Chem 151 Name: KEY

Quiz 2

25pts

Determining an Empirical Formula:

$NiCl_m \cdot nH_2O$

To determine the amount of H20 and Cl in the sample we will employ extreme heat.

You place 47.54g of the Nickel Chloride hydrate salt into a special heat proof evacuated container of 7.0 L that has a pressure sensor. Because our volume is only accurate to 7.0, disregard any changes in volume that may occur due to the changes in state of any reactants or products.

You bring the sample to the following temperatures and then take a pressure reading:

	Temperature (C)	Pressure (atm)	Volume (L)
1	25	0.000	7.0
2	180	6.227	7.0
3	Decompose		
4	180	7.265	7.0
5	25	0.683	7.0

1) Interpret the experiment: (6pts)
   a) What is giving rise to the Pressure gain at the second measurement?

   Although the temperature is increasing, at 25C there are no gas molecules. At 180C the water molecules are liberated from the Nickel salt and become a gas, increasing "n" the number of molecules in the gas state.

   *** In step 3 you heat the sample enough to decompose the nickel salt into metallic nickel and chlorine gas.

   b) What one factor explains the change in pressure between reading 3 and 4?

   Chlorine is now a gas, Cl_2, and adds more "n" to PV=nRT

   c) What two factors cause the large pressure decrease for the last reading? Which factor causes the greatest decrease?

   Temperature decrease causes Chlorine gas's partial pressure to drop. Water vapor cools and condenses to liquid water. This removes the partial pressure of water from the gas phase.

2) Determine % Mass of H2O. (4pts)
   a) What temperature and pressure can you use to determine the moles of H_2O released by your original sample?

   Use 180C and 6.227atm at 7L to calculate "n" of water vapor.

   b) Use that sample to determine the % mass of H_2O in the sample.

$$n = PV/RT = \frac{6.227atm(7.0L)}{0.08206\frac{L\cdot atm}{mole\cdot K}(453.15K)} = 1.2moles$$

$$1.2moles(18.02g\cdot mole^{-1}) = 21.12g$$

$$\frac{21.12g}{47.54g} * 100\% = 44\%$$

3) Determine % mass for of chlorine. (4pts)
   a) What reading could you use to determine the % mass of chlorine gas released by heating the original sample?

   Use the difference in pressure before and after step 3 to get the partial pressure of Cl2(g) = 1.038atm, 180C, still 7.0L.

   b) Use that sample to determine the % mass of chlorine in the original sample.

$$n = PV/RT = \frac{1.038atm(7.0L)}{0.08206\frac{L\cdot atm}{mole\cdot K}(453.15K)} = 0.195moles\ of\ Cl_2$$

$$0..195moles(70.90g\cdot mole^{-1}) = 13.85g\ of\ Cl_2$$

$$\frac{13.85g}{47.54g} * 100\% = 29\%$$

4) (3pts) If you could weigh out the pure nickel metal produced from this process, what would its mass be?

$$47.57g - 13.85g - 21.12g = 12.57g\ of\ Ni^0$$

5) (4pts) What is the empirical formula of this nickel salt?

Convert grams of Ni to moles of Ni. 0.21moles Ni

Divide moles calculated by least number of moles (moles Cl_2) to get a ratio of 1 to 1 to 6 for Ni, Cl_2, H_2O. So:

$NiCl_2 \cdot 6H_2O$

6) (2pts) Finish and balance this equation for this decomposition reaction, noting the state of each molecule:

$$NiCl_2 \cdot 6H_2O_{(s)} \xrightarrow{\text{HEAT}} Ni^0_{(s)} + Cl_{2(g)} + 6H_2O_{(l)}$$

This would be assuming an end point at 25C for water to be in the liquid state.

7) (2pts) Do the oxidation numbers of any of the elements change from product to reactant? If so, which elements and how much.

Ni is reduced from Ni^{+2} to Ni^0
Cl is oxidized from Cl^{-1} to Cl^0

Average Atomic Masses:

Ni 58.693 g/mole
H 1.0079 g/mole
O 15.999 g/mole
Cl 35.45 g/mole
Nickel has a melting point of ~1500°C