Calculations involving equilibrium

1. The equilibrium constant for the following reaction is 0.0900 at 25C°: $H_2O(g) + Cl_2O(g) \Longleftrightarrow 2HOCl(g)$
For which of the following situations is the system at equilibrium? For those which are not at equilibrium, in which direction will they shift?
a. P_{H_2O} = 200 torr; P_{Cl_2O} 49.8 torr; P_{HOCl} = 21.0 torr   b. P_{H_2O} = 1.00 atm; P_{Cl_2O} 1.00 atm; P_{HOCl} = 1.00 atm
c. P_{H_2O} = 296 torr; P_{Cl_2O} 15.0 torr; P_{HOCl} = 20.0 torr

2. The value of the equilibrium constant for the following reaction is 1.5×10^{-5} at 298K. $2HF(g) \Longleftrightarrow H_2(g) + F_2(g)$
If the [HF] = 2.0M. What is the final concentrations of all species once equilibrium is established?

3. The value of the equilibrium constant for the following reaction at 500K is 4.35: $N_2(g) + 3H_2(g) \Longleftrightarrow 2NH_3(g)$
If the initial $[N_2]$ = 2.3 M and the $[H_2]$=1.25M. What are the total concentrations of all species once equilibrium is established?

4. Phosphorus pentachloride, at initial partial pressure of 189.2 torr was placed into an empty flask and allowed to decompose to PCl_3 and Cl_2 by the following reaction at 557K. $PCl_5(g) \Longleftrightarrow PCl_3(g) + Cl_2(g)$
At equilibrium the total pressure inside the flask was observed to be 358.7 torr. Calculate the partial pressure of each gas at equilibrium and the value of K_p at 557K

Equilibrium AP Practice

1) $2\,NaHCO_3(s) \Longleftrightarrow Na_2CO_3(s) + H_2O(g) + CO_2(g)$

Solid sodium hydrogen carbonate, $NaHCO_3$, decomposes on heating according to the equation above.

(a) A sample of 100. grams of solid $NaHCO_3$ was placed in a previously evacuated rigid 5.00-liter container and heated to 160. °C. Some of the original solid remained and the total pressure in the container was 7.76 atmospheres when equilibrium was reached. Calculate the number of moles of $H_2O(g)$ present at equilibrium.

(b) How many grams of the original solid remained in the container under the conditions described in (a)?

(c) Write the equilibrium expression for the equilibrium constant, K_p, and calculate its value for the reaction under the conditions in (a)

(d) If 110. grams of solid $NaHCO_3$ had been placed in the 5.00-liter container and heated to 160 °C, what would the total pressure have been at equilibrium? Explain.

2) Solve the following problem. $H_2(g) + CO_2(g) \Longleftrightarrow H_2O(g) + CO(g)$

When $H_2(g)$ is mixed with $CO_2(g)$ at 2,000 K, equilibrium is achieved according to the equation above. In one experiment, the following equilibrium concentrations were measured.

$[H_2]$ = 0.20 mol/L $[CO_2]$ = 0.30 mol/L $[H_2O]$ = [CO] = 0.55 mol/L

(a) What is the mole fraction of CO(g) in the equilibrium mixture?

(b) Using the equilibrium concentrations given above, calculate the value of K_c, the equilibrium constant for the reaction.

(c) Determine K_p, in terms of K_c for this system.

(d) When the system is cooled from 2,000 K to a lower temperature, 30.0 percent of the CO(g) is converted back to $CO_2(g)$. Calculate the value of K_c at this lower temperature.

(e) In a different experiment, 0.50 mole of $H_2(g)$ is mixed with 0.50 mole of $CO_2(g)$ in a 3.0-liter reaction vessel at 2,000 K. Calculate the equilibrium concentration, in moles per liter, of CO(g) at this temperature.