RATE CONSTANT

Let us consider a reaction of the type.

$A \rightarrow$ Product

$r = K[A]$ where K is the rate constant. If $[A]=1$, then $r = K$

∴ Rate constant is equal to the rate of the reaction when the concentration of the reactant is unity.

Let us consider the reaction.

$A+B \longrightarrow$ Product

$r = K[A][B]$

when,

$[A] = [B] = 1$

then,

$r = K$

Rate constant is equal to the rate of the reaction when concentrations of the reactants are separately equal to unity. Hence, it is also specific reaction rate.

The units of rate constants can also be determined by starting with the appropriate rate equation for the reaction as is shown below:-

(a) Zero Order Reactions:

$$-\frac{d[A]}{dt} = K$$

Units of $[A]/t = \frac{mol\,dm^{-3}}{s} = mol\,dm^{-3}\,s^{-1}$.

It should be noted that units of $d[A]$, the change in concentration, are the same as those of $[A]$. Similarly the units of dt are the same as those.

(b) **First Order Reactions:**

$$\frac{-d[A]}{dt} = K_1[A]$$

$$K_1 = \frac{-1}{[A]} \times \frac{d[A]}{dt}$$

$$\text{Units of } K_1 = \frac{1}{mol\,dm^{-3}} \times \frac{mol\,dm^{-3}}{s} = s^{-1}$$

(c) **Second Order Reactions:**

(i) $$\frac{-d[A]}{dt} = K_2[A]^2$$

$$K_2 = -\frac{1}{[A]^2} \times \frac{d[A]}{dt}$$

$$\text{Units of } K_2 = \frac{1}{(mol\,dm^{-3})^2} \times \frac{mol\,dm^{-3}}{s}$$

$$= dm^3\,mol^{-1}\,s^{-1}$$

(ii) $$-d[A]/dt = K_2[A][B]$$

$$= \frac{-1}{[A][B]} \times \frac{d[A]}{dt}$$

$$\text{Units of } K_2 = \frac{1}{(mol\,dm^{-3})^2} \times \frac{mol\,dm^{-3}}{s}$$

$$= dm^3\,mol^{-1}\,s^{-1}$$

(e) **Half Order Reactions:**

$$\frac{-d[A]}{dt} = K[A]^{1/2}$$

$$K = \frac{1}{[A]^{1/2}} \times \frac{d[A]}{dt}$$

Units of K

$$= \frac{1}{(mol\ dm^{-3})^{1/2}} \times \frac{mol\ dm^{-3}}{s}$$

$$= mol^{1/2}\ dm^{-3/2}\ s^{-1}$$

In general for an nth order reaction, the units of K_n are:

$$\boxed{(dm^3)^{n-1}\ mol^{1-n}\ s^{-1}}$$