FREE NOTES · NCERT + JEE/NEET LEVEL

Alcohols, Phenols & Ethers

Classification aur naming, alcohols aur phenols banana, physical properties, acidity, O–H bond, C–O bond aur ring ke reactions, pehchaan ke tests, aur ethers: banana aur reactions.

01 Classification & naming
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01 Classification & naming

- **Alcohols:** sp^3 carbon pe –OH. Mono-, di- (glycol), tri-hydric (glycerol). –OH wale carbon ke hisaab se 1°, 2°, 3°. Allylic aur benzylic alcohols bhi.
- **Phenols:** –OH seedha benzene ring pe (sp^2 C).
- **Ethers:** R–O–R′. Symmetrical (CH_3OCH_3) ya unsymmetrical ($CH_3OC_2H_5$).

Formula	Common	IUPAC
$CH_3CH(OH)CH_3$	Isopropyl alcohol	Propan-2-ol
$(CH_3)_3COH$	tert-Butyl alcohol	2-Methylpropan-2-ol
$HOCH_2CH_2OH$	Ethylene glycol	Ethane-1,2-diol
$C_6H_4(OH)_2$ (1,2 / 1,3 / 1,4)	Catechol / Resorcinol / Hydroquinone	Benzene-1,2-diol wagaira
$C_6H_5OCH_3$	Anisole	Methoxybenzene

Shape: methanol me C–O–H ~108.9°; dimethyl ether me C–O–C ~111.7° (bhaari groups ki wajah se bada).

02 Alcohols banana

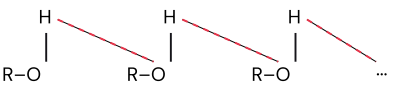
Kisse	Reagent	Product
Alkene	H_2O / H^+ (acid hydration)	Markovnikov alcohol
Alkene	**B_2H_6 phir H_2O_2/OH^-** (hydroboration-oxidation)	Anti-Markovnikov jaisa alcohol
Aldehyde / ketone	H_2/Pd, $NaBH_4$, $LiAlH_4$	1° / 2° alcohol
Acid / ester	$LiAlH_4$ (ya ester + H_2/catalyst)	1° alcohol
HCHO + RMgX	phir H_3O^+	1° alcohol
RCHO (baaki) + RMgX	phir H_3O^+	2° alcohol
Ketone + RMgX	phir H_3O^+	3° alcohol

03 Phenols banana

- **Haloarene se:** chlorobenzene + NaOH, 623 K, 300 atm, phir acid.
- **Benzenesulphonic acid se:** NaOH ke saath fuse, phir acid.
- **Diazonium salt se:** paani ke saath garam: $C_6H_5N_2^+Cl^- + H_2O \rightarrow C_6H_5OH + N_2 + HCl$.
- **Cumene se** (industry me): cumene + O_2 → cumene hydroperoxide → H^+/H_2O → **phenol + acetone**.

04 Physical properties

- Alcohols aur phenols ka **boiling point zyada**, intermolecular H-bonding ki wajah se (ethanol 351 K vs propane 231 K vs methoxymethane 248 K).
- Chain lambi ⇒ b.p. zyada; branching ⇒ kam.
- Chhote alcohols **paani me ghulte** (paani ke saath H-bond); alkyl chain badhe to solubility ghatti.
- Ethers: kam b.p. (O–H nahi, aapas me H-bond nahi), par paani me thoda ghulte (O paani se H-bond le sakta).



dashed = hydrogen bonds ⇒ high boiling point

Alcohol molecules ke beech hydrogen bonding

05 Acidity

- Alcohols bahut weak acids: 2ROH + 2Na → 2RONa + H_2. Order: **1° > 2° > 3°** (alkyl ka +I O pe electrons dhakelta). Paani alcohols se zyada acidic.
- **Phenol alcohol se zyada acidic**: phenoxide ion resonance se stable (negative charge ring pe phail jaata). Phenol NaOH se react karta, $NaHCO_3$ se nahi.
- o/p pe **electron-withdrawing** group (–NO_2) acidity badhata; **electron-releasing** group (–CH_3) ghatata.

YE ACIDITY ORDER YAAD RAKHO

picric acid (2,4,6-trinitrophenol) > p-nitrophenol > o-nitrophenol > m-nitrophenol > phenol > p-cresol > paani > ethanol

06 Alcohols ke reactions

Reaction	Reagent	Nateeja
Esterification	RCOOH / H^+ (ya RCOCl, $(RCO)_2O$)	Ester (reversible; paani hatao)
HX ke saath	HCl + anhydrous $ZnCl_2$ (Lucas)	3°: turant turbidity; 2°: ~5 min; 1°: room temp pe nahi
PX_3, $SOCl_2$ ke saath		Alkyl halide
Dehydration	conc. H_2SO_4, 443 K (1°)	Alkene; aasaani 3° > 2° > 1° (carbocation)
1° ka oxidation	PCC → aldehyde; $KMnO_4/K_2Cr_2O_7$ → acid	
2° ka oxidation	CrO_3	Ketone
3°	Aasani se oxidise nahi; Cu/573 K se alkene	
Dehydrogenation	Cu, 573 K	1° → aldehyde, 2° → ketone

07 Phenol ke reactions (ring)

–OH ring ko bahut **activate** karta aur **ortho aur para** pe bhejta.

- **Nitration:** dilute HNO_3 (298 K) → o- aur p-nitrophenol (steam distillation se alag: o- steam volatile hai, **intramolecular** H-bond ki wajah se). Conc. HNO_3 → **picric acid**.
- **Bromination:** CS_2 me Br_2 (kam temp) → mono-bromophenols; **bromine water** → **2,4,6-tribromophenol** ka safed ppt.
- **Kolbe's reaction:** sodium phenoxide + CO_2 (4–7 atm, 400 K), phir H^+ → **salicylic acid** (o-hydroxybenzoic acid) → aspirin.
- **Reimer-Tiemann:** phenol + $CHCl_3$ + aq. NaOH, phir H^+ → **salicylaldehyde**.
- **Zn dust ke saath:** phenol → benzene.
- **Oxidation:** $Na_2Cr_2O_7/H_2SO_4$ → benzoquinone.

08 Ethers

- **Dehydration se:** $2C_2H_5OH$, conc. H_2SO_4, **413 K** → $C_2H_5OC_2H_5$ (443 K pe ethene banta). Sirf 1° alcohols ke liye.
- **Williamson synthesis:** R–X + $R'O^-Na^+$ → R–O–R'. **1° halide** lo, alkoxide koi bhi; 3° halide se elimination (alkene) hoga. tert-butyl methyl ether ke liye: $(CH_3)_3CO^-Na^+ + CH_3Br$, na ki $(CH_3)_3CBr + CH_3ONa$.
- **HI se todna:** R–O–R' + HI → ROH + R'I. Alag alkyl groups ho to I^- **chhote** group pe jaata (SN2); 3° group ho to 3° wali taraf (SN1). Anisole + HI → **phenol + CH_3I** (iodobenzene kabhi nahi).
- Anisole: $–OCH_3$ ring activate karta, o/p directing (halogenation, Friedel-Crafts, nitration).

09 Named reactions & pehchaan ke tests

Test	Kya deta
Lucas test	1°/2°/3° alcohol alag karta (turbidity ka time)
Neutral $FeCl_3$	Phenol: violet rang; alcohol: kuch nahi
Bromine water	Phenol: safed ppt
Iodoform (I_2 + NaOH)	$CH_3CH(OH)–$ wale alcohols (ethanol, propan-2-ol) se peela CHI_3, methanol se nahi
Na metal	Alcohol/phenol H_2 dete; ether nahi

10 JEE Extra + Tricks

JEE LEVEL

- Lucas test ($ZnCl_2$ + HCl): 3° alcohol turant turbidity, 2° ~5 min me, 1° room temperature pe nahi.
- Acidity: phenol (pK_a ~10) > paani > alcohols; o/p-nitrophenol zyada acidic, cresols phenol se kam.
- Reimer–Tiemann ($CHCl_3$/NaOH ⇒ salicylaldehyde); Kolbe (CO_2/NaOH ⇒ salicylic acid); phenol + Br_2 water ⇒ 2,4,6-tribromophenol (safed ppt).
- Williamson ether synthesis: 1° alkyl halide + alkoxide (3° halide se elimination).
- Ethers + HI: chhota alkyl iodide banta (S_N2); 3° alkyl ho to 3° alkyl iodide (S_N1). Anisole + HI ⇒ phenol + CH_3I.
- Dehydration: 3° alcohol sabse aasaan; conc. H_2SO_4 443 K ⇒ alkene, 413 K ⇒ ether.

11 Solved questions, mistakes & practice

Q1. o-nitrophenol p-nitrophenol se zyada volatile kyun?

o- me intramolecular H-bond (molecules aapas me nahi judte); p- me intermolecular H-bond, isliye b.p. zyada.

Q2. Grignard reagent se propan-2-ol banao.

$CH_3CHO + CH_3MgBr \rightarrow (CH_3)_2CHOMgBr \rightarrow H_3O^+ \rightarrow (CH_3)_2CHOH$.

Q3. $CH_3OC_2H_5 + HI$ ke products?

$CH_3I + C_2H_5OH$ (I^- chhote methyl pe attack karta).

- Anisole + HI se iodobenzene likhna.
- Kehna ki phenol $NaHCO_3$ se react karta (itna strong acid nahi).
- Williamson synthesis me 3° halide lena.
- Dehydration me 413 K (ether) aur 443 K (alkene) mix karna.

1. Lucas test turant kaun deta?
2. Reimer-Tiemann ka product?
3. Kaun zyada acidic: phenol ya ethanol?
4. Phenol ka industrial source jo acetone bhi deta?

ANSWERS

1) 3° alcohol · 2) Salicylaldehyde · 3) Phenol · 4) Cumene process

12 Quick revision: exam se 5 minute pehle

BANANA

- HCHO/RCHO/R_2CO + RMgX ⇒ 1°/2°/3°.
- Hydroboration ⇒ anti-Markovnikov.
- Cumene ⇒ phenol + acetone.

ACIDITY

- Phenol > paani > alcohol.
- $-NO_2$ ↑ acidity, $-CH_3$ ↓.
- 1° > 2° > 3° alcohol.

PHENOL REACTIONS

- Br_2 water ⇒ 2,4,6-tribromophenol.
- Kolbe ⇒ salicylic acid.
- Reimer-Tiemann ⇒ salicylaldehyde.

ETHERS

- Williamson: 1° halide + alkoxide.
- Anisole + HI ⇒ phenol + CH_3I.
- H_2SO_4 413 K ⇒ ether.

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