UNIT 06

SOLUTIONS

Long Answers Questions

Q1. Define the following: 09206001

i.	**Solution**	**ii.**	**Aqueous solution**	**iii.**	**Universal Solvent**
iv.	**Solute**	**v.**	**Solvent**	**vi.**	**Unsaturated Solution**

Ans.

(i) Solution:

Solution is a homogeneous mixture of two or more substances. For example, sugar dissolved in water. The boundaries of the components cannot be distinguished i.e., solution exist as one phase.

(ii) Aqueous Solution:

The solution which is formed by dissolving a substance in water is called an aqueous solution. For example, sugar in water and table salt in water.

(iii) Universal Solvent:

Water is called a universal solvent because it dissolves majority of compounds present in Earth's crust. Water is a polar solvent. Due to this polar covalent compounds and Ionic compounds mostly dissolve in it.

(iv) 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, in salt and water solutions, salt is solute. More than one solute may be present in a solution. For example, in soft drink; sugar, salts and CO_2 are solutes.

(v) Solvent:

The component of a solution which is present in larger quantity is called solvent. Solvent always dissolves solutes. For example, in soft drinks water is solvent.

(vi) 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. For example 0.1M $Na_2S_2O_3$ solution.

Q2.(Ex. Q.1)**What is saturated solution and how is it prepared?** **(Board 2015)** 09206002

Ans. Saturated Solution:

A solution containing maximum amount of solute at a given temperature is called saturated solution. In saturated solution undissolved solute is in equilibrium with dissolved solute.

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

Preparation of Saturated Solution:

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

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

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

Q3. Define supersaturated solution and how is it prepared? 09206003

Ans. Supersaturated Solution:

The solution that is more concentrated than a saturated solution, is known as supersaturated solution.

Preparation of 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.

Supersaturated 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 20.9g of salt per $100cm^3$ 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 20.9g of salt per $100cm^3$ of water at 20°C will be a supersaturated solution.

Q4.(Ex. Q.2) Differentiate between dilute and concentrated solutions with a common example.

(Board 2014,16) 09206004

Ans. Dilute solution:

Dilute solutions are those which contain relatively small amount of dissolved solute in the solution.

Concentrated solution: (Board 2016)

Concentrated solutions are those which contain relatively large amount of dissolved solute in the solution are called concentrated solutions.

Example:

i) Brine is a concentrated solution of common salt in water. Addition of more solvent will dilute the solution and its concentration decreases.

ii) 0.5M NaOH solution is dilute solution as compared to 1M NaOH solution (Concentrated Solution).

Q5. Write down the types of solutions with examples. 09206005

Ans. Each solution consists of two components; solute and solvent. The solute as well as solvent may exist as gas, liquid or solid.

There are nine types of solutions depending upon physical states of solute and solvent

Different Types of Solutions with Examples

	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.

Q6. What is meant by concentration of solution? Describe concentration units. 09206006

Ans. *The proportion of a solute in a solution is called concentration. It is also a ratio of amount of solute to the amount of solution or ratio of amount of solute to the amount of solvent.* Concentration does not depend upon the total volume or total amount of solution. For example a sample taken from the bulk solution will have the same concentration.

Concentration Units:

There are various types of units used to express concentration of solutions.

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.

i) Percentage- mass/mass (% m/m): **(Board 2014)**

It is the number of grams of solute in 100 grams of solution. For example 10 % m/m sugar solution means that 10g of sugar is dissolved in 90 g of water to make 100g of solution.

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

ii) Percentage-mass/volume (% m/v): **(Board 2014)**

It is the number of grams of solute dissolved in $100cm^3$ of solution. For example 10% m/v sugar solution contains 10g of sugar in 100 cm^3 of the solution. The exact volume of solvent is not known.

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

Where, $1dm^3 = 1000cm^3$

iii) Percentage-volume/mass (% v/m):

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

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

iv) 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% v/v alcohol solution means $30cm^3$ of alcohol dissolved in sufficient amount of water, so that total volume of solution becomes $100cm^3$.

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

Q7.(Ex. Q.4) What is Molarity and give its formula to prepare molar solution. 09206007

Ans. *Number of moles of solute dissolved in one dm^3 of solution is called molarity.* It is represented by M. It is a concentration unit. The formula used for preparation of molar solution is as follows:

$$\text{Molarity (M)} = \frac{\text{No. of moles of solute}}{\text{Volume of solution } (dm^3)}$$

or

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

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 40g of NaOH in sufficient water to make the total volume 1 dm^3.

Molarity increases with increase of solute. 2M solution is more concentrated than 1M solution.

Q8.(Ex. Q.3) Explain, how dilute solutions are prepared from concentrated solutions?

(Board 2016) **09206008**

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

Explanation:

Suppose we want to make 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 1dm^3 of solution. Then 0.01 M solution is prepared by the dilution according to the following calculations:

Concentrated solution Dilute solution

$$M_1V_1 = M_2V_2$$

Where $M_1 = 0.1$ M

$V_1 = ?$

And

$V_2 = 100\ cm^3$

$M_2 = 0.01$ M

By putting the values in above equation, we get

Concentrated solution Dilute solution

$$V_1 \times 0.1 = 0.01 \times 100$$

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

So, $V_1 = 10cm^3$

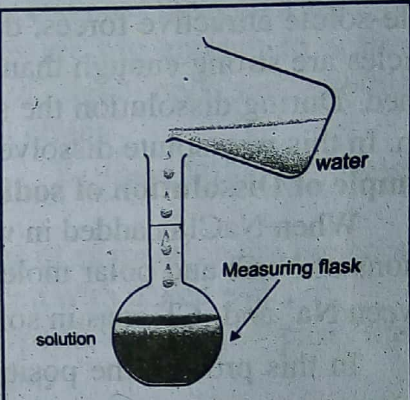

Fig: Dilution of a solution.

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

Q9.(Ex. Q.6) What is solubility? Describe its general principle. (Board 2016,17) **09206009**

Ans. Solubility:

The number of grams of the solute dissolved in 100g of solvent to prepare a saturated solution at a particular temperature is called solubility.

General Principle of Solubility:

The general principle of solubility is, **like dissolves like.**

(i) Polar substances are soluble in polar solvents. Ionic solids and polar covalent compounds are soluble in water (Polar Solvent) e.g. KCl, 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.

Q10. (Ex. Q.5) **Explain solute – solvent interaction for the preparation of solution.** 09206010

Ans. Solute-solvent interaction can be explained in terms of creation of attractive forces between the particles of solute and those of solvent. For dissolution of solute in solvent following three events must occur:

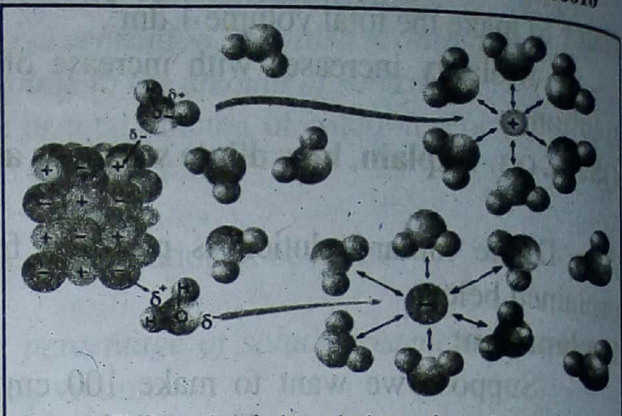
Fig: Interaction of solute and solvent to form solution.

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.

Dissolution of solute 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 developed 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. During dissolution the solvent molecules first pull apart the solute ions and then surround them. In this way solute dissolves and solution forms.

Example of Dissolution of sodium chloride:

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 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 position in the crystal and thus NaCl dissolves.

Q11.(Ex. Q.7) **Discuss the effect of temperature on solubility.** (Board 2013, 14, 15,16) 09206011

Ans. Change of temperature can change the solubility 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 on solubility. These possibilities are:

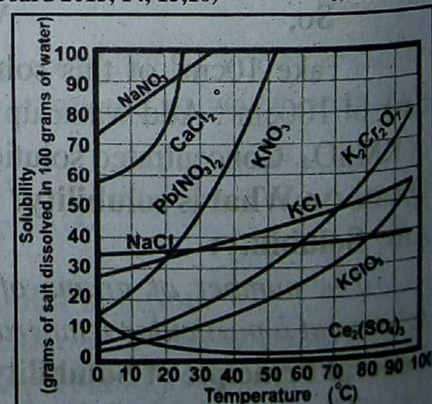

Fig: Effect of temperature on solubility of different salts in water

(i) Heat is absorbed:

When salts like KNO_3, $NaNO_3$ and KCl are added in water, heat is absorbed. It means dissolution of these salts is endothermic process.

$$\text{Solute + Solvent + Heat} \longrightarrow \text{Solution}$$

Whenever temperature of solution of such salt is increased, the solubility of solute is increased. It means heat is required to break the attractive forces between the ions of solute. When such salts are dissolved in water, container becomes cold because heat is absorbed and temperature of surroundings falls down.

(ii) Heat is given out:

A few substances like Li_2SO_4 and $Ce_2(SO_4)_3$(Cerium Sulphate) etc. dissolve in water with the evolution of heat. It means dissolution of such substances is exothermic process. Therefore container becomes hot.

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 heat is absorbed nor released. When salt like NaCl is added in water, the solution temperature remains same. In such cases temperature has minimum effect on solubility.

Q12.(Ex. Q.8) Give five characteristics of colloids. (Board 2017) 09206012

Ans.

i. The particles of colloid are large consisting of many atoms, ions or molecules.

ii. A colloid appears to be a homogeneous but actually it is a heterogeneous mixture. Hence, they are not true solutions. Particles do not settle down for a long time, therefore, colloids are quite stable.

iii. Particles are large but can't be seen with naked eye.

iv. Although particles of colloid are big but they can pass through a filter paper.

v. Particles are big enough to scatter the beam of light rays i.e. exhibit the Tyndall effect.

Q13.(Ex. Q.9) Give at least five characteristics of suspensions. (Board 2018) 09206013

Ans.

i. The particles of suspension are of largest size. They are larger than 10^{-5} **cm** in diameter.

ii. Particles remain undissolved and form a heterogeneous mixture. Particles settle down after sometime.

iii. Particles of suspension are big enough to be seen with naked eye.

iv. Solute particles cannot pass through filter paper.

v. Particles of suspension are so big that light is blocked and difficult to pass.

Q14. Define true solution, suspension and colloid with examples. 09206014

Ans. __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 e.g. drop of ink mixed in water is an example of true solution.

__Colloid:__

These are the solutions in which the solute particles are larger than those present in the true solution 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**. Tyndall affect is the main characteristic which distinguishes colloids from solutions.

Hence these solutions are called **false solutions** or **colloidal solutions**.

Examples: starch, albumin and soap solutions, blood, milk, ink, jelly, toothpaste etc.

__Suspension:__

Suspension is a heterogeneous mixture of undissolved particles in a given medium. Particles are big enough to be seen with naked eye.

Examples: chalk in water (milky suspension), **paints** and **milk of Magnesia** (suspension of magnesium oxide in water).

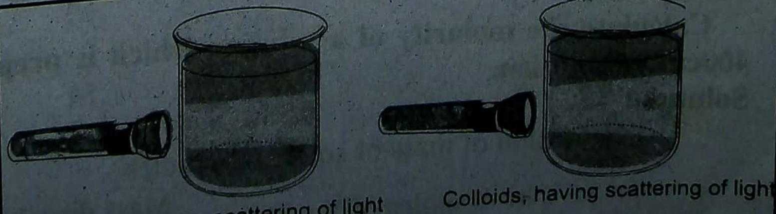

Fig: Tyndall effect by colloids.

Q15. Give comparison of the characteristics of Solution, Colloid and Suspension. 09206015

Ans. (Board 2018)

Solution	Colloid	Suspension
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 larger 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 solutions. 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.

Q16. Write the relationship of solutions to different products in the community. 09206016

Ans. 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 found 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, in fact there is almost nothing that we use in our daily life that is not a chemical. Some are used as solid or gas but majority of them are used as solutions or suspensions.

Book Examples

Example 6.1 09206017

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

Solution:

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

$$\% \text{ v/v} = \frac{5}{90} \times 100 = 5.5$$

The concentration of solution is 5.5 percent by volume.

Example 6.2 09206018

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

Solution:

Conversion of mass of solute into moles

$$\text{No. of moles of } Na_2SO_4 = \frac{\text{Mass dissolved (g)}}{\text{Molar mass (g mol}^{-1})}$$

$$\text{No. of moles of } Na_2SO_4 = \frac{28.4g}{142(g\,mol^{-1})} = 0.2mol$$

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

$$= 0.4\ dm^3$$

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

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

Example 6.3

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

Solution:

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

$$\text{Volume in } dm^3 = \frac{500\,cm^3}{1000\,cm^3}$$

$$= 0.5\ dm^3$$

Putting the values in the formula.

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

$$\text{Mass of solute} = \text{Molarity} \times \text{molar mass} \times \text{volume}$$

$$= 0.4 \times 40 \times 0.5$$

$$= 8g$$

09206020

Example 6.4

10cm³ of 0.01 molar $KMnO_4$ solution has been diluted to 100cm³. Find out the molarity of this solution.

Data:

$M_1 = 0.01\ M$ $\quad V_2 = 100cm^3$

$V_1 = 10cm^3$ $\quad M_2 = ?$

Solution:

Required volume can be calculated by using the formula:

$$M_1V_1 = M_2V_2$$

or

$$M_2 = \frac{M_1V_1}{V_2}$$

By putting these values we get molarity.

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

$$M_2 = 0.001M \text{ Ans.}$$

Exercise Numericals

Q1. A solution contains 50g of sugar dissolved in 450g of water. What is the concentration of this solution? 09206021

Ans.

Given Data:

Mass of sugar = 50g
Mass of water = 450g

Required:

Concentration of solution (% m/m) = ?

Solution:

$$\text{Concentration of solution (\% m/m)} = \frac{\text{Mass of solute (g)}}{\text{Mass of solute (g)} + \text{Mass of solvent (g)}} \times 100$$

$$= \frac{50g}{50g + 450g} \times 100$$

$$= \frac{50g}{500g} \times 100$$

= 10% m/m Ans.

Q2. If 60cm³ of alcohol is dissolved in 940cm³ of water. What is the concentration of this solution? 09206022

Ans.

Given Data:

Volume of alcohol = $60cm^3$
Volume of water = $940cm^3$

Required:

Concentration of solution (% v/v) = ?

Solution:

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

$$= \frac{60cm^3}{60cm^3 + 940cm^3} \times 100$$

$$= \frac{60cm^3}{1000cm^3} \times 100$$

= 6% v/v Ans.

Q.3. How much salt will be required to prepare following solutions (atomic masses: K = 39, Na = 23, S = 32, O = 16, H = 1) 09206023

(a) $250cm^3$ of KOH solution of 0.5M
(b) $600cm^3$ of $NaNO_3$ solution of 0.25M
(c) $800cm^3$ of Na_2SO_4 solution of 1.0M

Ans. (a) $250cm^3$ of KOH solution of 0.5M

Given Data:

Molarity of solution = 0.5M

Volume of solution $= 250cm^3 = \frac{250}{1000} dm^3 = 0.25\ dm^3$

Molar mass of KOH $=39+16+1=56 gmol^{-1}$

Required:

Mass of KOH = ?

Solution:

Using the formula:

$$Molarity = \frac{\text{Mass of solute (g)}}{\text{Molar mass of solute (g mol}^{-1}) \times \text{volume of solution (dm}^3)}$$

$$0.5M = \frac{\text{Mass of solute (g)}}{56 \text{ g mol}^{-1} \times 0.25 \text{ dm}^3}$$

Mass of solute $= 0.5 \times 56 \times 0.25$

$= 7g$

(b) $600cm^3$ of $NaNO_3$ solution of 0.25M

Given Data:

Molarity of $NaNO_3$ solution = 0.25M

Volume of solution = $600cm^3$

Volume of solution in dm^3 $= \frac{600cm^3}{1000cm^3}$

$= 0.6dm^3$

Molar mass of $NaNO_3$ $= 23 + 14 + (16\times3)$

$= 85gmol^{-1}$

Required:

Mass of $NaNO_3$ = ?

Solution:

Using the formula:

$$Molarity = \frac{\text{Mass of solute (g)}}{\text{Molar mass of solute (g mol}^{-1}) \times \text{volume of solution (dm}^3)}$$

$$0.25M = \frac{\text{Mass of solute}}{85gmol^{-1} \times 0.6dm^3}$$

Mass of solute $= 0.25 \times 85 \times 0.6$

Mass of solute $= 12.75$ g Ans.

(c) $800cm^3$ of Na_2SO_4 solution of 1.0M

Given Data:

Molarity of Na_2SO_4 Solution = 1.0 M

Volume of solution $= 800cm^3$

Volume of solution in dm^3 $= \frac{800cm^3}{1000cm^3}$

$= 0.8dm^3$

Molar mass of Na_2SO_4 $= 2(23) +32+4(16)$

$= 46+ 32+64$

$= 142 \text{ gmol}^{-1}$

Required:

Mass of Na_2SO_4 = ?

Solution:

Using the formula:

$$\text{Molarity} = \frac{\text{Mass of solute (g)}}{\text{Molar mass of solute (g mol}^{-1}) \times \text{volume of solution (dm}^3)}$$

$$1.0\text{M} = \frac{\text{Mass of solute}}{142\text{gmol}^{-1} \times 0.8\text{dm}^3}$$

Mass of solute $= 1.0 \times 142 \times 0.8$

$= 113.6$ g

Q4. When we dissolve 20g of NaCl in 400cm³ of solution, what will be its molarity? 09206024

Ans.

Given Data:

Mass of NaCl $= 20$g

Volume of solution $= 400\text{cm}^3$

Volume of solution in dm³ $= \frac{400\text{cm}^3}{1000\text{cm}^3}$

$= 0.4\text{dm}^3$

Molar mass of NaCl $= 23+35.5$

$= 58.5\text{g mol}^{-1}$

Required:

Molarity of solution = ?

Solution:

Using the formula:

$$\text{Molarity} = \frac{\text{Mass of solute (g)}}{\text{Molar mass of solute (g mol}^{-1}) \times \text{volume of solution (dm}^3)}$$

$$\text{Molarity} = \frac{20\text{g}}{58.5\,(\text{g mol}^{-1}) \times 0.4(\text{dm}^3)}$$

$$= \frac{20}{23.4} = 0.85\text{M}$$

Q5. We desire to prepare 100cm³ 0.4 M solution of $MgCl_2$. How much $MgCl_2$ is needed?

Ans. 09206025

Given Data:

Molarity of solution $= 0.4$ M

Volume of solution $= 100\text{cm}^3 = \frac{100}{1000}\text{dm}^3 = 0.1\text{dm}^3$

Molar mass of $MgCl_2$ $= 24 + 2(35.5)$

$= 24 + 71$

$= 95\text{ gmol}^{-1}$

Required:

Mass of $MgCl_2$ = ?

Solution:

Using the formula:

$$\text{Molarity} = \frac{\text{Mass of solute (g)}}{\text{Molar mass of solute (g mol}^{-1}) \times \text{volume of solution (dm}^3)}$$

$$0.4M = \frac{\text{Mass of solute (g)}}{95gmol^{-1} \times 0.1dm^3}$$

Mass of solute = 0.4 x 95 x 0.1
= 3.8g

Q.6. 12M H_2SO_4 solution is available in the laboratory. We need only 500cm^3 of 0.1M solution, how will it be prepared? 09206026

Ans.
Given Data:

Molarity of H_2SO_4 solution (concentrated) M_1 =12M
Volume of H_2SO_4 solution (concentrated) V_1 = ?
Molarity of H_2SO_4 solution (dilute) M_2 = 0.1M
Volume of H_2SO_4 solution (dilute) V_2 = 500cm^3

Solution:

Concentrated solution = Dilute solution

$$M_1V_1 = M_2V_2$$
$$12 \times V_1 = 0.1 \times 500$$
$$V_1 = \frac{0.1 \times 500}{12}$$
$$= 4.16\ cm^3$$

Take 4.16 cm^3 of concentrated H_2SO_4 solution with the help of graduated pipette and put in a measuring flask of 500cm^3. Add water upto the mark present at the neck of flask. Now it is 0.1 molar solution of H_2SO_4.

Short Answers Questions

Exercise Short Answers Questions

Q1. Why does suspension and solutions not show Tyndall effect while colloids do? 09206027

Ans. Because particles of colloids are big enough to scatter the beam of light but there is no scattering of light by particles of solution because they are so small they cannot scatter the rays whereas particles of suspensions are so big that light is blocked.

Q2. What is the reason for the difference between solutions, colloids and suspensions? (Board 2014) 09206028

Ans. In solution particles are very small. In colloid, particles are larger than solution particles. In suspension particles are big enough to be seen with naked eye and do not dissolve in solvent.

Q3. Why does the suspension not form a homogeneous mixture? 09206029

Ans. Particles in suspension remain undissolved and settle down after some time. Therefore suspension does not form a homogeneous mixture.

Q4. How will you test whether given solution is colloidal solution or not? 09206030

Ans. If a solution causes the scattering of light (tyndall effect) it is a colloidal solution while a solution showing no tyndall effect is not a colloidal solution.

Q5. Classify the following into true solution and colloidal solution.
Blood, starch solution, Glucose solution, toothpaste, copper sulphate solution, silver nitrate solution. (Board 2018) 09206031

Ans. True solution:
Glucose solution, copper sulphate solution, silver nitrate solution.

Colloidal solution:
Blood, starch solution, toothpaste.

Q6. Why do we stir paints thoroughly before using? (Board 2018) 09206032

Ans. Paint is a suspension. In suspension particles remain undissolved and settle down.

Due to this we stir paints thoroughly before using.

Q7. Which of the following will scatter light and why?

Sugar solution, Soap solution, Milk of Magnesia 09206033

Ans. Sugar solution:

Sugar solution will not scatter light because particles of solution are so small that they cannot scatter light.

Soap solution:

Soap solution scatter the light because it is colloidal solution and its particles are large enough that they can scatter light i.e. exhibit the Tyndall effect.

Milk of magnesia:

Milk of magnesia cannot scatter the light because it is suspension and its particles are so big that light is blocked.

Q8. What do you mean, like dissolves like? Explain with examples. 09206034

Ans. Like dissolves like means polar substances are soluble in polar solvents and non-polar substances are soluble in non polar solvents. Ionic solids and polar covalent solids are soluble in water. e.g. KCl and sugar is soluble in water. Non polar substances are soluble in non-polar substances. e.g. grease is soluble in ether.

Q9. How does nature of attractive forces of solute-solute and solvent-solvent affect the solubility? 09206035

Ans. Solubility depends upon the relative strength of attractive forces between solute-solute, solvent - solvent and solute - solvent. If new forces between solute and solvent particles overcome the solute - solute attractive forces, then solute dissolves. If forces between solute particles are stronger than solute - solvent forces, solute will be insoluble and solution is not formed.

Q10. How can you explain the solute-solvent interaction to prepare NaCl solution? 09206036

Ans. When NaCl is added in water, it dissolves readily because the attractive interaction between ions of NaCl and polar molecules of water are strong enough to overcome attractive forces between Na^+ and Cl^- in solid NaCl. In this way NaCl dissolves in water.

Q11. Justify with example that solubility of a salt increases with increase in temperature. (Board 2013) 09206037

Ans. When a salt like KNO_3 is dissolved in water, heat is absorbed. It means heat is required to break the attractive forces between ions of solute. Therefore solubility of such salt increases with increase of temperature.

Q12. What do you mean by volume/volume %? (Board 2017,18) 09206038

Ans. It is the volume in cm^3 of a solute dissolved per $100cm^3$ of the solution.

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

Test yourself 6.1

Q35. Why is a solution considered mixture? 09206061

Ans. Because components of a solution show their properties. They can be separated by physical means and can be mixed in any ratio.

Q36. Distinguish between the following pairs as compound or solution. 09206062

a. **Water and salt solution**
b. **Vinegar and benzene**
c. **Carbonated water and acetone**

Ans. (a) Water is compound and salt solution is solution.

(b) Vinegar is solution and benzene is a compound.

(c) Carbonated water is solution and acetone is compound.

Q37. What is the major difference between a solution and a mixture? 09206063

Ans. A solution is always homogeneous but mixture may be homogeneous or heterogeneous.

Q38. Why are the alloys considered solutions? 09206064

Ans. Alloys are homogeneous mixtures, which show properties of their components. They have a variable composition. That's why, they are considered solutions.

Q39. Dead sea is so rich with salt that it forms crystals when temperature lowers in the winter. Can you comment why is it named as dead sea? 09206065

Ans. Because it does not support aquatic life due to high concentration of salts.

Test yourself 6.2

Q40. Does the percentage calculation require the chemical formula of the solute? 09206066

Ans. No. chemical formula of a solute is not required for percentage calculation because molar mass is not required in this calculation.

Q41. Why is the formula of solute necessary for calculation of the molarity of the solution? 09206067

Ans. The formula of solute is necessary for calculation of the molarity of the solution because we have to calculate molar mass of solute. Molar mass of solute can be calculated from its chemical formula.

Q42. 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? 09206068

Ans. To prepare 15% m/m solution of common salt 15g solute and 85g water is required which will collectively make 100g of solution.

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

$$= \frac{15g}{15g + 85g} \times 100 = \frac{15}{100} \times 100$$

$$= 15\% \text{ solution of salt}$$

Q43. How much water should be mixed with $18cm^3$ of alcohol so as to obtain 18% (v/v) alcohol solution? 09206069

Ans. $18cm^3$ of alcohol is dissolved in $82cm^3$ of water so that the total volume of the solution becomes $100cm^3$.

Q44. Calculate the concentration % (m/m) of a solution which contains 2.5g of salt dissolved in 50g of water. 09206070

Ans. Solution:

Mass of salt = 2.5g
Mass of water = 50g

$$\text{Concentration}(\%m/m) = \frac{\text{Mass of solute}}{\text{Mass of solute} + \text{mass of solvent}} \times 100$$

$$= \frac{2.5}{2.5+50} = \frac{2.5}{52.5} = 4.7\%$$

Q45. Which one of the following solutions is more concentrated: one molar or three molar? 09206071

Ans. Three molar solution is more concentrated than one molar solution because 3M solution contains 3.0 moles of solute dissolved in it.

Test yourself 6.3

Q46. What will happen if the solute-solute forces are stronger than those of solute-solvent forces? 09206072

Ans. If the solute-solute forces are stronger than those of solute-solvent forces then solute will not dissolve in the solvent.

Q47. When solute-solute forces are weaker than those of solute-solvent forces, will solution form? 09206073

Ans. When solute-solute forces are weaker than those of solute-solvent forces, then solute will dissolve and solution will form.

Q48. Why is iodine soluble in CCl_4 and not in water? (Board 2018) 09206074

Ans. Iodine is soluble in CCl_4 not in water because iodine is non-polar in nature and CCl_4 is also non-polar but water is polar and forces of attraction do not develop between water molecules and iodine.

Q49. Why does test tube become cold when KNO_3 is dissolved in water? 09206075

Ans. Test tube becomes cold when KNO_3 is dissolved in water. Because heat of mixture is used to break the forces between ions of solute and extra heat is absorbed from surrounding to continue dissolution process.

Test yourself 6.4

Q50. What is the difference between colloid and suspension? (Board 2016) 09206076

Ans. Colloid:

In colloid particles are larger than those present in the true solution. The solute particle can pass through the filter paper. It shows Tyndall effect.

Suspension:

Suspension is a heterogeneous mixture of undissolved particles in given medium. Solute particles are bigger which cannot pass through the pores of filter paper. It blocks the light and does not show Tyndall effect.

Q51. Can colloids be separated by filtration, if not why? 09206077

Ans. Colloids cannot be separated by filtration.Because particles are not so big and pass through the filter paper.

Q52. Why are the colloids quite stable? 09206078

Ans. Colloids are quite stable because particles do not settle down for a long time.

Q53. Why does the colloid show Tyndall effect? (Board 2013) 09206079

Ans. Colloids show Tyndall effect because their particles scatter the path of light rays.

Q54. What is Tyndall effect and on what factors does it depend? (Board 2014) 09206080

Ans. The scattering of beam of light by particles of colloids is called Tyndall effect. It depends upon the size of particles.

Q55. Identify as colloids or suspensions from the following: (Board 2018) 09206081

Paints, milk, milk of magnesia, soap solution

Ans. Suspension:

Paints, milk of magnesia.

Colloids: (Give two examples of colloids.) (Board 2015)

Soap solution, milk.

Q56. How can you justify that milk is a colloid? 09206082

Ans. Milk is colloid because particles of milk do not settle down for a long time. These particles are large but can not be seen by naked eye and these particles cause the scattering of beam of light and therefore, show Tyndall effect. Can also pass through filter paper.

Multiple Choice Questions

Exercise MCQs

1. **Mist is an example of solution: (Board 2017,18)** 09206083
   (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? (Board 2015)** 09206084
   (a) Sugar in water (b) Butter
   (c) Opal (d) Fog
3. **Concentration is ratio of:** 09206085
   (a) Solvent to solute
   (b) Solute to solution
   (c) Solvent to solution
   (d) Both (a) & (b)
4. **Which one of the following solutions contains more water? (Board 2017)** 09206086
   (a) 2 M (b) 1M
   (c) 0.5M (d) 0.25M
5. **A 5 percent (w/w) sugar solution means that:** 09206087
   (a) 5g of sugar is dissolved in 90g of water
   (b) 5g of sugar is dissolved in 100g of water
   (c) 5g of sugar is dissolved in 105g of water
   (d) 5g of sugar is dissolved in 95g of water

6. If the solute-solute forces are strong enough than those of solute-solvent forces. The solute: 09206088
(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? (Board 2014) 09206089
(a) KCl (b) KNO_3
(c) $NaNO_3$ (d) NaCl

8. Which one of the following is heterogeneous mixture? 09206090
(a) Milk
(b) Ink
(c) Milk of magnesia
(d) Sugar solution

9. Tyndall effect is shown by (Board 2016)
(a) Sugar solution (b) Paints 09206091
(c) Jelly (d) Chalk solution

10. Tyndall effect is due to: 09206092
(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: (Board 2017) 09206093
(a) % w/w (b) % w/v
(c) % v/w (d) %v/v

12. When a saturated solution is diluted it turns into: 09206094
(a) Supersaturated solution
(b) Saturated solution
(c) A concentrated solution
(d) Unsaturated solution

13. Molarity is the number of moles of solute dissolved in: 09206095
(a) 1kg of solution
(b) 100 g of solvent
(c) 1 dm^3 of solvent
(d) 1 dm^3 of solution

Additional MCQs

14. 10% m/v sugar solution contains 10g of sugar in solution: 09206096
(a) 90g (b) 100g
(c) $100cm^3$ (d) $90cm^3$

15. 10% v/m alcohol solution contains $10cm^3$ of alcohol in solution: 09206097
(a) $100cm^3$ (b) 100g
(c) $90cm^3$ (d) 90g

16. One molar solution contains one mole of solute in volume of: 09206098
(a) $100cm^3$ (b) $1cm^3$
(c) $1dm^3$ (d) $10cm^3$

17. Ionic solids and polar covalent compounds are soluble in: 09206099
(a) Benzene (b) Ether
(c) Water (d) Petrol

18. Which one of the following solvents is polar? 09206100
(a) Benzene (b) Water
(c) Ether (d) Petrol

19. Grease, paints, naphthalene are soluble in: 09206101
(a) Water
(b) Ether
(c) Carbon tetrachloride
(d) Both b and c

20. The compound soluble in water is/are: (Board 2018) 09206102
(a) KCl (b) Na_2CO_3
(c) $CuSO_4$ (d) All of these

21. Solubility of which salt increases with the increase of temperature: 09206103
(a) KNO_3 (b) $NaNO_3$
(c) KCl (d) All of these

22. The solubility of which salt decreases with the increase of temperature? 09206104
(a) KNO_3 (b) $NaNO_3$
(c) Li_2SO_4 (d) KCl

23. Which of the following shows Tyndall effect? 09206105
(a) Albumin (b) Milk
(c) Paints (d) Both a and b

24. Which one is example of colloid? 09206106
(a) Jelly (b) Paints
(c) Milk of magnesia (d) None of these

25. Which one is a suspension? 09206107
(a) Blood (b) Toothpaste
(c) Ink (d) Chalk in water

26. Size of particles in true solution is:
(a) 10^{-2}cm (b) 10^{-8}cm 09206108
(c) 10^{-5}cm (d) 10^{-12}cm

27. Butter is example of solution: 09206109
(a) Gas-gas (b) Liquid-solid
(c) Solid-solid (d) None of these

28. Sea water is a source of naturally occurring elements: 09206110
(a) 18 (b) 92
(c) 118 (d) 95

29. Brass is a solid solution of Zn and:
(a) C (b) Sn 09206111
(c) Fe (d) Cu

30. Brass and Bronze are considered as:
(a) Compounds (b) Mixtures 09206112
(c) Elements (d) All of these

31. In soft drinks, CO_2 is: 09206113
(a) Solvent (b) Solute
(c) Solution (d) None of these

32. Which salt is used to prepare supersaturated solution? 09206114
(a) Na_2SO_4 (b) NaCl
(c) $Na_2S_2O_3$ (d) $NaHSO_4$

33. Air is an example of solution:
(Board 2016) 09206115
(a) Gas in liquid (b) Liquid in liquid
(c) Gas in gas (d) Solid in gas

34. Hydrogen absorbed in palladium is an example of solution: 09206116
(a) Solid in gas (b) Solid in liquid
(c) Gas in gas (d) Gas in solid

35. Example of liquid-gas solution is:
(a) Mist 09206117
(b) Fog
(c) Liquid Air pollutants
(d) All of these

36. Smoke in air is example of solution:
09206118
(a) Gas in gas (b) Solid in liquid
(c) Solid in gas (d) All of these

37. Example of solid in solid solution is:
(a) Brass (b) Bronze 09206119
(c) Opals (d) All of these

38. Example of liquid in liquid is: (Board 2014)
09206120
(a) Alcohol in water
(b) Butter in water
(c) Fog
(d) Mist

39. Which one can easily dissolve in carbon tetrachloride? (Board 2013) 09206121
(a) Sodium Chloride
(b) $AgNO_3$
(c) Magnesium oxide
(d) Iodine

40. Metal alloys are: (Board 2014, 15) 09206122
(a) Solution of solid in gas
(b) Solution of solid in liquid
(c) Solution of solid in solid
(d) Solution of gas in solid

41. Which one of the following solutions has less water? (Board 2014) 09206123
(a) 0.25M (b) 0.50M
(c) 0.60M (d) 2.0M

42. Which one of the following is suspension? (Board 2018) 09206124
(a) Milk of magnesia
(b) Sugar Solution
(c) Ink
(d) Milk

43. The example of solution of a solid solute in a solid solvent. (Board 2018)
(a) Fog (b) Brass 09206125
(c) Cheese (d) Air

Answer Keys

1.	a	2.	b	3.	b	4.	d	5.	d
6.	b	7.	d	8.	c	9.	c	10.	c
11.	c	12.	d	13.	d	14.	c	15.	b
16.	c	17.	c	18.	b	19.	d	20.	d
21.	d	22.	c	23.	d	24.	a	25.	d
26.	b	27.	b	28.	b	29.	d	30.	b
31.	b	32.	c	33.	c	34.	d	35.	d
36.	c	37.	d	38.	a	39.	d	40.	c
41.	d	42.	a	43.	b				