SOLUTIONS

Homogeneous mixture: Substances which dissolve with each other thoroughly to form a uniform mixture is called homogeneous mixture.
Eg: Water + Salt.

Solutions: A homogeneous mixture formed with two or more substances is called as solution.

Components: Substances present in solution are called as components.

Solvent: A component which is larger in quantity in a solution is called solvent.
Eg: Water in salt water.

Solute: A component which is less in quantity in a solution is called solute.
Eg: Salt in salt water

Aqueous Solution: If the solvent in a solution is water, the solution is called as aqueous solution.

Types of Solution: Solution are divided into unsaturated, saturated and super saturated solutions based on the solubility of the solute.
Note: Super saturated solution is more unstable.

Solubility: The maximum amount of solute by weight in grams in 100 grams of solvent at constant temperature is called the solubility of that substance.
Eg: Solubility of certain compounds at 30°C.

S.NO.	Compound (Formula)	Solubility - Grams (In 100 grams of water)
1	$CaCO_3$	0.0052
2.	$KMnO_4$	9.0
3.	$H_2C_2O_4.2H_2O$	14.3
4.	$CuSO_42H_2O$	31.6
5.	NaCl	36.3
6.	$AgNO_3$	300.0

Factors affecting solubility of substances.
(a) Nature of solute & solvent.
(b) Temperature.

Generally polar substances dissolve in polar solvents, but not in a non-polar solvents. In the same manner non-polar substances dissolve in non-polar solvents but not in polar solvents.

Eg (1): Copper Sulphate is a polar solute. Hence it dissolves in water which is also a polar solvent. But the same copper sulphate doesn't dissolve in kerosene as kerosene is a non-polar solvent.

Eg (2): Naphthalene is a non-polar solute. Hence it dissolves in kerosene which is also a non-polar solvent. But the same Naphthalene doesn't dissolve in water which is a polar solvent.

Solubility of KOH, $NaNO_3$, KNO_3, NH_4Cl increase with the increase in temperature.

Solubility of $Ce_2(SO_4)_3$ and all gases decrease as the temperature increases.

Effect of temperature is negligible with respect to NaCl solubility.

Concentration of Solution:

Concentration solution is expressed by the following methods.

(1) Weight percentage = $\left(\frac{w}{w+W}\right)\times 100$

(2) Volume percentage = $\left(\frac{v}{v+V}\right)\times 100$

(3) Molarity = $\frac{w}{\text{gram molecular weight}}\times\frac{1000}{v}$

where 'v' is in milli litres.

$= \frac{w}{\text{gram molecular weight}}\times\frac{100}{V}$

where 'V' is in litres.

(4) Mole fraction (X) = $\frac{\text{No. of moles of constituents}}{\text{Total no. of moles of all constituent present in the solution}}$

If n_A moles of solute A is dissolve in n_B moles of solvent B then

Mole fraction of A (X_A) = $\frac{\text{no.of moles of A}}{\text{Total no.of moles}}$

$= \frac{n_A}{n_A+n_B}$

Mole fraction of B(X_B) = $\frac{\text{no.of moles of B}}{\text{Total no.of moles}}$

$= \frac{n_B}{n_A+n_B}$

$\therefore X_A + X_B = \left(\frac{n_A}{n_A+n_B}\right)+\left(\frac{n_B}{n_A+n_B}\right)= 1$

Ionization of Substances in Water:
Ionization: The process of a molecule giving rise to ions is called ionization.

Weak Electrolytes: Substances which ionize in completely are known as weak electrolytes.
Eg: CH_3COOH, NH_4OH

Strong Electrolytes: Substances which ionize completely are known as strong electrolytes.
Eg: NaC*l* , KC*l* , $NaNO_3$, KNO_3

Non-Electrolytes: Substances which do not ionize is called as a non-electrolyte.
Eg: Glucose, Sucrose, Urea.
(**Standard Flask:** Standard solution ie known concentrated solution is prepared with the help of a standard flask)

Important Questions from Solutions:
5 Mark Questions:
1. Draw the diagram of standard flask and mention their capacities.

4 Mark Questions:
1. Make a brief note about the factors that affect solubility of a substance.
Ans- Factors affecting solubility of substances.
(a) Nature of solute & solvent.
(b) Temperature.
Generally polar substances dissolve in polar solvents, but not in a non-polar solvents. In the same manner non-polar substances dissolve in non-polar solvents but not in polar solvents.
Eg (1): Copper Sulphate is a polar solute. Hence it dissolves in water which is also a polar solvent. But the same copper sulphate doesn't dissolve in kerosene as kerosene is a non-polar solvent.

Eg (2): Naphthalene is a non-polar solute. Hence it dissolves in kerosene which is also a non-polar solvent. But the same Naphthalene doesn't dissolve in water which is a polar solvent.
Solubility of KOH, $NaNO_3$, KNO_3, NH_4C*l* increase with the increase in temperature.
Solubility of $Ce_2(SO_4)_3$ and all gases decrease as the temperature increases.
Effect of temperature is negligible with respect to NaC*l* solubility.

2. How do you prepare 0.1M standard Na_2CO_3 solution using 250 m*l* standard flask? (Molecular Weight of Na_2CO_3 = 106) [March-2001]
A. To prepare 0.1M standard Na_2CO_3 solution using 250 m*l* flask.

(1) Molarity $= \frac{W}{GMW} \times \frac{1}{V}(\text{vol. in litre})$; $0.1 = \frac{W}{106} \times \frac{1}{0.25}$

$\therefore$ W = 2.65 gm

(2) Thus we need 2.65 gm of Na_2CO_3 to prepare 0.1M Na_2CO_3 solution in 250 m*l* flask.

(3) Transfer this Na_2CO_3 into 250 m*l* standard flask with the help of a funnel.

(4) Rinse the walls of funnel with distilled water effect quantitative transfer.

(5) Shake gently the flask till the solid is dissolved.

(6) Make up the solution to the mark of the flask with distilled water.

(7) Close the flask and invert it several times to make the homogeneous solution.

3. Define molarity and mole fraction and give their equations.

[March-09, 03, June-01]

(a) **Molarity:** The number of moles of solute present in a litre of solution is called molarity. It is measured in moles/litre and denoted by the symbol 'M'.

M = Molarity $= \frac{n}{V} = \frac{\text{no.of moles of solute}}{\text{volume of solution in litres}}$

$n = \frac{W}{GMW} \therefore M = \frac{W}{GMW} \times \frac{1}{V}(V \text{ in litres})$

(b) **Mole fraction:** The ratio of number of moles of a constituent to the total number of moles of all constituents of a solution is called mole fraction of a constituent. It has no units.

n_A = no. of moles of A, n_B = no.of moles of B

Mole fraction of A$(X_A) = \frac{n_A}{n_A + n_B}$

Mole fraction of B$(X_B) = \frac{n_B}{n_A + n_B}$

$\therefore X_A + X_B = 1$

Problems

(4 Marks)

1. Calculate the moles of oxalic acid present in 400 m*l* of its 0.025M solution. **(Oct-1999)**

Sol:

Molarity = 0.025M volume in litres = 400 m*l* / 1000

No.of moels of solute n = Molarity × V in litres

= 0.025 × 400/1000 = 0.01

2. 10 grams of Na_2CO_3 present in 120 grams of its aqueous solution. Calculate the weight % . **(June-2004)**

Sol:

Weight of solute w = 10 grams

Weight of solution w + W = 120 grams

$$W\% = \frac{w}{w+W} \times 100 = \frac{10}{120} \times 100 = 8.33$$

3. 20 m*l* of alcohol is mixed with 160 m*l*. Find out the v% of this solution. **(March-2007)**

$$V\% = \frac{v}{v+V} \times 100 = \frac{20}{20+160} \times 100 = \frac{20}{180} \times 100 = 11.11\%$$

4. 15 m*l* of hexane is mixed with 45 m*l* of heptane. Calculate the V% of this solution. (Solution similar to 4th problem) **(June-2003)**

Volume of solute (v) = 15ml
Volume of solvent(V) = 45ml
Total volume of Solution = v+V
= 15+45 = 60ml

15/60 X100 =25

$$V\% = \frac{v}{v+V} \times 100 =$$ V% = 25

6. 2.12 grams of Sodium Carbonate (Na_2CO_3) is present is 0.25 litres of its solution. Calculate the molarity of the solution. (Mol. wt of Na_2CO_3 is 106) **(June-2010)**

Weight of solute (w) = 2.12gms
Volume of solvent = 250ml
Gram Molecular weight of Na_2CO_3 = 106

$$\text{Molarity} = \frac{w}{gm.mol.wt} x \frac{1}{V}$$

= 2.12/106 x 1/0.125
= 0.08M

Short Questions (2 Marks)

1. **Copper Sulphate is soluble in water, but not in kerosene. Give reason?** **(March-2008)**

A. Both copper sulphate and water are polar substances. Hence copper sulphate dissolves in water. Since kerosene is a non-polar solvent copper sulphate doesn't dissolve in kerosene.

2. **What are strong electrolytes? Give some examples?**

A. Substances which ionize completely are known as strong electrolytes.
Eg: NaC*l*, KC*l*, $NaNO_3$, NaOH.

3. What are weak electrolytes? Give some examples?

A. Substances which ionize incompletely are known as weak electrolytes.
Eg: CH_3COOH, NH_4OH etc.

4. What are non-electrolytes? Give some examples?

A. Substances which do not ionize are known as non-electrolytes.
Eg: Sucrose, Urea and Glucose.

5. Why Naphthalene soluble in Kerosene but not in water?

A. Both Naphthalene and Kerosene are non-polar substances. Hence Naphthalene dissolves in Kerosene. Since water is a polar solvent Naphthalene doesn't dissolve in water.

Very Short Questions

(1 Mark)

1. What is meant by standard solution?

A. When the concentration of solution is known it is called standard solution.

2. Give one example for each of polar and non-polar solvents? (March-1999)

A. Polar solvent: Water, non-polar solvent: Kerosene.

3. Define volume percentage?

A. The volume of solute present in 100 m*l* of solution is called "volume percentage" V%.

$$V\% = \frac{v}{v+V} \times 100$$

4. Define weight percentage?

A. The weight of solute present in 100 grams of solution is called weight percentage.

$$W\% = \frac{w}{w+W} \times 100$$

5. What is meant by ionization?

A. The process of a molecule giving rise to ions is called "Ionization".

Fill in the Blanks (1/2 Mark Questions)

1. When 10 grams of Na_2CO_3 is present in 120 grams of aqueous solution the w% is _____
(June-2005)
2. The amount of oxalic acid required to prepare 100 m*l* 0.2M solution (Mol.wt. of Oxalic Acid is 126)_____ **(June-2006)**
3. 10 grams of Na_2CO_3 is dissolved in 190 gms of water, the w% of solution is _____
(March-05, 09)
4. 4 m*l* of alcohol dissolved in 36 m*l* of water. The volume percentage of solution is_____
(June-2010, 07, March-2006, 2000)

5. Molecular weight of Na_2CO_3 is _____ **(March-08)**
6. Molecular weight of H_2SO_4 is _____
7. 12 grams of Na_2CO_3 is present in 120 grams of its aqueous solution. The weight percentage of solution is_____ **(March 02, June-03)**
8. If 2 moles of Na_2CO_3 is dissolved in 3 moles of water the mole fraction of water is _____ **(June-2000)**
9. Standard solution is prepared in _____
10. The sum of mole fraction of solute and solvent is equal to _____
11. Solubility of gases with increase in temperature _____

Answers:

1. 1000/120
2. 2.52 gm
3. 5
4. 10
5. 106
6. 98
7. 10
8. 0.6
9. Standard flask
10. one
11. decreases