By- SHAILENDRA SHUKLA SIR

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 that react further to give final products**.**

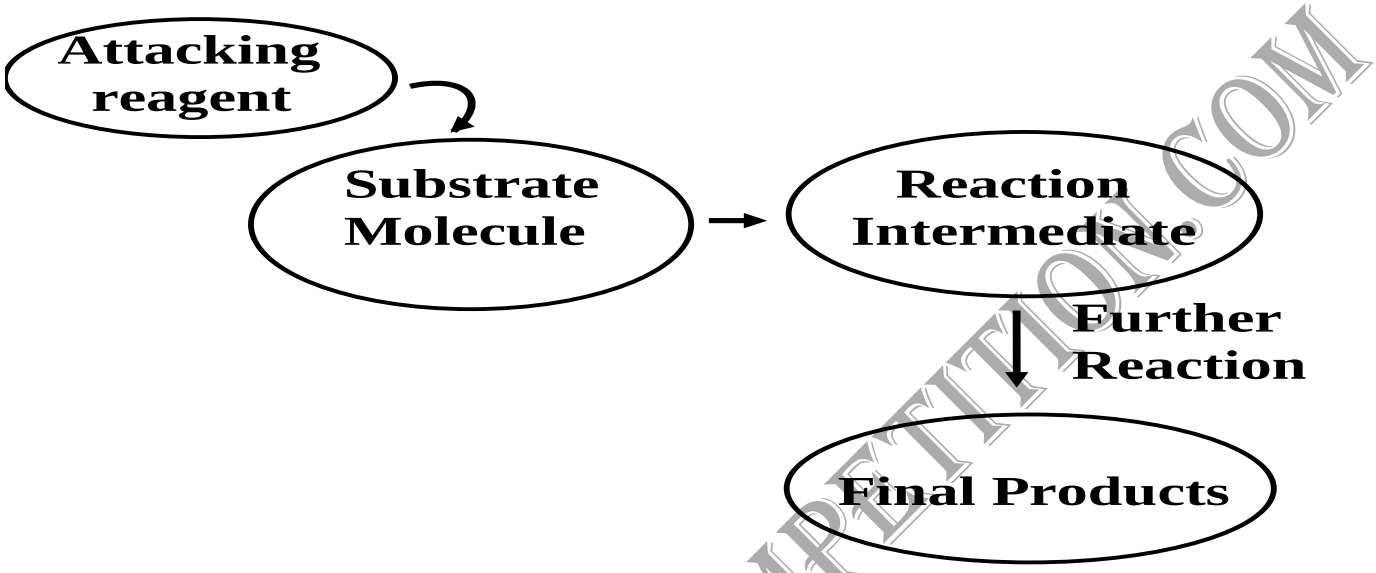


Fig.- Reaction Mechanism

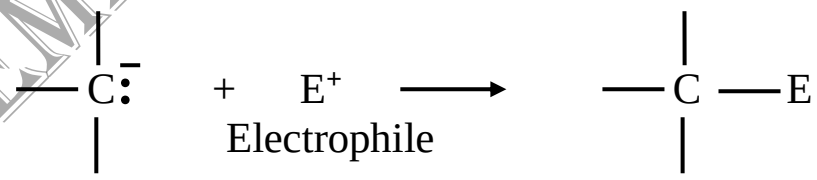
Thus, "The species which attacks on the substrate molecules during organic reactions are called attacking reagents".

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 molecule (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

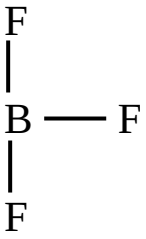
Electrophiles may be of following types-

(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^+ (Nitrosylinium ion), R^+ (Carbonium ion), CH_3CO^+ (acylinium ion), $C_6H_5N_2^+$ (benzene diazonium ion), NH_4^+ etc.

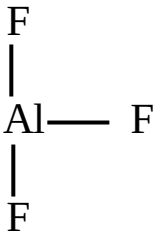
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Exceptions- Alkalies metal ions (Na^+, K^+, Rb^+ etc.) and alkaline earth metal ions (Mg^{2+}, Ca^{2+}, Sr^{2+} etc.). These ions have octet configuration and do not have any tendency to gain lone pair of electrons from nucleophiles.

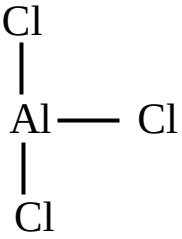
(2) Neutral molecules containing electron deficient central atom-



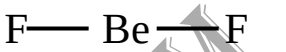
Boron trifluoride



Aluminium fluoride

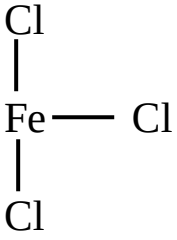


Aluminium chloride

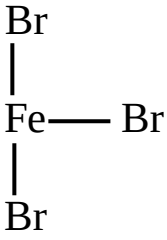


Berylium fluoride

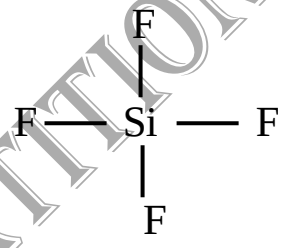
(3) Neutral molecules having central atom with vacant d-orbitals-



Ferric chloride



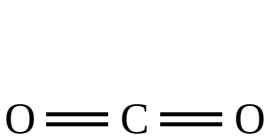
Ferric bromide



Silicon tetrafluoride

$ZnCl_2$ and ICl also belong to this category.

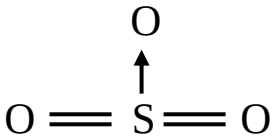
(4)Neutral molecules where atoms of different electronegativities remain bonded together by multiple bonds- For example,



Carbon dioxide

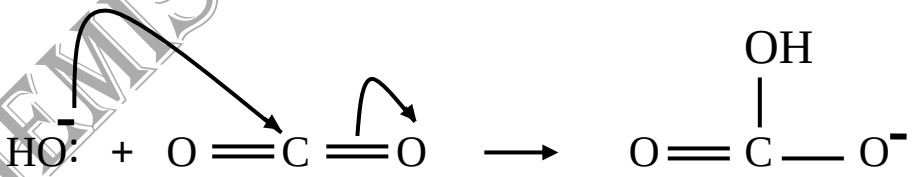


Sulphur dioxide



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,



Nucleophile Lewis acid Bicarbonate ion

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-



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(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).



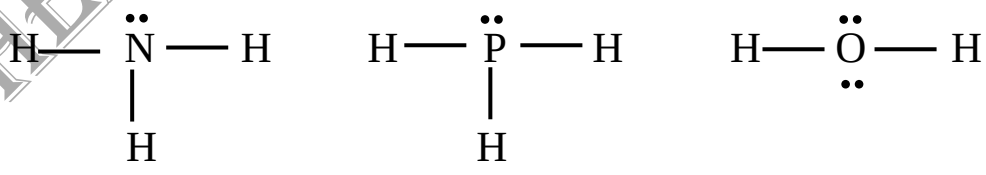
Substrate (Electrophile)

Neutral molecule

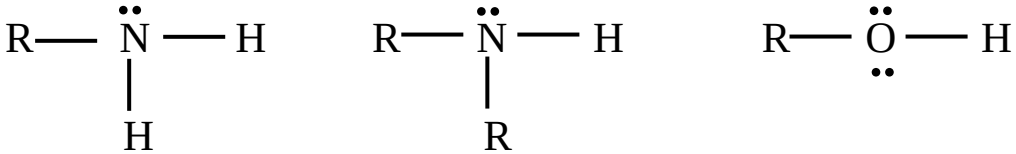
Nucleophiles may be of following types-

(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.

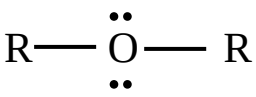
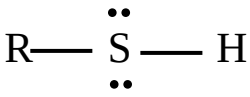
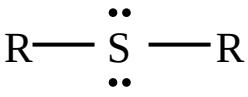
(2) Neutral molecules containing one or more lone pair of electrons on central atom-



Ammonia Phosphine Water



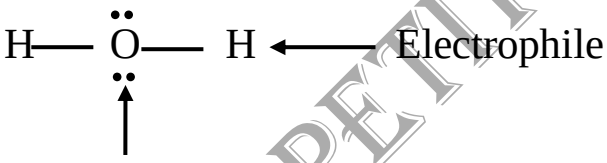
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1^0 Amine	2^0 Amine	Alcohol
		
Ether	Thio alcohol	Thio ether

(3) Anion carriers (such as H-H, 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).

- **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.



Water (As ambiphile)

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