Chemical Equilibrium

Effect Of Change Of Concentration On Chemical Equilibrium

It is a common observation that many physical processes and chemical reactions exist in the state of equilibrium. Our focus is on chemical reactions, the answer to the Question as to why many chemical reactions do not proceed to completion is that after some time the rates of forward reaction and backward reaction balance each other. This is the state of chemical equilibrium. Applying the law of mass action to a reversible reaction,

$$A + B \rightleftharpoons C + D$$

According to the law of mass action, the rate of the forward reaction, r_1, will be directly proportional to the product of concentrations of A and B and the rate of the backward reaction, r_2, will be directly proportional to the products of concentrations of C and D.

Thus, $r_1 = k_1[A][B]$ and $r_2 = k_2[C][D]$

where k_1 and k_2 are the rate constants for the forward and the backward reactions respectively and [A], [B], [C] and [D] are the molar concentrations of A, B, C and D respectively.

At equilibrium, r_1 will be equal to r_2

$k_1[A][B] = k_2[C][D]$

$$\frac{k_1}{k_2} = \frac{[C][D]}{[A][B]}$$

Putting $k_2 = k_c$ we have

$$k_c = \frac{[C]^c[D]^d}{[A]^a[B]^b}$$

k_c is called the equilibrium constant. Its value is independent of the initial concentration of reactants and is a function of temperature but remains constant at a constant temperature. At a given temperature, if the concentration of anyone of the reactants or products is changed, then the equilibrium is disturbed and according to Le Chatelier's principle, the reaction proceeds in that direction which counteracts the change in concentration, to maintain the equilibrium. The combined constant k is called the equilibrium constant and has a constant value of a reaction at a given temperature. The above equation is known as the law of chemical equilibrium.