

# Solubility Calculations

## 1. Concentration Calculations

- Concentration refers to the amount of solute per unit volume.

$$c = \frac{n}{V}$$

c - concentration  
n - number of moles  
V - volume

- When dealing with solutions, chemists express concentration as molarity (M), the number of moles of solute dissolved in one litre of solution.

$$M = \frac{\text{moles of solute}}{\text{liters of total solution}}$$

**Example:** If 0.750 L of a saturated AgCl solution contains 2.50 g AgCl, what is the molar solubility of AgCl?

need: M =  $\frac{\text{mol}}{\text{L}}$  need moles first  $\frac{2.50 \text{ g}}{143.4 \text{ g/mol}} = 0.0174 \text{ mol}$

Given: 0.750 L = V  
2.50 g AgCl

aka molarity

$$M = \frac{0.0174 \text{ mol}}{0.750 \text{ L}} = 0.0232 \text{ M}$$

**Example:** What mass of potassium chloride would be required to make 400 mL of 2.85 M solution?

Given: V = 400 mL  
2.85 M

need: g KCl need moles first

convert mL = 1000 mL

M =  $\frac{\text{mol}}{\text{L}}$   
mol = M · L  
= 2.85 M · 0.4 L  
= 1.14 mol

1.14 mol ×  $\frac{74.6 \text{ g}}{\text{mol}}$  = 85.0 g KCl

## 2. Calculating Ion Concentrations

- When an ionic compound dissolves, it dissociates into ions. After writing the balanced dissociation equation, we can calculate the concentrations of ions in solution using the

equation ratio

**Example:** What are the concentrations of ions in 0.25 M Na<sub>3</sub>PO<sub>4</sub> (aq)?

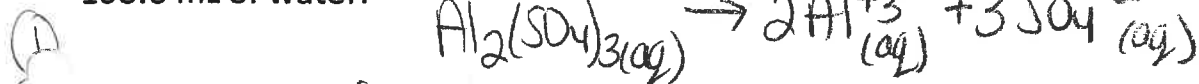
(1) write the balanced dissociation eqn Na<sub>3</sub>PO<sub>4</sub>(aq) → 3Na<sup>+</sup>(aq) + PO<sub>4</sub><sup>-3</sup>(aq)

(2) use ratio to find concentrations

$$0.25 \text{ M Na}_3\text{PO}_4 \times \left( \frac{3 \text{ mol Na}^+}{1 \text{ mol Na}_3\text{PO}_4} \right) = 0.75 \text{ M Na}^+$$

$$0.25 \text{ M Na}_3\text{PO}_4 \times \left( \frac{1 \text{ mol PO}_4^{3-}}{1 \text{ mol Na}_3\text{PO}_4} \right) = 0.25 \text{ M PO}_4^{3-}$$

Example: Calculate the ionic concentration for each ion when 85.6 g  $\text{Al}_2(\text{SO}_4)_3$  is dissolved in 100.0 mL of water.



② find Molarity first, since not given

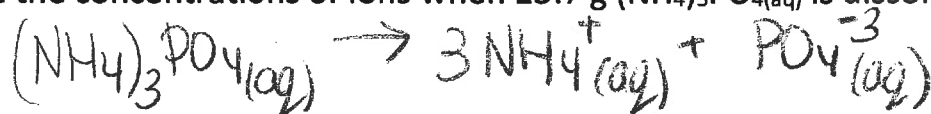
$$\frac{85.6\text{g}}{342.3\text{g/mol}} = 0.25\text{mol} = 2.5\text{M}$$

③ use equation ratios

$$2.5\text{M Al}_2(\text{SO}_4)_3 \times \left(\frac{2\text{mol Al}^{3+}}{1\text{mol Al}_2(\text{SO}_4)_3}\right) = \boxed{5.00\text{M}} \text{ Al}^{3+}$$

$$2.5\text{M} \times \left(\frac{3}{1}\right) = \boxed{7.50\text{M}} \text{ SO}_4^{2-}$$

Example: Calculate the concentrations of ions when 25.7 g  $(\text{NH}_4)_3\text{PO}_4(\text{aq})$  is dissolved in 250.0 mL  $\text{H}_2\text{O}$ .



$$\frac{25.7\text{g}}{149\text{g/mol}} = 0.1725\text{mol} = 0.690\text{M}$$

$$0.690\text{M} \times \left(\frac{3\text{mol}}{1\text{mol}}\right) = \boxed{2.01\text{M}} \text{ NH}_4^+$$

$$0.690\text{M} \times \left(\frac{1\text{mol}}{1\text{mol}}\right) = \boxed{0.690\text{M}} \text{ PO}_4^{3-}$$