Solution Concentration Problems

1) **A solution is prepared by dissolving 26.7 g of NaOH in 650. g of water. What is the mole fraction of the sodium hydroxide?**

2) **A solution is prepared by dissolving 36.4 g CaI_2 in 750 mL of water. What is the molality of the solution?**

3) **Concentrated sulfuric acid has a density of 1.84 g/mL and is 95.0% by mass H_2SO_4. What is the molarity of the acid?**

4) **What is the mass percent of K_2SO_4 in a 3.75 molal solution?**

5) **(a)** **If a solution is 0.638 molal in Na_2CO_3, how many grams of salt must be added to 250.0 g of water?**

(b) **What is the mole fraction of Na_2CO_3 in the solution?**

6) **How many grams of lithium chloride are required to make 1.00 L of a 3.00 M solution?**

Solutions

1) **m = 26.7 g NaOH** **m_w = 650. g H_2O**

$NaOH(aq) \rightarrow Na^+(aq) + OH^-(aq)$

n_1 = 26.7 ~~g NaOH~~ x 1 mol NaOH/40.00 ~~g NaOH~~ = 0.668 mol NaOH

n_2 = 650. ~~g H_2O~~ x 1 mol H_2O/18.02 ~~g H_2O~~ = 36.1 mol H_2O

$X_1 = n_1/n_T$

X_1 = 0.668 ~~mol~~/(0.668 ~~mol~~ + 36.1 ~~mol~~) = 0.0182

2) **m = 36.4 g CaI_2**

V = 750 mL

$CaI_2(s) \rightarrow Ca^{2+}(aq) + 2I^-(aq)$

D = M/V

M = D x V = 1.00 g/~~mL~~ x 750 ~~mL~~ = 750 g H2O

n = 36.4 ~~g CaI_2~~ x 1 mol CaI_2/293.88 ~~g CaI_2~~ = 0.124 mol CaI_2

m = n/kg = 0.124 mol/(750 g x 1 kg/10^3 g) = 0.17 m

3) **D = 1.84 g/mL**

m% = 95.0% H_2SO_4

$H_2SO_4(aq) \rightarrow H^+(aq) + HSO_4^-(aq)$

Assume 1.00 L of solution, therefore,

D = M/V

m = D X V = 1.84 g/~~mL~~ x 1 ~~L~~ x 10^3 ~~mL~~/~~L~~ = 1840 g solution

$m\% = m_{acid}/m_{sol}$ x 100%

m_{acid} = 1840 g H_2SO_4 x 0.950 = 1750 g H_2SO_4

n = 1750 ~~g H_2SO_4~~ x 1 mol H_2SO_4/98.09 ~~g H_2SO_4~~ = 17.8 mol H_2SO_4

[H_2SO_4] = n/V = 17.8 mol H_2SO_4/1.00 L = 17.8 M

4) **m = 3.75 molal**

$K_2SO_4(s) \rightarrow 2K^+(aq) + SO_4^{2-}(aq)$

Assume 1.00 kg of H_2O, therefore,

m = n/kg

n = m x 1.00 kg = 3.75 m x 1.00 kg = 3.75 mol K_2SO_4

m = 3.75 ~~mol K_2SO_4~~ x 174.27 g K_2SO_4/1 ~~mol K_2SO_4~~ = 654 g K_2SO_4

$m\% = m_1/m_T$ x 100%

m% = 654 g/(654 g + 1000. g) x 100% = 39.5%

5) **m = 0.638 m** **m_w = 250.0 g**

$Na_2CO_3(aq) \rightarrow 2Na^+(aq) + CO_3^{2-}(aq)$

(a)

m = n/kg

n = m x kg = 0.638 m x 250.0 g x 1 kg/10^3 g = 0.160 mol Na_2CO_3

m = 0.160 ~~mol Na_2CO_3~~ x 105.99 g Na_2CO_3/1 ~~mol Na_2CO_3~~

m = 17.0 g Na_2CO_3

(b)

n_w = 250.0 ~~g H_2O~~ x 1 mol H_2O/18.02 ~~g H_2O~~ = 13.87 mol H_2O

$X_1 = n_1/n_T$

X_1 = 0.160 ~~mol~~/(0.160 ~~mol~~ + 13.87 ~~mol~~) = 0.0114

6) **[LiCl] = 3.00 M**

V = 1.00 L

$LiCl(aq) \rightarrow Li^+(aq) + Cl^-(aq)$

[LiCl] = n/V

n = [LiCl] x V

n = 3.00 mol LiCl/~~L~~ x 1.00 ~~L~~ = 3.00 mol LiCl

m = 3.00 ~~mol LiCl~~ x 42.39 g LiCl/1 ~~mol LiCl~~ = 127 g LiCl