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Elementary and complex reaction

On the basis of mechanism we have two types of reaction

(I) Simple or Elementary reaction (Single step reaction)

(II) Complex reaction (multistep reaction)

Definition of complex reaction :-

The complex reaction refers to a reaction whose mechanism comprises more than one elementary step. Molecularity of complex reaction is not defined. Rate of complex reaction is given by the slowest step. It is called the rate determining step. Intermediates are formed in the complex reaction Intermediates are temporary. But it has its own identity It does not appear in the rate law. They are short lived.

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$R \rightarrow P$.

$R \rightarrow A$ (Intermediate) Step - 1

$A \rightarrow B$ (Intermediate) Step 2

$B \rightarrow P$. Step 3.

Steady State Approximation :- This approximation Simplifies the determination According to this approximation during a chemical reaction. the rate of formation of intermediates is taken as zero.

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Steady State Approximation [SSA]

Let us take a chemical reaction

$A \rightarrow P$

whose mechanism is

$A \xrightarrow{k_1} I$ → ① Slow (Where I is the intermediate.)

$I \xrightarrow{k_2} P$ → ② fast.

If $k_2 > k_1$ ∴ Equⁿ ① will be Slow, and equⁿ ② will be fast.

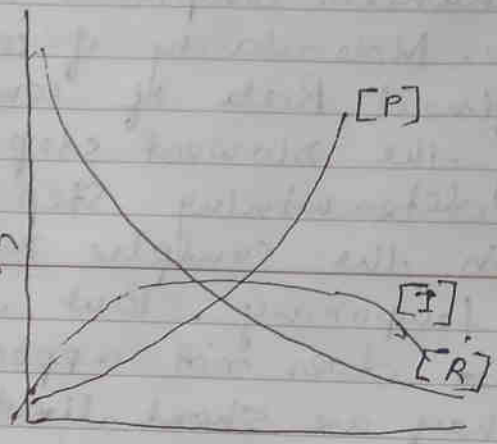
Now if concenⁿ of reactant-

$[R] >> [I]$.

and $[P] >> [I]$

Then according to steady state approximation. (SSA)

$$\frac{d[I]}{dt} = 0$$



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that is the concentration of intermediate [I] remains constant

$$\frac{d[I]}{dt} = k_1[R] - k_2[I]$$

According to steady state approximation,

$$\frac{d[I]}{dt} = 0$$

$$\therefore k_1[R] = k_2[I]$$

$$[I] = \frac{k_1[R]}{k_2}$$

$$\text{Rate} = k_2[I]$$

$$= k_2 \times \frac{k_1}{k_2}[R]$$

$$\text{Rate} = k_1[R]$$

So equⁿ ① is the rate determining step

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Chain Reaction :-

It is multistep reactions, whose machanism includes a cycle or reactions such that certain reaction intermediates consumed in one step are regenerated in other. The intermediates may be atoms, free radicals, or ions. If such a cycle ~~of reaction~~ is repeated more than once, the reaction is known as a chain reaction.

For example, if hydrogen and bromine react and the product HBr is removed as far as it is formed, the procen is believed to occur by the following steps.

(1) $Br_2 \xrightarrow{k_1} 2Br$ initiation.

(2) $Br + H_2 \xrightarrow{k_2} HBr + H$ } Chain propagation.

(3) $H + Br_2 \xrightarrow{k_3} HBr + Br$ }

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(4) $2Br \xrightarrow{k_4} Br_2$ Termination.

Reaction (2) and (3) constitute a cycle and are known as chain propagating steps. In step (2) a bromine atom is consumed but is produced in reaction (3), while in reaction (3), a hydrogen atom is consumed but is produced in reaction (2). Under usual condition this cycles occurs a number of times on the average, and the reaction is therefore a chain reaction. Reaction (1), which produces active intermediates (Br atom) is known as initiah step. and the step (4) in which no active spcies is formed, is called a chain terminating step or chain-ending step.