CLASS 12 CHEMISTRY — FORMULA SHEET

Chapter 7 : Alcohols, Phenols and Ethers (NCERT)

7.1 Classification & Structure

Concept	Detail
Alcohol	–OH attached to sp^3 carbon (R–OH)
Phenol	–OH attached directly to aromatic ring (C_6H_5OH)
Ether	R–O–R' (oxygen bonded to two carbons)
1°, 2°, 3° alcohol	Based on carbon bearing –OH (one, two, three C attached)
Mono / di / trihydric	Number of –OH groups present
C–O–H bond angle	Around 109° (alcohol) ; bent shape

7.2 Preparation of Alcohols

Method	Reaction
Hydration of alkenes	Alkene + H_2O / H^+ → alcohol (Markovnikov)
Hydroboration-oxidation	Alkene → anti-Markovnikov alcohol (B_2H_6 then H_2O_2/OH^-)
From haloalkanes	R–X + aqueous KOH → R–OH
Reduction of aldehyde/ketone	Carbonyl + H_2 (or $NaBH_4/LiAlH_4$) → alcohol
From Grignard reagent	R–MgX + carbonyl → alcohol (after hydrolysis)
Reduction of carboxylic acid	RCOOH + $LiAlH_4$ → 1° alcohol

7.3 Preparation of Phenols

Method	Reaction
From chlorobenzene (Dow process)	C_6H_5Cl + NaOH (high T, P) → phenol
From benzene sulphonic acid	Fuse with NaOH → sodium phenoxide → phenol
From diazonium salt	$C_6H_5N_2^+$ + H_2O (warm) → phenol + N_2
From cumene	Cumene + O_2 → cumene hydroperoxide → phenol + acetone

7.4 Properties of Alcohols & Phenols

Property	Detail
Acidity order	Phenol > water > alcohol (phenoxide ion is resonance-stabilised)
Acidity among alcohols	1° > 2° > 3° (electron-donating groups lower acidity)
Effect of $-NO_2$ on phenol	Increases acidity (especially at ortho/para)
Reaction with Na	Both give alkoxide/phenoxide + H_2 gas
Esterification	Alcohol + acid → ester + water (acid catalysed)
Oxidation of 1° alcohol	→ aldehyde → carboxylic acid

Property	Detail
Oxidation of 2° alcohol	→ ketone
3° alcohol	Resistant to oxidation (no H on C–OH)

7.5 Important Reactions

Reaction	Detail
Dehydration of alcohol	Conc. H_2SO_4 → alkene (3° easiest, follows Saytzeff)
Lucas test	Distinguishes 1°/2°/3° alcohols (turbidity speed with Lucas reagent)
Victor Meyer test	Distinguishes 1°/2°/3° alcohols by colour
Reimer-Tiemann (phenol)	Phenol + $CHCl_3$/NaOH → salicylaldehyde
Kolbe's reaction (phenol)	Sodium phenoxide + CO_2 → salicylic acid
Bromination of phenol	With Br_2 water → 2,4,6-tribromophenol (white ppt)
Phenol + $FeCl_3$	Violet colour (test for phenol)

7.6 Ethers — Preparation & Reactions

Concept	Reaction / Detail
Williamson synthesis	R–X + R'–O^-Na^+ → R–O–R' (best for ethers)
Best for Williamson	Use 1° alkyl halide (avoids elimination)
Dehydration of alcohol	2 R–OH + H_2SO_4 (413 K) → R–O–R (symmetrical ether)
Cleavage by HX	R–O–R' + HX → R–X + R'–OH (HI most reactive)
Cleavage product rule	Lower alkyl group forms the halide (3° forms alkene with HI)
Anisole reactions	Electrophilic substitution at ortho/para (–OCH_3 activates ring)

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Acidity order	Phenol > water > alcohol. Phenoxide is resonance-stabilised.
Oxidation	1° → aldehyde → acid ; 2° → ketone ; 3° → resists oxidation.
Dehydration ease	3° > 2° > 1° (more stable carbocation). Follows Saytzeff.
Lucas test	3° turns turbid immediately, 2° in 5 min, 1° only on heating.
Williamson	R–X + alkoxide → ether. Use 1° halide to avoid elimination.
Ether cleavage	HI cleaves ethers ; lower alkyl group becomes the iodide.
Phenol tests	$FeCl_3$ → violet colour ; Br_2 water → white tribromophenol ppt.
Hydroboration	Gives anti-Markovnikov alcohol (opposite of acid hydration).