Equilibrium Calculations Practice I

1. Suppose that 2.00 mol of HI in a 1.00 L flask at 425 °C react to produce H_2 and I_2. When equilibrium is reached the concentration of H_2 and I_2 are determined each to be 0.214 mol/L. What is the equilibrium constant?

2. For the reaction: $N_{2\,(g)} + 3\ H_{2\,(g)} \rightleftharpoons 2\ NH_{3\,(g)}$
If the initial $[N_2]$ = 0.32 M, and the initial $[H_2]$ = 0.60 M. At equilibrium $[H_2]$ =0.30 M What is K_c?

3. For the reaction: $H_{2\,(g)} + I_{2\,(g)} \rightleftharpoons 2\ HI_{(g)}$
K_c = 55.6. If the initial $[H_2]$ = 0.200 M, and the initial $[I_2]$ = 0.200 M, what is the equilibrium [HI]?

4. For the reaction: $H_{2\,(g)} + CO_{2\,(g)} \rightleftharpoons H_2O_{(g)} + CO_{(g)}$
K_c = 0.771. If 0.0100 mol each of CO_2 and $H_{2\,(g)}$ are mixed in a 1.0 L container, what are the concentration of all the substances at equilibrium?

5. K_c = 64 for the reaction: $N_{2\,(g)} + 3\ H_{2\,(g)} \rightleftharpoons 2\ NH_{3\,(g)}$
At a certain temperature. Suppose it was found that an equilibrium mixture of these gases contained 0.360 M NH_3 and 0.0192 M N_2. What was the concentration of H_2 in the mixture?

6. At a certain temperature K_c = 0.18 for the equilibrium:
$PCI_{3\,(g)} + Cl_{2\,(g)} \rightleftharpoons PCI_{5\,(g)}$
Suppose the reaction vessel at this temperature contained these gases at the following concentrations:
$[PCI_3]$ = 0.0420 M $[Cl_2]$ = 0.0240 M, $[PCl_5]$ = 0.00500 M
   a) Is the system at equilibrium?
   b) If not, which direction will the equilibrium have to proceed in order to attain equilibrium?

7. For the following reaction: $CH_{4(g)} + H_2O_{(g)} \rightleftharpoons CO_{(g)} + 3\ H_{2(g)}$
At 1500 °C, the equilibrium mixture of these gases is:
$[CO]$ = 0.300 mol dm^{-3} $[H_2]$ = 0.800 mol dm^{-3} $[CH_4]$ = 0.400 mol dm^{-3}
At 1500 °C, K_c = 5.67, what is the equilibrium concentration of $H_2O_{(g)}$?

8. For the reaction: $CO_{(g)} + H_2O_{(g)} \rightleftharpoons CO_{2(g)} + H_{2(g)}$
K_c = 4.06 at 500 °C, and the initial concentration of both $CO_{(g)}$, and of $H_2O_{(g)}$ is 0.100 mol dm^{-3}. Determine the equilibrium concentration of all the reactants and products at this temperature.

9. In an equilibrium mixture of the reaction: $PCl_{5(g)} \rightleftharpoons PCl_{3(g)} + Cl_{2(g)}$
at 250 °C in a 2.0 dm^3 vessel, there is 0.15 mol of PCl_3 and 0.090 mol of Cl_2.
K_c = 0.19 mol dm^{-3} at 250 °C.
a) Calculate the amount of PCl_5 present at equilibrium.
b) Calculate the mass of PCl_5 present at equilibrium.

Equilibrium Calculations II

1. $SO_{2\,(g)} + NO_{2\,(g)} \rightleftharpoons SO_{3\,(g)} + NO_{(g)}$

a) At equilibrium $[SO_2]$= 4.1 M, [NO] = 0.5 M, $[SO_3]$ = 3.0, $[NO_2]$ = 0.5 M Calculate K.

b) In another experiment, 8.00 mol of SO_2 and 4.00 mol of NO_2 are placed in a 2.00 L flask and are allowed to reach equilibrium, and the concentration of SO_3 at equilibrium is 0.4 mol. Calculate K.

a) $A_{(g)} + B_{(g)} \rightleftharpoons C_{(g)} + D_{(g)}$

b) 0.80 mol of A and 0.80 mol of B are placed in a 1.0 L flask and react until equilibrium is reached. Analysis reveals that 0.60 mol of both C and D are present. Calculate the equilibrium concentrations of A, B, C, and D, and then calculate K.

c) In another experiment, the initial concentrations of A and B are 2.0 M and 2.0 M respectively. Calculate the equilibrium concentrations of A, B, C and D.

3. $A_{(g)} + B_{(g)} \rightleftharpoons C_{(g)} + D_{(g)}$ K = 4.0

If the initial concentrations of A and B are 0.4 M and 0.4 M respectively. Calculate the equilibrium concentration of all relevant compounds.

4. At the temperature of 660 K, the reaction:

$SO_{2\,(g)} + NO_{2\,(g)} \rightleftharpoons SO_{3\,(g)} + NO_{(g)}$ K = 85.0

A reaction flask at 660 K contains gases at the following concentrations:

$[SO_2]$= 0.0025 M, $[NO_2]$ = 0.0035 M , [NO] = 0.025 M, $[SO_3]$ = 0.0400 M

a) Is the system at equilibrium?

b) If not which direction will the reaction have to go to attain equilibrium?

5. Calculate the equilibrium concentration of NH_3 for the reaction:

$N_{2\,(g)} + 3\,H_{2\,(g)} \rightleftharpoons 2\,NH_{3\,(g)}$

The equilibrium concentrations for the reactants are $[N_2]$= 0.45 M and $[H_2]$ = 1.10 M , K is 1.7×10^{-2}.

6. At 373 K, the following reaction has an equilibrium constant, $K = 2.2 \times 10^{-10}$

$COCl_{2\,(s)} \rightleftharpoons CO_{(g)} + Cl_{2\,(g)}$

If 1.00 mol of phosgene, $COCl_2$, is placed in a 10.0 L flask, calculate the concentration of carbon monoxide, CO, at equilibrium.

7. At 1000 ^{O}C, for the reaction: $2\,H_2O_{(g)} \rightleftharpoons 2\,H_{2(g)} + O_{2(g)}$

$K_c = 7.32 \times 10^{-18}$ mol dm^{-3}, what will be the $[H_{2(g)}]$ at equilibrium if 1.00 mol of $H_2O_{(g)}$ are placed in a 10.0 L vessel?

8. For the equilibrium: $2\,HBr_{(g)} \rightleftharpoons Br_{2(g)} + H_{2(g)}$

K_c = 0.190 mol dm^{-3} at 250 ^{O}C. 2.085g of $HBr_{(g)}$ was heated to 250 ^{O}C in a sealed container of 500 cm^3 capacity and maintained at this temperature until equilibrium was established. Calculate the concentration of the reactants and the products.

9. In an experiment for the following equilibrium system at 25 ^{O}C :

$CH_3COOH_{(l)} + C_2H_5OH_{(l)} \rightleftharpoons CH_3COOC_2H_{5(l)} + H_2O_{(l)}$; K_c = 4.00

The equilibrium concentrations are determined to be:

$[CH_3COOH]$ = 0.330 mol, $[CH_3COOC_2H_5]$ = 0.660 mol, $[H_2O]$ = 0.660 mol

What amount of C_2H_5OH is present at 25 ^{O}C?