

## 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<sub>2</sub> 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<sub>2</sub>SO<sub>4</sub>. What is the molarity of the acid?
  
- 4) What is the mass percent of K<sub>2</sub>SO<sub>4</sub> in a 3.75 molal solution?
  
- 5) (a) If a solution is 0.638 molal in Na<sub>2</sub>CO<sub>3</sub>, how many grams of salt must be added to 250.0 g of water?  
(b) What is the mole fraction of Na<sub>2</sub>CO<sub>3</sub> 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)  $m = 26.7 \text{ g NaOH}$   $m_w = 650. \text{ g H}_2\text{O}$



$$n_1 = 26.7 \text{ g NaOH} \times 1 \text{ mol NaOH} / 40.00 \text{ g NaOH} = 0.668 \text{ mol NaOH}$$

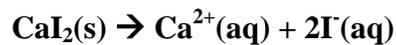
$$n_2 = 650. \text{ g H}_2\text{O} \times 1 \text{ mol H}_2\text{O} / 18.02 \text{ g H}_2\text{O} = 36.1 \text{ mol H}_2\text{O}$$

$$X_1 = n_1 / n_T$$

$$X_1 = 0.668 \text{ mol} / (0.668 \text{ mol} + 36.1 \text{ mol}) = \mathbf{0.0182}$$

2)  $m = 36.4 \text{ g CaI}_2$

$$V = 750 \text{ mL}$$



$$D = M / V$$

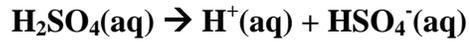
$$M = D \times V = 1.00 \text{ g/mL} \times 750 \text{ mL} = 750 \text{ g H}_2\text{O}$$

$$n = 36.4 \text{ g CaI}_2 \times 1 \text{ mol CaI}_2 / 293.88 \text{ g CaI}_2 = 0.124 \text{ mol CaI}_2$$

$$m = n / \text{kg} = 0.124 \text{ mol} / (750 \text{ g} \times 1 \text{ kg} / 10^3 \text{ g}) = \mathbf{0.17 \text{ m}}$$

3)  $D = 1.84 \text{ g/mL}$

$$m\% = 95.0\% \text{ H}_2\text{SO}_4$$



Assume 1.00 L of solution, therefore,

$$D = M/V$$

$$m = D \times V = 1.84 \text{ g/mL} \times 1 \text{ L} \times 10^3 \text{ mL/L} = 1840 \text{ g solution}$$

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

$$m_{\text{acid}} = 1840 \text{ g H}_2\text{SO}_4 \times 0.950 = 1750 \text{ g H}_2\text{SO}_4$$

$$n = 1750 \text{ g H}_2\text{SO}_4 \times 1 \text{ mol H}_2\text{SO}_4/98.09 \text{ g H}_2\text{SO}_4 = 17.8 \text{ mol H}_2\text{SO}_4$$

$$[\text{H}_2\text{SO}_4] = n/V = 17.8 \text{ mol H}_2\text{SO}_4/1.00 \text{ L} = \mathbf{17.8 \text{ M}}$$

4)  $m = 3.75 \text{ molal}$



Assume 1.00 kg of H<sub>2</sub>O, therefore,

$$m = n/\text{kg}$$

$$n = m \times 1.00 \text{ kg} = 3.75 \text{ m} \times 1.00 \text{ kg} = 3.75 \text{ mol K}_2\text{SO}_4$$

$$m = 3.75 \text{ mol K}_2\text{SO}_4 \times 174.27 \text{ g K}_2\text{SO}_4/1 \text{ mol K}_2\text{SO}_4 = 654 \text{ g K}_2\text{SO}_4$$

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

$$m\% = 654 \text{ g}/(654 \text{ g} + 1000. \text{ g}) \times 100\% = \mathbf{39.5\%}$$

5)  $m = 0.638 \text{ m}$                        $m_w = 250.0 \text{ g}$



(a)

$$m = n/\text{kg}$$

$$n = m \times \text{kg} = 0.638 \text{ m} \times 250.0 \text{ g} \times 1 \text{ kg}/10^3 \text{ g} = 0.160 \text{ mol Na}_2\text{CO}_3$$

$$m = 0.160 \text{ mol Na}_2\text{CO}_3 \times 105.99 \text{ g Na}_2\text{CO}_3/1 \text{ mol Na}_2\text{CO}_3$$

$$m = 17.0 \text{ g Na}_2\text{CO}_3$$

(b)

$$n_w = 250.0 \text{ g H}_2\text{O} \times 1 \text{ mol H}_2\text{O}/18.02 \text{ g H}_2\text{O} = 13.87 \text{ mol H}_2\text{O}$$

$$X_1 = n_1/n_T$$

$$X_1 = 0.160 \text{ mol}/(0.160 \text{ mol} + 13.87 \text{ mol}) = 0.0114$$

6)  $[\text{LiCl}] = 3.00 \text{ M}$

$$V = 1.00 \text{ L}$$



$$[\text{LiCl}] = n/V$$

$$n = [\text{LiCl}] \times V$$

$$n = 3.00 \text{ mol LiCl/L} \times 1.00 \text{ L} = 3.00 \text{ mol LiCl}$$

$$m = 3.00 \text{ mol LiCl} \times 42.39 \text{ g LiCl}/1 \text{ mol LiCl} = 127 \text{ g LiCl}$$