

Chemistry



9th Class

Sindh Board Notes

Chapter # 7

Solution And Suspension



Solved MCQs

پنجاب، سندھ، بلوچستان، خیبر پختونخواہ، بورڈز کے تمام نوٹس سابقہ پیرز، اس ویب سائٹ سے فری ڈاؤنلوڈ کریں۔

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➔ SOLUTION & SUSPENSION

7.1 SOLUTION

Q.1: Define the following terms.

- | | | |
|----------------------|---------------|--------------|
| i. Solution | ii. Solute | iii. Solvent |
| iv. Aqueous Solution | v. Solubility | |

Ans: SOLUTION:

Definition:

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

Example:

10% glucose solution in water.

SOLUTE:

Definition:

The component of solution present in smaller amount is called solute.

OR

The substance which is dissolved is called solvent.

Example:

Glucose is solute in Glucose solution.

SOLVENT:

Definition:

The component solution present in greater quantity is called solvent.

OR

The substance in which solute is dissolved is called solvent

Example:

Water is solvent in Glucose solution.

AQUEOUS SOLUTION:

Definition:

When water is solvent, the solution is called aqueous solution.

Example

Sugar solution, sodium chloride solution, etc.

SOLUBILITY:**Definition:**

The solubility is defined as the amount of solute dissolved at room temperature in 100 grams of the solvent.

Example:

It is expressed in grams/100ml or grams/100grams.

The solubility of sugar in water at 100C is 487 grams/100ml.

Q.2: What are the types of solution?**Ans: TYPES OF SOLUTION:**

Matter exists in three states i.e. solid, liquid and gas. On mixing these three states produce types of solutions which are given below.

Solute	Solvent	Example
Gas	Gas	Air (Mixture of 78% N ₂ , 21 % O ₂ and 1 % other gases)
Gas	Liquid	Carbonated soft drinks such as coca-cola, Bubble-up etc. NH ₃ gas in water, and air dissolved in water.
Gas	Solid	H ₂ gas adsorbed over palladium metal.
Liquid	Gas	Cloud (water vapors in air), steam.
Liquid	Liquid	Alcohol in water, water in milk, milk in tea, vinegar (acetic acid in water)
Liquid	Solid	Amalgam (e.g. Mercury in sodium), and water in jelly powder.
Solid	Gas	Smoke (carbon particles in air)
Solid	Liquid	Sugar in water, sea water
Solid	Solid	Alloys such as brass (copper and zinc) bronze (copper and tin), steel (carbon and iron) glass.

7.2 FACTORS AFFECTING SOLUBILITY

Q.3: Discuss the factor affecting the solubility?**Ans: FACTORS AFFECTING SOLUBILITY:**

Many factors affect the solubility of a solute in a solvent. These factors may be.

➤ Temperature.

- Pressure (For gases)
- Nature of solute.
- Nature of solvent.

SOLUBILITY AND TEMPERATURE:**Solubility Of Solid In Liquid:**

The Solubility of a solid in liquid or solubility of partially miscible liquids increases with increase in temperature. Thus solubility of sugar in water at 0°C is 179 g/ 100ml whereas at 100°C it is 487 g/ 100 ml.

Solubility Of Gases In Liquid:

The solubility of gases in a liquid decreases with the increase in temperature. For this reason when a glass of cold water is warmed, bubbles of air are seen on the inside of the glass.

SOLUBILITY AND PRESSURE:**Solubility Of Solids And Liquids:**

The solubility of solids and liquids are not affected by pressure.

Solubility Of A Gas In A Liquid:

The solubility of a gas in a liquid is directly proportional to the pressure of gas. This is called Henry's law.

$$\begin{aligned} m &\propto P \\ \text{or} \\ m &= KP \end{aligned}$$

Where m is the amount of gas dissolved.

Example:

This effect is used in manufacture of bottled soft-drinks as coca-cola; 7-up etc. these are bottled under a CO₂ pressure slightly greater than 1 atm. When the bottles are opened, pressure decreases, so solubility of CO₂ also decreases, hence bubbles of CO₂ comes out of solution.

SOLUBILITY AND NATURE OF SOLUTE AND SOLVENT:

Solute and solvent may be polar (as HO₂; Alcohol) and non-polar (as benzene, carbontetrachloride). Polar and ionic solutes easily dissolve in polar solvents whereas non-polar solute easily dissolve in non-polar solvents. Hence it is said that like dissolves like.

Example:

Common salt (NaCl) being an ionic compound easily dissolves in polar solvent like water but is insoluble in non-polar solvent like benzene or petrol.

7.2 UNSATURATED, SATURATED AND SUPER SATURATED SOLUTIONS

Q.4: Discuss the following types of solution.

- i. Unsaturated solution
- ii. Saturated solution
- iii. Super saturated solution

Ans: **UNSATURATED SOLUTION:**

Definition:

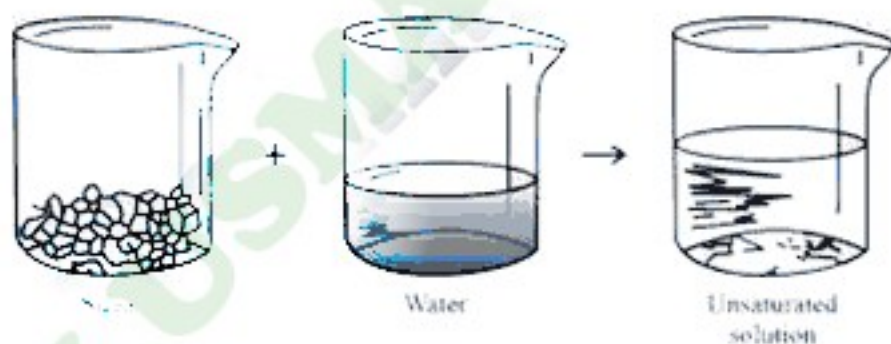
An unsaturated solution is that one which contains less solute than it has the capacity to dissolve. If more solute is added, at least some of it will dissolve.

OR

An unsaturated solution is the solution that can no more solute at a particular temperature.

Preparation Of Unsaturated Solution:

Take few crystals of sugar and dissolve them in a glass of water. This results in an unsaturated solution, because the solution has a capacity to dissolve more crystals of sugar (solute) at a given temperature.



SATURATED SOLUTION:

Definition:

A saturated solution is that one which contains maximum amount of solute in a given solvent at room temperature.

No more solute can dissolve in it and there is a dynamic equilibrium between the undissolved and dissolved solute.

OR

A saturated solution is that solution which contains less amount of solution than required to saturate it at that temperature.

Preparation Of A Saturated Solution:

Take some water, in a beaker. With constant stirring, add crystals of sugar, till they do not dissolve and start to settle down. The solution thus obtained is saturated solution of sugar, at room temperature.

SUPERSATURATED SOLUTION:**Definition:**

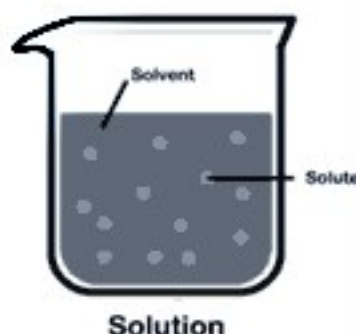
A supersaturated solution is that which contains greater amount of dissolved solute than that present in a saturated solution at the given temperature.

OR

A solution that is more concentrated than a saturated solution is called super saturated solution.

Preparation Of Super Saturated Solution:

Preparation of super saturated solution is required for crystallization. To prepare the super saturated solution greater amount of solute is dissolved in solvent at high temperature, it is allowed to cool down, then at lower temperature it cannot hold more solute in dissolved state.



7.3 CRYSTALLIZATION

Q.5: Define crystallization and preparation of crystals of copper sulphate and potassium nitrate?

Ans: CRYSTALLIZATION:

Definition:

The process in which dissolved solute comes out of solution in the form of crystals is called crystallization.

PREPARATION OF CRYSTALS OF COPPER SULPHATE ($\text{CuSO}_4 \cdot 5\text{H}_2\text{O}$)**➤ Preparation Of Saturated Solution:**

Prepare a saturated solution of copper sulphate in water at room temperature using a beaker.

➤ Heating:

Heat the saturated solution and try to dissolve some more quantity of copper sulphate while stirring the solution with glass rod.

➤ Cooling Of Filtrate:

Allow the super saturated solution of copper sulphate to cool down at room temperature.

➤ **Crystal Formation:**

Upon cooling and standing, crystals of $\text{CuSO}_4 \cdot 5\text{H}_2\text{O}$, i.e., blue vitriol will form.

➤ **Separation Of Crystals By Filtration:**

Filter out the crystals and observe the shape of crystals under a light microscope.

PREPARATION OF CRYSTALS OF POTASSIUM NITRATE (KNO_3):

➤ **Preparation Of Saturated Solution:**

Take 100 ml water in a beaker. Prepare a saturated solution of KNO_3 by dissolving 37g of solute at room temperature by means of stirring with glass rod.

➤ **Heating:**

Now heat this saturated solution to 50°C and dissolve 20g of additional KNO_3 while stirring the solution.

➤ **Filtration:**

Filter the hot super saturated solution quickly and collect the filtrate in another beaker.

➤ **Cooling:**

Cool the filtrate to room temperature.

➤ **Crystal Formation:**

Upon cooling crystals of KNO_3 are formed.

➤ **Separation Of Crystals By Filtration:**

Filter out the crystals and observe their shape under light microscope.

Q.6: Describe the purification of solids by crystallization?

Ans: PURIFICATION OF SOLIDS BY CRYSTALLIZATION:

Types Of Impurities:

An impure solid contains two types of impurities.

➤ **Soluble Impurity:**

It remains in soluble form at room temperature.

➤ **Insoluble Impurity:**

It is totally insoluble in the solvent even at boiling temperature.

A compound containing such two types of impurities could be easily removed by means of crystallization.

PURIFICATION OF IMPURE SAMPLE OF KNO_3 BY CRYSTALLIZATION:

42g impure sample of KNO_3 contains a small quantity of sand and NaCl . To obtain pure KNO_3 crystalline KNO_3 following techniques are used.

PROCEDURE:**➤ Preparation Of Solution:**

Take 50ml of water in a beaker and add the impure sample (40g) of KNO_3 to it while stirring with glass rod.

➤ Heating:

Supply heat gently till the temperature of the solution is above 50°C . Stir the solution at this temperature till most of the solid is dissolved.

➤ Filtration Of Hot Solution:

Filter the hot solution and collect the filtrate in a beaker. Sand being insoluble in water will be removed and collected on the filter paper.

➤ Formation Of Crystals On Cooling:

Upon cooling of the filtrate, crystals of KNO_3 will start appearing.

➤ Filtration For Collecting Crystals:

When no further crystals are formed, filter it again and collect the filtrate in a beaker.

RESULT:

- Purified crystals of KNO_3 are obtained on the filter paper.
- The filtrate will contain some quantity of the dissolved KNO_3 along with the NaCl , being a soluble impurity.

7.3 STRENGTHS OF A SOLUTION

Q.7: Define strength or concentration and describe common methods of expressing the concentration of a solution.

Ans: STRENGTH OR CONCENTRATION

Definition:

The strength (concentration) of a solution means the mass or volume of the solute present in known amount of solvent or solution.

METHODS OF EXPRESSING THE STRENGTH

- Molarity (M)
- Molality (m)
- Mole fraction (X)
- Percentage (%)
- Normality (N). It is not used in these days.

MOLARITY (M):**Definition:**

It is defined as the number of moles of solute dissolved in 1 litre (1 dm³) of a solution.

Symbol:

It is denoted by M.

Example:

Thus, 1 mole of NaOH (i.e. its gram formula mass) 40 g dissolved in 1 litre (1 dm³) of solution is said to be 1 molar (1M) solution. If only half of the mole i.e. 20g of NaOH is dissolved in one litre (1 dm³) of solution, the solution is said to be one-half molar (i.e. 0.5M).

Formula:

The molarity of any solution is found by dividing the number of moles of solute by the number of litres of solution.

$$\text{Molarity} = \frac{\text{Moles of solute}}{\text{Litre of solution or dm}^3 \text{ of solution}}$$

We know that

$$\text{Number of moles} = \frac{\text{Given mass of solute}}{\text{Gram formula mass of solute}}$$

$$\text{Litres of solution} = \frac{\text{mls of solution}}{1000}$$

Thus,

$$\text{Molarity(M)} = \frac{\text{Mass of solute}}{\text{Gram formula mass of solute}} \times \frac{1000 \text{ cm}^3(\text{ml})}{\text{ml}(\text{cm}^3) \text{ of solution}}$$

MOLALITY (m):**Definition:**

It is defined as the number of moles of solute dissolved per 1000g (1kg) of solvent, it is denoted by (m).

Example:

Thus 1mole of Na₂ CO₃ (i.e. its gram formula mass) 106g dissolved in 1000g of solvent is said to be 1 molal (1m) solution. If only half of the mole i.e. 53g of Na₂CO₃ is dissolved in 1000g of solvent, the solution is said to be one-half molal (i.e. 0.5m).

Formula:

The molality of a solution is found by the following formula.

$$\text{Molarity} = (M) = \frac{\text{Mass of solute} \times 1000\text{g}}{\text{Gram formula mass of solute} \times \text{grams of solvent}} \text{ or } \frac{\text{No. Moles of solute}}{\text{Kg of solvent}}$$

MOLE FRACTION (X):**Definition:**

Mole fraction (X) of any component in a solution is the number of moles of the component divided by total number of moles making up a solution. It is denoted by X.

Formula:

$$X_{\text{solute}} = \frac{\text{No. of moles of solute}}{\text{Total moles of solute and solvent in the solution}}$$

Example:

For example, a solution is prepared by dissolving 1 mole of ethyl alcohol $\text{C}_2\text{H}_5\text{-OH}$ in 3 moles of water (H_2O), where n_A and n_B represent the number of moles of ethyl alcohol and water respectively.

$$\text{Mole fraction of ethyl alcohol} = X_A = \frac{N_A}{n_A + n_B} = \frac{1}{1 + 3} = \frac{1}{4} = 0.25$$

$$\text{Mole fraction of water} = X_B = \frac{N_B}{n_A + n_B} = \frac{3}{1 + 3} = \frac{3}{4} = 0.75$$

Result:

$$\text{Mole fraction of ethyl alcohol} = X_A = 0.25$$

$$\text{Mole fraction of water} = X_B = 0.75$$

Note, that sum of the mole fractions is equal to 1.

$$\text{Mole fraction of ethyl alcohol} = 0.25$$

$$\text{Mole fraction of water} = 0.75$$

$$\text{Sum of the mole fractions} = 1.00$$

REMEMBER:

The mole fraction is dimensionless quantity that expresses the ratio of the number of moles of one component to the number of moles of all components present. The sum of mole fractions of all components of a solution must equal 1.

PERCENTAGE (%):

Percent concentration is based on mass (M) and volume (V) of the components solute and solvent in the solution. There are four different components of solute and solvent in the solution. There are four different ways in which percentage concentration can be expressed.

$$\text{Percentage in } \frac{M}{M} = \frac{\text{Mass}}{\text{Mass}} \%$$

- Percentage in $\frac{M}{V} = \frac{\text{Mass}}{\text{Vol.}} \%$
- Percentage in $\frac{V}{M} = \frac{\text{Vol.}}{\text{Mass}} \%$
- Percentage in $\frac{V}{V} = \frac{\text{Vol.}}{\text{Vol.}} \%$

Examples:

- % M/M solution means 5g solute in 95g solvent.
- 10% M/V solution means 10g solute in 100cm³ solution.
- 5% V/M solution means 5cm³ solute in 100g solution.
- 15% V/V solution means 15cm³ solute in 85 cm³ solvent

7.4 SUSPENSION

Q.8: What is suspension? Give example.

Ans: SUSPENSION

Definition:

Suspension is defined as a heterogeneous mixture consists of visible particles, each of which contains many thousands or even millions of molecules, surrounded by molecules of liquid.

Explanation:

In suspension the solute particles are not soluble in solvent and can be removed by filtration because the solute particles are big enough to pass from the pores of filter papers. Suspension is heterogeneous.

Example Of Suspension In Daily Life:

- **Smoke:**
A suspension of the particles of carbon in a gas or air.
- **Mud (slime):**
A suspension of fine particles of solid in small quantity of liquid.
- **Foam (foam):**
A suspension of fine particles of a gas in a liquid.
- **Emulsion:**
A suspension of droplets of one liquid into another in which it is not soluble.

Q.9: Differentiable between saturated and unsaturated solution.

Ans: DIFFERENCE BETWEEN SATURATED AND UNSATURATED SOLUTION:

saturated solution	unsaturated solution
Definition	
A saturated solution which contains maximum amount of solute in a given solvent at room temperature.	An unsaturated solution is that which contains less solute than it has the capacity to dissolve at room temperature.
Further Addition	
No more solute can dissolve in it and there is a dynamic equilibrium between the undissolved and dissolved solute.	If more solute is added at least some of it will dissolve.
Example	
If crystals of sugar are added in some water in a beaker or glass till they do not start to settle down, thus solution obtained is saturated solution.	If crystal of sugar are dissolved in a glass of water the solution obtained is unsaturated solution.

Q.10: Differentiate between solution and suspension?

Ans: DIFFERENCE BETWEEN SOLUTION AND SUSPENSION:

solution	suspension
Size	
The size of particles is between 0.1 to 1nm.	The size of particles is larger than 1000 nm.
Visibility	
Particles cannot be seen with low power microscope.	Particles can be seen by low power microscope.
Mixture	
It is called homogeneous mixture.	It is called heterogeneous mixture.
Settling Particles	
Particles of solution do not settle down	Particles of suspension settle down.
Transparency	
Solution is transparent.	Suspension is not transparent.
Separation Of Components	
Components (solute & solvent) cannot be separated by filtration.	Components (solute & solvent) can be separated by filtration.

Q.11: Define colloidal solution? Give the characteristics of a colloidal solution?

Ans: COLLOIDAL SOLUTION:

Definition:

A solution in which the solute particles do not homogenized with the solution is called a colloidal solution. e.g. white of an egg and starch solution.

CHARACTERISTICS OF A COLLOIDAL SOLUTION

- Particles of a colloidal solution are bigger than the solute particles in a true solution, but invisible to the naked eye.
- The particles of a colloidal solution do not settle down.
- These particles pass through the filter paper, on filtration.

Q.12: Explain why?

- Common salt dissolves in water but not in petrol.
- Cold drinks are bottled under CO_2 pressure greater than 1 atmosphere.
- 100 ml solution of KNO_3 can not hold more than 37gm of KNO_3 in dissolved state.

Ans: EXPLAINING:

- Common salt is soluble in water but not in petrol because like dissolves like. Sodium chloride being an ionic compound easily dissolves in polar solvent like water but insoluble in non polar solvent like petrol.
- Carbon dioxide gas is bottled at more than one atmospheric pressure in carbonated beverages because in this way sufficient amount of CO_2 gas is dissolved in solution. When the bottles are opened, pressure decreases, so solubility of CO_2 also decreases, hence bubbles of CO_2 come out of solution.
- In 100 ml KNO_3 solution, no more than 37g of KNO_3 can dissolve at room temperature, because this amount of potassium nitrate is required in making the saturated solution. In a saturated solution, there exists a dynamic between undissolved and dissolved solute. i.e. as more KNO_3 gets into solution, the K^+ potassium ions and N_3^- nitrate ions combine together to form KNO_3 crystals. So the amount of un-dissolved and dissolved KNO_3 remains constant.

Q.13: Calculate molarity of solution containing 16gm glucose per 300 ml solution?**Ans: THE FORMULA FOR CALCULATING MOLARITY IS GIVEN AS UNDER:**

$$\text{Molarity (M)} = \frac{\text{number of moles of solute}}{\text{Volume of solution in IL}}$$

$$\text{Moles} = \frac{\text{mass of solute in gms}}{\text{grams formula mass of solute}}$$

$$\text{Gram formula mass of glucose} = 6 \times 12 + 12 \times 1 + 6 \times 16 = 180\text{g}$$

$$\text{Moles of glucose} = \frac{16}{180} = \frac{4}{45} = 0.08889 \text{ mole}$$

$$\text{Volume of solution in litre} = \frac{300}{1000} = 0.3 \text{ litre}$$

$$\therefore \text{Molarity} = \frac{\text{No. of moles of glucose}}{\text{vol. of glucose solution in L}}$$

$$\boxed{\text{Molarity} = \frac{0.08889}{0.3} = 0.296 \text{ M}}$$

Q.14: Find the mass of sucrose (Molecular mass = 342) required to be dissolved per 600cm³ solution to prepare a semi-molar solution?

Ans: FROM THE FORMULA OF MOLARITY WE CAN CALCULATE MASS OF SUCROSE REQUIRED AS FELLOWS:

$$\therefore \text{Molarity} = \frac{\text{No. of moles of solute}}{\text{vol. of sol. solution in 1 Litre}}$$

Let the mass of sucrose required = x gm

$$\text{Molarity of solution} = 0.5 \text{ M}$$

$$\text{Vol. of solution in L} = \frac{600}{1000}$$

Putting the values in formula = 0.6 litre

$$\therefore 0.5 = \frac{\text{No. of moles of sucrose}}{0.6}$$

$$\therefore \text{No. of moles of sucrose} = 0.5 \times 0.6 = 0.30$$

Now

$$\text{Mole} = \frac{\text{Amount of required sucrose}}{\text{mol. mass of sucrose}}$$

$$0.3 = \frac{x}{342} = 0.3 \times 342 = 102.6 \text{ gm}$$

$$\boxed{102.6 \text{ gm of sucrose is required}}$$

Q.15: 5.3g of Na₂CO₃ was dissolved in 800g water, calculate the molality of solution?

Ans: THE FORMULA OF MOLALITY IS AS UNDER:

$$\text{Molality (m)} = \frac{\text{moles of solute}}{1000\text{g of solvent}} = \frac{\text{moles of solute}}{\text{Kg of solvent}}$$

Gram formula mass of Na_2CO_3

$$= 2 \times 23 + 1 \times 12 + 3 \times 16$$

$$= 46 + 12 + 48$$

$$= 106 \text{ g}$$

$$\therefore \text{Mole} = \frac{\text{Amount of } \text{Na}_2\text{CO}_3}{\text{gm formula mass of } \text{Na}_2\text{CO}_3}$$

$$= \frac{5.3^1}{106_{20}} = \frac{1}{20} = 0.05$$

$$\therefore \text{Molality (m)} = \frac{0.05}{0.8} = \frac{0.5}{8} = 0.0625 \text{ m}$$

$$\boxed{\text{Molality (m) of } \text{Na}_2\text{CO}_3 \text{ solution} = 0.0625 \text{ m}}$$

Q.16: It is desired to prepare 3 molal solution of sodium hydroxide (NaOH). How much mass of it must be dissolved in 1500g water?

Ans: We can calculate the mass of NaOH required to prepare desired molal solution with the help of following formula.

$$\text{Molality (m)} = \frac{\text{mass of solute in gms}}{\text{gm formula mass of solute}} \times \frac{1000}{\text{mass of solvent in g}}$$

$$3 = \frac{\text{mass of solute in grams}}{40} \times \frac{1000}{1500}$$

$$\therefore \text{Mass of solute} = \frac{3 \times 40 \times 1500}{1000}$$

$$\boxed{\text{Mass of solute} = 180 \text{ g NaOH}}$$

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