

NEET Revision Notes

Chemistry

Reaction mechanism

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The series of easy steps that trigger a chemical reaction is known as a reaction mechanism. When there are more than two steps involved, the response might become complex. The outcome is determined by the steps that proceeded slowest. Although the last step is the slowest, it doesn't really matter because the succeeding steps must wait if the initial step takes too long.

General Principles

- To understand the mechanism of chemical transformation, it is crucial to comprehend electron flow.
- The essential levers and drives that are connected to the models must be passed through.
- The lever in organic chemistry is made up of the flow of electrons, their solvent influence, polarity, stability, and balance reactions.

Reaction of Nucleophiles and Bases

- The nucleophile can easily bond with an atom that is electron deficient. These nucleophilic species generally have an electron pair for bonding. For example, adduct formed between NH_3 (nucleophile with lone pair) and BH_3 (electron deficient species).
- Bases or nucleophiles acting on molecules can result in a wide range of changes.
- These changes adhere to a set of guidelines. Depending on the level of comprehension that is appropriate in many circumstances, these transformations can be divided into many categories.
- Different electrophile and nucleophile varieties can convert substances in various ways.

Examples of nucleophile, Cl^- , Br^- , HO^- , H_2O , NH_3 , etc.

Reaction with Acid and Other Electrophiles

- Electrophiles can be defined as electron-deficient species which are able to attract electron-rich species.
- When an electrophile gains an electron pair, a nucleophile reacts to form a bond with it that also involves interactions between a proton and a base.
- The addition of nucleophiles to electrophiles and the processes of rearrangements, hydrolysis, and substitution are all influenced by the reaction of an electrophilic species, which is described by Lewis Acid.
- Electrophiles are generally compounds which have an atom that does not contain an octet of electrons. For example, BF_3 .

Examples of Electrophiles, Cl^+ , Br^+ , H^+ , ^+NO , $^+\text{NO}_2$, etc.

Radical and radical Anions

- The species that contain radicals have one or more unpaired electrons. While radical entities are likewise electron-deficient, they are typically uncharged and have characteristics that are different from carbenes.
- Early radical chemistry has high energy and is generally an unpredictable process. But throughout time, radical chemistry evolved into a well-developed collection of adaptable and predictable instruments that contribute to our understanding of chemical processes as a whole.
- Understanding the forces that drive these reactions and their effects is emphasized in key elements of the mechanics and results of many radical processes.

Multistep Reaction Mechanism

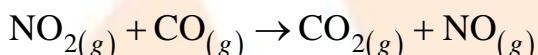
The detailed, step-by-step procedure by which a reaction takes place is described in detail by the reaction mechanism (or reaction route). An elementary reaction is any of the steps in a reaction mechanism. The balanced chemical equation defining the overall reaction is produced by adding these fundamental reactions, which take place in the order shown by the step equations.

One of the fundamental steps of a multistep reaction mechanism moves more slowly than the others, sometimes noticeably slower. The rate-limiting step is the slowest

step (or rate-determining step). A reaction can only move through its slowest phase; as a result, the rate-determining step restricts the rate of the entire reaction.

The balanced chemical equations for simple reactions can be used to directly derive rate laws. However, balanced equations frequently depict the total change in the chemical system brought on by multistep reaction mechanisms, which is not the case for the majority of chemical reactions. Deducing the response mechanism from the rate law requires first determining the rate law from experimental data.

For example, assume the reaction of NO_2 and CO:



The predicted rate law for this reaction is expressed as

$$\text{Rate} = k[\text{NO}_2][\text{CO}]$$

The reaction is first-order with regard to NO_2 and first-order with respect to CO, according to the rate law. However, the reaction is characterised by a distinct rate law that is second-order with regard to NO_2

$$\text{Rate} = k[\text{NO}_2]^2$$

The following two-step mechanism is consistent with this rate law but not the single step mechanism:



The rate-determining (slower) step gives a rate law showing second-order dependence on the NO_2 concentration, and the sum of the two elementary equations gives the net overall reaction.

The rate law for the overall reaction and the rate law for this step are typically the same when the rate-determining (slower) step is the first step in the reaction mechanism. The rate law for the entire reaction, however, may be more challenging to establish when the rate-determining step is preceded by an elementary phase involving a quickly reversible reaction, frequently because of the presence of reaction intermediates.

The idea that a reversible reaction reaches equilibrium when the speeds of the forward and reverse processes are equal can be applied in these circumstances.

Pericyclic Reaction

- The majority of these reactions are predictable rearrangements that result in a concerted transformation when they occur in an organic reaction in a cyclic transition state.
- It employs systems that were built on a variety of observations related to molecular orbital theory.
- The consistency and predictability of these modifications make them useful.

Oxidation and Reduction

- Reductions and oxidations are chemical reactions in which an atom or molecule has electrons added to it or taken away from them.
- Instead of involving electron transfer, oxidation or reduction entails a change in oxidation number.
- A variety of techniques have been devised to adjust the oxidation number or the state of oxidation in order to produce the required structural change.
- In organic chemistry, oxidations and reductions can occasionally be very useful tools that provide us with a chance to better understand the forces at work and prepare the materials we use on a daily basis.

The composition of the item is altered by chemical processes. A different equation and end product are produced when one atom breaks and a new atom is generated. Most reactions fall into one of four categories: -

1. Synthesis: A combination reaction is another name for the process. To make one complicated compound, the method uses two or more components. Additionally, the synthesis make up big molecules from smaller ones. Different types of chemicals can react with one another. Synthesis happens when numerous equations combine to generate a single equation.

2. Decomposition: It is the process through which a complex molecule splits into a simple one. Two molecules or substances interact and undergo a reaction. It is, in effect, the inverse of a synthesis reaction. For example, hydrogen oxide splits into oxygen, water, and hydrogen. Decomposition is another source of carbonation in soft drinks. Endothermic reactions make up the majority of breakdown processes. To create new chemical bonds and various products, more energy is needed. Most of them are not exothermic though. They expel more heat than they absorb. Thermal

decomposition, electrolytic decomposition, and photolytic decomposition are the many kinds of decomposition. Decomposition is another effect of a catalyst. The method is used to separate metals from oxides, alleviate acid indigestion, get compounded hydrogen, and identify other simple degraded products.

3. Single Displacement: It is also known as a single replacement reaction $A+BC=B+AC$ is the formula that stands out. Cation replacement, anion replacement, etc. are some examples of replacement types. The reaction does not take place if the reactant is not more reactive than a cation. Although the forward reaction is poor, the reaction itself is good. The single replacement reaction is straightforward to predict. Every halogen has a straightforward substitution with oxidation as the (-1).

The element, which takes the place of the compound's cation, is not a halogen. Never will two cations have the same oxidation state. The cation's reactivity series has ended and is no longer evident.

4. Double Replacement: It is the process of switching the positions of two compounds' cations and anions. Two new compounds are created by the ion exchange. The molecule typically has ionic bonds, however, the double replacement may also contain reactants that have covalent or ionic bonds. Water is typically the solvent used in double replacement. One needs just use the double replacement example of silver nitrate and sodium chloride in the water solvent. By observing how anions interact with one another, one can spot a double replacement. Neutralization, alkylation, acid-carbonation reaction, counter-ion exchange, double decomposition, and other processes are examples of double replacement.

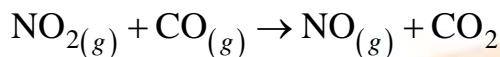
There can be other types of reactions also such as,

- Additional reactions in which a new atom or group of atoms is added to a compound.
- Substitution reactions in which a new atom replaces an already existing atom from the compound.
- Elimination reaction in which a small molecule or atom leaves a compound to form a new compound.
- Rearrangement reactions are those reactions in which rearrangement of atoms occurs within the same compound.

Important Formulas

1. Molecularity and the Rate-Determining Step:

Analyze the far less complicated interaction between carbon monoxide and nitrogen dioxide.



The experimentally determined rate law for the reaction is

$$\text{Rate} = k[\text{NO}_2]^2$$

2. Using Molecularity to Describe a Rate Law.

Elementary reaction	Molecularity	Rate law	Reaction order
$\text{A} \rightarrow \text{products}$	unimolecular	$\text{rate} = k[\text{A}]$	first
$2\text{A} \rightarrow \text{products}$	bimolecular	$\text{rate} = k[\text{A}]^2$	second
$\text{A} + \text{B} \rightarrow \text{products}$	bimolecular	$\text{rate} = k[\text{A}][\text{B}]$	second
$2\text{A} + \text{B} \rightarrow \text{products}$	termolecular	$\text{rate} = k[\text{A}]^2[\text{B}]$	third
$\text{A} + \text{B} + \text{C} \rightarrow \text{products}$	termolecular	$\text{rate} = k[\text{A}][\text{B}][\text{C}]$	third

The molecularity and order of reaction are not always the same. In many cases order of reaction can be fraction and zero but molecularity is a whole number. Molecularity we get from a balanced chemical equation and order of reaction from experimental results.

Solved Examples:

1. In an $\text{S}_{\text{N}}1$ reaction on chiral centers, there is

- (a) Racemic mixture formation
- (b) 100% retention
- (c) 100% inversion
- (d) 100% partial racemization

Ans: Option A

Due to the fact that a completely free carbocation is not actually generated, the $\text{S}_{\text{N}}1$ reaction results in a racemic mixture as it is not a stereospecific reaction. After the formation of carbocation the incoming group can attack either from front or from back. This means do types of isomers can be formed in this reaction. Therefore, there

is a racemic mixture in an S_N1 reaction on chiral centers. Hence, the correct option is A.

Q 2. Which is the best-suited method for the separation of para and ortho-nitrophenols from 1:1 mixture if in any reaction both of these compounds are formed together as products.

- (a) Crystallization
- (b) Sublimation
- (c) Steam Distillation
- (d) Chromatography

Ans: Option C

Because ortho nitrophenol creates intramolecular hydrogen bonding and has a lower boiling point than para-nitrophenol, which possesses intermolecular hydrogen bonding, the boiling points of the two compounds differ significantly. Therefore, distillation is the appropriate response since it divides components of a mixture according to their disparity in boiling points. Therefore, the correct option is C.