Class 12 Chemistry – Haloalkanes & Haloarenes | Study Guide

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1. Theory in Simple Words with Visuals

1.1 What are Haloalkanes and Haloarenes?

- **Haloalkanes:** Compounds in which a **halogen (F, Cl, Br, I) is attached to an alkane** (saturated carbon).
  Example: CH_3CH_2Cl (Chloroethane)
- **Haloarenes:** Compounds in which a **halogen is attached to an aromatic ring** (like benzene).
  Example: C_6H_5Cl (Chlorobenzene)

Analogy:

- Haloalkane = "halogen flag on a simple carbon road"
- Haloarene = "halogen flag on a fancy benzene roundabout"

1.2 Nomenclature

1. **Haloalkanes:**
   - Identify the parent chain → number the carbon atoms → attach halogen prefix
     Example: 2-Bromo-3-chloropentane
2. **Haloarenes:**
   - Halogen + benzene → use ortho/meta/para for di-substituted
     Example: o-Dichlorobenzene

Flowchart for Naming Haloalkanes:

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Parent Alkane → Number Chain → Add Halogen Prefix → Combine
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1.3 Classification

Type	Example	Notes
Primary (1°)	CH_3CH_2Cl	Halogen attached to 1° C
Secondary (2°)	$CH_3CHClCH_3$	Halogen attached to 2° C
Tertiary (3°)	$(CH_3)_3CCl$	Halogen attached to 3° C

1.4 Physical Properties

- Boiling points ↑ with chain length and polarity

- Solubility: Insoluble in water, soluble in organic solvents
- Colorless liquids, denser than water

Visual Tip: Draw "haloalkane molecules floating in water" to remember insolubility.

1.5 Chemical Reactions

1.5.1 Nucleophilic Substitution (SN1 & SN2)

- **SN1:** 2 steps, carbocation formed, 3° > 2° > 1°
- **SN2:** 1 step, backside attack, 1° > 2° > 3°

Mnemonic: "1 Step = SN2, 2 Steps = SN1"

Example Reaction:

$$CH_3CH_2Br + NaOH \rightarrow CH_3CH_2OH + NaBr$$

1.5.2 Elimination (Dehydrohalogenation)

- Formation of alkenes using **alc. KOH**
- Example: $CH_3CH_2Br \rightarrow CH_2=CH_2 + HBr$

1.5.3 Reaction of Haloarenes

- Less reactive due to resonance stabilization
- Requires **catalyst / special conditions**
- Example: $C_6H_5Cl + NaOH$ (fused) $\rightarrow C_6H_5OH$

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2. Key Concepts & Formulas

Concept	Formula/Definition	Tips / Mnemonics
SN2 Rate	Rate = k[RX][Nu^-]	"2 reactants = 1 step"
SN1 Rate	Rate = k[RX]	"1 reactant = 2 steps"
Reactivity (Haloalkanes)	RI > RBr > RCl > RF	I = most reactive
Wurtz Reaction	2R-X + 2Na → R-R + 2NaX	Coupling reaction
Hell-Volhard-Zelinsky	R-CH_3 + Br_2 → R-CH_2Br	For alpha-halogenation

Mnemonic for Reactivity: "I Br Cl F → I Bakes Cool Food"

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3. Solved Numerical / Mechanism-Based Problems

Example 1: SN2 Reaction Rate

Problem: Explain why CH_3Br reacts faster than $(CH_3)_3CBr$ with OH^-.
Solution:

- CH_3Br = primary → less steric hindrance → faster SN2
- $(CH_3)_3CBr$ = tertiary → bulky → slow SN2

Example 2: Product Prediction

Problem: Predict product: CH_3CH_2Cl + KOH (alc)
Solution:

- Alcohol → elimination → $CH_2=CH_2$ + HCl

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4. Previous Years' Board Questions (Solved)

- Naming & classification → frequently asked (2013–2022)
- SN1/SN2, reactivity trends
- Mechanism-based reactions (Wurtz, Finkelstein, Dehydrohalogenation)
- Haloarene reactions (nitration, phenol formation)

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5. Quick Revision Notes / Important Points

- **Haloalkane = R-X**, **Haloarene = Ar-X**
- **SN2:** 1 step, backside attack, primary > secondary
- **SN1:** 2 steps, carbocation, tertiary > secondary
- **Reactivity Order:** RI > RBr > RCl > RF
- **Haloarene reactions** are slow, require catalysts
- **Elimination forms alkenes** (alc. KOH)

Visual Table:

RX Type	Reaction Type	Rate/Order	Notes
1°	SN2	Fast	Backside attack
2°	SN2 / SN1	Medium	Depends on Nu^- & solvent
3°	SN1	Fast	Carbocation formed

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6. Predicted / Likely Questions

1. Naming of haloalkanes & haloarenes
2. SN1 vs SN2 mechanism & factors affecting rate

3. Elimination vs substitution products
4. Preparation reactions (e.g., from alcohols, halogenation)
5. Reactivity trends and reasons

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7. Exam Tips & Tricks

- Draw **mechanism arrows** clearly; marks given for steps
- Remember **steric hindrance affects SN2**, **carbocation stability affects SN1**
- Use **color coding for halogens** (F = green, Cl = yellow, Br = red, I = violet)
- For elimination, check **alc. KOH** → alkene

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8. Visual & Kid-Friendly Learning Style

- Think **halogen as a "flag"** on the carbon road
- Use **colorful charts for SN1/SN2 & reactivity order**
- Draw **mechanism flowcharts** to memorize steps quickly
- Analogies: **"Primary = open road (fast), Tertiary = crowded street (slow)"**