Rate of a Reaction:

The rate of a reaction is defined as *the rate at which one of the reactants disappears or the rate at which one of the products appears.* For example, consider the following reaction:

$$A + 2B \rightarrow 3C$$

In the above reaction, it can be observed that two moles of B disappear for every mole of A reacting and three moles of C are formed for each mole of A disappears.

$$\therefore -\frac{d[A]}{dt} = -\frac{1}{2}\frac{d[B]}{dt} = \frac{1}{3}\frac{d[C]}{dt}$$

Negative sign indicates that the consumption of the reactants and *positive sign* indicates the production of the product.

Unit of Rate of reaction $= \frac{unit \text{ of concentration}}{unit \text{ of time}}$

$=$ **mole litre^{-1} time^{-1}**

How to express rate for the decomposition of N_2O_5

$$2N_2O_5(g) \leftrightarrows 4NO_2(g) + O_2(g)$$

The rate of disappearance of $N_2O_5 = -\frac{\Delta[N_2O_5]}{\Delta t}$

Rate of appearance of $NO_2 = +\frac{\Delta[NO_2]}{\Delta t}$

Rate of appearance of $O_2 = +\frac{\Delta[O_2]}{\Delta t}$

In the above reaction one mole of O2 is formed, four moles of NO2 are formed and two moles of N2O5 disappear.

Rate Law or Rate Expression

Rate of a reaction depends on the concentrations of one or more of the reactants. However, from the stoichiometric equation of a reaction we cannot tell which reactants, products or foreign substances (like catalysts) will affect the rate. This information can be obtained only from *actual experimental* studies.

For a reaction of the type

$$aA + bB + cC \rightarrow \text{Products}$$

the rate equation is written in the form

$$\text{Rate} = k[A]^x [B]^y [C]^z$$

where the constant of proportionality, k, is called the *rate constant.* If [A] = [B] = [C] = 1, then k = r. Thus, rate constant may be *defined as the rate of the reaction when the concentration of each of the reactants is unity*.

Example:

a) A $\rightarrow$ Products rate = k[A]^1

b) 2A $\rightarrow$ Products rate = k[A]^2

d) A + B + C $\rightarrow$ Products rate = $k[A][B][C]$