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Introduction

Overview

- **Haloalkanes:** Compounds formed by replacing one or more hydrogen atoms in alkanes with halogen atoms (-F, -Cl, -Br, -I).
- **Haloarenes:** Compounds where a hydrogen atom of the benzene ring is replaced by a halogen atom, general formula C_6H_5X.
- Haloalkanes have halogen attached to sp^3 hybridized carbon atoms (alkyl group).
- Haloarenes have halogen attached to sp^2 hybridized carbon atoms (aryl group).
- Many halogenated organic compounds occur naturally and have clinical uses.

Solved Examples

- **Ex 1:** Identify the type of compound: CH_3Cl.
  - CH_3Cl is a haloalkane with halogen on sp^3 carbon.
- **Ex 2:** Identify the compound type: C_6H_5Br.
  - C_6H_5Br is a haloarene with halogen on sp^2 carbon of benzene ring.

Practice Set

- Q1: What is the hybridization of carbon bonded to halogen in haloalkanes?
  - A. sp
  - B. sp^2
  - C. sp^3
  - D. None
- Q2: Which of the following is a haloarene?
  - A. CH_3Cl
  - B. C_6H_5Cl
  - C. C_2H_5Br
  - D. CH_2Cl_2
- Q3: Haloalkanes differ from haloarenes in that halogen is attached to:
  - A. sp carbon in haloalkanes

- B. sp^3 carbon in haloarenes
- C. sp^3 carbon in haloalkanes
- D. sp^2 carbon in haloalkanes

Answer Key

- Q1: C - Haloalkanes have halogen attached to sp^3 carbon.
- Q2: B - C_6H_5Cl is a haloarene (halogen on benzene ring).
- Q3: C - Haloalkanes have halogen on sp^3 carbon; haloarenes on sp^2.

Memory Aids

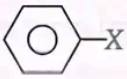
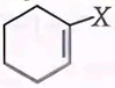
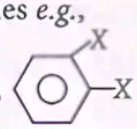
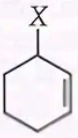
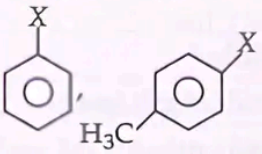
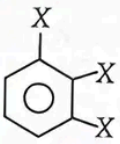
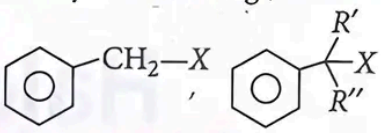
- Haloalkanes = Halogen on sp^3 carbon (alkyl).
- Haloarenes = Halogen on sp^2 carbon (aryl ring).
- Remember: "Alkane = sp^3, Arene = sp^2" for halogen attachment.

Classification

Types of Halo Compounds

- Classified by number of halogen atoms: Mono-, Di-, Tri-halo compounds.
- Classified by carbon-halogen bond hybridization: sp^3 (alkyl) or sp^2 (aryl/vinyl).
- **Monohalo compounds:**
  - sp^3 C–X: Alkyl halides (e.g., CH_3Cl)
  - sp^2 C–X: Vinylic halides (e.g., $CH_2=CHCl$)
- **Dihalo compounds:**
  - sp^3 C–X: Allylic halides (halogen on carbon adjacent to double bond)
  - sp^2 C–X: Aryl halides (halogen on aromatic ring)
- **Trihalo compounds:**
  - sp^3 C–X: Benzylic halides (halogen on benzylic carbon)
- Examples and structures illustrate each category.

Haloalkanes and haloarenes may be classified as follows :

No. of *X*-atoms	sp^3 C — *X* bond	sp^2 C — *X* bond
Monohaloalkane/arene $C_nH_{2n+1}X$ *e.g.*, C_2H_5X, 	Alkyl halides/Haloalkanes *e.g.*, $R—CH_2X$ (1°), $R_2CH—X$ (2°) $R_3C—X$ (3°)	Vinylic halides *e.g.*, $CH_2=CH—X$, 
Dihaloalkane/arene Geminal dihalides *e.g.*, $CH_3CH(X)_2$ Vicinal dihalides *e.g.*, $CH_2X—CH_2X$, 	Allylic halides, *e.g.*, $CH_2=CH—CH_2X$, 	Aryl halides, *e.g.*, 
Trihaloalkane/arene *e.g.*, $CH_2X—CHX—CH_2X$, 	Benzylic halides *e.g.*,  $R' = CH_3$, $R'' = H$(2°) $R' = R'' = CH_3$ (3°)	

Solved Examples

- **Ex 1:** Classify CH_2=CHCl.
  - Monohalo compound with sp^2 C–X bond → Vinylic halide.
- **Ex 2:** Identify type of $C_6H_5CH_2Cl$.
  - Trihalo compound with sp^3 C–X bond → Benzylic halide.

Practice Set

- Q1: What type of halide is CH_3CH_2Cl?
  - A. Vinylic halide
  - B. Alkyl halide
  - C. Aryl halide
  - D. Allylic halide
- Q2: Which halide has halogen attached to sp^2 carbon?
  - A. Alkyl halide
  - B. Vinylic halide
  - C. Benzylic halide
  - D. Allylic halide

- Q3: $C_6H_5CH_2Cl$ is an example of:
  - A. Allylic halide
  - B. Benzylic halide
  - C. Aryl halide
  - D. Vinylic halide

Answer Key

- Q1: B - CH_3CH_2Cl is an alkyl halide (sp^3 C–X).
- Q2: B - Vinylic halides have halogen on sp^2 carbon.
- Q3: B - $C_6H_5CH_2Cl$ is a benzylic halide (sp^3 C–X).

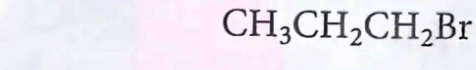
Memory Aids

- Mono = single halogen; Di = two; Tri = three halogens.
- sp^3 C–X: Alkyl, allylic, benzylic halides.
- sp^2 C–X: Vinylic, aryl halides.
- Benzylic halides have halogen on carbon next to aromatic ring.

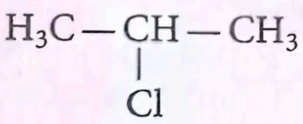
Nomenclature

Common and IUPAC Naming of Alkyl Halides

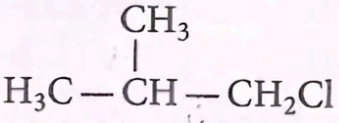
- Common names: Alkyl group name + halide (e.g., ethyl bromide).
- IUPAC names: Halosubstituted hydrocarbons (e.g., bromoethane).
- Monohalogen benzene derivatives: Common and IUPAC names are identical.
- Dihalogen benzene derivatives: Common prefixes o-, m-, p- correspond to IUPAC locants 1,2-; 1,3-; 1,4- respectively.



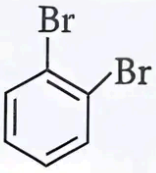
Common name : *n*-Propyl bromide
IUPAC name : 1-Bromopropane



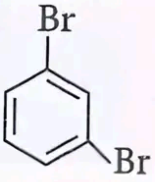
Iso-propyl chloride
2-Chloropropane



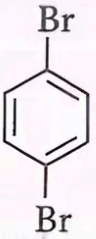
Iso-butyl chloride
1-Chloro-2-methylpropane



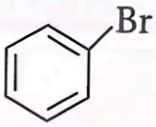
Common name : *o*-Dibromobenzene
IUPAC name : 1, 2-Dibromobenzene



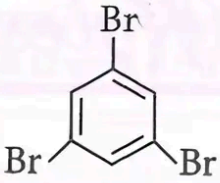
m-Dibromobenzene
1, 3-Dibromobenzene



p-Dibromobenzene
1, 4-Dibromobenzene



Common name : Bromobenzene
IUPAC name : Bromobenzene



sym-Tribromobenzene
1, 3, 5-Tribromobenzene

Solved Examples

- Ex 1: Name CH_3CH_2Br
  - Common: Ethyl bromide
  - IUPAC: Bromoethane
- Ex 2: Name $C_6H_4Br_2$ with bromines at 1,3 positions
  - Common: m-Dibromobenzene
  - IUPAC: 1,3-Dibromobenzene

Practice Set

- Q1: What is the IUPAC name of CH_3CH_2Cl?
  - A. Ethyl chloride
  - B. Chloroethane
  - C. Ethane chloride
  - D. Chloromethane
- Q2: The common name for 1,4-dibromobenzene is:
  - A. o-Dibromobenzene
  - B. m-Dibromobenzene
  - C. p-Dibromobenzene
  - D. 1,4-Dibromobenzene

- Q3: Which prefix corresponds to 1,2-dibromobenzene in common naming?
    - A. o-
    - B. m-
    - C. p-
    - D. None

Answer Key

- Q1: B - Chloroethane is the correct IUPAC name for CH_3CH_2Cl.
- Q2: C - p-Dibromobenzene is the common name for 1,4-dibromobenzene.
- Q3: A - o- prefix corresponds to 1,2-dibromobenzene.

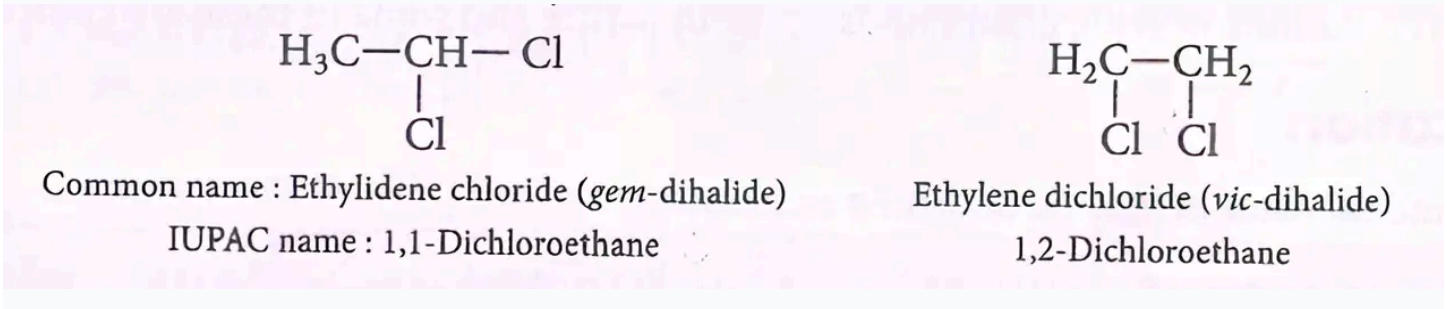
Memory Aids

- o- = 1,2- (ortho)
- m- = 1,3- (meta)
- p- = 1,4- (para)
- Alkyl halides: Alkyl name + halide (common), Halosubstituted hydrocarbon (IUPAC)

Dihaloalkanes

Classification and Naming

- Dihaloalkanes with same halogen atoms are named as alkylidene or alkylene dihalides.
- Geminal halides: Both halogen atoms on the same carbon (gem-dihalides).
- Vicinal halides: Halogen atoms on adjacent carbons (vic-dihalides).
- Common names: Gem-dihalides = alkylidene halides; Vic-dihalides = alkylene dihalides.
- IUPAC names: Both are named as dihaloalkanes with locants.



Solved Examples

- Ex 1: Name CH_3CHCl_2
  - Common: Ethylidene chloride
  - IUPAC: 1,1-Dichloroethane
- Ex 2: Name CH_2ClCH_2Cl
  - Common: Ethylene dichloride
  - IUPAC: 1,2-Dichloroethane

Practice Set

- Q1: What is the IUPAC name of CH_3CHCl_2?
  - A. 1,2-Dichloroethane
  - B. 1,1-Dichloroethane
  - C. Ethylene dichloride
  - D. Ethylidene chloride
- Q2: Which is a geminal dihalide?
  - A. CH_2ClCH_2Cl
  - B. CH_3CHCl_2
  - C. CH_3CH_2Cl
  - D. CH_3CH_2Br
- Q3: The common name for 1,2-dichloroethane is:
  - A. Ethylidene chloride
  - B. Ethylene dichloride
  - C. 1,1-Dichloroethane
  - D. 1,2-Dichloroethane

Answer Key

- Q1: B - 1,1-Dichloroethane is the IUPAC name for CH_3CHCl_2.
- Q2: B - CH_3CHCl_2 is a geminal dihalide (both Cl on same carbon).
- Q3: B - Ethylene dichloride is the common name for 1,2-dichloroethane.

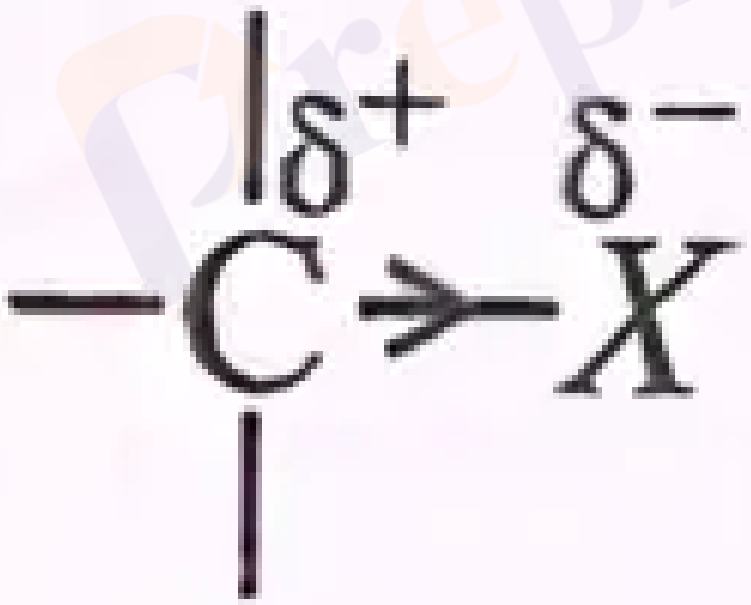
Memory Aids

- Geminal = same carbon (gem-dihalide = alkylidene halide)
- Vicinal = adjacent carbons (vic-dihalide = alkylene dihalide)
- IUPAC uses locants for exact positions (e.g., 1,1- or 1,2-)

Nature of C — X Bond

Bond Polarity and Electronegativity

- Halogen atoms (X) are more electronegative than carbon (C).
- Carbon-halogen bond in alkyl halides is polar covalent.
- Carbon atom carries partial positive charge (δ^+), halogen carries partial negative charge (δ^-).
- Electron density shifts from carbon to halogen, making the bond polar.



Solved Examples

- **Ex 1:** Identify the polarity in CH_3Cl.
  - Cl is more electronegative than C.
  - Bond is polar with C as δ^+ and Cl as δ^-.

Practice Set

- Q1: Which atom in alkyl halides carries a partial positive charge?
  - A. Halogen
  - B. Carbon
  - C. Hydrogen
  - D. Oxygen
- Q2: What type of bond is formed between carbon and halogen in alkyl halides?
  - A. Ionic
  - B. Nonpolar covalent
  - C. Polar covalent
  - D. Metallic
- Q3: In the C—X bond, the arrow indicating electron density points from:
  - A. Halogen to Carbon
  - B. Carbon to Halogen
  - C. Hydrogen to Carbon
  - D. Carbon to Hydrogen

Answer Key

- Q1: B - Carbon carries partial positive charge due to electronegativity difference.
- Q2: C - The bond is polar covalent because electrons are shared unevenly.
- Q3: B - Electron density shifts from carbon to more electronegative halogen.

Memory Aids

- Remember: "C is δ^+, X is δ^-" in alkyl halides.
- Polar bond due to electronegativity difference between C and X.

Bond Length and Bond Enthalpy

Trend with Halogen Size

- As halogen size increases (F to I), bond length increases.

- Bond enthalpy decreases with increasing bond length.
- Fluorine forms shortest and strongest C—F bond.
- Iodine forms longest and weakest C—I bond.

Halide	$H_3C—F$	$H_3C—Cl$	$H_3C—Br$	$H_3C—I$
Bond length (pm)	139	178	193	214
Bond enthalpy (kJ mol^{-1})	452	351	293	234

Solved Examples

- **Ex 1:** Compare bond enthalpy of C—F and C—I bonds.
  - C—F bond enthalpy = 452 kJ/mol (strongest)
  - C—I bond enthalpy = 234 kJ/mol (weakest)

Practice Set

- Q1: Which C—X bond has the shortest bond length?
  - A. C—Cl
  - B. C—I
  - C. C—F
  - D. C—Br
- Q2: What happens to bond enthalpy as bond length increases?
  - A. Increases
  - B. Decreases
  - C. Remains same
  - D. First increases then decreases
- Q3: Arrange the following bonds in order of increasing bond length: C—Br, C—F, C—I.
  - A. C—F < C—Br < C—I
  - B. C—I < C—Br < C—F
  - C. C—Br < C—I < C—F
  - D. C—F < C—I < C—Br

Answer Key

- Q1: C - Fluorine forms shortest bond due to smallest atomic size.

- Q2: B - Bond enthalpy decreases as bond length increases.
- Q3: A - Bond length increases from F to I.

Memory Aids

- Bond length: F < Cl < Br < I
- Bond enthalpy: F > Cl > Br > I

Dipole Moment Variation

Effect of Halogen Size and Electronegativity

- Dipole moment depends on bond polarity and bond length.
- From F to I, halogen size increases, electronegativity decreases.
- Dipole moment varies irregularly due to these opposing effects.
- CH_3Cl has highest dipole moment among CH_3F, CH_3Cl, CH_3Br, CH_3I.

	CH_3F	CH_3Cl	CH_3Br	CH_3I
Dipole moment (Debye) :	1.847	1.860	1.830	1.636

Solved Examples

- **Ex 1:** Identify molecule with highest dipole moment among CH_3F, CH_3Cl, CH_3Br, CH_3I.
  - CH_3Cl has dipole moment 1.860 D (highest).

Practice Set

- Q1: Which molecule has the highest dipole moment?
  - A. CH_3F
  - B. CH_3Cl
  - C. CH_3Br
  - D. CH_3I

- Q2: Dipole moment generally depends on:
  - A. Only electronegativity
  - B. Only bond length
  - C. Both electronegativity and bond length
  - D. Neither electronegativity nor bond length
- Q3: Why does dipole moment vary irregularly from F to I?
  - A. Because electronegativity and size change oppositely
  - B. Because all halogens have same electronegativity
  - C. Because bond length remains constant
  - D. Because carbon electronegativity changes

Answer Key

- Q1: B - CH_3Cl has highest dipole moment due to optimal electronegativity and size.
- Q2: C - Dipole moment depends on both electronegativity difference and bond length.
- Q3: A - Opposite trends in electronegativity and size cause irregular variation.

Memory Aids

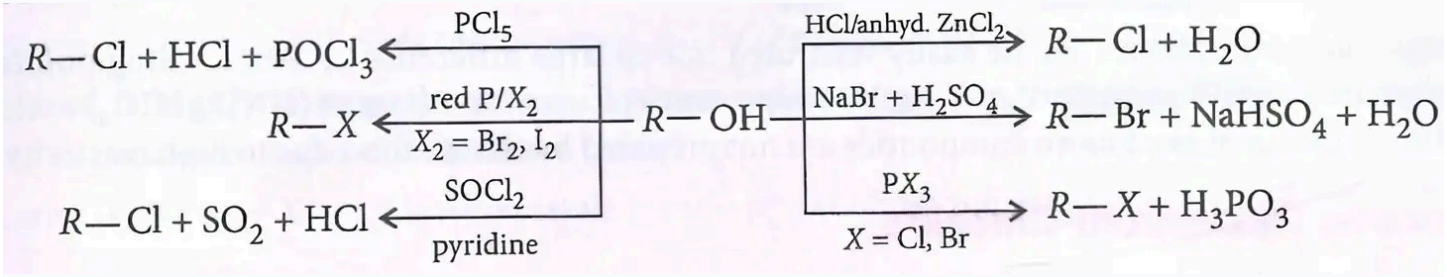
- Dipole moment peaks at intermediate halogen size (Cl).
- Remember: Dipole moment ≠ directly proportional to electronegativity alone.

Methods of Preparation of Haloalkanes

From Alcohols

- Alcohols (R 6OH) react with halogenating agents to form haloalkanes (R 6X).
- Alkyl chlorides (R 6Cl) formed using HCl with anhydrous $ZnCl_2$ catalyst for 1 6 and 2 6 alcohols; tertiary alcohols react directly with concentrated HCl.
- Alkyl bromides (R 6Br) formed by reacting alcohols with NaBr and H_2SO_4.
- Phosphorus halides (PX_3, X = Cl, Br) convert alcohols to alkyl halides.
- Red phosphorus with halogens (Br_2, I_2) also converts alcohols to alkyl halides.
- Other reagents: PCl_5, $SOCl_2$ with pyridine convert alcohols to alkyl chlorides.

- Good yields of alkyl iodides (R 6I) obtained by heating alcohols with sodium or potassium iodide in 95% ortho phosphoric acid.
- Reactivity order with haloacid: tertiary > secondary > primary alcohols.



Solved Examples

- Ex 1: Convert 2 6propanol to 2 6bromopropane using NaBr and H_2SO_4.
- Step 1: Mix 2 6propanol with NaBr and H_2SO_4.
- Step 2: Reaction proceeds to form 2 6bromopropane and water.

Practice Set

- Q1: Which reagent converts tertiary alcohols to alkyl chlorides at room temperature?
  - A. HCl with $ZnCl_2$
  - B. Concentrated HCl
  - C. NaBr and H_2SO_4
  - D. PCl_5
- Q2: What is the order of reactivity of alcohols with haloacids?
  - A. 1 6 > 2 6 > 3 6
  - B. 3 6 > 2 6 > 1 6
  - C. 2 6 > 3 6 > 1 6
  - D. 1 6 > 3 6 > 2 6
- Q3: Which reagent is used to obtain good yields of alkyl iodides from alcohols?
  - A. NaI in 95% ortho phosphoric acid
  - B. NaBr and H_2SO_4
  - C. PCl_5
  - D. $SOCl_2$ with pyridine

Answer Key

- Q1: B - Tertiary alcohols react directly with concentrated HCl at room temperature.
- Q2: B - Reactivity order is tertiary > secondary > primary alcohols.
- Q3: A - Heating alcohols with NaI in 95% ortho phosphoric acid gives good yields of alkyl iodides.

Memory Aids

- Remember: 3 6 alcohols react fastest with haloacids.
- Use $ZnCl_2$ catalyst for 1 6 and 2 6 alcohols with HCl.
- NaI + 95% H_3PO_4 for alkyl iodides.

From Hydrocarbons

Free Radical Halogenation

- Methane (CH_4) reacts with Cl_2 under UV light or heat to form chloromethanes.
- Chlorine splits into radicals that replace hydrogen atoms stepwise.
- Products: CH_3Cl, CH_2Cl_2, $CHCl_3$, CCl_4 plus HCl byproduct.
- Ease of hydrogen replacement: tertiary > secondary > primary.

By free radical halogenation :

$$CH_4 + Cl_2 \xrightarrow[\text{or heat}]{\text{UV light}} CH_3Cl + CH_2Cl_2 + CHCl_3 + CCl_4 + HCl$$

Addition to Alkenes

- Alkenes react with hydrogen halides (HX) and halogens (X_2).
- HX addition follows Markovnikov's rule: halogen attaches to carbon with fewer hydrogens.
- In presence of peroxide, HBr adds via Anti-Markovnikov's rule.
- Halogens add across double bonds to form vic-dihalides.

- **By electrophilic addition of HX to alkene :**

$$RCH=CH_2 + HX \longrightarrow \underset{\underset{X}{|}}{RCH}-CH_3 + RCH_2CH_2X \quad (\text{where, } X = Cl, Br, I)$$

(Major)
(Markovnikov's rule)

$$RCH=CH_2 + HBr \xrightarrow{\text{Peroxide}} RCH_2-CH_2Br \quad (\text{Anti-Markovnikov's rule})$$

- **By addition of halogens to alkene :** $CH_2=CH_2 + Br_2 \xrightarrow{CCl_4} BrCH_2-CH_2Br$

vic-Dibromide

Solved Examples

- Ex 1: Chlorination of methane under UV light forms CH_3Cl.
- Step 1: UV light splits Cl_2 into radicals.
- Step 2: Cl radical replaces H in CH_4 forming CH_3Cl.

Practice Set

- Q1: What initiates free radical halogenation of methane?
  - A. Heat or UV light
  - B. Catalyst $ZnCl_2$
  - C. Concentrated HCl
  - D. Peroxide
- Q2: Which rule does HX addition to alkenes usually follow?
  - A. Anti-Markovnikov
  - B. Markovnikov
  - C. Zaitsev
  - D. Saytzeff
- Q3: In presence of peroxide, HBr adds to alkenes following?
  - A. Markovnikov's rule
  - B. Anti-Markovnikov's rule
  - C. Free radical substitution
  - D. Electrophilic addition

Answer Key

- Q1: A - Heat or UV light initiates radical formation.
- Q2: B - HX addition follows Markovnikov's rule normally.
- Q3: B - HBr adds via Anti-Markovnikov's rule in presence of peroxide.

Memory Aids

- Free radical halogenation needs UV or heat.
- Markovnikov: halogen to carbon with fewer H.
- Anti-Markovnikov: halogen to carbon with more H (only HBr + peroxide).

Halogen Exchange

Finkelstein Reaction

- Alkyl halide (R 6X, X = Cl or Br) reacts with NaI in dry acetone.
- Halogen X is replaced by iodine forming alkyl iodide (R 6I).
- NaCl or NaBr precipitates out, driving reaction forward (Le Chatelier's principle).

Finkelstein reaction : $R-X + NaI \xrightarrow{\text{dry acetone}} R-I + NaX$ (where, X = Cl, Br)

Swarts Reaction

- Alkyl halide (RX, X = Cl or Br) reacts with AgF.
- Halogen replaced by fluorine forming alkyl fluoride (RF).
- Byproduct: silver halide (AgX).
- Other reagents: HgF_2, CoF_3, SbF_5 can also be used.

Swarts reaction : $RX + AgF \longrightarrow RF + AgX$

(X = Cl, Br) (or Hg_2F_2 or CoF_2 or SbF_3)

Additional Notes

- Relative rates of hydrogen abstraction by Cl_2: 3 6:2 6:1 6 = 5:3.8:1.
- By Br_2 at 400 K: 1600:82:1.
- Direct iodination is reversible; requires oxidising agents (HNO_3, HIO_3).

Solved Examples

- Ex 1: Convert R 6Cl to R 6I using NaI in dry acetone (Finkelstein reaction).
- Step 1: Mix R 6Cl with NaI in dry acetone.
- Step 2: R 6I forms, NaCl precipitates.

Practice Set

- Q1: In Finkelstein reaction, which solvent is used?
  - A. Water
  - B. Dry acetone
  - C. Ethanol
  - D. Benzene
- Q2: Swarts reaction replaces halogen with?
  - A. Chlorine
  - B. Bromine
  - C. Fluorine
  - D. Iodine
- Q3: Which reagent is NOT used in Swarts reaction?
  - A. AgF
  - B. HgF_2
  - C. NaI
  - D. CoF_3

Answer Key

- Q1: B - Dry acetone is solvent in Finkelstein reaction.
- Q2: C - Swarts reaction replaces halogen with fluorine.
- Q3: C - NaI is not used in Swarts reaction; it is used in Finkelstein reaction.

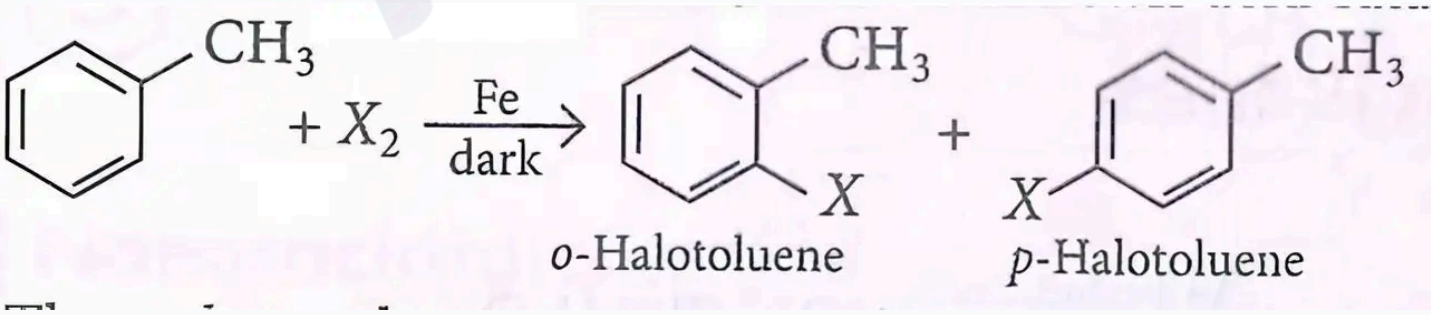
Memory Aids

- Finkelstein: halogen exchange with NaI in dry acetone.
- Swarts: halogen replaced by fluorine using AgF or similar.
- Direct iodination needs oxidising agents.

Preparation of Haloarenes

From Hydrocarbons by Electrophilic Substitution

- Aryl chlorides and bromides are prepared by electrophilic substitution of arenes with Cl_2 or Br_2.
- Lewis acid catalysts like Fe or $FeCl_3$ are used to activate halogens.
- Reaction occurs in the dark to prevent side reactions.
- Example: Toluene reacts with X_2 (Cl_2/Br_2) in presence of Fe catalyst to give ortho- and para-halotoluene.
- Ortho- and para-isomers differ in melting points and can be separated easily.
- Iodination requires oxidizing agents (HNO_3, HIO_4) to oxidize HI formed; reaction is reversible.
- Fluoro compounds are not prepared by this method due to fluorine's high reactivity.



Solved Examples

- **Ex 1:** Toluene + Br_2 / Fe → o-bromotoluene + p-bromotoluene
- Step 1: Add Br_2 and Fe catalyst to toluene in dark.
- Step 2: Electrophilic substitution occurs at ortho and para positions.
- Step 3: Separate isomers by melting point difference.

Practice Set

- Q1: Which catalyst is used for electrophilic halogenation of benzene?
  A. $FeCl_3$
  B. NaCl
  C. HCl
  D. CuCl
- Q2: What is the major product when toluene reacts with Cl_2 in presence of Fe?
  A. Meta-chlorotoluene
  B. Ortho- and para-chlorotoluene
  C. Benzyl chloride
  D. Chlorobenzene
- Q3: Why are fluoroarenes not prepared by electrophilic substitution?
  A. Fluorine is too reactive
  B. Fluorine is unreactive
  C. Fluorine forms unstable intermediates
  D. Fluorine reacts only with alkanes

Answer Key

- Q1: A. $FeCl_3$ - It acts as a Lewis acid catalyst activating halogens.
- Q2: B. Ortho- and para-chlorotoluene - Electrophilic substitution occurs at ortho and para positions due to methyl group activation.
- Q3: A. Fluorine is too reactive - High reactivity prevents controlled substitution.

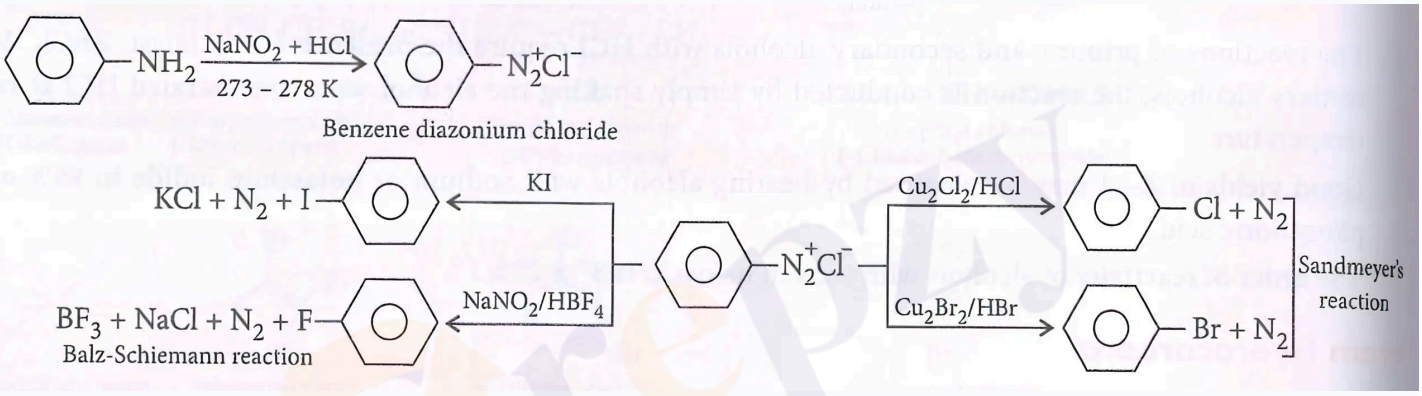
Memory Aids

- $Fe/FeCl_3$ catalyzes Cl_2/Br_2 substitution on benzene rings.
- Methyl group directs substitution to ortho and para positions.
- Fluorine too reactive for electrophilic substitution on arenes.

From Benzene Diazonium Chloride

Key Reactions and Mechanism

- Start with aniline ($C_6H_5–NH_2$).
- React with $NaNO_2$ and HCl at 273–278 K to form benzene diazonium chloride ($C_6H_5–N_2^+Cl^-$).
- Benzene diazonium chloride is a versatile intermediate for halogenation.
- Balz-Schiemann reaction: React with $NaNO_2$ and HBF_4 to produce fluorobenzene.
- Sandmeyer's reaction: React with Cu_2Cl_2/HCl to give chlorobenzene + N_2 gas.
- Similarly, react with Cu_2Br_2/HBr to give bromobenzene + N_2 gas.



Solved Examples

- **Ex 1:** Preparation of fluorobenzene
  Step 1: Aniline + $NaNO_2$/HCl → Benzene diazonium chloride (273–278 K)
  Step 2: Benzene diazonium chloride + $NaNO_2$/HBF_4 → Fluorobenzene + N_2
- **Ex 2:** Preparation of chlorobenzene
  Step 1: Aniline + $NaNO_2$/HCl → Benzene diazonium chloride
  Step 2: Benzene diazonium chloride + Cu_2Cl_2/HCl → Chlorobenzene + N_2

Practice Set

- Q1: What is the temperature range for diazotization of aniline?
  A. 273–278 K
  B. 300–310 K

C. 250–260 K

D. 280–290 K

- Q2: Which reagent is used in Balz-Schiemann reaction to produce fluorobenzene?
  A. Cu_2Cl_2
  B. $NaNO_2$ and HBF_4
  C. HCl
  D. Cu_2Br_2
- Q3: What gas is released during Sandmeyer's reaction?
  A. CO_2
  B. N_2
  C. H_2
  D. O_2

Answer Key

- Q1: A. 273–278 K - Low temperature is essential for stable diazonium salt formation.
- Q2: B. $NaNO_2$ and HBF_4 - Used in Balz-Schiemann reaction to replace diazonium group with fluorine.
- Q3: B. N_2 - Nitrogen gas is released as a byproduct in Sandmeyer's reaction.

Memory Aids

- Benzene diazonium chloride is key intermediate for halogenation of benzene.
- Balz-Schiemann reaction produces fluorobenzene using HBF_4.
- Sandmeyer's reaction replaces diazonium group with Cl or Br releasing N_2.

Physical Properties

General Characteristics

- Alkyl halides are colourless when pure.
- Bromides and iodides develop colour on exposure to light.
- Many volatile halogen compounds have a sweet smell.

- Methyl chloride, methyl bromide, ethyl chloride, and some chlorofluoromethanes are gases at room temperature; higher members are liquids or solids.

Boiling Points and Intermolecular Forces

- Halogen derivatives have stronger intermolecular forces (dipole-dipole and van der Waals) than parent hydrocarbons due to greater polarity and molecular mass.
- Boiling points of chlorides, bromides, and iodides are higher than hydrocarbons of similar molecular mass.
- For the same alkyl group, boiling points decrease in order: RI > RBr > RCl > RF due to increasing van der Waals forces with halogen size.
- Boiling points of isomeric haloalkanes decrease with increased branching.
- Boiling points of isomeric dihalobenzenes are nearly the same; para-isomers have higher melting points due to better crystal lattice symmetry.

Density and Solubility

- Bromo, iodo, and polychloro derivatives are heavier than water.
- Density increases with the number of carbon atoms, halogen atoms, and atomic mass of halogen atoms.
- Example densities (g mL^{-1}): n-C_3H_7Cl = 0.89, n-C_3H_7Br = 1.335, n-C_3H_7I = 1.747.
- Haloalkanes are very slightly soluble in water but more soluble in organic solvents due to similar intermolecular attractions.

Photochemical Decomposition of Alkyl Iodides

- Alkyl iodides become violet or brown on standing due to weak C–I bond.
- They decompose in sunlight, releasing iodine which dissolves in alkyl iodide, imparting a dark colour.

$$2R - I \xrightarrow{h\upsilon} R - R + I_2$$

The reaction: $2R–I \xrightarrow{h\nu} R–R + I_2$

Solved Examples

- **Ex 1:** Explain why alkyl iodides develop colour on standing.
  - C–I bond is weak.
  - Sunlight breaks 2R–I into R–R and I_2.
  - Iodine dissolves in alkyl iodide, causing violet/brown colour.
- **Ex 2:** Arrange the boiling points of RI, RBr, RCl, and RF.
  - Order: RI > RBr > RCl > RF due to increasing van der Waals forces with halogen size.

Practice Set

- **Q1:** Which alkyl halide is a gas at room temperature?
  A. n-C_3H_7Cl
  B. Methyl bromide
  C. n-C_3H_7I
  D. Ethyl iodide
- **Q2:** What causes the higher boiling points of alkyl halides compared to hydrocarbons?
  A. Lower molecular mass
  B. Stronger intermolecular forces
  C. Less polarity
  D. Smaller size
- **Q3:** Why do para-isomers of dihalobenzenes have higher melting points?
  A. Less symmetry
  B. Better crystal lattice fitting
  C. Lower molecular mass
  D. Higher branching

Answer Key

- **Q1:** B - Methyl bromide is a gas at room temperature due to low molecular weight.
- **Q2:** B - Alkyl halides have stronger dipole-dipole and van der Waals forces, raising boiling points.
- **Q3:** B - Para-isomers fit better in crystal lattice due to symmetry, increasing melting points.

Memory Aids

- Boiling point order: RI > RBr > RCl > RF (increasing halogen size increases van der Waals forces).
- Alkyl iodides decompose under light: $2R–I \xrightarrow{h\nu} R–R + I_2$.
- Para-isomers have higher melting points due to symmetry.

Chemical Reactions

Reactions of Haloalkanes

Nucleophilic Substitution Reactions

- C—X bond is highly polarised due to electronegativity difference (X > C).
- Polarity causes nucleophilic substitution reactions.
- General mechanism: Nucleophile attacks δ+ carbon, displaces X^-.
- Common nucleophilic substitutions:
  - RX + KOH (aq) → R–OH (alcohol)
  - RX + NaOR' → R–OR' (ether, Williamson synthesis)
  - RX + NaSH → R–SH (thioalcohol)
  - RX + KCN → R–CN (alkyl cyanide)
- Ambident nucleophiles (e.g., CN^-, NO_2^-) can attack through two sites, giving different products.
- Mechanisms: SN1 (two-step, carbocation intermediate) and SN2 (one-step, backside attack).
- Reactivity order: R–I > R–Br > R–Cl > R–F.
- Primary allylic and benzylic halides react faster in SN1 due to resonance-stabilized carbocations.
- Optical isomerism arises from chiral centers (carbon with four different groups).
  - Dextrorotatory (+) rotates plane-polarized light right.
  - Laevorotatory (−) rotates left.
  - Racemisation: conversion of enantiomer to racemic mixture (optically inactive).
  - Meso compounds have internal symmetry and are optically inactive.

Solved Examples

- **Ex 1:** SN2 reaction of CH_3Br with OH^- gives CH_3OH with inversion of configuration.
- **Ex 2:** 2-Bromobutane + alc. KOH → 2-butene (major) + 1-butene (minor) via elimination.

Practice Set

- Q1: Which halide is most reactive in SN2?
  - A. R–F
  - B. R–Cl
  - C. R–Br
  - D. R–I
- Q2: What product forms when RX reacts with KCN?
  - A. Alcohol
  - B. Alkyl cyanide
  - C. Ether
  - D. Thioalcohol
- Q3: Which mechanism involves carbocation intermediate?
  - A. SN1
  - B. SN2
  - C. E2
  - D. E1

Answer Key

- Q1: D. R–I; Iodides have weakest C–X bond, highest reactivity.
- Q2: B. Alkyl cyanide; KCN substitutes CN group forming R–CN.
- Q3: A. SN1; involves carbocation intermediate in two-step mechanism.

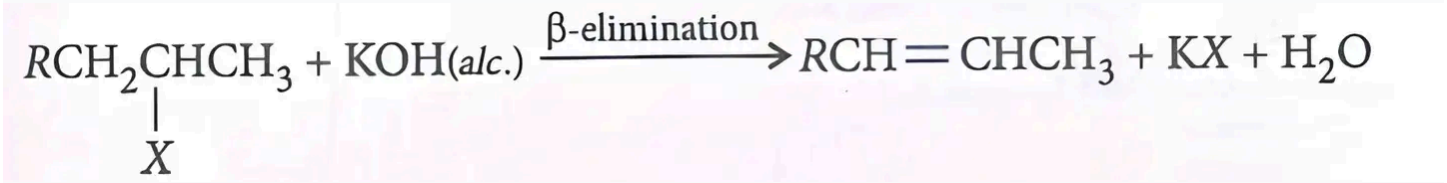
Memory Aids

- SN2: One step, backside attack, inversion of configuration.
- SN1: Two steps, carbocation intermediate, racemisation possible.
- Saytzeff's rule: Major alkene has more alkyl substituents.
- Ambident nucleophiles: CN^- (C or N), NO_2^- (O or N).

Elimination Reactions

Elimination of HX from Haloalkanes

- Haloalkanes with β-hydrogen undergo dehydrohalogenation with alc. KOH on heating.
- Reaction forms alkenes, KX, and H_2O.
- Major alkene follows Saytzeff's rule: more substituted alkene is favored.



Solved Examples

- **Ex 1:** 2-Bromobutane + alc. KOH → 2-butene (major) + 1-butene (minor)

Practice Set

- Q1: What is the major product of elimination from 2-bromopentane?
  - A. 1-pentene
  - B. 2-pentene
  - C. Pentane
  - D. 3-pentene
- Q2: Which reagent is used for dehydrohalogenation?
  - A. Aqueous KOH
  - B. Alcoholic KOH
  - C. NaOH (solid)
  - D. HCl
- Q3: Saytzeff's rule states that the major alkene formed has?
  - A. Least alkyl groups
  - B. Most alkyl groups
  - C. Equal alkyl groups
  - D. No alkyl groups

Answer Key

- Q1: B. 2-pentene; more substituted alkene is major product.
- Q2: B. Alcoholic KOH; used for elimination reactions.
- Q3: B. Most alkyl groups; Saytzeff's rule favors more substituted alkene.

Memory Aids

- Elimination requires β-hydrogen and base (alc. KOH).
- Saytzeff's rule: More substituted alkene is major product.

Reactions with Metals

Reactions of Haloalkanes with Metals

- RX + Mg (dry ether) → R–MgX (Grignard reagent)
- Grignard reagents react with proton donors to form RH.
- RX + Li (dry ether) → RLi (organolithium compound)
- 2 RX + 2 Na (dry ether) → R–R + 2 NaX (Wurtz reaction)

(iii) Reaction with Metals

- $R-X + Mg \xrightarrow[\text{Grignard reagent}]{\text{dry ether}} R-MgX$ (where, X = Cl, Br, I)

Grignard reagents are highly reactive and react with any source of proton to form hydrocarbons.

$R-MgX + H-G \longrightarrow RH + Mg\begin{matrix}X\\G\end{matrix}$ (where, G = OH, RO, NH_2, $RC \equiv C^-$)

- $R-X + 2Li \xrightarrow{\text{dry ether}} RLi + LiX$
- $2R-X + 2Na \xrightarrow{\text{dry ether}} R-R + 2NaX$ (Wurtz reaction)

Solved Examples

- **Ex 1:** Preparation of Grignard reagent from bromobenzene and Mg.
- **Ex 2:** Wurtz reaction: 2 CH_3Cl + 2 Na → C_2H_6 + 2 NaCl.

Practice Set

- Q1: Grignard reagent is formed by reaction of RX with?
  - A. Na
  - B. Mg
  - C. Li
  - D. K
- Q2: Wurtz reaction joins two alkyl halides using?
  - A. Mg
  - B. Li
  - C. Na
  - D. K
- Q3: Organolithium compounds are formed by reaction of RX with?
  - A. Na
  - B. Mg
  - C. Li
  - D. K

Answer Key

- Q1: B. Mg; Grignard reagents form with magnesium in dry ether.
- Q2: C. Na; Wurtz reaction uses sodium metal.
- Q3: C. Li; Organolithium compounds form with lithium.

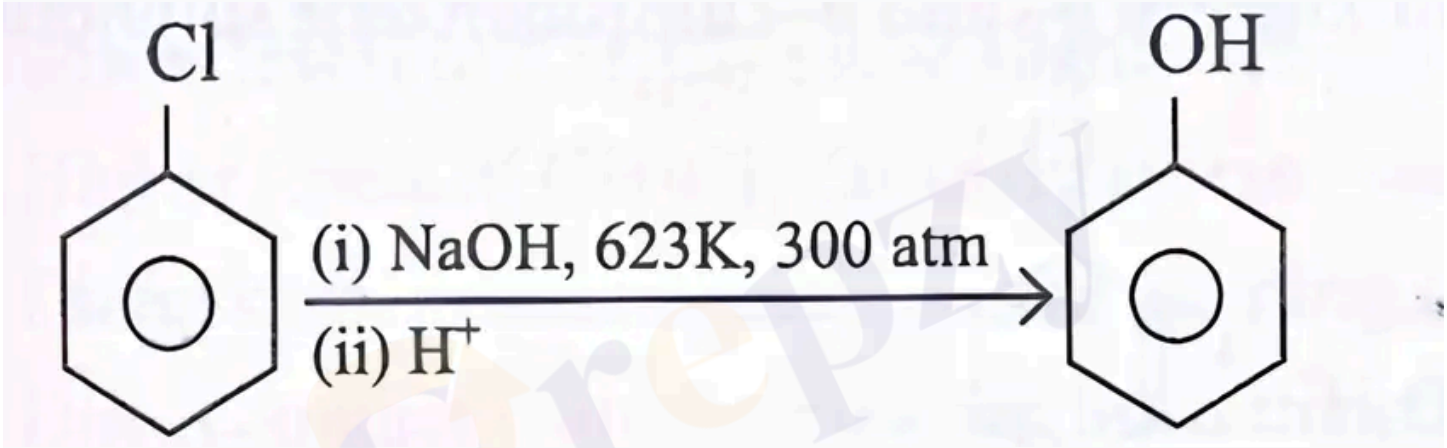
Memory Aids

- Grignard reagent: RX + Mg → R–MgX.
- Wurtz reaction: 2 RX + 2 Na → R–R + 2 NaX.
- Organolithium: RX + Li → RLi.

Reactions of Haloarenes

Nucleophilic Substitution Reactions

- Haloarenes less reactive than alkyl halides due to:
  - Partial double bond character of C—X (resonance with benzene).
  - Less polar C—X bond (sp^2 C more electronegative than sp^3 C).
  - Phenyl cation unstable; SN1 mechanism not favored.
  - Electron-rich nucleophiles repel electron-rich aromatic ring.
- Replacement of Cl by OH requires harsh conditions (NaOH, 623 K, 300 atm, acid work-up).
- Electron withdrawing groups (-NO_2) at ortho/para increase reactivity.



Solved Examples

- **Ex 1:** Chlorobenzene + NaOH (623 K, 300 atm) → Phenol + NaCl
- **Ex 2:** 2-Chloronitrobenzene + NaOH → 2-Nitrophenol

Practice Set

- Q1: Why are haloarenes less reactive in nucleophilic substitution?
  - A. Strong C—X bond
  - B. Partial double bond character and resonance
  - C. High polarity of C—X bond
  - D. Stable phenyl cation
- Q2: Which group increases reactivity of haloarenes?
  - A. Electron donating

    - B. Electron withdrawing (-NO_2)
    - C. Alkyl
    - D. Halogen
- Q3: Conditions to replace Cl by OH in chlorobenzene?
    - A. NaOH, room temp
    - B. NaOH, 623 K, 300 atm, acid work-up
    - C. NaOH, 100 K
    - D. NaOH, 500 atm

Answer Key

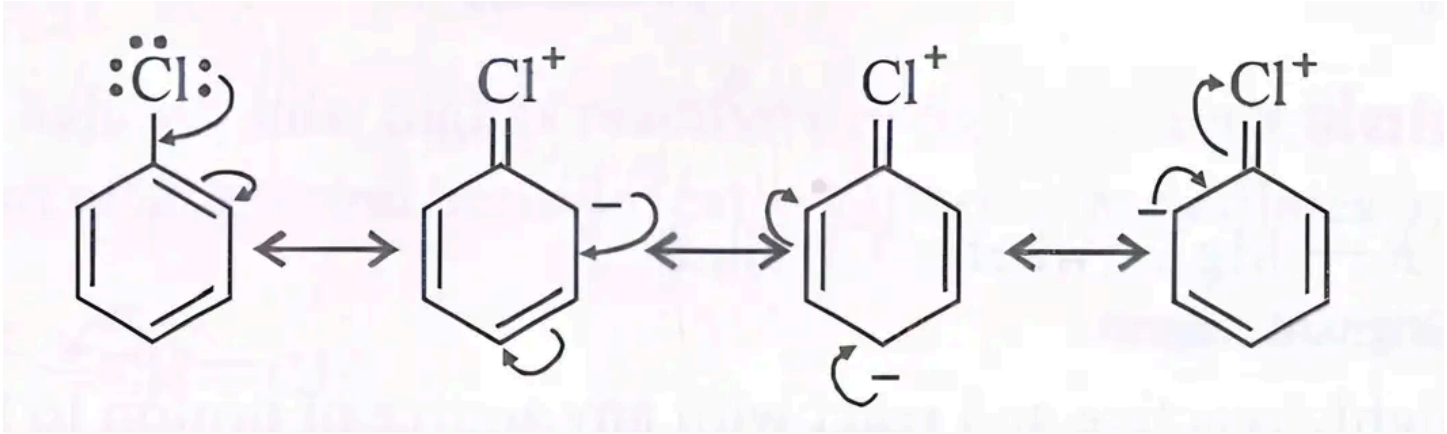
- Q1: B; Resonance and partial double bond reduce reactivity.
- Q2: B; Electron withdrawing groups activate haloarenes.
- Q3: B; High temp, pressure, and acid needed for substitution.

Memory Aids

- Haloarenes: C—X partial double bond, less reactive.
- Electron withdrawing groups increase nucleophilic substitution.
- Harsh conditions needed for OH substitution.

Electrophilic Substitution Reactions

- Halogen I-effect withdraws electrons, deactivating ring.
- Halogen +M effect increases electron density at ortho/para.
- Haloarenes are ortho/para directing.
- Halogenation: Haloarene + Cl_2 + $FeCl_3$ → dihalobenzene.
- Nitration: Haloarene + HNO_3/H_2SO_4 → o- and p-halonitrobenzene.
- Sulphonation: Haloarene + H_2SO_4 → o- and p-halo benzene sulfonic acid.
- Friedel-Crafts alkylation: Haloarene + alkyl halide + $AlCl_3$ → o- and p-haloalkylbenzene.
- Friedel-Crafts acylation: Haloarene + acid chloride + $AlCl_3$ → o- and p-acetophenone.



Solved Examples

- **Ex 1:** Chlorobenzene + $Cl_2/FeCl_3$ → 1,4-dichlorobenzene (major) + 1,2-dichlorobenzene (minor)
- **Ex 2:** Chlorobenzene + HNO_3/H_2SO_4 → 1-chloro-4-nitrobenzene (major) + 1-chloro-2-nitrobenzene (minor)
- **Ex 3:** Chlorobenzene + $CH_3Cl/AlCl_3$ → 1-chloro-4-methylbenzene (major) + 1-chloro-2-methylbenzene (minor)

Practice Set

- Q1: Haloarenes are less reactive due to?
  - A. Strong C—X bond
  - B. Partial double bond character and resonance
  - C. High polarity
  - D. Stable carbocation
- Q2: Halogen directs substitution to?
  - A. Meta
  - B. Ortho and para
  - C. Only para
  - D. Only ortho
- Q3: Major product of chlorobenzene + $Cl_2/FeCl_3$ is?
  - A. 1,2-dichlorobenzene
  - B. 1,3-dichlorobenzene
  - C. 1,4-dichlorobenzene
  - D. 1,5-dichlorobenzene

Answer Key

- Q1: B; Resonance and partial double bond reduce reactivity.
- Q2: B; Halogens are ortho/para directing.
- Q3: C; Para is major due to less steric hindrance.

Memory Aids

- Halogen I-effect deactivates, +M effect directs ortho/para.
- Halogenation needs $FeCl_3$ catalyst.
- Friedel-Crafts reactions give ortho/para products.

Polyhalogen Compounds

Overview

- Carbon compounds containing more than one halogen atom.
- Examples: $CHCl_3$ (chloroform), CH_2Cl_2 (dichloromethane).

Solved Examples

- **Ex 1:** Identify a polyhalogen compound with three chlorine atoms.
  - Answer: $CHCl_3$ (chloroform).

Practice Set

- Q1: Which of the following is a polyhalogen compound?
  - A. CH_4
  - B. $CHCl_3$
  - C. C_2H_6
  - D. C_2H_4
- Q2: Polyhalogen compounds contain how many halogen atoms?

    - A. One
    - B. Two or more
    - C. None
    - D. Exactly one
- Q3: Which is an example of a polyhalogen compound?
    - A. CH_3Cl
    - B. CH_2Cl_2
    - C. CH_4
    - D. CCl_4

Answer Key

- Q1: B - $CHCl_3$ contains multiple halogen atoms.
- Q2: B - Polyhalogen compounds have two or more halogen atoms.
- Q3: B - CH_2Cl_2 is a polyhalogen compound.

Memory Aids

- Polyhalogen = multiple halogens attached to carbon.
- Common examples: chloroform ($CHCl_3$), dichloromethane (CH_2Cl_2).

Dichloromethane (Methylene Chloride), CH_2Cl_2

Uses

- Widely used as a solvent.
- Used as paint remover.
- Used as propellant in aerosol sprays.

Harmful Effects

- Harms the human central nervous system.
- Low exposure: impaired hearing and vision.

- High exposure: dizziness, nausea, tingling, numbness in fingers and toes.
- Direct skin contact: intense burning and mild redness.
- Eye contact: can burn the cornea.

Solved Examples

- **Ex 1:** Name a use of dichloromethane.
  - Answer: Solvent or paint remover.

Practice Set

- Q1: What is a common use of CH_2Cl_2?
  - A. Fuel
  - B. Solvent
  - C. Food additive
  - D. Fertilizer
- Q2: Which harmful effect is caused by high exposure to CH_2Cl_2?
  - A. Improved vision
  - B. Dizziness and nausea
  - C. Increased energy
  - D. Skin whitening
- Q3: Direct contact of CH_2Cl_2 with eyes causes?
  - A. Cornea burn
  - B. Eye whitening
  - C. No effect
  - D. Eye color change

Answer Key

- Q1: B - CH_2Cl_2 is widely used as a solvent.
- Q2: B - High levels cause dizziness and nausea.
- Q3: A - Direct eye contact can burn the cornea.

Memory Aids

- CH_2Cl_2 = paint remover and solvent.
- Harmful to CNS; avoid skin and eye contact.

Trichloromethane (Chloroform), $CHCl_3$

Uses

- Major use: production of freon refrigerant R-22.
- Solvent for resins, rubbers, oils, fats, alkaloids, iodine.
- Preparation of chloretone (drug) and chloropicrin (insecticide).
- Used to preserve anatomical specimens.

Harmful Effects

- Oxidised to phosgene ($COCl_2$), a poisonous gas causing liver and kidney damage.
- Inhalation depresses central nervous system causing dizziness, fatigue, headache.

$$2CHCl_3 + O_2 \xrightarrow{\text{Light}} \underset{\text{Phosgene}}{2COCl_2} + 2HCl$$

Solved Examples

- **Ex 1:** Write the reaction of chloroform with oxygen under light.
  - 2 $CHCl_3$ + O_2 □1hv□1 $COCl_2$ + 2 HCl

Practice Set

- Q1: Chloroform is mainly used to produce?
  - A. Freon refrigerant R-22

    - B. Paint remover
    - C. Fertilizer
    - D. Fuel
- Q2: Phosgene gas formed from chloroform causes damage to?
    - A. Heart
    - B. Liver and kidney
    - C. Lungs only
    - D. Brain
- Q3: Inhalation of chloroform vapors causes?
    - A. Increased energy
    - B. CNS depression, dizziness, fatigue
    - C. Skin rash
    - D. No effect

Answer Key

- Q1: A - Major use is freon refrigerant production.
- Q2: B - Phosgene damages liver and kidney.
- Q3: B - Vapors depress CNS causing dizziness and fatigue.

Memory Aids

- Chloroform □1hv□1 Phosgene + HCl (photochemical reaction).
- Phosgene is highly toxic; avoid inhalation.

Triiodomethane (Iodoform), CHI_3

Uses

- Used as antiseptic in wound dressing (liberates iodine).
- Used as methylating agent in organic synthesis.
- Replaced due to objectionable smell by other iodine formulations.

Solved Examples

- **Ex 1:** Why is iodoform replaced in antiseptics?
  - Due to its strong, unpleasant smell.

Practice Set

- Q1: Iodoform is used as?
  - A. Solvent
  - B. Antiseptic
  - C. Fuel
  - D. Fertilizer
- Q2: Iodoform liberates which element?
  - A. Chlorine
  - B. Iodine
  - C. Fluorine
  - D. Bromine
- Q3: Why is iodoform replaced in medical use?
  - A. Toxicity
  - B. Objectionable smell
  - C. Instability
  - D. High cost

Answer Key

- Q1: B - Used as antiseptic.
- Q2: B - Liberates iodine.
- Q3: B - Replaced due to bad smell.

Memory Aids

- Iodoform = antiseptic with iodine release.
- Smell is main drawback.

Tetrachloromethane (Carbon Tetrachloride), CCl_4

Uses

- Manufacture of refrigerants and aerosol propellants.
- Synthesis of chlorofluorocarbons and pharmaceuticals.
- Cleaning agent and spot remover.
- Fire extinguisher (pyrene).

Harmful Effects

- Causes liver cancer.
- Common effects: dizziness, nausea, vomiting.
- Can cause permanent nerve damage leading to coma or death.
- May irritate eyes.
- Depletes ozone layer.

Solved Examples

- **Ex 1:** Name a harmful effect of CCl_4.
  - Liver cancer in humans.

Practice Set

- Q1: Carbon tetrachloride is used as?
  - A. Fertilizer
  - B. Fire extinguisher
  - C. Food additive
  - D. Fuel
- Q2: Which is a harmful effect of CCl_4?
  - A. Eye whitening
  - B. Liver cancer
  - C. Increased energy
  - D. Skin tanning

- Q3: CCl_4 causes ozone layer depletion because?
  - A. It is stable in atmosphere
  - B. It reacts with ozone directly
  - C. It releases chlorine radicals in stratosphere
  - D. It absorbs UV rays

Answer Key

- Q1: B - Used as fire extinguisher (pyrene).
- Q2: B - Causes liver cancer.
- Q3: C - Releases chlorine radicals causing ozone depletion.

Memory Aids

- CCl_4 = toxic, causes liver cancer and ozone depletion.
- Used in fire extinguishers and solvents.

Freons

Preparation

- Chlorofluorocarbon compounds of methane and ethane with chlorine and fluorine.
- Example: CF_2Cl_2 (Freon-12).
- Manufactured by Swarts reaction: $CCl_4 + 2AgF_2 \square 1\ CCl_2F_2 + 2AgCl$.

Properties

- Extremely stable, unreactive, non-toxic, non-corrosive gases.
- Easily liquefiable.

Uses

- Aerosol propellants.
- Refrigeration and air conditioning.

Harmful Effects

- Stable freons diffuse unchanged into stratosphere.
- Initiate free radical chain reactions with ozone.
- Cause depletion of ozone layer.

Solved Examples

- **Ex 1:** Write the Swarts reaction for Freon-12 preparation.
  - $CCl_4 + 2AgF_2 \rightarrow CCl_2F_2 + 2AgCl$

Practice Set

- Q1: Freons are used as?
  - A. Fertilizers
  - B. Aerosol propellants
  - C. Food preservatives
  - D. Fuels
- Q2: Freons cause ozone depletion because?
  - A. They react with oxygen
  - B. They release chlorine radicals in stratosphere
  - C. They absorb UV light
  - D. They are unstable
- Q3: Freon-12 is prepared by?
  - A. Reaction of methane with chlorine
  - B. Swarts reaction of CCl_4 with AgF_2
  - C. Direct fluorination of ethane
  - D. Electrolysis of chlorofluorocarbons

Answer Key

- Q1: B - Used as aerosol propellants.
- Q2: B - Release chlorine radicals causing ozone depletion.
- Q3: B - Prepared by Swarts reaction.

Memory Aids

- Freons = stable chlorofluorocarbons used in refrigeration.
- Cause ozone depletion via chlorine radicals.

p, p’-Dichlorodiphenyl Trichloroethane, DDT

Preparation

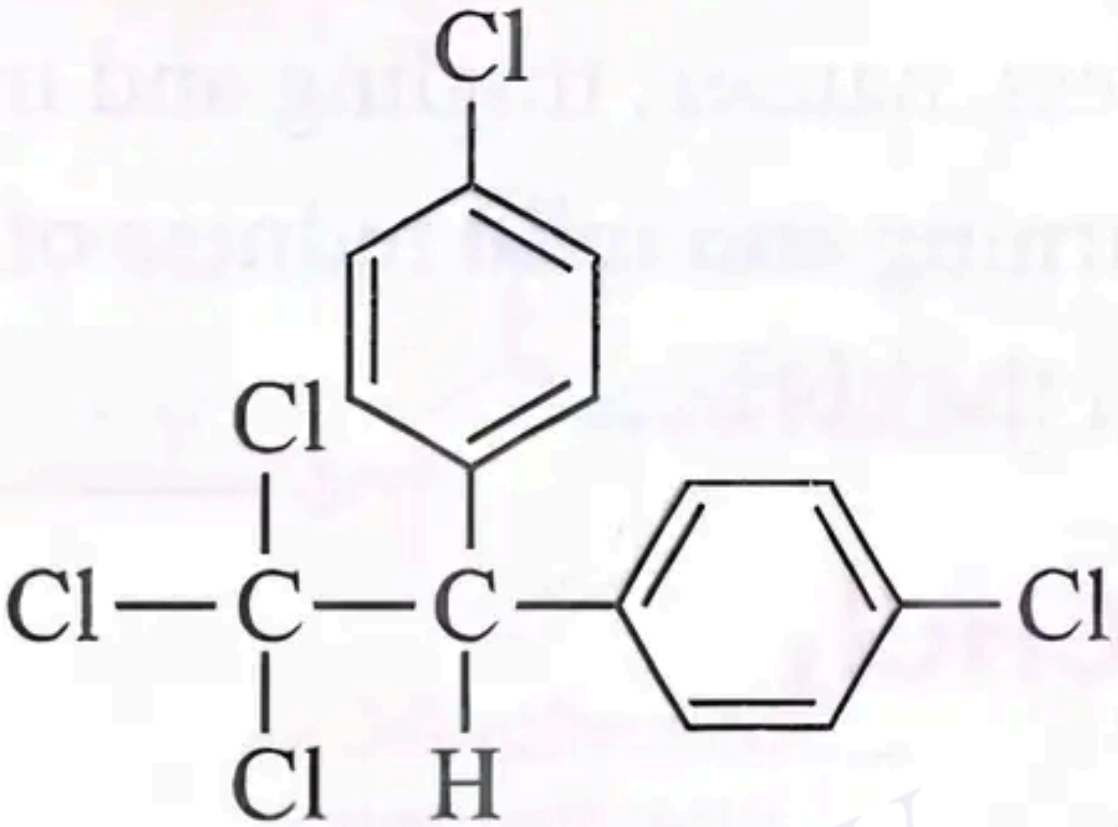
- Condensation of chloral with chlorobenzene in presence of concentrated H_2SO_4.

Properties

- Powerful insecticide.
- Effective against mosquitoes (malaria) and lice (typhus).

Harmful Effects

- Insects developed resistance.
- Highly toxic to fish.
- Chemically stable and fat soluble.
- Not rapidly metabolised by animals.
- Accumulates in fatty tissues, builds up over time.



DDT

Some important polyhalogen compounds

Chloretone	$(CH_3)_2C(OH)(CCl_3)$	Hypnotic
Phosgene	$COCl_2$	Poisonous gas used in warfare
Chloropicrin	CCl_3NO_2	Tear gas and insecticide
Iodoform	CHI_3	Antiseptic
Halothane	FCHClBr	Inhalation anaesthetic
Pyrene	CCl_4	Fire extinguisher
Freon	CCl_2F_2	Refrigerant
Gammaxane	$C_6H_5Cl_6$	Insecticide
Westron	$CHCl_2CHCl_2$	Industrial solvent
Westrosol	$CCl_2=CHCl$	Industrial solvent

Solved Examples

- **Ex 1:** How is DDT prepared?

- By condensation of chloral with chlorobenzene using conc. H_2SO_4.

Practice Set

- Q1: DDT is used as?
  - A. Fertilizer
  - B. Insecticide
  - C. Solvent
  - D. Fuel
- Q2: Which is a harmful effect of DDT?
  - A. Rapid metabolism in animals
  - B. High toxicity to fish
  - C. Water soluble
  - D. No resistance in insects
- Q3: DDT accumulates in?
  - A. Blood
  - B. Fatty tissues
  - C. Bones
  - D. Muscles

Answer Key

- Q1: B - DDT is a powerful insecticide.
- Q2: B - Highly toxic to fish.
- Q3: B - Deposited in fatty tissues.

Memory Aids

- DDT = stable, fat soluble insecticide accumulating in animals.
- Resistance developed by insects reduces effectiveness.

Polyhalogen Compounds Table

Summary Table

- Lists important polyhalogen compounds with formula and uses.
- Examples: Chloretone (drug), Phosgene (poison gas), Freon (refrigerant), DDT (insecticide).
- Shows diverse applications in medicine, industry, and agriculture.

Some important polyhalogen compounds

Chloretone	$(CH_3)_2C(OH)(CCl_3)$	Hypnotic
Phosgene	$COCl_2$	Poisonous gas used in warfare
Chloropicrin	CCl_3NO_2	Tear gas and insecticide
Iodoform	CHI_3	Antiseptic
Halothane	FCHClBr	Inhalation anaesthetic
Pyrene	CCl_4	Fire extinguisher
Freon	CCl_2F_2	Refrigerant
Gammaxane	$C_6H_5Cl_6$	Insecticide
Westron	$CHCl_2CHCl_2$	Industrial solvent
Westrosol	$CCl_2=CHCl$	Industrial solvent

Solved Examples

- **Ex 1:** Name a polyhalogen compound used as insecticide.
  - Answer: DDT.

Practice Set

- Q1: Which compound is used as a refrigerant?
  - A. DDT
  - B. Phosgene
  - C. Freon
  - D. Chloretone

- Q2: Phosgene is used as?
  - A. Poisonous gas
  - B. Fertilizer
  - C. Solvent
  - D. Insecticide
- Q3: Chloretone is a?
  - A. Hypnotic drug
  - B. Insecticide
  - C. Refrigerant
  - D. Solvent

Answer Key

- Q1: C - Freon is used as refrigerant.
- Q2: A - Phosgene is a poisonous gas.
- Q3: A - Chloretone is a hypnotic drug.

Memory Aids

- Polyhalogen compounds have diverse uses: drugs, insecticides, refrigerants, gases.

Distinction between Chloroform and Iodoform

Key Difference

- Iodoform on heating with $AgNO_3$ gives yellow precipitate of AgI.
- Chloroform does not give this test due to its stable nature.

Solved Examples

- **Ex 1:** Which compound gives yellow precipitate with $AgNO_3$?
  - Iodoform (CHI_3).

Practice Set

- Q1: Which compound gives yellow precipitate with $AgNO_3$?
  - A. Chloroform
  - B. Iodoform
  - C. Dichloromethane
  - D. Carbon tetrachloride
- Q2: Why does chloroform not give yellow precipitate with $AgNO_3$?
  - A. It is unstable
  - B. It is stable
  - C. It reacts slowly
  - D. It forms colorless precipitate
- Q3: Yellow precipitate formed is?
  - A. AgCl
  - B. AgI
  - C. AgBr
  - D. AgF

Answer Key

- Q1: B - Iodoform gives yellow AgI precipitate.
- Q2: B - Chloroform is stable, no precipitate formed.
- Q3: B - Yellow precipitate is AgI.

Memory Aids

- Iodoform test: yellow AgI precipitate with $AgNO_3$.
- Chloroform is stable, no precipitate.