Exercise Numericals.

2.4. Concentrated Nitric acid used in laboratory work is 68%. Nitric acid by mass in aqueous solution. What should be the molarity of such a sample of the acid if the density of the solution is $1.504\ g\ mL^{-1}$?

Sol: Mass of HNO_3 in solution = 68 g.
Molar mass of HNO_3 = $63\ g\ mol^{-1}$
Mass of solution = 100 g.
Density of solution = $1.504\ g\ mL^{-1}$

$$\text{Vol. of solution} = \frac{M}{D} = \frac{100}{1.504} = 66.5\ mL = 0.0665\ L$$

$$M = \frac{\text{Mass of } HNO_3 / \text{Molar mass of } HNO_3}{\text{Vol. of sol (l)}} = \frac{68/63}{0.0665} = 16.23\ mol\ L^{-1}$$

$$= 16.23\ M.$$

2.5 A solution of glucose in water is labelled as 10% w/w, what would be the molality and mole fraction of each component in the solution? If the density of solution is $1.2\ g\ mL^{-1}$, then what shall be the molarity of the solution?

Sol: 10% w/w i.e 10 g of Glucose in 100 g of H_2O

Mass of Glucose = 10 g
Mass of Solution = 100 g.
Mass of Water in Solution = 100 g − 10 g = 90 g = 0.09 kg

g → kg ÷1000

Step 1 - Calculation for molality

Molality of Solution (m) = $\frac{\text{Mass of Glucose given} \,/\, \text{Molar mass of glucose}}{\text{Mass Solvent in Kg}}$

Molar mass of Glucose $C_6H_{12}O_6$ - $6\times12 + 12\times1 + 6\times16$

$= 180\,g/mol$

$$m = \frac{10\,g \,/\, 180\,g/mol}{0.09\,kg} = 0.617\,mol/kg.$$

$$= 0.617\,m$$

Step II - Calculation of Molefraction of each component in Solution.

90g of Water used in Solution,

18g of H_2O — 1 mol

90g of H_2O — $\frac{90}{18} = 5$ mol

10g of Glucose used.

180g of Glucose — 1 mol

10g of Glucose — $\frac{10}{180} = 0.055$ mol

Molefraction of H_2O (x_A) = $\frac{5\,mol}{5\,mol + 0.055\,mol} = 0.98$

Molefraction of Glucose (x_B) = $\frac{0.055\,mol}{5\,mol + 0.055\,mol} = 0.01$

Step III - Calculation of molarity of solution

Mass of solution = 100 g

Density of solution = 1.2 g mL^{-1}

$$\text{Volume of solution} = \frac{\text{Mass of solution}}{\text{Density}}$$

$$= \frac{(100\,g)}{(1.2\,g\,mL^{-1})} = 83.33\,mL$$

$$= 0.08333\,L$$

$$\text{Molarity of solution (M)} = \frac{\text{Mass of glucose} \,/\, \text{Molar mass of glucose}}{\text{Volume of solution (in litres)}}$$

$$= \frac{(10\,g)\,/\,(180\,g\,mol)}{(0.08333\,L)} = 0.67\,mol\,L^{-1}$$

$$= 0.67\,M$$