PHYSICAL CHEMISTRY

CONCENTRATION TERMS

1. The mole fraction of urea in an aqueous urea solution containing 900 g of water is 0.05. If the density of the solution is 1.2 g cm^{-3}, the molarity of urea solution is ___ **[JEE(Advanced) 2019]**

(Given data : Molar masses of urea and water are 60 g mol^{-1} and 18 g mol^{-1}, respectively)

2. The mole fraction of a solute in a solution is 0.1. At 298 K, molarity of this solution is the same as its molality. Density of this solution at 298 K is 2.0 g cm^{-3}. The ratio of the molecular weights of the solute and solvent, $\left(\frac{MW_{solute}}{MW_{solvent}}\right)$, is **[JEE(Advanced) 2016]**

3. A compound $\mathbf{H_2X}$ with molar weight of 80 g is dissolved in a solvent having density of 0.4 g mol^{-1}, Assuming no change in volume upon dissolution, the **molality** of a 3.2 molar solution is

[JEE(Advanced) 2014]

SOLUTIONS

1. Ans. (2.80 or 3.05)

Sol. $X_{urea} = 0.05 = \frac{n}{n+50}$

$19n = 50$

$n = 2.6315$

$V_{sol} = \frac{(2.6315 \times 60 + 900)}{1.2} = 881.5789$ ml

$\text{Molarity} = \frac{2.6315 \times 1000}{881.5789} = 2.9849$

Molarity = 2.98 M

2. Ans. (9)

Sol. 1 mole solution has 0.1 mole solute and 0.9 mole solvent

Let M_1 = Molar mass solute

M_2 = Molar mass solvent

Molality, $m = \frac{0.1}{0.9 M_2} \times 1000$ ....(1)

Molarity, $M = \frac{0.1}{0.1 M_1 + 0.9 M_2} \times 2 \times 1000$ ....(2)

$\because$ m = M

$\Rightarrow \quad \frac{0.1 \times 1000}{0.9 M_2} = \frac{200}{0.1 M_1 + 0.9 M_2} \Rightarrow \frac{M_1}{M_2} = 9$

Alternate solution :

$\because$ M = m

$\Rightarrow$ volume of solution = mass of solvent

$\Rightarrow \quad \frac{W_{solute} + W_{solvent}}{2} = W_{solvent}$

$W_{solute} = W_{solvent}$

$0.1 \times M_{solute} = 0.9 \times M_{solvent}$

$\frac{M_{solute}}{M_{solvent}} = 9$

3. Ans. (8)

Sol. Molarity = 3.2 M

Let volume of solution = 1000 ml = volume of solvent

Mass of solvent = 1000 × 0.4 = 400 gm

n_{solute} = 3.2 mole

$\text{Molality (m)} = \frac{3.2}{400/1000} = 8$