Solutions and Concentrations

Example 1: If you dissolve 25.5g KBr in enough water to make 1.75 L of solution, what is the molarity of the solution?

$M_w(KBr) = 39.10 \text{ g/mol} + 79.90 \text{ g/mol} = 119.0 \text{ g/mol}$

$\# \text{moles}(KBr) = 25.5 g \cdot \frac{1 \text{ mol}}{119.0 g} = 0.214 \text{ mol}$

$\text{molarity}(M) = \frac{0.214 \text{ mol}}{1.75 L} = 0.122 M$

Example 2: How many liters of a 0.125 M NaOH solution contain 0.255 mol NaOH?

$M = \frac{n}{V} \Rightarrow V = \frac{n}{M}$

$V = \frac{0.255 \text{ mol}}{0.125 \text{ mol/L}} = 2.04 L$

Example 3: What is the molarity of a 150 ppm solution of NaCl ($d = 1\,g/cm^3$)

$$150\,ppm = \frac{150\,mg\,(NaCl)}{1\,kg\,(water)} \begin{array}{l} \rightarrow \text{convert to moles} \\ \rightarrow \text{volume} \end{array}$$

$M_w(NaCl) = 58.44\,g/mol$

$$\#\,moles\,(NaCl) = 150\,mg \cdot \frac{1\,g}{1000\,mg} \cdot \frac{1\,mol}{58.44\,g}$$

$$= 2.92 \cdot 10^{-3}\,mol$$

$$150\,mg \cdot \frac{1\,g}{1000\,mg} = 0.15\,g$$

$$mass\,(solution) = 1000.15\,g \approx 1000\,g$$

$$1\,g/cm^3 = 1\,\frac{g}{cm^3} \cdot \frac{1\,mL}{1\,cm^3} = \boxed{1\,g/mL}$$

$$1\,g/cm^3 = 1\,\frac{g}{cm^3} \cdot \frac{1000\,cm^3}{1\,dm^3} = \frac{1000\,g}{1\,dm^3} \cdot \frac{1\,dm^3}{1\,L}$$

$$= \frac{1\,kg}{1\,L}$$

$$molarity\,(NaCl) = \frac{2.92 \cdot 10^{-3}\,mol}{1\,L} = 2.92 \cdot 10^{-3}\,M$$

$$= 2.92 \cdot 10^{-3}\,M \cdot \frac{1000\,mM}{1\,M}$$

$$= 2.92\,mM$$

What is the molality of a solution prepared by dissolving 32.0 g $CaCl_2$ in 271 g of H_2O ?

$$\# \text{moles} (CaCl_2) = 32.0\,g \cdot \frac{1\,mol}{110.98\,g} = 0.288\,mol$$

$$m = \frac{0.288\,mol\,(CaCl_2)}{271\,g \cdot \frac{1\,kg}{1000\,g}} = 1.06\,m$$

Common Ion Problems

What is the concentration of Na^+ when you mix 100 mL of 0.100M Na_2SO_4 and 0.250L of 0.500 M NaCl solution (both are strong electrolytes)

1. Identify common ion

$$Na_2SO_4 \xrightarrow{H_2O} \underline{2Na^+} + SO_4^{2-}$$

$$NaCl \xrightarrow{H_2O} \underline{Na^+} + Cl^-$$

Na^+ is the common ion

2. Calculate # of moles of Na^+ in both solutions

Na_2SO_4:

$$\#\text{ moles }(Na^+) = 2 \cdot 0.100\,M \cdot 100\,mL \cdot \frac{1\,L}{1000\,mL}$$
$$= 0.0200\text{ mol}$$

$NaCl$

$$\#\text{ moles }(Na^+) = 1 \cdot 0.500\,M \cdot 0.250\,L = 0.125\text{ mol}$$

$$\text{Total moles }(Na^+) = 0.0200\text{ mol} + 0.125\text{ mol}$$
$$= 0.145\text{ mol}$$

3. Calculate the molarity of Na^+

$$\text{Total Volume} = 100\,mL \cdot \frac{1\,L}{1000\,mL} + 0.250\,L = 0.350\,L$$

$$M(Na^+) = \frac{0.145\text{ mol}}{0.350\,L} = 0.414\,M$$

$$\overset{+2}{Fe_3}\overbrace{(PO_4)_2}^{-6} \xrightarrow{H_2O} 3Fe^{2+}(aq) + 2PO_4^{3-}(aq)$$

$$\overset{2+}{Fe}\overset{1-}{Cl_2} \rightarrow Fe^{2+}(aq) + 2Cl^-(aq)$$

Dilution: To what volume should you dilute 0.200L of a 15.0M NaOH solution to obtain a 3.00M NaOH solution?

Given: $V_i = 0.200\,L$

$M_i = 15.0\,M$

$M_f = 3.00\,M$

$$V_i M_i = V_f M_f$$

$$V_f = \frac{V_i M_i}{M_f} = \frac{0.200L \cdot 15.0M}{3.00M} = 1L$$