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(A)

For Deg I subsidiary Chemistry

Chemical equilibrium

Reversible reaction :-

Such reactions which take place in both directions are known as reversible reaction.

It is denoted by $\rightleftharpoons$ sign.

e.g. - $PCl_5 \rightleftharpoons PCl_3 + Cl_2$

$NH_4Cl \rightleftharpoons NH_3 + HCl$

$CaCl_2 + Na_2CO_3 \rightleftharpoons CaCO_3 + 2NaCl$

Reversible reaction comprises of two reactions —

(1) Forward reaction

(2) Backward reaction

Such reaction which takes place in forward ~~reaction~~ direction is known as forwarad reaction.

$PCl_5 \longrightarrow PCl_3 + Cl_2$

$NH_4Cl \longrightarrow NH_3 + HCl$

Such reaction which takes place in backward direction is known as backward reaction.

$PCl_3 + Cl_2 \rightarrow PCl_5$

$NH_3 + HCl \rightarrow NH_4Cl$

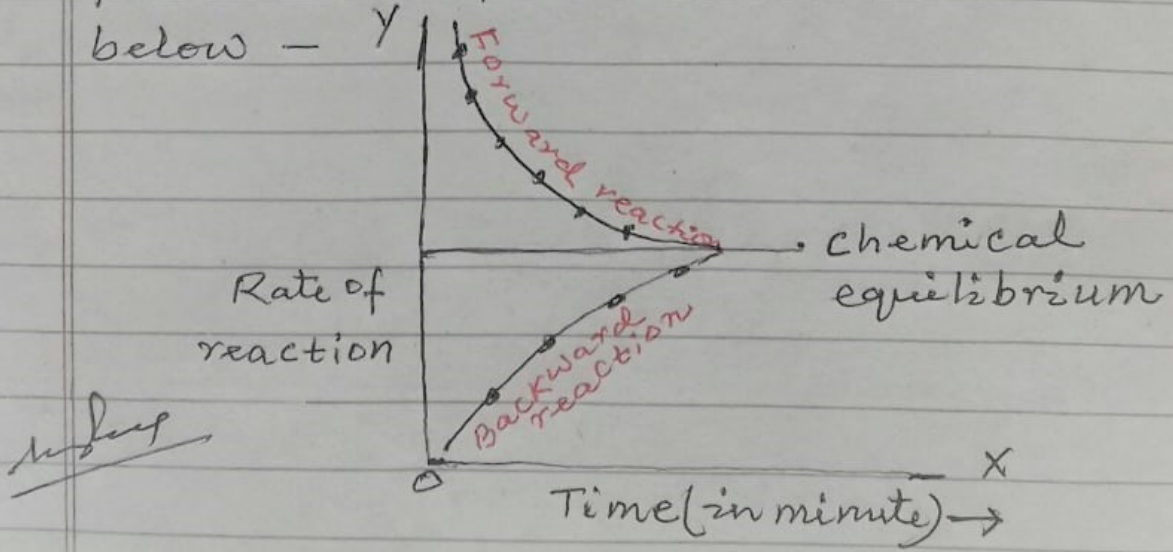
(B)

Chemical equilibrium

A stage of chemical reaction at which the rate of forward reaction becomes equal to the rate of backward reaction is known as chemical equilibrium

Initially the rate of forward reaction is fast but with the passage of time it becomes slower. Initially the rate of backward reaction is slow but with the passage of time it becomes faster.

A stage is reached when the rate of both the reaction become ~~equili~~ equal. This is the state of chemical equilibrium. It is clear from the graph which is shown below –



At the stage of chemical ~~reaction~~ equilibrium the concentration of each substance present remains constant. Reaction appears to be very slow in this condition.

Law of mass action :—

According to Guldberg and Waage the rate at which a substance reacts is directly proportional to its active mass and the rate of a chemical reaction is directly proportional to the product of the active masses of reactants.

Let us conside a general type of a reversible reaction

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

The rate of forward reaction

$$v_f \propto [A] \times [B]$$

$$\therefore v_f = K_f \times [A] \times [B] \quad \text{—— (1)}$$

where K_f is the rate constant of forward reaction

Similarly, the rate of backward reaction $v_b \propto [C] \times [D]$

$$\therefore v_b = K_b \cdot [C] \times [D] \quad \text{—— (1)}$$

Where K_b is another constant known as the rate constant of backward reaction.

At chemical equilibrium
the rate of forward reaction = the rate of backward reaction

$$V_f = V_b$$

or $K_f \times [A] \times [B] = K_b \times [C] \times [D]$

$$\therefore \frac{K_f}{K_b} = \frac{[C] \times [D]}{[A] \times [B]}$$

or $$K_c = \frac{[C] \times [D]}{[A] \times [B]}$$ $K_c = \frac{K_f}{K_b}$

Where K_c = Equilibrium Constant

K_c = A Product of the active masses of product / Product of the active masses of reactants

K_p is the equilibrium Constant in terms of Partial Pressure

K_p = Product of the Partial Pressure of Products / Product of the Partial Pressure of reactants

$$\therefore K_p = \frac{p_C \times p_D}{p_A \times p_B}$$