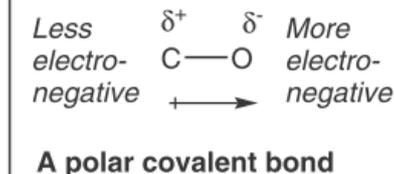
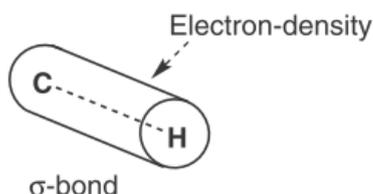
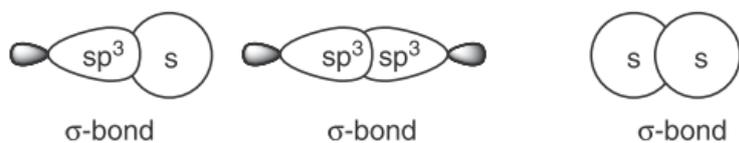


Practical LESSON 2

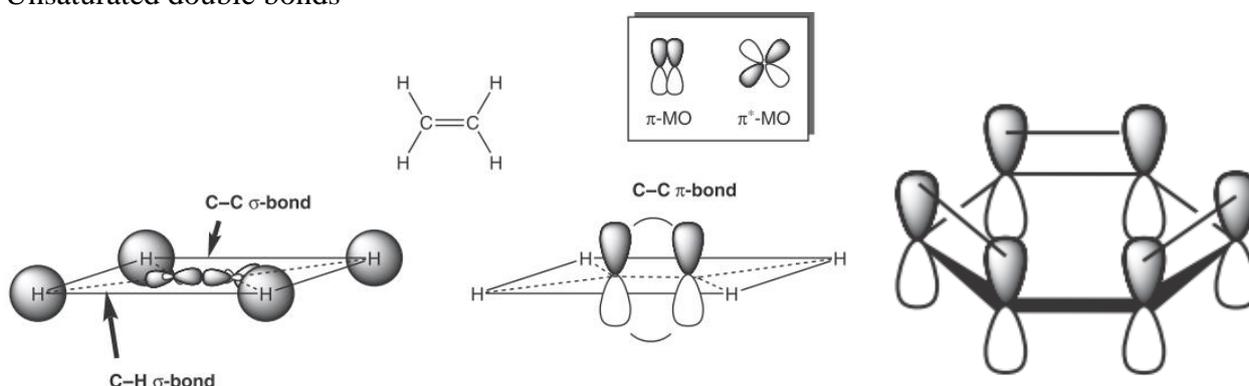
Type of covalent bonds and hybridization

Saturated single bonds



Shape Around an Atom (A)	Approximate Bond Angle ($^\circ$)
linear	180
trigonal planar	120
tetrahedral	109.5

Unsaturated double bonds



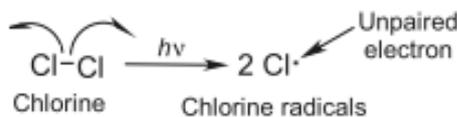
Types of organic reactions

Reaction types	Brief definition	Where they occur
Radical reactions	New bond is formed using radical from each reactant.	Alkanes and alkenes.
Addition reactions	Addition means two systems combine to a single entity.	Alkenes, alkynes, aldehydes and ketones.
Elimination reactions	Elimination refers to the loss of water, hydrogen halide or halogens from a molecule.	Alcohols, alkyl halides and alkyl dihalides.
Substitution reactions	Substitution implies that one group replaces the other.	Alkyl halides, alcohols, epoxides, carboxylic acid and its derivatives, and benzene and its derivatives.
Oxidation–reduction reactions	Oxidation = loss of electrons.	Alkenes, alkynes, 1 $^\circ$ and 2 $^\circ$ alcohols, aldehydes and ketones.
	Reduction = gain of electrons.	Alkene, alkyne, aldehydes, ketones, alkyl halides, nitriles, carboxylic acid and its derivatives, and benzene and its derivatives.
Pericyclic reactions	Concerted reaction that takes place as a result of a cyclic rearrangement of electrons.	Conjugated dienes and α,β -unsaturated carbonyl compounds.

Radical reactions: free radical chain reactions

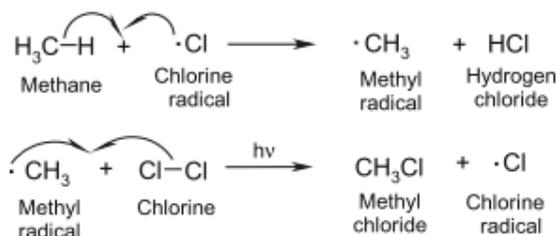
1) Initiation.

A chlorine atom is highly reactive because of the presence of an unpaired electron in its valence shell. It is electrophilic, seeking a single electron to complete the octet.



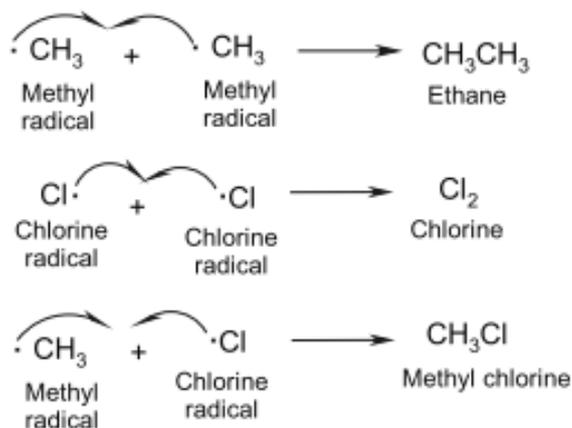
2) Propagation.

In this step, the intermediate reacts with a stable molecule to produce another reactive intermediate and a product molecule



3) Termination.

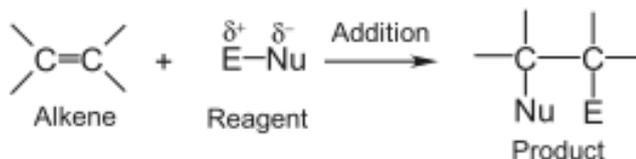
In this step, the reactive particles are consumed, but not generated.



Addition reactions

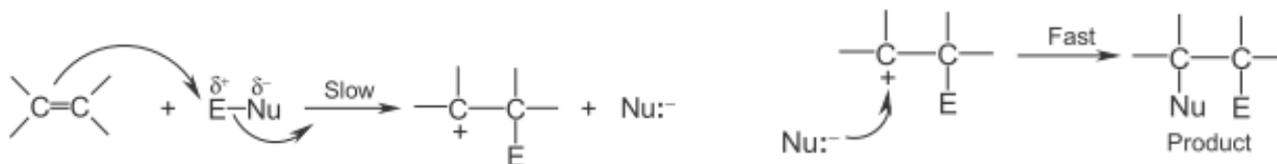
Addition reactions occur in compounds having π -electrons in carbon-carbon double (alkenes) or triple bonds (alkynes) or carbon-oxygen double bonds (aldehydes and ketones). Addition reactions are of two types: electrophilic addition to alkenes and alkynes, and nucleophilic addition to aldehydes and ketones. In an addition reaction, the product contains all of the elements of the two reacting species.

General reaction and mechanism of A_E

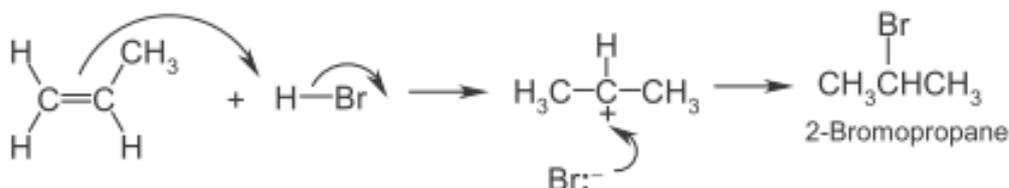


1 stage is a formation of a carbocation intermediate (slow)

2 stage is an attack of carbocation by the nucleophile Nu^- and fast product formation



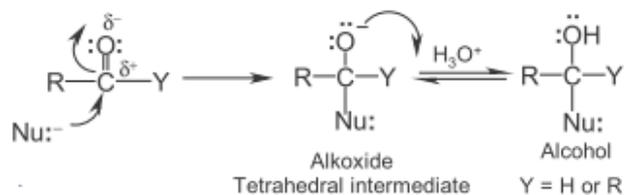
Example



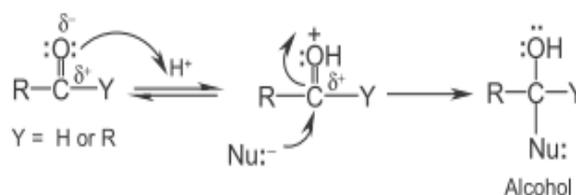
The most common reaction of aldehyde and ketone is **nucleophilic addition**. Aldehyde generally undergoes nucleophilic addition more readily than ketone. In the nucleophilic addition reaction, carbonyl compound can behave as both Lewis acid and Lewis base

The carbonyl group is strongly polarized, with the oxygen bearing partial negative charge (δ^-) and the carbon bearing partial positive charge (δ^+). So the carbon is electrophilic, and therefore readily attacked by the nucleophile. The attacking nucleophile can be either negatively charged (Nu^-) or a neutral (Nu) molecule. Aldehydes and ketones react with nucleophiles to form addition products followed by protonation.

If nucleophile is a negatively charged anion

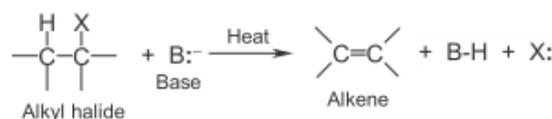
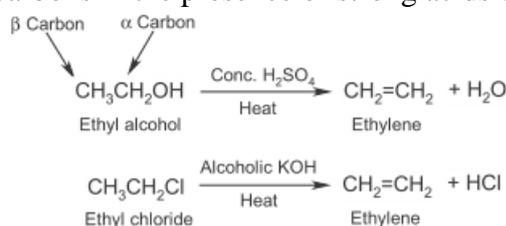


If nucleophile is neutral molecule with a lone pair of electrons



Elimination reactions

The electronegative atom or a leaving group is removed along with a hydrogen atom from adjacent carbons in the presence of strong acids or strong bases and high temperatures.

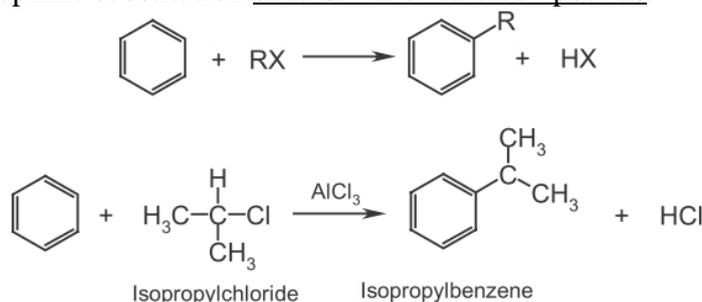


Mechanism

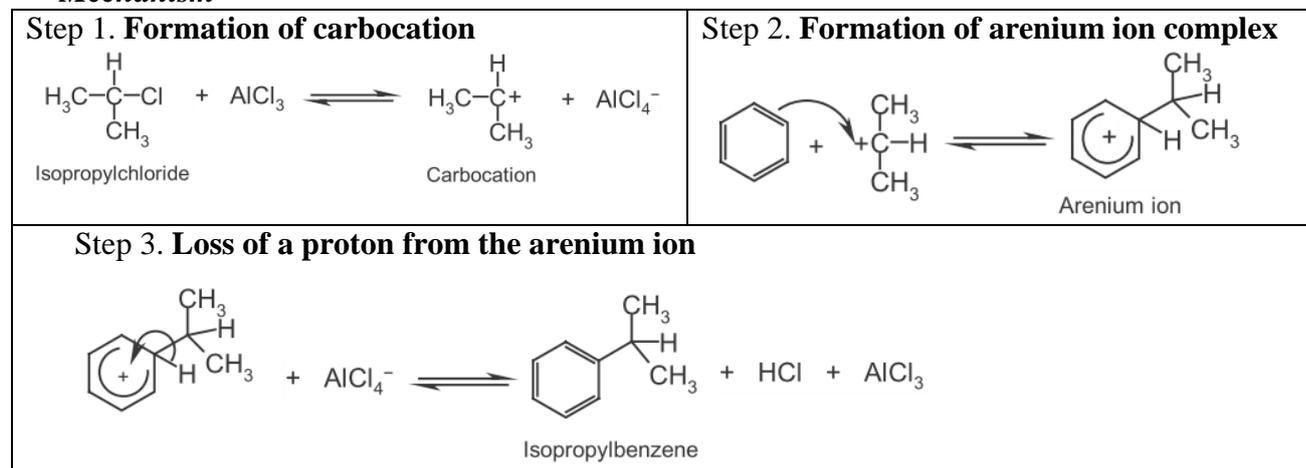
Substitution reactions

It is the replacement of one atom or group by another. Two types of substitution reaction can occur: **nucleophilic substitution** and **electrophilic substitution**. A nucleophile is an electron rich species that reacts with an electrophile. The term **electrophile** literally means 'electron-loving', and is an electron-deficient species that can accept an electron pair.

Electrophilic substitution reactions are those where an electrophile displaces another group, usually a hydrogen. Electrophilic substitution occurs in aromatic compounds.

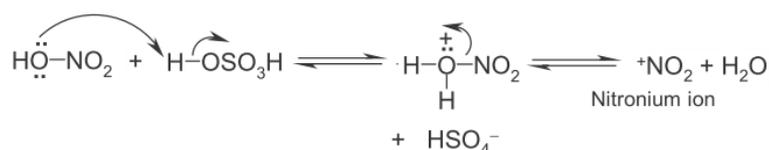


Mechanism

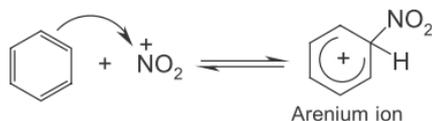


Or another example:

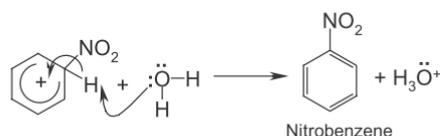
Step 1. Generation of nitronium ion (${}^+\text{NO}_2$), an electrophile



Step 2. Formation of arenium ion complex

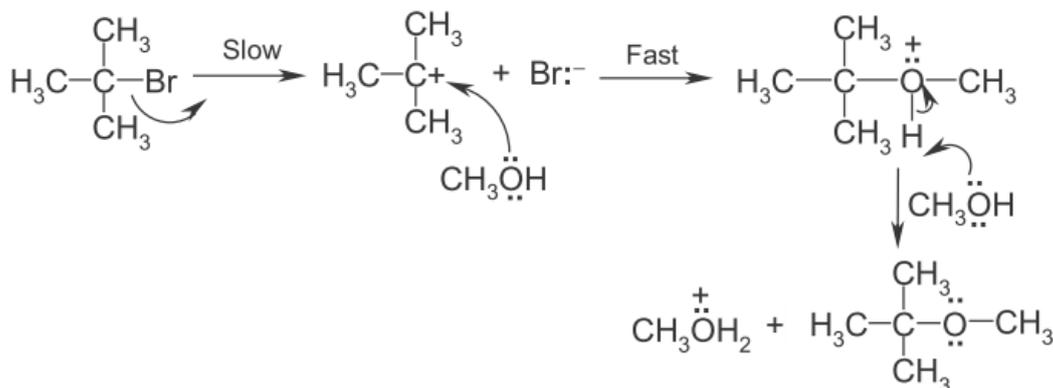


Step 3. Loss of a proton from the arenium ion complex



Two different mechanisms for **nucleophilic substitution** are $\text{S}_{\text{N}}1$ and $\text{S}_{\text{N}}2$ mechanisms. In fact, the preference between these mechanisms depends on the structure of the alkyl halide, the reactivity and structure of the nucleophile.

$\text{S}_{\text{N}}1$

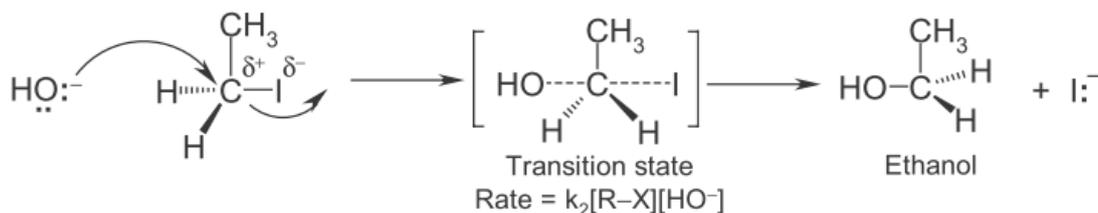


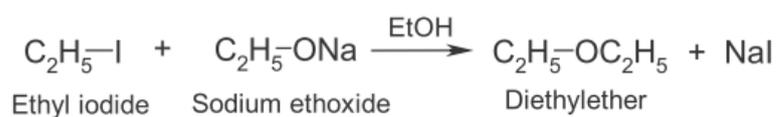
Second order nucleophilic substitution: $\text{S}_{\text{N}}2$ reaction

First stage is the hydroxide ion produces ethanol in an $\text{S}_{\text{N}}2$ reaction.

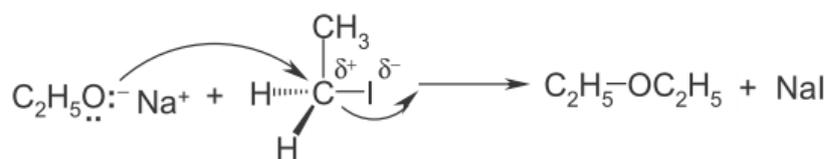


Mechanism.





Mechanism



Reference:

Satyajit D. Sarker, Lutfun Nahar Chemistry for Pharmacy Students General, Organic and Natural Product Chemistry. John Wiley & Sons Ltd, The Atrium, Southern Gate, Chichester, West Sussex PO19 8SQ, England, 2007. – 383 p.