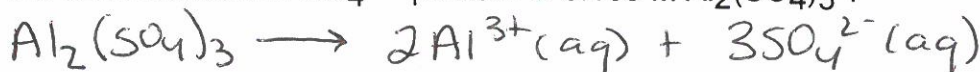


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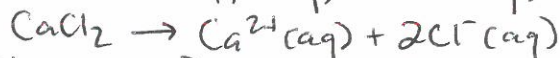
**Chemistry 11
 Assignment #4**

1. What is the concentration of SO_4^{2-} present in 0.135 M $\text{Al}_2(\text{SO}_4)_3$?



$$\frac{0.135 \text{ mol Al}_2(\text{SO}_4)_3}{\text{L}} \times \frac{3 \text{ mol SO}_4^{2-}}{1 \text{ mol Al}_2(\text{SO}_4)_3} = \boxed{0.405 \text{ M SO}_4^{2-}}$$

2. What is the concentration of Cl^- produced when 55.0 mL of 0.300 M HCl is mixed with 80.0 mL of 0.550 M CaCl_2 ?



$$[\text{HCl}]_p = \frac{0.300 \text{ M} \times 0.0550 \text{ L}}{(0.0550 \text{ L} + 0.0800 \text{ L})} = 0.122 \text{ M HCl}$$

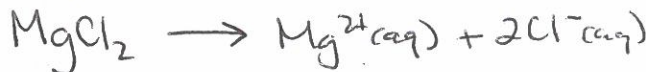
$$[\text{Cl}^-] = \frac{0.122 \text{ mol HCl}}{1 \text{ L}} \times \frac{1 \text{ mol Cl}^-}{1 \text{ mol HCl}} = 0.122 \text{ M Cl}^-$$

$$[\text{CaCl}_2]_p = \frac{0.550 \text{ M} \times 0.0800 \text{ L}}{0.135 \text{ L}} = 0.326 \text{ M CaCl}_2$$

$$[\text{Cl}^-] = \frac{0.326 \text{ mol CaCl}_2}{1 \text{ L}} \times \frac{2 \text{ mol Cl}^-}{1 \text{ mol CaCl}_2} = 0.652 \text{ M Cl}^-$$

$$[\text{Cl}^-] = 0.122 \text{ M} + 0.652 \text{ M} = \boxed{0.774 \text{ M Cl}^-}$$

3. When 350.0 mL of 0.250 M MgCl_2 is boiled down to a final volume of 275.0 mL, what is the $[\text{Cl}^-]$ in the resulting solution?



$$[\text{MgCl}_2]_p = \frac{0.250 \text{ M} \times 0.3500 \text{ L}}{0.2750 \text{ L}} = 0.318 \text{ M MgCl}_2$$

$$[\text{Cl}^-] = \frac{0.318 \text{ mol MgCl}_2}{\text{L}} \times \frac{2 \text{ mol Cl}^-}{1 \text{ mol MgCl}_2} = \boxed{0.636 \text{ M Cl}^-}$$

4. Calculate the number of moles of all aqueous ions in the following solutions:

a. 0.60 L of 0.20 M K_2SO_4



$$\frac{0.20 \text{ mol K}_2\text{SO}_4}{1 \text{ L}} \times 0.60 \text{ L} = 0.12 \text{ mol K}_2\text{SO}_4$$

$$0.12 \text{ mol K}_2\text{SO}_4 \times \frac{2 \text{ mol K}^+}{1 \text{ mol K}_2\text{SO}_4} = \boxed{0.24 \text{ mol K}^+}$$

$$0.12 \text{ mol K}_2\text{SO}_4 \times \frac{1 \text{ mol SO}_4^{2-}}{1 \text{ mol K}_2\text{SO}_4} = \boxed{0.12 \text{ mol SO}_4^{2-}}$$



b. 0.450 L of 0.300 M Na_3PO_4

$$\begin{aligned} & 0.300 \text{ mol Na}_3\text{PO}_4 \times 0.450 \text{ L} = 0.135 \text{ mol Na}_3\text{PO}_4 \\ & 0.135 \text{ mol Na}_3\text{PO}_4 \times \frac{3 \text{ mol Na}^+}{1 \text{ mol Na}_3\text{PO}_4} = \boxed{0.405 \text{ mol Na}^+} \\ & 0.135 \text{ mol Na}_3\text{PO}_4 \times \frac{1 \text{ mol PO}_4^{3-}}{1 \text{ mol Na}_3\text{PO}_4} = \boxed{0.135 \text{ mol PO}_4^{3-}} \end{aligned}$$

c. 75.0 mL of 0.160 M MnCl_2

$$\begin{aligned} & \text{MnCl}_2 \longrightarrow \text{Mn}^{2+}(\text{aq}) + 2\text{Cl}^-(\text{aq}) \\ & 0.160 \text{ mol MnCl}_2 \times 0.0750 \text{ L} = 0.0120 \text{ mol MnCl}_2 \\ & 0.0120 \text{ mol MnCl}_2 \times \frac{2 \text{ mol Cl}^-}{1 \text{ mol MnCl}_2} = \boxed{0.0240 \text{ mol Cl}^-} \\ & 0.0120 \text{ mol MnCl}_2 \times \frac{1 \text{ mol Mn}^{2+}}{1 \text{ mol MnCl}_2} = \boxed{0.0120 \text{ mol Mn}^{2+}} \end{aligned}$$

d. 0.0950 L of 0.235 M $\text{Fe}_2(\text{SO}_4)_3$

$$\begin{aligned} & \text{Fe}_2(\text{SO}_4)_3 \longrightarrow 2\text{Fe}^{3+}(\text{aq}) + 3\text{SO}_4^{2-}(\text{aq}) \\ & 0.235 \text{ mol Fe}_2(\text{SO}_4)_3 \times 0.0950 \text{ L} = 0.0223 \text{ mol Fe}_2(\text{SO}_4)_3 \\ & 0.0223 \text{ mol Fe}_2(\text{SO}_4)_3 \times \frac{2 \text{ mol Fe}^{3+}}{1 \text{ mol}} = \boxed{0.0446 \text{ mol Fe}^{3+}} ; \boxed{0.0669 \text{ mol SO}_4^{2-}} \end{aligned}$$

5. A solution is made by mixing 100.0 mL of 0.200 M BaCl_2 and 150.0 mL of 0.400 M NaCl . What is the concentration of each ionic species in the final solution?

$$[\text{BaCl}_2]_0 = \frac{0.200 \text{ M} \times 0.100 \text{ L}}{0.2500 \text{ L}} = 0.0800 \text{ M BaCl}_2 \quad [\text{NaCl}]_0 = \frac{0.400 \text{ M} \times 0.1500 \text{ L}}{0.2500 \text{ L}} = 0.240 \text{ M NaCl}$$

$$[\text{Ba}^{2+}] = \boxed{0.0800 \text{ M Ba}^{2+}} \quad [\text{Na}^+] = \boxed{0.240 \text{ M Na}^+}$$

$$[\text{Cl}^-] = \frac{0.0800 \text{ mol BaCl}_2 \times 2 \text{ mol Cl}^-}{1 \text{ mol BaCl}_2} = 0.160 \text{ M Cl}^-$$

$$[\text{Cl}^-] = \frac{0.240 \text{ mol NaCl} \times 1 \text{ mol Cl}^-}{1 \text{ mol}} = 0.240 \text{ M Cl}^-$$

$$\boxed{0.400 \text{ M Cl}^-}$$

6. IF 75.0 mL of 0.200 M Na_3PO_4 is added to 25.0 mL of 0.800 M K_3PO_4 , what is the final concentration?

$$[\text{Na}_3\text{PO}_4]_0 = \frac{0.200 \text{ M} \times 0.0750 \text{ L}}{0.100 \text{ L}} = 0.150 \text{ M Na}_3\text{PO}_4 \quad [\text{K}_3\text{PO}_4]_0 = \frac{0.800 \text{ M} \times 0.0250 \text{ L}}{0.100 \text{ L}} = 0.200 \text{ M}$$

$$\frac{0.150 \text{ mol Na}_3\text{PO}_4}{1 \text{ L}} \times \frac{1 \text{ mol PO}_4^{3-}}{1 \text{ mol}} = 0.150 \text{ M PO}_4^{3-}$$

$$\frac{0.200 \text{ mol K}_3\text{PO}_4}{1 \text{ L}} \times \frac{1 \text{ mol PO}_4^{3-}}{1 \text{ mol}} = 0.200 \text{ M PO}_4^{3-}$$

$$\boxed{0.350 \text{ M PO}_4^{3-}}$$

*7 What is the concentration of all the ions in a solution produced by mixing 15.0 mL of 0.325 M Na_3PO_4 with 35.0 mL of 0.225 M K_2SO_4 ?

$$\begin{aligned} & \text{Na}_3\text{PO}_4 \longrightarrow 3\text{Na}^+ + \text{PO}_4^{3-} \quad \text{K}_2\text{SO}_4 \longrightarrow 2\text{K}^+ + \text{SO}_4^{2-} \\ & [\text{Na}_3\text{PO}_4]_0 = \frac{0.325 \text{ M} \times 0.0150 \text{ L}}{0.0500 \text{ L}} = 0.0975 \text{ M} \quad [\text{K}_2\text{SO}_4]_0 = \frac{0.225 \text{ M} \times 0.0350 \text{ L}}{0.0500 \text{ L}} = 0.158 \text{ M} \end{aligned}$$

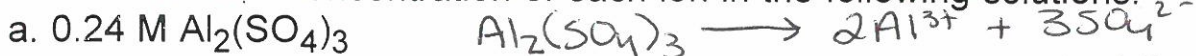
$$[\text{Na}^+] = \frac{0.0975 \text{ mol}}{1} \times \frac{3 \text{ mol}}{1 \text{ mol}} = \boxed{0.293 \text{ M Na}^+}$$

$$[\text{PO}_4^{3-}] = \frac{0.0975 \text{ mol}}{1} \times \frac{1 \text{ mol}}{1 \text{ mol}} = \boxed{0.0975 \text{ M PO}_4^{3-}}$$

$$[\text{K}^+] = \frac{0.158 \text{ mol}}{1} \times \frac{2 \text{ mol}}{1 \text{ mol}} = \boxed{0.316 \text{ M K}^+}$$

$$\boxed{[\text{SO}_4^{2-}] = 0.158 \text{ M SO}_4^{2-}}$$

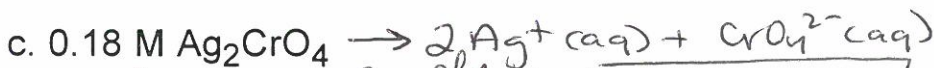
8. Calculate the concentration of each ion in the following solutions:



$$\frac{0.24 \text{ mol Al}_2(\text{SO}_4)_3}{1 \text{ L}} \times \frac{2 \text{ mol Al}^{3+}}{1 \text{ mol Al}_2(\text{SO}_4)_3} = \boxed{0.48 \text{ M Al}^{3+}} \quad \frac{0.24 \text{ mol Al}_2(\text{SO}_4)_3}{1 \text{ L}} \times \frac{3 \text{ mol SO}_4^{2-}}{1 \text{ mol Al}_2(\text{SO}_4)_3} = \boxed{0.72 \text{ M SO}_4^{2-}}$$



$$0.6 \text{ mol CrCl}_3 \times \frac{1 \text{ mol Cr}^{3+}}{1 \text{ mol}} = \boxed{0.6 \text{ M Cr}^{3+}} \quad 0.6 \text{ mol CrCl}_3 \times \frac{3 \text{ mol}}{1 \text{ mol}} = \boxed{1.8 \text{ M Cl}^-}$$



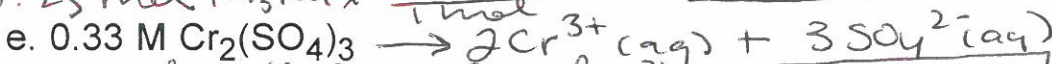
$$0.18 \text{ mol Ag}_2\text{CrO}_4 \times \frac{2 \text{ mol Ag}^+}{1 \text{ mol Ag}_2\text{CrO}_4} = \boxed{0.36 \text{ M Ag}^+}$$

$$0.18 \text{ mol Ag}_2\text{CrO}_4 \times \frac{1 \text{ mol}}{1 \text{ mol}} = \boxed{0.18 \text{ M CrO}_4^{2-}}$$



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

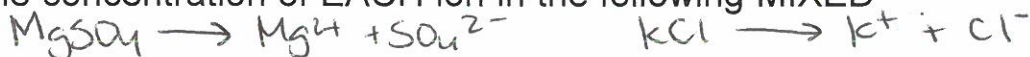
$$0.25 \text{ mol Na}_3\text{PO}_4 \times \frac{1 \text{ mol}}{1 \text{ mol}} = \boxed{0.25 \text{ M PO}_4^{3-}}$$



$$0.33 \text{ mol Cr}_2(\text{SO}_4)_3 \times \frac{2 \text{ mol Cr}^{3+}}{1 \text{ mol}} = \boxed{0.66 \text{ M Cr}^{3+}}$$

$$0.33 \text{ mol Cr}_2(\text{SO}_4)_3 \times \frac{3 \text{ mol SO}_4^{2-}}{1 \text{ mol}} = \boxed{0.99 \text{ M SO}_4^{2-}}$$

9. Calculate the concentration of EACH ion in the following MIXED solutions:



a. 3.0 L of 0.5 M MgSO_4 mixed with 2.5 L of 0.080 M KCl

$$[\text{MgSO}_4]_D = \frac{0.5 \text{ M} \times 3.0 \text{ L}}{5.5 \text{ L}} = 0.3 \text{ M MgSO}_4 \quad [\text{KCl}]_D = \frac{0.080 \text{ M} \times 2.5 \text{ L}}{5.5 \text{ L}} = \boxed{0.036 \text{ M KCl}}$$

$$[\text{Mg}^{2+}] = 0.3 \text{ M} \times \frac{1 \text{ mol}}{1 \text{ mol}} = \boxed{0.3 \text{ M Mg}^{2+}} \quad [\text{K}^+] = 0.036 \text{ M} \times \frac{1 \text{ mol}}{1 \text{ mol}} = \boxed{0.036 \text{ M K}^+}$$

$$[\text{SO}_4^{2-}] = 0.3 \text{ M} \times \frac{1 \text{ mol}}{1 \text{ mol}} = \boxed{0.3 \text{ M SO}_4^{2-}} \quad [\text{Cl}^-] = 0.036 \text{ M} \times \frac{1 \text{ mol}}{1 \text{ mol}} = \boxed{0.036 \text{ M Cl}^-}$$

b. 2.0 L of 6.4 M AlBr_3 mixed with 0.300 L of 0.020 M BaBr_2



$$[\text{AlBr}_3]_D = \frac{6.4 \text{ M} \times 2.0 \text{ L}}{2.3 \text{ L}} = \frac{12.8 \text{ mol}}{2.3 \text{ L}} = \boxed{5.6 \text{ M AlBr}_3}$$

$$[\text{BaBr}_2] = \frac{0.020 \text{ M} \times 0.300 \text{ L}}{2.3 \text{ L}} = \frac{0.006 \text{ mol}}{2.3 \text{ L}} = \boxed{2.6 \times 10^{-3} \text{ M BaBr}_2}$$

$$[\text{Al}^{3+}] = 5.6 \text{ mol} \times \frac{1 \text{ mol}}{1 \text{ mol}} = \boxed{5.6 \text{ M Al}^{3+}} \quad [\text{Ba}^{2+}] = 2.6 \times 10^{-3} \text{ mol} \times \frac{1 \text{ mol}}{1 \text{ mol}} = \boxed{2.6 \times 10^{-3} \text{ M Ba}^{2+}}$$

$$[\text{Br}^-] = \frac{5.6 \text{ mol}}{2.3 \text{ L}} \times \frac{3 \text{ mol}}{1 \text{ mol}} = 16.8 \text{ M Br}^- \quad [\text{Br}^-] = \frac{2.6 \times 10^{-3} \text{ mol} \times 2 \text{ mol}}{2.3 \text{ L}} = \frac{5.2 \times 10^{-3} \text{ mol}}{2.3 \text{ L}} = \boxed{2.6 \times 10^{-3} \text{ M Br}^-}$$

$$[\text{Br}^-] = 16.8 \text{ M} + 2.6 \times 10^{-3} \text{ M} = \boxed{16.8 \text{ M Br}^-}$$

10. Calculate the concentration of the solute in M (mol/L) in each of the following DILUTED solutions.

a. 125 mL of 0.64 M HCl diluted to 2.0L

$$[\text{HCl}]_D = \frac{0.64 \text{ M} \times 0.125 \cancel{\text{L}}}{2.0 \cancel{\text{L}}} = \boxed{0.040 \text{ M HCl}}$$

b. 1.00mL of 0.50 M NH₄Cl diluted to 250.0 mL

$$[\text{NH}_4\text{Cl}]_D = \frac{0.50 \text{ M} \times 0.001 \cancel{\text{L}}}{0.250 \cancel{\text{L}}} = \boxed{0.0020 \text{ M NH}_4\text{Cl}}$$

11. Write the dissociation equations for each of the following solutions and then calculate the concentration of each ion in each solution.

a. 0.060 M Fe₂(SO₄)₃ → 2 Fe³⁺(aq) + 3 SO₄²⁻(aq)

$$\frac{0.060 \text{ mol Fe}_2(\text{SO}_4)_3}{\cancel{\text{L}}} \times \frac{2 \text{ mol Fe}^{3+}}{1 \text{ mol}} = \boxed{0.12 \text{ M Fe}^{3+}}$$

$$\frac{0.060 \text{ mol Fe}_2(\text{SO}_4)_3}{\cancel{\text{L}}} \times \frac{3 \text{ mol SO}_4^{2-}}{1 \text{ mol}} = \boxed{0.18 \text{ M SO}_4^{2-}}$$

b. 2.40 M Li₃PO₄ → 3 Li⁺(aq) + PO₄³⁻(aq)

$$\frac{2.40 \text{ mol Li}_3\text{PO}_4}{\cancel{\text{L}}} \times \frac{3 \text{ mol Li}^+}{1 \text{ mol}} = \boxed{7.20 \text{ M Li}^+}$$

$$\frac{0.240 \text{ mol Li}_3\text{PO}_4}{\cancel{\text{L}}} \times \frac{1 \text{ mol PO}_4^{3-}}{1 \text{ mol}} = \boxed{0.240 \text{ M PO}_4^{3-}}$$

c. 1.70 M (NH₄)₃PO₄ → 3 NH₄⁺(aq) + PO₄³⁻(aq)

$$\frac{1.70 \text{ mol (NH}_4)_3\text{PO}_4}{\cancel{\text{L}}} \times \frac{3 \text{ mol NH}_4^+}{1 \text{ mol}} = \boxed{5.10 \text{ M NH}_4^+}$$

$$\frac{1.70 \text{ mol (NH}_4)_3\text{PO}_4}{\cancel{\text{L}}} \times \frac{1 \text{ mol PO}_4^{3-}}{1 \text{ mol}} = \boxed{1.70 \text{ M PO}_4^{3-}}$$