**Chem 2 Homework #4-6: Gravimetric Analysis** (Problems from text pg. 155 # 76 – 80)
**and Predicting Products Review**

**4.76** **Distilled water (not tap water) must be used in the gravimetric analysis of chlorides. Why?**
Because tap water contains chloride ions that can interfere with the tests.

**4.77** **If 30.0 mL of 0.150 M $CaCl_2$ is added to 15.0 ml of 0.100 M $AgNO_3$, what is the mass in grams of AgCl precipitate?**

**Molecular Eq**: $CaCl_2(aq)$ + $AgNO_3(aq)$ ⟶ AgCl (s) + $Ca(NO_3)_2$ (aq)

| | | | | | |
|---|---|---|---|---|---|
| | **30.0 mL** | | **15.0 mL of** | | **? g** |
| | **0.150 M** | | **0.100 M** | | |

**Net Ionic Eq**: $Cl^-$ (aq) + $Ag^+$ (aq) ⟶ AgCl (s)

Find Limiting reactant:

$$\text{mol } Ag^+ = \frac{0.100 \text{ mol } Ag^+}{1000 \text{ mL soln}} \times 15.0 \text{ mL soln} = 1.50 \times 10^{-3} \text{ mol } Ag^+$$

$$\text{mol } Cl^- = \frac{0.150 \text{ mol } CaCl_2}{1000 \text{ mL soln}} \times \frac{2 \text{ mol } Cl^-}{1 \text{ mol } CaCl_2} \times 30.0 \text{ mL soln} = 9.00 \times 10^{-3} \text{ mol } Cl^-$$

Since $Ag^+$ and $Cl^-$ combine in a 1:1 mole ratio, $AgNO_3$ is the limiting reagent. Only $1.50 \times 10^{-3}$ mole of AgCl can form. Converting to grams of AgCl:

$$1.50 \times 10^{-3} \text{ mol AgCl} \times \frac{143.4 \text{ g AgCl}}{1 \text{ mol AgCl}} = \mathbf{0.215 \text{ g AgCl}}$$

**4.78** **0.6760 g $Ba^{2+}$ compound with excess $Na_2SO_4$ → 0.4105 g $BaSO_4$.**
**What is the mass % of Ba in the original compound?**

**Net Ionic Eq:** $Ba^{2+}$ + $SO_4^{2-}$ → $BaSO_4$ (s)

| | | |
|---|---|---|
| 0.6760g | excess | 0.4105 g |

$$\text{? mass of Ba} = 0.4105 \text{ g } BaSO_4 \times \frac{1 \text{ mol } BaSO_4}{233.4 \text{ g } BaSO_4} \times \frac{1 \text{ mol Ba}}{1 \text{ mol } BaSO_4} \times \frac{137.3 \text{ g Ba}}{1 \text{ mol Ba}} = 0.2415 \text{ g Ba}$$

$$\textbf{\%Ba by mass} = \frac{0.2415 \text{ g}}{0.6760 \text{ g}} \times 100\% = \mathbf{35.72\%}$$

**4.79** **Mass of NaCl required to precipitate $Ag^+$ from $2.50 \times 10^2$ mL of 0.0113 M $AgNO_3$?**

**Net ionic equation:** $Ag^+(aq)$ + $Cl^-(aq)$ ⟶ $AgCl(s)$

$$\text{mol } Ag^+ = \frac{0.0113 \text{ mol } Ag^+}{1000 \text{ mL soln}} \times (2.50 \times 10^2 \text{ mL soln}) = 2.83 \times 10^{-3} \text{ mol } Ag^+$$

$$(2.83 \times 10^{-3} \text{ mol } Ag^+) \times \frac{1 \text{ mol } Cl^-}{1 \text{ mol } Ag^+} \times \frac{1 \text{ mol NaCl}}{1 \text{ mol } Cl^-} \times \frac{58.44 \text{ g NaCl}}{1 \text{ mol NaCl}} = \mathbf{0.165 \text{ g NaCl}}$$

**4.80** **What is $[Cu^{2+}]$ in water sample if treatment of 800. mL of water with excess $Na_2S$ yields 0.0177 g CuS(s)?**

**Net ionic equation**: $Cu^{2+}(aq) + S^{2-}(aq)$ ⟶ $CuS(s)$

$$\textbf{mol } Cu^{2+} = 0.0177 \text{ g CuS} \times \frac{1 \text{ mol CuS}}{95.62 \text{ g CuS}} \times \frac{1 \text{ mol } Cu^{2+}}{1 \text{ mol CuS}} = \mathbf{1.85 \times 10^{-4} \text{ mol } Cu^{2+}}$$

$$[Cu^{2+}] = \frac{1.85 \text{ mol } Cu^{2+}}{0.800 \text{ L}} = \mathbf{2.31 \times 10^{-4}\ \textit{M}}$$

**WKS: Predicting Products Review** For each question, assume that a reaction takes place and write out the molecular equation and net ionic equation (if one can be written.) If asked, determine if reaction would occur and explain logic.

1) Aqueous lead(II) nitrate is added to aqueous aluminum chloride *(Is this a redox reaction? No )*

*Mol. Eq:* $3\ Pb(NO_3)_2\ (aq) + 2\ AlCl_3\ (aq) \rightarrow 3\ PbCl_2\ (s) + 2\ Al(NO_3)_3\ (aq)$

*Net Ionic:* $Pb^{2+} + 2\ Cl^- \rightarrow PbCl_2$

2) Calcium metal is added to water. *(Is this a redox reaction? Yes )*

*Mol. Eq:* $Ca\ (s) + 2\ H_2O\ (l) \rightarrow Ca(OH)_2\ (aq) + H_2\ (g)$ *$Ca(OH)_2$ is only somewhat soluble, but used aq

*Net Ionic:* $Ca + H_2O \rightarrow Ca^{2+} + 2\ OH^- + H_2$

*Does this reaction occur? Yes Explain how you know. Any of the following is good:*
- Ca is more easily oxidized than $H_2$ and Ca is a very reactive metal so forward reaction occurs.
- $H_2O$ is more easily reduced than $Ca^{2+}$ so forward reaction occurs

3) Silver wire is immersed in aqueous sulfuric acid. *(Is this a redox reaction? Yes )*

*Mol. Eq:* $2\ Ag\ (s) + H_2SO_4\ (aq) \rightarrow Ag_2SO_4\ (aq) + H_2\ (g)$

*Net Ionic:* $2\ Ag + 2\ H^+ \rightarrow 2\ Ag^+ + H_2$

*Does this reaction occur? No Explain how you know.*
- Ag is harder to oxidize than $H_2$ so forward reaction does not occur.
- $H^+$ is harder to reduce than $Ag^+$ so forward reaction does not occur.

4) Chlorine gas is bubbled through an aqueous solution of potassium fluoride. *(Is this a redox rxn? Yes )*

*Mol. Eq:* $Cl_2\ (g) + 2\ KF\ (aq) \rightarrow 2\ KCl\ (aq) + F_2\ (g)$

*Net Ionic:* $Cl_2 + 2\ F^- \rightarrow 2\ Cl^- + F_2$

*Does this reaction occur? No Explain how you know.*
- $Cl_2$ is harder to reduce than $F_2$ so forward reaction does not occur.
- $F^-$ is harder to oxidize than $Cl^-$ so forward reaction does not occur.

5) An aqueous solution of lithium hydroxide is mixed with an aqueous solution of phosphoric acid. *Redox No ?*

Mol Eq: $3\ LiOH\ (aq) + H_3PO_4\ (aq) \rightarrow Li_3PO_4\ (aq) + 3\ H_2O\ (l)$

Net Ionic: $3\ OH^- + H_3PO_4 \rightarrow PO_4^{3-} + 3\ H_2O$

6) Aluminum metal is placed into an aqueous solution of lead (II) nitrate. *(Is this a redox rxn? Yes )*

Mol Eq: $2\ Al(s) + 3\ Pb(NO_3)_2\ (aq) \rightarrow 3\ Pb\ (s) + 2\ Al(NO_3)_3\ (aq)$

Net Ionic: $2\ Al + 3\ Pb^{2+} \rightarrow 3\ Pb + 2\ Al^{3+}$

*Does this reaction occur? Yes Explain how you know.*
- Al is easier to oxidize than Pb so forward reaction does occur.
- $Pb^{2+}$ is easier to reduce than $Al^{3+}$ so forward reaction does occur.

7) Aqueous solutions of ammonium chloride and cobalt(II) sulfate are mixed. (Is this a redox rxn? No )

Mol Eq: $2\ NH_4Cl + CoSO_4\ (aq) \rightarrow (NH_4)_2SO_4\ (aq) + CoCl_2\ (aq)$

Net Ionic: none possible. No reaction occurs because both "products" are soluble