

# Haloalkanes & Haloarenes

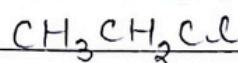
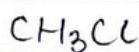
The replacement of hydrogen atom(s) in an aliphatic or aromatic hydrocarbon by halogen atom (s) results in the formation of alkyl halide (haloalkane) and aryl halide (haloarene), respectively.

## Classification :

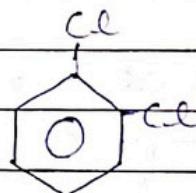
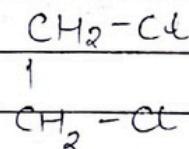
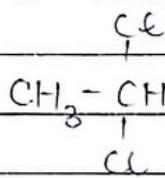
### 1. On the basis of number of Halogen atoms :

#### (a) Monosubstituted haloalkane and haloarenes :

e.g.



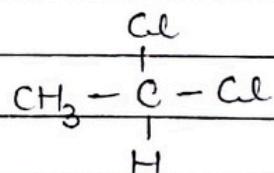
#### (b) Di-substituted haloalkane and haloarenes :



Di-substituted haloalkanes can be further classified as -

#### (i) Gem-di-halide

when both the X-atom are attached to same carbon.

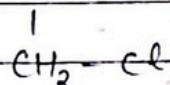
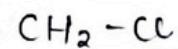


Ethyldene chloride.

#### ↳ Alkyldene halide

(ii) vic - dihalide

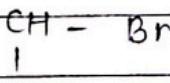
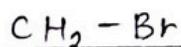
when the two X - atoms are attached to the adjacent carbon .



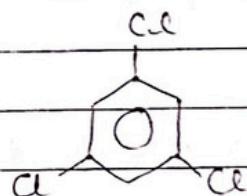
Ethylene chloride

↳ Alkylene halids

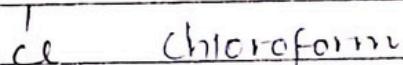
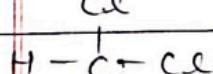
© Polysubstituted haloalkane and haloarene :



Tri-haloalkane



Tri-haloarene .



Chloroform

2. On the basis of Hybridisation :

@ (i) X is attached to a  $\text{sp}^3$  hybridised Carbon

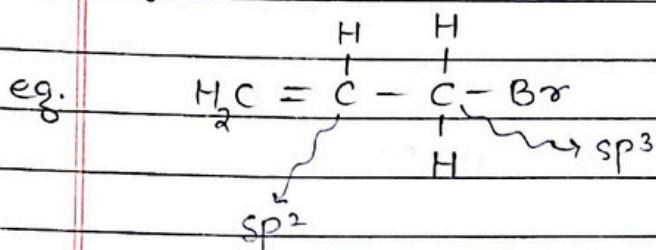
e.g.

Alkyl halide

(b)

Allylic halides

when halogen is attached to a  $sp^3$  hybridised carbon which is attached to a  $sp^2$  hybridised carbon.

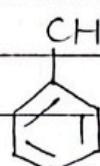


3-bromo prop-1-ene.

(c)

Benzyllic halide:

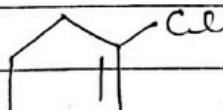
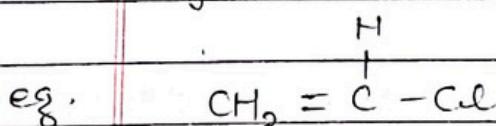
$X$  is attached to  $sp^3$  hybridised carbon which is attached to an aromatic ring.  
(every carbon atom is  $sp^2$  hybridised).



Benzyl bromide.

ii)  $X$  is attached to  $sp^2$  hybridised carbon;Vinylic halide:

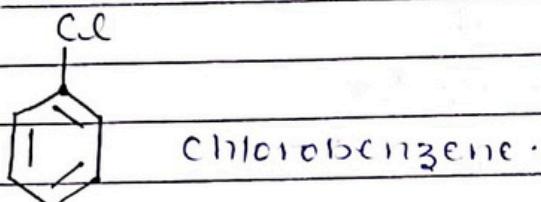
when  $X$  is attached directly to a  $sp^2$  hybridised carbon.



② Aryl halide

when X is attached directly to aromatic ring. (C is  $sp^2$  hybridised).

e.g.



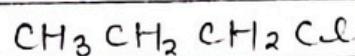
Nomenclature:

(i) Trivial nomenclature:

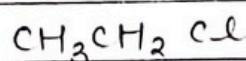
↳ Alkyl Halide

③ 'n' : Prefix

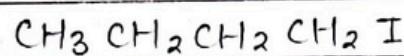
- Edg chain of C and unbranched



n - Propyl chloride



Ethyl chloride

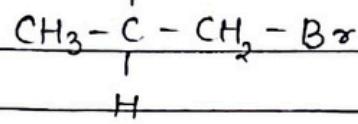


n - butyl iodide

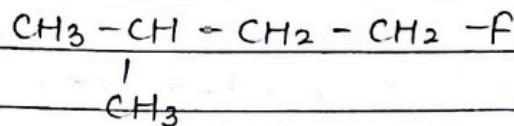
Note: if number of C is more than 2 ; then  
'n' should be used.

(b) 'iso' : Prefix

- When second last C is having  $-CH_2-$  group , then such C are called iso - C.



iso - butyl bromide.

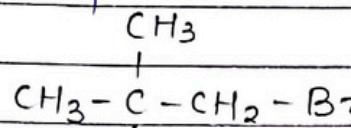


iso - pentyl fluoride

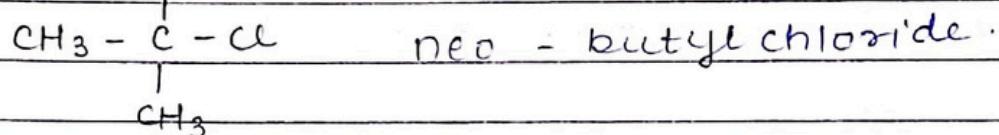
Note: In trivial nomenclature we need to count all the carbon.

③ 'neo' - prefix

- when second last C is attached to 3 methyl group.

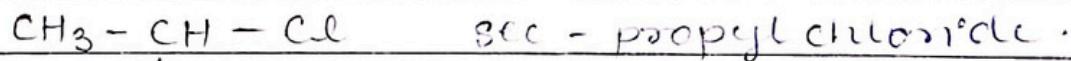
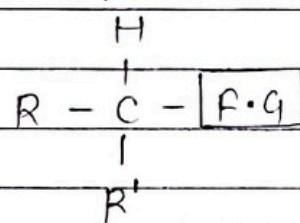


neo - pentyl bromide.



neo - butyl chloride.

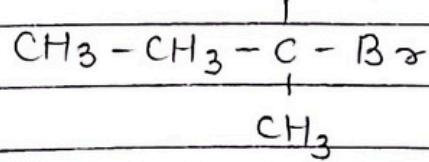
④ Sec :  $2^\circ$  or secondary.



sec - propyl chloride.

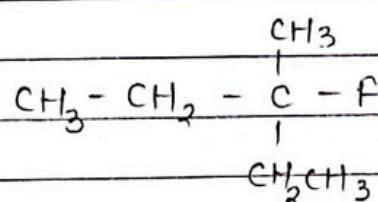
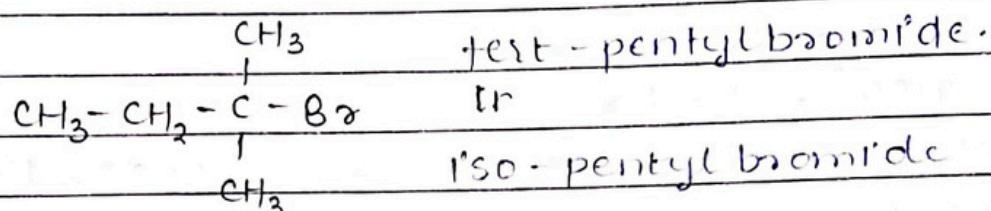
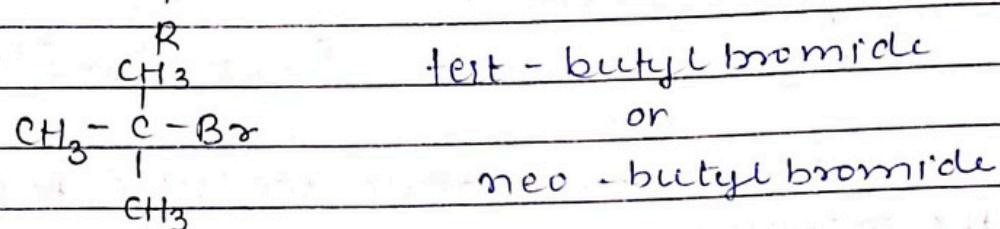
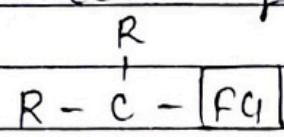
or

iso - propyl chloride



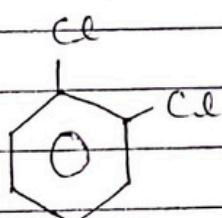
sec - butyl bromide.

(c) tert : tertiary or  $3^\circ$  .

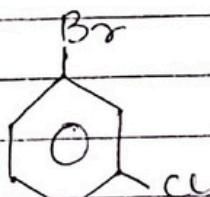


tert - hexyl fluoride .

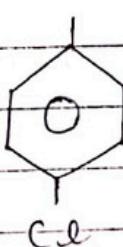
benzene :-



$\cdot$  o - dichlorobenzene .



$\cdot$  m - dichlorobenzene



$\cdot$  p - di'chlorobenzene

(2)

## IUPAC nomenclature :

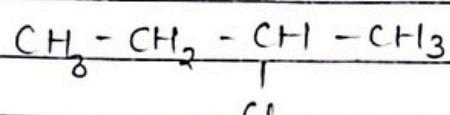
→ note the point for nomenclature :

▷ longest C-chain

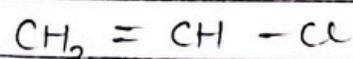
▷ lowest sum rule

▷ In case of = / ≡ prefer them rather than halogen

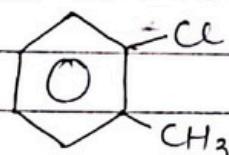
eg :



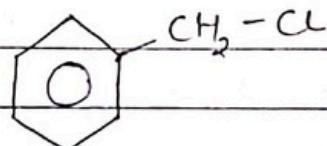
2-chlorobutane.



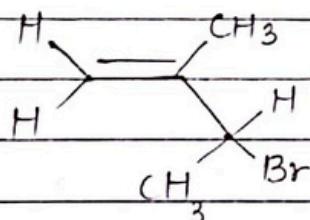
1-chloroeth-1-ene.



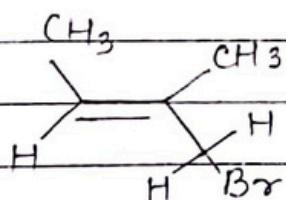
2-chloro-1-phenylcyclohexene.



1-chloro-1-phenylmethane.

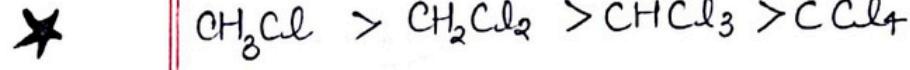


3-bromo-2-methylbut-1-ene



1-bromo-2-methylbut-2-ene.

Dipole moment :



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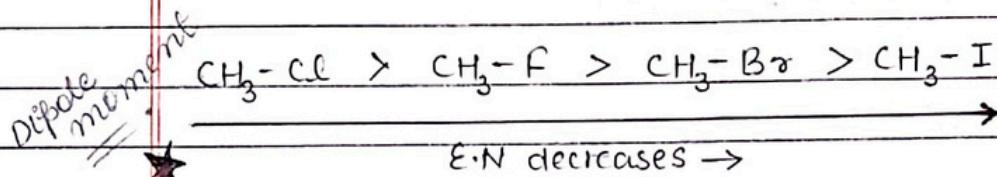
Nature of C-X Bond :-

- Halogen atoms are more electronegative than Carbon.
- C-X bond is polar in nature.

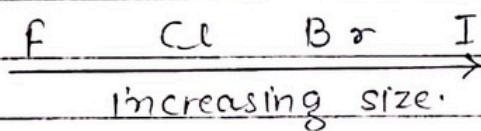
Measure of polarity is dipole moment :

$$\mu = d \times q$$

- More the electronegativity ; greater the polarity. but it also depends on distance between them.



Electronegativity of Fluorine is greater than Chlorine but bond length of Cl is greater than Fluorine. Here, bond length dominates.



Consequently, the C-X bond length also increases from C-F to C-I

Bond length increases	C-F C-Cl C-Br C-I
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\*  $\text{ZnCl}_2$  is required with  $1^\circ$  and  $2^\circ$  alcohols with  $\text{HCl}$ .  
 $3^\circ$  alcohol do not need  $\text{ZnCl}_2$ .

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## Method of Preparations of Haloalkane :

### 1. From alcohols :

@ with haloacids ( $\text{HX}$ ):



For a given alcohol ; order of reactivity of  $\text{HX}$  is  $\text{H-I} > \text{H-Br} > \text{H-Cl}$

$\because$  Bond dissociation enthalpy  $\downarrow$   
 with  $\uparrow$  in bond length.

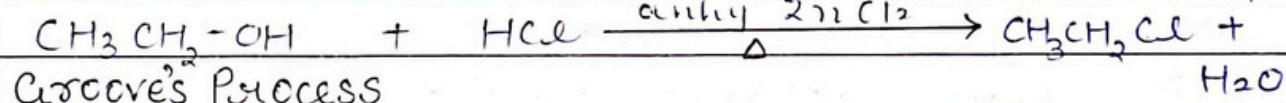
This is because of large size of iodine, As a result bond easily break down.

For a given halogen ; order of reactivity of  $\text{R-OH}$ -

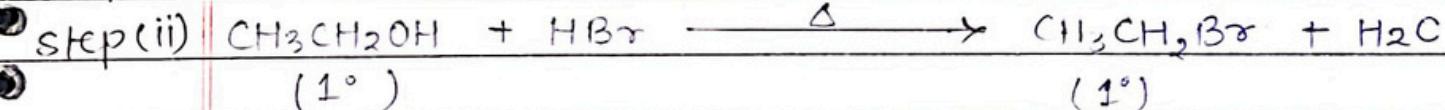
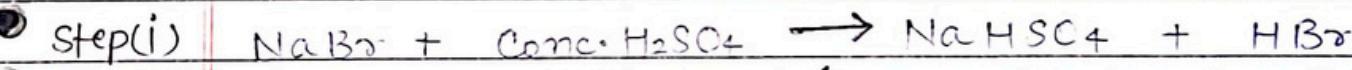
$$3^\circ > 2^\circ > 1^\circ$$

Creates the stability of carbocations bonded with  $-\text{OH}$ ,

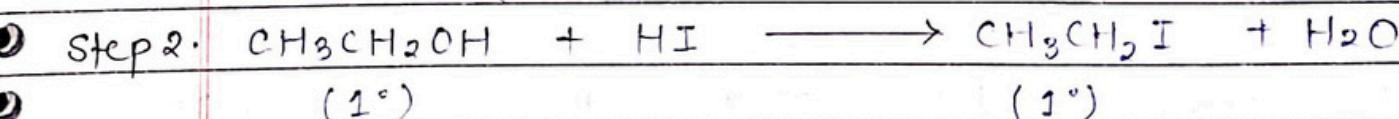
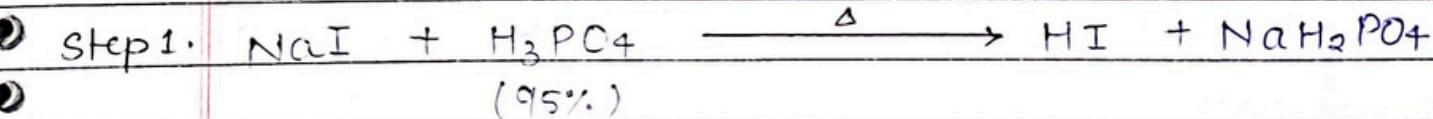
eg. Chlorohaloalkane : greater will be ease of formation of  $\text{RX}$  and faster will be rate of rxn



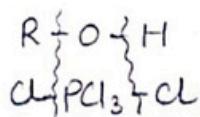
Bromohaloalkane :



Iodohaloalkane :



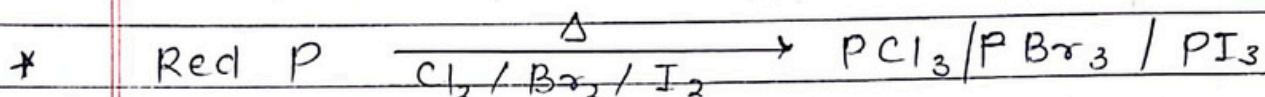
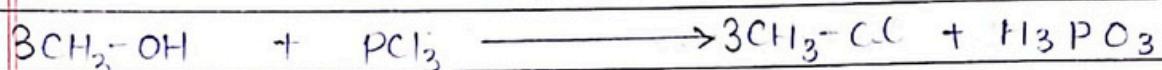
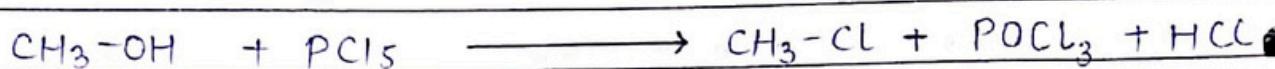
Note:- with  $\text{NaI}$ ;  $\text{H}_2\text{SO}_4$  is not used because  $\text{NaI}$  will get oxidised into  $\text{I}_2$ .



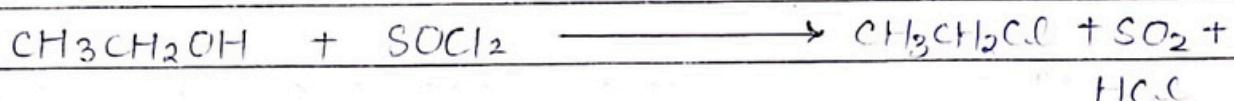
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(b) By the action of phosphorus halides:



(c) From thionyl chloride : (Darzen reaction)

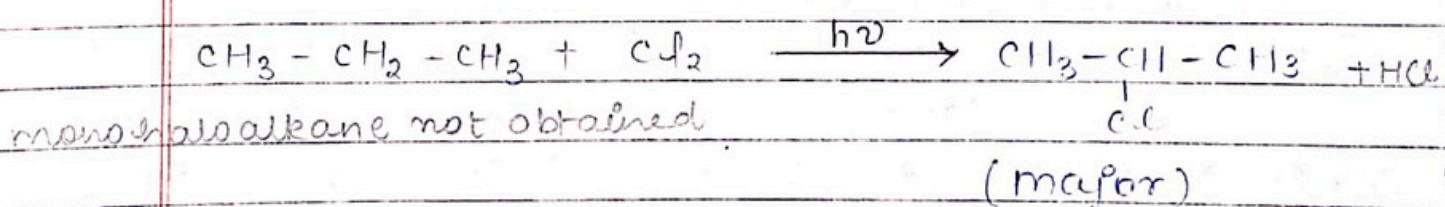
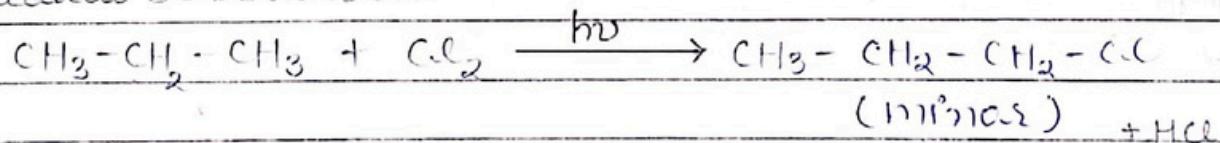


\* Thionyl chloride is preferred because in this reaction alkyl halide is formed along with gases  $SO_2$  and  $HCl$ . The two gases are escapable hence, the reaction gives pure alkyl halides.

2). From Hydrocarbons :

@ From alkanes by free radical halogenation:

By free radical substitution

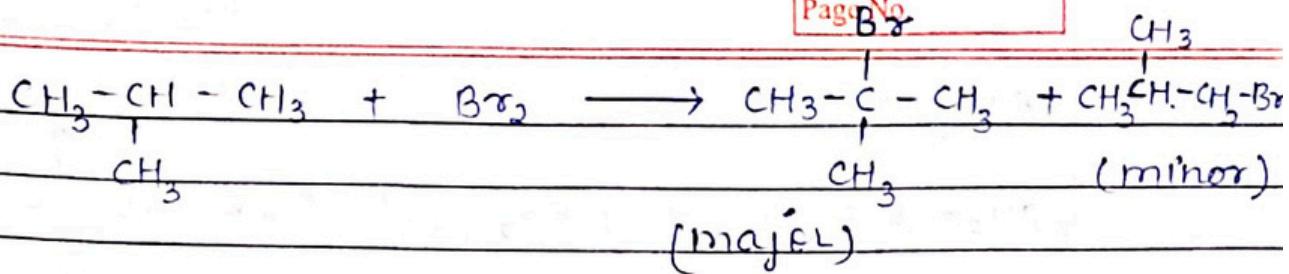


Note : because  $1^\circ$  carbocation is less stable than  $2^\circ$  carbocation.

\* Chain initiation.

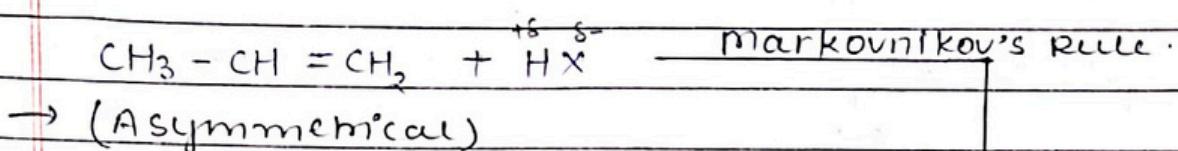
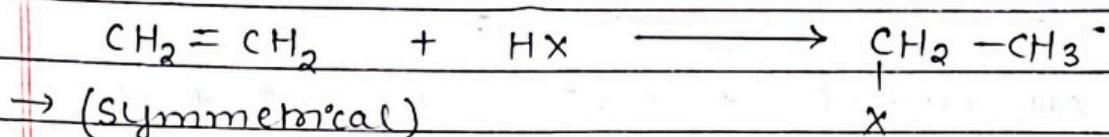
\* Propagation step

\* Termination step

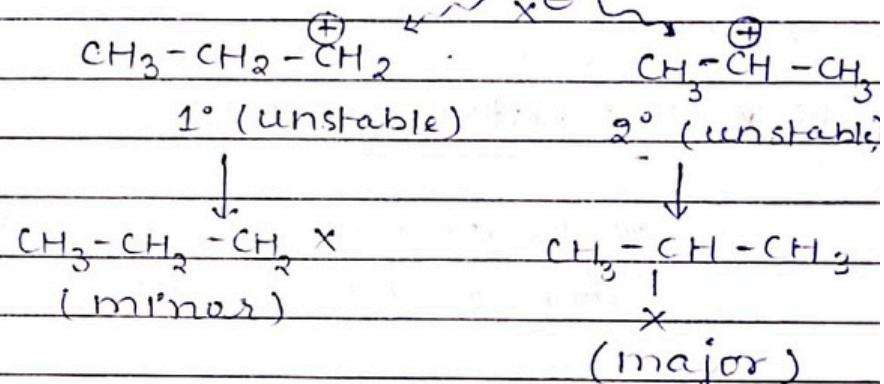


(b) From alkenes :

(I) Addition of hydrogen halide. ( $\text{HX}$ ) :



\* → rearrangement

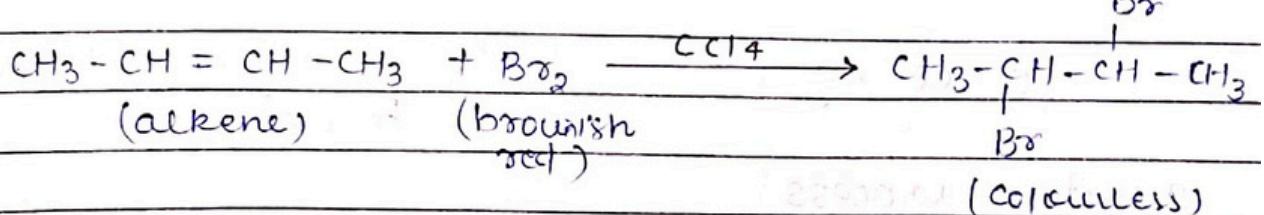


According to Markovnikov's rule :

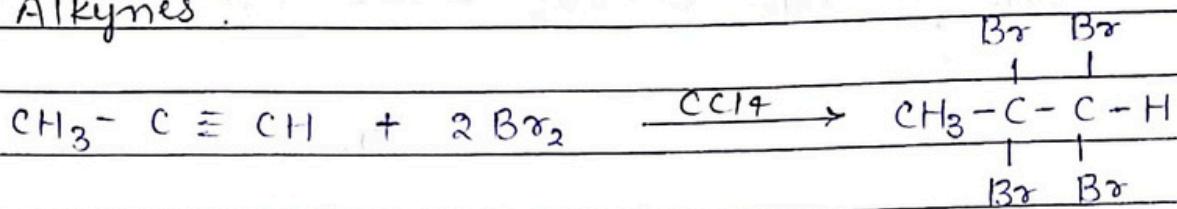
'The negative part goes to that double bond carbon atom which has less number of H- atom.'

II Addition of halogen :

\*\* Test for unsaturation : double bond detection

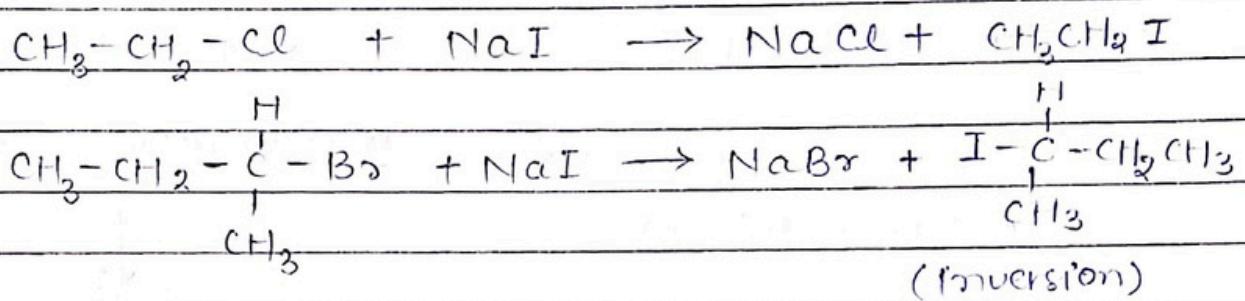


### Alkynes :



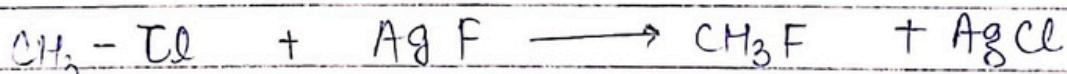
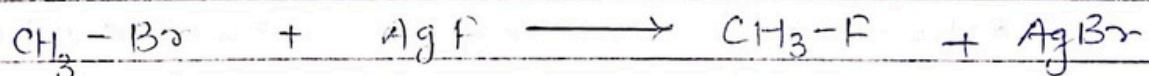
### (3) Halogen Exchange :

#### \* Finkelstein Reaction : ( $X = \text{Cl}, \text{Br}$ )

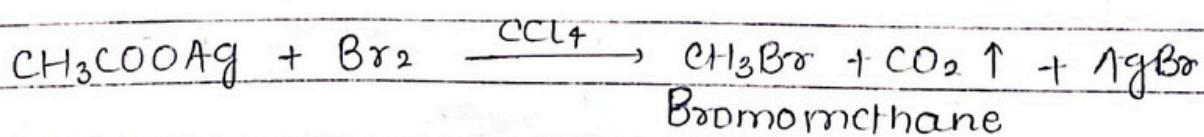


#### \* Swartz reaction :

- ↳ It is reaction of formation of alkyl fluoride from alkyl bromide or chloride.
- ↳ Heating in presence of inorganic fluoride ( $\text{AgF}, \text{SbF}_3, \text{Hg}_2\text{F}_2, \text{CoF}_2$ ) is done.



### 4. From silver salts of carboxylic acid:

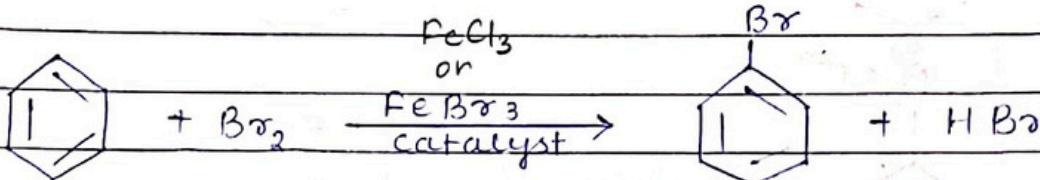
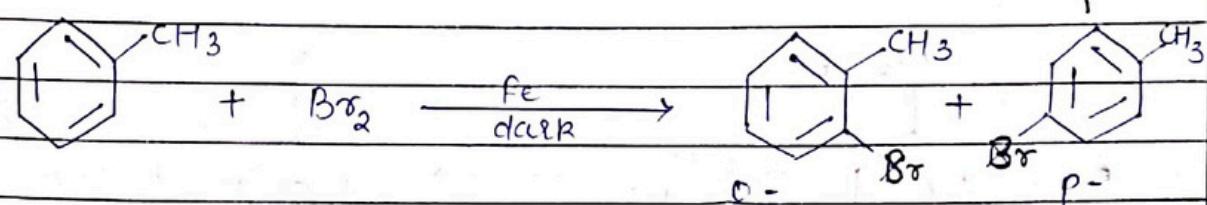


Step down process

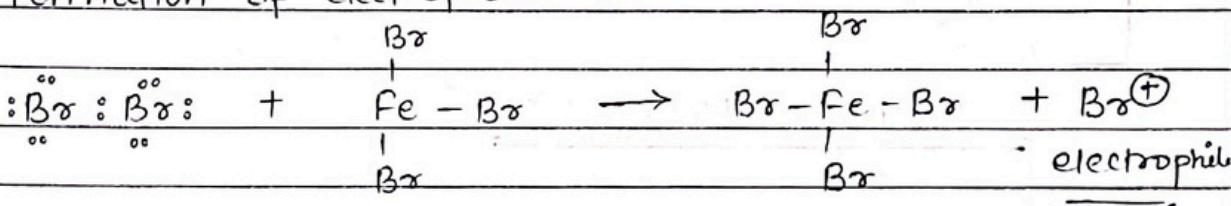
## Preparation of Haloarenes :

(i) From hydrocarbons by electrophilic substitution:

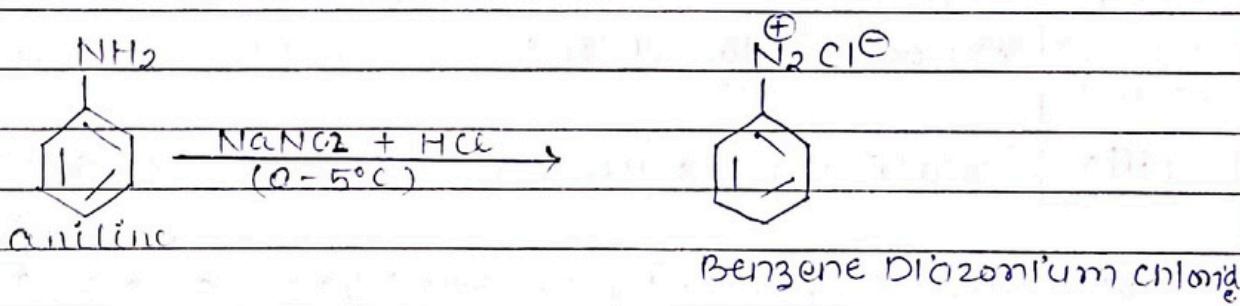
B.P.  $\uparrow$



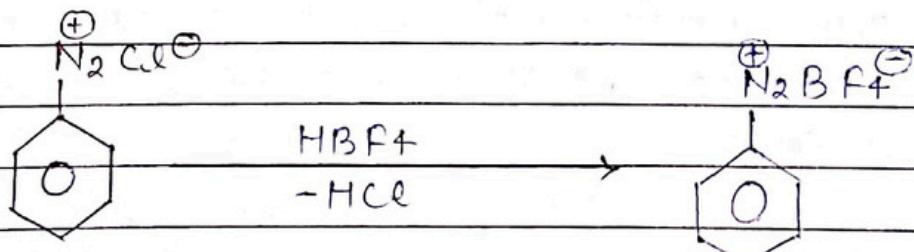
Formation of electrophile  $\text{Br}^{\oplus}$



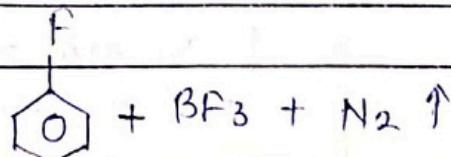
(ii) From Amine by Sandmeyer's reaction

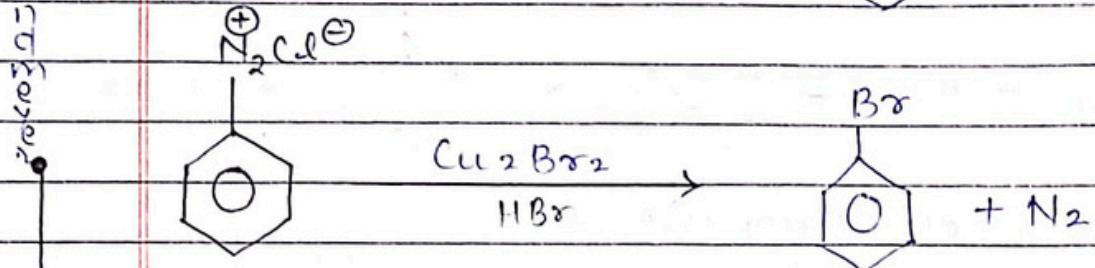
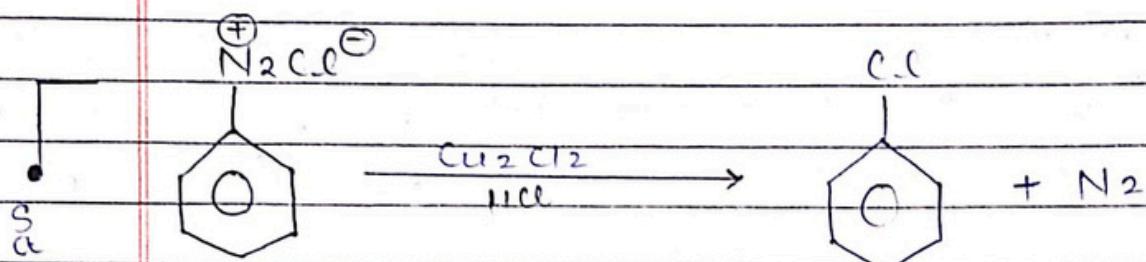
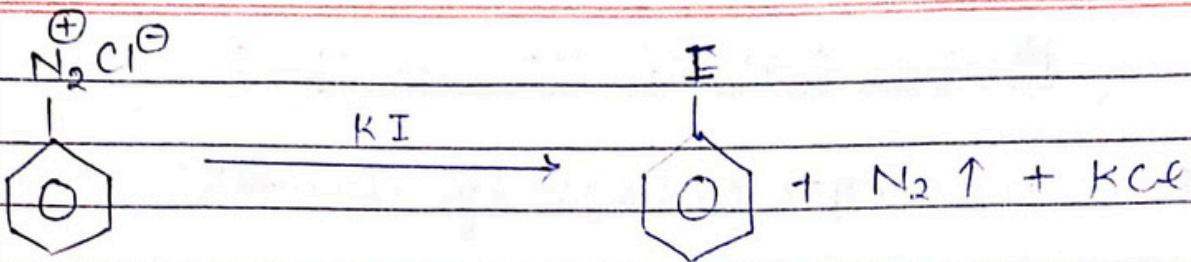


Benzene Diazonium chloride



Batz-Schiemann reaction





### Physical Properties :

- (i) When pure alkyl halide are colourless.
- (ii) Bromide & iodides develops colour when exposed to light.
- (iii) volatile halogen compounds have sweet smell.
- (iv)  $\text{CH}_3\text{Cl}$ ,  $\text{CH}_3\text{Br}$ ,  $\text{CH}_3\text{CH}_2\text{Cl}$  and  $\text{CH}_3\text{CH}_2\text{F}$  (chlorofluorodethane) are gases at room temperature. Higher members are liquid or solid.
- (v) Alkyl halide have higher B.P than hydrocarbon of comparable mass.

↑ in no. of C, surface area ↑  
∴ MP and BP ↑

(v) Reason : In hydrocarbon , London forces ( weakest intermolecular force ) are present , but in alkyl halides , dipole - dipole interaction which is strong as compared to London forces.

(vi)  $\text{RI} > \text{RBr} > \text{RCl} > \text{RF}$

\* Size of halogen  $\uparrow$  ; surface area  $\uparrow$  more intermolecular force  $\uparrow$   
So, Boiling point  $\uparrow$

(vii)  $\text{CH}_3\text{X} < \text{C}_2\text{H}_5\text{X} < \text{C}_3\text{H}_7\text{X}$

\* As number of C increases in alkyl group , intermolecular forces increases and boiling point also increases .

(viii) As branching increases in an isomer boiling point decreases .

e.g. n - bromobutane  $>$  sec - bromo butane  $>$  tert bromo butane .

Reason - With increase in branching  
surface area decreases  
Intermolecular force decreases .

So, Boiling point decreases .

(ix) In dihalobenzene , B.P are nearly same but para - compounds shows high M.P because of symmetry ; it fits very well in crystal lattice .



$\rightarrow$  symmetry

(X) Density increases with increase in number of carbon and halogen mass.

Bromo, iodo and polychloro derivatives have high density than water.

(XI) Haloalkane are less soluble in water.

Reason: The energy released by the break down of intermolecular forces between alkyl halide RX is not sufficient enough to break the H-bond between water.  
 $\therefore$  less soluble in water.

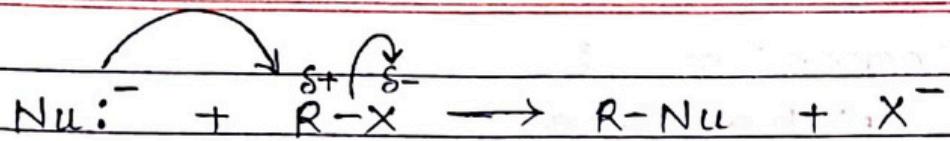
### Chemical Reactions :-

↳ 3 types of reaction:

- i). Nucleophilic Substitution reaction
- ii). Elimination Reaction
- iii). Reaction with metals.

### Nucleophilic Substitution Reaction :-

Such reaction in which a stronger nucleophile displaces a weaker nucleophile are called nucleophilic substitution reaction, and the atom or group which departs with its bonding pair of electron is called the leaving group. Better the leaving group more facile is the reaction.

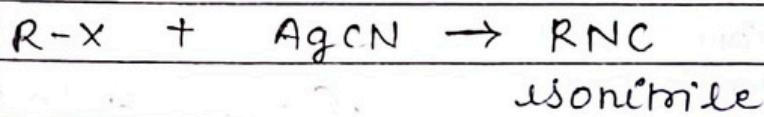
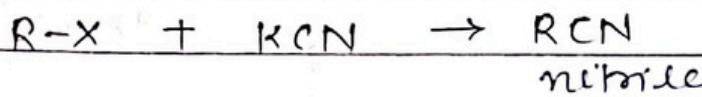
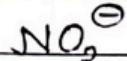
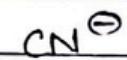


- Ambidentate Nucleophile:

both. denticity: donor

Nucleophile in which more than one (both) the atom have capacity to donate the lone pair to  $\text{C}^+$ .

e.g.



Alkali metal cyanide like  $\text{NaCN}$ ,  $\text{KCN}$  are ionic in nature. In principle the rxn can occur through carbon since C-C bonds are stronger than C-N bond and hence alkyl cyanide are chief product. On the other hand;  $\text{AgCN}$  is covalent. Therefore only nitrogen electron pair is available for bond formation. As a result alkyl isocyanide is chief product.

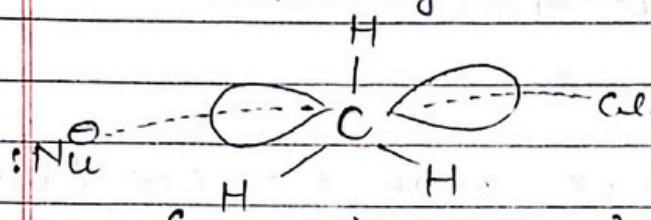
And the same goes for  $\text{AgNO}_2$  (covalent) and  $\text{KNO}_2$  (ionic).

## Mechanism :

→ bimolecular.

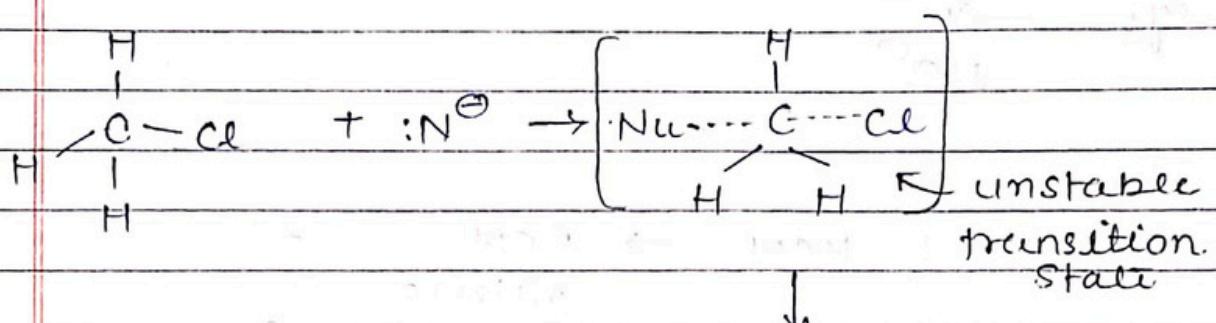
### (1) $S_N2$ Mechanism :

molecularity = 2



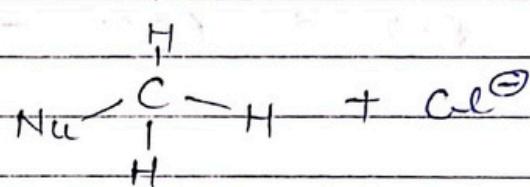
$sp^2$ : Trigonal planar ( $120^\circ$ )

one p-orbital  
↳ one lobe is attached with incoming and another with outgoing :Nu<sup>-</sup>(cl.)



$S_N2$  : Inversion take place.

(single step).



$S_N2$  Steric hindrance ↑ : reactivity  $S_N2 \downarrow$

Reactivity :  $CH_3-X > 1^\circ > 2^\circ > 3^\circ$  alkyl halide alkyl halide alkyl halide

► Due to STERIC HINDERANCE.

$S_N2$

Reactivity:  $R-I > R-Br > R-Cl > R-F$

► Due to bond dissociation enthalpy.

\*  $S_N2$  is supported by Aprotic solvent.

\* SN<sub>1</sub> is two step process in which  $3^\circ$  is most stable ct.

Date \_\_\_\_\_

Page No. \_\_\_\_\_

## (2) S<sub>N</sub>1 mechanism :

Two step process

I → Ionisation (formation of cation  $\text{C}^+$ )

II → Attack of  $:\text{Nu}^-$  on the cation.

↳ Unimolecular reaction

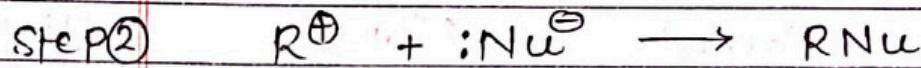
rate is depend on  
↑ concn. of  $\text{RX}$ .  
order = 1.



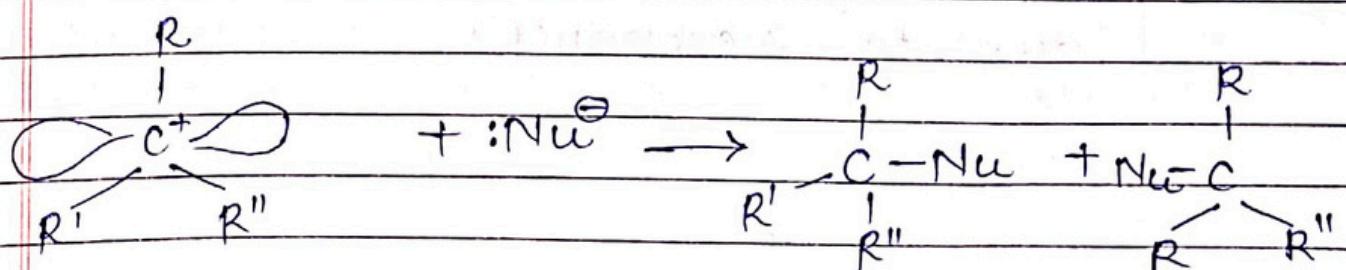
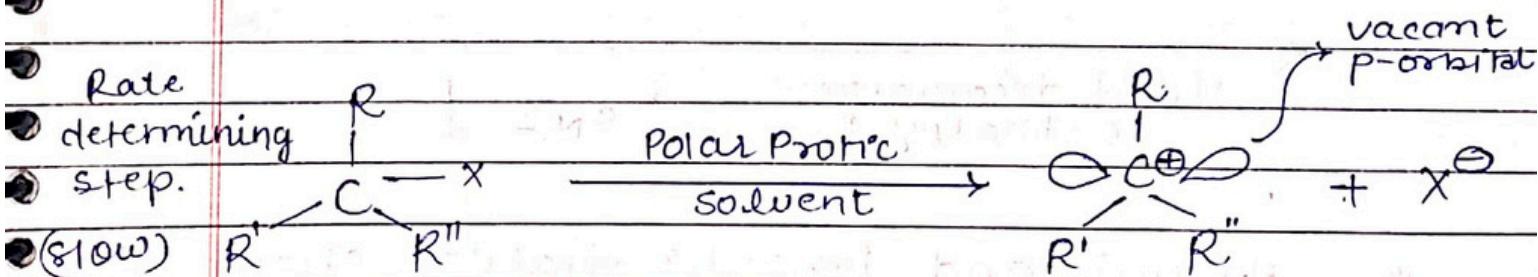
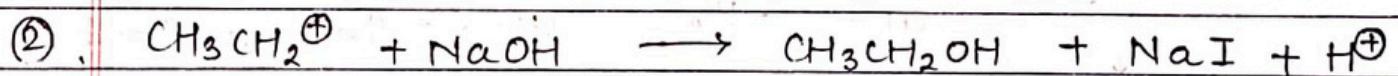
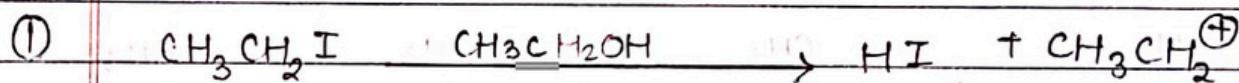
Rate determining step : slow step.

Polar Protic solvent ( $\text{H}_2\text{O}$ ,  $\text{CH}_3\text{COOH}$ ,  $\text{CH}_3\text{OH}$ ,  $\text{C}_2\text{H}_5\text{OH}$ ).

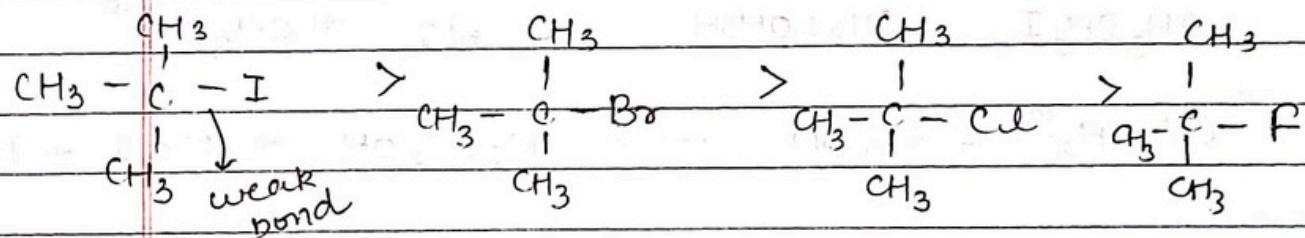
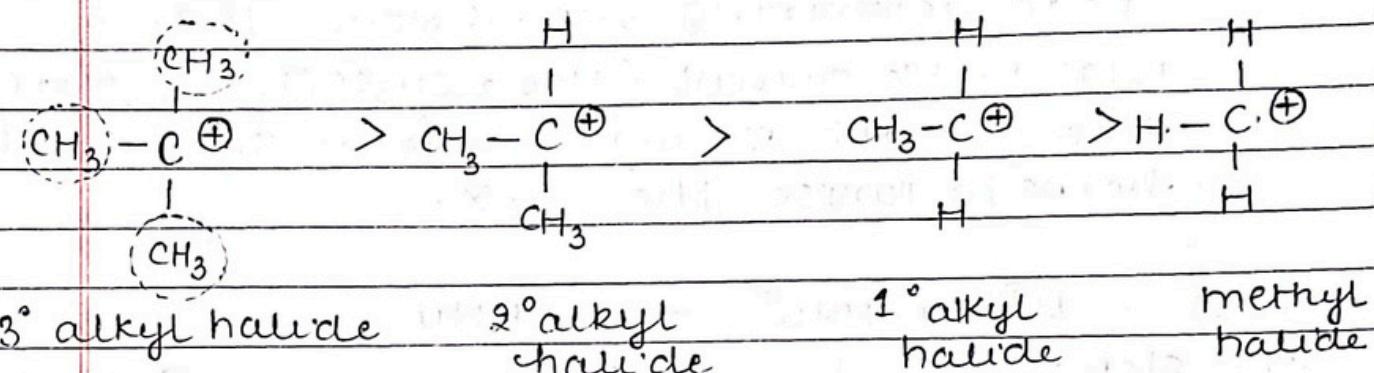
↳ because  $\text{H}^+$  is released from solvent which helps to ionise the  $\text{R-X}$ .



fast step : I, no dependency on  $:\text{Nu}^-$  concentration



- In  $S_N1$  mechanism two types of product are seen where 1 take place by RETENTION and other one by INVERSION.
- $S_N1$  mechanism depends on the stability of  $C^+$ .



← bond dissociation enthalpy ↑ ;  $S_N1 \downarrow$

- \* Allylic and benzylic halide show high reactivity towards  $S_N1$  reaction due to resonance.

S<sub>N</sub>2S<sub>N</sub> 1

- Second order
  - :Nu<sup>-</sup> should be strong.
  - Steric hindrance decrease reactivity.
  - Single Step.
  - Polar aprotic solvent.
  - Inversion take place
  - No rearrangement
  - No intermediate.
- First order kinetics
  - C+ stability increases
  - S<sub>N</sub>1 reactivity increases.
  - :Nu<sup>-</sup> is not imp (strength)
  - multistep.
  - Coodronising solvent
  - Invalue Recemisation
  - Rearrangement possible
  - Intermediate involved.

→ 3-D

### Stereochemical Aspect of Nucleophilic Substitution Reaction :-

#### (i) Optical activity :

Plane polarised light produced by passing ordinary light through Nicol prism is rotated when passing through solution of certain compounds. Such compounds are called optically active.

which show no optical activity are called optically inactive.

The angle by which the plane polarised light is rotated is measured by, Polarimeter.

If light rotate clockwise from its path then it is called dextrorotatory or d-form.

It is indicated by placing a positive (+) sign before the degree of rotation.

If the light rotate anti-clockwise from its path then it is called Laevo-rotatory or l-form.

It is indicated by placing a negative (-) sign before the degree of rotation.

Optical Isomers :- compound that have same molecular formula but have different optical activity i.e. one is dextro and other is laevo.

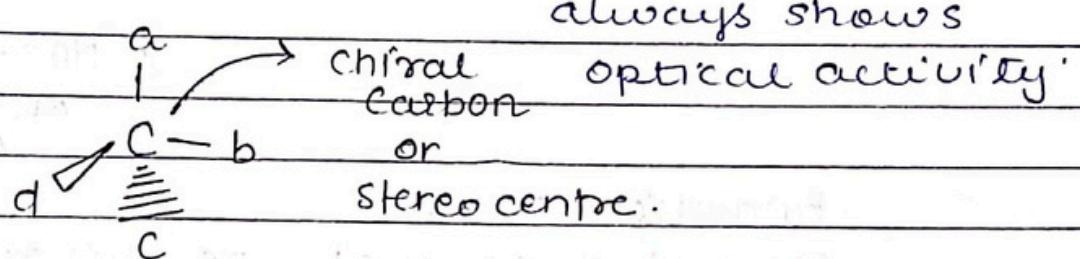
This phenomenon is called optical Isomerism.

ii) Molecular asymmetry, chirality and enantiomers :-

Louis Pasteur observed that the compound that have crystal which are mirror images of each other have different optical activity also.

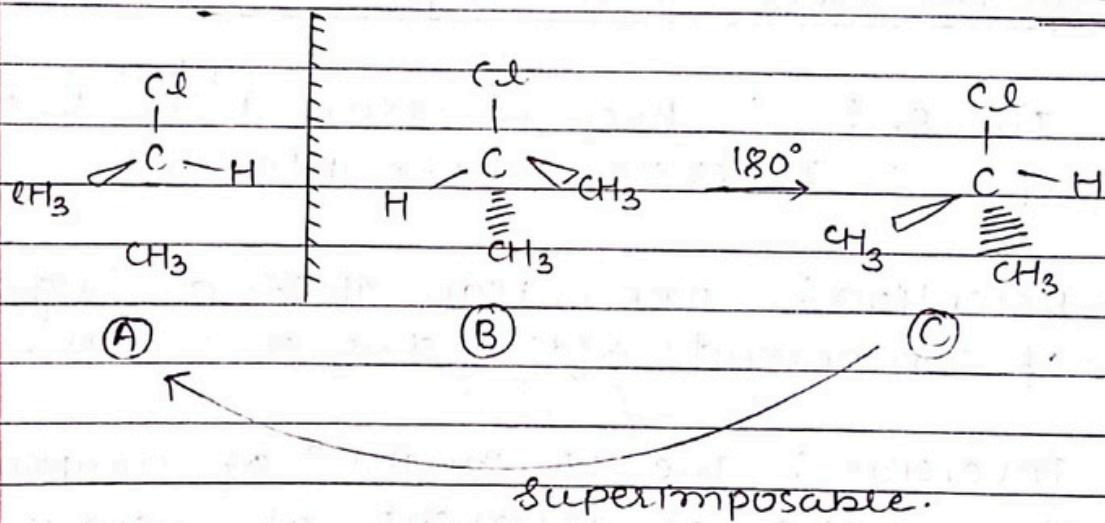
He suggested that the optical activity is because of different in 3D arrangement of atom in their molecule.

Vant' Hoff and Le Bel independently suggested that those carbon in a molecule that have all four valencies satisfied by four different group are molecular asymmetric.

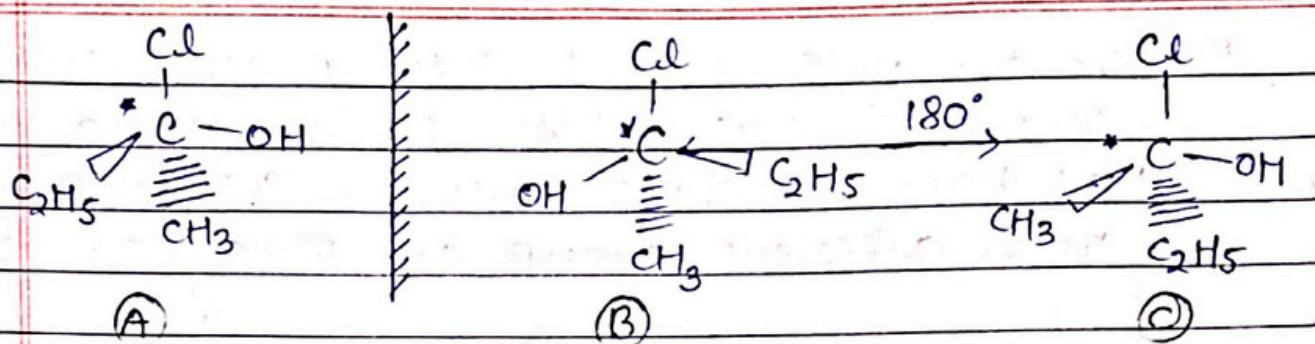


→ Molecular asymmetrical compound is there, then it shows mirror image which are Non-imposable, and are optically Active.

→ Superimposable compounds are optically Inactive.



Superimposable compounds are non-chiral which means they do not have 4 different group around carbon.



[ Non-Superimposable  
optical  
Activity. ]

### Enantiomers :

Stereoisomers that are mirror image of each other are known as Enantiomers.

Enantiomers have same MP, BP, solubility, refractive index etc. but different optical activity.

Enantiomers are always chiral.

In  $S_N1$  : Recemisation take place but in  $S_N2$  : Inversion take place.

\* Retention : prevention of 3-D arrangement of compound after the reaction.

\* Inversion : the 3D structure of compounds shows the attachment of new on opposite side after reaction.

\* Recemization : process of mixing 2 enantiomer in equal proportion. The mixture is called Racemic mixture or recemic modification. This mixture is optically inactive.

## 2. Elimination Reactions :

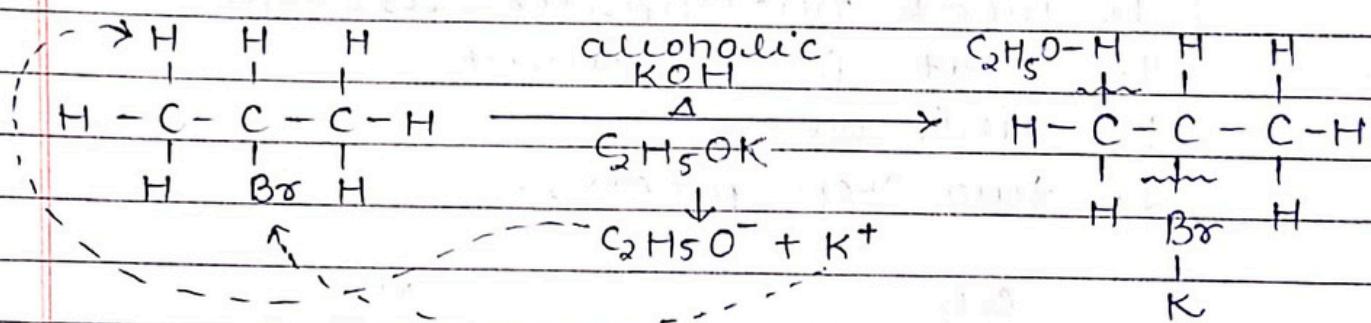
Reaction in which hydrogen atom ( $\beta$ -hydrogen) is removed from compound (alkyl halides) along with the nucleophile forming an alkene or alkyne.

- \* alcoholic KOH is required for such reaction.
- \* always proceed with  $\Delta$ .

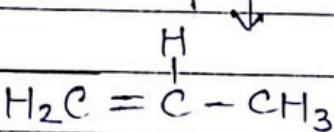
Elimination reaction can move through two different pathways:

### 1) E<sub>2</sub> reaction :

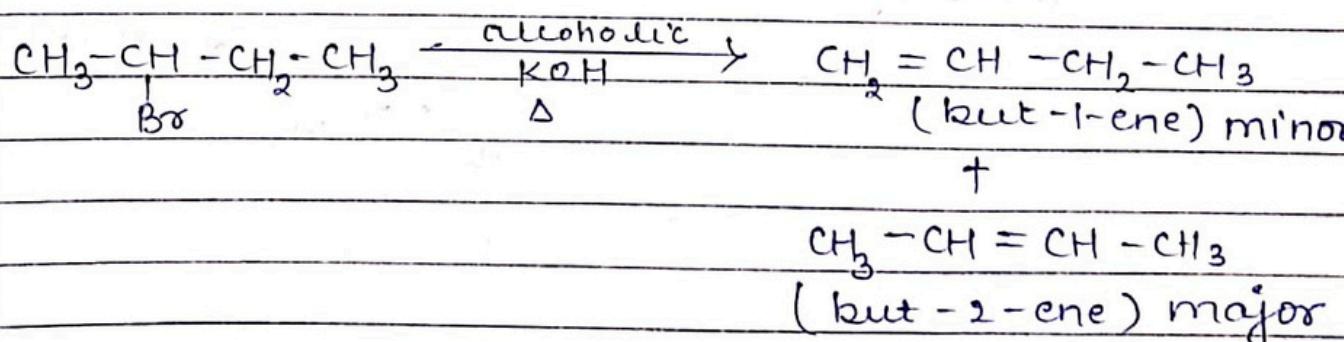
↳ bimolecular

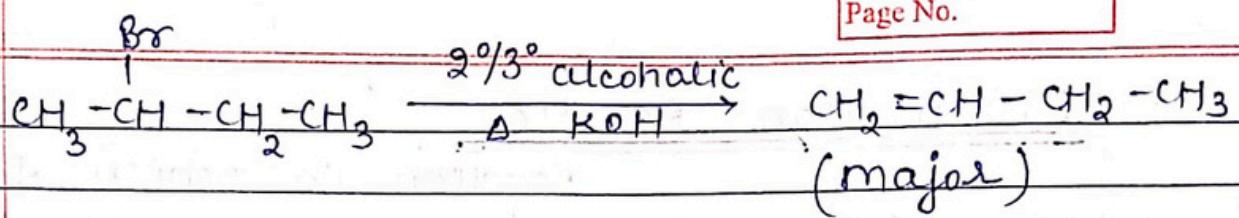


- \* Saytzeff Rule :- Those alkene/alkyne will be formed in major quantity that have maximum number of substituent around their  $=/\equiv$  bond.



Prop-1-ene .



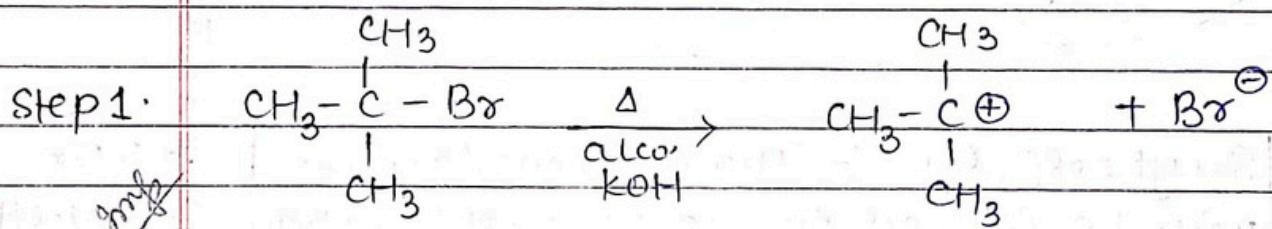


Note :

\* In presence of  $2\% / 3^\circ$  alcohol the  $\text{:Nu}^-$  become very bulky and feel steric hindrance from the C present around the  $\beta$ -carbon. Hence, it will attack only terminal  $\beta$ -carbon's hydrogen.  $(\text{CH}_3)_3\text{CO}^-\text{K}^+, \Delta$

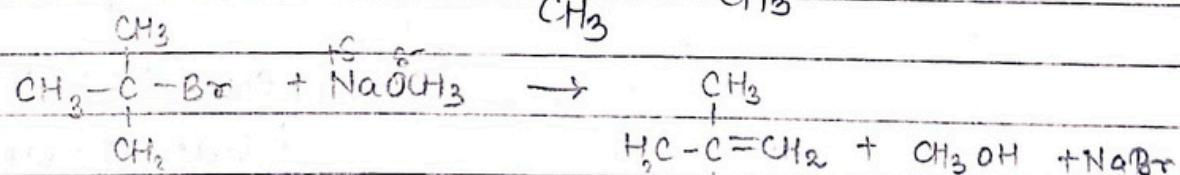
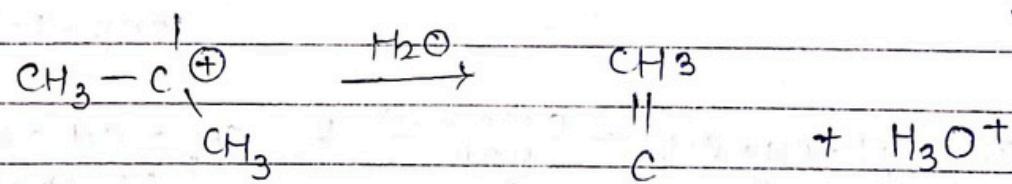
↳ bulky group

- ii) E<sub>1</sub> reaction :  $\text{CH}_3\text{CH}_2\text{CH}=\text{CH}_2$  +  $\text{CH}_3\text{CH}=\text{CHCH}_3$
- major minor
- ↳ weak nucleophile is required ( $\text{H}_2\text{O}$ )
  - ↳ heat is required
  - ↳ unimolecular
  - ↳ two step process.



$(2^\circ / 3^\circ \rightarrow \text{stable cation})$

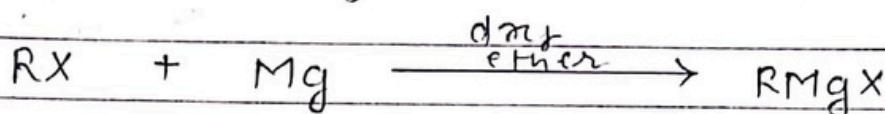
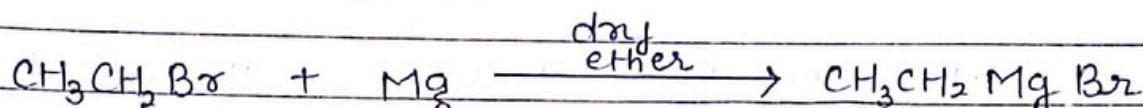
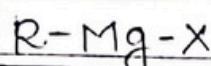
$1^\circ \rightarrow \text{unstable and do not show given elimination } (\text{run}).$



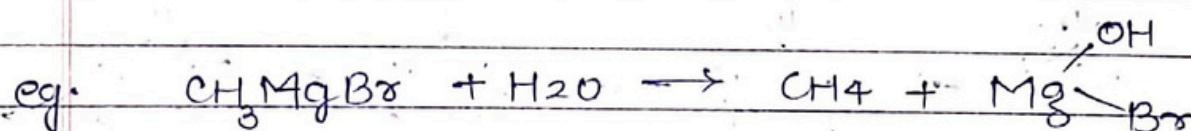
3. Reaction with metals:

Alkyl chlorides, alkyl bromides and alkyl iodides react with Mg in presence of dry ether to form an organo-metallic compounds known as Grignard reagent.

→ Grignard reagent.



- In Grignard reagent, C-Mg bond is covalent, and highly polar and the magnesium-halogen bond is essentially ionic bond.
- Grignard reagent is highly reactive towards  $H^+$  donor compounds.
- React with  $H_2O$ , alcohol, and  $RNH_2$  etc to give hydrocarbon.

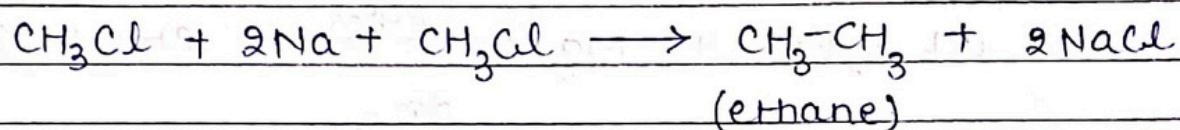
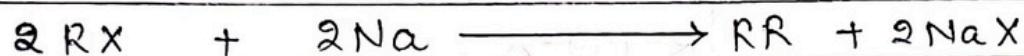


It is necessary to avoid traces of moisture from Grignard reagent. That's why dry ether is used.

## Wurtz Reaction :

Alkyl halides reacts with sodium in dry ether to give hydrocarbon (double the number of carbon).

↳ Both the alkyl halide should be same same.

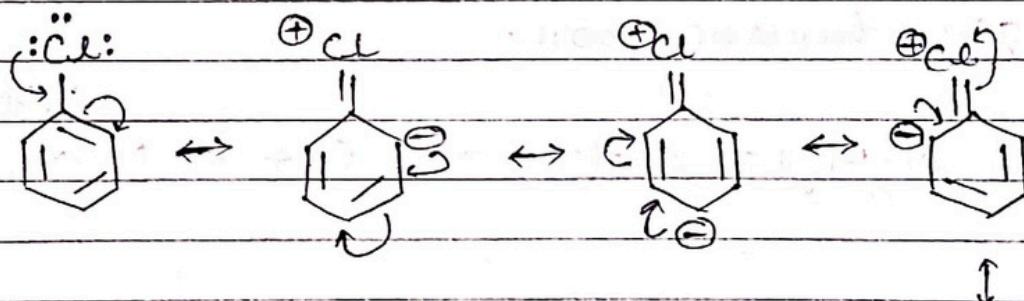


## Reactions of Haloarenes :-

↳ do not show nucleophilic substitution because they are less reactive towards this mechanism.

Reason -

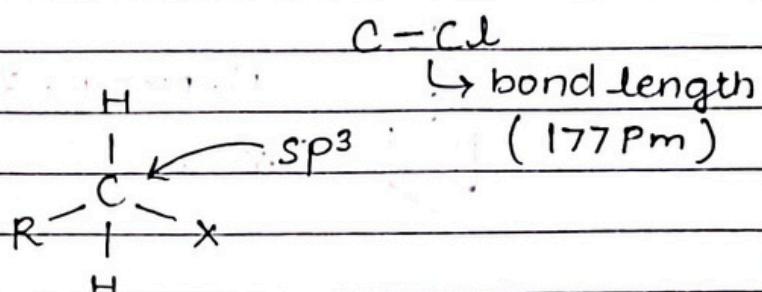
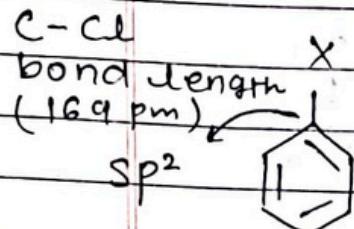
i). Resonance



because of resonance there is partial double bond character between C-Cl, which is difficult to break.



ii) Difference in hybridisation of carbon atom in  $\text{C-X}$  bond :-

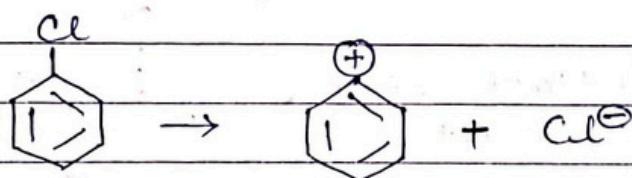


$\text{SP}^2$  hybridised C have more s-character and it's more electronegative and can hold  $e^-$  pair of  $\text{C-X}$  more tightly than  $\text{SP}^3$  hybridised C.

So, it is difficult to break shorter bond than a longer bond,  $\therefore$  halocuenes are less reactive than haloalkane towards nucleophilic reaction.

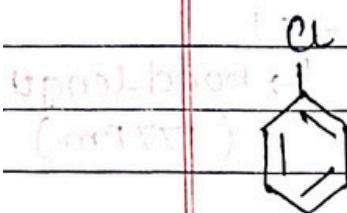
iii) Because of the possible repulsion, it is likely for  $e^-$  rich nucleophile to approach  $e^-$  rich haloarenes.

iv) Instability of phenyl cation :



$\rightarrow$  highly unstable  
 $\rightarrow$  not conjugated to show resonance  
 $\rightarrow \text{S}_{\text{N}}^1$  mechanism is ruled out completely.

## Replacement by hydroxyl group -

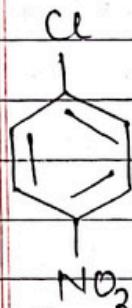


i).  $\text{NaOH}$ ,  $623\text{ K}$ ,  $300\text{ atm}$       OH

ii)  $\text{H}^+$



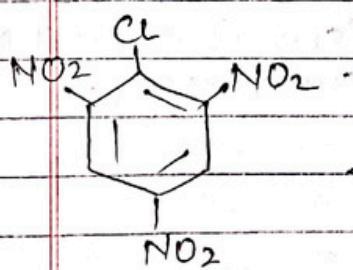
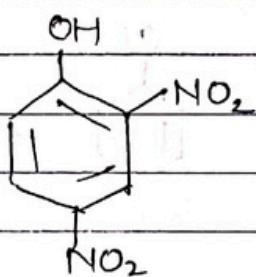
The presence e- withdrawing group ( $-\text{NO}_2$ ) at ortho- and para- position increases the reactivity of haloarenes.



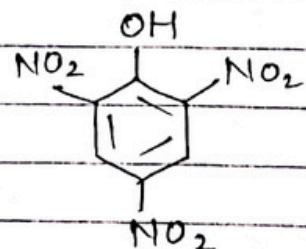
i)  $\text{NaOH}$ ,  $443$   
ii)  $\text{H}^+$



i)  $\text{NaOH}$ ,  $368\text{ K}$   
ii)  $\text{H}^+$



warm  
 $\text{H}_2\text{O}$



\* Picric acid

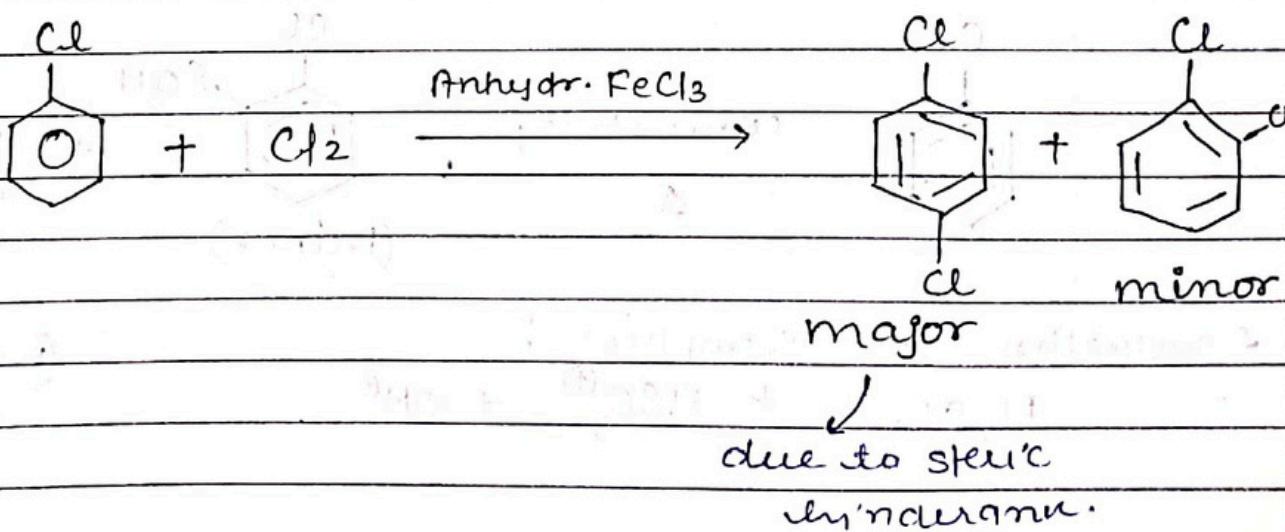
Note:  $\text{NO}_2$  group shows its effect only at  $\sigma$ - and  $p$ - positions and not at  $m$ - position because during resonance the  $e^-$  density does not increase on  $m$ -position. Hence, attachment of  $-\text{NO}_2$  on meta position is useless.

## 2. Electrophilic Substitution reactions:

Electrophilic substitution reactions are not easy with haloarenes and extreme condition like high temp, catalyst, high pressure etc. are required.

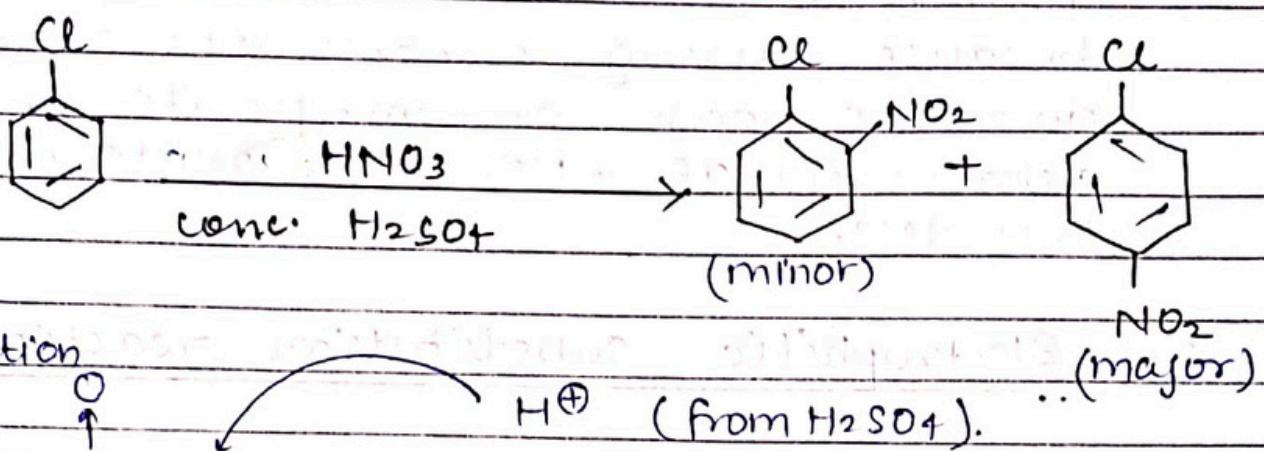
- In haloarenes both  $-I$  effect and resonance works but  $-I$  effect dominates.
- $-I$  effect decides reactivity but resonance decides orientation ( $\sigma$ - and  $p$ -).

### i) Halogenation:



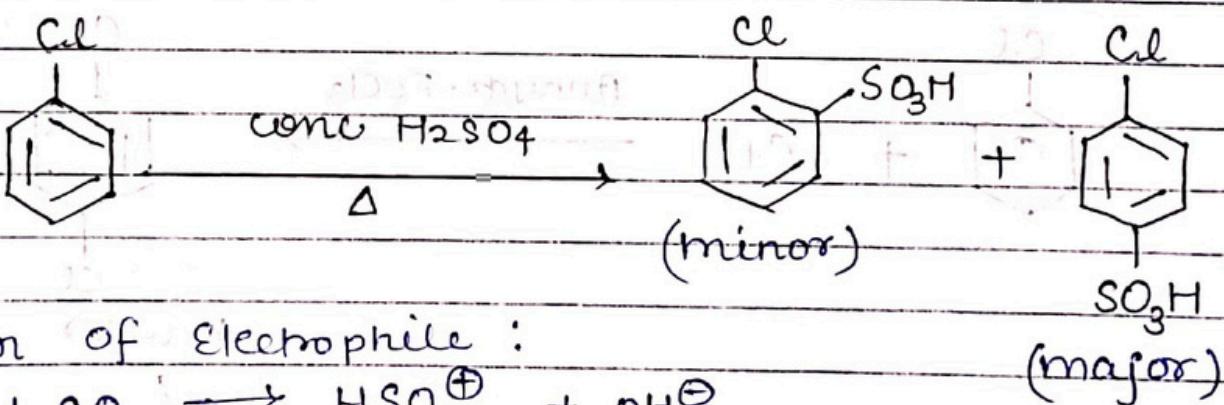
ii)

## Nitration :



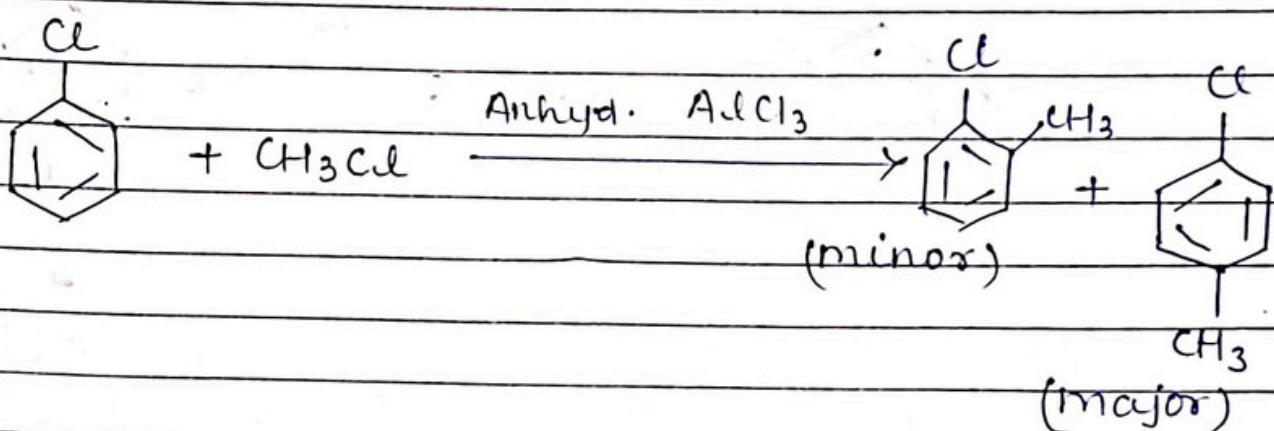
iii)

## Sulphonation :

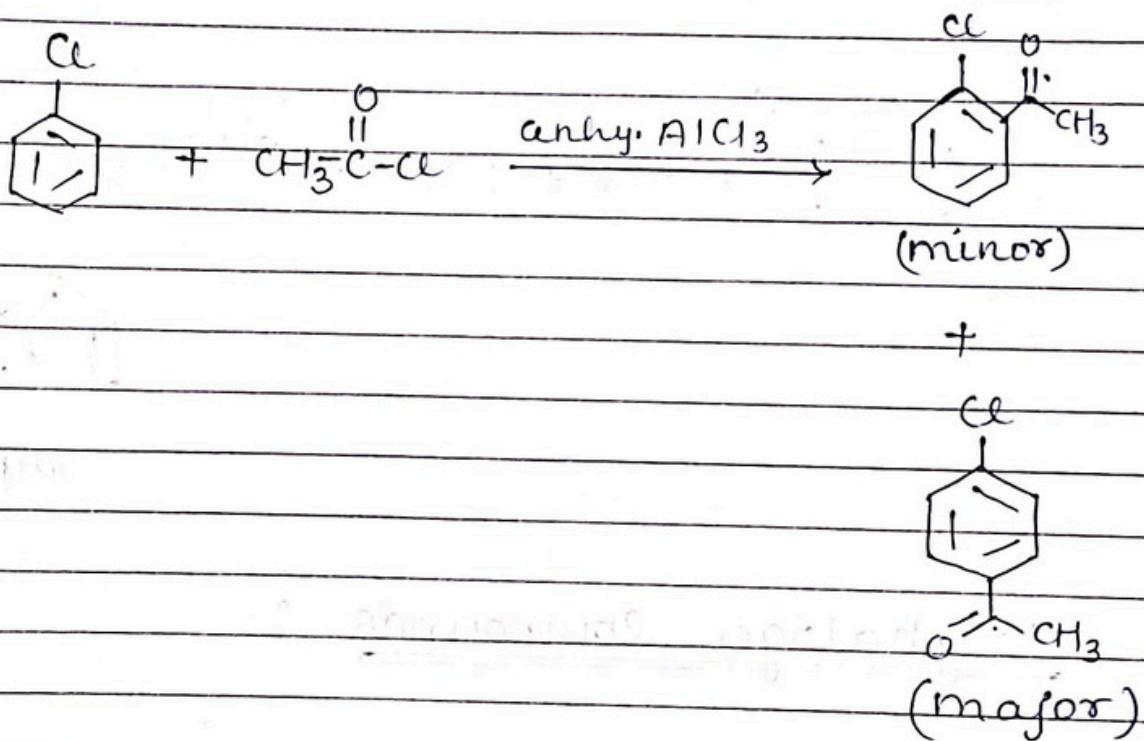


#### iv). Friedel Crafts reaction : reactions

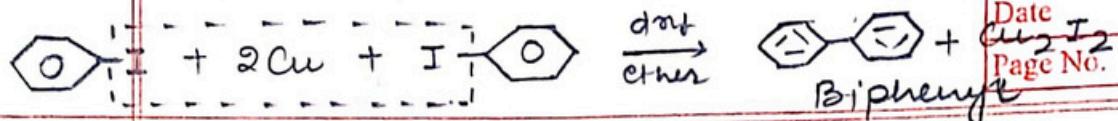
##### Alkylation :



##### Acylation :

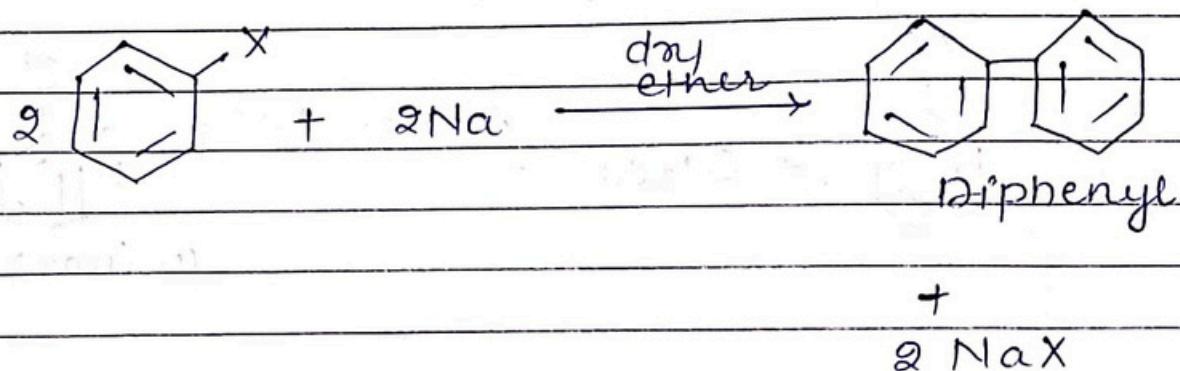


\* Ullmann Rn<sup>n</sup>

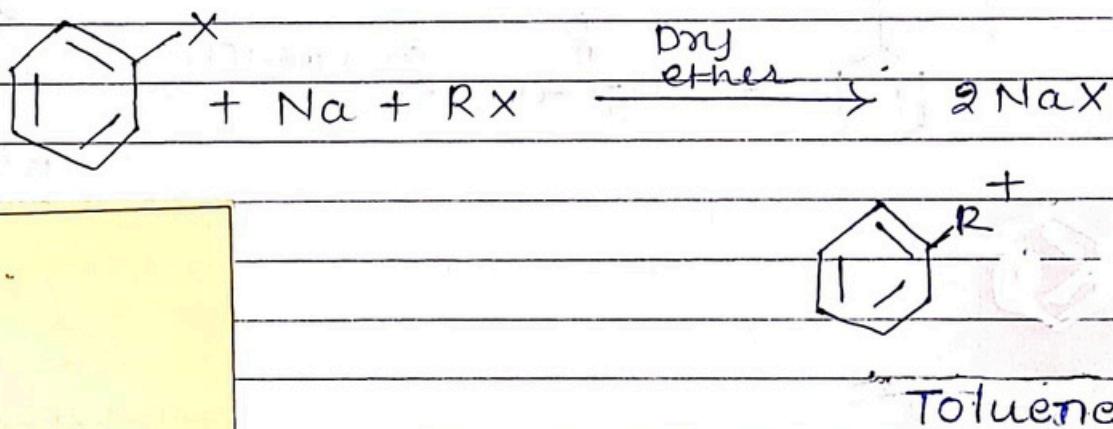


3. Reaction with metals :-

Fittig reaction -

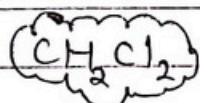


Wurtz Reaction :-



Polyhalogen Compounds :-

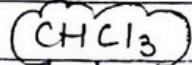
1. Dichloro methane (Methylene chloride). :-



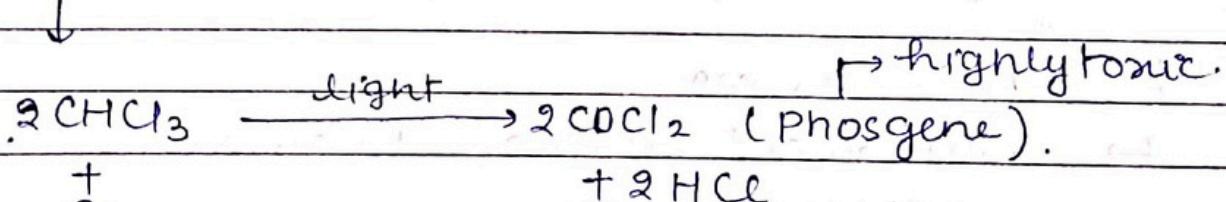
- Solvent as paint remover
- Propellant in aerosols
- Solvent in drug manufacturing
- Metal cleaning and finishing solvent

- It harms CNS.
- Exposure to lower level in air can lead to impaired vision and hearing.
- High level - dizziness, Nausea, Tingling, Numbness in finger and toes.
- Skin burning and mild redness.
- Burn cornea.

## 2. Trichloromethane (chloroform) :



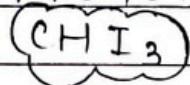
- ↳ Solvents for fats, alkaloids, iodine etc.
- ↳ General anesthetic in surgery (depressant-CNS) but replaced by ethers (less toxic).
- ↳ Used for production of FREON REFRIGERANT
- ↳ Breathing 900 ppm cause fatigue, headache and dizziness.
- ↳ Chronic  $\text{CHCl}_3$  exposure cause damage of liver / kidney and sores of skin.



that's why air

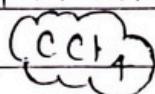
- ↳ Stored in dark colour bottles and air tight.

3. Trichloromethane : Iodoform



- ↳ earlier used as antiseptic.
- ↳ but its antiseptic properties were due to liberation of free  $\text{I}_2$  and not because of it.
- ↳ Due to its bad odour it is now replaced by other substances.

4. Trichloromethane : Carbon tetrachloride.

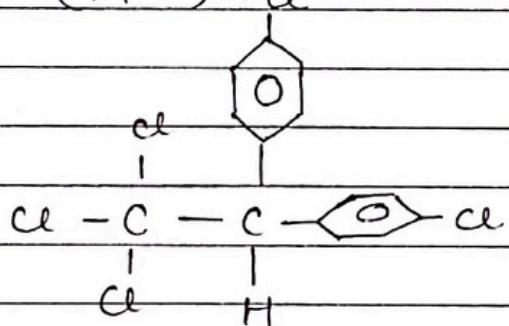


- ↳ production of refrigerants and propellants for aerosol cans.
- ↳ Used as feedstock in synthesis of CFCs.
- ↳ Solvent in pharmaceuticals.
- ↳ By 1960 : cleaning fluid, degreasing agents, spot removers, fire extinguisher.
- ↳ Liver cancer.
- ↳ permanent damage to nerve cells, nausea, dizziness etc.
- ↳ In severe case : Stupor, coma; unconsciousness, death.
- ↳ Ozone layer Depletion.

## 5. Freons :-

- ↳ the CFCs of methane and ethane are collectively known as Freons.
- ↳ Extremely stable, unreactive, non-toxic non-corrosive and easily liquefiable gas.
- ↳ Freon - 12 ( $\text{CCl}_2\text{F}_2$ ) - most common form in industries.
- ↳ It is manufactured from  $\text{CCl}_4$  by Swarts reaction.
- ↳ In atmosphere, remain unchanged in stratosphere and initiate  $\text{O}_3$  layer damage by radical chain method.

## 6. p,p-dichlorodiphenylm'chloroethane : (DDT) . e



- ↳ Chorinated organic insecticides.

- ↳ prepared in 1873 but in 1939 Paul Muller due to insecticide effect.
- ↳ Paul Muller got noble prize in 1948 in Medicine and physiology.

- ↳ During world war II , mosquitoes and lice was threat for soldiers ? used high.
- ↳ Nowadays , many species of insect develops resistance to DDT but fishes show toxicity .
- ↳ Major proportion in its stability and fat solubility . ∵ deposits in the tissues of animals and leads to toxicity .
- ↳ US banned DD in 1973 .