Chapter 6

Solutions

Major Concepts

6.1 Solution, aqueous solution, solute and solvent
6.2 Saturated, unsaturated, supersaturated solutions and dilution of solution
6.3 Types of solutions
6.4 Concentration units
6.5 Comparison of solutions, suspensions and colloids

Time allocation

Teaching periods	16
Assessment periods	02
Weightage	14%

Students Learning Outcomes

Students will be able to:

- Define the terms: solution, aqueous solution, solute and solvent and give an example of each.
- Explain the difference between saturated, unsaturated and supersaturated solutions.
- Explain the formation of solutions (mixing gases into gases, gases into liquids, gases into solids) and give an example of each.
- Explain the formation of solutions (mixing liquids into gases, liquids into liquids, liquids into solids) and give an example of each.
- Explain the formation of solutions (mixing solids into gases, solids into liquids, solids into solids) and give an example of each.
- Explain what is meant by the concentration of a solution.
- Define molarity.
- Define percentage solution.
- Solve problems involving the molarity of solution.
- Describe how to prepare dilute solutions from concentrated solutions of known molarity.
- Convert between the molarity of a solution and its concentration in g/dm .
- Use the rule that "like dissolves like" to predict the solubility of one substance in another.

Introduction

Solutions are homogeneous mixtures of two or more components. Generally, solutions are found in three physical states depending upon the physical state of the solvent, e.g. alloy is a solid solution; sea water is a liquid solution and air is a gaseous solution. There are nine types of solutions ranging from gas-gas e.g air we breathe to solid-solid solutions e.g dental amalgam for filling of tooth. Liquid solutions are the most common solutions because of the most common solvent water. Therefore, there is a wide variety of liquid solutions ranging from a drop of rain to oceans. Sea water is a resource of 92 naturally occurring elements.

6.1 SOLUTION

A solution is a *homogeneous mixture of two or more substances.* The boundaries of the components can't be distiguished i.e. a solution exist as one phase. For example, the air we breathe is a solution of several gases, brass is a solid solution of Zn and Cu. Sugar dissolved in water is an example of liquid solution.

The simplest way to distinguish between a solution and a pure liquid is evaporation. The liquid which evaporates completely, leaving no residue, is a pure compound, while a liquid which leaves behind a residue on evaporation is solution. An alloy like brass or bronze is also a homogeneous mixture. Although, it cannot be separated by physical means, yet it is considered a mixture as:

i. It shows the properties of its components and

ii. It has a variable composition.

6.1.1 Aqueous Solutions

The solution which is formed by dissolving a substance in water is called an **aqueous solution**. In aqueous solutions water is always present in greater amount and termed as solvent. For example, sugar in water and table salt in water. Aqueous solutions are mostly used in the laboratories. Water is called a universal solvent because it dissolves majority of compounds present in earth's crust.

6.1.2 Solute

The component of solution which is present in smaller quantity is called **solute**. A solute is dissolved in a solvent to make a solution. For example, salt solution is made by dissolving salt in water. So in salt solution, salt is the solute and water is solvent. More than one solutes may be present in a solution. For example, in soft drinks, water is a solvent while other substances like sugar, salts and CO_2 are solutes.

6.1.3 Solvent

The component of a solution which is present in larger quantity is called **solvent**. Solvent always dissolves solutes. In a solution, if more than two substances are present, one substance acts as solvent and others behave as solutes. For example, as referred above in soft drinks, water is solvent while other substances like sugar, salts and CO_2 are solutes.

6.2 SATURATED SOLUTION

When a small amount of solute is added in a solvent, solute dissolves very easily in the solvent. If the addition of solute is kept on, a stage is reached when solvent cannot dissolve any more solute. At this stage, further added solute remains undissolved and it settles down at the bottom of the container.

$$\text{Solute} + \text{Solvent} \underset{\textit{crystalize}}{\overset{\textit{dissolve}}{\rightleftharpoons}} \text{Solution}$$

A solution containing maximum amount of solute at a given temperature is called **saturated solution**. On the particle level, a saturated solution is the one, in which undissolved solute is in equilibrium with dissolved solute.

$$\text{Solute (crystallized)} \rightleftharpoons \text{Solute (dissolved)}$$

At this stage, dynamic equilibrium is established. Although dissolution and crystallization continues at a given temperature, but the net amount of dissolved solute remains constant.

6.2.1 Unsaturated Solution

A solution which contains lesser amount of solute than that which is required to saturate it at a given temperature, is called **unsaturated solution**. Such solutions have the capacity to dissolve more solute to become a saturated solution.

6.2.2 Supersaturated Solution

When saturated solutions are heated, they develop further capacity to dissolve more solute. Such solutions contain greater amount of solute than is required to form a saturated solution and they become more concentrated. *The solution that is more concentrated than a saturated solution is known as* **supersaturated solution**. Super-saturated solutions are not stable. Therefore, an easy way to get a supersaturated solution is to prepare a saturated solution at high temperature. It is then cooled to a temperature where excess solute crystallizes out and leaves behind a saturated solution. For example, a saturated solution of sodium thiosulphate ($Na_2S_2O_3$) in water at 20 °C has 20.9 g of salt per 100 cm^3 of water. Less than this amount of salt per 100 cm^3 of water at 20 °C will be an unsaturated solution. A solution having more amount than 20.9 g of salt per 100 cm^3 of water at 20 °C will be a supersaturated solutuion.

6.2.3 Dilution of Solution

The solutions are classified as dilute or concentrated on the basis of relative amount of solute present in them. **Dilute solutions** *are those which contain relatively small amount of dissolved solute in the solution.* **Concentrated solutions** *are those which contain relatively large amount of dissolved solute in the solution.* For example, brine is a concentrated solution of common salt in water. These terms describe the concentration of the solution. Addition of more solvent will dilute the solution and its concentration decreases.

The preparation of dilute solutions from concentrated solutions has been explained in Section 6.4.3.1.

6.3 TYPES OF SOLUTION

Each solution consists of two components, solute and solvent. The solute as well as solvent may exist as gas, liquid or solid. So, depending upon the nature of solute and solvent different types of solutions may form, which are given in table 6.1.

Table 6.1 Different Types of Solutions with Examples

Sr. No	Solute	Solvent	Example of Solution
1	Gas	Gas	Air, mixture of H_2 and He in weather balloons, mixture of N_2 and O_2 in cylinders for respiration.
2	Gas	Liquid	Oxygen in water, carbon dioxide in water.
3	Gas	Solid	Hydrogen adsorbed on palladium.
4	Liquid	Gas	Mist, fog, liquid air pollutants.
5	Liquid	Liquid	Alcohol in water, benzene in toluene.
6	Liquid	Solid	Butter, cheese.
7	Solid	Gas	Dust particles or smoke in air.
8	Solid	Liquid	Sugar in water.
9	Solid	Solid	Metal alloys(brass, bronze), opals.

Test yourself
6.1

i. *Why is a solution considered mixture?*
ii. *Distinguish between the following pairs as compound or solution:*
(a) water and salt solution (b) vinegar and benzene
(c) carbonated drinks and acetone
iii. *What is the major difference between a solution and a mixture?*
iv. *Why are the alloys considered solutions?*
v. *Dead sea is so rich with salts that it forms crystals when temperature lowers in the winter. Can you comment why is it named as "Dead Sea"?*

6.4 CONCENTRATION UNITS

Concentration is the proportion of a solute in a solution. It is also a ratio of the amount of solute to the amount of solution or ratio of amount of solute to the amount of the solvent. Please keep in mind that concentration does not depend upon the total volume or total amount of the solution. For example, a sample taken from the bulk solution will have the same concentration. There are various types of units uspd to express concentration of solutions. A few of these units are discussed here.

6.4.1 Percentage

Percentage unit of concentration refers to *the percentage of solute present in a solution.* The percentage of solute can be expressed by mass or by volume.

It can be expressed in terms of percentage composition by four different ways.

6.4.1.1 Percentage - mass/mass (%m/m)

It is the number of grams of solute in 100 grams of solution. For example, 10% m/m sugar solution means that 10 g of sugar is dissolved in 90 g of water to make 100 g of solution. Calculation of this ratio is carried out by using the following formula:

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

$$= \frac{\textit{mass of solute}(g)}{\textit{mass of solution}(g)} \times 100$$

6.4.1.2 Percentage - mass/volume (%m/v)

It is the number of grams of solute dissolved in 100 cm^3 (parts by volume) of the solution. For example, 10 % m/v sugar solution contains 10 g of sugar in 100 cm^3 of the solution. The exact volume of solvent is not mentioned or it is not known.

$$\%\ \text{m/v} = \frac{\textit{Mass of solute (g)}}{\textit{Volume of solution } (cm^3)} \times 100$$

6.4.1.3 Percentage - volume/mass (%v/m)

It is the volume in cm^3 of a solute dissolved in 100 g of the solution. For example, 10 % v/m alcohol solution in water means 10 cm of alcohol is dissolved in (unknown) volume of water so that the total mass of the solution is 100 g. In such solutions the mass of solution is under consideration, total volume of the solution is not considered.

$$\% \text{ v/m} = \frac{\textit{Volume of solute } (cm^3)}{\textit{Mass of solution } (g)} \times 100$$

6.4.1.4 Percentage - volume /volume (% v/v)

It is the volume in cm^3 of a solute dissolved per 100 cm^3 of the solution. For example, 30 percent alcohol solution means 30 cm of alcohol dissolved in sufficient amount of water, so that the total volume of the solution becomes 100 cm^3.

$$\% \text{ volume/volume} = \frac{\text{Volume of solute (cm}^3)}{\text{Volume of solution (cm}^3)} \times 100$$

Example 6.1

If we add 5 cm^3 of acetone in water to prepare 90 cm^3 of aqueous solution. Calculate the concentration(v/v) of this solution.

Solution

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

$$= \frac{5}{90} \times 100 = 5.5$$

Thus concentration of solution is 5.5 percent by volume.

6.4.2 Molarity

It is a concentration unit defined *as number of moles of solute dissolved in one dm^3 of the solution.* It is represented by ***M***. Molarity is the unit mostly used in chemistry and allied sciences. The formula used for the preparation of molar solution is as follows:

$$\text{Molarity } (\boldsymbol{M}) = \frac{\dfrac{Mass\ of\ solute(g)}{Molar\ mass\ of\ solute(gmol^{-1})}}{Volume\ of\ solution(dm^3)} = \frac{\text{No. of moles of solute}}{\text{Volume of solution (dm}^3)}$$

or $$\text{Molarity } (\boldsymbol{M}) = \frac{Mass\ of\ solute\ (g)}{(Molar\ mass\ of\ solute(gmol^{-1}))\times(Volume\ of\ solution\ (dm^3))}$$

6.4.2.1 Preparation of Molar Solution

One Molar solution is prepared by dissolving 1 *mole* (molar mass) of the solute in sufficient amount of water to make the total volume of the solution up to 1 dm^3 in a measuring flask. For example, 1*M* solution of NaOH is prepared by dissolving 40 g of NaOH in sufficient water to make the total volume 1 dm^3.

As amount of solute is increased, its concentration or molarity also increases. 2.0 M solution is more concentrated than 1.0 M solution.

Test yourself 6.2

i. Does the percentage calculations require the chemical formula of the solute ?
ii. Why is the formula of solute necessary for calculation of the molarity of the solution?
iii. You are asked to prepare 15 percent (m/m) solution of common salt. How much amount of water will be required to prepare this solution ?
iv. How much water should be mixed with 18 cm3 of alcohol so as to obtain 18 % (v/v) alcohol solution?
v. Calculate the concentration % (m/m) of a solution which contains 2.5 g of salt dissolved in 50 g of water.
vi. Which one of the following solutions is more concentrated: one molar or three molar

6.4.3 Problems involving the molarity of a solution

The following solved examples will help you to understand how molar solutions are prepared.

Example 6.2

Calculate the molarity of a solution which is prepared by dissolving 28.4 g of Na_2SO_4 *in 400* cm^3 *of solution.*

Solution

Conversion mass of solute into *moles*

$$\text{No of moles } Na_2SO_4 = \frac{mass\ dissolved\ (g)}{molar\ mass\ (gmol^{-1})}$$

$$= \frac{28.4\ g}{142\ gmol^{-1}} = 0.2\ mol$$

$$\text{Conversion of volume into } dm^3 = \frac{400\ cm^3}{1000\ cm^3} \times 1\ dm^3 = 0.4\ dm^3$$

$$\text{Molarity} = \frac{no.of\ moles}{volume\ of\ solution\ (dm^3)}$$

$$= \frac{0.2}{0.4} = 0.5\ \text{mol dm}^{-3}$$

Example 6.3

How much NaOH is required to prepare its 500 cm³ of 0.4 M solution.

Solution

Molar mass of NaOH $= 40\ \text{gmol}^{-1}$

Volume in dm^3 $= \dfrac{500\ \text{cm}^3}{1000\ \text{cm}^3} \times 1\ dm^{-3}$

$= 0.5\ dm^3$

Putting the values in formula:

$$\text{Molarity} = \frac{mass\ of\ solute\,(g)}{molar\ mass\,(gmol^{-1}) \times volume\ of\ the\ solution\,(dm^3)}$$

Mass of solute $=$ Molarity $\times$ molar mass $\times$ volume

$= 0.4 \times 40 \times 0.5$

$= 8\ g$

6.4.3.1 Dilution of Solution

Dilute molar solution is prepared from a concentrated solution of known molarity as explained below:

Suppose we want to prepare 100 cm^3 of 0.01 M solution from given 0.1 M solution of potassium permanganate. First 0.1 M solution is prepared by dissolving 15.8 g of potassium permanganate in 1 dm^3 of solution. Then 0.01 M solution is prepared by the dilution according to following calculations:

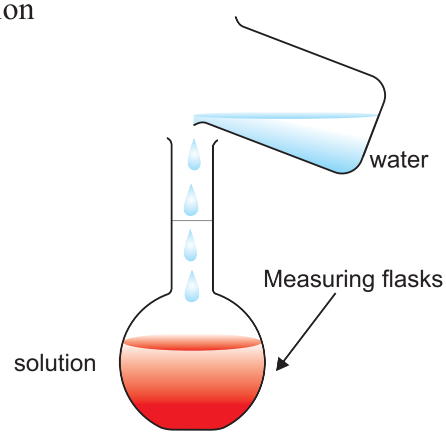

Fig. 6.1 Dilution of a solution.

Concentrated solution ***Dilute solution***

$$\mathbf{M_1V_1 = M_2V_2}$$

Where $M_1 = 0.1\ M$

$V_1 = ?$

and

$V_2 = 100\ cm^3$

$M_2 = 0.01\ M$

Putting the values in above equation we get:

Concentrated solution ***Dilute solution***

$V_1 \times 0.1 = 0.01 \times 100$

$V_1 = \dfrac{0.01 \times 100}{0.1}$

$= 10\ \text{cm}^3$

Concentrated solution of $KMnO_4$ has dense purple colour. Take 10 cm^3 of this solution with the help of a graduated pipette and put in a measuring flask of 100 cm^3. Add water upto the mark present at the neck of the flask. Now it is 0.01 molar solution of $KMnO_4$.

Example 6.4

10 cm^3 of 0.01 molar $KMnO_4$ solution has been diluted to 100 cm^3. Find out the molarity of this solution.

Solution:

Data

M_1	=	0.01 M	M_2	=	?
V_1	=	10 cm^3	V_2	=	100 cm^3

Using following formula, volume required can be calculated

$$M_1V_1 = M_2V_2$$

$$\text{or} \quad M_2 = \frac{M_1V_1}{V_2}$$

By putting these values we get molarity:

$$M_2 = \frac{0.01 \times 10}{100} = 0.001\ M$$

6.5 SOLUBILITY

Solubility is defined as *the number of grams of the solute dissolved in 100 g of a solvent to prepare a saturated solution at a particular temperature.* The concentration of a saturated solution is referred to as solubility of the solute in a given solvent.

Following are the factors which affect the solubility of solutes:

1. The general principle of solubility is, like dissolves like.
   - i. The ionic and polar substances are soluble in polar solvents. Ionic solids and polar covalent compounds are soluble in water e.g., KC1, Na_2CO_3, $CuSO_4$, sugar, and alcohol are all soluble in water.
   - ii. Non-polar substances are not soluble in polar solvents. Non-polar covalent compounds are not soluble in water such as ether, benzene, and petrol are insoluble in water.
   - iii. Non-polar covalent substances are soluble in non-polar solvents (mostly organic solvents). Grease, paints, naphthalene are soluble in ether or carbon tetrachloride etc.
2. Solute-solvent interaction.
3. Temperature.

6.5.1 Solubility and Solute-solvent interaction

The solute-solvent interaction can be explained in terms of creation of attractive forces between the particles of solute and those of solvent. To dissolve one substance (solute) in another substance (solvent) following three events must occur :

i. Solute particles must separate from each other

ii. Solvent particles must separate to provide space for solute particles.

iii. Solute and solvent particles must attract and mix up.

Solution formation depends upon the relative strength of attractive forces between solute-solute, solvent-solvent and solute-solvent. Generally solutes are solids. Ionic solids are arranged in such a regular pattern that the inter-ionic forces are at a maximum. If the new forces between solute and solvent particles overcome the solute-solute attractive forces, then solute dissolves and makes a solution. If forces between solute particles are strong enough than solute-solvent forces, solute remains insoluble and solution is not formed. Figure 6.2 shows dissolution process by the interaction of solvent molecules with the solute ions. The solvent molecules first pull apart the solute ions and then surround them. In this way, solute dissolves and solution forms.

For example, when NaCl is added in water it dissolves readily because the attractive interaction between the ions of NaCl and polar molecules of water are strong enough to overcome the attractive forces between Na^+ and Cl^- ions in solid NaCl crystal. In this process, the positive end of the water dipole is oriented towards the Cl^- ions and the negative end of water dipole is oriented towards the Na^+ ions. These ion-dipole attractions between Na^+ ions and water molecules, Cl^- ions and water molecules are so strong that they pull these ions from their positions in the crystal and thus NaCl dissolves. It is shown in the figure 6.2.

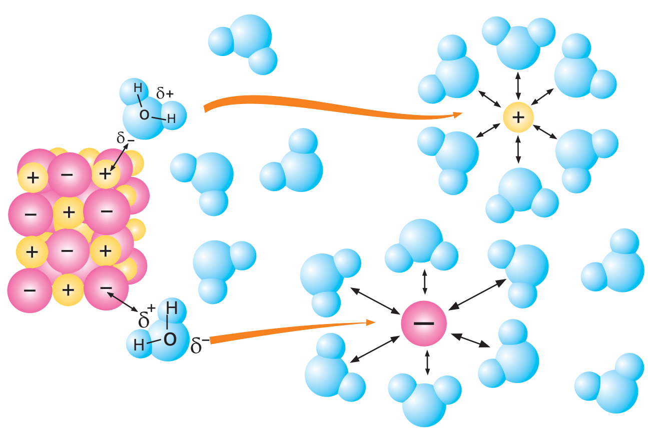

Fig. 6.2 Interaction of solute and solvent to form solution.

6.5.2 Effect of Temperature on solubility

Temperature has major effect on the solubility of most of the substances. Generally, it seems that solubility increases with the increase of temperature, but it is not always true. When a solution is formed by adding a salt in solvent, there are different possibilities with reference to effect of temperature on solubility as shown in the figure 6.3. These possibilities are discussed here.

i. Heat is absorbed

When salts like KNO_3, $NaNO_3$ and KC1 are added in water, the test tube becomes cold. It means during dissolution of these salts heat is absorbed. Such dissolving process is called *'endothermic'*.

solvent + solute + heat ⟶ solution

Solubility usually increases with the increase in temperature for such solutes. It means that heat is required to break the attractive forces between the ions of solute. This requirement is fulfilled by the surrounding molecules. As a result, their temperature falls down and test tube becomes cold.

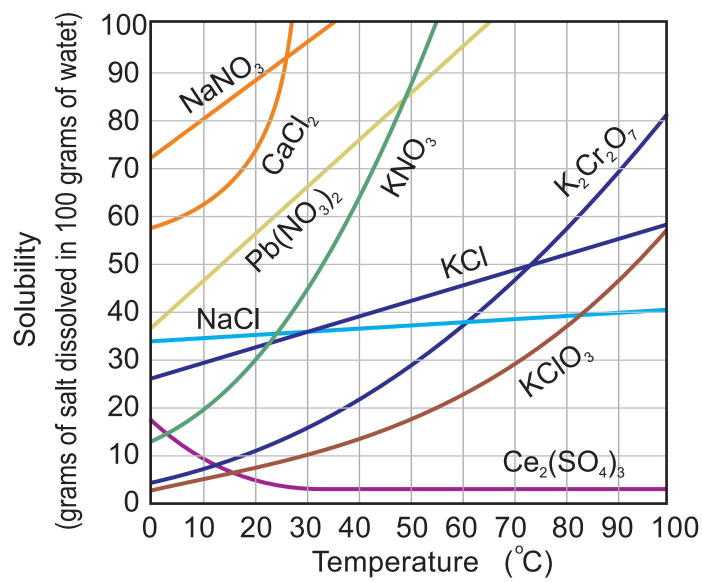

Fig. 6.3 Effect of temperature on solubility of different salts in water.

ii. Heat is given out

On the other hand, when salts like Li_2SO_4 and $Ce_2(SO_4)_3$ are dissolved in water, the test tube becomes warm. i.e. heat is released during this dissolution.

solvent + solute ⟶ solution + heat

In such cases, the solubility of salt decreases with the increase of temperature. In such cases, attractive forces among the solute particles are weaker and solute-solvent interactions are stronger. As a result, there is release of energy.

iii. No change in heat

In some cases, during a dissolution process neither the heat is absorbed nor released. When salt like NaCl is added in water, the solution temperature remains almost the same. In such case temperature has a minimum effect on solubility .Figure 6.3 shows the trend of solubilities of different salts with the increase in temperature.

Test yourself 6.3

i. *What will happen if the solute-solute forces are stronger than those of solute-solvent forces?*
ii. *When solute-solute forces are weaker than those of solute-solvent forces? Will solution form?*
iii. *Why is iodine soluble in CCI4 and not in water.*
iv. *Why test tube becomes cold when KNO_3 is dissolved in water*

6.6 COMPARISON OF SOLUTION, SUSPENSION AND COLLOID

6.6.1 Solution

Solutions are the homogeneous mixtures of two or more than two components. Each component is mixed in such a way that their individual identity is not visible. The simplest example is that of a drop of ink mixed in water. This is an example of true solution.

6.6.2 Colloid

These are solutions in which the solute particles are larger than those present in the true solutions but not large enough to be seen by naked eye. The particles in such system dissolve and do not settle down for a long time. *But particles of colloids are big enough to scatter the beam of light. It is called* ***Tyndall effect.*** We can see the path of scattered light beam inside the colloidal solution. Tyndall effect is the main characteristic which distinguishes colloids from solutions. Hence, these solutions are called false solutions or colloidal solutions. Examples are starch, albumin, soap solutions, blood, milk, ink, jelly and toothpaste, etc.

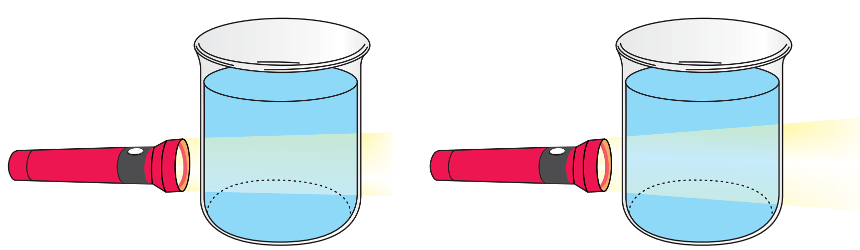

Fig. 6.4 Tyndall effect by colloids.

6.6.3 Suspension

Suspensions are a heterogeneous mixture of undissolved particles in a given medium. Particles are big enough to be seen with naked eyes. Examples are chalk in water(milky suspension), paints and milk of magnesia (suspension of magnesium oxide in water).

For better understanding of true solutions, false solution and suspension, a comparison of their characteristics is given in table 6.2.

Table 6.2 Comparison of the Characteristics of Solutions, Colloidals and Suspensions

Solutions	Colloids	Suspensions
The particles exist in their simplest form i.e. as molecules or ions. Their diameter is 10^{-8} cm.	The particles are large consisting of many atoms, ions or molecules.	The particles are of largest size. They are larger than 10^{-5} cm in diameter.
Particles dissolve uniformly throughout and form a homogeneous mixture.	A colloid appears to be a homogeneous but actually it is a heterogeneous mixture. Hence, they are not true solution. Particles do not settle down for a long time, therefore, colloids are quite stable.	Particles remain undissolved and form a heterogeneous mixture. Particles settle down after sometime.
Particles are so small that they can't be seen with naked eye.	Particles are large but can't be seen with naked eye.	Particles are big enough to be seen with naked eye.
Solute particles can pass easily through a filter paper.	Although particles are big but they can pass through a filter paper.	Solute particles cannot pass through filter paper.
Particles are so small that they cannot scatter the rays of light, thus do not show tyndall effect.	Particles scatter the path of light rays thus emitting the beam of light i.e. exhibit the tyndall effect.	Particles are so big that light is blocked and difficult to pass.

Test yourself 6.4

i. *What is difference between colloid and suspension?*
ii. *Can colloids be separated by filtration, if not why?*
iii. *Why are the colloids quite stable?*
iv. *Why does the colloid show tyndall effect?*
v. *What is tyndall effect and on what factors it depends?*
vi. *Identify as colloids or suspensions from the following: Paints, milk, milk of magnesia, soap solution.*
vii. *How can you justify that milk is a colloid.*

RELATIONSHIP OF SOLUTIONS TO DIFFERENT PRODUCTS IN THE COMMUNITY

Our body is made up of tissues, which are all composed of water based chemicals. The water becomes the best solvent in our body. We need an adequate supply of chemicals in the form of food, vitamins, hormones, and enzymes. For taking care of our health we need medicines. We find that chemicals and chemistry penetrate into every aspect of our life. Paper, sugar, starch, vegetable oils, ghee, essential oils, tannery, soap, cosmetics, rubber, dyes, plastics, petroleum, infact, there is almost nothing that we use in our daily life that is not a chemical. Some are usable as solid or gas but majority of them are used as solutions or suspensions.

Key Points

- Solution is a homogeneous mixture of two or more substances.
- Aqueous solution is formed by dissolving substances in water.
- The component which is lesser in quantity is called solute and the component in greater quantity is called solvent.
- A solution containing less amount of solute than that is required to saturate it at a given temperature is called unsaturated solution.
- A solution that is more concentrated than that of a saturated solution is called as supersaturated solution at that particular temperature.
- Solution may be dilute or concentrated depending upon the quantity of dissolved solute in solution.
- Concentration of solutions are expressed as % w/w, % w/v, % v/w and % v/v.
- The practical unit of concentration is molarity. It is the number of moles of solute dissolved in one dm of solution.
- Solubility is defined as the number of grams of the solute dissolved in 100 g of solvent to prepare a saturated solution at a given temperature . It depends upon solute-solvent interactions and temperature.
- Colloidal solutions are false solutions and in these solutions particles are bigger than in the true solutions.

EXERCISE

Multiple Choice Questions

Put a (✓) on the correct answer

1. Mist is an example of solution:
(a) liquid in gas (b) gas in liquid
(c) solid in gas (d) gas in solid

2. Which one of the following is a 'liquid in solid' solution?
(a) sugar in water (b) butter
(c) opal (d) fog

3. Concentration is ratio of:
(a) solvent to solute (b) solute to solution
(c) solvent to solution (d) both a and b

4. Which one of the following solutions contains more water?
(a) 2 M (b) 1 M
(c) 0.5 M (d) 0.25 M

5. A 5 percent (w/w) sugar solution means that:
(a) 5 g of sugar is dissolved in 90 g of water
(b) 5 g of sugar is dissolved in 100 g of water
(c) 5 g of sugar is dissolved in 105 g of water
(d) 5 g of sugar is dissolved in 95 g of water

6. If the solute-solute forces are strong enough than those of solute - solvent forces. The solute:
(a) dissolves readily (b) does not dissolve
(c) dissolves slowly (d) dissolves and precipitates.

7. Which one of the following will show negligible effect of temperature on its solubility?
(a) KCl (b) KNO_3
(c) $NaNO_3$ (d) NaCl

8. Which one of the following is heterogeneous mixture?
(a) milk (b) ink
(c) milk of magnesia (d) sugar solution

9. Tyndall effect is shown by:
(a) sugar solution (b) paints
(c) jelly (d) chalk solution

10. Tyndall effect is due to:

(a) blockage of beam of light
(b) non-scattering of beam of light
(c) scattering of beam of light
(d) passing through beam of light

11. If 10 cm^3 of alcohol is dissolved in 100 g of water, it is called:

(a) % w/w (b) %w/v
(c) % v/w (d) %v/v

12. When a saturated solution is diluted it turns into:

(a) supersaturated solution (b) unsaturated solution
(c) a concentrated solution (d) non of these

13. Molarity is the number of moles of solute dissolved in:

(a) 1kg of solution (b) 100 g of solvent
(c) 1 dm^3 of solvent (d) 1 dm^3 of solution.

Short answer questions.

1. Why suspensions and solutions do not show tyndall effect, while colloids do?
2. What is the reason for the difference between solutions, colloids and suspensions?
3. Why the suspension does not form a homogeneous mixture?
4. How will you test whether given solution is a colloidal solution or not?
5. Classify the following into true solution and colloidal solution:

   Blood, starch solution, glucose solution, toothpaste, copper sulphate solution, silver nitrate solution.
6. Why we stir paints thoroughly before using?
7. Which of the following will scatter light and why? sugar solution, soap solution and milk of magnesia.
8. What do you mean, like dissolves like? Explain with examples
9. How does nature of attractive forces of solute-solute and solvent-solvent affect the solubility?
10. How you can explain the solute-solvent interaction to prepare a NaCl solution?
11. Justify with an example that solubility of a salt increases with the increase in temperature.
12. What do you mean by volume/volume %?

Long Answer Questions

1. What is saturated solution and how it is prepared?
2. Differentiate between dilute and concentrated solutions with a common example.
3. Explain, how dilute solutions are prepared from concentrated solutions?
4. What is molarity and give its formula to prepare molar solution?
5. Explain the solute-solvent interaction for the preparation of solution.
6. What is general principle of solubility?
7. Discuss the effect of temperature on solubility.
8. Give the five characteristics of colloid.
9. Give at least five characteristics of suspension.

Numerical

1. A solution contains 50 g of sugar dissolved in 450 g of water. What is concentration of this solution?
2. If 60 cm^3 of alcohol is dissolved in 940 cm^3 of water, what is concentration of this solution?
3. How much salt will be required to prepare following solutions (atomic mass: K=39; Na=23; S=32; 0=16 and H=l)
   a. 250 cm^3 of KOH solution of 0.5 M
   b. 600 cm^3 of $NaN0_3$ solution of 0.25 M
   c. 800 cm^3 of $Na2SO_4$ solution of 1.0 M
4. When we dissolve 20 g of NaCl in 400 cm^3 of solution, what will be its molarity?
5. We desire to prepare 100 cm^3 0.4 M solution of $MgCl_2$, how much $MgCl_2$ is needed?
6. 12 M H_2SO_4 solution is available in the laboratory. We need only 500cm^3 of 0.1 ***M*** solution , how it will be prepared?