Equilibrium Practice Sheet

1. The reaction H2 (g) + I2 (g) ⮀ 2 HI (g) has Kp = 45.9 at 763 K. A particular equilibrium mixture at that temperature contains gaseous HI at a partial pressure of 4.00 atm and hydrogen gas at a partial pressure of 0.200 atm. What is the partial pressure of I2?
2. A 50.0 L reaction vessel contains 1.00 mol of nitrogen gas, 3.00 mol of hydrogen gas, and 0.500 mol of ammonia. Will more ammonia be formed or will it dissociate when the mixture goes to equilibrium at 400 °C?

N2 (g) + 3 H2 (g) ⮀ 2 NH3 (g) Kc = 0.500

1. Given the equation 2 NOCl(g) ⮀ 2 NO(g) + Cl2(g) the equilibrium constant Kc is 0.0150 at 115ºC. Calculate Kp.
2. Calculate Kp for H2O(g) + ½ O2(g) ⮀ H2O2(g) at 600 K, using the following data:

H2(g) + O2(g) ⮀ H2O2(g) Kp1 = 2.3 x 106 at 600 K

2 H2(g) + O2(g) ⮀ 2 H2O(g) Kp2 = 1.8 x 1037 at 600 K

1. **SHOW ALL WORK. *Clearly state and justify any assumptions that you may make.*** At 500 °C, a 2.00 L container was filled with 0.020 moles of CH4 and0.050 moles of H2S. Calculate the molar concentration of CS2 in this system afterthe above equilibrium is established. (Kc = 7.5 x 10-17)

CH4 (g) + 2 H2S (g) 🡨🡪 CS2 (g) + 4 H2 (g)

1. KP equals 0.050 for the reaction N2 (g) + O2 (g) ↔ 2NO (g). Calculate the equilibrium partial pressures of all species present in a mixture that has PNO2=PNO=2.5 atm, and PN2O3=0. Show your work; prove that your answer is correct.
2. Kc = 0.040 for the system below at 450°C. If a reaction is initiated with 0.20 mol of Cl2 and 0.20 mol of PCl3 in a 1.0 L container, what is the equilibrium concentration of Cl2 in the same system?
3. For the reaction 2 NH3 (g) ⮀ N2 (g) + 3 H2 (g), Kc = 0.395 at 350oC. A 25.6 g sample of NH3 is placed in a 5.00 L reaction vessel and heated to 350oC. What are the equilibrium concentrations of NH3, H2, and N2? (You will want to use the method of successive approximations for this one!)
4. For the equilibrium C(s) + 2 H2(g) <==> CH4(g) + heat

For each of the following changes to the system at equilibrium, predict the direction of the shift and explain why it occurs:

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| **Change** | **Shift** | **Reason** |
| The volume of the reaction vessel is doubled. |  |  |
| The temperature is increased. |  |  |
| The pressure of H2 (g) is increased. |  |  |
| C(s) is added to the system. |  |  |
| Adding a catalyst |  |  |

1. Consider the following equilibrium system in a closed container:

Ni(s) + 4 CO (g)  Ni(CO)4 (g) Ho = - 161 kJ

In which direction will the equilibrium shift in response to each change, and what will be the effect on the indicated quantity?

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|  | **Change** | **Direction**  **of Shift**  ( ; ; or *no change*) | **Effect on**  **Quantity** | **Effect**  (increase, decrease,  or *no change*) |
| (a) | add Ni(s) |  | Ni(CO)4(g) |  |
| (b) | raise temperature |  | Kc |  |
| (c) | add CO(g) |  | amount of Ni(s) |  |
| (d) | remove Ni(CO)4(g) |  | CO(g) |  |
| (e) | decrease in volume |  | Ni(CO)4(g) |  |
| (f) | lower temperature |  | CO(g) |  |
| (g) | remove CO(g) |  | Kc |  |

*Putting Concepts together*

1. A mixture of 0.0500 mol A, 0.0100 mol B and 0.0100 mol D were combined in a 250.0 mL reaction flask.

2 B (g) + 2 D (g) 🡨🡪 4 A (s) *Kc* = 1.9 x 105

1. Which direction will the reaction proceed to get to equilibrium? You must explain your reasoning to get credit for your answer.
2. Calculate the amounts of all species at equilibrium. Show your work clearly.

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