Ch. 4.6 Gravimetric Analysis

- Gravimetric Analysis
  - Analytical technique based on measurement of mass of a product
  - Precipitation reaction to determine concentration/moles/mass of one ion in solution:
    - 5.000 g of an impure sample of NaCl was dissolved in water to give a 100.0 mL solution. 10.00 mL of the solution yields 1.080 g $PbCl_2$ when mixed with a solution of excess $Pb(NO_3)_2$. What is the mass percent of NaCl in the original sample?
      - First write the reaction for stoichiometry:
        $2\ NaCl\ (aq) + Pb(NO_3)_2\ (aq) \rightarrow 2\ NaNO_3\ (aq) + PbCl_2\ (s)$
        ? g NaCl 1.080 g
      - Next find the mass of NaCl in the 10.00-mL sample:

$$?\ g\ NaCl = 1.080\ g\ PbCl_2 \times \frac{1\ mol\ PbCl_2}{278.1\ g\ PbCl_2} \times \frac{2\ mol\ NaCl}{1\ mol\ PbCl_2} \times \frac{58.44\ g\ NaCl}{1\ mol\ NaCl} = 0.4539\ g\ NaCl$$

      - Next find the mass of NaCl in 100 mL of the solution:

$$?\ g\ NaCl = 0.4539\ g\ NaCl \times \frac{100.0\ mL\ solution}{10.00\ mL\ sample} = 4.539\ g\ NaCl$$

      - Finally find the mass % in the original sample: $\%NaCl = \frac{4.539\ g\ NaCl}{5.000\ g\ Sample} \times 100\% = 90.78\%$
    - Calculate the volume of a 0.550 M NaCl(aq) solution that must be added to 1.50 L of a 0.100 M $AgNO_3$ solution to precipitate all of the Ag^+ ions in the form of AgCl.
      - First write equation: $AgNO_3\ (aq) + NaCl\ (aq) \rightarrow AgCl(s) + NaNO_3(aq)$
        1.50 L of 0.100 M ? L of 0.550 M
      - Next determine the moles of $AgNO_3$ = M×V = (0.100 mol/L)(1.50 L) = 0.150 mol $AgNO_3$
      - Since there is a 1:1 ratio of $AgNO_3$ to NaCl, we have:
        mol NaCl = mol $AgNO_3$ = 0.150 mol NaCl
      - Finally, the volume can be determined from:

$$?\ L\ NaCl(aq) = 0.150\ mol\ NaCl \times \frac{1\ L\ NaCl(aq)}{0.550\ mol\ NaCl} = 0.273\ L\ NaCl(aq)$$

    - When NaF(aq) and $Pb(NO_3)_2$ (aq) are mixed, PbF_2 precipitates. What mass of PbF_2 is formed when 0.800 L of 0.500 M $Pb(NO_3)_2$ (aq) and 2.00 L of 0.0250 M NaF are mixed?
      - First, write equation: $2\ NaF\ (aq) + Pb(NO_3)_2\ (aq) \rightarrow PbF_2\ (s) + 2\ NaNO_3\ (aq)$
      - Next, determine *limiting reactant*:

$$mol\ PbF_2\ from\ NaF = 2.00\ L\ NaF \times \frac{0.0250\ mol\ NaF}{1\ L\ NaF} \times \frac{1\ mol\ PbF_2}{2\ mol\ NaF} = 0.0250\ mol\ PbF_2$$

$$mol\ PbF_2\ from\ Pb(NO_3)_2 = 0.800\ L\ Pb(NO_3)_2(aq) \times \frac{0.500\ mol\ Pb(NO_3)_2}{1\ L\ Pb(NO_3)_2(aq)} \times \frac{1\ mol\ PbF_2}{1\ mol\ Pb(NO_3)_2} = 0.400\ mol\ PbF_2$$

$$NaF\ is\ limiting,\ so\ mass\ PbF_2 = 0.0250\ mol\ PbF_2 \times \frac{245.2\ g\ PbF_2}{mol\ PbF_2} = 6.13\ g\ PbF_2$$