EQUILIBRIUM

RELATIONSHIP BETWEEN EQUILIBRIUM CONSTANT K, REACTION QUOTIENT Q AND GIBBS ENERGY G

❖ REACTION QUOTIENT AND EQUILIBRIUM CONSTANT

Consider the following reversible reaction

$$A + B \longrightarrow C + D$$

The reaction quotient (Q_C) is ratio of the product of active masses of the products and product of active masses of the reactants, at any given time.

$$\therefore \quad Q_C = \frac{[C][D]}{[A][B]}$$

The concentration is not necessarily equilibrium concentration.

[At equilibrium $Q_C = K_C$]

Case I

If $Q_C < K_C$ Then: [Reactants] > [Products]

then the system is not at equilibrium

The value of $\frac{[\text{Pioduct}]}{[\text{Readant}]}$ is small

$\therefore$ For establishment of equilibrium the reaction will go in forward direction. [Reactants $\rightarrow$ Products]

Case II

If $Q_C = K_C$ Then: The system is at equilibrium and the concentration of the species C,D,B,A are at equilibrium.

Case III

If $Q_C > K_C$ Then: [Product] > [Reactants]

The system is not at equilibrium.

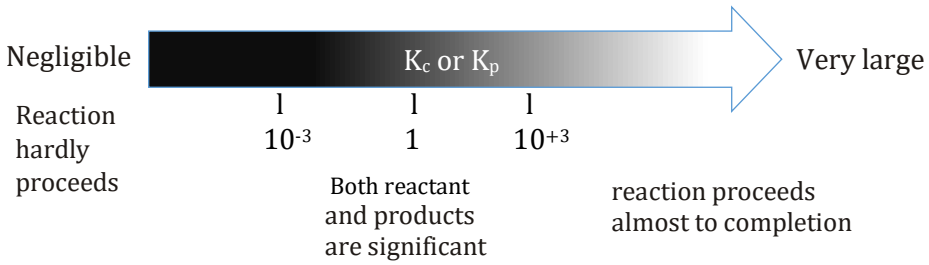
The value of $\frac{[\text{Pioduct}]}{[\text{Reactant}]}$ is large

∴ For establishment of equilibrium the reaction will go in backward direction.

[Products → Reactants]

Predicting The Extent of The Reaction

$$K = \frac{[\text{Product}]_{eq}}{[\text{Reactant}]_{eq}}$$



Case-I

If K is large ($K > 10^3$) then product concentration is very larger than the reactant ([Product] >>[Reactant]) Hence concentration of reactant can be neglected with respect to the product. In this case, the reaction is product favorable and equilibrium will be more in forward direction than in backward direction.

Case-II

If K is very small ($K < 10^{-3}$)

[Product] << [Reactant]

Hence concentration of Product can be neglected as compared to the reactant.

In this case, the reaction is reactant favorable.

Ex. The K_P values for three reactions are 10^{-5}, 20 and 300 then what will be the correct order of the percentage composition of the products.

Sol. Since K_p order is $10^{-5} < 20 < 300$ so the percentage composition of products will be greatest for $K_p = 300$.