



2.1. Calculate the mass percentage of benzene (C_6H_6) and carbon tetrachloride (CCl_4) if 22 g of benzene is dissolved in 122 g of carbon tetrachloride.

Ans:

Mass of solution = Mass of C_6H_6 + Mass of CCl_4

= 22 g + 122 g = 144 g

Mass % of benzene = $22/144 \times 100 = 15.28\%$

Mass % of CCl_4 = $122/144 \times 100 = 84.72\%$

2.2. Calculate the mole fraction of benzene in solution containing 30% by mass in carbon tetrachloride.

Ans:

30% by mass of C_6H_6 in CCl_4 \Rightarrow 30 g C_6H_6 in 100 g solution

\therefore no. of moles of C_6H_6 , ($n_{C_6H_6}$) = $30/78 = 0.385$

(molar mass of C_6H_6 = 78g)

no. of moles of

$$CCl_4 (n_{CCl_4}) = \frac{70}{154} = 0.455$$

$$\begin{aligned} x_{C_6H_6} &= \frac{n_{C_6H_6}}{n_{C_6H_6} + n_{CCl_4}} \\ &= \frac{0.385}{0.385 + 0.455} = \frac{0.385}{0.84} = 0.458 \\ x_{CCl_4} &= 1 - 0.458 = 0.542 \end{aligned}$$

2.3. Calculate the molarity of each of the following solutions: (a) 30 g of $CO(NO_3)_2 \cdot 6H_2O$ in 4.3 L of solution (b) 30 mL of 0.5 M H_2SO_4 diluted to 500 mL.

Ans:

(a) Molar mass of $CO(NO_3)_2 \cdot 6H_2O$ = 310.7 g mol^{-1}

no. of moles = $30/310.7 = 0.0966$

Vol. of solution = 4.3 L

Molarity = $0.0966/4.3 = 0.022M$

(b) 1000 mL of 0.5M H_2SO_4 contain H_2SO_4 = 0.5 mole

30 mL of 0.5 M H_2SO_4 contain H_2SO_4

= $0.5/1000 \times 30 = 0.015$ mole

Volume of solution = 500mL = 0.5 L

Molarity = $0.015/0.5 = 0.03M$

2.4. Calculate the mass of urea (NH_2CONH_2) required in making 2.5 kg of 0.25 molal aqueous solution.

Ans:

0.25 Molal aqueous solution to urea means that

moles of urea = 0.25 mole

mass of solvent (NH_2CONH_2) = 60 g mol^{-1}

\therefore 0.25 mole of urea = $0.25 \times 60 = 15g$

Mass of solution = $1000 + 15 = 1015 \text{ g} = 1.015 \text{ kg}$
 1.015 kg of urea solution contains 15g of urea
 $\therefore 2.5 \text{ kg of solution contains urea} = 15/1.015 \times 2.5 = 37 \text{ g}$

2.5. Calculate (a) molality (b) molarity and (c) mole fraction of KI if the density of 20% (mass/mass) aqueous KI is 1.202 g mL^{-1} .

Ans:

20% aq. KOH solution \Rightarrow 20g of KI in 100g solution

\therefore Mass of solvent = $100 - 20 = 80 \text{ g}$

$$\begin{aligned} \text{(i)} \quad \text{Molality} &= \frac{\text{no. of moles of KI}}{\text{mass of solvent (kg)}} \\ &= \frac{0.120}{0.080} = 1.5 \text{ mol kg}^{-1} \end{aligned}$$

$$\text{(ii)} \quad \text{Density of solution} = 1.202 \text{ g mL}^{-1}$$

$$\begin{aligned} \text{Volume of solution} &= \frac{100}{1.202} = 83.2 \text{ mL} \\ &= 0.0832 \text{ L} \end{aligned}$$

$$\therefore \text{Molarity} = \frac{0.120}{0.0832} = 1.44 \text{ M}$$

$$\begin{aligned} \text{(iii)} \quad \text{No. of moles of KI} &= 0.120 \\ n_{\text{H}_2\text{O}} &= \frac{80}{18} = 4.44 \end{aligned}$$

$$\begin{aligned} x_{\text{KI}} &= \frac{0.120}{0.120 + 4.44} \\ &= \frac{0.120}{4.560} = 0.0263 \end{aligned}$$

2.6. H_2S , a toxic gas with rotten egg like smell, is used for the qualitative analysis. If the solubility of H_2S in water at STP is 0.195 m, calculate Henry's law constant.

Ans:

Solubility of H_2S gas = 0.195 m
 = 0.195 mole in 1 kg of solvent
 1 kg of solvent = 1000g

$$= \frac{1000}{18} = 55.55 \text{ moles}$$

$$\therefore x_{\text{H}_2\text{S}} = \frac{0.195}{0.195 + 55.55}$$

$$= \frac{0.195}{55.745} = 0.0035$$

– Pressure at STP = 0.987 bar

Applying Henry's law,

$$P_{\text{H}_2\text{S}} = K_{\text{H}} \times x_{\text{H}_2\text{S}}$$

$$\Rightarrow K_{\text{H}} = \frac{P_{\text{H}_2\text{S}}}{x_{\text{H}_2\text{S}}} = \frac{0.987}{0.0035} = 282 \text{ bar}$$

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