Friday Worksheet **Name: ……………….**

Ammonia worksheet 4

1) Nitrogen and hydrogen gases were mixed in a reaction vessel within a bomb calorimeter and allowed to form ammonia gas. A volume of 100.0 mL of water in the calorimeter at 25.0 ^{o}C was heated to 33.1 ^{o}C. If 70.0 % of the energy released by the reaction goes into heating up the water and 1.70 grams of ammonia formed write a balanced thermochemical equation for the reaction between hydrogen and nitrogen gases to form ammonia gas.

Step 1 calculate the mol of NH_3 formed

=> 1.70/17.0 = 0.100 mol

Step 2 Calculate the amount of energy released knowing that only 70% goes into heating up the water.

=> Energy = (4.18 j/g/^{o}C X 100.0 X 8.1^{o}C) /0.70 = 4837 J

Step 3 Calculate the energy released per mol of ammonia formed = 9614/0.100 = 48370 J

Step 4 Write the balanced chemical equation

=> $3H_2(g) + N_2(g) \rightleftarrows 2NH_3(g)$

Step 5 Find the Δ**H**

=> since two mol of ammonia form

=> ΔH = -48370 X 2 = 96.73 kJ/mol

Step 6 Thermochemical equation

$3H_2(g) + N_2(g) \rightleftarrows 2NH_3(g)$ **ΔH = - 96.73 kJ/mol**

2) In an experiment, a mixture of H_2, N_2 and NH_3 was placed in a sealed reaction vessel and allowed to reach equilibrium at a temperature of 470°C. The concentrations of gases at equilibrium were analysed and found to contain 0.121M H_2, 0.0400M N_2 and 0.00272M NH_3. Calculate the equilibrium constant at this temperature

a) Write the equilibrium expression for this reaction.

$K = [NH_3]^2/[N_2][H_2]^3$

b) Calculate the equilibrium constant at 472 ^{o}C.

$K = [0.00272]^2/[0.0400][0.121]^3 = 0.104\ M^{-2}$

3) In one experiment, 0.015 mol of $H_2(g)$ and 0.010 mol of $N_2(g)$ are combined in a 2.00 L vessel at 470°C. The mixture is allowed to come to equilibrium and the concentration of $NH_3(g)$ is observed to be 3.20 x 10^{-3}M. Calculate the equilibrium concentration of $H_2(g)$ at this temperature.

Step 1 Calculate the mol of NH_3 formed.

=> n = C X V = 3.20 x 10^{-3}M X 2.00 = 6.40 x 10^{-3}mol

Step 2 Calculate the amount of H_2 gas that reacted to form this amount of NH_3

=> Stoichiometric ratio 3 (H_2) : 2(NH_3)

=> 3/2 X 6.40 x 10^{-3} = 0.00960

Step 3 find the amount of H_2 left unreacted.

=> 0.015 – 0.00960 = 0.0054 mol

Step 4 Calculate the [H_2]

=> 0.0054 / 2.00 = 2.7 X 10^{-3}M