EQUILIBRIUM CONSTANT - WORKSHEET 2

1. Write the equilibrium constant expression for each of the following reactions:

   a) N_2 (g) + O_2 (g) ⇋ 2 NO_2 (g)

   $$K = \frac{[NO_2]^2}{[N_2]\,[O_2]}$$

   b) 2 C(s) + 3 H_2 (g) ⇋ C_2H_6 (g)

   $$K = \frac{[C_2H_6]}{[H_2]^3}$$

   c) I_2 (aq) ⇋ I_2 (s)

   $$K = \frac{1}{[I_{2\,(aq)}]}$$

2. For the following reaction:

   Fe^{2+} (aq) + Ag^{+} (aq) ⇋ Fe^{3+} (aq) + Ag (s)

   At equilibrium, $[Fe^{2+}]$ = 0.50 M, $[Ag^{+}]$ = 1.0 M, $[Fe^{3+}]$ = 1.50 M

   a) Calculate the equilibrium constant for the reaction.

   K = 3.0

   b) If at equilibrium, $[Fe^{2+}]$ = 0.20 M and $[Ag^{+}]$ = 0.30 M, what must be the concentration of Fe^{3+}?

   $[Fe^{3+}]$ = 0.18 mol/L

3. 2 NO (g) + O_2 (g) ⇋ 2 NO_2 (g) K = 5.0 x 10^{-5}

   Calculate the equilibrium concentration of oxygen gas if the NO and NO_2 concentrations are equal at equilibrium.

   $[O_2]$ = 2.0 x 10^{4} mol/L

4. a) CH_3COOH (aq) ⇋ H^{+} (aq) + CH_3COO^{-} (aq) K = 1.8 x 10^{-5}

   b) H^{+} (aq) + HS^{-} ⇋ H_2S (aq) K = 1.0 x 10^{7}

   Which of the above reactions would have the greatest amount of products present at equilibrium compared to reactants?

   Reaction b. Since K is larger the amount of products must be larger, because K is products/reactants.

5. For the reaction:

   $N_{2\,(g)}$ + 3 $H_{2\,(g)}$ ⇋ 2$NH_{3\,(g)}$ + 92kJ

   at an equilibrium temperature of 1000°C, a 1.00 L flask contains 0.120 moles of ammonia, 1.03 moles of nitrogen and 1.62 moles of hydrogen. Calculate the equilibrium constant at this temperature.

   K = 3.28 x 10^{-3}

6. For the following equilibrium reaction:

$$N_2O_{4\,(g)} + 58.9\ kJ \rightleftharpoons 2NO_{2\,(g)}$$

a one litre flask at 55°C is found to contain 3.6 moles of $N_2O_{4\,(g)}$ in equilbrium with 1.75 moles of $NO_{2\,(g)}$. Calculate the value of K_{eq} for this reaction.

K = 0.85

7. For the following reaction at equilibrium at 2000°C, $K_{eq} = 1.6 \times 10^3$.

$$2\ NO_{(g)} \rightleftharpoons N_{2\,(g)} + O_{2\,(g)}$$

The concentration of NO is 0.13 mol/L. If the concentrations of N_2 and O_2 are equal, calculate the concentration of N_2.

$[N_2]$ = 5.2 mol/L

8. At equilibrium at 1120°C the concentration of the reactants and products are measured and found to be CO = 0.010M, H_2O = 0.020M, CO_2 = 0.010M, and H_2 = 0.010M. For the following reaction, does the equilibrium favour the formation of the products or the reactants?

$$CO_{(g)} + H_2O_{(g)} \rightleftharpoons H_{2\,(g)} + CO_{2\,(g)}$$

K = 0.50 Since K<1 the reactants are favoured.

9. At 800°C the equilibrium constant for the following reaction is 0.279.

$$CO_{2\,(g)} + H_{2\,(g)} \rightleftharpoons H_2O_{(g)} + CO_{(g)} \qquad \Delta H = +42.6\ kJ/mol$$

At a different temperature the equilibrium constant is 0.100. Is this different temperature higher or lower than 800°C? Give your reasoning.

K decreases, ∴ [products]↓ and [reactants]↑

∴ reverse reaction must have occurred

If the temperature is decreased the reverse reaction must occur according to Le Châtelier's principle, so the new temperature must be lower.