

بِسْمِ اللَّهِ الرَّحْمَنِ الرَّحِيمِ



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**TOPIC:**

**FIRST ORDER COMPLEX REACTION**

**Prepared by:**

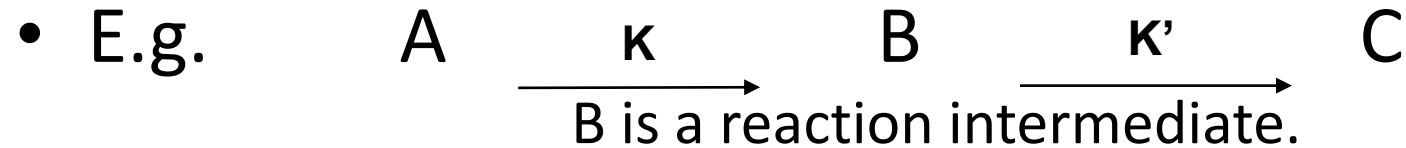
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# Complex Reaction:

- It is a Multi-step reaction.
- These are reactions involving simultaneous breakdown by a sequence of reaction steps.
- Slowest step of complex reaction is called rate determining step.

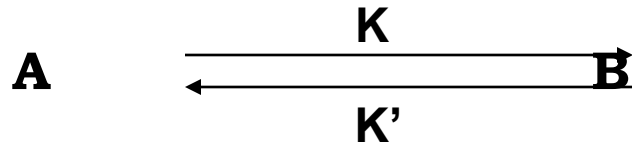


- **Three types of reaction;**
  - a) **OPPOSING REACTION (REVERSIBLE)**
  - b) **SIDE REACTIONS (PARALLEL)**
  - c) **CONSECUTIVE REACTIONS**

....cont:

**a) OPPOSING REACTION (REVERSIBLE):**

- The simplest case is, in which both reactions are of first order



**b) SIDE REACTIONS (PARALLEL):**

- Here the reacting substance can be removed by two or more reactions occurring simultaneously,

**EXAMPLE:**

- Purified insulin degrades by two mechanisms- deamidation and polymerization.

....cont:

**c) CONSECUTIVE REACTIONS:**

- Simplest is one where both the reaction is of first order.
- If  $k_2 > k_1$  then B can be considered as unstable intermediate and rate determining step for overall reaction would be conversion of A to B.



**Examples: -**



Degradation of chlorbenzodiazepine by hydrolysis to lactam form and further to benzophenone.

# Order of Reaction:

- This is the number of concentration terms that determine the rate.
- Consider the reaction:



- The overall equation is,

$$\mathbf{Rate = k [A]^x [B]^y}$$

- The overall order of reaction is **x+y**

.....cont:

- Reactions may be classified according to the order of reaction, which is the number of reacting species whose concentration determines the rate at which the reaction occurs.
- Types of order of reaction:
  - 1. Zero order reaction**
  - 2. First order reaction**
  - 3. Second order reaction**
  - 4. Third order reaction & Higher**
  - 5. Pseudo order reaction**
  - 6. Complex reactions**

# 1<sup>st</sup> order reaction:

- When the reaction rate depends on the **first power of concentration** of a single reactant, it is considered to be **first order**.

$$K = \frac{2.303 \log (a/a-x)}{t}$$

- **Unit of K** for first order is **time<sup>-1</sup>** i.e. **SI unit is (sec)<sup>-1</sup>**.



# First Order Complex Reactions:

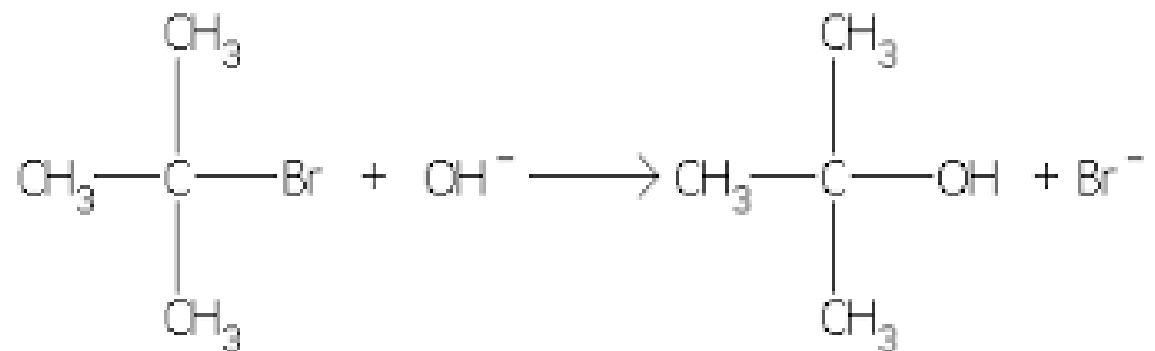
- The complex reactions in which reaction rate depends on a single reactant, are known as first order complex reactions.
- Radioactive decay processes are all first order.
- Complex reactions may or may not have reaction orders equal to their stoichiometric coefficients.
- Reaction orders can be determined only by experiment.

# .....cont:

- There is no detectable difference between first order and zero order at less than **15%** decomposition.
- Many companies take the attitude of plotting by **first order** in situation where the order is unknown.
- Establishing the true order of reaction can often be difficult, due to the fact that strength changes at **25°C** are small and that unit-to-unit and assay variation make such a distinction difficult

# EXAMPLE :

- The reaction between Trimethylbromomethane (tert-butyl bromide) and the hydroxide ions from sodium hydroxide solution is first order complex reaction :



- The overall reaction replaces the bromine atom in the organic compound by an OH group.

.....cont:

- The reaction takes place in two elementary steps :

1. In the first elementary step

Trimethylbromomethane breaks to give ions :



Carbon-bromine bonds are reasonably strong, so this is a slow change .

.....cont:

- In the second elementary step ,tert-butyl radical reacts with hydroxide ion to give “Butyl Alcohol” :



Because carbon-oxygen bonds are strong, once the OH group has attached to the carbon atom, it tends to stay attached. The reaction is fast, & Butyl Alcohol is the final product.

.....cont:

- The tert-butyl radical is the reaction intermediate.
- The slow step of a reaction is known as the *rate determining step*. SO,



- The reaction is first order with respect to the organic compound.

# Summary:

- Complex reaction is a Multi-step reaction.
- Order of reaction is the number of concentration terms that determine the rate.
- first order complex reactions are those in which reaction rate depends on a single reactant.
- Reaction orders can be determined only by experiment.
- There is no detectable difference between first order and zero order at less than **15%** decomposition.

Thank You

