Chemistry 121 – Summer 2008 – Worksheet #8

1. Assign oxidation numbers to all the atoms in the following:

(a) HNO₂  H = +1, O = -2  so  (+1) + N + 2(-2) = 0   N = +3

(b) Cr₂O₇²⁻  O = -2,  so  2Cr + 7(2-) = 2-  Cr = +6

(c) CuSO₄  Cu = +2, O = -2,  so  (+2) + S + 4(-2) = 0   S = +6

(d) CHCl₃  Cl = -1, H = +1,  so  C + (+1) + 3(-1) = 0   C = +4

2. Which substance is being oxidized and which reduced in the following reactions:

(a)  2 Al (s)   +   3 O₂ (l)  →  Al₂O₃ (s)

   Al → Al³⁺ + 3 e⁻ = oxidation
   O + 3 e⁻ → O₂⁻ = reduction

(b)  CuSO₄(aq) + Zn (s)  →  ZnSO₄(aq) + Cu(s)

   Zn → Zn²⁺ + 2 e⁻ = oxidation
   Cu²⁺ + 2 e⁻ → Cu = reduction

3. What is the mass of solute, in grams, in 250.00 mL of a 0.0125 M solution of KMnO₄?

   Moles KMnO₄ = M × V = 0.0125 M × 0.250 L = 3.13 × 10⁻³ mol KMnO₄

   grams KMnO₄ = 3.13 × 10⁻³ mol KMnO₄ × (158.03 g KMnO₄/1 mol KMnO₄)

   = 0.495 g

4. What volume of 0.123 M NaOH, in liters, contains 25.0 g of NaOH?

   Moles n = M × V, so V = n / M

   M = 0.123 mol L⁻¹ NaOH,

   n = 25.0 g NaOH × (40.00 g NaOH/1 mol NaOH) = 0.635 mol NaOH

   V = 0.635 mol NaOH / 0.123 mol L⁻¹ NaOH = 5.08 L
5. If 4.00 mL of 0.0250 M CuSO₄ is diluted to 10.0 mL with pure water, what is the molar concentration of copper (II) sulfate in the diluted solution?

\[
M_1V_1 = M_2V_2
\]

\[
M_1 = 0.0250 \text{ M} \ ; \ V_1 = 4.00 \text{ mL}
\]

\[
M_2 = ? \text{ M} \ ; \ V_2 = 10.0 \text{ mL}
\]

\[
M_2 = \frac{M_1V_1}{V_2} = \frac{0.0250 \text{ M} \times 4.00 \text{ mL}}{10.0 \text{ mL}} = 0.0100 \text{ M CuSO}_4
\]

6. How many mL of 0.150 M H₂SO₄ will react with 50.0 mL of 0.325 M NaOH?

\[
\text{mol H}^+ = \text{mol OH}^-
\]

Each NaOH produces 1 OH⁻, so

\[
\text{mol OH}^- = M_{\text{NaOH}} \times V_{\text{NaOH}}
\]

\[
= 0.325 \text{ M} \times 50.0 \text{ mL} \times (1 \text{ L} / 1000 \text{ mL}) = 0.0163 \text{ mol OH}^-
\]

Each H₂SO₄ produces 2H⁺, so

\[
\text{mol H}^+ = 2 \times M_{\text{H}_2\text{SO}_4} \times V_{\text{H}_2\text{SO}_4}
\]

\[
= 2 \times 0.150 \times V_{\text{H}_2\text{SO}_4} \times (1 \text{ L} / 1000 \text{ mL})
\]

\[
= 3.00 \times 10^{-4} \times V_{\text{H}_2\text{SO}_4} \text{ mol H}^+
\]

So,

\[
3.00 \times 10^{-4} \times V_{\text{H}_2\text{SO}_4} = 0.0163
\]

\[
V_{\text{H}_2\text{SO}_4} = \frac{(0.0163 / 3.00 \times 10^{-4})}{54.3 \text{ mL H}_2\text{SO}_4}
\]