CHAPTER #9

CHEMICAL EQUTLIBRIUM

SELF ASSESSMENT Exercise 9.1

Q Write Both forword and revesse reactions and describe macroscopic charaiteistics of each?

i. $N_2(g)\ 3H_2(g) \rightleftharpoons 2NH_3(g)$

ii) $H_2(g) + I_2(g) \rightleftharpoons 2HI(g)$

Solution:

Forword reactions:

$$N_2(g) + 3H_2 g \longrightarrow 2HN_3(g)$$

Reverse reactions:

$$2NH_3(g) \longrightarrow N_2 g + 3H_2(g)$$

Self ASSESSMENT Exercise 9.2.

= Following reactions can occur during lightning storms.

$3O_2(g) \rightleftharpoons 2O_3(g)$

Derive equilibrium constant expression for this reaction.

2. Write equilibrium constant expression for the following reaction.

a: $4HCI(g) + O_2(g) \longrightarrow 2H_2O(g) + 2Cl_2(g)$

b: $CH_3COOH(l) + C_2H_5OH_1 \rightleftharpoons CH_3COOC_2H_5(l) + H_2O$

c: $2HF(g) \rightleftharpoons H_2(g) + F_2(g)$

d: $2NO_2(g) \rightleftharpoons N_2O_2(g)$

Solution: 1:

$$2O_2 g \rightleftharpoons 2O_3(g)$$

$$K_c = \frac{[O_3]^2}{[O_2]^3}$$

Solution 2:

a: $4HCl(g) + O_2(g) \rightleftharpoons 2H_2O(g) + 2Cl_2(g)$

$$K_c = \frac{[H_2O]^2[Cl_2]^2}{[HCl]^4[O_2]}$$

b: $CH_3COOH(l) + C_2H_5OH(l) \rightleftharpoons CH_3COOC_2H_5(l) + H_2O(l)$

c: $2HF(g) \rightleftharpoons H_2(g) + F_2(g)$

$$K_c = \frac{[H_2][F_2]}{[HF]^2}$$

d: $2NO_2(g) \rightleftharpoons N_2O_2(g)$

$$K_c = \frac{[N_2O_2]}{[NO_2]^2}$$

SELF ASSESMENT Exercise 9.3.

Determine the units of equilibrium constant for the following reactions.

1. $N_2(g) + O_2(g) \rightleftharpoons 2NO(g)$
2. $H_2(g) + CO_2(g) \rightleftharpoons H_2O(g) + CO(g)$
3. $PCl_5(g) \rightleftharpoons PCl_3(g) + Cl_2(g)$
4. $CO(g) + 2H_2(g) \rightleftharpoons CH_3OH(g)$

Solution:

1: $N_2(g) + O_2(g) \rightleftharpoons 2NO(g)$

$$K_c = \frac{[NO]^2}{[N_2][O_2]} = \frac{[Mole\text{-}dm^{-3}]^2}{[mol\text{-}dm^{-3}][Mole\text{-}dm^{-3}]}$$

= no units.

Note: K_c has not unit when the total number of moles of reactants is equal to the total number of moles of products in a balanced chemical equation.

2. $PCl_5(g) \rightleftharpoons PCl_3(g) + Co(g)$

$$K_c = \frac{[PCl_3][Co]}{[PCl_5][Co_2]} = \frac{[mole\text{-}dm^{-3}][mole\text{-}dm^{-3}]}{[mole\text{-}dm^{-3}][mole\text{-}dm^{-3}]}$$

$$= [Mole\text{-}dum^{-3}]$$

4. $Co(g) + 2H_2(g) \rightleftharpoons CH_3OH(g)$

$$K_c = \frac{[CH_3OH]}{[Co][H_2]^2} = \frac{[mole\text{-}dum^{-3}]}{[mole\text{-}dum^{-3}][mole\text{-}dum^{-3}]}$$

$$= [mole\text{-}dum^{-3}]^{-2} = mole^{-2}\ dm6.$$