sns academy

an International CBSE Finger Print School

Coimbatore

SUBJECT – CHEMISTRY

GRADE-XII

SOLUTIONS

TOPIC – MOLARITY

SOLUTIONS

MOLARITY

F) MOLARITY

It is denoted by M

Definition:

The number of moles of solute dissolved in 1 litre of a solution.

Formula:

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

Units = moles/litre

F) MOLARITY

FORMULAE

$$\text{Molarity} = \frac{\textit{weight of the solute}}{\textit{GMW of the solute}} \times \frac{1000}{V(\textit{in ml})}$$

Or

$$M = \frac{W}{GMW} \times \frac{1000}{V\ (\textit{in ml})}$$

$$\textit{Weight of the solute} = \frac{M \times GMW \times V(\textit{in ml})}{1000}$$

F) MOLARITY

FORMULAE

For dilution process : $M_1 V_1 = M_2 V_2$

For neutralisation reactions:

$$\frac{M_1V_1}{n_1} = \frac{M_2V_2}{n_2}$$

For mixed solution molarity

$$= \frac{M_1V_1 + M_2V_2 + \ldots\ldots\ldots}{V_1 + V_2 + \ldots\ldots\ldots}$$

F) MOLARITY

FORMULAE

$$\text{No of moles of solute} = \text{Molarity} \times \text{volume of solution in litres}$$

Or

$$n = M \times V$$

$$\text{No of milli moles of solute} = \text{Molarity} \times \text{volume of solution in ml}$$

F) MOLARITY

- **Molarity is inversely proportional to volume.**

$$M \propto \frac{1}{V}$$

- **Molarity changes with temperature because volume depends on temperature.**
- **With rise in temperature volume increases.**
- **With fall in temperature volume decreases.**

F) MOLARITY

- **With increase in temperature molarity decreases.**
- **With decrease in temperature molarity increases.**

Important points :

Decimolar	=	0.1 molar
Centimolar	=	0.01 molar
Millimolar	=	0.001 molar
Semimolar	=	0.5 molar
Decamolar	=	10 molar

Question

Will the molarity of a solution at 50^0C be same, less or more than molarity at 25^0C?

Answer:

Molarity at 50^0C of a solution will be less than at 25^0C because molarity decreases with temperature.

Question

What is meant by 1.0 M NaOH ?

Answer:

1 mole (40gms) NaOH on dissolution in water to make a litre solution is called 1.0 M

Question

What happens to the molarity of solution, if the solution is heated ?

Answer:

Molarity decreases due to raise in temperature and increase in volume.

MCQs

1. Which of the following are correct statements?

a) $M \propto \frac{1}{V}$

b) $M \propto \frac{1}{T}$

c) $M \propto T$

d) Both a & b

NORMALITY

Equivalent weight:

- Equivalent weight of a substance expressed in grams is known as gram-equivalent weight or gram-equivalent or equivalent
- the weight of the substance that combines or displace with 1.008 grams of hydrogen or 8 grams of oxygen or 35.5 grams of chlorine

a) Equivalent weight of an element

Equivalent weight of hydrogen

$$= \frac{\text{Weight of the element}}{\text{weight of hydrogen}} \times 1.008$$

Equivalent weight of oxygen

$$= \frac{\text{Weight of the element}}{\text{Volume of hydrogen at STP in ml}} \times \mathbf{11200}$$

No. of gram equivalents

$$= \frac{\text{Weight of the substance in grmas}}{\text{Equivalent Weight}}$$

b) Equivalent weight of Acid :

$$= \frac{\text{Formula weight (or) molecular weight}}{\text{Basicity}}$$

Number of replaceable hydrogen's of acid is called Basicity

$$E_{HCl} = \frac{M}{1} = \frac{36.5}{1} = 36.5$$

$$E_{H_2SO_4} = \frac{M}{2} = \frac{98}{2} = 49$$

$$E_{H_3PO_4} = \frac{M}{3} = \frac{98}{3} = 32.6$$

$$E_{H_3PO_3} = \frac{M}{2} = \frac{98}{2} = 49$$

$$E_{H_3PO_4} = \frac{M}{1} = \frac{98}{1} = 98$$

$$E_{H_2C_2O_4} = \frac{90}{2}$$

c) Equivalent weight of Base:

$$E_{Base} = \frac{\text{Formula weight of Base}}{\text{Acidity of Base}}$$

Number of replaceable hydroxyl group of base is called Acidity.

$$E_{Ba(OH)_2} = \frac{M}{2} = \frac{171.33}{2} = 85.67$$

$$E_{Fe(OH)_3} = \frac{M}{3} = \frac{107}{3} = 35.7$$

c) Equivalent weight of salt:

$$E_{Salt} = \frac{\text{Formula weight of the salt}}{\text{Total charge of the cation or anion of the salt}}$$

Examples :

Potassium dichromate = $K_2Cr_2O_7$

$$Cr_2O_7^{-2} + 6e^- \rightarrow 2Cr^{+3}$$

Change in oxidation number

For one ‘Cr’ atom = 3

Change in oxidation number

For two ‘Cr’ atom = 6

Number of electrons gained = 6

$$E_{K_2Cr_2O_7} = \frac{F}{6} = \frac{204}{6} = 49$$

Equivalent weight of reducing agent :

$$E_{reductant} = \frac{\text{Formula weight of reductant}}{\text{Electrons lost by reductant}}$$

Ex : 1) Morh's salt (Ferrous Ammonium sulphate)

Formula = $FeSO_4(NH_4)_2SO_4.6H_2O$

Formula weight = 392

$$E_{Morh's\ salt} = \frac{392}{1} = 392$$

$Fe^{2+} \rightarrow Fe^{3+} + e^-$

Ex : 2) $2Na_2S_2O_3 + I_2 \longrightarrow Na_2S_4O_3 + 2NaI$

$$E_{Na_2S_2O_3.5H_2O} = \frac{248}{1} = 248$$

$S^{2+} \rightarrow S^{+} + e^-$

Ew of a compound in a Disproportionation Reaction

P_4 undergoes disproportionation in basic medium to give PH_3, (phosphine) and $H_2PO_2^-$ (dihydrogen hypophosphite ion). Atomic weight of P is 31.

$P_4 \rightarrow 4H_2PO_2^- + 4e^-$ (n= 4) (oxidation)

$12e^- + P_4 \rightarrow 4PH_3$ (n= 12) (reduction)

$$Ew(P_4) = \frac{Mw(P_4)}{4} + \frac{Mw(P_4)}{12}$$

$$= \frac{31 \times 4}{4} + \frac{31 \times 4}{12} \qquad = 31 + \frac{31}{3} = 31 + 10.33 = 41.33g$$

NORMALITY

- The no.of gram equivalents of solute present in 1 litre of solution
- A normal solution contains one gram equivalent of solute
- A decinomal solution is N/10 or 0.1 N solution

$$\text{Normality} = \frac{\text{Weight of the solute in grams} \times 1000}{\text{GEW} \times \text{V(in ml)}}$$

$$N_1V_1 = N_2V_2$$

MOLALITY

G) MOLALITY

- ***It is denoted with m***

Definition:

The number of moles of the solute present in 1 kg of the solvent or 1000gms of the solvent is called *molality*.

Formula:

$$\textit{Molality (m)} = \frac{\textit{no. of moles of the solute}}{\textit{Mass of solvent in kg}}$$

Units = moles/kg

G) MOLALITY

- **Molality is independent on temperature because the mass does not change with temperature.**
- **So, it is the most common and convenient method to express the concentration of the solutions.**

G) MOLALITY

Formulae related to molality

$$Molality\ (m) = \frac{\text{no. of moles of the solute}}{\text{Mass of solvent in kg}}$$

$$Molality\ (m) = \frac{\text{weight of the solute in grams}}{\text{GMW of solute}} \times \frac{1000}{\text{Weight of solvent in grams}}$$

Question

Does molality change with temperature and why ?

Answer:

Because the mass doesn't change with temperature.

Question

Why is 1 molar aqueous solution more concentrated than 1 molal solution?

Answer:

- **1 molar aqueous solution means 1 mole of solute in 1000 ml of solution.**
- **Whereas 1 molal aqueous solution is 1 mole of solute in 1 kg of solvent**

Question

A solution of glucose in water is labelled as 10% w/w. What would be the molality of the solution?

Answer:

Mass of glucose (w) = 10 g

Mass of solution (w) = 100 g

Mass of Water = 100 - 10

= 90 g

= 0.09 kg

Molecular mass of glucose ($C_6H_{12}O_6$) = 180 $gmol^{-1}$

Question

A solution of glucose in water is labelled as 10% w/w. What would be the molality of the solution?

Answer:

Molality of a solution

$$\therefore\ m = \frac{\text{mass of the glucose}}{\text{GMW of glucose}} \times \frac{1}{\text{mass of solvent (kg)}}$$

Question

A solution of glucose in water is labelled as 10% w/w. What would be the molality of the solution?

Answer:

Molality of a solution

$$\therefore\ m = \frac{10}{180} \times \frac{1}{0.09}$$

$$= 0.617 \text{ mol kg}^{-1}$$

$$\text{or } 0.617 \text{ m}$$

Question

Calculate the molarity of a solution containing 5 g of NaOH in 450 mL solution.

Answer:

$$\text{Moles of NaOH} = \frac{5\ \text{g}}{40\ \text{gmol}^{-1}} = 0.125\ \text{mol}$$

$$\text{Volume of the solution in liters} = \frac{450\ \text{mL} \times 1\ \text{L}}{1000\ \text{mL}}$$

$$= 0.45\ \text{L}$$

Question

Calculate the molarity of a solution containing 5 g of NaOH in 450 mL solution.

Answer:

Using equation

$$Molarity\ (M) = \frac{no.\ of\ moles\ of\ the\ solute}{Volume\ of\ solution\ in\ litres}$$

$$= \frac{0.125}{0.45}$$

$$= 0.278\ M$$

Question

Calculate the molality of 2.5g of ethanoic acid (CH_3COOH) in 75 g of benzene.

Answer:

Molecular weight of $C_2H_4O_2$ = 60

Weight of ethanoic acid = 2.5 g

Weight of benzene = 75 g

Question

Calculate the molality of 2.5g of ethanoic acid (CH_3COOH) in 75 g of benzene.

Answer:

$$\textit{Molality (m)} = \frac{\textit{weight of the solute}}{\textit{Molecular weight of solute}} \times \frac{1000}{\textit{Weight of solvent in g}}$$

$$= \frac{2.5}{60} \times \frac{1000}{75}$$

$$= 0.556\ m$$

IMPORTANT POINTS REGARDING CONCENTRATION

Relation between Molarity & Molality

$$\frac{1}{\mathrm{m}} = \frac{d}{M} - \frac{GMW\ of\ solute}{1000}$$

$$\mathrm{m} = \frac{M}{(d_{Solute} - 0.01 \times M \times M_B)}$$

$$\mathrm{M} = \mathrm{m}(d_{Solute} - 0.01 \times M \times M_B)$$

$$(M_B = M.wt\ of\ solute)$$

Relation between Molality & Mole fraction

$$\frac{X_B}{X_A} = \frac{n_B}{n_A}$$

$$\frac{X_B}{1 - X_B} = \frac{w_B}{M_B} \times \frac{M_A}{w_A}$$

$$\frac{X_B}{1 - X_B} = \frac{w_B}{M_B} \times \frac{1000}{w_A} \times \frac{M_A}{1000}$$

$$\frac{X_B}{1 - X_B} = \frac{w_B}{M_B} \times \frac{1000}{w_A} \times \frac{M_A}{1000}$$

$$\frac{X_B}{1 - X_B} = m \times \frac{M_A}{1000}$$

X_B =mole fraction of the solute

Relation between Molarity & Normality

$$Molarity \times G.M.W = Normality \times G.E.W$$

Important points to remember:

- **Mass percentage is used in industrial applications**
- **Mole fraction unit is very useful in relating some physical properties of solutions, say vapour pressure with the concentration of solutions and quite useful in describing the calculations involving gas mixtures.**

Important points to remember:

- A 35.5% (V/V) solution of ethylene glycol, an antifreeze, is used in cars for cooling engine.
- It lowers the freezing point of water from 0^0C to -17.6^0 C (255.4K).

Important points to remember:

- **Commercial bleaching solution contains 3.62% mass percentage of sodium hypochlorite (NaOCl).**

NOTE

- **Mass percentage, Parts per million, mole fraction and molality do not change with temperature.**
- **Only molarity changes with temperature.**

MCQs

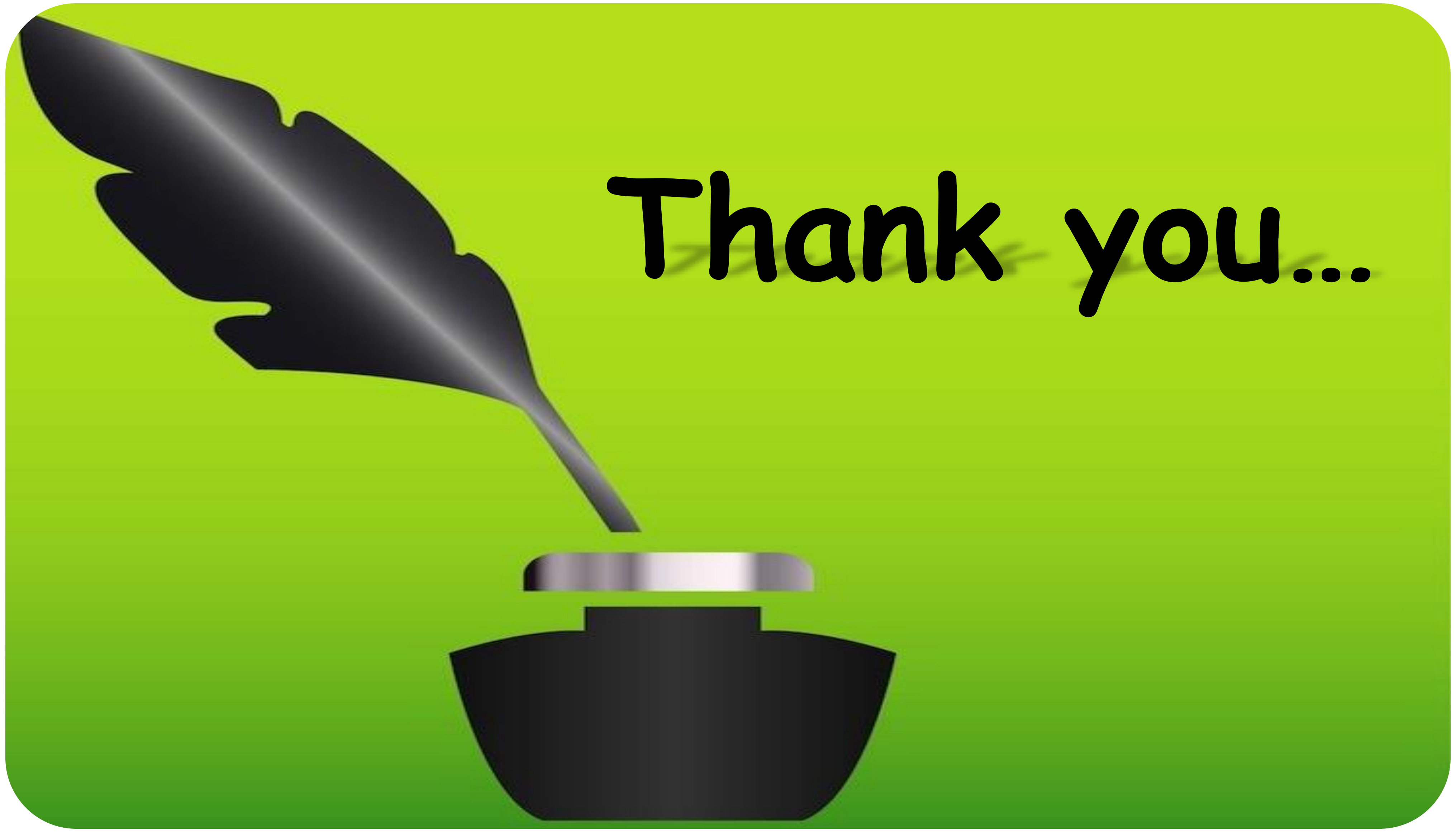
1.Which is independent of temperature?

a) Mass percentage

b) mole fraction

c) Parts per million

d) all


Thank you...