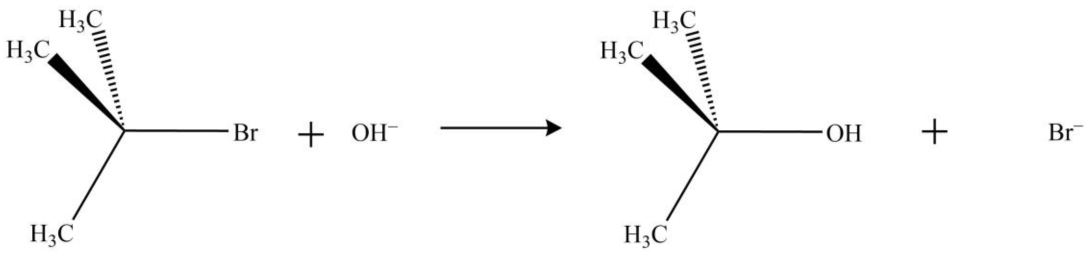
❖ Types of Reactions

Although the number of possible organic reactions and corresponding mechanisms is very large, certain patterns can still be observed which are used to describe numerous useful organic reactions. Each type of reaction has a stepwise route which explains how it occurs, though the actual picture of these steps cannot always be visualized only by looking at the reactants' list. Furthermore, despite their basic classification, many organic reactions may fall into more than one category. For instance, some of the substitution reactions follow an addition-elimination route. Hence, this classification doesn't mean to include all the organic reactions but most of them for general studies.

➢ *Substitution Reactions*

A substitution or single displacement reaction may simply be defined as a chemical change where one functional group in an organic compound is displaced by another functional group.



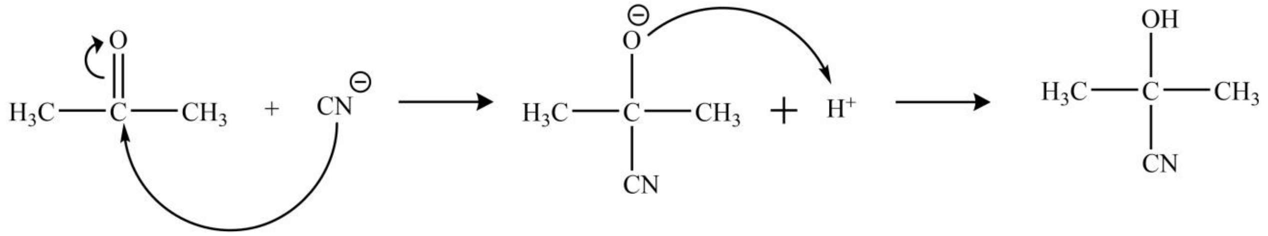
Unimolecular Aliphatic Nucleophilic Substitution Reactions

These types of organic reactions can be classified primarily into three categories; electrophilic substitution, nucleophilic substitution, and radical substitution depending upon the type and nature of the attacking reagent involved. Further classification is also possible by considering whether the reactive intermediate is a carbanion, a carbocation, or a free radical; or if the substrate is aliphatic or aromatic.

➢ *Addition Reaction*

The addition reaction in organic chemistry may simply be defined as a chemical change where two or more molecular entities combine to give rise to a bigger molecule (i.e., the adduct). Also, since the incoming group needs to bind to substrate, addition reactions are pretty much limited to organic compounds with multiple bonds, like molecules with carbon-carbon double or triple bonds (alkenes), and compounds that possess rings in them (i.e. also a kind of unsaturation). Furthermore, besides alkenes, alkynes, or ring structures, the organic compound can also have carbon-hetero multiple double bonds like imine (C=N) groups or carbonyl (C=O) groups; and therefore, are also capable of undergoing addition reactions.

The addition reaction can also be treated as the opposite of an elimination reaction. For example, the alkene's hydration to alcohol is the opposite of the dehydration reaction. The addition reactions can primarily be classified into two types: polar addition and non-polar addition. Polar additions are further divided into electrophilic addition and nucleophilic additions; whereas the non-polar addition reactions can be subdivided into free-radical addition and cycloaddition types.



Nucleophilic Addition Reaction

Finally, it is also worthy to note that addition reactions are also found in polymerization processes and are typically labeled as addition polymerization.

➢ ***Elimination Reactions***

An elimination reaction in organic chemistry may simply be defined as a chemical change where two substituents are detached from a molecule in either a one- or two-step pathway. The one-step pathway is abbreviated as the E_2 mechanism, whereas the two-step pathway is abbreviated as the E_1 mechanism. Hence, the subscript in E_1 or E_2 reactions does not represent the number of steps involved, but the kinetics followed; E_1 is unimolecular (first-order) while E_2 is bimolecular (second-order).

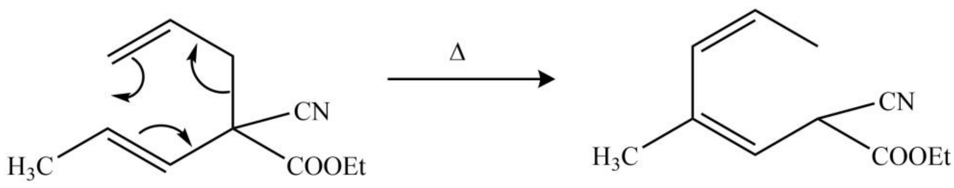
E1 Elimination Reaction

Furthermore, if the molecule can stabilize an anion but does have a poor leaving group, the third kind of mechanism, called E_1CB, also exists. Lastly, a fourth kind, called the internal elimination (E_i), also exists which is generally followed by pyrolysis of xanthate and acetate esters.

➢ ***Rearrangement Reactions***

A rearrangement reaction in organic chemistry may simply be defined as a chemical change where the carbon skeleton of an organic compound rearranges itself to give rise to a structural isomer. Generally, a group moves from one atom to another atom within the same molecule.

Now although the domain of rearrangement reactions is extremely wide, these changes can still primarily be classified into four categories; 1, 2 rearrangements, metathesis reactions, sigmatropic rearrangements, and electrocyclic reactions. A fifth kind called group transfer reactions also exist but are far less important than what we have mentioned. One of the most common examples of rearrangement reactions is the 'Cope rearrangement' which is a 1, 3-sigmatropic rearrangement involving the movement R group from 1st carbon to 3rd carbon in the same molecule.

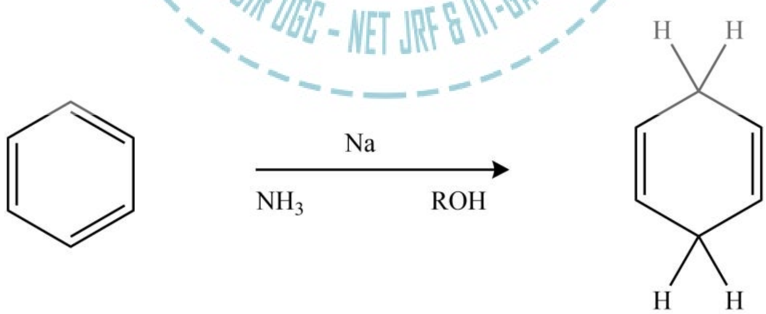


Cope Rearrangement

Besides intramolecular rearrangements, intermolecular rearrangements are also possible in many organic compounds; the group transfer reaction we mentioned is an example. It is also worthy to note that a rearrangement cannot be represented by the simple and discrete electron in a very good manner. For instance, in Wagner-Meerwein rearrangement, the actual mechanism of alkyl group migration involves the transfer of the alkyl group fluidly along with a bond, and not the typical bond breaking-making. Similarly, the pericyclic rearrangements are explained in terms of orbital interactions rather than discrete electron transfers. Nevertheless, it is quite possible to draw the curved arrows mechanism for rearrangement reaction for simple and fast understanding, even if these are not realistic necessarily, excepting in allylic rearrangement.

- ***Redox Reactions***

Redox reactions in organic chemistry may simply be defined as the chemical changes where the reduction or oxidation of organic compounds occurs to give rise to new products. It is also worthy to note that the meaning of oxidations and reductions in organic chemistry is different from simple redox reactions because numerous reactions bear the label but do not include the actual electron transfer in the electrochemical context. In its place, organic oxidation is the gain of oxygen or loss of hydrogen; whereas organic reduction means the gain of hydrogen or the loss of oxygen. Nevertheless, simple functional groups can still be organized in the ascending order of oxidation states for approximation.



Birch Reduction

Finally, we need to remember that the reactant can undergo both oxidation and reduction in the same chemical reaction to give rise to two separate compounds (disproportionation reactions).

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Mandeep Dalal
(M.Sc, Ph.D, CSIR UGC – NET JRF, IIT-GATE)
Founder & Educator, Dalal Institute
E-Mail: dr.mandeep.dalal@gmail.com
www.mandeepdalal.com

Mandeep Dalal is an Indian research scholar who is primarily working in the field of Science and Philosophy. He received his Ph.D in Chemistry from Maharshi Dayanand University, Rohtak, in 2018. He is also the Founder of "Dalal Institute" (India's best coaching centre for academic and competitive chemistry exams), the organization that is committed to revolutionize the field of school-level and higher education in Chemistry across the globe. He has published more than 40 research papers in various international scientific journals, including mostly from Elsevier (USA), IOP (UK), and Springer (Netherlands).

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