Chapter 6 Solutions

Section A Multiple Choice Questions (M.C.Qs)

Tick mark (✓) the correct answer:

01. *An alloy is the homogeneous mixture of:*
(a) two solids (b) two liquids (c) two gases (d) solid and liquid

02. *A saturated solution of KCl on heating becomes:*
(a) unsaturated (b) supersaturated (c) diluted (d) all of these

03. *If we dissolve sand into the water, then the mixture is said to be:*
(a) solution (b) suspension (c) colloids (d) concentrated solution

04. *Solubility is usually expressed in grams of the solute dissolved in _____ gram of a solvent.*
(a) 10 grams (b) 100 grams (c) 500 grams (d) 1000 grams

05. *Example of a heterogeneous mixture is:*
(a) sugar and water (b) sand and water (c) salt and water (d) ink and water

06. *2 moles of sodium chloride (NaCl) is equal to:*
(a) 123 grams (b) 135 grams (c) 158 grams (d) 117 grams

07. *Molarity of a solution which is prepared by dissolving 40g sodium chloride in 500cm^3 of a solution is:*
(a) 1.4 M (b) 1.5 M (c) 1.33 M (d) 1.36 M

08. *10% (w/w) sugar solution mean that 10 grams of solute dissolved in:*
(a) 90g of water (b) 95g of water (c) 100g of water (d) 105g of water

09. *An example of a true solution is:*
(a) solution of starch (b) solution of soap (c) ink in water (d) tooth paste

10. *Which solution contains more water?*
(a) 1.0 M (b) 0.75 M (c) 0.5 M (d) 0.25 M

11. *When a saturated solution is diluted, it changes into:*
(a) saturated solution (b) unsaturated solution
(c) concentrated solution (d) supersaturated solution

12. *Butter is an example of a solution:*
(a) gas–liquid (b) solid–liquid (c) liquid–solid (d) gas–solid

13. *A solution that contains solid solute into the liquid solvent is called:*
(a) solids in gas (b) liquids in solids (c) solids in solids (d) solids in liquid

14. *What is the particle size in suspension?*
(a) 10^3nm (b) 10^7nm (c) less than 10^3nm (d) greater than 10^3nm

15. ***Which of the following statements is true?***
   (a) A solvent is the homogenous mixture of solute and solution.
   (b) A solvent is the heterogenous mixture of solute and solution.
   (c) A solution is the homogenous mixture of solute and solvent.
   (d) A solution is the heterogenous mixture of solute and solvent.

16. ***Glass of milk, blood and tap water are the examples of:***
   (a) solution (b) solute (c) solvent (d) None of them

17. ***The nutrient absorbed by plants from the soil is the example of the:***
   (a) solvent (b) solution (c) Both 'a' & 'b' (d) None of these

18. ***Brass is an example of:***
   (a) solute (b) solvent (c) solution (d) None of these

19. ***Brass is:***
   (a) zinc dissolved in copper (b) iron dissolved in copper
   (c) iron dissolved in zinc (d) tin dissolved in iron

20. ***In aqueous solution, water is present in greater amount and termed as:***
   (a) solution (b) solvent (c) solute (d) None of these

21. ***The component of a solution which is always present in smaller amount is called the:***
   (a) solution (b) solvent (c) solute (d) None of these

22. ***The component of the solution which is present in larger amount is called:***
   (a) solution (b) solvent (c) solute (d) None of these

23. ***It is also called as the universal solvent.***
   (a) Alcohol (b) Kerosene oil (c) Mineral oil (d) Water

24. ***A solution that cannot dissolve more solute in it at a particular temperature is called a:***
   (a) saturated solution (b) unsaturated solution
   (c) supersaturated solution (d) diluted solution

25. ***A solution that can dissolve more solute than it contained in the saturated solution after heating is called a:***
   (a) saturated solution (b) unsaturated solution
   (c) supersaturated solution (d) diluted solution

26. ***In carbonated drinks, the state of solute is:***
   (a) gas (b) liquid (c) solid (d) All of these

27. ***In fog, the state of solvent is:***
   (a) gas (b) liquid (c) solid (d) All of these

28. ***Concentration = :***
   (a) mass of solute in gram × volume of solution in dm^3
   (b) $\frac{\text{Mass of solute in gram}}{\text{volume of solution in } dm^3}$ (c) $\frac{\text{volume of solution in } dm^3}{\text{Mass of solute in gram}}$
   (d) None of these

29. ***1 litre = :***
   (a) 1 cm^3 (b) 1 ml (c) 1000 cm^3 (d) 1 dm^3

30. ***Molarity is defined as the number of moles of solute dissolved in:***
   (a) 1 ml (b) 1 cm^3 (c) 1 dm^3 (d) 1000 cm^3

31. ***Solubility is increased by:***
   (a) increasing the temperature (b) decreasing the temperature
   (c) leaving the solution for a period of time (d) All of these

32. *2 moles of water is equal to:*
(a) 18 g (b) 36 g (c) 56 g (d) 46 g

33. *A solution that contains large amount of dissolved solute is called:*
(a) dilute (b) saturated (c) supersaturated (d) concentrated

34. *Homogenous mixture of solute and solvent is called:*
(a) solvent (b) solute (c) solution (d) suspension

35. *The number of ways of representing percent concentration are:*
(a) one (b) two (c) three (d) four

36. *Solubility is usually expressed in grams of solute per:*
(a) 10 grams of solvent (b) 100 grams of solvent
(c) 1000 grams of solvent (d) 10000 grams of solvent

37. *In colloids, particles are too big to:*
(a) dissolve (b) absorb (c) crystallize (d) disappear

38. *Suspensions are :*
(a) homogenous (b) heterogeneous (c) uniform (d) solutions

Answers

01.	(a)	06.	(a)	11.	(b)	16.	(a)	21.	(c)	26.	(a)	31.	(a)	36.	(b)
02.	(a)	07.	(d)	12.	(c)	17.	(b)	22.	(b)	27.	(a)	32.	(b)	37.	(a)
03.	(b)	08.	(c)	13.	(d)	18.	(c)	23.	(d)	28.	(b)	33.	(d)	38.	(b)
04.	(b)	09.	(d)	14.	(d)	19.	(a)	24.	(a)	29.	(d)	34.	(c)		
05.	(b)	10.	(d)	15.	(c)	20.	(b)	25.	(c)	30.	(c)	35.	(d)		

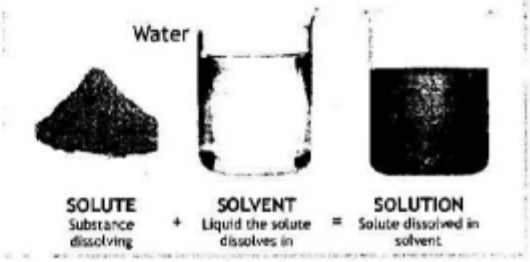
Section B&C — Short & Detailed Answer Questions

Q.1 ***Define solution with examples.***

Ans: **Solution:** A solution is a homogeneous mixture of two or more substances to form a single phase. In other words, a solution is the homogenous mixture of solute and solvent.
Examples: A solution exists in all three states of matter. An example of a solid solution is brass (Zinc dissolved in copper), the liquid solution is sugar into water and a gaseous solution is air we breathe. Air is made up of gases oxygen, nitrogen, carbon dioxide etc.

Q.2 ***Define aqueous solution.***

Ans: An aqueous solution is formed by dissolving a substance in water. The word aqueous is derived from the Latin word called aqua meaning water. Sugar, salt, and acid in water are examples of the aqueous solution. In an aqueous solution, water (H_2O) is present in a greater amount and termed as solvent.



Q.3 Define solute with examples.

Ans: ***Solute:*** The component of a solution that is always present in a smaller amount is called the solute. A solute is dissolved in a solvent to make a solution.

Examples: An everyday example of a solute is sugar in water. Sugar is the solute and water is the solvent. In a solution, more than two solutes may be present. For example, in a soft drink, sugar, salt and carbon dioxide are solute and water is a solvent. We consider another example, the air is a solution of several gases like nitrogen, carbon dioxide, oxygen and inert gases. In this solution carbon dioxide, oxygen and inert gases are solute and nitrogen is solvent.

Q.4 Define solvent and universal solvent.

Ans: ***Solvent:*** The component of the solution which is present in a larger amount is called a solvent. A solvent is generally liquid, but can also be gas or liquid or solid. The component of a solution which can dissolve solute is called a solvent.

Universal Solvent: Water is the most common solvent because it can dissolve most of the solute. It is also called the universal solvent.

Q.5 Why solutions are important for us?

Ans: ***Importance of Solution:*** Solutions are everywhere around us. Many substances around us is a solution like a glass of milk, drugs and medicines, blood, alloy, kerosene oil, tap water, cooking utensils and surgical tools. These all are the example of a solution. The nutrient absorbed by plants from the soil is also an example of the solution. The foods we eat come into contact with enzymes with the help of a solution. The majority of chemical reactions occur in solutions. All these are possible with the presence and support of the solution.

Q.6 Why solution called mixture?

Ans: A solution is a specific term that describes an even or homogeneous mixture of a solute, the substance being mixed, in a solvent, the substance that is in a greater amount in which the solute dissolves. All solutions are mixtures because it is two or more substances mixed together.

Q.7 How is a solution formed?

Ans: A solution is made when one substance called the solute "dissolves" into another substance called the solvent.

Q.8 Air is a solution of general gases like nitrogen, carbon dioxide, oxygen and inert gases, why nitrogen is called solvent?

Ans: Nitrogen makes up the largest portion of air, so it is the solvent. Other gases present, such as oxygen and carbon dioxide, are solutes.... So, nitrogen gas is the solvent because it is present in the greatest proportion. All other gases, oxygen, argon, carbon dioxide and so on are solutes.

Q.9 Describe the terms saturated, unsaturated and supersaturated solutions.

Ans: ***Saturated Solution:*** We take some water in a beaker and add sugar in a small amount. The sugar dissolved very easily in the water at a certain temperature. If the adding of sugar continues, it is found that a limit is reached when the water cannot dissolve any more sugar and settling down and no more solute can dissolve in it. Such a solution is said to be a saturated solution. Thus we can define a saturated solution as follows:

A solution that cannot dissolve more solute at a particular temperature is called a saturated solution.

Unsaturated Solution: A solution that contains a lesser amount of solute than is required to saturate it at a particular temperature, is called an unsaturated solution. Salt dissolved in water is an example of an unsaturated solution if the solution can dissolve more solute to become a saturated solution.

Supersaturated Solution: When we heat the saturated solution, it develops the further capacity to dissolve more amount of sugar (solute). This solution contains a greater amount of solute than that present in a saturated solution and the solution become more concentrated. Now the solution is called supersaturated.

Thus, we can define a supersaturated solution as:

A solution that can dissolve more solute than it contained in the saturated solution after heating is called a supersaturated solution.

Q.10 *What do you know about the dilution of a solution?*

Ans: ***Dilution of Solution:*** We already know about two basic terms dilute and concentrated solutions and both are depending on the relative amount of solute present in it. Dilute solution contains a relatively small amount of solute in a large amount of solvent like adding more water to a solution whereas, a concentrated solution contains a relatively large amount of solute in a small amount of solvent.

Q.11 *How can we prepare dilute solution in the laboratory?*

Ans: Dilution of a solution is a necessary process in the laboratory, as a stock solution (more concentrated) are often purchased and stored in the laboratory when the desired concentration of the solution is required can be prepared by diluting the stock solution by given formula.

Preparing Dilute Solution: In a laboratory, we can make a dilute solution from a concentrated solution by using formulas:

Concentrated Solution = Dilute Solution

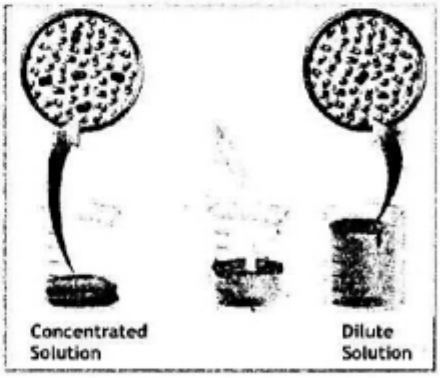
$$M_1V_1 = M_2V_2$$

where, M_1 = Molarity of concentrated solution

V_1 = Volume of concentrated solution

M_2 = Molarity of dilute solution

V_1 = Volume of dilute solution



Q.12 *How many types of solution are there?*

Ans: ***Types of Solution:*** As we know that there are three states of matter, i.e. solid, liquid and gas. A solute, as well as solvent, can exist in any one of the three states of matter By the combination of these three states different types of solutions are formed, which are given in the following table.

Sr.No	State of Solute	State of Solvent	State of Solution	Example of Solution
1.	Gas	Gas	Gas	Air, mixture of hydrogen and helium in water balloon, oxygen in air.
2.	Gas	Liquid	Liquid	Carbonated drinks (carbon dioxide dissolved in water)

3.	Gas	Solid	Solid	Hydrogen gas in palladium, nitrogen in titanium, smoke
4.	Liquid	Gas	Gas	Fog (water vapour in air) liquid air pollutants.
5.	Liquid	Liquid	Liquid	Alcohol dissolvesin water, oil in ether.
6.	Liquid	Solid	Solid	Amalgam, butter, cheese.
7.	Solid	Gas	Gas	Smoke (carbon particles in air).
8.	Solid	Solid	Liquid	Salt in water, Sugar in water.
9.	Solid	Solid	Solid	Brass an alloy (Zinc dissolved in copper), Bronze (tin dissolved in copper).

Q.13 ***Define concentration. Write its expression. Name the ways of expressing the concentration of the solution.***

Ans: ***Concentration:*** Concentration is the amount of solute present in a given amount of solvent or solution. It is also the ratio of the amount of solute to the amount of solution or the ratio of the amount of solute to the amount of solvent.

We can express the concentration in terms of grams of solute per dm^3 (g / dm^3) of solution.

$$\text{Concentration in g/dm}^3 = \frac{\text{Mass of solute in gram}}{\text{Volume of solution in dm}^3}$$

There are many ways of expressing the concentration of the solution. The two of them are:

(i) percentage (ii) molarity

Q.14 ***Describe percentage concentration.***

Ans: ***Percentage:*** It is a unit of concentration. It refers to the percentage of solute present in a solution. It can be expressed in four different ways:

(i) ***Mass by Mass Percent (% m/m):*** It is the mass of solute in gram dissolve in 100 gram of solution.

For example, 5% m/m sugar solution means that 5 grams of sugar dissolved in 95 grams of water to make 100 grams of solution.

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

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

(ii) ***Mass by Volume Percent (%m/v):*** It is the mass of the solute in grams dissolved per $100cm^3$ of the solution.

For example, 5%m/v sugar solution means that 5 grams of sugar in $100cm^3$ of the solution.

(iii) ***Volume by Mass Percent (%v/m):*** It is the volume of solute in cm^3 dissolved in 100 gram of the solution.

For example, 5%(v/m) solution means $5cm^3$ of alcohol is dissolved in a (unknown) volume of water so that mass of the solution become 100g.

$$\text{Percent of the solution } (\frac{V}{m}) = \frac{\text{Volume of Solute (cm}^3)}{\text{Mass of solution (g)}} \times 100$$

(iv) ***Volume by Volume Percent (%v/v):*** The volume of solute in cm^3 is dissolved per $100cm^3$ of the solution.

For example, 5%(v/v) solution means that 5cm^3 of alcohol is dissolved in 95 cm^3 of the water to make 100 cm^3 of the solution.

$$\text{Percent of the solution } (\frac{V}{V}) = \frac{\text{Volume of Solute (cm}^3\text{)}}{\text{Volume of Solution (cm}^3\text{)}} \times 100$$

Q.15 Define molarity.

Ans: ***Molarity:*** Molarity is defined as the number of moles of solute dissolved in one dm^3 of the solution. Morality is the concentration unit in which the amount of solute is expressed in gram and the amount of solution is expressed in dm^3. It is denoted by "M" and its unit is mol/dm^3.

$$\text{Molarity (M)} = \frac{\text{Number of moles of solute}}{\text{Volume of solution in dm}^3}$$

$$\text{Number of moles of solute} = \frac{\text{mass of solute}}{\text{molar mass of the solute (gmol}^{-1}\text{)}}$$

$$\text{The volume of solution in dm}^3 = \frac{\text{Volume of solution (cm}^3\text{)}}{1000}$$

$$\text{Molarity} = \frac{\text{Mass of solute (g)}}{\text{Molar mass of the solute (gmol}^{-1}\text{)}} \times \frac{1000}{\text{Volume of Solution (cm}^3\text{)}}$$

Q.16 How to prepare molar solution?

Ans: ***Preparation of Molar Solution:*** One mole (molar mass) of a solute is dissolved in a sufficient amount of water so that the total volume is 1dm^3. The solution is said to be one molar solution.

For example, to prepare a 1.0 M solute of NaCl in 1 dm^3, the following steps may be considered:

(i) Weigh out 58.5 grams of NaCl Molar mass of NaCl = 23 + 35.5 = 58.5g/mol

(ii) Put the NaCl into a volumetric flask.

(iii) Add water to dissolve the salt and prepare 1dm^3 solution.

We have prepared a 1M NaCl solution by dissolving 58.5 grams of NaCl insufficient water to make the volume 1dm^3. Similarly, to make a 0.1 M solution, we could dissolve 5.85g of NaCl in 1 dm^3 of water.

Q.17 Brass contains 20% zinc and 80% copper. Identify the state of solute and solvent in the solution. Also, write the type of solution.

Ans: Brass is a solid solution of metals, principally Copper and Zinc. Here zinc is solute and copper is solvent. The type of solution is solid-solid.

Q.18 Which one of the solutions is more diluted: 2M or 3M?

Ans: 2M solution is more diluted.

Q.19 Define solubility.

Ans: ***Solubility:*** Solubility is defined as the maximum quantity of solute that can be dissolved in 100 grams of solvent to prepare a saturated solution at a particular temperature.

Different substances have different capability to dissolve in the same solvent at a particular temperature. For example, the solubility of sodium chloride in 100g of water at 100°C is 39.12g, whereas, the solubility of silver chloride in 100g of water at 100°C is 0.002g. This shows that sodium chloride is much more soluble in water than silver chloride.

Q.20 *Name the general principles of solubility.*

Ans: ***General Principles of Solubility:***

(i) The general, principle of solubility is "Like dissolves like". It means that two substances with similar intermolecular forces are likely to be soluble in one another. It has been that:

- Ionic and polar solute dissolved in polar solvents. For example, Na_2CO_3, sugar and alcohol are polar and dissolved in water because water is also polar.
- Nonpolar solute dissolved in non-polar solvents. Such as oil and paints are non-polar, they are dissolved in the ether as both are non-polar. Similarly, waxes and fats dissolve in benzene and not in water.
- Nonpolar compounds are not soluble in polar solvents (water). For example, oil, petrol, benzene are non-polar, they are not dissolved in water because water is polar.

(ii) Solute-solvent interaction

(iii) Temperatures

Q.21 *Describe solubility and solute-solvent interaction. OR Why solute dissolves in solvent?*

Ans: ***Solubility and Solute-Solvent Interaction:*** To dissolve the solute into a solvent, the following conditions must be fulfilled.

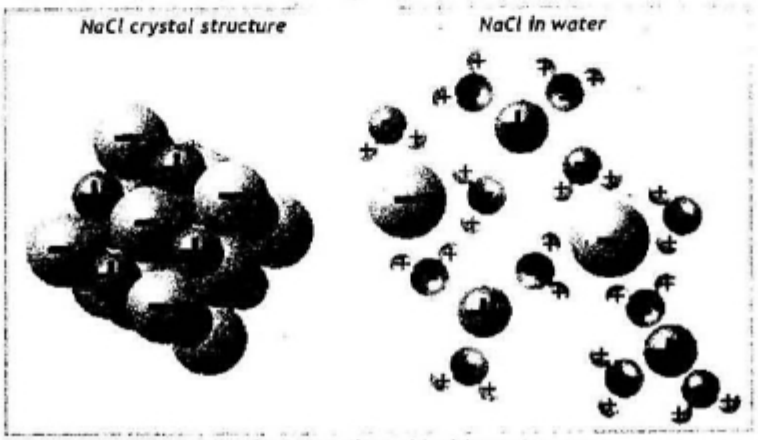
(i) Solute-solute bonding should be broken.

(ii) Solvent-solvent bonding should be broken to provide space for solute particles.

(iii) Solute-solvent attraction should be maximized.

The process of solution formation depends upon the relative strength of attractive forces between solute-solute, solvent-solvent and solute-solvent. A solute will dissolve in a solvent if the solute-solvent forces of attraction are greater enough to overcome the solute-solute and solvent-solvent forces of attraction. A solute will not dissolve if the solute-solvent forces of attraction are weaker than individual solute and solvent intermolecular attractions.

As we know that sodium chloride is an ionic compound. When sodium chloride (NaCl) is placed in water, it dissolves quickly. The negative end of water molecules is attracted to sodium ions and the positive end of water molecules is attracted to chlorine ions. In this case, solute solvent attractions are more in comparison with solute-solute interaction; therefore solution of sodium chloride is formed. These attractive forces of water are stronger enough to overcome the attraction between Na^+ and Cl^- ions in NaCl. The following shows the attraction of Na+ and Cl^- ions with water molecules.



Interaction of sodium chloride and water

Now it is concluded that if there is more attraction between solute-solvent attractions in comparison with solute-solute interaction, then the solution will be formed. If solute-solute interaction is greater than solute-solvent attraction then solute will not dissolve in a solvent.

Q.22 ***What is the effect of temperature on solubility?***

Ans: ***Effect of Temperature on Solubility:*** Solubility is directly proportional to the temperature in solid and liquid. Solubility is increased by increasing the temperature because hot water molecules have greater kinetic energy and collide with solid solute more vigorously. For example, a greater amount of sugar will dissolve in warm water than in cold water. The solubility of potassium chloride is 34.7g to 100g of water at 20°C. It will become 56.7gm/cm^3 at 100°C.

For all gases, the solubility decreases as the temperature of the solution increases.

Q.23 ***Suppose solute-solute forces are weaker than those of solute-solvent forces. Will a solution be formed?***

Ans: If solute-solute forces are weaker than those of solute-solvent forces then solute dissolves, solution is formed.

Q.24 ***What is the main reason that solute did not dissolve in water?***

Ans: When solute-solute or solvent-solvent interactions are much more than solute-solvent interaction, a solution will not form.

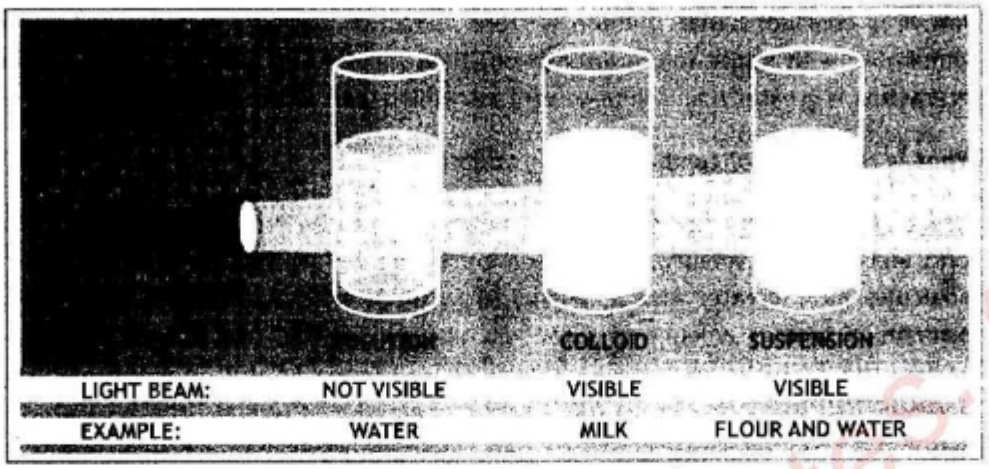
Q.25 ***Define solution, suspension and colloids.***

Ans: When a solute (sugar or table salt) is placed in water after some time sugar or salt completely dissolve in water and we cannot even see the particles of sugar or salt. Now if we repeat the same practice with sand or clay, we won't get the same results. The solution of sugar in water is clear, whereas sand or clay in water is not a clear solution. After some time, sand or clay settles at the bottom and we can see the particles of sand. Now compare these two solutions with milk. Milk is not a clear solution but particles do not settle at the bottom with time. So we can say that particles remain dispersed in solution, but the size is big enough that does not allow the clear appearance of the solution.

Based on particles size and their characteristics, mixtures can be classified as a true solution, colloid and suspension.

Solution: A solution is a homogeneous mixture of two or more components. When we dissolve sugar in water after some time sugar completely dissolve in water and we cannot even see the particles of sugar. Sugar is dissolved into the water and a drop of ink mixed in water is an example of the true solution. The solute particles in true solutions are very tiny so that we cannot see them with naked eyes.

Colloid: In a colloid, the particles are larger than those present in a true solution but smaller than the particles that make up a suspension. Therefore, they will not settle to the bottom of the container and remain dispersed in the medium. The dispersed particles of colloids cannot be separated by filtration, but they scatter the beam of light. This phenomenon is called the Tyndall effect. These solutions are also called false solutions. Milk, butter, jelly, blood are the example of colloidal solution. Few other examples of colloid are fog, smoke and dust particles which are suspended in the air and the beam of light can be easily scattered.



Tyndall Effect by colloid and suspension

Suspension: A suspension is a heterogeneous mixture of solute and solvent in which solute particles do not dissolve. A suspension contains large particles suspended in a liquid. The particles will eventually, slowly settle to the bottom in the absence of agitation. For examples mud in water, chalk in water paints. The solute particles are big enough to be seen with naked eyes and they can scatter light like colloids.

Q.26 ***Which one is a colloidal solution, starch solution or glucose solution?***

Ans: The starch solution is a colloidal solution.

Q.27 ***Justify that milk is a colloidal solution.***

Ans: Milk appears to be a homogeneous mixture; it is a colloid because it has small globules of fat and protein that do not settle out after standing due to the particles (usually negatively) charged particles. These particles repel each other so they do not collect into larger particles that would settle out.

A colloid includes gels, sols, and emulsions; its particles do not settle and cannot be separated by ordinary filtering or centrifuging like those in a suspension. So by that mean milk is a colloid.

Q.28 ***Define false solution.***

Ans: In a false solution, solutes cannot pass through a filter paper and the solution cannot be dialyzed. The false solution can scatter light rays i.e. the false solution exhibits the Tyndall effect.

Colloids are regarded as false solutions - the solutes are not really dissolved in the solvent but appear so to the optical eyes (due to the very tiny size of the solutes particles). The solute particles are actually in suspension but are not large enough to settle to the bottom of the containing vessel, hence, colloids are also not true suspensions.

Q.29 ***Write a note on the importance of solution and their influence in our daily life.***

Ans: ***Importance and Influenced of Solutions in Our Daily Life:*** Solutions have great importance and influence in our daily life. As we look in our surrounding, such as air, soft drinks, beverages, medicines, butter, toothpastes, natural gas and even water are solutions. When we stir sugar in a cup of tea, we are making a solution. Most of the chemical reactions that take place in the bodies of a living organism occur in presence of water as a solvent. The food assimilation process in our bodies also occurs in solution. Brass and steel are also solutions. These solutions are widely used

for making cooking utensils, surgical instruments, cutlery, and many other objects. Silver and tin amalgams are widely used to make the dental filling. The majority of chemical processes are reactions that occur in solution. Gaseous solutions are also used in chemical industries for the preparation of urea, ammonia gas, nitric acid, rubber, vegetable oil etc.

Q.30 ***Define, with an example, one molar solution.***

Ans: A one molar solution is a solution in which one mole of a compound is dissolved in a total volume of one litre.
For Example: The molecular weight of sodium chloride (NaCl) is 58.44, so one gram molecular weight (= 1 mole) is 58.44g. If we dissolve 58.44g of NaCl in a final volume of 1 litre, we have made a 1M NaCl solution.

Differences

1. What is the difference between saturated, unsaturated and supersaturated solution.

Ans: ***The Difference Between Saturated, Unsaturated and Supersaturated Solution***

Saturated Solution	*Unsaturated Solution*	*Supersaturated Solution*
In a saturated solution, the maximum amount of solute can be dissolved at a particular temperature.	In an unsaturated solution, more amount of solute can be dissolved at a particular temperature.	In supersaturated solution, more amount of solute has been dissolved than its maximum capacity.
The solution has high concentration than an unsaturated solution.	The solution has low concentration than a saturated solution.	The solution has more concentration than a saturated solution.
There is no formation of precipitation at the bottom of the container.	There is also no precipitation at the bottom of the container.	There is a formation of precipitation at the bottom of the container.
A solution having 20.9 gram of sodium sulphate per 100 cm^3 of water at 20°C is an example of saturated solutions.	A solution having an amount of salt less than 20.9 gram of sodium sulphate per 100 cm^3 of water at 20°C is an example of unsaturated solutions.	A solution having more amount than 20.9 gram of sodium sulphate per 100 cm^3 of water at 20°C is an example of supersaturated solutions.

2. Write the difference between diluted and concentrated solution.

Ans: ***Difference Between Diluted and Concentrated Solution***

Concentrated Solution	*Dilute Solution*
A liquid with a high solute concentration is called a concentrated solution.	A liquid with a less solute concentration is called a dilute solution.
The solution becomes more concentrated as more solute is applied to a solution.	The dissolved salt from a well in the drinking water is a dilute solution.
There is a significant amount of water in a concentrated solution.	By adding more water, the concentration of a solution can be further decreased and diluted.

3. *Write the comparison and differences between solution, suspension and colloid.*

Ans:

Solution	Suspension	Colloid
Particle size less than 1nm	Particle size greater than 1000nm	Particle size 1 to 100nm
Homogeneous (particles dissolve uniformly)	Heterogeneous (particles settle down after sometimes)	Homogeneous and Heterogeneous (particles do not settle down for a long time)
Particles can not be distinctly seen with the naked eye	Particles are big enough but can be seen with naked eyes	Colloidal particles can not be seen with the naked eye but can be seen through ultra microscope
Clear, transparent and homogeneous	Cloudy, but uniform and homogeneous	Cloudy, heterogeneous, at least two substances visible
Transparent but often colored	Translucent and often opaque but can be transparent	Often opaque, but can be transparent
Cannot be separated	Cannot be separated	Can be separated easily
Do not scatter light	Scatter light, but are not transparent	Scatter light (Tyndall effect)
Particles can pass through filter paper	Particles pass through filter paper	Particles do not pass through filter paper

Reasons

1. *Why benzene does not dissolve in water?*

Ans: Benzene is insoluble in water because

(i) Benzene is a symmetrical compound and thus it has zero dipole moment and is non-polar, while water is a polar compound possessing dipole moment.

(ii) When benzene is mixed with water, the molecular attraction will be more and benzene won't be able to interfere with the water molecules. Hence, it is insoluble in water.

(iii) Both the carbon and hydrogen in benzene are equidistant and hence the net charge is balanced. Because of the ring structure, the net dipole moment is zero.

(iv) Hence, mixing the charged liquid and uncharged liquid is not possible which fails.

2. *Paint is a colloidal solution. Give reason.*

Ans: Paints are a type of mixture called a colloid. In a colloid, particles of one substance are mixed and dispersed with particles of another substance- but they are not dissolved in it. In the paint the liquid is dispersed into the liquid, to form a binding medium ad solvent solution.

3. *Why sugar solution does not scatter the light?*

Ans: Sugar solution is a true solution where sugar particles are completely dissolved in water and hence do not scatter light.

4. *Why does the colloidal show the Tyndall effect?*

Ans: The particles of colloids are big enough to scatter the beam of light. That's why they show the Tyndall effect.

5. *Polar and ionic solutes dissolve in polar solvents only.*

Ans: Like dissolves like Polar solutes and ionic solutes dissolve in polar solvents because of the attraction of oppositely charged ions which results in the dissolution of the solute in the solvent.
e.g. NaCl in water.

6. ***A polar solute does not dissolve in a non-polar solvent.***

Ans: The solvent particles are non-polar and thus have little attraction for the solute particles. In addition, the solute particles are polar and are attracted to each other. Again, solution to any extent is unlikely. It means that no solution is formed.

7. ***Why gasoline does not dissolve in water?***

Ans: Gasoline is a non-polar molecule and water is a polar molecule. Since polar dissolves polar and non polar dissolves non-polar therefore there will be no attraction between the two types of molecules allowing them to be mixed.

Section D Numericals:

Solved Examples of the Textbook

Example 6.1: How do you prepare 100ml of 0.40M $MgSO_4$ from a stock solution of 2.0M $MgSO_4$?

Solution:

Data: $M_1 = 2.0M\ MgSO_4$ $M_2 = 0.40M\ MgSO_4$

$V_2 = 100ml$ $V_1 = ?$

Concentrated Solution = Dilute Solution

$$M_1V_1 = M_2V_2$$

$$2 \times V_1 = 0.40 \times 100$$

$$V_1 = \frac{0.4 \times 100}{2} = 20cm^3$$

Transfer $20cm^3$ of 2 M $MgSO_4$ to a $100cm^3$ measuring flask and dilute it by adding water up to the marks. It is a 0.40M solution of $MgSO_4$.

Example 6.2: How would you prepare 500 cm^3 of 0.20 M NaOH (aq) from a stock solution of 1.5 M NaOH?

Solution:

Data: $M_1 = 1.5M\ NaOH$ $M_2 = 0.2M\ NaOH$

$V_2 = 500cm^3$ $V_1 = ?$

Concentrated Solution = Dilute Solution

$$M_1V_1 = M_2V_2$$

$$1.5 \times V_1 = 0.20 \times 500$$

$$V_1 = \frac{0.20 \times 500}{1.5}$$

$$= 66.67\ cm^3$$

Take 66.67 cm^3 of concentrated NaOH and place in a measuring flask and dilute it by adding water up to the mark. It will become a 0.2M solution of NaOH.

Example 6.3 (Percent by Mass): Calculate the percentage concentration (m/m) of the solution obtained by dissolving 15g salt in 110g water.

Solution: Mass of salt = 15g Mass of water = 110g

Mass % of salt = ?

Total mass of solution = 15g salt + 110g water = 125g

Percent by mass would be calculated as:

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

$$= \frac{15}{125} \times 100 = 12\%$$

Thus the concentration of a solution is 12% by mass.

Example 6.4 (Percent by Volume): **Calculate the volume/volume percent of the solution obtained by mixing 25cm^3 of ethanol in water to produce 150cm^3 of the solution.**

Solution: Volume of solute = 25 cm^3 Volume of solution = 150 cm^3
Volume/volume percent = ?

$$\text{Percent of the solution } \left(\frac{V}{V}\right) = \frac{\text{Volume of Solute (cm}^3\text{)}}{\text{Volume of Solution (cm}^3\text{)}} \times 100$$

$$= \frac{25}{150} \times 100 = 16.7\%$$

Thus the concentration of a solution is 16.7% by volume.

Problems Based on Molarity of a Solution

Example 6.5: **20 gram of salt is dissolved in 500cm^3 of a solution. Calculate the molarity of that solution.**

Data: Mass of solute = 20g Molar mass of NaCl = 23 + 35.5 = 58.5g/mol
Volume of solution = 500cm^3 Molarity (M) = ?

Formula:
$$\text{Molarity} = \frac{\text{Mass of solute}}{\text{Molar mass of solute (g)}} \times \frac{1000}{\text{Volume of Solution (cm}^3\text{)}}$$

Solution:
$$\text{Molarity} = \frac{20\text{g}}{58.5\text{g/mol}} \times \frac{1000}{500}$$

Molarity = 0.683 mole / dm^3

Example 6.6: **What is the mass of oxalic acid present in 100 cm^3 of 2 molar solution?**

Data: Molarity = 2 mol/dm^3 Volume in cm^3 = 100
Molar mass of oxalic acid ($C_2H_2O_4$) = (12 × 2) + (2 × 1) + (16 × 4)
= 24 + 24 + 64 = 90g/mol
Mass of solute = ?

Formula:
$$\text{Molarity} = \frac{\text{Mass of solute}}{\text{Molar mass of solute (g)}} \times \frac{1000}{\text{Volume of solution (cm}^3\text{)}}$$

Solution:
$$2 = \frac{\text{Mass of solute}}{90} \times \frac{1000}{100}$$

$$\text{Mass of solute} = \frac{2 \times 90 \times 100}{1000} = 18\text{gm}$$

Example 6.7: **A sample of sulphuric acid has the molarity 20M. How many cm^3 of solution should you use to prepare 500 cm^3 of 0.5M H_2SO_4?**

Solution: M_1 = Molarity of given H_2SO_4 = 20M
M_2 = Molarity of required H_2SO_4 = 0.5M
V_2 = Volume required in H_2SO_4 on = 500 cm^3
V_1 = volume of concentrated solution needs to be diluted = ?

$$M_1V_1 = M_2V_2$$

$$V_1 = \frac{M_2V_2}{M_1} = \frac{0.5 \times 500}{20}$$

12.5cm^3 of 20M is used to make a 500cm^3 aqueous solution to form 0.5M H_2SO_4.

Solved Numericals

1. ***Consider two beakers A and B. Each one having 20ml of water. Add 10g of sodium thiosulphate in beaker A and 20g in beaker B and stir carefully. Answer the following questions:***

(a) Which beaker's solution is saturated?

Ans: B

(b) How can be supersaturated solution prepared from the above experiment?

Ans: By heating beaker B, it develops the further capacity to dissolve more amount of sodium thiosulphate. This solution contains a greater amount of solute than that present in a saturated solution and the solution become more concentrated.

(c) Which beaker's solution is unsaturated?

Ans: A

(d) How is an unsaturated solution prepared?

Ans: Adding more water in beaker B makes it unsaturated.

2. ***10M HNO_3 solution is available in laboratory. How would you prepare 500cm^3 of 0.1M solution?***

Solution: ***Data:*** M_1 = 10M HNO_3 M_2 = 0.1 HNO_3

$V_2 = 500cm^3$ $V_1 = ?$

Concentrated Solution = Dilute Solution

$$M_1V_1 = M_2V_2$$

$$10 \times V_1 = 0.1 \times 500$$

$$V_1 = \frac{0.1 \times 500}{10}$$

$$= 5\ cm^3$$

Take 5 cm^3 of concentrated HNO_3 and place it in a measuring flask and dilute it by adding water up to the mark. It will become a 0.1M solution of HNO_3.

3. ***A solution of NaOH has a concentration of 1.2M, calculate the mass of NaOH in g/dm^3 in this solution.***

Solution: ***Data:*** Molarity = 1.2 M Volume of solution = 1 dm^3

Molar mass of NaOH = 23 + 16 + 1 = 40g/mol Mass of NaOH = ?

Calculation:

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

$$1.2 = \frac{\text{Mass of NaOH}}{40} \times \frac{1}{1}$$

Mass of NaOH = 1.2 × 40 × 1 = 48 g

4. ***Determine the percentage concentration of the solution obtained by dissolving 10g sugar in 140g water.***

Solution: ***Data:*** Sugar dissolves = 10g Mass of Water = 140g

Total mass of the solution = 140g + 10g = 150g

Calculation:

Therefore,

$$\text{mass by mass percentage of the solution} = \frac{\text{Mass of the solute}}{\text{Total mass of the solution}} \times 100$$

$$= \frac{10}{150} \times 100 = 6.66\ \%$$

5. ***A student asked to prepare a 10 % (m/m) solution of sugar. How much solvent will be required to prepare this solution?***

Solution: ***Data:*** mass by mass percentage of the solution = 10%

Mass of the solvent = ?

Calculation: Total mass of the solution = 10g + 90g = 100g

Mass of the solvent = 90 g

6. ***What is the molarity of the solution prepared by dissolving 1.25 g of HCl gas into enough water to make 30 cm³ of the solution?***

Solution: *Data:* Mass of solute = 1.25g Molar mass of HCl = 1 + 35.5 = 36.5g/mol

Volume of solution = 30cm³ Molarity (M) = ?

Formula:

$$\text{Molarity} = \frac{\text{Mass of solute}}{\text{Molar mass of solute (g)}} \times \frac{1000}{\text{Volume of Solution (cm}^3\text{)}}$$

Calculation:

$$\text{Molarity} = \frac{1.25\text{g}}{36.5\text{g/mol}} \times \frac{1000}{30}$$

Molarity = 1.14 mole / dm³

7. ***A solution of potassium chloride was prepared by dissolving 2.5 g of potassium chloride (KCl) in water and making the volume up to 100 cm³. Find the concentration of the solution in mol/dm³.***

Solution: *Data:* Mass of solute = 2.5 g

Molar mass of KCl = 39.09 + 35.5 = 74.59 g/mol

Volume of solution = 100 cm³

Calculation: We know that

$$\text{Molarity} = \frac{\text{Mass of solute}}{\text{Molar mass of solute (g)}} \times \frac{1000}{\text{Volume of Solution (cm}^3\text{)}}$$

$$\text{Molarity} = \frac{2.5\text{g}}{74.59\text{g/mol}} \times \frac{1000}{100} = 0.335 \text{ mole/dm}^3$$

For most analytical and calculation purposes the concentration of an aqueous solution is usually expressed in terms of moles of dissolved substance per cubic decimetre of solution. 1 cubic decimetre(dm³) = 1 litre (l)

concentration = molarity = moles of solute / volume of solvent

8. ***A flask contains 0.25 M NaOH solution. What mass of NaOH is present per dm³ of the solution?***

Ans: *Data:* Molarity of NaOH = 0.25 M = 0.25 mol NaOH/l

Mass of NaOH = ?

Calculation:

$$\text{Molarity} = \frac{\text{moles of solute}}{\text{liters of solution}}$$

We know that mass = moles (n) × molar mass (M)

Therefore, n of NaOH = 0.25 mol

M of NaOH = 23 + 16 + 1 = 40 g/mol

m of NaOH = 0.25 mol × 40 g/mol = 10 g NaOH

9. ***What volume of 0.5M acid is needed to neutralize 200ml of 4M base?***

Ans: As we know, molarity is defined as the number of moles of solute present in 1 L of solution.

Now, notice that the base, which has a molarity of 4 M, is

$$\frac{4\text{ M}}{0.5\text{ M}} = 8$$

times more concentrated than the acid solution, which has a molarity of 0.5 M. In other words, for the same volume of both solutions, the base solution contains 8 times more moles of solute than the hydrochloric acid solution.

This means that to have equal numbers of moles of both solutes, we need to have a volume of acid solution that is 8 times bigger than the volume of the base solution.

Since the base solution has a volume of 200 ml, it follows that the volume of the acid needed will be

$V_{acid} = 8 \times 200 \text{ ml} = 1600 \text{ ml}$

10. ***A mineral water bottle contains 28 mg of calcium in 100 cm^3 of solution. What is the concentration in g/dm^3?***

Solution: ***Data:*** Mass of solute = 28 mg = $\frac{28}{1000}$ g = 0.028 g

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

Calculation: Concentration in g/dm^3 = $\frac{\text{Mass of solute in gram}}{\text{Volume of solution in } dm^3}$

= $\frac{0.028}{0.1}$ = 0.28 g/dm^3

11. ***A solution of 20 cm^3 of alcohol is dissolved in 80cm^3 of water. Calculate the concentration (v/v) of this solution.***

Solution: ***Data:*** Volume of solute = 20 cm^3 Volume of solution = 80 cm^3

Volume/volume percent = ?

Percent of the solution $(\frac{V}{V})$ = $\frac{\text{Volume of Solute } (cm^3)}{\text{Volume of Solution } (cm^3)} \times 100$

= $\frac{20}{80} \times 100$ = 25%

Thus the concentration of a solution is 25% by volume.

12. ***How much sodium hydroxide (NaOH) is required to prepare 400 cm^3 of 0.3M solution?***

Solution: ***Data:*** Molarity = 0.3 mol/dm^3 Volume in cm^3 = 400

Molar mass of sodium hydroxide (NaOH) = 23 + 16 + 1 = 40 g/mol

Mass of solute = ?

Formula: Molarity = $\frac{\text{Mass of solute}}{\text{Molar mass of solute (g)}} \times \frac{1000}{\text{Volume of solution } (cm^3)}$

Solution: $0.3 = \frac{\text{Mass of solute}}{40} \times \frac{1000}{400}$

Mass of solute = $\frac{0.3 \times 40 \times 400}{1000}$ = 4.8 gm

Summary

- A solution is a homogeneous mixture of two or more substances.
- The substance which is dissolved is called the solute.
- The substance in which the solute is dissolved is called a solvent.
- The solution is a single-phase homogeneous mixture of solute and solvent.
- The component of a solution which is present in a small quantity and can be dissolved in the solvent is called "solute".
- Component of solution which is present in large quantity and it can dissolve solute is called "solvent".
- The aqueous solution is a type of solution, in which water used as a solvent.
- In an unsaturated solution, the amount of solute is less than its original capacity to dissolve.
- In a saturated solution maximum amount of solute dissolves in a solvent according to their capacity.
- In a super saturated solution, the capacity to dissolve the solute is increased by increasing the temperature.
- A solution has nine types based on the nature of solute and solvent. A solute may be solid, liquid and gas. If the solution is in liquid so it is considered a true solution.
- A dilute solution has a small amount of solute in a large amount of solvent.

- A concentrated solution has a large amount of solute in a small amount of solvent.
- We can dilute the solution by the formula. $M_1V_1 = M_2V_2$.
- The proportion of solute in a solution is called concentration.
- Molarity is defined as the number of moles dissolved in a dm^3 of the solution. Those solutions whose concentration is expressed in molarity are called a molar solution.
- Percent solution is based on the mass and volume of the components of solute and solvent.
- The quantity of solute and solvent may be increase or decrease according to the percentage of the solution. Percent solution has four types.
- Solubility is defined as the amount of solute dissolved in 100g of solvent. The main factors which affect the solubility are temperature, pressure and nature of solute and solvent.
- The nature of solute and solvent obey the principle of" like dissolves like".
- A heterogeneous mixture containing undissolved particles large enough to be seen with naked eyes is called suspension.
- In colloidal solutions, solute particles are larger than those present in the true solution but not large enough to be seen by naked eyes. They are also called a false solution.

Solution of Textbook Exercise

SECTION-A: MULTIPLE CHOICE QUESTIONS

Tick Mark (✓) the correct answer:

See "Multiple Choice Questions (M.C.Qs)" - (1) to (14)

(xv) Write the example of each type of solution.

Solute	*Solvent*	*Example*
Solid	Liquid	
Gas	Gas	
Solid	Solid	
Liquid	Solid	
Liquid	Gas	
Liquid	Liquid	

Ans: See 'Short & Detailed Answer Questions" - Q.12

SECTION-B: SHORT QUESTIONS:

1. Explain the solute-solvent interaction to prepare sodium chloride solution.

Ans: See "Short & Detailed Answer Questions" - Q.21

2. Differentiate between the saturated and unsaturated solution.

Ans: See "Differences" - Q.1

3. Define solution and explain the major components of a solution.

Ans: See "Short & Detailed Answer Questions" - Q.1, 3 & 4

4. What do you mean by mass/volume percent?

Ans: See "Short & Detailed Answer Questions" - Q.14 (ii)

5. Define with example one molar solution.

Ans: See "Short & Detailed Answer Questions" - Q.30

6. Why does colloidal show the Tyndall effect?

Ans: See "Reasons" - Q.4

7. Define the terms: (i) Dilution (ii) Concentration (iii) Solubility (iv) Molarity

Ans: *(i)* See "Short & Detailed Answer Questions" - Q.10
(ii) See "Short & Detailed Answer Questions" - Q.13
(iii) See "Short & Detailed Answer Questions" - Q.19
(iv) See "Short & Detailed Answer Questions" - Q.15

8. *Polar and ionic solutes dissolve in polar solvent only. Why?*
Ans: See "Reasons" - Q.5
9. *Why does Polar solute not dissolve in nonpolar solvent?*
Ans: See "Reasons" - Q.6
10. *How are solutions beneficial for the community?*
Ans: See "Short & Detailed Answer Questions" - Q.29
11. *Why salt dissolves in water?*
Ans: See "Short & Detailed Answer Questions" - Q.21
12. *Air is a solution containing oxygen, carbon dioxide, nitrogen and other gases. Which one of the gas is called the solvent and why?*
Ans: See "Short & Detailed Answer Questions" - Q.8
13. *Why gasoline does not dissolve in water?*
Ans: See "Reasons" - Q.7

SECTION-C: DETAILED QUESTIONS:

1. *Describe how to prepare dilute solution from the concentrated solution.*
Ans: See "Short & Detailed Answer Questions" - Q.11
2. *Define the term solubility. How does the nature of solute and solvent determine the extent of dissolution?*
Ans: See "Short & Detailed Answer Questions" - Q.19 & Q.21
3. *Why the solubility of salt increases with the increase in temperature?*
Ans: See "Short & Detailed Answer Questions" - Q.22
4. *Explain the attraction of Na^+ and Cl^- ions for a water molecule.*
Ans: See "Short & Detailed Answer Questions" - Q.21
5. *Explain the solubility with reference to the "like dissolve like" principle.*
Ans: See "Short & Detailed Answer Questions" - Q.20
6. *What is the difference between solution, colloids and suspension?*
Ans: See "Short & Detailed Answer Questions" - Q.25
See "Differences" - Q.3

SECTION-D: NUMERICAL

1. *What is the molarity of the solution prepared by dissolving 1.25 g of HCl gas into enough water to make 30 cm^3 of the solution?*
Ans: See "Solved Numericals" - Q.6
2. *A solution of potassium chloride was prepared by dissolving 2.5 g of potassium chloride (KCl) in water and making the volume up to 100 cm^3. Find the concentration of the solution in mol/dm^3.*
Ans: See "Solved Numericals" - Q.7
3. *A flask contains 0.25 M NaOH solution. What mass of NaOH is present per dm^3 of the solution?*
Ans: See "Solved Numericals" - Q.8
4. *What volume of 0.5M acid is needed to neutralize 200ml of 4M base?*
Ans: See "Solved Numericals" - Q.9
5. *A mineral water bottle contains 28 mg of calcium in 100 cm^3 of solution. What is the concentration in g/dm^3?*
Ans: See "Solved Numericals" - Q.10
6. *A solution of 20cm^3 of alcohol is dissolved in 80cm^3 of water. Calculate the concentration (v/v) of this solution.*
Ans: See "Solved Numericals" - Q.11
7. *How much sodium hydroxide (NaOH) is required to prepare 400 cm^3 of 0.3M solution?*
Ans: See "Solved Numericals" - Q.12