecules aggregate to form particles of colloidal size, are called **associated colloids,** e.g. the molecules of soaps and detergents are of small size but in concentrated solutions the molecules associate to form micelles.
  The minimum concentration the electrolyte required for the formation of a colloid is called **Critical micelle concentration** (CMC) and the temperature above which the micelle is formed called **Kraft temperature** (T_K). Soap when dissolved in water, dissociates to give negative and positive ions.

$$C_{17}H_{35}COONa \rightleftharpoons C_{17}H_{35}COO^- + Na^+$$

Emulsions

Colloids in which both dispersed phase and dispersion medium are liquids are called Emulsions. The emulsions are of two types:

- **Oil-in-Water Emulsions**
  When oil is the dispersed phase and water is dispersion phase e.g. milk (in which liquid fat is dispersed in water) and vanishing cream.
- **Water-in-Oil Emulsions**
  When oil acts as dispersion phase and water is dispersed in it e.g. butter and cold cream.
  The process of making an emulsion is called **emulsification.**
  For stabilizing an emulsion, an emulsifying agent is required along with dispersed phase and dispersion medium. Some common emulsifying

agents are soaps, detergents, proteins, gum, agar, etc.

The separation of an emulsion into its constituents is called **demulsification.**

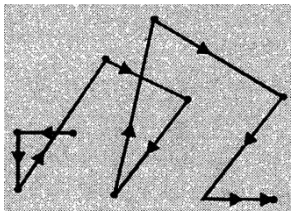
The two layers of oil and liquid separate into layers by boiling, freezing, centrifugation, etc.

Properties of Colloids

Since the particle size of colloids lies between true solution and suspension, they show some specific properties.

- **Brownian Movement**

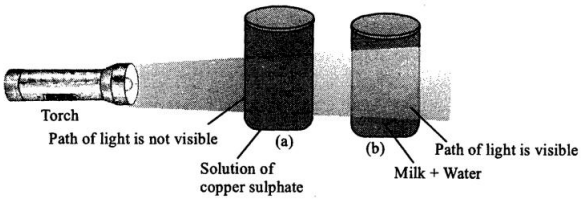
  Colloidal particles are in a state of constant and zig-zag motion when viewed under an ultra-microscope. This motion arises due to the collision of the colloidal particles with the particles of dispersion medium.



- **Tyndall Effect**

  The scattering of a beam of light by colloidal particles is called Tyndall effect. Due to scattering of light, the path of the light becomes visible. When a beam of sunlight enters a dark room through a small hole from the window, the path of light becomes visible and dust particles present in air can be seen in the rays of light.

  Sky looks blue due to scattering of light by dust particles present in air.



Diagrammatic illustration of Tyndall effect

- **Electrophoresis**

  All the colloidal particles of a particular colloid carry same charge which may be either positive or negative. When an electric field is applied to a colloidal sol, the charged particles towards the oppositely charged electrode depending on the charge present on them. This movement of charged colloidal particles under the influence of an electric field is called electrophoresis.

- **Coagulation**

  The process by which the colloidal particles are separated by addition of small amount of electrolyte is called coagulation. It is generally carried out by addition of electrolytes like sodium chloride, barium chloride, alum, etc.

- **Applications of Colloids**
  - **Smoke precipitators:** Smoke contains carbon particles dispersed in air. The carbon particle a can be precipitated or coagulated by applying electric field.
  - **Cleansing action of soaps** by forming micelles.
  - **Sewage disposal:** Sewage water which contains colloidal particles of dirt, mud, etc. can be coagulated by passing it through metallic electrodes.
  - **Medicines:** A number of medicines are in the form of colloidal dispersions or emulsions.
  - **Production of rubber:** Rubber is produced from latex by coagulation with acetic acid.
  - **In preparation of paints.**
  - **For extraction of metals.**

Comparison of characteristics of true solution, colloidal solution and suspensions

Property	True Solution	Colloidal Solution	Suspension
1. Particle size (Diameter)	$<10^{-7} cm$ (or 10^{-9} m or 1 nm)	Between $10^{-7}-10^{-5} cm$ (10^{-9} to $10^{-7} m$ or $1nm-100nm$)	$>10^{-5} cm$ (or $10^{-7} m$ or 100 nm)
2. Appearance	Clear and transparent	Translucent	Opaque
3. Nature	Homogeneous	Heterogeneous	Heterogeneous
4. Filterability	Pass through ordinary filter paper as well as animal membranes (having pores smaller than filter paper)	Pass through ordinary filter paper but does not pass through semi permeable membranes.	Neither pass through filter paper nor through semi permeable membranes.
5. Settling of particles	Particles do not settle down on standing, *i.e.,* true solutions are stable.	Colloidal particles also do not settle on keeping, *i.e.,* colloids are also stable. However, they can be made to settle by centrifugation.	Particles of suspension settle down on standing i.e., suspensions are unstable.
6. Visibility	Solute particles are not visible even under a	Particles themselves are generally invisible but their presence can be	Particles are visible to the naked eye.

	microscope.	detected under an ultra-microscope.	
7. Tyndall effect	Does not scatter light and hence does not show Tyndall effect.	Shows Tyndall effect due of scattering of light.	Tyndall effect may be observed.

Separating Components of a Mixture

The separation of a mixture depends upon the nature, physical state and difference in properties of various constituents of the mixture.

- **Evaporation** dissolved in a liquid. The solution is heated on a water bath or sand bath. The liquid evaporates leaving the solid behind.

ILLUSTRATION

10. How can you recover common salt from its solution in water?

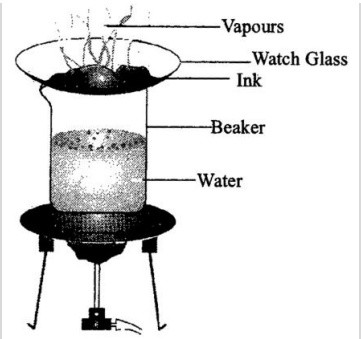
Sol. Common salt may be recovered from its aqueous solution by evaporating the water from the solution. Common salt present in sea water is collected in large shallow ponds and left in the sun for some days. Water is evaporated and common salt is left behind in the ponds.

- **Centrifugation**
  This method is based on the principle that when a mixture containing very small particles is rotated at a high speed the lighter particles come on the surface and heavier particles settle down.

ACTIVITY CORNER

To obtain coloured component (dye) from blue or black ink

- Make a water-bath by taking water in a beaker or make a sand bath by taking sand in an iron vessel.
- Put few drops of ink on a watch glass.
- Put the watch glass on water or sand bath and start heating.
- Observations:
  Water starts evaporating and after some time complete water evaporates leaving behind blue or black residue on the watch glass.
- **Conclusion:**
  The volatile component of a solution (solvent) can be separated from the non-volatile component (solute) by the method of evaporation.



To separate cream from milk

- Take some full cream milk in a test tube.
- Keep the test tube in a centrifuging machine for two minutes.
- **Observations:**
  Since cream is lighter than milk, it comes to the surface and is skimmed off.
- **Conclusion:**
  Centrifugation method can be used to separate out butter from cream and squeezing out water from wet clothes in washing machines.

- **Separation Using a Separating Funnel**
  A mixture of two immiscible liquids can be separated by using a separating runnel. Two liquids which do not mix with each other are called immiscible liquids. These liquids form heterogeneous mixture. On standing they separate out into two separate layers depending upon their densities,

ILLUSTRATION

11. What are the examples of separation of mixture on the basis of their densities?

Sol. (i) A mixture of carbon tetrachloride (lower layer) and water (upper layer).
(ii) During extraction of iron in blast furnace two separate layers of slag and iron are formed.
The molten slag form upper layer and the heavier molten iron form lower layer. The layers are removed through separate holes in the furnace.

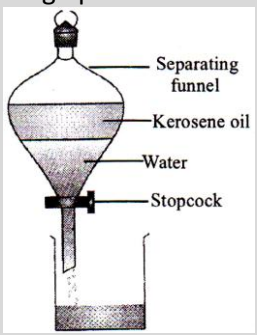
- **Sublimation**
  This process is used to separate those solids from their mixtures which directly pass to the vapour

state on heating without passing through the liquid state.

ACTIVITY CORNER

To separate a mixture of kerosene oil and water

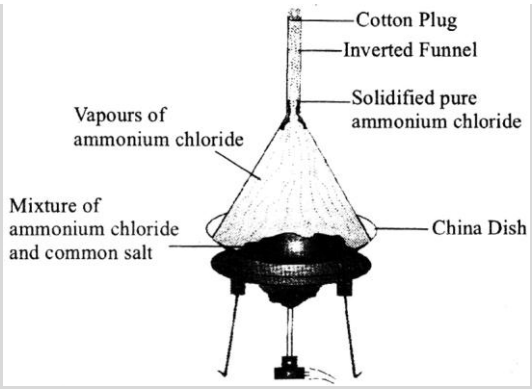
- Pour the mixture of kerosene oil and water in a separating funnel.
- Allow the mixture to stand for some time so that separate layers of oil and water are formed.
- Open the stop cock and let the water run out carefully.
- Close the stop cock and take out the oil in another container.
- **Observations:** Water being heavier forms the lower layer and is separated first.
- **Conclusion:** The immiscible liquids separate out in layers depending upon their densities.



To separate a mixture of ammonium chloride and common salt

- Take a mixture of ammonium chloride and common salt in a china dish.
- Put an inverted funnel over the china dish.
- Put a cotton plug at the stem of the funnel and start heating it slowly.
- **Observations:** The vapours of pure ammonium chloride sublimate and are deposited near the neck of the funnel while common salt, the non-sublimate remains in the china dish as residue.
- **Conclusion:**

- A sublimable volatile component can be separated from a non- volatile component of the mixture.
- Other substances which can be separated by this method are camphor, naphthalene, anthracite, benzoic acid, iodine, etc.



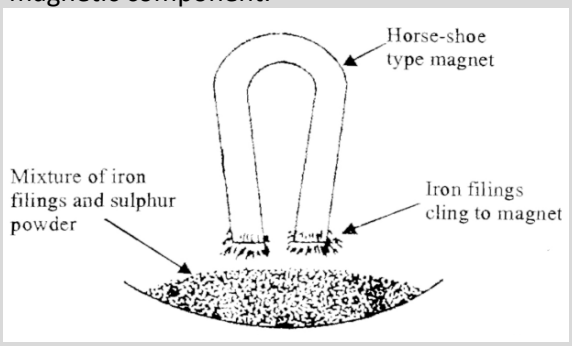
- **Magnetic Separation**

  This method is based on the property of iron of getting attracted by magnet. The mixture in which one component is magnetic in nature can be separated out by this method.

To separate a mixture of iron and sulphur

- Take a mixture of iron filings and sulphur powder.
- Move a horse shoe magnet on the mixture.
- **Observation:**
- Iron filings get attracted to the magnet and sulphur powder is left behind.
- **Conclusion:**

  Non- magnetic component can be separated from magnetic component.

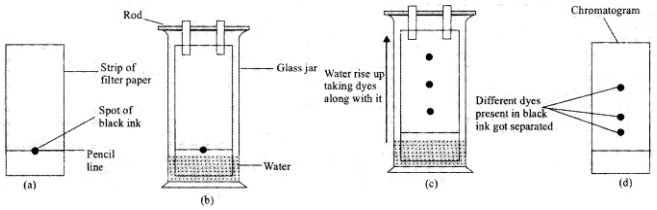


- **Chromatography**
- This is a modern method used for separation of mixture into their components and to test the purity of components. The name chromatography is based on Greek word kroma means colour and graphy means writing because it was first used to separate coloured substances found in plants. Separation of different components of a mixture based upon their different solubilities in the same solvent is known as chromatography.

ACTIVITY CORNER

To separate the components of ink by chromatography

- Take a thin strip of special chromatographic filter paper.
- Draw a line using a pencil about 3 cm from the bottom.
- Put a small drop of ink from a sketch pen or a fountain pen at the centre of this line and let it dry [fig. (a)].
- Suspend the filter paper in jar or beaker containing water just to dip the end of the filter paper and to keep the spot of ink above the water level [fig. (b)].
- Leave the jar undisturbed for some time.
- **Observations.**
  The water rises up on the filter paper and as it moves up, it takes along with it the particles of ink. Two or three coloured spots are seen on the filter paper different heights [fig. (c)].
- When the water reaches the maximum height the filter paper is removed and dried. The paper containing different coloured spots is known as chromatogram [fig. (d)].
- Conclusion:
  The coloured component which is more soluble in water, rises faster and produces a spot at higher position while the least soluble component remains at the bottom.

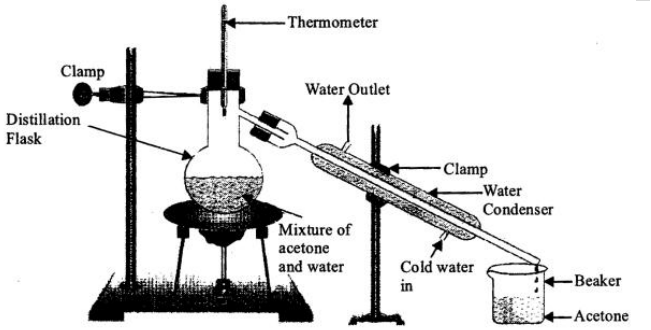


- **Distillation**
  If liquids in a mixture are miscible and have different boiling points, they can be separated by distillation. Distillation involves conversion of a liquid into vapours and then condensing the vapours back into liquid. Distillation is used only if the liquids have a difference in boiling point of more than 25 K.

ACTIVITY CORNER

To separate a mixture of acetone and water by distillation

- Set up the distillation apparatus as shown in the figure.
- Take mixture of acetone and water in the distillation flask fitted with a thermometer.
- Connect the water inlet pipe to the cold water.
- Start heating the mixture slowly.
- **Observations:**
  On heating, the acetone starts boiling first and is converted into vapours at 329 K. The vapours are cooled, condensed and collected in the beaker.
- As the heating continues the water starts boiling at 373 K. The vapours are cooled, condensed and collected in another beaker.
- The non-volatile impurities, if present are left in the flask.
- Conclusion:
  The method can be used to separate a non-volatile solid from a volatile liquid like salt and water solution or an impure mixture of liquids with different boiling points and non-volatile impurities or mixture of two or more miscible liquids,



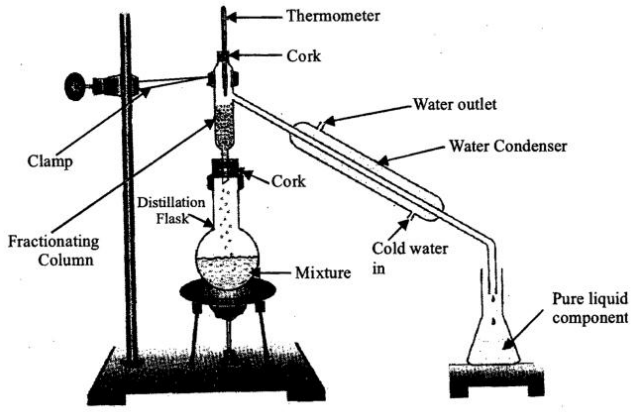
- **Fractional Distillation**
  If the boiling point of the two miscible liquids of the mixture are very close to one another, i.e., less than 25 K or so, the separation cannot be achieved by the simple distillation method as described above. This is due to the reason that at the boiling point of the more volatile liquid of the mixture there will be sufficient vapours of the less volatile liquid as well. As a result, both the liquids of the mixture will distil together and the separation cannot be achieved.
  The separation of such a liquid mixture into individual components can, however, be achieved by fractional distillation, which involves repeated distillations and condensations. Fractional distillation is carried out using a fractionating column. It usually consists of a long glass tube with a wide bore packed with glass beads or small stones or porcelain pieces. The actual purpose of the fractionating column is to increase the cooling surface area and to provide hurdles or

obstructions to the ascending vapours and descending liquid.

ACTIVITY CORNER

To separate a mixture of alcohol and water

- Take a mixture of ethyl alcohol (b. pt. 351 K) and water (b. pt. 373 K) in a distillation flask provided with a fractionation column.
- Start heating the liquid mixture till the mixture starts boiling.
- **Observations:**
  - More volatile liquid is condensed first and collected in the flask.
  - Less volatile liquid with high boiling point is collected next in another flask.
- **Conclusion:**
  On heating, vapours of alcohol (low boiling point escape from the flask and get condensed more readily).
  At the same time the vapours of water (high boiling point) fall back in the flask after getting condensed through fractionating column. When whole of the alcohol has distilled, the temperature starts rising on further heating. When the vapour pressure of water becomes. Equal to atmospheric pressure, it starts boiling. The vapours are condensed and collected.



- **Fractional Distillation of Air**
  Air is a homogeneous mixture of many gases which can be separated by fractional distillation.
  Air is cooled and compressed by applying pressure and decreasing temperature. Air is compressed to form liquid air called liquefied air. Liquid air is subjected to fractional distillation and different gases are separated according to their boiling points.

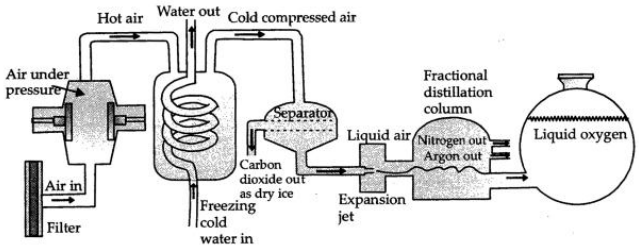


Fig. Separation of components of air

The flow diagram for the method is as follows:

Air

↓

Compressed and cooled by increasing pressure and decreasing temperature.

↓

Liquid Air

↓

Allowed to warm up slowly in fractional distillation column

↓

Gases get separated at different heights

↓

	Oxygen	Argon	Nitrogen
Boiling Point (^{o}C)	-183	-186	-196
% in Air by Volume	20.9	0.9	78.1

Flow diagram shows the process of obtaining gases from air

ILLUSTRATION

12. Is air a mixture or a compound? Give three reasons.

Sol. Air is a mixture and not a compound as discussed below:

(i) The properties of a mixture are in between those of its constituents. The two major components of air are oxygen (20.9% by volume) and nitrogen (78.1% by volume).

In Oxygen, any fuel burns brightly but in nitrogen it gets extinguished. In contrast, in air the fuel burns slowly.

(ii) The components of a mixture can be separated by simple physical methods. For example, the components of air can be separated by fractional distillation of liquid air.

(iii) The composition of a mixture is variable.

The composition of air is also variable. It has more oxygen in the country side than in big cities.

13. What is the function of fractionating column in fractional distillation?

Sol. A fractionating column obstructs the up wards movement of the vapours of the liquids. As a result, the energy (latent heat of fusion) which is released by the high boiling liquid is taken by the low boiling liquid. It remains in the vapour state. The high boiling liquid by releasing energy condenses and falls back in the distillation flask. Thus, fractionating column helps in the separation of the components from a mixture.

- **Crystallization**

  The process by which a pure soluble substance is separated in the form of crystals from its hot and saturated solution on cooling is called crystallization.

  Crystallization is better than simple evaporation as a method to get pure solids from liquids as:

  (i) some solids may decompose or get charred when heated to dryness.

  (ii) on evaporation some dissolved impurities may also get deposited with the solid while in crystallization, crystals of pure solid are crystallized leaving the impurities in the solution.

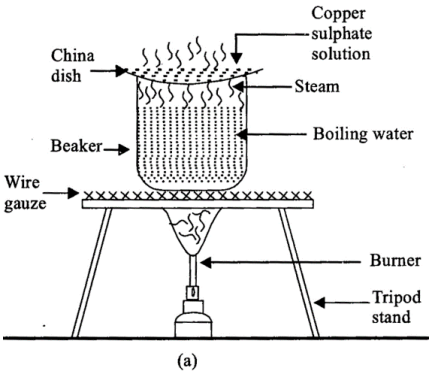
ACTIVITY CORNER

To separate pure crystals of copper sulphate by crystallization

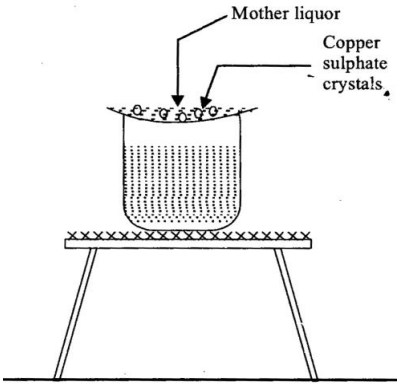
- Take about 5 g of impure copper sulphate and dissolve it in minimum amount of water.
- Filter the solution to remove the impurities.
- Heat the solution in a china dish to evaporate some water to get a saturated solution.
- Leave the solution undisturbed for a few hours.
- **Observations:**

  - Pure copper sulphate crystals separate out.
  - The liquid left after removing the crystals is called mother liquor and is separated from the crystals by decantation.
- **Conclusion:**

  The crystallization method is used to purify solids e.g. to remove impurities from salt which we get from sea water.



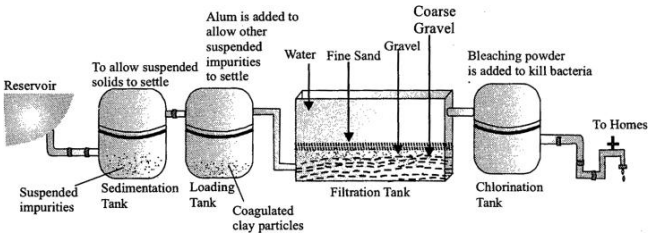
(a)



(b)

- **Purification of Drinking Water**

  A number of dissolved and suspended impurities are too removed from the river or lake water before making it fit for drinking purposes.



A typical water purification system in water works.

A typical water works involved in the process includes the following processes.

(i) Removal of suspended impurities (Sedimentation tank) - Water is allowed to stand for some time so that suspended impurities are settled down.

(ii) Removal of colloidal particles (Loading tank) - To remove the small particles present in colloidal state some alum is added to water. Particles like clay get neutralized and are coagulated at the bottom of the tank.

(iii) Filtration of impure water (Filtration tank) - The water from which insoluble impurities have been removed is passed through filtration tank which has three layers. Coarse gravel at the bottom, fine gravel in the centre and fine sand at the top acts as filters. Impure water is introduced from the bottom. The impurities are retained in

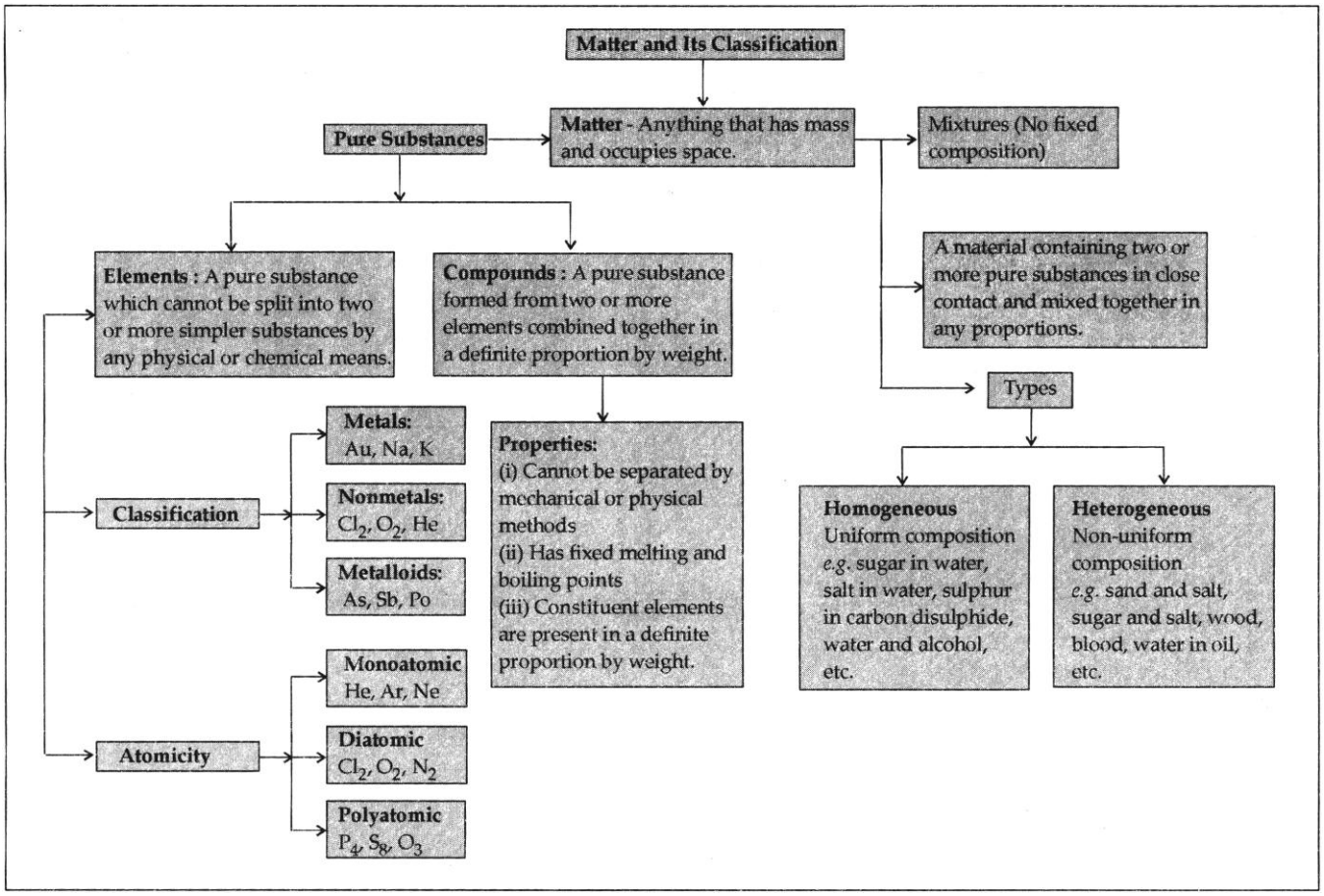
the three layers of gravel and pure water goes to the top and sent to chlorination tank.

(iv) Chlorination tank - Filtered water is treated with bleaching powder or ozone or any other germicide to kill bacteria. The pure water is now supplied to homes for drinking purposes.

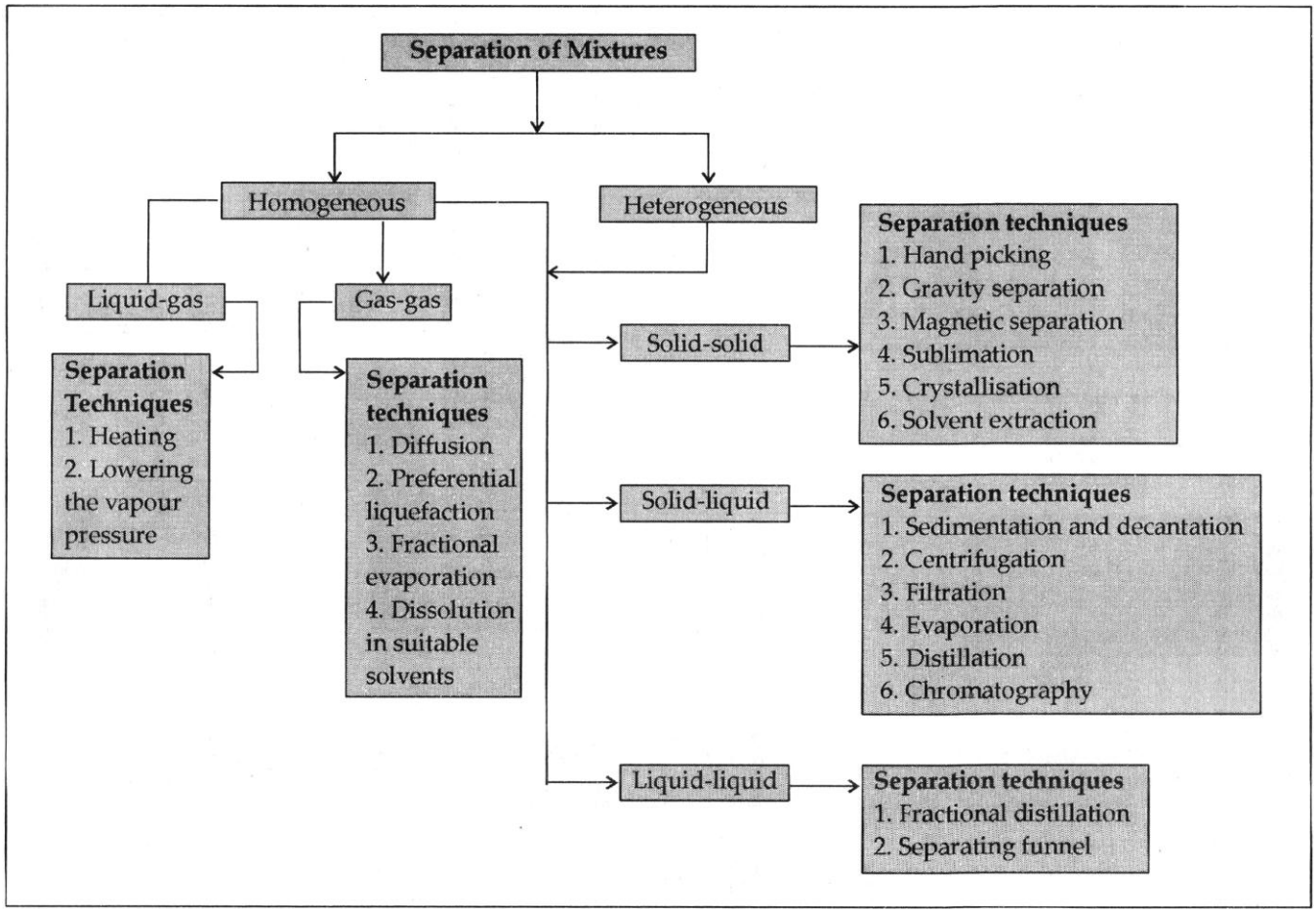
Do You Know

- Formation of deltas in the sea at the mouth of a river is due to the precipitation (or coagulation) of the colloidal clay in the river water.
- A large number of medicines and pharmaceutical preparations are colloidal in nature. Such colloidal medicines are easily adsorbed by the body tissues and therefore are more effective.
- Full-cream milk contains 6% fat, standard milk contains 3% fat and double toned milk contains 1% fat.
- First man-made element is technetium.
- Saline-glucose solution administered to patients suffering from dehydration is a solution of glucose and various salts in water.
- Cough syrups invariably contain alcohol and water.
- Eye and ear drops are aqueous solutions of boric acid or various antibiotics.
- An aqueous solution of H_2O_2 is used as a bleaching agent in dental treatment and textile industry.
- An aqueous solution of potassium permanganate or phenol is used as disinfectant.

CONCEPT MAP



CONCEPT MAP



ESSENTIAL POINTS For COMPETITIVE EXAMS

Summary of the separation techniques

- **Separating the Components of Solid Mixtures**

Method	When to apply	Example
1. Hand-picking	When the constituents are bigger in size and distinctly visible.	Stones + rice, gram + wheat
2. Sieving	When the sizes of constituent particles are different and not distinctly visible.	Bran + flour
3. Magnetic separation	When one of the constituents is attracted by a magnet.	Iron + sand
4. Sublimation	When one of the constituents sublimes on heating.	Ammonium chloride + common salt, iodine + sand

- **Separating the Components of Solid-Liquid Mixtures**

Method	When to apply	Example
1. Sedimentation	When the mixture is heterogeneous and the solid constituent is heavy.	Sand + water, dirt particle + muddy water
2. Centrifugation	When the mixture is homogeneous and one of the constituents is heavy.	Milk + cream
3. Filtration	When one of the constituents dissolves in a solvent.	Tea, muddy water metal pieces and engine oil
4. Evaporation is non-volatile.	When the solid present in the liquid carbon disulphide	Solution of sulphur in
5. Distillation	Any mixture whether homogeneous or heterogeneous.	Solution of sugar or salt in water
6. Chromatography	When the constituents are soluble in the same solvent.	Components of ink

- **Separating the Components of Liquid Mixtures**

Method	When to apply	Example
1. Distillation	When liquids are miscible and their boiling points differ by a wide margin.	Acetone + water
2. Fractional distillation	When liquids are miscible and their boiling points differ by a small margin.	Components of petroleum
3. Use of separating funnel	When the liquids are immiscible.	Oil + water

Summary of the Separation Techniques

- **Vacuum distillation (Distillation Under Reduced Pressure)**

  This type of distillation process is used for purification of high boiling liquids and liquids which decompose at or below their normal boiling points.

  Boiling point of a liquid is the temperature at which its vapour pressure becomes equal to atmospheric pressure. If the outer pressure is reduced (by suction pump or vacuum pump), the liquid boils at lower temperature without decomposition, e.g., glycerol (b.pt. 563 K) can be distilled at 453 K under 12 mm Hg pressure without decomposition. Cane sugar juice is concentrated by this method in sugar industry.

- **Steam Distillation**

  This type of distillation process is used for the separation and purification of organic compounds (solid or liquid) which are volatile in steam, immiscible with water, possess a high vapour pressure of about 10-15 mm Hg at 373 K and contain non-volatile impurities. In this process steam is passed through the organic mixture to be distilled so that the distilling mixture consists of steam and volatile organic compound, which follows that

  Atmospheric pressure = Vapour pressure of organic substance + vapour pressure of steam.

  It is obvious from the above relation that organic compounds distil below its normal boiling point without decomposition. For example, aniline can be distilled at 371.5 K against its normal boiling point 457 K. o-Nitro phenol can be separated from p-nitrophenol, since o-nitro phenol is volatile in steam. Some other compounds which can be purified by this method are nitrobenzene, bromobenzene, aniline, essential oils, turpentine oil, sandal wood oil, o-hydroxy acetophenone, etc.

- **Azeotropic Distillation**

  Azeotropes are constant boiling mixtures, which distil as a single compound at a fixed temperature.

  Components of an azeotropic mixtures cannot be separated by fractional distillation. The most common example of azeotropic mixture is ethanol and water (rectified spirit) in the ratio of 95.87 : 4.13.

  Constituents of azeotropic mixture can be separated by azeotropic distillation. In this method a third component is used in distillation. The process is based on the fact that dehydrating agents like benzene, carbon tetrachloride, diethyl ether, etc. depress the partial pressure of one component so that the boiling point of that component is raised sufficiently and thus other component will distil over.

  Dehydrating agents having low boiling point (e.g., C_6H_6,CCl_4, ether, etc.) depress the partial vapour pressure of alcohol more than that of water whereas dehydrating agents having high boiling point e.g., glycerol, glycol, etc. depress the partial vapour pressure of water more than that of alcohol.

- **Differential Extraction**

  This method of purification is used for the separation of an organic compound, from its aqueous solution by shaking it with a suitable solvent such as ether, chloroform or benzene.

  The solvent chosen should be immiscible with water and dissolve the organic compound to be separated. If the extracting solvent is used in several installments instead of a single lot, the extraction is more efficient.

  Organic compounds which are less soluble in organic solvents are extracted by continuous extraction using **Soxhiet extractor.** Vanilla can be extracted from vanilla beans by **Soxhiet extractor.**

- **Chromatography**

  This method of purification was first discovered by a Russian botanist Tswett in 1906. This method has a wide application for separation, purification, identification and characterization of the constituents of complex substances (solids, liquids or gases) such as ammo acids, sugars, vitamins, hormones and plant pigments, etc.

  The technique of chromatography depends on the selective distribution of components of the mixture between two phases, one stationary phase or fixed phase and other mobile phase. The stationary phase can be solid or liquid. The mobile phase may be liquid or gas. The mixture to be separated is dissolved in mobile phase and passed

over stationary phase. Different components in two phases can be separated either by adsorption or partition.

- Adsorption chromatography: This method is based on the different adsorption affinity of various components of a mixture for the suitable adsorbent such as alumina, silica gel, magnesium oxide etc. The component which has maximum affinity for the adsorbent is adsorbed first near to the starting point and thus components with different adsorption affinity are adsorbed at different distances from the starting point. Hence different bands or chromatograms are formed at different parts of the adsorbant. Different components can be recovered from these bands by elution and analyzed.

If a column of suitable adsorbent is used in the process we call it column chromatography.

But if the process takes place on a thin layer of adsorbent coated on a glass plate, then it is known as thin layer chromatography.

- Partition chromatography: It is a liquid-liquid chromatography in which both the mobile phase and stationary phase are liquids. Paper chromatography is an important type of partition chromatography in which the stationary phase is water which is adsorbed or chemically bound to special type of paper called chromatographic paper and mobile phase is another liquid which is a mixture of two or three solvents with water as one of the components. A spot of the mixture of components to be separated is applied on the paper, as the solvent rises upon the paper, different components of mixture travel with solvent through different distances depending upon their solubility or partitioning between stationary and mobile phase. The separated compounds can be analyzed for characterization.

Relation between Percentage by Weight and Percentage by Volume

We know that % by weight

$$= \frac{(\text{weight of solute})\text{g}}{(\text{weight to solution})\text{g}} \times 100 \quad \text{...(i)}$$

$$\%\text{ by volume} = \frac{(\text{weight of solute})\text{g}}{(\text{volume of solution})\,\text{mL}} \times 100$$

Dividing (i) by (ii), we get $\frac{\%\,\text{by weight}}{\%\,\text{by (volume}} =$

$$\frac{(\text{weight of solute/weight of solution}) \times 100}{(\text{weight of solute/volume of solution}) \times 100}$$

$$\Rightarrow \frac{\%\,\text{by weight}}{\%\,\text{by volume}} = \frac{\text{volume of solution}}{\text{weight of solution}}$$

$$= \frac{1}{\frac{\text{weight of solution}}{\text{volume of solution}}} = \frac{1}{d_{\text{solution}}} \left(\text{density} = \frac{\text{mass}}{\text{volume}} \right)$$

$\Rightarrow$ % by volume weight of solution $(d_{\text{solution}}) \times$ % by weight

Relation between Solubility (S) and Weight Percentage (% w)

Let w_i and w_2 be the weight of solute and solvent respectively. We know that

Solubility (S)

$$= \frac{\text{weight of solute}}{\text{weight of solvent}} \times 100 = \frac{w_{\text{solute}}}{w_{\text{solvent}}} \times 100 \ldots\text{(i)}$$

Percentage by weight (% w)

$$= \frac{\text{weight of solute}}{\text{weight of solvent}} \times 100 = \frac{w_{\text{solute}}}{w_{\text{solution}}} \times 100 \ldots\text{(ii)}$$

$$\frac{\text{(ii)}}{\text{(i)}} = \frac{\%w}{S} \frac{\frac{w_{\text{solute}}}{w_{\text{solution}}} \times 100}{\frac{w_{\text{solute}}}{w_{\text{solvent}}} \times 100} \Rightarrow \frac{\%w}{S} = \frac{w_{\text{solvent}}}{w_{\text{solution}}} = \frac{w_2}{w_1 + w_2}$$

$$\Rightarrow \%w = S \times \frac{w_2}{w_1 + w_2}$$

$\therefore$ w =solubility $\times \frac{w_{\text{solvent}}}{w_{\text{solution}}}$, where w_1 and w_2 are the weight of solute and solvent in grams respectively.

SOLVED EXAMPLES

1. **How will you separate a mixture of common salt, sulphur powder and sand?**

Sol. First shake the mixture with carbon disulphide, sulphur powder dissolves leaving behind common salt and sand. The mixture is filtered. Evaporation of carbon disulphide from the filtrate gives sulphur powder. The residue left on the filter paper consists of common salt and sand. Shake this mixture well with water when common salt dissolves leaving behind sand. The mixture is filtered. Evaporation of water from the filtrate gives common salt.

2. **Comment upon the following :**
(i) Smoke and fog are aerosols.
(ii) An emulsifying agent stabilizes a colloidal sol of a solid in a liquid.
(iii) Amalgamated zinc is a compound.

Sol. (i) A colloidal solution in which gas is the dispersion medium is called the aerosol.

Since smoke is a colloidal sol of solid carbon particles is air and fog is a colloidal sol of moisture (water droplets) in air, therefore, both are aerosols.

(ii) Colloidal sols of solid in liquid or liquid in solid are quite stable. Therefore, they do not need any emulsifying agent. However, liquid in liquid type colloidal sols called emulsions are usually unstable. Therefore, to stabilize them usually emulsifying agents are added.

For example, milk in which liquid fat is dispersed in water is stabilized by the protein lactalbumin present in it.

(iii) Amalgamated zinc is obtained by vigorously shaking zinc granules with a solution of mercuric chloride. As a result, the surface of zinc granules is coated with mercury. In other words, amalgamated zinc is not a compound but is a heterogeneous mixture of zinc and mercury.

3. Classify the following as pure substances or mixtures. Separate the pure substances into elements, compounds and divide the mixtures into homogeneous and heterogeneous:

(i) Air (ii) Milk (iii) Graphite (iv) Gasoline (v) Diamond (vi) Tap water (vii) Distilled water (viii) Oxygen (ix) Brass (x) 22 Carat gold (xi) Steel (xii) Iron (xiii) Sodium chloride (xiv) Iodized table salt.

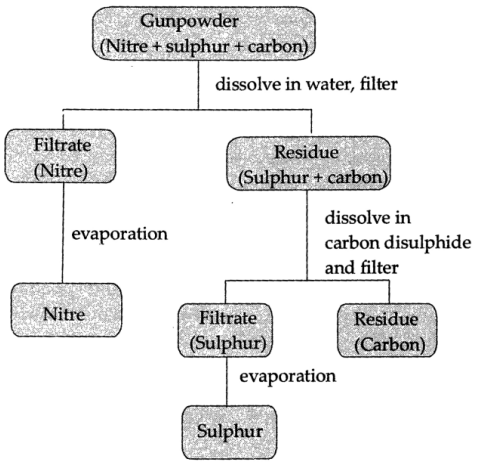
Sol.
(i) Air : Mixture (Homogeneous)
(ii) Milk : Mixture (Homogeneous)
(iii) Graphite : Pure substance (Element)
(iv) Gasoline : Mixture (Homogeneous)
(v) Diamond : Pure substance (Element)
(vi) Tap water : Mixture (Homogeneous)
(vii) Distilled water : Pure substance (Compound)
(viii) Oxygen : Pure substance (Element)
(ix) Brass : Mixture (Homogeneous)
(x) 22 Carat gold : Mixture (Homogeneous)
(xi) Steel : Mixture (Homogeneous)
(xii) Iron : Pure substance (Element)
(xiii) Sodium chloride :Pure substance (Compound)
(xiv) Iodized table salt : Mixture (Homogeneous)

4. How will you separate the components of gun powder?

Sol. Gunpowder is a mixture of nitre (potassium nitrate), sulphur and powdered charcoal.

The mixture is thoroughly shaken with water when nitre goes into solution leaving behind sulphur and charcoal undisclosed. The solution is filtered out. The filtrate contains aqueous solution of nitre. On slow evaporation, the filtrate gives crystals of nitre. Undisclosed residue containing sulphur and charcoal is treated with carbon disulphide solution.

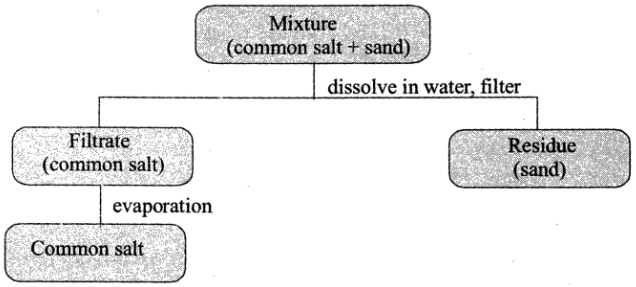
Sulphur dissolves in the solution but charcoal does not. On filtration, charcoal is obtained as a residue. The filtrate, which contains sulphur, on evaporation gives sulphur as the residue.



5. How will you separate the components of a mixture of common salt and sand?

Sol. The mixture is treated with water. Common salt dissolves in water, but sand remains undissolved. The solution is filtered. The filtrate is an aqueous solution of common salt

The solution on evaporation gives common salt as the residue.



6. Calculate the concentration of a solution in volume per cent made when 56 g of water is mixed with 0.17 L of ethanol.

Sol. Volume of water

$$=\frac{\text{mass}}{\text{density}}=\frac{5\text{g}}{1.0\text{gcm}^{-3}}=56\text{cm}^3=56\text{mL}$$

Volume of ethanol = 0.17 L = 0.17 x 1000 mL = 170 mL

$\therefore$ volume of solution = (56+170) mL= 226 mL

$\therefore$ concentration percent by

$$\text{volume}=\frac{56}{226}\times 100=24.78\%$$

7. How will you separate iron filings, ammonium chloride and sand from their mixture?

Sol. The mixture containing iron filings, ammonium chloride and sand is separated as follows:

(i) Iron filings are attracted by a magnet so they are removed by the method of magnetic separation. When a magnet is moved in this mixture, iron filings cling to the magnet and get separated. We are then left with ammonium chloride and sand.

(ii) Ammonium chloride sublimes on heating whereas sand does not sublime. So, ammonium chloride is separated from sand by the process of sublimation. When the mixture containing ammonium chloride and sand is heated, then ammonium chloride forms vapours easily.

These vapours on cooling give pure ammonium chloride.

8. You are given a mixture of sand, water and mustard oil. How will you separate the components of this mixture?

Sol. This mixture contains three components: sand, water and mustard oil. Now, sand is a solid which is insoluble in water as well as mustard oil. Water and mustard oil are immiscible liquids.

(i) The mixture of sand, water and mustard oil is filtered. Sand is left on the filter paper as residue. Water and mustard oil collects as filtrate.

(ii) The filtrate containing water and mustard oil is put in a separating funnel. Water forms the lower layer and mustard oil forms the upper layer in separating funnel. The lower layer of water is run out first by opening the stop-cock of the separating funnel.

Mustard oil remains behind in the separating funnel and can be removed separately.

9. If 110 g of salt is present in 550 g of solution, calculate the concentration of solution.

Sol. Here, mass of solute (salt) = 110 g

And, mass of solution = 550 g

Now, we know that:

Concentration of solution

$$= \frac{\text{Mass of solute}}{\text{Mass of solution}} \times 100 = \frac{110}{550} \times 100 = \frac{100}{5} = 20$$

Percent (or 20%) Thus, the concentration of this salt solution is 20 percent (or it is a 20% salt solution).

10. A solution contains 50 mL of alcohol mixed with 150 mL of water. Calculate the concentration of this solution.

Sol. This solution contains a liquid solute (alcohol) mixed with a liquid solvent (water), so we have to calculate the concentration of this solution in terms of volume percentage of solute (alcohol). Now, we know that:

Concentration of solution

$$= \frac{\text{volume of solute}}{\text{Volume of solution}} \times 100$$

Here, Volume of solute (alcohol) = 50 mL

And, Volume of solvent (water) = 150 mL

So, Volume of solution = Volume of solute + Volume of solvent = 50 + 150 = 200 mL

Now, putting the values of 'volume of solute' and 'volume of solution' in the above formula we get:

Concentration of solution

$$= \frac{50}{200} \times 100 = \frac{50}{2} = 25\%$$

11. Can physical and chemical changes occur together? Illustrate your answer.

Sol. In some cases, physical and chemical changes occur together. One such example is burning of candle. The solid wax present in the candle first changes into liquid state and then into the vapour state. Both these changes are physical changes. The wax vapours then combine with oxygen of the air to form a mixture of carbon dioxide and water. This involves a chemical change. The un burnt wax vapours again change first to the liquid state and finally to the solid state. This inter conversion of states is a physical change. Thus, burning of candle involves both physical and chemical changes.

12. How can a saturated solution be made unsaturated?

Sol. A saturated solution can be made unsaturated in the following two ways:

(i) By increasing the temperature of the solution. When a saturated solution is heated, solubility of the solute increases and hence the solution becomes unsaturated.

(ii) By adding more of the solvent or by diluting.

13. Mercuric oxide is a red powder (HgO). When heated in a dry test tube, it gives out liquid mercury and colourless oxygen gas as :

Mercuric oxide $\rightarrow$ Mercury + Oxygen

What conclusion will you draw regarding these three substances: mercuric oxide, mercury and oxygen?

Sol. Mercuric oxide: It is a compound because it splits up into simpler substances mercury and oxygen.

Mercury: It is an element because it cannot be further decomposed into simpler substances.

Oxygen: It is also an element because it cannot be further decomposed into simpler substances.

14. Hydrogen is a combustible gas and oxygen is a supporter of combustion. Water contains both hydrogen and oxygen but it is used to existinguish fire. Explain.

Sol. Hydrogen and oxygen are elements and have their characteristic properties. But water is a compound of hydrogen and oxygen combined together in a fixed ratio of 1:8 by mass. The properties of a compound are entirely different from those of its constituent atoms from which it is formed. Therefore, water has different properties than hydrogen and oxygen.

15. Name the following:

(a) An element which is liquid at room temperature and metallic in nature.

(b) An element attracted by magnet.

(c) A non-metal which is gaseous at room temperature.

(d) Two gases present in air.

(e) Components of alloy brass.

Sol. (a) Mercury

(b) Iron

(c) Hydrogen

(d) Oxygen and nitrogen

(e) Copper and zinc

16. Identify the dispersed phase and dispersion medium in the following colloidal solutions.

(i) milk, (ii) latex, (iii) sponge, (iv) sprays.

Sol. (i) Dispersed phase $\rightarrow$ fat, proteins dispersion medium $\rightarrow$ water

(ii) Dispersed phase $\rightarrow$ rubber particles; dispersion medium $\rightarrow$ water

(iii) Dispersed phase $\rightarrow$ air; dispersion medium $\rightarrow$ rubber (material of the sponge)

(iv) Dispersed phase $\rightarrow$ liquid perfume; dispersion medium $\rightarrow$ gas (Freon)

NCERT SECTION

1. What is meant by a pure substance?

Ans. A pure substance is one which is made up of only one kind of atom or molecules. e.g. water is made up of only one kind of particles. So water is a pure substance.

2. List the points of difference between homogeneous and heterogeneous mixture.

Ans.

Homogeneous mixture	Heterogeneous mixture
1. A mixture in which different constituents are mixed uniformly.	1. A mixture in which different constituents are not mixed uniformly.
2. They cannot have physically distinct parts.	2. They have physically distinct parts.
3. The constituents cannot be easily seen.	3. The constituents can be easily seen.
4. The constituents cannot be easily separated.	4. The constituents can be easily separated.
5. **Example :** Sugar solution, soda, water, soft drinks, vinegar, air etc.	5. **Example :** Sugar and sand mixture, milk, ink, paint, wood, blood etc.

3. Differentiate between homogeneous and heterogeneous mixtures with examples.

Ans.

Homogeneous mixture	Heterogeneous mixture
1. A mixture in which different constituents are mixed uniformly.	1. A mixture in which different constituents are not mixed uniformly.
2. They cannot have physically distinct parts.	2. They have physically distinct parts.
3. The constituents cannot be easily seen.	3. The constituents can be easily seen.
4. The constituents cannot be easily separated.	4. The constituents can be easily separated.
5. **Example :** Sugar solution, soda, water, soft drinks, vinegar, air etc.	5. **Example :** Sugar and sand mixture, milk, ink, paint, wood, blood etc.

4. How are sol, solution and suspension differ from each other?

Ans.

Property	Sol	Solution	Suspension
1. Nature	Heterogeneous	Homogeneous	Heterogeneous
2. Particle size (diameter)	Between 10^{-7} to 10^{-5} cm (10^{-9} to 10^{-7} m or 1 nm to 100 nm)	Less than 1 nm (less than 10^{-9} to 10^{-7}m)	More than 100 nm
3. Appearance	Generally clear	Clear	Opaque
4. Visibility	Visible with ultra microscope	Not visible	Visible with naked eye
5. Diffusion	Diffuses very slowly	Diffuses rapidly	Does not diffuse
6. Tyndall effect	Show	Do not show	May show
7. Settling of particles	Settle only on centrifugation	Do not settle	Settle of their own
8. Brownian movement	Shows	May or may not show	May show

5. To make a saturated solution 36 g of sodium chloride is dissolved in 100 g of water at 293 K. Find its concentration at this temperature.

Ans. Mass of sodium chloride = 36 g

Mass of solution = 36 + 100 = 136 g

Conc entration of solution

$$= \frac{mass\ of\ solute}{mass\ of\ solution} \times 100 = \frac{36}{136} \times 100 = 26.47\%\,(w/w)$$

6. How will you separate a mixture containing kerosene and petrol, (difference in their building points is more than 25°C), which are miscible with each other?

Ans. The mixture of two miscible liquids such as kerosene and petrol whose boiling points differ by more than 25°C can be easily separated by the technique of simple distillation.

The separation is based upon the principle that the boiling point of more volatile (low building liquid of the mixture. The vapour almost exclusively consists of the more volatile liquid Likewise at the boiling of the less volatile (high boiling) liquid/ vapours almost entirely consists of the less volatile liquid since the more volatile liquid has already distilled over.

7. Name the technique to separate

(i) butter from curd

(ii) salt from sea water

(iii) camphor from salt

Ans. (i) Butter from curd can be separated by the technique of centrifugation.

(ii) Salt from sea water can be separated by the technique of crystallization or by the evaporation.

(iii) Camphor is sublimable but salt is not. So, camphor can be separated from salt sublimation technique.

8. What type of mixtures are separated by the technique of crystallization?

Ans. Homogeneous mixtures such as common salt solution and copper sulphate solution separated by technique of crystallization.

9. Classify the following as chemical or physical changes.

(1) cutting of trees

(2) melting of butter in a pan

(3) rusting of almirah

(4) boiling of water to form steam

(5) passing of electric current through water and the water breaking down into hydrogen and oxygen

(6) dissolving common salt in water

(7) making a fruit salad with raw fruits

(8) burning of paper and wood

Ans. (1) Cutting of trees is a chemical change since all chemical reactions stop and we cannot get back the original tree from the wooden peaces.

(2) Melting of butter in a pan is a physical change since there is no change in the chemical composition of butter, only the physical state changes from solid to liquid.

(3) Rusting of almirah is a chemical change since during rusting, a new chemical compound called hydrated iron oxide (rust) is formed.

(4) Boiling of water to form steam is a physical change because during this change only changer of state occurs from liquid water to steam (gaseous) without any change in its chemical composition.

(5) Passing of electric energy through water to form hydrogen and oxygen is a chemical change since the properties of hydrogen (combustible gas) and oxygen (supporter of combustion) are altogether different from those of water which is neither combustible nor a supporters of combustion but it actually extinguishes fire.

(6) Dissolution of common salt in water is a physical change since salt can be easily recovered by evaporating water.

(7) Making a fruit salad with raw fruits is a physical change since there is no change in the chemical properties of the fruits but only the physical appearance has changed.

(8) Burning of paper is a chemical change since carbon dioxide, water vapours, smoke and ash which are the products of combustion cannot be converted back into paper or wood by any physical method.

10. Try segregating the things around you as pure substances or mixtures.

Ans. Pure substances: Distilled water, diamond, graphite, raw rubber.

Mixtures: Curd, ice-cream, kerosene oil, cooking oil, steel, vulcanized rubber, solder wire (alloy of lead and tin).

11. Which separation techniques will you apply for the separation of the following?

(a) Sodium chloride from its solution in water.

(b) Ammonium chloride from a mixture containing sodium chloride and ammonium chloride.

(c) Small pieces of metal in the engine oil of a car.

(d) Different pigments from an extract of flower petals.

(e) Butter from curd.

(f) Oil from water.

(g) Tea leaves from tea.

(h) Iron pins from sand.
(i) Wheat grains from husk.
(j) Find mud particles suspended in water.

Ans. (a) **Evaporation:** Water will evaporate leaving behind sodium chloride.
(b) **Sublimation:** Ammonium chloride will be collected as sublime.
(c) **Filtration:** Pieces of metal can be separated by filtration.
(d) **Chromatography:** Pigments (coloured components) from the extract of flower plants can be separated by chromatography.
(e) **Centrifugation:** Butter will get separated upon centrifugation.
(f) Separating funnel: Oil and water can be separated by the use of separating funnel.
(g) **Filtration:** Upon filtration through a sieve, tea leaves will be collected on the sieve.
(h) **Magnetic separation:** A magnet will attract iron pins and not sand particles.
(i) **Sieving:** Wheat grains from husk can be separated with the help of sieves.
(j) **Sedimentation:** As a result of sedimentation, mud particles will settle as precipitate. It can be separated later on by filtration.

12. Write the steps you would use for making tea. Use the words solution, solvent, solute, dissolve, soluble, insoluble, filtrate and residue.

Ans. Take 100 mL of water which acts as solvent. Boil water on a gas stove. Add one teaspoon of sugar which acts as solute. Sugar is soluble in water, so gets dissolved in water and forms a solution. Now add about half a teaspoon of tea leaves which are insoluble in water. Boil the contents for 4 to 5 minutes and add a half cup of milk and allow to boil again for 2-3 minutes. Filter the tea with the help of a sieve. Tea leaves will be left as residue while tea will be obtained as filtrate.

13. Pragya tested the solubility of three different substances at different temperatures and collected the data as given below (results are given in the following table, as grams of substance dissolved in 100 grams of water to form a saturated solution).

Substance Dissolved	Temperature in K				
	283	293	313	333	353
Potassium nitrate	21	32	62	106	167
Sodium chloride	36	36	36	37	37
Potassium chloride	35	35	40	46	54
Ammonium chloride	24	37	41	55	66

(a) What mass of potassium nitrate would be needed to produce a saturated solution of potassium nitrate in 50 grams of water at 313 K?
(b) Pragya makes a saturated solution of potassium chloride in water at 353 K and leaves the solution to cool at room temperature. What would she observe as the solution cools? Explain.
(c) Find the solubility of each salt at 293 K. Which salt has the highest solubility at this temperature?
(d) What is the effect of change of temperature on the solubility of a salt?

Ans. (a) Solubility of potassium nitrate at $313K = \frac{62}{100}$
100 g of water contains potassium nitrate = 62 g
$\therefore$ 50 g of water contains potassium nitrate $= \frac{62}{100} \times 50 = 31g$
Thus, 31 g potassium nitrate would be needed to produce a saturated solution of potassium nitrate in 50 g of water at 313 K.
(b) When a saturated solution of potassium chloride at 353 K is cooled/ the solubility potassium chloride in water decreased. As a result the amount of potassium chloride which exceeds its solubility at lower temperature separates out as crystals.
(c) The maximum amount of the salt which is dissolved in 100 g of water to form a saturate solution at the given temperature/ is known as solubility.
Solubility of potassium nitrate at $293K = \frac{32}{100}$
Solubility of sodium chloride at $293K = \frac{36}{100}$
Solubility of potassium chloride at $293K = \frac{35}{100}$
Solubility of ammonium chloride at $293K = \frac{37}{100}$
From the above data it is clear that ammonium chloride has the highest solubility at 293
(d) In general the solubility of a salt increases with temperature. The increase is however

different for different salts. For example the solubility of potassium nitrate increase appreciably that of ammonium chloride increases slightly that of potassium chloride increases marginally while that of sodium chloride almost remains constant.

14. Explain the following giving examples.
(a) saturated solution
(b) pure substance
(c) colloid
(d) suspension

Ans. (a) **Saturated solution:** A solution in which no more solute can be dissolved in a given amount of solvent at a particular temperature is called saturated solution. For example, if we dissolve 40 g sodium chloride in 100 g of water at 293 K/ it will form a saturated solution because the solubility of sodium chloride at 293 K is 36 g per 100 g of water.

(b) **Pure substance:** A substance made up of only one kind of atoms or molecules is called a pure substance. A pure substance has the same colour taste and texture at a given temperature and pressure. A pure substance also has a fixed melting and boiling point at a constant pressure. For example hydrogen gas sodium chloride water etc.

(c) **Colloid:** A substance is said to be a colloid if its particles size lies between 1 to 100 nm.

A colloidal solution is a heterogeneous and consists of two phases, i.e., dispersed phase (colloidal particles) and dispersion medium in which colloidal particles are suspended.

For example colloidal solution of sulphur or starch milk etc.

(d) **Suspension:** It is a heterogeneous mixture in which the particles of the solute do not dissolve but remain suspended throughout the bulk of the solvent. The size of the suspension particles is more than 10^{-7} m. For example, chalk powder in water is a suspension.

15. Classify each of the following as a homogeneous or heterogeneous mixtures.
Soda water, wood air soil vinegar filtered tea

Ans. Homogeneous mixtures: Soda water/ vinegar and filtered tea.

Heterogeneous mixtures: Wood and soil.

Air is a homogeneous mixture of different gases. However, if some dust or other particles are also present, then air becomes heterogeneous mixture.

16. How would you confirm that a colourless liquid given to you is pure water?

Ans. The boiling point and freezing point of the given liquid comes out to be 100°C or 373 K and 0°C or 273 K respectively under one atmospheric pressure, it confirms that the given liquid is pure water.

17. Which of the following materials fall in the category of a "pure substance"?
(a) ice, (b) milk, (c) iron, (d) hydrochloric acid, (e) calcium oxide, (f) mercury, (g) brick, (h) wood, (i) air

Ans. Ice, iron, calcium oxide and mercury are pure substances since they contain particles of only one kind of matter. In contrast, milk, hydrochloric acid (hydrogen chloride gas dissolved in water), brick and air cannot be called pure substances because they consists of particles of more than one kind of matter.

18. Identify the solutions among the following mixtures.
(a) Soil, (b) sea water, (c) air, (d) coal, (e) soda water

Ans. A solution is a homogeneous mixture of two or more substance. In the light of this, the solution among the following are (b) sea water, (c) air and (e) soda water.

19. Which of the following will show Tyndall effect?
(a) Salt solution
(b) Milk
(c) Copper sulphate solution
(d) Starch solution

Ans. (b) milk and (d) starch solution show Tyndall effect because they are colloidal solution.

Whereas (a) salt solution and (c) copper sulphate solution are true solution. Their particle size is too small to scatter light. So they do not show Tyndall effect.

20. Classify the following into elements, compounds and mixtures.
(a) Sodium, (b) soil, (c) sugar solution, (d) silver, (e) calcium carbonate,(f) tin, (g) silicon, (h) coal, (i) air, (j) soap, (k) methane, (1) carbon dioxide, (m) blood

Ans. **Elements:** The elements are regarded as the building blocks of the universe. So (a) sodium, (d) silver, (f) tin and (g) silicon are elements.

Compounds: It is a pure substance made up of two or more elements chemically combined in a fixed proportion by mass. So, (e) calcium carbonate, (k) methane and (1) carbon dioxide are compounds.

Mixtures: It is a substance containing two or more substance (elements or compound) in any proportion. So (b) soil, (c) sugar solution,

(h) coal, (i) air, (j) soap and (m) blood are mixtures.

21. Which of the following are chemical changes?
(a) Growth of a plant
(b) Rusting of iron
(c) Mixing of iron filings and sand
(d) Cooking of food
(e) Digestion of food
(f) Freezing of water
(g) Burning of a candle

Ans. (a) Growth of a plant, (b) rusting of iron, (d) cooking of food, (e) digestion of food and (g) burning of a candle, are chemical changes.

NCERT EXEMPLAR PROBLEMS-SOLUTIONS

Multiple Choice Questions (MCQs)

1. Which of the following statements are true for pure substances?
(i) Pure substances contain only one kind of particles.
(ii) Pure substances may be compounds or mixtures.
(iii) Pure substances have the same composition throughout.
(iv) Pure substances can be exemplified by all elements other than nickel.
(a) (i) and (ii) (b) (i) and (iii)
(c) (iii) and (iv) (d) (ii) and (iii)

Thinking Process

All elements (e.g., hydrogen, oxygen, sulphur, iron, nickel, mercury, gold, silver etc.) and compounds (e.g., water, carbon dioxide, sodium chloride, copper sulphate etc.) are pure substances. Mixtures are impure substances.

Ans. **(b)** A pure substance is one which is made up of only one kind of atoms or molecules.
They have the same composition throughout.

2. Rusting of an article made up of iron is called
(a) corrosion and it is a physical as well as chemical change
(b) dissolution and it is a physical change
(c) corrosion and it is a chemical change
(d) dissolution and it is a chemical change

Thinking Process

Dissolution is the process in which a solute is dissolved in a solvent to form solution.

Ans. **(c)** Rusting of an article made up of iron is called corrosion.
Corrosion is a chemical change because rust is a chemical compound (hydrated iron oxide, $Fe_2O_3.xH_2O$ which is totally different from element iron (Fe). Corrosion is

$$4Fe + 3O_2 + xH_2O \longrightarrow \underbrace{2Fe_2O_3 \cdot xH_2O}_{\text{Rust}}$$

Physical changes are those changes in which no new substances are formed. The substances do not change their identity and they can be easily returned to their original form by some physical processes, e.g., melting of ice, glowing of an electric bulb, breaking of glass tumbler, etc.
On the other hand, **chemical changes** are those changes in which new substances are formed. The substances involved change their identity and they get converted into entirely new substances, which cannot be returned to their original form. e.g., burning of paper, rusting of iron, burning of magnesium wire, etc.

3. A mixture of sulphur and carbon disulphide is
(a) heterogeneous and shows Tyndall effect
(b) homogeneous and shows Tyndall effect
(c) heterogeneous and does not show Tyndall effect
(d) homogeneous and does not show Tyndai I effect

Thinking Process

(i) Homogeneous mixtures are those mixtures in which the substances are completely mixed together and can not be distinguished from one another. They have uniform composition throughout.
(ii) Heterogeneous mixtures are those mixtures, in which the substances remain separate. They do not have a uniform composition throughout.

Ans. (a) A mixture of sulphur and carbon disulphide is a heterogeneous colloid and shows Tyndall effect. In a colloidal solution, the particles are big enough to scatter light.
The scattering of light by colloidal particles is known as Tyndall effect. Colloids are actually heterogeneous in nature though they appear to be homogeneous.

4. Tincture of iodine has antiseptic properties. This solution is made by dissolving
(a) iodine in potassium iodide
(b) iodine in vaseline
(c) iodine in water
(d) iodine in alcohol

Thinking Process

It is also called weak iodine solution. It is prepared by dissolution of usually 2-7% elemental iodine, along with potassium iodide or sodium iodide, in a mixture of alcohol (ethanol) and water.

Ans. (d) Tincture of iodine is made by dissolving iodine in alcohol.

5. Which of the following are homogeneous in nature?
(i) Ice (ii) Wood
(iii) Soil (iv) Air
(a) (i) and (iii) (b) (ii) and (iv)
(c) (i) and (iv) (d) (iii) and (iv)

Ans. **(c)** Options (i) Ice and (iv) Air are homogeneous in nature as their particles are not distinctly visible. A homogeneous mixture has a uniform composition throughout its mass. It has no visible boundaries of separation between its various constituents, e.g., air, sugar solution, brass, etc.
A heterogeneous mixture does not have a uniform composition throughout its mass. It has visible boundaries of separation between its various constituents, e.g., soil, wood, blood etc.

6. Which of the following are physical changes?
(i) Melting of iron metal
(ii) Rusting of iron
(iii) Bending of an iron rod
(iv) Drawing a wire of iron metal
(a) (i), (ii) and (iii) (b) (i), (ii) and (iv)
(c) (i), (iii) and (iv) (d) (ii), (iii) and (iv)

Ans. **(c)** Options (i) Melting of iron metal, (iii) Bending of an iron rod and (iv) Drawing a wire of iron metal are physical changes, because in three processes, iron changes its form, not the chemical composition. In rusting of iron, its chemical composition is changed.

7. Which of the following are chemical changes?
(i) Decaying of wood
(ii) Burning of wood
(iii) Sawing of wood
(iv) Hammering of a nail into a piece of wood
(a) (i) and (ii) (b) (ii) and (iii)
(c) (iii) and (iv) (d) (i) and (iv)

Ans. **(a)** Options (i) Decaying of wood and (ii) Burning of wood are chemical changes, because in these processes, the chemical composition of wood is changed and new substances are formed, which cannot be converted back into their original form.
In (iii) Sawing of wood and (iv) Hammering of a nail into a piece of wood, chemical composition of wood is not changed, therefore, (iii) and (iv) are physical changes.

8. Two substances, A and B were made to react to form a third substance, A_2B according to the following reaction $2A+B \rightarrow A_2B$. Which of the following statements concerning this reaction are incorrect?
(i) The product A_2B shows the properties of substances A and B.
(ii) The product will always have a fixed composition.
(iii) The product so formed cannot be classified as a compound.
(iv) The product so formed is an element.
(a) (i), (ii) and (iii) (b) (ii), (iii) and (iv)
(c) (i), (iii) and (iv) (d) (ii), (iii) and (iv)

Ans. **(c)** A_2B is a compound made up of two elements A and B in a fixed ratio. The properties of a compound (e.g., A_2B) are entirely different from those of its constituent elements (e.g., A and B). The composition of a compound is fixed.

9. Two chemical species X and Y combine together to form a product P which contains both X and $Y, X+Y \rightarrow P, X$ and Y cannot be broken down into simpler substances by simple chemical reactions. Which of the following concerning the species X, Y and P are correct?
(i) P is a compound
(ii) X and Y are compounds
(iii) X and Y are elements
(iv) P has a fixed composition
(a) (i), (ii) and (iii) (b) (i), (ii) and (iv)
(c) (ii), (iii) and (iv) (d) (i), (iii) and (iv)

Thinking Process

An element is a substance which cannot be broken down into two or more simpler substances by simple chemical methods of applying heat, light or electric energy.

Ans. **(d)** In this reaction, X and Y can not be broken down into simpler substances by chemical reactions; therefore, X and v are elements. A

compound is a substance made up of two or more elements chemically combined in a fixed proportion by mass. therefore, P is a compound, having a fixed composition.

Short Answer Type Questions

10. Suggest separation technique(s) one would need to employ to separate the following mixtures.

(a) Mercury and water

(b) Potassium chloride and ammonium chloride

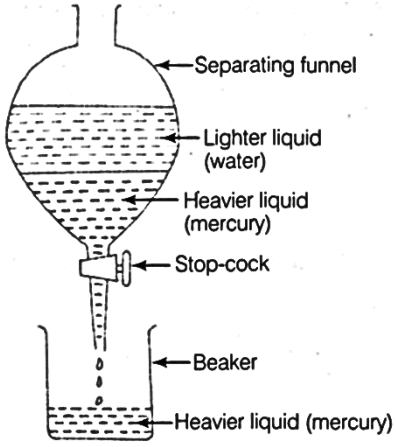
(c) Common salt, water and sand

(d) Kerosene oil, water and salt

Ans. (a) Mercury and water are separated by decantation by using separating funnel as the separation of two immiscible liquids by a separating funnel depends on the difference in their densities. Mercury is heavier than water therefore, forms the lower layer and separated from water.

(b) Potassium chloride and ammonium chloride are separated by sublimation method because ammonium chloride being a sublimate, sublimes leaving behind the potassium chloride.

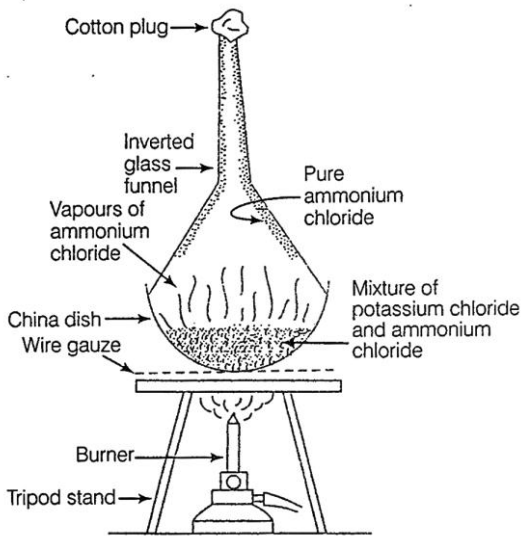
Sublimation is the process in which a solid changes directly into vapours on heating and vapours change into solid on cooling without going in liquid state.



Separation of two immiscible liquids by using a separating funnel

(b) Potassium chloride and ammonium chloride are separated by sublimation method because ammonium chloride being a sublimate, sublimes leaving behind the potassium chloride.

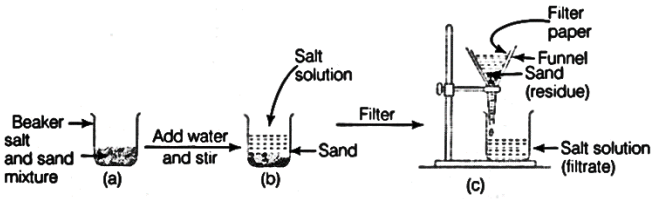
Sublimation is the process in which a solid changes directly into vapours on heating and vapours change into solid on cooling without going in liquid state.



Separation of potassium chloride and ammonium chloride by sublimation

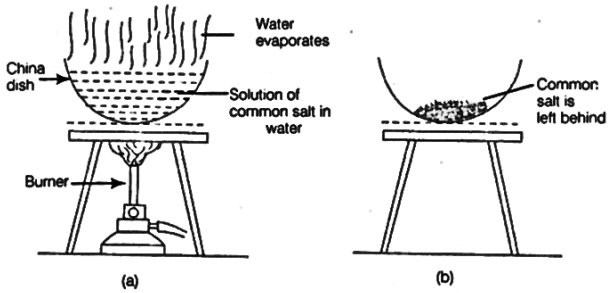
(c) Common salt, water and sand are separated by

(i) Decantation (or filtration) process is used to separate sand from common salt solution in water because common salt is soluble in water whereas sand is insoluble in water. Therefore, by filtration, sand will be separated as insoluble substance as residue and filtrate will be common salt solution in water.



Separation of salt and sand mixture

(ii) Evaporation process is used to separate common salt from water. Water evaporates and common salt remains as residue.

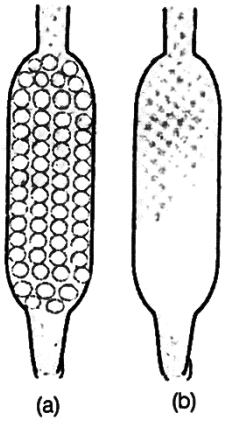


Separation of common salt dissolved in water by evaporation

(d) (i) Decantation by using separating funnel is used to separate kerosene nil from salt solution in water as they form separate layers (salt is soluble in water).

(ii) Evaporation is used to separate salt from water.

11. Which of the tubes in Figure (a) and (b) will be more effective as a condenser in the distillation apparatus?



Thinking Process

Condenser is an equipment which is used to condense vapours to from liquids. Now greater is the surface area, faster is the condensation.

Ans. Figure (a) will be more effective condenser in the distillation apparatus because beads present will provide more surface area for cooling of the vapours passing through it.

12. Salt can be recovered from its solution by evaporation. Suggest some other technique for the same?

Thinking Process

The process of cooling a hot, concentrated solution of a substance to obtain crystals is called crystallisation while the process of changing of a liquid into vapours is called evaporation.

Ans. Salt can be recovered from its solution by 'crystallisation'.

Crystallisation' is a better technique than 'evaporation' because it removes soluble impurities also, which do not get removed in the process of evaporation.

13. The 'sea-water' can be classified as a homogeneous as well as a heterogeneous mixture. Comment.

Ans. 'Sea-water' is called homogeneous as it contains dissolved salts in it. It may be called heterogeneous as it contains various insoluble components too as sand, microbes, shells made of calcium carbonate and so many other things.

14. While diluting a solution of salt in water, a student by mistake added acetone (boiling point 56°C). What technique can be employed to get back the acetone? Justify your choice.

Ans. Acetone is soluble in water, a homogeneous mixture is obtained and hence separation by separating funnel cannot be used. Acetone can be get back by simple distillation because the difference in the boiling points of acetone and water is more than 25°C.

Boiling point of acetone — 56°C

Boiling point of water — 100°C

In distillation flask, acetone will boil at 56°C and change into vapours and can be collected in flask after condensation.

15. What would you observe when

(a) a saturated solution of potassium chloride prepared at 60°C is allowed to cool at room temperature?

(b) an aqueous sugar solution is heated to dryness?

(c) a mixture of iron filings and sulphur powder is heated strongly?

Thinking Process

(i) The process of cooling a hot, concentrated solution of a substance to obtain crystals is called crystallization.

(ii) Evaporation occurs even on dry heating of sugar and it turns black.

(iii) Elements react with each other and form compounds.

Ans. (a) When a saturated solution of potassium chloride prepared at 60'C is allowed to cool at room temperature, crystals of potassium chloride will be formed.

(b) Initially, sugar will obtained as water will get evaporated. But on dry heating sugar gets charred and it turns black.

$$C_{12}H_{22}O_{11} \xrightarrow{\Delta} \underset{(Black)}{12C} + 11H_2O\uparrow$$

(c) The black coloured compound, iron sulphide is formed when a mixture of iron filings and sulphur powder is heated strongly.

$$\underset{\text{Iron fillngs}}{Fe} + \underset{\text{Sulphur powder}}{Fe} \xrightarrow{\Delta} \underset{\text{Iron sulphide}}{FeS}$$

16. Explain why particles of a colloidal solution do not settle down when left undisturbed, while in the case of a suspension they do?

Thinking Process

Recall Brownian movement and compare the size of colloidal particles and suspension particles, also the effect of gravity on them.

Ans. The colloidal particles are smaller and not heavy. They always remain in a state of zig-zag motion, called Brownian movement, which counters the force of gravity acting on colloidal particles and hence, helps in providing stability to colloidal sols by not allowing them to settle down. Apart from this, colloidal particles are charged and repel each other.

This fact also do not the particles of colloidal solution to settle down. Whereas particles of suspension are larger, heavy and have less movement, thus settle down due to gravity.

17. Smoke and fog both are aerosols. In what way are they different?

Thinking Process

An aerosol is a colloid in which a solid of liquid is dispersed in a gas (including air).

Ans. In smoke and fog. dispersion medium is same, i.e., air but they differ in dispersed phase.

In smoke, solid carbon particles are dispersed in air while in fog, liquid water particles are dispersed in air.

18. Classify the following as physical or chemical properties.

(a) The composition of a sample of steel is : 98% iron, 1.5% carbon and 0.5% other elements.

(b) Zinc dissolves in hydrochloric acid with the evolution of hydrogen gas.

(c) Metallic sodium is soft enough to be cut with a knife.

(d) Most metal oxides form alkalis on interacting with water.

Ans. (a) It is a physical property as no new compound is formed because steel is an alloy and alloy is a homogeneous mixture of two or more metals or of metallic elements with non-metallic elements.

(b) It is chemical property because chemical reaction takes place between zinc and hydrochloric acid with the evolution of hydrogen gas and a compound zinc chloride is formed.

$$Zn(s) + 2HCl(dil) \longrightarrow ZnCl_2(aq) + H_2(g)$$

(c) It is physical property because cutting with knife does not form new substance.

(d) It is chemical property as new compound is being formed by the reaction of metal oxide and water.

$$\underset{\text{Metal oxide}}{M_2O(s)} + \underset{\text{Water}}{H_2O(l)} \longrightarrow \underset{\text{Metal hydroxide}}{2MOH(aq)}$$

19. The teacher instructed three students 'A', 'B' and 'C respectively to prepare a 50% (mass by volume) solution of sodium hydroxide (NaOH).

'A' dissolved 50g of NaOH in 100 mL of water. 'B' dissolved 50g of NaOH in 100g of water while 'C dissolved 50g of NaOH in water to make 100 mL of solution. Which one of them has made the desired solution and why?

Thinking Process

The percentage concentration (w/v) of a solution is the amount of solute (g) present in 100 mi of its solution.

Ans. In the given question, student 'C' has made it correctly because 50% (mass by volume) means 50 g of solute for every 100 mL of solution and not in 100 mL of solvent.

Mass/volume per cent

$$= \frac{\text{mass of solute (in g)}}{\text{volume of solution (in mL)}} \times 100$$

Student 'A' dissolved 50 g of NaOH in 100 mL of water (solvent) which is incorrect. Student 'B' dissolved 50 g of NaOH in 100 g of water (solvent), which is incorrect.

20. Name the process associated with the following

(a) Dry ice is kept at room temperature and at one atmospheric pressure.

(b) A drop of ink placed on the surface of water contained in a glass spreads throughout the water.

(c) A potassium permanganate crystal is in a beaker and water is poured into the beaker with stirring.

(d) A acetone bottle is left open and the bottle becomes empty.

(e) Milk is churned to separate cream from it.

(f) Settling of sand when a mixture of sand and water is left undisturbed for some time.

(g) Fine beam of light entering through a small hole in a dark room.

Illuminates the particles in its paths.

Ans. (a) The process is sublimation because when dry ice (solid CO_2) is kept at room temperature at one atmospheric pressure, it sublimes leaving no residue.

(b) This process is diffusion because in diffusion, mixing of one substance (ink) into another substance (water) goes on until a uniform mixture is formed.
(c) This process is dissolution/diffusion as potassium permanganate crystal is dissolved in water.
(d) This process is evaporation as acetone evaporates when kept open in the bottle.
(e) This process is centrifugation. Milk is put in a closed container in big centrifuge machine. When machine is switched on, milk is rotated at a very high speed.
Due to this, milk separates into 'cream' and 'skimmed milk'. The cream being lighter, floats over the skimmed milk and then can be removed.
(f) This process is sedimentation as sand does not dissolve completely in water and forms suspension and settles down at the bottom when left undisturbed for some time.
(g) This shows Tyndall effect, i.e., scattering of light by colloidal solution or by particles in a fine suspension. Dust particles are suspended in air which scatter the light coming from small hole.

21. You are given two samples of water labelled as 'A' and 'B'. Sample 'K boils at 100°C and sample 'Q' boils at 102°C.Which sample of water will not freeze at 0°C? Comment.

Thinking Process

The presence of impurities increases the boiling point and decreases the freezing point/melting point of a substance.

Ans. Sample 'B' will not freeze at 0''C as, it is impure water. It is because sample "S' boils at 102°C while the boiling point of pure water is 100°C. It means this sample contains impurities. Only pure substance has sharp melting point.

22. What are the favourable qualities given to gold when it is alloyed with copper or silver for the purpose of making ornaments?

Ans. Gold is soft metal and can easily change its shape with a little force. Therefore, it is not suitable for making ornaments. But when it is alloyed with copper or silver, the gold becomes harder and stronger and its brittleness decreases. Thus, it becomes suitable for making ornaments.

23. An element is sonorous and highly ductile. Under which category would you classify this element? What other characteristics do you expect the element to possess?

Thinking Process

(i) Classify the elements into metals, non-metals and metalloids and compare their properties with the given properties of the given element and then classify this element.
(ii) Write the characteristics of this category.

Ans. As the given element is sonorous and highly ductile, therefore, it is categorised as a metal.
Some other e pected characteristics of are
(i) It should possesses metallic lustre and can be polished.
(ii) It should be good conductors of heat and electricity.
(iii) It should be ductile.
(iv) It should be malleable.
(v) It should has high tensile strength.
(vi) It should has high densities and melting point/boiling point too.
(vii) It should be hard (except sodium and potassium which are soft metals).
(viii) It should be solid at room temperature (except mercury, which is liquid at room temperature).
While the characteristics of non-metals are
(i) Non-metals are neither malleable nor ductile and do not conduct electricity.
(ii) Metalloids show some properties of metals and some other properties of non-metals.

24. Give an example each for the mixture having the following characteristics.
Suggest a suitable method to separate the components of these mixtures.
(a) A volatile and a non-volatile component.
(b) Two volatile components with appreciable difference in boiling points.
(c) Two immiscible liquids.
(d) One of the components changes directly from solid to gaseous state.
(e) Two or more coloured constituents soluble in some solvent.

Ans. (a) Example Mixture of acetone and water.
Method Simple distillation can be used to separate a mixture of volatile and non-volatile components.
(b) **Example** Mixture of kerosene and petrol.
Method Simple distillation can be used to separate two volatile components with appreciable difference in boiling points.

(c) **Example** Mixture of mustard oil and water.
Method Separating runnel is used to separate a mixture of immiscible liquids.
(d) **Example** Mixture of ammonium chloride and common salt.
Method Sublimation can be used to separate the mixture in which one component changes directly from solid to gas.
(e) **Example** A mixture of different pigments from an extract of flower petals.
Method Chromatography method can be used to separate two different substances present in the same solution.

25. **Fill in the blanks.**
(a) A colloid is a…….. mixture and its components can be separated by the technique known as……..
(b) Ice, water and water vapour look different and display different…….. properties but they are…….. the same.
(c) A mixture of chloroform and water taken in a separating funnel is mixed and left undisturbed for some time. The upper layer in the separating funnel will be of…….. and the lower layer will be that of
(d) A mixture of two or more miscible liquids, for which the difference in the boiling points is less than 25 K can be separated by the process called ..... .
(e) When light is passed through water containing a few drops of milk, it shows a bluish tinge. This is due to the…….. of light by milk and the phenomenon is called…….. .
This indicates that milk is a ..... solution.

Ans. (a) A colloid is a **heterogeneous** mixture and its components can be separated by the technique known as centrifugation.
(b) Ice, water and water vapour look different and display different **physical** properties but they are **chemically** the same.
(c) A mixture of chloroform and water taken in a separating funnel is mixed and left undisturbed for some time. The upper layer in the separating funnel will be of **water** and the lower layer will be that of **chloroform** (It is because water is lighter than chloroform).
(d) A mixture of two or more miscible liquids, for which the difference in the boiling points is less than 25 K can be separated by the process called fractional distillation.
(e) When light is passed through water containing a few drops of milk, it shows a bluish tinge. This is due to the **scattering** of light by milk and the phenomenon is called **Tyndall effect.** This indicates that milk is a **colloidal** solution.

26. Sucrose (sugar) crystals obtained from sugarcane and beetroot are mixed together. Will it be a pure substance or a mixture? Give reasons for the same.

Ans. According to law of constant composition or definite proportions; irrespective of the source a chemical compound it is always found to be made of the same elements combined together in the same fixed proportion by mass.
Thus, in the light of the above law, it will be a pure substance. It is because sugar obtained by different sources like sugarcane and beetroot will have the same composition.

27. Give some examples of Tyndall effect observed in your surroundings?
Thinking Process
The scattering of light by colloidal particles or by particles in a fine suspension is called Tyndall effect.

Ans. Examples of Tyndall effect
(i) When sunlight passes through the canopy of a dense forest.
(ii) When a fine beam of light enters a dark room through a small hole.

28. Can we separate alcohol dissolved in water by using a separating funnel?
If yes, then describe the procedure. If not, explain.

Thinking Process
Separating funnel is used to separate immiscible liquids. Miscible liquids can be separated by the process of distillation.

Ans. No, alcohol cannot be separated from water by using a separating funnel because alcohol is completely miscible in water.

29. On heating calcium carbonate gets converted into calcium oxide and carbon dioxide.
(a) Is this a physical or a chemical change?
(b) Can you prepare one acidic and one basic solution by using the products formed in the above process? If so, write the chemical equation involved.

Ans. (a) The phenomena given in question is a chemical change because the composition of product formed is different from the substance taken. The reaction involved is

$$\underset{\text{Calcium carbonate}}{CaCO_3} \xrightarrow{\Delta} \underset{\text{Calcium oxide}}{CaO} + \underset{\text{Carbon dioxide}}{CO_2}$$

(b) Yes

When CaO dissolves in water it forms calcium hydroxide which is basic solution.

$$CaO(s) + H_2O(l) \longrightarrow \underset{\text{Calcium hydroxide}}{CaO}$$

(ii) When CO_2 (g) dissolves in water it forms carbonic acid which is acidic solution.

$$CO_2(g) + H_2O(l) \longrightarrow \underset{\text{Carbonic acid}}{H_2CO_3(aq)}$$

30. Non-metals are usually poor conductors of heat and electricity. They are non-lustrous, non-sonorous, non-malleable and are coloured.

(a) Name a lustrous non-metal.

(b) Name a non-metal which exists as a liquid at room temperature.

(c) The allotropic form of a non-metal is a good conductor of electricity. Name the allotrope.

(d) Name a non-metal which is known to form the largest number of compounds.

(e) Name a non-metal other than carbon which shows allotropy.

(f) Name a non-metal which is required for combustion.

Ans. (a) Iodine is a lustrous non-metal.

(b) Bromine is a non-metal which exists as a liquid at room temperature.

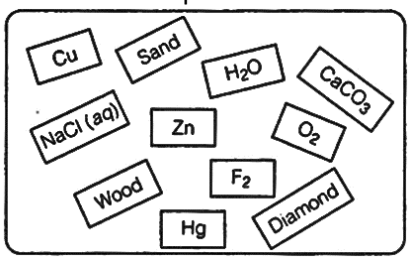
(c) Graphite is the allotropic form of carbon and it is a good conductor of electricity.

(d) Carbon is a non-metal which is known to form the largest number of compounds.

(e) Phosphorus is a non-metal other than carbon which shows allotropy.

(f) Oxygen is a non-metal which is required for combustion.

31. Classify the substances given in Figure into elements and compounds.



Thinking Process

(i) An element is a substance which is made of only one kind of atoms.

(ii) A compound is a substance made up of two or more elements chemically combined in a fixed proportion by mass.

Ans.

Elements	Compounds
Cu	Sand
O_2	H_2O
Zn	$CaCO_3$
F_2	$NaCl\,(aq)$
Hg Diamond (Carbon)	

Wood is neither an element nor compound. It is a mixture.

32. Which of the following are not compounds?

(a) Chlorine gas (b) Potassium chloride

(c) Iron (d) Iron sulphide

(e) Aluminium (f) Iodine

(g) Carbon (h) Carbon monoxide

(i) Sulphur powder

Thinking Process

An element is a substance which is made of only one kind of atoms while a compound is a substance made up of two or more elements chemically combined in a fixed proportion by mass.

Ans. These are not compounds

(a) Chlorine gas (c) Iron

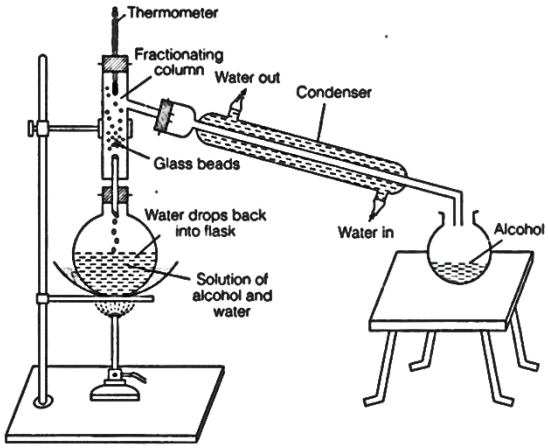
(e) Aluminium (f) Iodine

(g) Carbon (i) Sulphur powder

Long Answer Type Questions

33. Fractional distillation is suitable for separation of miscible liquids with a boiling point difference of about 25 K or less. What part of fractional distillation apparatus makes it efficient and possess an advantage over a simple distillation process. Explain using a diagram.

Ans. Fractionating column is the most important part of the fractional distillation apparatus. This column is provided with some glass beads in it.



Separation of miscible liquids by fractional distillation

It helps to obstruct the upward movement of the vapours of the two liquids. The vapours of high boiling liquid gets condensed earlier (at lower level). The energy (latent heat) released helps to take the vapours of low boiling liquid to a height in the fractionating column.

The advantages are as given below

(i) This method can separate the liquids with a boiling point difference about or less than 25 K.

(ii) During the process, both evaporation and condensation take place simultaneously.

(iii) A mixture (like petroleum) can also be separated by fractional distillation process which contains several components.

34. (a) Under which category of mixtures will you classify alloys and why?

(b) A solution is always a liquid. Comment.

(c) Can a solution be heterogeneous?

Ans. (a) Alloys are homogeneous mixtures of metals, because

(i) It shows the properties of its constituents, and

(ii) It has variable composition, e.g., brass is considered a mixture, because it shows the properties of its constituents, copper and zinc, and it has a variable composition (amount of Zn in brass can vary from 20 to 35 per cent).

(b) A solution is generally a liquid, not always. It may involve solids and gases also, e.g., alloys are solution of solid in solid. Air is solution of gases in gases.

(c) Colloidal solutions are heterogeneous in nature, though they appear to be homogeneous.

35. Iron filings and sulphur were mixed together and divided into two parts, 'A' and 'B'. Part 'A' was heated strongly while part 'B' was not heated. Dilute hydrochloric acid was added to both the parts and evolution of gas was seen in both the cases. How will you identify the gases evolved?

Ans. As part 'A' is heated, a compound FeS is formed by the reaction between iron filings and sulphur. When dilute HCl is added to part A, FeS will react with dil HCl to form H_2S gas which has smell of rotten eggs and will turn lead acetate paper black.

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

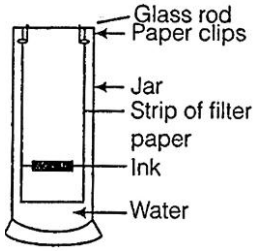
$$FeS(s)+2HCl(dil.)\longrightarrow FeCl_2(aq)+H_2S(g)$$

$$\underset{\text{Lead acetate}}{(CH_3COO)_2\,Pb(aq)}+H_2S(g)\longrightarrow \underset{\text{Black ppt}}{PbS(s)}+2\underset{\text{Acetic acid}}{CH_3COOH}$$

As part 'B' is not heated, so B is a mixture of iron filings and sulphur powder. When dil, HCl is added to it, iron filings react with dill. HCl to form H_2(g) which burns with a 'pop' sound if burning match stick is brought near it.

$$Fe(s)+2HCl(dil.)\longrightarrow FeCl_2(aq)+H_2(g)$$

36. A child wanted to separate the mixture of dyes constituting a sample of ink. He marked a line by the ink on the filter paper and placed the filter paper in a glass containing water as shown in figure. The filter paper was removed when the water moved near the top of the filter paper.



(a) What would you expect to see, if the ink contains three different coloured components?

(b) Name the technique used by the child.

(c) Suggest one more application of this technique.

Thinking Process

(i) Chromatography is a technique of separating two or more dissolved solids which are present in a solution in very small quantities.

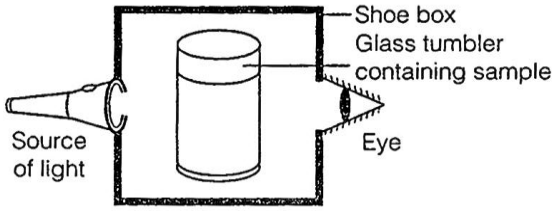
(ii) The simplest form of chromatography is paper chromatography.

Apply the principle of chromatography, i.e., it is based on the fact that though two (or more) substances are soluble in the same solvent

(say water) but their solubility's may be different.

Ans. (a) Three different coloured spots are obtained on the strip at different heights.
(b) Chromatography (paper chromatography) technique is used.
(c) The chromatography method is also employed to separate drugs from the blood.

37. A group of students took an old shoe box and covered it with a black paper from all sides. They fixed a source of light (a torch) at one end of the box by making a hole in it and made another hole on the other side to view the light. They placed a milk sample contained in a beaker/tumbler in the box as shown in the Figure. They were amazed to see that milk taken in the tumbler was illuminated. They tried the same activity by taking a salt solution but found that light simply passed through it?



(a) Explain why the milk sample was illuminated? Name the phenomenon involved.
(b) Same results were not observed with a salt solution. Explain.
(c) Can you suggest two more solutions which would show the same effect as shown by the milk solution?

Thinking Process

(a) In a colloidal solution, the particles are big enough to scatter light. Therefore, they show Tyndall effect.
(ii) In true solution the solute particle size is too small to scatter the light, therefore, it does not show Tyndall effect.

Ans. (a) The milk sample was illuminated because milk is a colloidal solution and its particles are big enough to scatter the light, hence, they scatter the light passing through it. The phenomenon observed is called "Tyndall effect".
(b) As salt solution is a true solution i.e., solute particle size is too small to scatter the light, hence, it does not show "Tyndall effect".
(c) Examples of colloid are gold sol, arsenius sulphide (As_2S_3) sol., Blood etc.

38. Classify each of the following, as a physical or a chemical change. Give reasons.
(a) Drying of a shirt in the sun.
(b) Rising of hot air over a radiator.
(c) Burning of kerosene in a lantern.
(d) Change in the colour of black tea on adding lemon juice to it.
(e) Churning of milk cream to get butter.

Thinking Process

In physical change, no change occurs in the chemical composition of the substance and in chemical change, chemical composition of the substance is changed.

Ans. (a) Physical change because evaporation of water takes place but no change occurs in the composition of the substance.
(b) Physical change because it is also involving only movement of air, no change in composition of air.
(c) First physical change, when kerosene vaporises. After that, burning of kerosene is a chemical change as new products are formed.
(d) Physical change as there occurs only the dissolution.
(e) Physical .change as there is no change in composition. Only the separation of components takes place by the physical phenomenon, centrifugation.

39. During an experiment the students were asked to prepare a 10% (mass/mass) solution of sugar in water. Ramesh dissolved 10 g of sugar in 100 g of water while Sarika prepared it by dissolving 10 g of sugar in water to make 100 g of the solution.
(a) Are the two solutions of the same concentration?
(b) Compare the mass % of the two solutions.

Thinking Process

(i) The concentration of a solution is the mass of white in grams present in 100 g of the solution and not in 100 g of the solvent.
(ii) Concentration of solution $= \frac{\text{mass of solute}}{\text{mass of solution}} \times 100$
(iii) Mass of solution =mass of solute + mass of solvent.

Ans. (a) No, the two solutions do not have the same concentration.

(b) Mass percentage of solution prepared by

$$\text{Ramesh} = \frac{\text{mass of solute}}{\text{mass of solution}} \times 100$$

$$= \frac{\text{mass of solute} \times 100}{\text{mass of solute} + \text{mass of solvent}}$$

$$= \frac{10g}{(10g + 100g)} \times 100 = \frac{100}{11} = 9.09\%$$

Mass percentage of solution prepared by

$$\text{Sarika} = \frac{10}{100} \times 100 = 10\%$$

The solution prepared by Ramesh has less percentage (9.09%) by mass than that of Sarika (10%).

40. You are provided with a mixture containing sand, iron filings, ammonium chloride and sodium chloride. Describe the procedures you would use to separate these constituents from the mixture?

Thinking Process

The steps involved in separation of these constituents are

(i) Magnetic separation

(ii) Sublimation

(iii) Filtration after dissolution

(iv) Crystallization or evaporation

Ans. (i) Remove iron filings with the help of magnet place the mixture on a paper of petridish, move a bar magnet many times over the mixture. Iron filings get attached to the magnet and get separated.

(ii) Remove ammonium chloride from sand and sodium chloride by sublimation

The remaining mixture is transferred to China dish and subjected to sublimation.

Ammonium chloride will get vaporised and change into vapours and on condensation will form $NH_4Cl(s)$ Sand and sodium chloride will be left in China dish.

(iii) Remove sand from sodium chloride by filtration after dissolution dissolve the sand and sodium chloride in water, Sodium chloride will dissolve. Filter the solution. Sand will be left as residue and is separated.

(iv) Get sodium chloride by evaporation or crystallization. In the filtrate sodium chloride is present. So, evaporate the filtrate to dryness to get sodium chloride back or use crystallisation.

41. Arun has prepared 0.01% (by mass) solution of sodium chloride in water.

Which of the following correctly represents the composition of the solutions?

(a) 1.00 g of NaCl + 100 g of water

(b) 0.11 g of NaCl + 100 g of water

(c) 0.01 g of NaCl + 99.99 g of water

(d) 0.10 g of NaCl + 99.90 g of water

Ans. (c) Here Mass%

$$= \frac{\text{mass of solute} \times 100}{(\text{mass of solute} + \text{mass of solvent})}$$

$$= \frac{0.01g \times 100}{(0.01 + 99.99)g} = \frac{0.01 \times 100}{100.00} = 0.01\%$$

Which is equal to the percentage of sodium chloride in water prepared by Arun. So, option (c.) is correct.

In option a), mass %

$$= \frac{1.00g \times 100}{(1.00 + 100)g} = \frac{1.00 \times 100}{101.00} = 0.99\%$$

In option b, mass %

$$= \frac{0.11g \times 100}{(0.11 + 100)g} = \frac{11}{100.11} = 0.11\%$$

In option(d), mass %

$$= \frac{0.1g \times 100}{(0.1 + 99.90)g} = \frac{10}{100} = 0.1\%$$

These % are not equal to the % of sodium chloride solution in water prepared by Arun.

So, these are incorrect.

42. Calculate the mass of sodium sulphate required to prepare its 20% (mass per cent) solution in 100 g of water?

Ans. In the given question, mass% of sodium sulphate solution = 20%

Mass of the solvent = 100 g

Let the mass of solute (sodium sulphate) $= xg$

Applying the formula,

$$\text{Mass\%} = \frac{\text{mass of solute}}{\text{mass of solution}} \times 100$$

$$= \frac{\text{mass of solute} \times 100}{\text{mass of solute} + \text{mass of solvent}} \times 100$$

$$20 = \frac{xg}{(x + 100)g} \times 100 \Rightarrow 20(x + 100) = 100x$$

$$20x + 2000 = 100x \Rightarrow 100x - 20x = 2000$$

$$80x = 2000 \Rightarrow x = \frac{2000}{80} = 25g$$

Mass of sodium sulphate = 25 g

EXERCISE

Multiple Choice Questions

1 Which of the following would be described as impure?
(a) Crystallized salt (b) Salt solution
(c) Rock salt (d) All of the above.

2 If the component of the substance can be separated by a chemical change only then it is
(a) element (b) compound
(c) mixture (d) none of these.

3. Water is a compound because
(a) it exists as a solid, liquid or gas
(b) it cannot be split up
(c) it contains two different elements joined by chemical bonds
(d) it has 3 elements.

4. Mixtures always have
(a) definite composition
(b) invariable composition
(c) variable composition
(d) none of the above.

5. The zig-zag movement of dispersed phase particle in a colloidal system is known as
(a) Brownian motion
(b) transitional motion
(c) circular motion
(d) linear motion.

6. Iodized common salt is
(a) homogeneous mixture
(b) heterogeneous mixture
(c) pure substance
(d) oxidized substance.

7. The concentration of a solution indicates
(a) the quantity of the solute present in solution
(b) the quantity of the impurities present in a solution
(c) the quantity of the solvent present in a solution
(d) the total quantity of solution.

8. In sweetened tea, the sugar is
(a) solvent (b) solute
(c) solution (d) none of these

9. A solution that has dissolved as much solute as it is capable of dissolving at a given temperature is
(a) only solution
(b) unsaturated solution
(c) saturated solution
(d) concentrated solution.

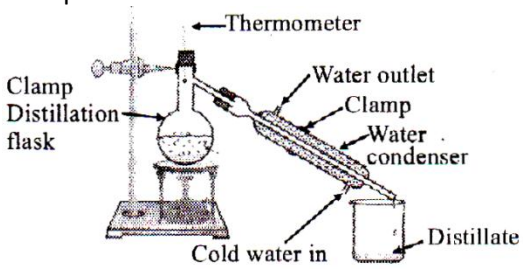
10. Pigments of natural colors can be separated
(a) By chromatography (b) centrifugation
(c) filtration (d) sublimation.

11. The fine particles of an insoluble substance uniformly dispersed throughout a gas or liquid is called
(a) suspension (b) precipitate
(c) colloidal solution (d) impurity.

12. What kind of solution is gel?
(a) Colloid (b) Mixture
(c) Emulsion (d) Suspension.

13. What will happen when a solute is added to a saturated solution?
(a) The solution will freeze
(b) The solution will become less concentrated
(c) A precipitate will form
(d) Concentration will increase.

14. While using the given apparatus, what must be kept in mind?



(a) The mixture in the distillation flask must contain a solid.
(b) The temperature difference between the boiling point of components of the mixture must be less then $25^{o}C$.
(c) The temperature difference between the boiling points of components of the mixture must be more than $25^{o}C$.
(d) All of these.

15. A small amount of the sample of a soil was mixed with water in beaker. After stirring for some time, the beaker was allowed to stand. The mud was found to settle down. The liquid above the mud was carefully filtered. The filtrate will be
(a) a true solution
(b) a colloidal solution
(c) can be a true solution or a colloidal solution
(d) a suspension.

16. Which of the following upon shaking with water will not form a true solution?
(a) Alum (b) Common salt
(c) Albumin (d) Sucrose. .

17. Water was taken in four beakers labeled as to IV. To these beakers the following substances were added.
Beaker (I) Common salt
Beaker (II) Alum

Beaker (III) Potassium nitrate
Beaker (IV) A few drops of barium chloride and a few drops of dilute H_2SO_4.
After sometime, the contents of the beakers were filtered. The contents of which beaker will leave residue on the filter paper.
(a) Beaker (I) (b) Beaker (II)
(c) Beaker (III) (d) Beaker (IV).

18. A student mixed a small amount of iron filings and sulphur powder in a dish. He could not affect the separation by simple hand picking. Which liquid will you suggest to effect the separation?
(a) Carbon disulphide (b) Cold water
(c) Boiling water (d) Kerosene.

19. Which of the following will show Tyndall effect?
(a) Starch solution
(b) Sodium chloride solution
(c) Copper sulphate solution
(d) Sugar solution

20. An emulsion is a colloidal solution formed by mixing
(a) two miscible liquids
(b) any two liquids
(c) any two gases
(d) two immiscible liquids.

21. The size of colloidal solution is in the range of
(a) $1-100\,nm$ (b) $100-1000\ nm$
(c) $10^{-5}\,m-10^{-7}\,m$ (d) $10^{7}-10^{9}\,m$

22. Brass contains
(a) gold and copper (b) copper and zinc
(c) zinc and silver (d) copper and silver.

23. Which of the following is NOT a colloid?
(a) Sugar syrup (b) Fog
(c) Milk (d) Cheese

24. A liquid non-metal, amongst the following is
(a) bromine (b) mercury
(c) phosphorus (d) both (a) and (b)

25. Which of the following is a homogeneous mixture?
(a) Solution of sugar in water
(b) Chalk powder in water
(c) Kerosene oil in water
(d) None of these

26. A mixture of common salt, sulphur, and iron filings is shaken with carbon disulphide and filtered through a filter paper. The filtrate is evaporated to dryness in a china dish. What will be left in the dish after evaporation?
(a) Sand (b) Sulphur
(c) Iron filings (d) Common salt

27. A mixture of sulphur and iron filings is heated strongly to obtain a residue. Which of the following is not a characteristic property of the residue?
(a) It can be separated into sulphur and iron filings by physical methods
(b) Its composition does not change from one part to another.
(c) Its properties are entirely different from those of sulphur and iron filings.
(d) Its appearance is different from those of sulphur and iron filings.

28. Solutions with low concentrations of solutes are
(a) concentrated (b) dilute
(c) solvents (d) none of these.

29. Which of these is a mixture?
(a) Solution (b) Alloy
(c) Amalgam (d) All of these

30. Which of the following is always true when a substance undergoes a physical change?
(a) It changes colour
(b) A new substance is formed
(c) It boils
(d) Its composition remains the same

31. Which of the following statement is correct?
(a) A pure substance must contain only one type of atom.
(b) A mixture containing two compounds must be heterogeneous.
(c) A heterogeneous mixture must contain at least three elements.
(d) A homogeneous mixture must be uniform.

32. Which of the following is not an example of a physical change?
(a) Dissolving sugar in water
(b) Casting iron in moulds
(c) Setting of cement
(d) Magnetization of iron

33. Distillation involves all the following processes except
(a) change of state (b) boiling
(c) condensation (d) evaporation

34. Separation of petroleum into its components is done by
(a) chromatography (b) sublimation
(c) distillation
(d) fractional distillation

35. Simple distillation can be best used to separate
(a) a mixture of benzene (boiling point $80^{o}C$)
(b) and toluene (boiling point $110^{o}C$)
(c) a mixture of ether (boiling point $35^{o}C$) and toluene (boiling point $110^{o}C$)a mixture of

ethanol (boiling point $78^{o}C$)and water (boiling point$100^{o}C$)
(d) none of these.

36. Which method cannot be used for purification of liquids?
(a) Chromatography
(b) Distillation
(c) Sublimation
(d) Fractional distillation

37. A mixture contains four solid compounds A, B, C, D. On heating C changes to vapor state. C can be separated from rest of the solids by
(a) crystallization (b) sublimation
(c) distillation (d) filtration

38. A liquid is found to scatter a beam of light but leaves no residue when passed through the filter paper. The liquid is
(a) a suspension (b) a true solution
(c) a colloidal sol (d) oil

39. Identify the false statement.
(a) colloids are homogeneous
(b) colloids show Tyndall effect
(c) colloids show Brownian movement
(d) The size of colloidal particles ranges between 1 - 100 nm.

40. Which is not an example of macromolecular colloids?
(a) Nylon (b) Plastics
(c) Rubber (d) Soaps

41. Which of the following is not a colloid?
(a) Foam (b) Cloud
(c) Roohafza syrup (d) Egg

42. Smoke is an example of
(a) gas dispersed in liquid
(b) gas dispersed in solid
(c) solid dispersed in gas
(d) solid dispersed in solid

43. Micelles are
(a) emulsion cum gel (b) associated colloids
(c) true solution (d) suspensions

44. Which one of the following is correct matched?
(a) Emulsion - curd (b) Foam - mist
(c) Aerosol – smoke (d) Solid sol - cake

45. For a colloidal solution, dispersion medium dispersed phase is liquid - liquid. This is example of
(a) emulsion (b) aerosol
(c) gel (d) sol

46. Suspensions are
(a) visible to naked eye
(b) invisible through microscope
(c) not visible by any means
(d) invisible under electron microscope.

47. Butter is a colloid formed when
(a) fat is dispersed in fat
(b) fat is dispersed in water
(c) water is dispersed in fat
(d) proteins dispersed in water

48. Which one is an example of Micelle system?
(a) Soap + water (b) Rubber + benzene
(c) Protein + water (d) Rubber + water

49. The cause of Brownian movement is
(a) heat change in liquid state
(b) convection current
(c) impact of molecules of dispersion medium on colloidal particles
(d) attractive forces between the particles

50. The number of phases in colloidal system are
(a) one (b) two
(c) three (d) four

51. If we heat iodine , then it is a
(a) physical change (b) chemical change
(c) no change (d) color change

52. Color of rust is
(a) blue (b) green
(c) reddish brown (d) white

53. Which of the following is not a chemical Change
(a) electrolysis of water
(b) boiling of water
(c) digestion of food
(d) burning of magnesium

54. Which of the following is a compound?
(a) Steel (b) Water
(c) Brass (d) Iodine

55. Tincture of iodine is a solution of iodine in
(a) water (b) acetone
(c) benzene (d) ethyl alcohol

56. Which gas present in air has the highest boiling point?
(a) Oxygen (b) Nitrogen
(c) Argon (d) Hydrogen

57. Which method is used to separate drugs from blood?
(a) Fractional distillation
(b) Crystallization
(c) Chromatography
(d) Distillation

58. Which of the following involves both physical and chemical change?
(a) Burning of a candle (b) Rusting of iron
(c) Cooking of food (d) Boiling of water

59. The particles of a true solution are
(a) > 1 nm in diameter
(b) < 1 nm in diameter
(c) = 1 nm in diameter
(d) > or = 1 nm in diameter

60. Which of the following is the smallest part of a compound whose properties are the same as those of a compound?
(a) Atom (b) Molecule
(c) Mixture (c) Unit cell

61. What is the name of the insoluble substance which settles to the bottom of its container?
(a) Solute (b) Solvent
(c) Sediment (d) Slag

62. We can separate a pure solid from its solution by
(a) crystallization (b) simple distillation
(c) sedimentation (d) both (a) and (b)

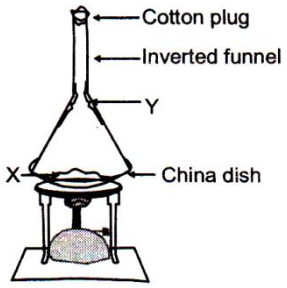
63. Boron, silicon, germanium are
(a) metals (b) non-metals
(c) metalloids (d) impurities

64. Which of the following statements is correct about non-metals?
(a) They have lustre.
(b) They make a ringing sound when hit.
(c) They are poor conductors of heat and electricity.
(d) They have shine.

65. In modern surgery, metal pins are used for holding the broken bones together. This pin is made of
(a) copper (b) stainless steel
(c) aluminum (d) none of these

66. Soda water is a solution of carbon dioxide in water. What is this solution composed of?
(a) Liquid solute in a gaseous solvent
(b) Gaseous solute in a liquid solvent
(c) Liquid solute in a liquid solvent
(d) Gas in suspended form in liquid

67. Identify X and Y in the given figure.



(a) $X =$ Mixture of naphthalene and anthracene $Y =$ Solid naphthalene
(b) $X =$ Mixture of $NaCl$ and water $Y =$ Solid $NaCl$
(c) $X =$ Mixture of $NaCl$ and anthracene $Y =$ Solid anthracene
(d) $X =$ Mixture of sugar and $NaCl$ $Y =$ Solid sugar

68. Which of the following is not true for a compound?
(a) It is heterogeneous in nature.
(b) A compound contains different elements in a fixed ratio.
(c) Properties of a compound are entirely different from those of the elements present in it.
(d) Constituents of a compound cannot be separated by simple physical methods.

69. Two substances A and B when brought together form a substance C with the evolution of heat. The properties of C are entirely different from those of A and B. The substance C is
(a) a compound (b) an element
(c) a mixture (d) none of the above

70. Purity of a solid substance can be checked by its characteristic
(a) boiling point (b) melting point
(c) solubility in water
(d) solubility in a alcohol

71. Which of the following pairs does not contain both elements?
(a) Carbon, silicon (b) Helium, nitrogen
(c) Bronze, zinc (d) Copper, silver.

72. Solvent used in crystallization should
(a) not dissolve the impurities
(b) not react chemically with substance
(c) do not crystallize on cooling
(d) all of the above

73. Principle of chromatography is
(a) rate of absorption (b) rate of adsorption
(c) rate of diffusion (d) none of these.

74. Solvent used in chromatography is
(a) alcohol (b) water
(c) both (a) and (b) (d) ether

75. In chromatography different constituents of a mixture get adsorbed differently on same adsorbent because
(a) they have difference in pressure
(b) they have different rates of movement
(c) both (a) and (b)
(d) none of these

76. The gas which is added to water to kill germs is
(a) CO_2 (b) Cl_2
(c) O_2 (d) H_2

77. To supply drinking water in a city the water from a river is pumped by the pumping static into a large reservoir called
(a) sedimentation tank (b) loading tank
(c) filtration tank (d) chlorination tank

78. Which of the following is a non-aqueous solvent?
(a) Water (b) Chloroform
(c) Both (a) and (b) (c) None of the above

79. Super saturated solution contains

(a) amount of solute more than saturation level
(b) amount of solute less then saturation level
(c) amount of solute equal to saturation level
(d) no solute at all.

80. Identify the aqueous solution
(a) sugar dissolved in water
(b) sugar dissolved in alcohol
(c) iodine dissolved in ether
(d) sulphur dissolved in carbon disulphide

81. A 15% alcohol solution means
(a) 15 mL alcohol and 85 mL water
(b) 15 mL alcohol and 100 mL water
(c) 15 mL water and 85 mL alcohol
(d) 15 mL alcohol and 50 mL water

82. The solution which has two components is known as
(a) binary solution (b) true solution
(c) quaternary solution (d) aqueous solution

FILL IN THE BLANKS

1. In general, on decrease of temperature.....solution is converted into super saturated solution and on increase of temperature a saturated solution is converted in to.....

2. Heating of coal is considered as.....change.

3. Digestion of food is..... change.

4. Gases can be separated from air by.....method

5. 10% by mass of a solution means..... g of solute is present in 50 g of solution.

6. In an unsaturated solution more solute can be dissolved without increasing the amount of the

7. Oil and water do not mix easily. They are said to be..... .

8. Milk is an emulsion in which the dispersed phase is..... and the dispersion medium is..... .

9. Fog is a colloid consisting of..... in air.

10. Soap solution is a colloidal solution in which the dispersed phase is.....while the dispersion medium is..... .

11. The reaction between an aqueous solution of sodium chloride and silver nitrate is a..... change.

12. Milk is a..... solution while vinegar is a..... solution.

13. There is a difference in properties of a solution, colloid and suspension due to difference in

14. When a liquid is dispersed in other liquid, the colloid is termed as..... .

15. The zig - zag motion of colloidal particles is known as..... .

16. The colloidal dispersion of liquids in solid media are called ……

17. The sky looks blue due to..... effect.

18. Mixing of iron filings and sand is a.....change.

19. The properties of a compound differ from those of it's ..... .

20. Migration of colloidal particles under the influence of an electric field is known as.....

TRUE OR FALSE

1. Solution of copper sulphate will show Tyndall effect.

2. Immiscible liquids separate out in layers depending on the densities.

3. During burning of a candle, both physical and chemical changes take place.

4. Constituents of a mixture can be separated by physical methods.

5. Mixture of salt and ammonium chloride can be separated by crystallization process.

6. The colored components present in a dye can be separated by a process known as chromatography.

7. The particles of a colloid can pass through a filter paper.

8. Colloidal state is an intermediate state between suspension and true solution.

9. Mixtures are always combination of the same compounds that are in different states.

10. "Element" word was first used by Robert Boyle in 1661.

11. A true solution is a heterogeneous mixture.

12. Two or more miscible liquids can be separated by distillation.

13. Graphite is a good conductor of electricity.

14. Mixture of sand and sulphur can be separated by dissolving the mixture in water and filtering it.

15. Making of wine from grapes is a chemical change.

16. Drying of paint on a door is a physical change.

17. An element can be distinguished from its compounds by examination of its physical properties only.

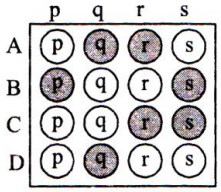
18. A chemical change is a permanent change and cannot be reversed by removing the cause of the change.

19. A homogeneous liquid which on boiling leaves a solid residue is a solution containing solid as solute.

20. Gold does not get rusted since it is a noble metal.

MATRIX MATCH TYPE

In this section, each question contains statements given in two columns which have to be matched. Statements (A, B, C, D) in Column-I have to be matched a with statements (p, q, r, s) in Column-II. The answers to these questions have to be appropriately bubbled as illustrated in the following example. If the correct matches are A-q, A-r, B-p, B-s, C-r, C-s and D-q, then the correctly bubbled matrix will look like as shown.



1.

Column I	**Column II**
(A) Fog	(p) Solid in gas
(B) Smoke	(q) Solid in solid
(C) Steel	(r) Solid in liquid
(D) Toothpaste	(s) Liquid in gas

2.

Column I	**Column II**
(A) Solution which can dissolve more solute	(p) Saturated solution
(B) Solution which has excess of solute	(q) True solution
(C) Solution which cannot dissolve any more solute	(r) Supersaturated solution
(D) Solution which has particle size 10"7 cm	(s) Unsaturated solution

3.

Column I	**Column II**
(A) Salt solution	(p) Suspension
(B) Blood	(q) Colloid
(C) Smoke	(r) True solution
(D) Chalk water	(s) Emulsion

4.

Column I	**Column II**
(A) Butter	(p) solvent hating
(B) Cheese	(q) Associated colloid
(C) Micelles	(r) Emulsion
(D) Lyophobic	(s) Gel

5.

Column I (Property)	**Column II (Application)**
(A) Tyndall effect	(p) Smoke precipitator
(B) Electrophoresis	(q) Sewage disposal
(C) Coagulation	(r) Cleansing action of soap
(D) Micelles	(s) Blue sky

6.

Column I	**Column II**
(A) A solution generally	(p) No units has
(B) A true solution is	(q) True solution
(C) The concentration of solution has	(r) two components
(D) Only one phase exists in	(s) Homogeneous in nature

7.

Column I	**Column II**
(A) Miscible liquids	(p) Distillation
(B) Immiscible liquids	(q) Crystallization
(C) Impure copper sulphate	(r) Sublimation
(D) Salt and ammonium chloride	(s) Funnel

8.

Column I	**Column II**
(A) Diamond	(p) Mixture
(B) Iron	(q) Compound
(C) Water	(r) Element
(D) Gun powder	(s) Metal

9.

Column I	**Column II**
(A) Rusting of iron	(p) Physical as well as chemical change
(B) Melting of wax	(q) Chemical change
(C) Burning of candle	(r) Physical change
(D) Baking of cake	(s) No change

10.

Column I	**Column II**
(A) Aluminum	(p) Compound
(B) Fluorine	(q) Metal
(C) Tellurium	(r) Non-metal
(D) Lime stone	(s) Metalloid

ASSERTION & REASON QUESTIONS

Directions: In each of the following questions, a statement of Assertion (A) is given followed by a corresponding statement of Reason (R) just below it of the statements, mark the correct answer as

(a) If both assertion and reason are true and reason is the correct explanation of assertion

(b) If both assertion and reason are true but reason is not the correct explanation of assertion

(c) If assertion is true but reason is false

(d) If assertion is false but reason is true.

1. **Assertion:** In sublimation a substance Changes directly from solid to vapor without passing through liquid state and vice-versa.
Reason: Distillation involves two process i.e. vaporization and condensation.

2. **Assertion:** Impure benzoic add can be purified by sublimation.
Reason: Benzoic acid sublimes on heating.

3. **Assertion:** Colloidal solutions are stable and the colloidal particles do not settle down.
Reason: Brownian movement counters the force of gravity acting on colloidal particles.

4. **Assertion:** Chromatography can be used to separate a mixture of plant pigments.
Reason: Chromatography can be used to separate colored substances into individual components.

5. **Assertion:** A mixture of benzoic acid and naphthalene can be separated by crystallization from water.
Reason: Benzoic acid is soluble in hot water but naphthalene is in soluble in hot water.

6. **Assertion:** A mixture of sugar and benzoic acid can be separated by shaking with ether.
Reason: Sugar is insoluble in water.

7. **Assertion:** True solution exhibit Tyndall effect.
Reason: Particles are very small in size.

8. **Assertion:** When a beam of light is passed through a colloidal solution placed in a dark place the path of the beam becomes visible.
Reason: Light gets scattered by the colloidal particles.

9. **Assertion:** A solution of table salt in a glass of water is homogeneous.
Reason: A solution having different composition throughout is homogeneous.

10. **Assertion:** Lyophobic sols are less stable than lyophilic sols.
Reason: Lyophilic sols have solvent hating nature.

11. **Assertion:** If the dispersed phase is liquid and the dispersion medium is solid, the colloid formed is known as emulsion.
Reason: Whipped cream is an example of an emulsion.

12. **Assertion:** Tyndall effect is an optical property.
Reason: Electrophoresis is an electrical property.

13. **Assertion:** Boiling point determines the purity of solid compounds.
Reason: Melting point of a solid compounds which is pure is fixed.

14. **Assertion:** A mixture of acetone and methanol can be separated by fractional distillation.
Reason: The difference between their boiling points is very less.

15. **Assertion:** A mixture of camphor and ammonium chloride cannot be separated by sublimation.
Reason: Camphor on heating sublimes, ammonium chloride does not.

PASSAGE

PASSAGE 1: Emulsions are colloidal solutions in which dispersed phase as well as dispersion medium are liquids. It may be oil in water or water in oil type. Emulsifiers like soap, detergents, gum, etc. are used to stabilize emulsions. In oil in water type emulsions water acts as dispersion medium while in water in oil type emulsions, oil acts as dispersion medium.

1. Which of the following is are oil in water type of emulsions?
(a) Ink (b) Detergent
(c) Soap (d) Milk

2. Which of the following is homogeneous?
(a) Milk (b) Paint
(c) Shampoo (d) None of these

3. Cold cream and butter are emulsions in which
(a) milk fat is dispersed in water
(b) oil is dispersed in water
(c) gas is dispersed in water
(d) water is dispersed in oil

4. The substances like proteins, gums are added to an emulsion as emulsifying agent. Their main function is to
(a) stabilize an emulsion
(b) precipitate an emulsion
(c) dilute an emulsion
(d) increase the concentration of an emulsion,

PASSAGE 2: Both water and cooking oil are liquid but their chemical properties are different. They differ in odour and inflammability. Oil bums in air whereas water extinguishes fire. It is the chemical property of oil that makes it different from water. During a chemical change one substance reacts with other to undergo a change in chemical compositions. A chemical change is also called a chemical reaction. Sometimes both physical and chemical change take place together.

1. The inter conversion of solid, liquid and gas state is a
(a) physical change (b) chemical change
(c) both (a) and (b) (d) no change.

2. Burning of a candle involves a
(a) physical change (b) chemical change
(c) both physical and chemical change
(d) no change.

3. Chemical change brings change in..... of matter.
(a) physical properties
(b) chemical properties
(c) both physical and chemical properties
(d) no change

4. Color, hardness, melting points, boiling points, odour, etc. are
(a) chemical properties
(b) physical properties
(c) both physical and chemical properties
(d) example of chemical reactions.

PASSAGE 3: Crystallization is a process that separates a pure solid in the form of its crystals from a solution. A solid can also be separated from its solution by evaporation. However crystallization technique is better than simple evaporation technique. We can get an impure sample of a solid even after evaporation. Some solids decomposes or some may get charred on heating to dryness during evaporation.

1. Crystallization process is used in one of the following processes.
(a) Purification of salt that we get from seawater.
(b) To separate salt from sea water.
(c) To separate camphor from salt.
(d) To separate colors in a dye.

2. Crystallization is a better process than evaporation because
(a) it takes lesser time.
(b) some impurities may remain in the filtrate which remain with the solid after evaporation.
(c) some solid is lost during evaporation.
(d) chemical properties change during evaporation.

3. What type of mixtures are separated by crystallization?
(a) A mixture in which one component is soluble in a solvent.
(b) A mixture in which impurities are soluble in a solvent.
(c) A mixture in which both the components are soluble in a solvent.
(d) A mixture in which both the components are insoluble in water.

PASSAGE 4: Pure substances can be elements or compounds. An element is a form of matter which cannot be broken down by chemical reactions into simpler substances. A compound is a substance composed of two or more different types of elements, chemically combined in a fixed proportion. Properties of a compound are different from its constituent elements, whereas a mixture shows the properties of its constituting elements or compounds.

1. Which of the following is not a pure substance?
(a) Tin (b) Coal
(c) Ice (d) Lime stone

2. The substance formed by mixing, crushing and heating iron filings and sulphur powder is
(a) an element (b) a compound
(c) a mixture (d) a solution

3. Lustre, ductility, malleability, conductivity are properties of
(a) metal (b) non-metal
(c) metalloids (d) compounds

4. Name the element which becomes liquid at a temperature slightly above the room temperature.
(a) Cesium (b) Silicon
(c) Iodine (d) Sodium

SUBJECTIVE PROBLEMS

VERY SHORT ANSWER TYPE QUESTIONS

1. In terms of physical properties why is it possible to separate the components of a mixture by physical means?

2. Is ice water homogeneous or heterogeneous substance? Is it pure or impure substance?

3. Explain why filter paper cannot be used to separate colloids?

4. What is meant by the terms composition and structure when referring to matter?

5. Classify the following elements as metal, non-metal or metalloid: aluminum, fluorine, gallium, phosphorus, tellurium, thorium, barium, strontium, calcium, krypton.

6. What type of mixture can be separated by technique of crystallization?

7. What is a sand bath?

8. How can a saturated solution be made unsaturated?

9. Sodium chloride contains two elements, but it is still a pure substance. Assign reason.

10. Name the methods used for
(a) getting pure sugar from impure sample.
(b) separating mixtures of components in blue ink.

11. What separation technique should be applied for the separation of iron filings mixed with sand?

12. Give an example of a non-aqueous solution.

13. $100\,mL$ of alcohol is dissolved in $400\,mL$ of water. Calculate the volume percentage of the solute.

14. Particle size of a substance in water is 200 nm. What in the nature of the solution?

15. How will you bring about the following separations?
(a) Fine mud particles suspended in water.

(b) Carbon particles suspended in smoke.

16. What is mother liquor?

SHORT ANSWER TYPE QUESTIONS

1. Which type of solution is aerated water?

2. Bronze is an alloy of zinc and copper. What type of solution is bronze?

3. What type of a change is rusting of iron?

4. List the following samples of water in order of increasing purity: ocean water, rain water and drinking water.

5. By using the words solvent, solute, dissolve, solution, soluble, insoluble, filtrate and residue, explain how will you separate common salt from wheat husk?

6. A mixture of ethyl alcohol and water is homogeneous while that of oil and water is heterogeneous. Why?

7. Identify the statements which belongs to a mixture and a compound
(a) The properties of the constituents are entirely different from the properties of the product formed by their chemical reaction.
(b) The constituents retain their individual chemical properties in the product formed by mixing them.

8. Assign reasons for regarding salt solution as mixture.

9. Why do we stir the paint thoroughly before using it?

10. What is meant by the concentration of a solution?

11. Aluminum metal melts at 660°C and bums in oxygen to form aluminum oxide. Identify the physical and chemical properties and changes involved in the above statement.

12. Name the elements present in the following compounds.
(a) Quick lime (b) Hydrogen chloride
(c) Lime stone (d) Sodium sulphate

13. Calculate the concentration of a solution in volume percent made when 200 mL of water is mixed with 100 mL of ethanol.

14. Identify the following as either a physical or a chemical property.
(i) Soap is slippery
(ii) Gold does not rust
(iii) Water freezes at 0°C
(iv) Cooking gas bums in air to give a flame.
(v) Ice melts when kept outside the fridge.

15. Explain why colloids can be separated only by special filter papers and not by ordinary filter papers used to separate the solid from liquid.

LONG ANSWER TYPE QUESTIONS

1. When 100 g of a saturated solution is evaporated at 50°C, 50 g of solid is left over. Find the Solubility of the substance at 50°C.

2. A hot solution contains 5 g of a substance in 15 g of water at 35°C. What is the solubility of the substance at this temperature?

3. If solubility of a solute is S, find its percentage by weight.

4. A beam of light is visible when it is passed through a colloidal solution/ but it is not visible when passed through true solution and suspensions. Explain.

5. The solubility of a substance in water is 40. What is the maximum amount of solute required to prepare a saturated solution in the 50 g of water?

6. Why is the product formed on heating 1 g of sulphur powder and 2 g of copper turnings called a compound while the product formed by mixing 1 g of sulphur powder and 2 g of copper turnings is called a mixture?

7. Tell whether each of the following properties describes a heterogeneous mixture, a solution or a homogeneous mixture a compound or an element.
(a) A homogeneous liquid which leaves a solid residue on boiling.
(b) A cloudy liquid which after sometimes appear more cloudy towards the bottom.
(c) A uniform white solid that has a sharp and definite melting point which cannot be decomposed into simpler substances by special techniques.
(d) A colorless liquid which boils at one unchanging temperature and can be decomposed into simpler substances.

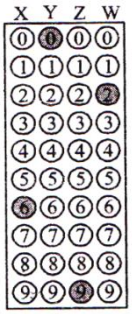
8. What is electrophoresis? Explain it by an experiment.

9. List few applications of colloids.

10. During fractional distillation how does the process of distillation continue and the separation of liquid is on the basis of repeated distillation?

INTEGER ANSWER TYPE

This section contains 5 questions. The answer to each of the questions is a single digit integer, ranging from 0 to 9. If the correct answers to question numbers X, Y, Z and W (say) are 6, 0, 9 and 2 respectively, then the correct darkening of bubbles will look like the following.



1. 0.5 g of substance is dissolved in 25 g of a solvent. The percentage amount of the substance in the solution is

2. If $117\,g$ $NaCl$ is dissolved in $1000\,g$ of water, the concentration of the solution is said to be ..... molal.

3. Air contains about 0.03% of carbon dioxide. If concentration in parts per million is $x \times 10^2$ ppm, the value of x is

4. A solution contains 30 g of common salt dissolved in 470 g of water. The concentration of solution is

5. The weight percentage and volume percentage (w/v) of a solution are 22 and 44 respectively. The density of the solution is

ANSWER – KEY

1. C	**2.** B	**3.** C	**4.** C	**5.** A	**6.** A	**7.** A
8. B	**9.** C	**10.** A	**11.** C	**12.** A	**13.** C	**14.** C
15. B	**16.** C	**17.** D	**18.** A	**19.** A	**20.** D	**21.** A
22. B	**23.** A	**24.** A	**25.** A	**26.** B	**27.** A	**28.** B
29. D	**30.** D	**31.** D	**32.** C	**33.** D	**34.** D	**35.** B
36. C	**37.** B	**38.** C	**39.** A	**40.** D	**41.** C	**42.** C
43. B	**44.** C	**45.** A	**46.** A	**47.** C	**48.** A	**49.** C
50. B	**51.** A	**52.** C	**53.** B	**54.** B	**55.** D	**56.** A
57. C	**58.** A	**59.** B	**60.** B	**61.** C	**62.** A	**63.** C
64. C	**65.** B	**66.** B	**67.** C	**68.** A	**69.** A	**70.** B
71. C	**72.** D	**73.** B	**74.** C	**75.** B	**76.** B	**77.** A
78. B	**79.** A	**80.** A	**81.** A	**82.** A		

Fill in the Blanks

1. Saturated , unsaturated	**2.** Chemical
3. Chemical	**4.** Fractional distillation
5. 5	**6.** Solvent
7. Immisciblec	**8.** Fat (milk protein) , water
9. Water droplets	**10.** Solid (soap) , liquid (water)
11. Chemical	**12.** Colloidal, true.
13. Particle size.	**14.** Emulsion
15. Brownian movement	**16.** Gel
17. Tyndall	**18.** Physical
19. Constituents	**20.** Electrophoresis.

True or False

1. False. It is a true solution.
2. True
3. True
4. True
5. False. Mixture is salt and ammonium chloride can be separated by sublimation.
6. True
7. True
8. True
9. False. Any substance can be mixed with another substance to make a mixture.
10. True
11. False. A true solution is a homogeneous mixture.
12. True
13. True
14. False. Sulphur and sand are insoluble in water. Sulphur dissolves in carbon disulphide (CS_2).
15. True
16. False. It is a chemical change.
17. False. There is no similarity between physical properties of an element and its compounds.
18. True
19. True
20. True

Matrix Match Type

1. A → s; B → p; C → q; D → r
2. A → s; B → r; C → p; D → q
3. A → r; B → q; C → q; D → p
4. A → s; B → s; C → q; D → p
5. A → s; B → p; C → q; D → r
6. A → r; B → s; C → p; D → q
7. A → p; B → s; C → q; D → r
8. A → r; B → s; C → q; D → p
9. A → q; B → r; C → p; D → q
10. A → q; B → r; C → s; D → p

Assertion and Reason Type

1. D	**2.** A	**3.** D	**4.** D	**5.** C
6. C	**7.** A	**8.** D	**9.** C	**10.** B
11. A	**12.** A	**13.** D	**14.** B	**15.** A
16. D	**17.** B	**18.** B	**19.** C	**20.** C

Passage - 1

1. D	**2.** D	**3.** D	**4.** A

Passage - 2

1. A	**2.** C	**3.** B	**4.** B

Passage - 3

1. A	**2.** B	**3.** A

Passage - 4

1. B	**2.** B	**3.** A	**4.** A

Integer Answer Type

1. 2	**2.** 2	**3.** 3	**4.** 6	**5.** 2