CHEMISTRY

(FOR IIT, NEET, AIIMS)

Chapter : General Organic Chemistry

Topic- Attacking Reagents

➢Attacking Reagents

➢In general, in a chemical reaction, there is a substrate molecule which is attacked by an attacking reagent to form a highly reactive reaction intermediate which reacts further to give final products.

➢Thus, “The species which attacks on the substrate molecules during organic reactions are called attacking reagents”.

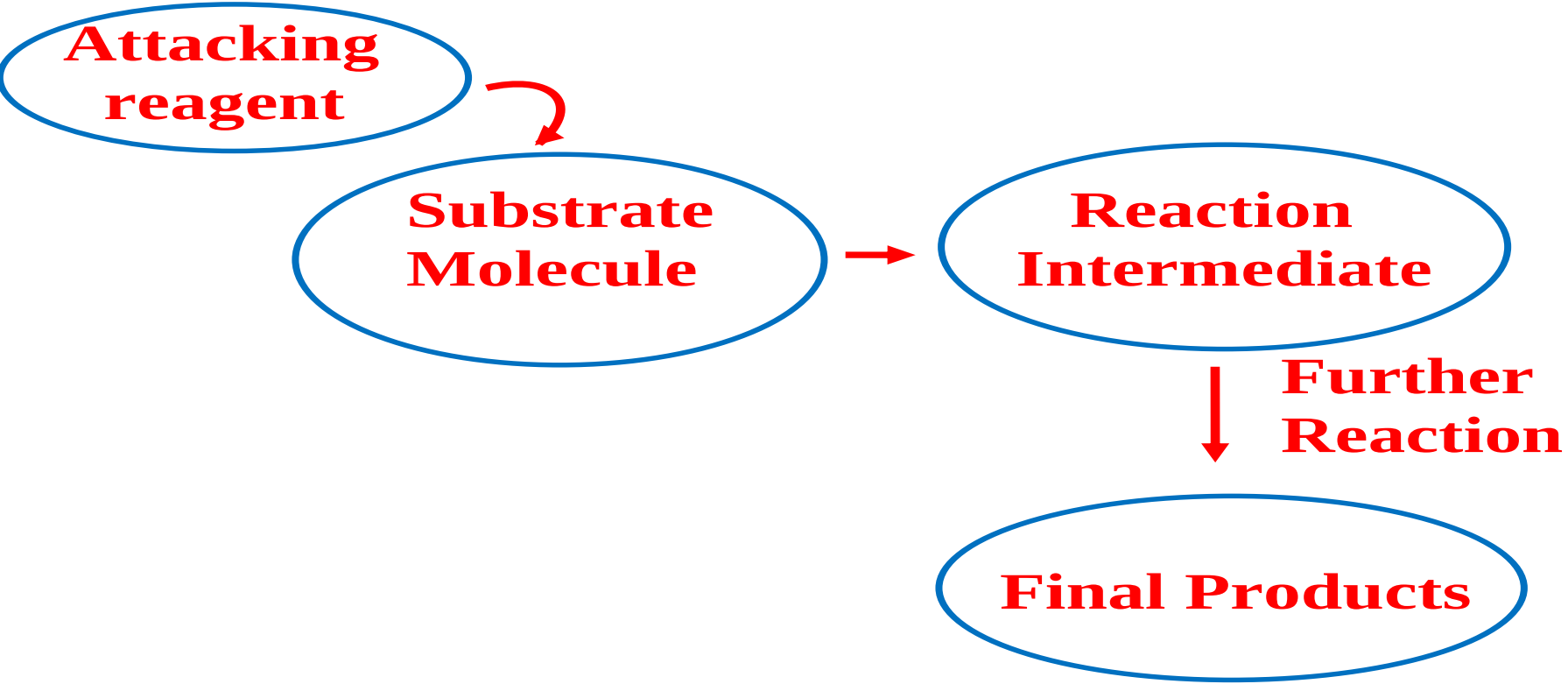


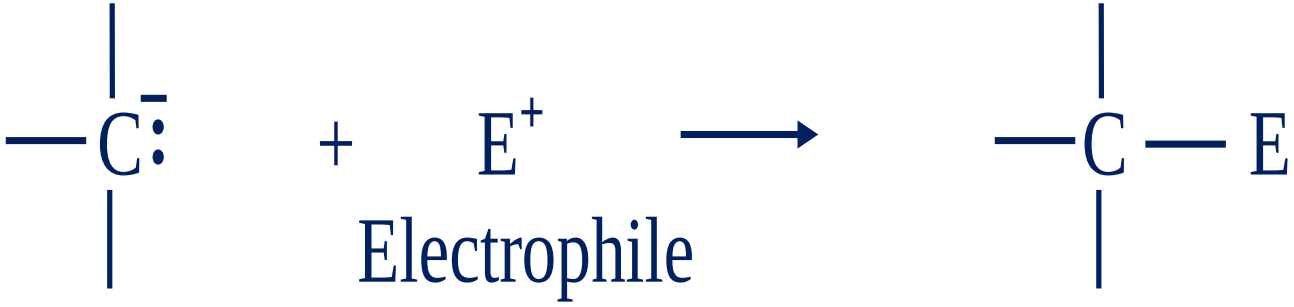
Fig.- Reaction Mechanism

➢Types of attacking reagents

➢Attacking reagents may be of following two types-

(a) Electrophilic reagents or Electrophiles

- ➢ These are electron deficient or positively charged species which attack on electron rich or negatively charged centre of substrate molecules (Electro = electron, philous = loving).
- ➢ Electrophiles usually contain a sextet of electron and attack on the region of high electron density of substrate molecules (nucleophiles).



Substrate (Nucleophile)

Neutral molecule

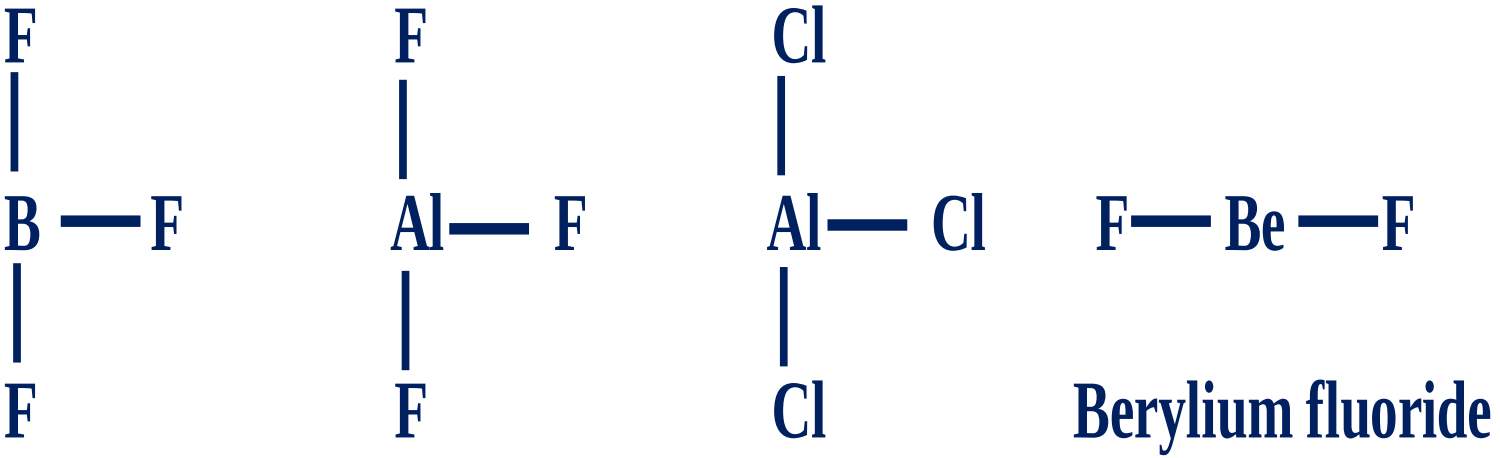
➢Types of Electrophiles

➢Electrophiles may be of following types-

(1) All cations- H^+ (H_3O^+), Ag^+, Cu^{2+}, Fe^{3+}, Cl^+ (Chloronium ion), Br^+ (Bromonium ion), I^+ (Iodinium ion), NO_2^+ (Nitronium ion), NO^+ (Nitrocylinium ion), R^+ (Carbonium ions), CH_3CO^+ (acylinium ion), $C_6H_5N_2^+$ (benzene diazonium ion), NH_4^+ etc.

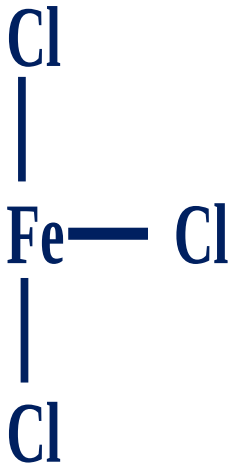
➢ **Exceptions-** Alkalies metal ions (Na^+, K^+, Rb^+ etc.) and alkaline earth metal ions (Mg^{2+}, Ca^{2+}, Sr^{2+}etc.). These ions have octet configuration and do not have any tendency to gain lone pair of electrons from nucleophiles.

(2) Neutral molecules containing electron deficient central atom-

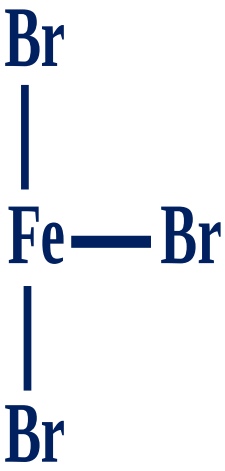


Boron trifluoride Aluminium fluoride Aluminium chloride Berylium fluoride

(3) Neutral molecules having central atom with vacant d-orbitals-



Ferric chloride



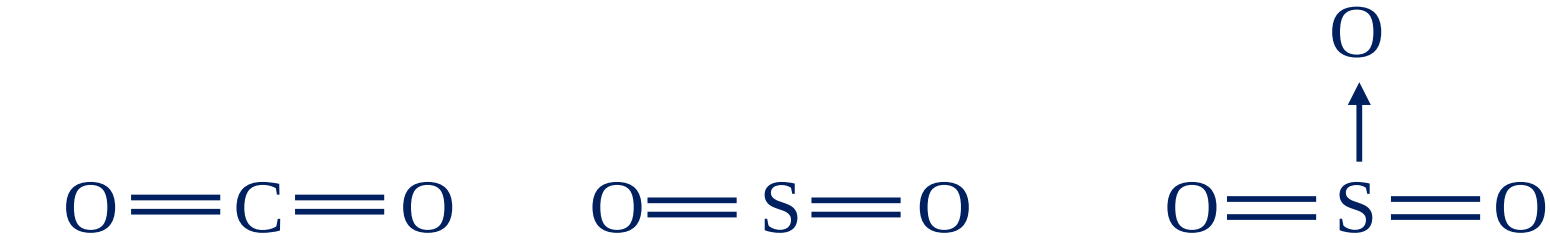
Ferric bromide



Silicon tetrafluoride

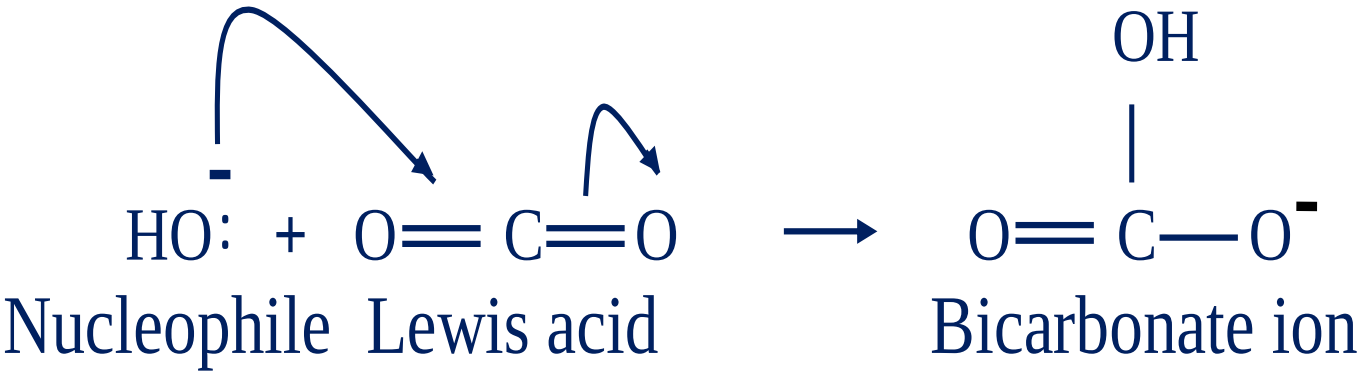
- $ZnCl_2$ and ICl also belong to this category.

(4)Neutral molecules where atoms of different electronegativities remain bonded together by multiple bonds- For example,



Carbon dioxide Sulphur dioxide Sulphur trioxide

➢In fact, at the approach of nucleophile, these molecules undergo electrophilic change and gain a lone pair of electron from the nucleophile. For example,



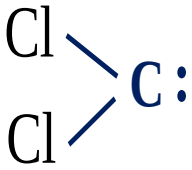
➢Some other examples of this category are- Carbonyl compounds (aldehydes and ketones), acid halides (RCOX), acid anhydrides[$(RCO)_2O$]etc.

(5) Grignard's reagents-



(6) Carbenes-





(7) Nitrenes-



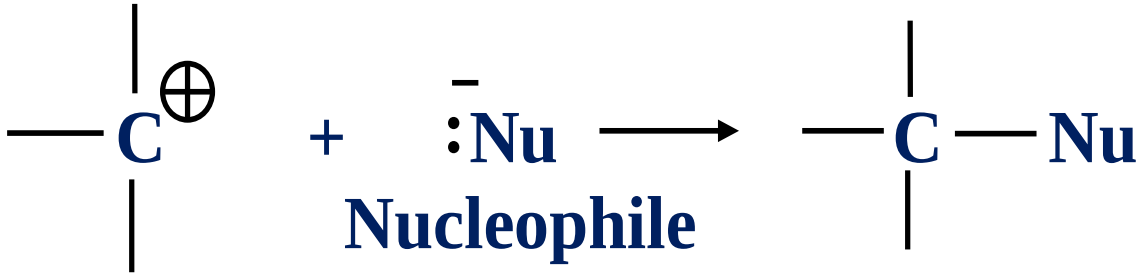
(8) Cation carriers (such as Br - Br, H - Br, Cl-OH, O_2N-OH), **oxidising agents** (such as Fe^{3+}, R-O-O-R, O_3 etc.) and **free radicals** (such as $Cl\cdot$, $H_3C\cdot$) are also considered to be electrophiles.

➢It is clear that, the electrophiles are in general Lewis acids and have capability to gain one or more lone pair of electrons from nucleophiles (Lewis base).

(b) Nucleophilic reagents or Nucleophiles

➢These are electron rich or negatively charged species which attack on electron deficient or positively charged centre of substrate molecule (Nucleo = nucleus, philous = loving).

➢Nucleophiles usually contain one or more lone pair of electrons and attack on the region of low electron density of substrate molecules (electrophiles).



Substrate (Electrophile)

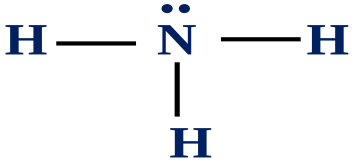
Neutral molecule

➢ Types of Nucleophiles

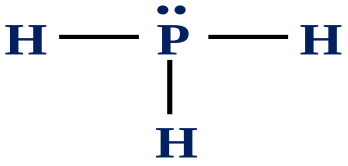
➢ Nucleophiles may be of following types-

(1) All anions- H^-, OH^-, SH^-, CN^-, HSO_3^- (Bisulphite ion), Cl^- (chloride ion), Br^- (Bromide ion), I^- (Iodide ion), NO_2^- (Nitrite ion), R^- (Carbonium ions), RO^- (alkoxide ion), NH_2^- (Amide ion), RNH^-, R_2N^-, $RCOO^-$ (Carboxylate ion), N_3^- (Azide ion), $[CH(COOC_2H_5)_2]^-$, $[CH_3COCHCOOC_2H_5]^-$ etc.

(2) Neutral molecules containing one or more lone pair of electrons on central atom



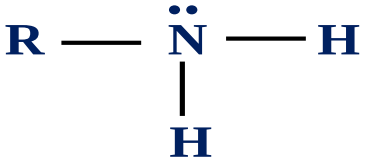
Ammonia



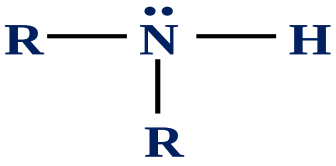
Phosphine



Water



1^0 Amine



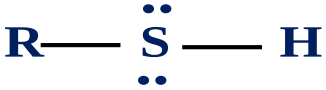
2^0 Amine



Alcohol



Ether



Thio alcohol

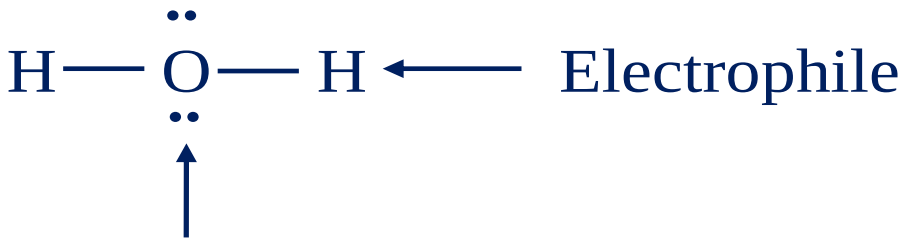


Thio ether

(3)Anion carriers (such as H-H, R-MgX, R-Li, H-$LiAlH_3$, alkenes, benzene, reducing agents (such as Fe^{2+}, $[Fe(CN)_6]^{4-}$ etc. are also considered to be nucleophiles.

➢It is clear that, the nuclophiles are in general Lewis bases and contain one or more lone pair of electrons, that can be donated to an electrophile (Lewis acid) during the reaction.

➢**Ambiphiles (Ambidents)-** Such attacking reagents which can act both like electrophile and nucleophile are called ambiphiles or ambidents. For example, H-O-H, R-O-H, RPH_2, CH_3CN, HCHO etc.



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