## 3) Kinetics of Consecutive Reactions

The reactions in which the final product is formed through one or more intermediate steps are called consecutive or sequential reactions.

In consecutive reactions the product formed in one of the elementary reactions acts as the reactant for some other elementary reac$^n$. Various step reactions can be written for the overall reaction as

$$A \xrightarrow{K_1} B \xrightarrow{K_2} C$$

| | | | |
|---|---|---|---|
| Initial conc$^n$ | $[A]_0$ | 0 | 0 |
| Conc$^n$ after time $t$ | $[A]$ | $[B]$ | $[C]$ |

The product C is formed from the reactant A through intermediate B.

In this reaction the rate constant $K_1$ for the first step and $K_2$ for the second step.

The net or overall rate of reaction depends upon the magnitude of these two rate constants.

The initial concentration and concentration after time $t$ are shown below –

It is clear that

$$[A]_0 = [A] + [B] + [C]$$

The differential rate expressions are

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

$$\frac{d[B]}{dT} = K_1[A] - K_2[B]$$

and, $$\frac{d[C]}{dT} = K_2[B]$$

During reaction the concentration of A, B and C vary as shown in the figure.

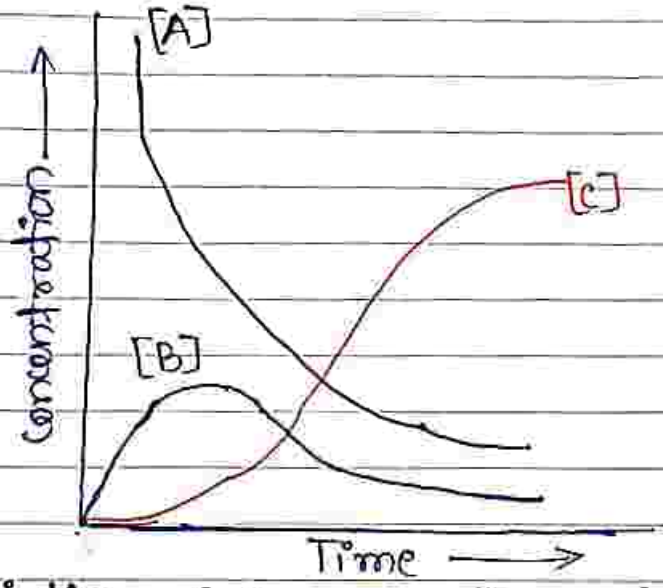



Fig:- Variation of concentration of Reactants and Products in a Consecutive Reaction.

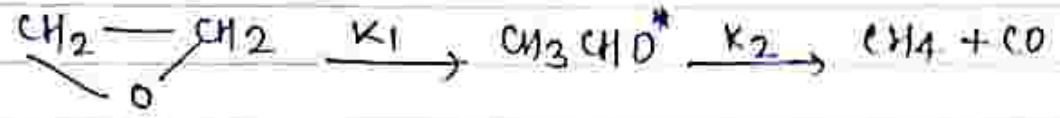
from figure it is clear that the concentration of [A] decreases exponentially. The concentration of [B] first increases and then decreases and that of C increases (from zero) with time and finally attains the value equal to $[A]_0$ (Initial Conc$^n$ A) when all A has changed into the final product C.

## Examples of consecutive Reactions

1. Decomposition of dimethyl ether in gaseous phase

$$CH_3OCH_3 \xrightarrow{K_1} CH_4 + HCHO \xrightarrow{K_2} H_2 + CO$$

② Decomposition of Ethylene oxide




③ Any radioactive decay of the type

$$^{218}_{84}Po \xrightarrow{-\alpha} {}^{214}_{82}Pb \xrightarrow{-\beta} {}^{214}_{83}Bi \xrightarrow{-\beta} {}^{214}_{84}Po$$