FREE NOTES · NCERT + JEE/NEET LEVEL

Haloalkanes & Haloarenes

Classification aur naming, C–X bond, banane ke tareeke, physical properties, SN1 aur SN2 mechanism, stereochemistry, elimination, metals ke saath reactions, haloarenes ke reactions aur zaroori polyhalogen compounds.

01 Classification & C–X bond ka nature
02 Banane ke tareeke
03 Physical properties
04 Nucleophilic substitution
05 SN1 vs SN2
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01 Classification & C–X bond ka nature

- Mono-, di-, poly-halo compounds. Carbon ke type se: **1°, 2°, 3°** alkyl halides; **allylic** (C=C ke bagal wale C pe X), **benzylic** (ring ke bagal wale C pe X), **vinylic** (C=C pe X), **aryl** (ring pe X).
- C–X polar hai (C δ+, X δ-). Bond length C–F < C–Cl < C–Br < C–I; strength ulti ⇒ **reactivity R–I > R–Br > R–Cl > R–F**.
- Naming: halogen prefix banta (2-bromobutane, 1-chloro-2-methylpropane). Common naam: CH_2Cl_2 methylene chloride, $CHCl_3$ chloroform, CHI_3 iodoform, CCl_4 carbon tetrachloride.

02 Banane ke tareeke

Kisse	Reagent	Note
Alcohol	HX + $ZnCl_2$ (Lucas, 1°/2° ke liye), PCl_3, PCl_5, **$SOCl_2$**	$SOCl_2$ best: by-products SO_2, HCl gas ban ke ud jaate
Alkane	Cl_2 / hv (free radical)	Products ka mixture
Alkene	HX (Markovnikov); HBr + peroxide (anti-Markovnikov)	X_2 se vic-dihalide
Halide exchange	**Finkelstein:** R–Cl + NaI (acetone) → R–I; **Swarts:** R–Br + AgF/Hg_2F_2 → R–F	Acetone me NaCl ppt hota, reaction aage badhta
Arene	X_2 + Fe/$FeCl_3$ (andhere me); ortho + para	Electrophilic substitution
Aniline	**Sandmeyer:** $ArN_2^+Cl^-$ + CuCl/HCl ya CuBr/HBr; ArI ke liye KI	Diazonium salt ke through

03 Physical properties

- Boiling point: parent alkane se zyada (polarity, zyada mass). Same alkyl group ke liye: RI > RBr > RCl > RF. Isomers me zyada branching ⇒ kam b.p.
- Density: bromo, iodo aur polychloro compounds paani se bhaari.
- Paani me thoda ghulte (mazboot H-bond nahi bana paate), organic solvents me ghulte.
- p-Dichlorobenzene ka m.p. o- aur m- se zyada (symmetry, crystal me achhe se fit).

04 Nucleophilic substitution

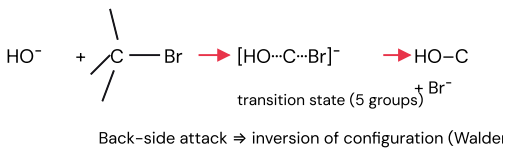
Nucleophile (Nu^-) X^- ki jagah le leta. R–X + Nu^- → R–Nu + X^-.

Reagent	Product
aq. KOH / NaOH	Alcohol R–OH
NaOR′	Ether R–O–R′ (Williamson)
KCN (ionic)	Alkyl cyanide R–CN (C se attack)
AgCN (covalent)	Isocyanide R–NC (N se attack)
KNO_2	Alkyl nitrite R–O–N=O
$AgNO_2$	Nitroalkane R–NO_2
NH_3	Amines (mixture)
$LiAlH_4$	Alkane R–H
R′COOAg	Ester

CN^- aur NO_2^- **ambident** nucleophiles hain: do alag atoms se attack kar sakte.

05 SN1 vs SN2

	SN2	SN1
Steps	Ek step, ek saath	Do steps, **carbocation** ke through
Rate law	k[RX][Nu^-] (second order)	k[RX] (first order)
Reactivity	CH_3X > 1° > 2° > 3° (bheed attack rokti)	3° > 2° > 1° > CH_3X (carbocation stability)
Stereo	**Inversion**	**Racemisation** (dono taraf se attack)
Solvent	Polar aprotic (acetone, DMSO)	Polar protic (paani, alcohol)
Ye bhi tez		Allylic aur benzylic halides (resonance se stable cation)



SN2: nucleophile peeche se aata, leaving group nikalta

06 Stereochemistry basics

- **Chiral carbon:** jis carbon pe chaar alag groups (2-bromobutane). Aise molecules **optically active**.

- **Enantiomers:** mirror images jo ek doosre pe fit nahi hote; plane-polarised light ko barabar par ulti disha me ghumate (d/+ aur l/–).
- **Racemic mixture:** dono enantiomers 50:50, optically inactive (external compensation).
- **Retention** = reaction ke baad same arrangement; **inversion** = palat gaya.

07 Elimination & metals ke saath reaction

Dehydrohalogenation: alc. KOH HX hatata ⇒ alkene. **Saytzeff (Zaitsev) rule:** zyada substituted alkene major product. 2-bromobutane → but-2-ene (major) + but-1-ene.

SUBSTITUTION VS ELIMINATION

Aqueous KOH ⇒ substitution (alcohol). Alcoholic KOH ⇒ elimination (alkene). Bhaari strong base aur 3° halide elimination ko badhate.

- **Grignard reagent:** R–X + Mg (dry ether) → RMgX. Bahut reactive; paani se: RMgX + H_2O → R–H, isliye sookha rakhna zaroori.
- **Wurtz reaction:** 2R–X + 2Na (dry ether) → R–R. **Wurtz-Fittig:** ArX + RX + Na → Ar–R. **Fittig:** 2ArX + 2Na → Ar–Ar.

08 Haloarenes

Haloarenes nucleophilic substitution me bahut **kam reactive** kyunki:

1. **Resonance**: C–X me partial double bond character aa jaata.
2. C **sp^2** hai (zyada s character) ⇒ chhota, mazboot C–X bond.
3. Phenyl cation unstable (SN1 nahi).
4. Electron se bhari ring nucleophile ko door dhakelti.

Badalne ke liye sakht conditions: chlorobenzene + NaOH, 623 K, 300 atm → phenol (Dow process). **Ortho/para pe $-NO_2$** ho to aasaan (2,4,6-trinitrochlorobenzene garam paani se hi react karta).

ELECTROPHILIC SUBSTITUTION

Halogen **deactivating** (–I effect) par **ortho/para directing** (+R effect). Chlorobenzene halogenation, nitration, sulphonation, Friedel-Crafts me o- aur p- products deta (para major).

09 Polyhalogen compounds

Compound	Use / asar
CH_2Cl_2	Solvent, paint remover; nervous system pe asar
$CHCl_3$	Solvent; purana anaesthetic. Light + hawa me zehreela **phosgene** $COCl_2$ banta, isliye dark bottle me ooper tak bhar ke 1% ethanol ke saath rakhte
CHI_3 (iodoform)	Antiseptic (I_2 chhodta), peela
CCl_4	Solvent, refrigerants; ozone aur liver ko nuksaan
Freons (CCl_2F_2)	Refrigerants, aerosols; Cl radicals chhodte jo ozone tod dete
DDT	Pehla chlorinated insecticide (malaria ke machhar); biodegradable nahi, food chain me jama hota

10 JEE Extra + Tricks

JEE LEVEL

- S_N2: ek step, inversion (Walden), rate $\propto$ [RX][Nu]; kram CH_3X > 1° > 2° > 3°. S_N1: carbocation, racemisation, rate $\propto$ [RX]; 3° > 2° > 1°.
- Polar aprotic solvents (DMSO, acetone) S_N2 ke liye; polar protic (paani, alcohol) S_N1 ke liye.
- Saytzeff rule: elimination se zyada substituted alkene; alcoholic KOH $\Rightarrow$ elimination, aqueous KOH $\Rightarrow$ substitution.
- Aryl halides nucleophilic substitution me mushkil (partial double bond, sp^2 C); o/p pe $-NO_2$ activate karta (Meisenheimer complex).
- KCN se nitrile (C hamla); AgCN se isocyanide (N hamla). KNO_2 $\Rightarrow$ nitrite; $AgNO_2$ $\Rightarrow$ nitroalkane.
- Naam wale: Finkelstein (acetone me NaI), Swarts (AgF/Hg_2F_2), Wurtz–Fittig, Fittig, Sandmeyer.

11 Solved questions, mistakes & practice

Q1. SN2 me kaun tez: 1-bromobutane ya 2-bromobutane?

1-bromobutane (1°, kam bheed).

Q2. SN1 ke liye order lagao: CH_3CH_2Br, $(CH_3)_2CHBr$, $(CH_3)_3CBr$.

$(CH_3)_3CBr$ > $(CH_3)_2CHBr$ > CH_3CH_2Br (3° > 2° > 1° carbocation stability).

Q3. Product batao: CH_3CH_2Br + KCN aur CH_3CH_2Br + AgCN.

CH_3CH_2CN (propanenitrile) aur CH_3CH_2NC (ethyl isocyanide).

- KCN (cyanide) aur AgCN (isocyanide) me confusion.
- SN2 me retention likhna (inversion hota hai).
- Chlorine ko activating group kehna (deactivate karta par o/p direct karta).
- Jab alkene chahiye tab aqueous KOH lagana.

1. Reaction ka naam: R–Br + NaI acetone me.
2. Chloroform dark bottle me kyun?
3. 2-bromopentane + alc. KOH ka major product?
4. Kaun optically active: 1-bromobutane ya 2-bromobutane?

ANSWERS

1) Finkelstein · 2) Light + hawa se phosgene banta · 3) Pent-2-ene · 4) 2-bromobutane

12 Quick revision: exam se 5 minute pehle

BANANA

- Alcohol ke liye $SOCl_2$ best.
- Finkelstein (I), Swarts (F).
- Sandmeyer: ArN_2^+ + CuX.

MECHANISM

- SN2: 1° tez, inversion.
- SN1: 3° tez, racemisation.
- Alc. KOH ⇒ alkene (Saytzeff).

REAGENTS

- KCN → RCN; AgCN → RNC.
- KNO_2 → R–ONO; $AgNO_2$ → RNO_2.
- Wurtz: 2RX + 2Na → R–R.

HALOARENES

- Kam reactive: resonance, sp^2 C.
- X: deactivating, o/p directing.
- $CHCl_3$ light me → phosgene.

Koi doubt? padhaiadda.netlify.app pe AI Doubt Solver se poocho, ya is chapter ka mock test do.