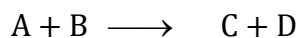


## EQUILIBRIUM

### FACTORS AFFECTING EQUILIBRIA

❖ **Factors Affecting Equilibrium Constant**

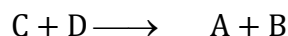
(a) **Mode of Representation of The Reaction**



The equilibrium constant for the reaction

$$K_c = \frac{[C][D]}{[A][B]}$$

If the reaction is reversed



then, 
$$K_c^1 = \frac{[A][B]}{[C][D]}$$

The two-equilibrium constant related as  $\rightarrow K_c = \frac{1}{K_c^1}$

**Ex.** For  $N_2 + 3H_2 \longrightarrow 2NH_3$  if  $K_C = 5$  then find  $K_C'$  for reverse reaction.

**Ans.**  $K_C' = 1/5 = 0.2$

(b) **Stoichiometry of The Reaction**

When a reversible reaction can be written with the help of two or more stoichiometric equation, the value of equilibrium constant will be numerically different.

For reaction  $2NO_2 \longrightarrow N_2 + 2O_2$

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

For reaction  $NO_2 \longrightarrow \frac{1}{2} N_2 + O_2$

$$K_c^1 = \frac{[N_2]^{\frac{1}{2}}[O_2]}{[NO_2]} \quad \text{The two constants are related as } K_c^1 = \sqrt{K_c}$$

(c) **Temperature:** The value of equilibrium constant changes with the change of temperature. If  $K_1$  and  $K_2$  be the equilibrium constants of a reaction at absolute temperatures  $T_1$  and  $T_2$  and  $\Delta H$  is the heat of reaction at constant volume, then:

$$\frac{d(\ln K)}{dT} = \frac{\Delta H}{RT^2}$$

$$\log \frac{K_2}{K_1} = \log K_2 - \log K_1 = \frac{-\Delta H}{2.303R} \left[ \frac{1}{T_2} - \frac{1}{T_1} \right]$$

(According to Vant Hoff equation)

(i)  $\Delta H = 0$  (neither heat is absorbed or evolved)

$$\log K_2 - \log K_1 = 0$$

$$\log K_1 = \log K_2$$

$$K_1 = K_2$$

Thus, equilibrium constant remains the same at all temperatures

If temp.  $T_2$  is higher than  $T_1$

$$\frac{1}{T_2} - \frac{1}{T_1} < 0, \log K_2 - \log K_1 = \frac{+ve \Delta H}{2.303R}$$

(ii) When  $\Delta H = +ve$  (endothermic reaction)

$$\log K_2 - \log K_1 > 0$$

or  $\log K_2 > \log K_1$

$$K_2 > K_1$$

The value of equilibrium constant is higher at higher temperature in case of endothermic reactions.

$$K_C \propto T$$

(iii) When  $\Delta H = -ve$  (exothermic reaction)

$$\log K_2 - \log K_1 < 0$$

$$\log K_2 < \log K_1$$

$$K_2 < K_1$$

The value of equilibrium constant is lower at higher temperature in the case of exothermic reactions.

$$K_C \propto 1/T$$

The value of equilibrium constant is independent of the following factors: -

(a) Initial concentrations of reactants.

- (b) The presence of a catalyst.
- (c) The direction from which the equilibrium has been attained.
- (d) Presence of inert materials.