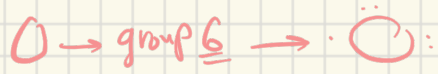


Chapter 1 :-

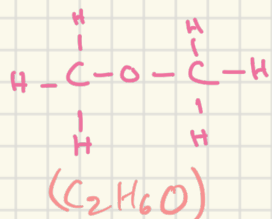
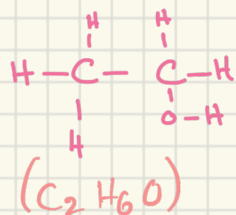
Valance electrons :

Number of electrons = number of the group



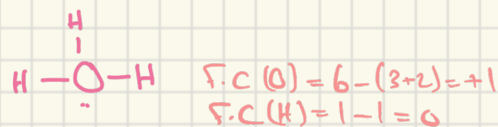
Structural isomers (Constitutional) :

Molecules which have the same molecular formula but different arrangement of atoms.

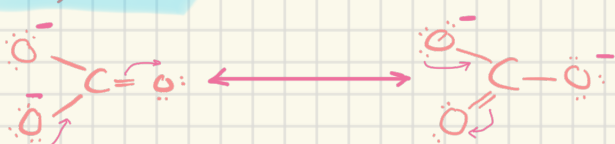


Formal charge :

F.C = n. of valence e⁻ - (dots + bonds)



Resonance :



Properties :

- 1- Bonds Have The Same Length.
- 2- Only Electrons can be moved.
- 3- Red structure is a resonance hybrid.

Compounds :

- 1- Acyclic
- 2- Carbocyclic
- 3- Heterocyclic

Polar covalent bond: Two different elements NF_3

Non-Polar covalent bond: Same element N_2, O_2

Chapter 2 :-

Saturated hydrocarbons → single bond

Unsaturated hydrocarbons → double-triple bond

Aromatic hydrocarbons → Cyclic compounds

Alkanes :

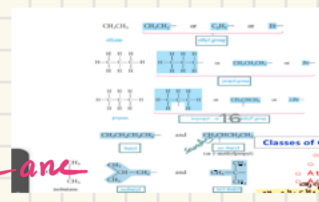
① $\text{C}_n \text{H}_{2n+2}$

② cycloalkanes: $\text{C}_n \text{H}_{2n}$

③ sp^3 orbitals, tetrahedral, 109.5°

Naming :

- 1. longest chain named as -ane
- 2. Branches have the least numbers
- 3. Substituents named as Alkyl
- 4. Use prefixes if there were more than one substituent di-tri-tetra ...
- 5. Numbers separated by commas, letters by hyphens
- 6. If there were two chains with same C numbers and same substituents, we choose the straight one
- 7. Naming the substituents alphabetically.



Properties :

Physical: $\text{C}_1 - \text{C}_4$ gases, $\text{C}_5 - \text{C}_{17}$ liquids, C_{18} and larger solid

Solubility: Non polar "like dissolve like"

↳ Soluble in non polar solvents: benzene, CCl_4
↳ insoluble in polar solvents: water

Boiling points :

n-bond > dipole-dipole > London forces

↑ branches ↓ B.P // ↑ M.wt ↑ B.P

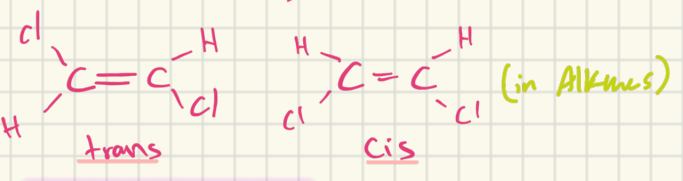
Cycloalkanes Naming :

- 1. Naming by adding -cyclo before alkane name.
- 2. Numbering substituent with the least numbers

Continue Ch. 2

Stereoisomers (Geometrical isomers)

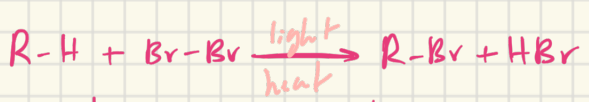
Cis/Trans isomers



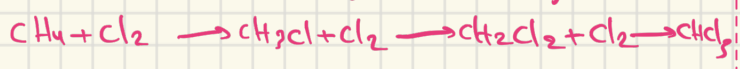
Reactions

- Oxidation and Combustion**
 complete: $CH_4 + 2O_2 \xrightarrow{\text{carbon dioxide}} CO_2 + 2H_2O + \text{heat}$
 partial: $2CH_4 + 3O_2 \xrightarrow{\text{Carbon monoxide}} 2CO + 4H_2O$

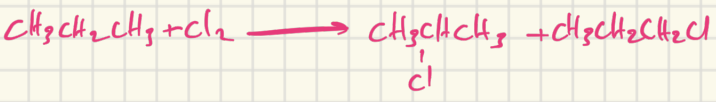
- Halogenation Substitution**



* If excess halogen is present, the reaction will continue further to give polyhalogenated products



* Can give more than one product



Chapter 3

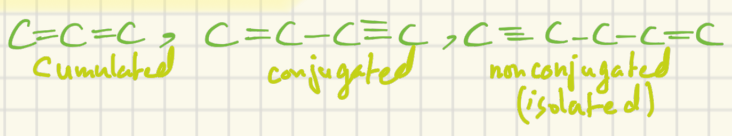
Alkenes

- C_nH_{2n}
- sp^2 orbitals, trigonal, planar (restricted), 120°

Alkynes

- C_nH_{2n-2} , called acetylenes
- sp orbitals, linear, 180°

Classifications



Continue Ch. 3

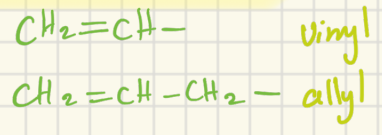
Naming

- We name the chain which have $\Rightarrow \equiv$ and add -ene or -yne
- Numbering by which the $\Rightarrow \equiv$ and substituents have least possible numbers.
- The double has priority than the triple bond

Cyclic hydrocarbons

- The double or triple have the least numbers.

Common names



Reactions

Alkenes

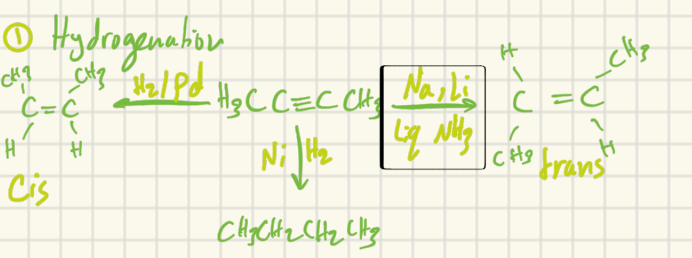
All are electrophilic Addition

- Hydrogenation "Cin-Addition"**
 $CH_3CH_2CH=CH_2 \xrightarrow[\text{Pt}]{H_2} CH_3CH_2CH_2CH_3$
- Halogenation "Anti-Addition"**
 $CH_3CH=CHCH_3 + Cl_2 \rightarrow CH_3\underset{\text{Cl}}{CH}CH\underset{\text{Cl}}{CH_3}$ (vicinal dihalide)
 Two halogens attached to adjacent carbons
- Hydration**
 $CH_2=CH_2 + H_2O \xrightarrow{H^+} CH_3CH_2OH$ (symmetrical)
- Addition of Acids**
 $CH_2=CH_2 + HCl \rightarrow CH_3CH_2Cl$ (symmetrical)
- (3+1) in Unsymmetrical compounds**
 $CH_3CH=CH_2 + H_2O \xrightarrow{H^+} CH_3\underset{\text{OH}}{CH}CH_3$
 $\quad \quad \quad + HCl \rightarrow CH_3\underset{\text{Cl}}{CH}CH_3$
- * The reason of Markovnikov's rule is that $3^\circ > 2^\circ > 1^\circ$ most stable
- Hydroboration (anti Markovnikov's rule)**
 $CH_3CH=CH_2 + BH_3 \rightarrow CH_3CH_2CH_2-B$
 $CH_3\overset{\text{CH}_3}{C}=CH_2 \xrightarrow{BH_3} \xrightarrow[\text{OH}^-]{H_2O_2} CH_3\underset{\text{CH}_3}{CH}-CH_2OH$
- Oxidation**
 $3CH_2=CH_2 + 2K^+MnO_4^- + 4H_2O \rightarrow 3\underset{\text{OH}}{CH_2}-\underset{\text{OH}}{CH_2}$
- Ozonolysis (O₃)**
 $CH_2=CH_2 \xrightarrow[Zn, H_3O^+]{O_3} CH_2O + OCH_2$

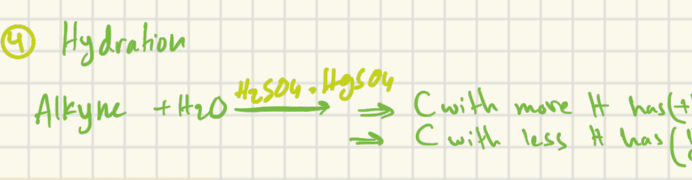
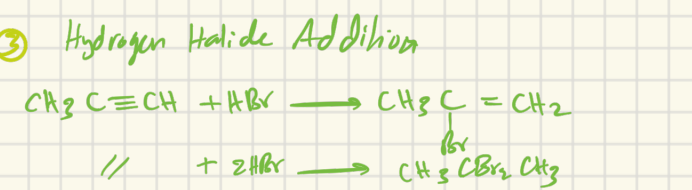
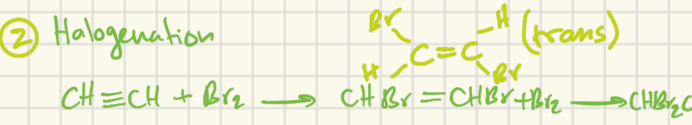
Continue ch. 3

Reactions Alkynes

All are electrophilic Addition

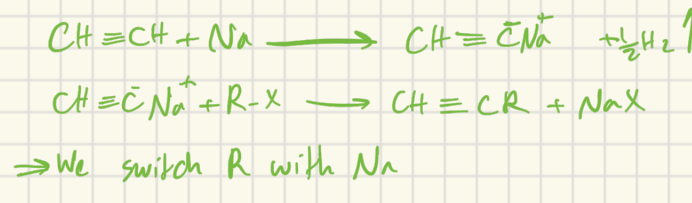


Pd/H_2 → called Lindlar's catalyst



Preparation

Nucleophilic substitution Reaction



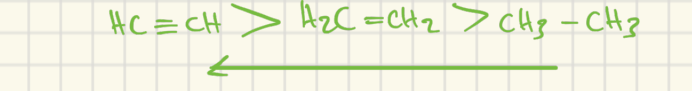
Orbitals

sp^3	sp^2	sp
s 25%	s 33%	s 50%
p 75%	p 66%	p 50%

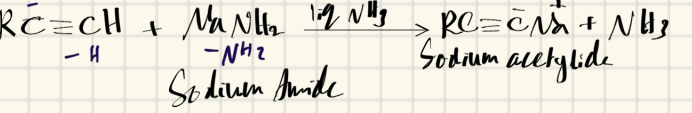
Acidity

* Terminal Alkynes weakly acidic, can be removed by a strong base (NaNH_2)

* Non-Terminal Alkynes have no exceptionally acidic H



Acidity increases

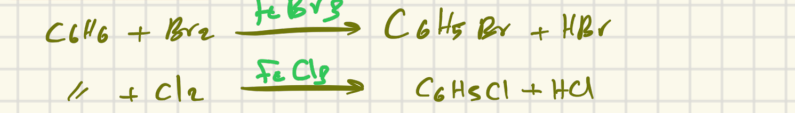


Chapter 4

Benzene

- 1- Unsaturated structure.
- 2- Although it is unsaturated, it reacts in substitution reactions
- 3- Does not decolorize bromine solutions
- 4- Not easily oxidized by (KMnO_4) potassium permanganate.

Reactions



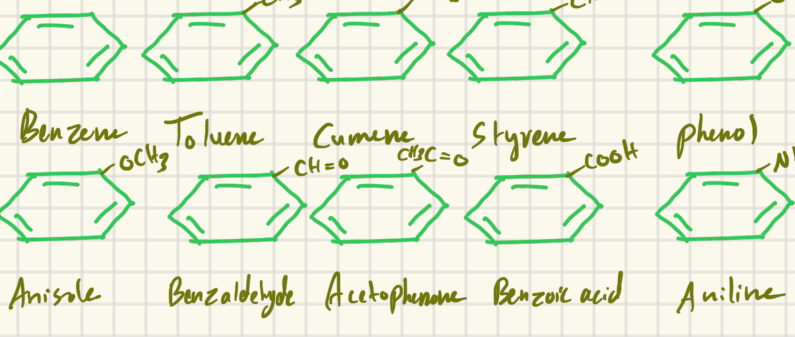
Resonance

- 1- planar.
- 2- Carbon-carbon lengths are identical.
- 3- Each Carbon atom at the corner of a regular hexagon.

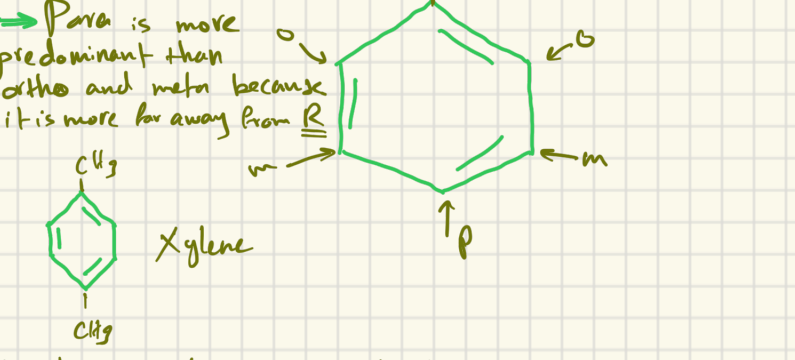


4- p orbitals overlap laterally to form π orbitals to create a ring or cloud of e⁻ above and below the plane of the ring.

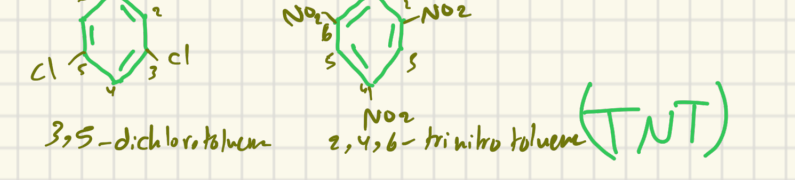
Common names



* When two substituents are present we use o, p, m

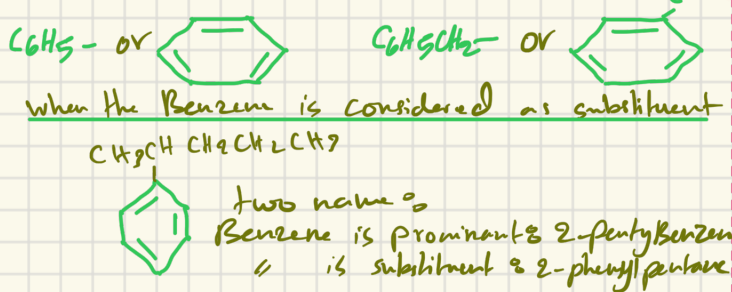


* when more than two substituents are present we use numbering



Continue Ch. 4

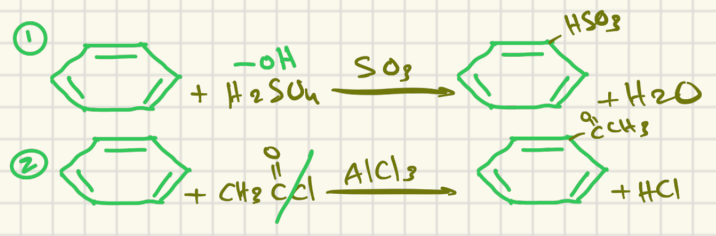
phenyl group Benzyl group



Electrophilic Aromatic substitution

Note 1: If the reagent has OH, we remove the OH and H from Benzene and merge it.

Note 2: If the reagent has X (halogen), we remove HX, and merge the rest.



Activating and Deactivating substituents

o/p directing	Amino Hydroxy, alkoxy acylamino alkyl Halo	increase in the acidity	NH_2, NHR, NR_2 OH, OCH_3, OR $NHCO-R$ $-CH_3, -CH_2CH_3, -R$ F, Cl, Br, I	Activating
m- directing	acyl, carbonyl carbamoyl, carbalkoxy sulfonic acid cyano nitro		$O=CR, OH-C=O$ $O=C-NH_2, O=C-OR$ (SO_3H) $SO_3(OH)$ $-C\equiv N$ (NO_2), $-N=O$	Deactivating

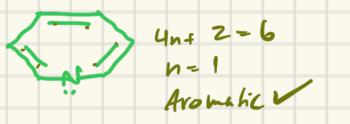
Mechanism :-

* Donate e^- → increase e^- density, hence and speed
Activating groups


* Withdraw e^- → decrease e^- density, slow reaction
Deactivating groups

Note: Although, Halogens are withdrawing groups they are deactivating groups, but have unshared e^- pairs, therefore are o/p directing

Aromatic



① planar

② conjugated and cyclic  $4n+2=6$
 $n=1$
Aromatic ✓

③ $4n+2 = \pi e^-$
 $n = 0, 1, 2, \dots$

Chapter 5

Stereoisomers

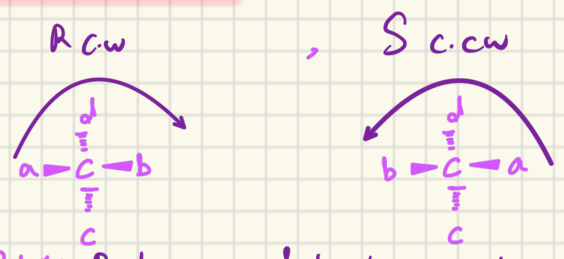
Compounds which have the same structural formula, but different arrangements of the atoms in space.

- | | |
|--|---|
| <p><u>Chiral compounds</u></p> <ul style="list-style-type: none"> → Mirror image, superimposable → No plane of symmetry → Optically active $[\alpha] \neq 0$ → Posses of Handness | <p><u>Achiral compounds</u></p> <ul style="list-style-type: none"> → Mirror image - non-superimposable → Has plane of symmetry → Optically inactive $[\alpha] = 0$ → Do not posses of Handness |
|--|---|

Enantiomers: Achiral compound
Chiral compounds (stereogenic) have 4 different groups attached to its carbon
Plane of symmetry: One side of a molecule is the exact reflection of the other side.

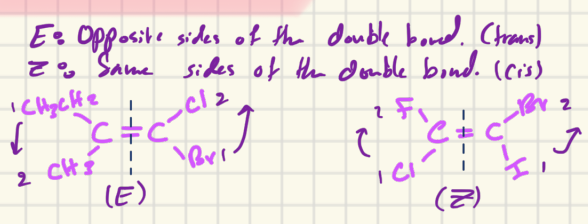


Configurations



- Rule 1: Ranking accord to atomic number.
 $I > Br > Cl > S > P > F > O > N > C > H$
- Rule 2: More carbon side has top priority ethyl > methyl!
- Rule 3: Multiple bonds equals single bonds.
- $-C\equiv CH \rightarrow \begin{matrix} \text{c} & & \text{c} \\ & \diagdown & / \\ & C & - CH \\ & & | \\ & & c \end{matrix}$
- $-CH=O \rightarrow \begin{matrix} & & \text{c} \\ & & | \\ \text{c} & - & C & - & CH \\ & & | & & | \\ & & o & & c \end{matrix}$

The Z-E convention



Polarized light and Optical activity

Polarimeter: Instrument used to detect optical activity.

→ Dextrorotatory C.W +
→ Levorotatory C.CW -

$[\alpha] = \frac{\alpha}{l \cdot d}$
 $\frac{d}{l \cdot d} \text{ g/ml} \rightarrow C \cdot l \rightarrow d \cdot m = 10 \text{ cm}$

Continue ch. 5

Enantiomers

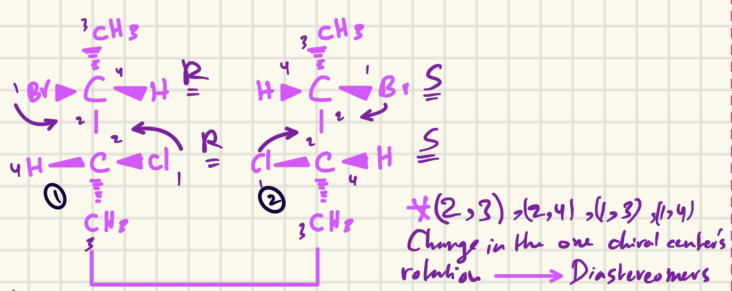
Have identical achiral properties such as B.p, m.p and density. Have different chiral properties, in the rotation (C.W, C.CW)
 * No relation between (S,R) and sign of rotation.
 * If group n.4 is \blacktriangle , we change the rotation. S \rightarrow R, R \rightarrow S

Fischer projection formulas

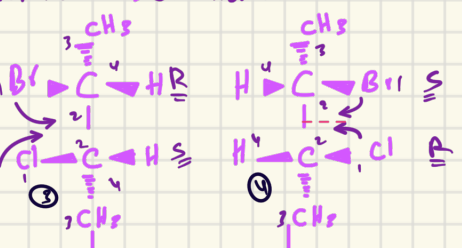
Two-Dimensional formula of a molecule used to represent the three-Dimensional configuration of stereogenic centers.
 * If group n.4 is on the right or left, we change the rotation.

Dia stereomers

Stereoisomers that are not mirror image of each other.
 \Rightarrow Possible n. of stereoisomers = 2^n , n = Chiral centers.



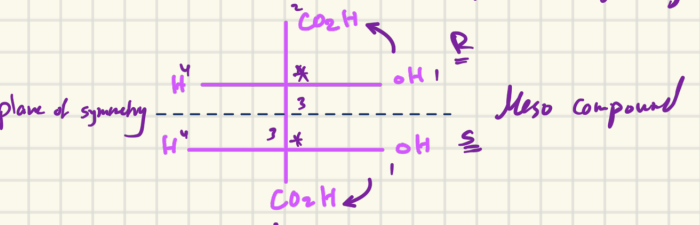
Change in the chiral centers' rotation \rightarrow Enantiomers



Change in the chiral centers' rotation \rightarrow Enantiomers

Meso compounds

Achiral diastereomers which have a plane of symmetry.



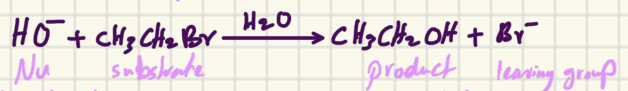
Racemic mixture

\Rightarrow 50:50 mixture of a pair of Enantiomers.
 \Rightarrow Inactive Achiral mixture.

Chapter 6

Nucleophilic Substitution

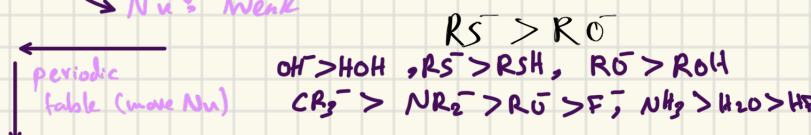
Reaction where Alkyl halides undergo nucleophilic displacement to the halide (leaving group) from the Alkyl halide (substrate)



- If the Nu has negative charge, we substitute Nu \rightarrow X
 Exa: $\text{CH}_3\text{CH}_2\text{Cl} + \text{CN}^- \rightarrow \text{CH}_3\text{CH}_2\text{CN} + \text{Cl}^-$
- If the Nu is neutral and has H, we remove H from Nu and substitute.
 Exa: $\text{CH}_3\text{CH}_2\text{Cl} + \text{H}_2\text{O} \rightarrow \text{CH}_3\text{CH}_2\text{OH} + \text{HCl}$
- If the Nu is neutral and doesn't have H, we substitute it and put a positive charge.
 Exa: $\text{CH}_3\text{CH}_2\text{Cl} + (\text{CH}_3)_3\text{N} \rightarrow \text{CH}_3\text{CH}_2\text{N}^+(\text{CH}_3)_3 + \text{Cl}^-$

Nu: OH⁻, O⁻, N⁻, S⁻, X (Halogen), C⁻

Nu = strong
 Nu = weak



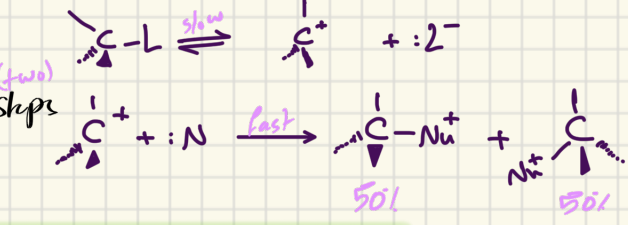
* Iodide (I) is the halogen which reacts because its E.N is low, therefore we can take the C easily.

S_N2 Mechanism

- Depend on two molecules which are R-X, Nu strong Nu
 - Happens in one step
 - Rate activity $\text{CH}_3\text{X} > 1^\circ > 2^\circ > 3^\circ$
 - Inversion of configuration R \rightarrow S, cis \rightarrow trans
- (one) $\text{Nu}^- + \text{C-L} \rightarrow [\text{Nu}^{\delta-} \cdots \text{C} \cdots \text{L}^{\delta-}]^{\ddagger} \rightarrow \text{Nu-C} + \text{L}^-$
 Step Transition state Inversion

S_N1 Mechanism

- Depends on one molecule which is R-X. Weak Nu
 - Happens in two steps.
 - Rate activity $3^\circ > 2^\circ > 1^\circ > \text{CH}_3$
 - Racemization Reaction, 50% + 50%, [Nu] = 0, Achiral
- If one chiral center \rightarrow Enantiomers 50% + 50%
 " two " " \rightarrow Diastereomers 50% + 50%
 " No " " \rightarrow One product will be produced 100%



Elimination 2 Mechanism

\Rightarrow Like S_N1 in properties.
 \Rightarrow Reacts in basic Nu.

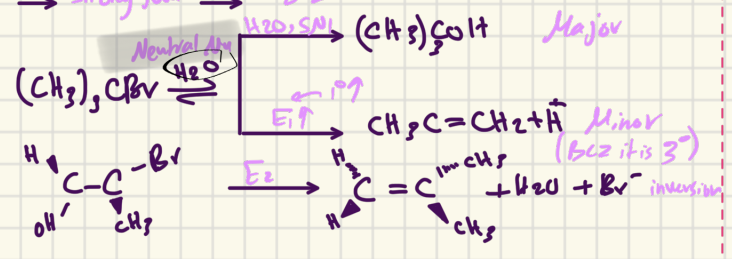
Elimination 1 Mechanism

\Rightarrow Like S_N1 in properties
 \Rightarrow Reacts with primary halides.

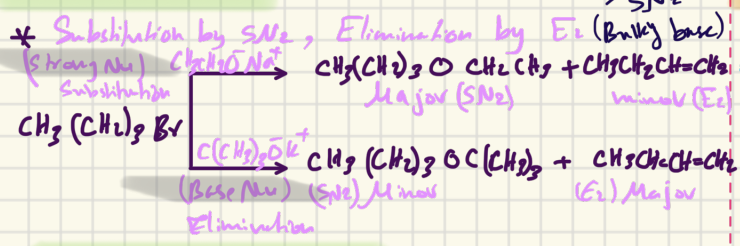
Continue Ch. 6

Tertiary Halides:

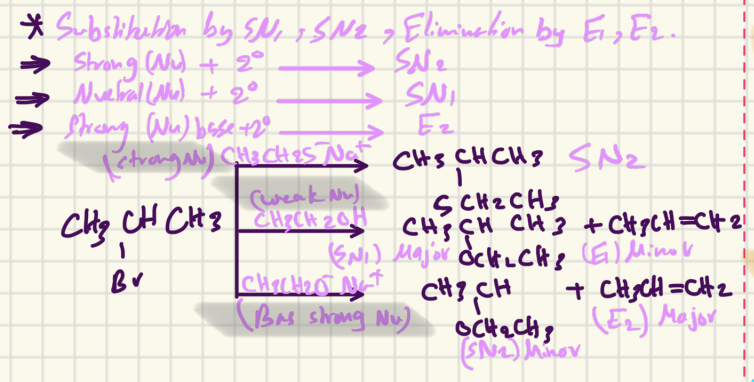
- * Substitution by S_N1 , Elimination by $E1$ and $E2$
- weak Nu → $S_N1 + E1$
- Strong Nu → $E2$



Primary Halides



Secondary Halides:



Chapter 7

- Alcohols: R-OH
- Phenols: Aromatic ring of alcohols with OH attached.
- Thiols: Thiophenols, oxygen is replaced with sulfur, R-SH

Alcohols:

IUPAC Name: Ending with -ol priority in numbering

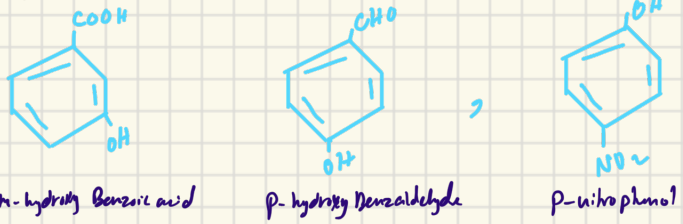
Common Name: Alkyl group + Alcohol

IUPAC	CH ₃ OH	CH ₃ CH ₂ CH ₂ OH
common	Methanol	2-propanol
	Methyl alcohol	iso-propanol

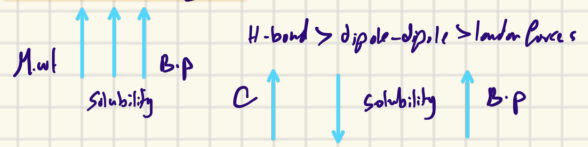
Phenols

Ch. 4

Hydroxyl group is a substituent if there is carboxylic acid, aldehyde or ketone

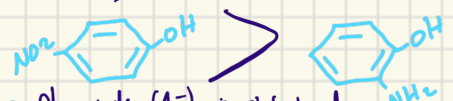


Hydrogen Bonding:



Acidity and Basicity:

- ⇒ Phenols are stronger acids than alcohols.
- ⇒ Activating groups decrease acidity, De-activating groups increase acidity.



- ⇒ Phenoxide (A⁻) is stabilized resonance, o-p rings
- ⇒ Electron withdrawing groups increase acidity by stabilizing the conjugated base, Electron-donating groups decrease acidity by dis-stabilizing the conjugated base.
- ⇒ Alcohols do not convert to their alkoxide (A⁻), because A⁻ are stronger bases than hydroxide ion, Phenols can be converted into (A⁻)



Continue ch. 7

Dehydration

It is an Elimination (1,2) reaction depending on the class of alcohol.
 $3^\circ \rightarrow E_1$, $1^\circ \rightarrow E_2$
 In 2° alcohols, the reaction gives me two products, the product where the C has least H is the predominant.
 $CH_3CH_2OH \xrightarrow{H^+ / 100^\circ} CH_2=CH_2 + H_2O$

Reaction with Hydrogen Halides

Substitution: $ROH + HX \rightarrow RX + H_2O$
 No Reaction: $ROH + X^- \rightarrow X$
 1° Alcohols must be heated with a Zinc catalyst to react faster (ZnCl₂) but 3° Alcohol need minutes and (rt) to react in the same reaction.
 S_N1 $3^\circ (CH_3)_3COH + HCl \xrightarrow{rt} (CH_3)_3CCl + H_2O$
 S_N2 $1^\circ CH_3(CH_2)_5OH + HCl \xrightarrow{\text{ZnCl}_2 \cdot \text{heat}} CH_3(CH_2)_5Cl + H_2O$

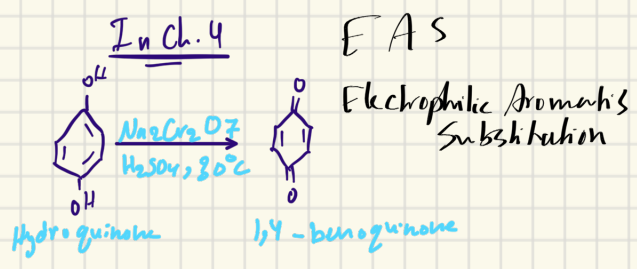
Preparation of Alcohols

1. Thionyl chloride reacts with alcohols to give alkyl chlorides. (Better method)
 $ROH + Cl-S(=O)-Cl \xrightarrow{\text{Heat}} [R-O-S(=O)-Cl] \rightarrow R-Cl + SO_2$
 Thionyl chloride, ester
 2. Phosphorus halides convert alcohols to alkyl halides:
 $3ROH + PX_3 \rightarrow 3RX + H_3PO_3$ (X = Cl or Br)
 Phosphorus halide

Oxidation of Alcohols

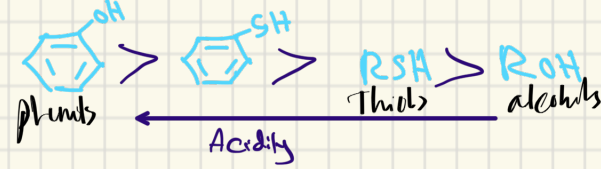
$1^\circ \rightarrow$ aldehyde, carboxylic acid
 $2^\circ \rightarrow$ ketone
 $3^\circ \rightarrow$ Does not react
 * Jones reagent (CrO₃) gives me carboxylic acids
 PCC gives me aldehydes in 1° alcohols

Aromatic substitution phenols



Thiols

Naming: Sulfhydryl group, also called mercaptans
 $CH_3CH_2CH_2CH_2SH$
 1-butanthiol (n-butyl mercaptan).
 \Rightarrow Thiols more acidic than Alcohols.



Chapter 8

Ethers

Naming: ROR, Alkyl group + Ether, when O is substituent (alkoxy)
 $CH_3CH_2OCH_2CH_3$ diethyl ether
 $CH_3CH(CH_3)CH_2CH_2OCH_3$ 2-methoxy pentane

Properties

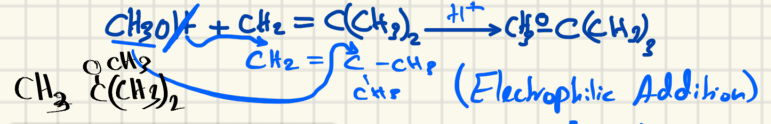
Branched \downarrow Bp \uparrow Solubility \uparrow
 \Rightarrow B.p does not be affected by M.wt.
 \Rightarrow Ethers do not form H-bonds with one another, but they form with alcohols.
 \Rightarrow Ethers are inert compounds, react with acids, bases, oxidizing and reducing agents, they don't react with Na unlike alcohols.
 \Rightarrow Ethers are polar compounds, therefore they are soluble.
 \Rightarrow Ethers with air form peroxides, with FeSO₄ they destroy peroxides
 $CH_3CH_2OCH_2CH_3 + O_2 \xrightarrow{FeSO_4} CH_3CH_2OCH_2CH_2OCH_2CH_3$
 ether hydroperoxide

Grignard Reagent

* $RX + Mg \xrightarrow{\text{ether}} R^-Mg^+X$ Ox: alkyl, acts in reaction
 * $R^-Mg^+X + H_2O \rightarrow RH + Mg^+OH^-X^-$ Acid/base reaction
 $// + DO_2 \rightarrow RO + Mg^+ODX^-$ D-OP (Heavy water)
 * $R-X + 2Li \rightarrow R^-Li^+ + Li^+X^-$ Alkyl lithium, oxidation/reduction reaction

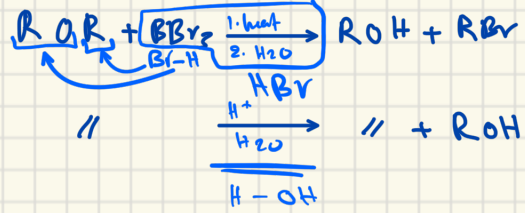
Preparations

$ROH + HOR \rightarrow ROR + H_2O$ (In symmetric ethers)
 * remove H from Alcohols and OH from the other alcohol to form water

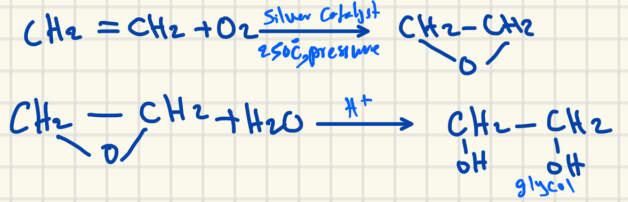


Williamson synthesis

Depend on S_N1, S_N2
 Alcohol reacts with Na: $ROH + Na \rightarrow RO^-Na^+ + H_2$
 Not ether: $RO^-Na^+ + R'-X \rightarrow ROR' + Na^+X^-$ Alkoxide, ether, S_N2
 \Rightarrow The Alkyl halide must be primary 1° .

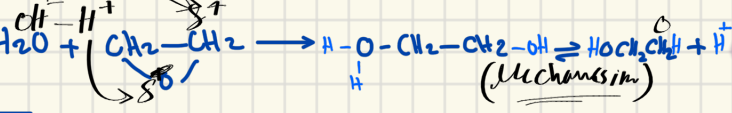


Epoxides (oxiranes)

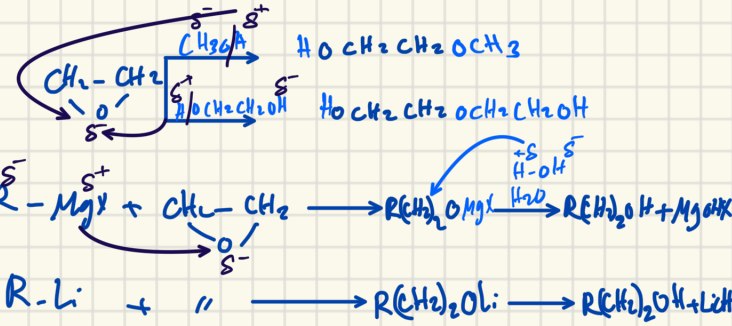


Continue ch. 8:

1 Reaction with water:



2 Reaction with Nu:



Crown ethers:

No reaction with Na, Na₂S₂O₄

⇒ Bracket number represents the ring size and terminal numbers gives the number of oxygen.

[18] crown-6 18 → C+O, 6 → O, C=18-6=12
 ⇒ They form complexes with positive ions depending on the size of the ring.

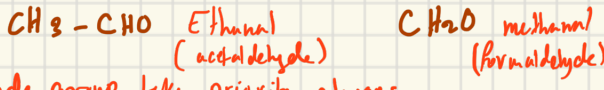
⇒ Nonactin: selective transport for K⁺ (Not Na⁺), they are tetrahydrofuran or four ester links compound, Antibiotics

Chapter 9:

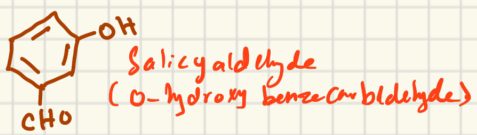
Aldehydes:

⇒ Characterized by the presence of (C=O) carbonyl group

Naming: Ending with -al



⇒ Aldehyde group take priority always.
 ⇒ In cyclic compounds, we add suffix -carbaldehyde.

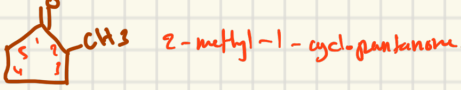


Ketones:

Naming: Ending with -one.
 common name → Alkyl Alkyl ketone

like ethers CH₃C(=O)CH₂CH₃ 2-butanone (ethyl methyl ketone)

⇒ Priority always for ketone.

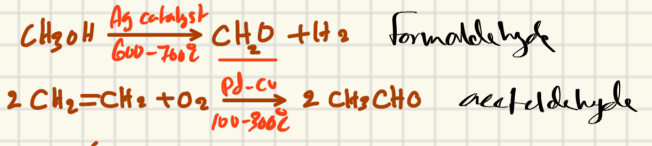


With carboxylic Acids, ketones act as a branch (OXO)

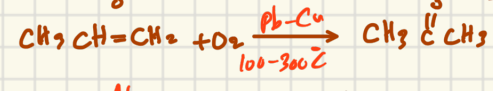
Continue ch. 9:

Common Aldehydes and ketones:

Formaldehyde:



Acetone (CH₃C(=O)CH₃) we prepare it by oxidizing propene.



Quinones → Alizarin → Dye red coats.
 → Vitamin K → Normal clotting of blood.

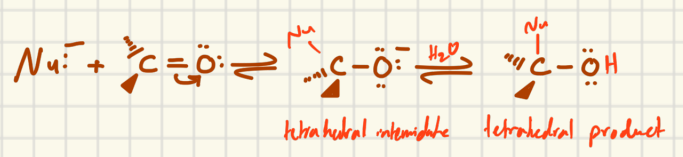
Synthesis of Aldehydes and ketones:

- ⇒ By oxidation reactions in Ch. 7 (Aldehyde and ketones)
- ⇒ By Friedel-Crafts acylation (AlCl₃) Ch. 4 (ketones)
- ⇒ By terminal alkyenes by acid and Mercury ch. 3 (ketones)

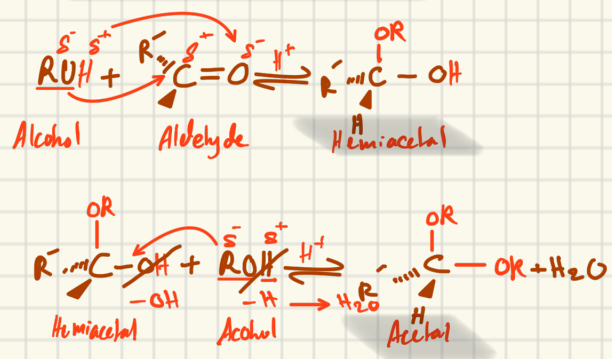
Carbonyl group:

- ⇒ sp²-hybridized.
 - ⇒ θ = 120°.
 - ⇒ C=O is polarized.
-
- Attack by Nu react with proton
- ⇒ They don't have O-H bond only C=O, cannot form hydrogen bonds with one another as alcohols.
 - ⇒ Have higher B.p than hydrocarbons, but less than alcohols
- alcohols > ketones, aldehyde > hydrocarbon
- ↑ B.p
- Mut ↓ solubility > because they can form hydrogen bonds with water molecules but not with themselves.

Nucleophilic Addition:



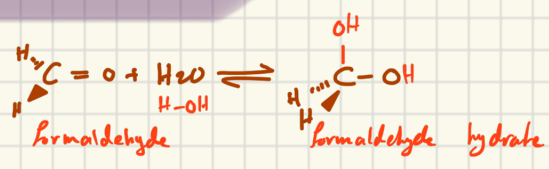
Addition of Alcohols:



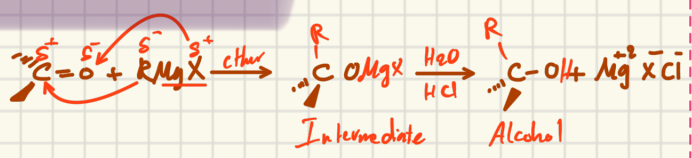
- ⇒ Hemiacetal → OR + OH + H
- ⇒ Acetal → OR + OR + H

Continue ch. 9

Addition of water:



Addition of Grignard:

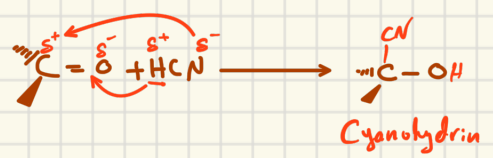


Formaldehyde → 1° Alcohol
Aldehyde → 2° Alcohol
ketone → 3° Alcohol

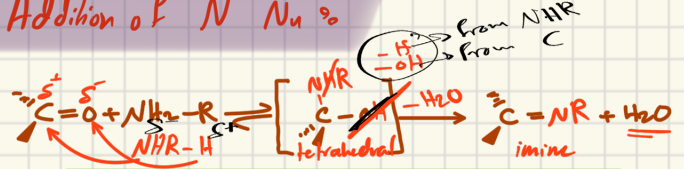
} there is difference in carbon numbers when we use Grignard

(Nucleophilic Addition)

Addition of Hydrogen Cyanide, cyanohydrins:

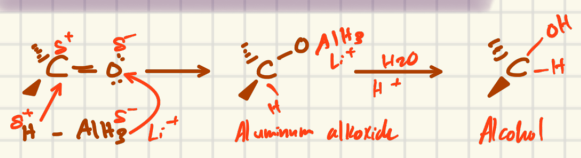


Addition of N Nu:



Formula of ammonia derivative	Name	Formula of carbonyl derivative	Name
RNH ₂ or ArNH ₂	primary amine	C=NR or C=NAr	imine
NH ₂ OH	hydroxylamine	C=NOH	oxime
NH ₂ NH ₂	hydrazine	C=NNH ₂	hydrazone
NH ₂ NHC ₆ H ₅	phenylhydrazine	C=NNHC ₆ H ₅	phenylhydrazone

Reduction of Carbonyl compounds:



⇒ By using reducing agents such as (LiAlH₄, NaBH₄) (Lithium aluminum hydride, Sodium borohydride), we reduce Aldehyde to 1° Alcohols and ketones to 2° Alcohols. We don't reduce = and ≡ bonds with these agents.

pt > H⁺

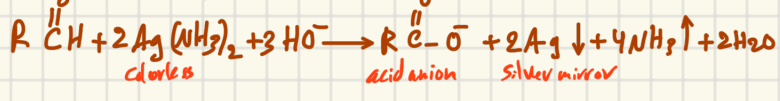
Continue ch. 9:

Oxidation of Carbonyl compounds:

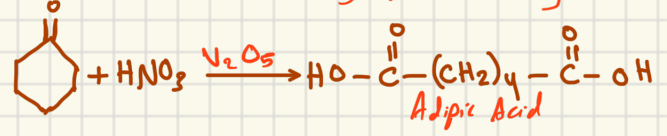
Ch. 7

⇒ Aldehydes are more easily oxidized than ketones.
⇒ By using reducing agents KMnO₄, CrO₃, Ag₂O and peracids.
⇒ Can't use KMnO₄ with Aldehyde Compounds which have double bond = because it will reduce the = bond too, instead we use (Ag₂O).

* Tollen's Silver Mirror: Ag(NH₃)₂
It reduces Aldehydes but not ketones.



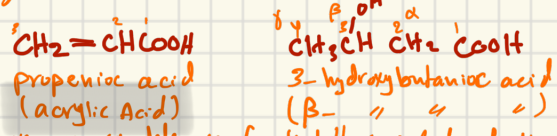
⇒ Ketones can be oxidized by special oxidizing conditions:



Chapter 10:

Carboxylic Acids:

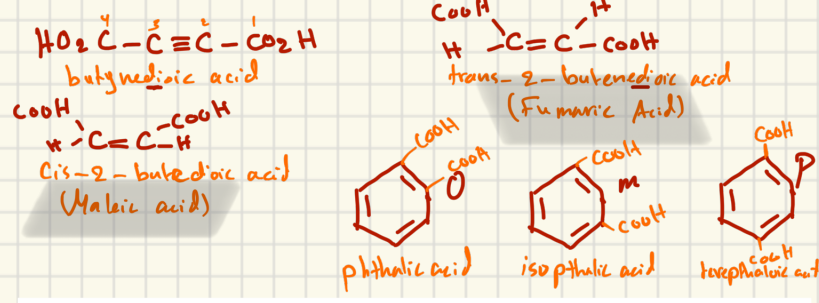
* Naming: End with the suffix -oic Can't be a substituent.



Common names We use Greek letters instead of Numbers (α, β, γ)

Carbon atoms	Formula	Source	Common name	IUPAC name
1	HCOOH	ants (Latin, <i>formica</i>)	formic acid	methanoic acid
2	CH ₃ COOH	vinegar (Latin, <i>acetum</i>)	acetic acid	ethanoic acid
3	CH ₃ CH ₂ COOH	milk (Greek, <i>protos pion</i> , first fat)	propionic acid	propanoic acid
4	CH ₃ (CH ₂) ₂ COOH	butter (Latin, <i>butyrum</i>)	butyric acid	butanoic acid
5	CH ₃ (CH ₂) ₃ COOH	valerian root (Latin, <i>valere</i> , to be strong)	valeric acid	pentanoic acid

Formula	Common name	Source	IUPAC name
HOOC-COOH	oxalic acid	plants of the <i>oxalic</i> family (for example, sorrel)	ethanedioic acid
HOOC-CH ₂ -COOH	malonic acid	apple (Gk. <i>malon</i>)	propanedioic acid
HOOC-(CH ₂) ₂ -COOH	succinic acid	amber (L. <i>succinum</i>)	butanedioic acid



$\text{R}-\text{C}(=\text{O})-$	$\text{H}-\text{C}(=\text{O})-$	$\text{CH}_3-\text{C}(=\text{O})-$	$\text{CH}_3\text{CH}_2-\text{C}(=\text{O})-$	$\text{C}_6\text{H}_5-\text{C}(=\text{O})-$
an acyl group	formyl (methanoyl)	acetyl (ethanoyl)	propanoyl	benzoyl

Continue ch. 10

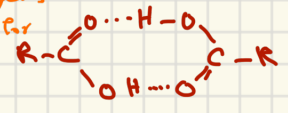
Properties

Carboxylic Acids > Alcohols > Aldehyde, ketones > ethers > hydrocarbons

Activity

Mel ↑ BP ↑ C ↓ solubility

→ Carboxylic Acids are polar
 → " " form H-bonds with themselves and with other molecules
 → They form dimers, two H-bonds between electron rich oxygens and electron-poor hydrogens.
 → H-bonds explains the solubility for carboxylic Acids

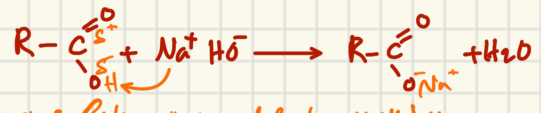


Acidity:

→ Closer with drawing groups to the carboxylic Acid will increase it's acidity.
CH3CH2CH(Cl)COOH > CH3CH(Cl)CH2COOH
 → More carbon will decrease the acidity.
CH3COOH < HCOOH

→ Phenols have more resonance structures than carboxylic acids, but carboxylic acids are more acidic, this is because of the withdrawing groups that carboxylic acids have (C=O).

Conversion of Acids to Salts



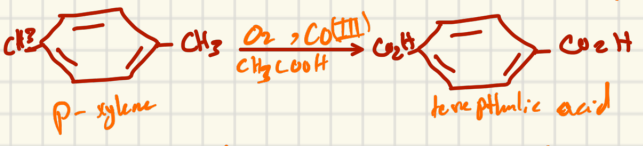
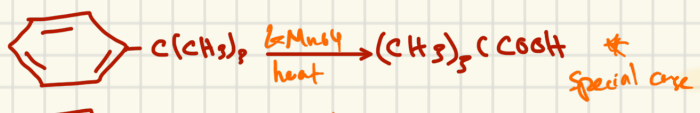
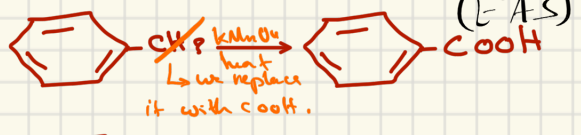
Naming: Cation is named first, weak base then the name of carboxylic acid but instead of -ic, -ate



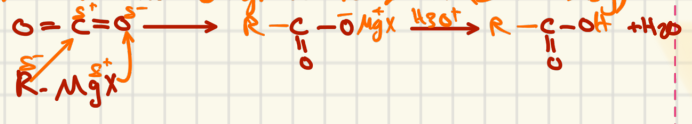
Preparations

1 Oxidation of 1° Alcohols and aldehydes (like mentioned in previous chapters)

2 Oxidation of Aromatic Side chains (EAS)

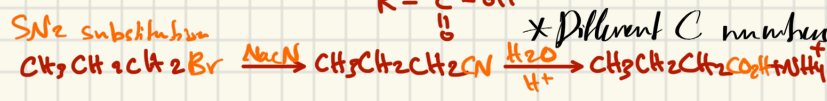
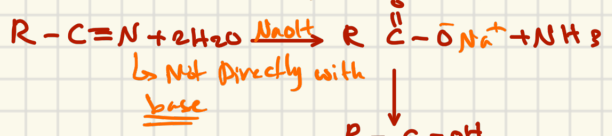
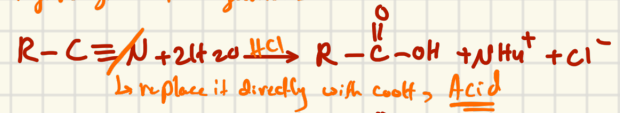


3 Reaction with Grignard reagent, (Irreversibly)



Continue ch. 10

Hydrolysis of Cyanides.

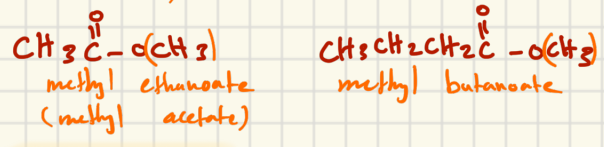


Carboxylic Acid Derivatives:

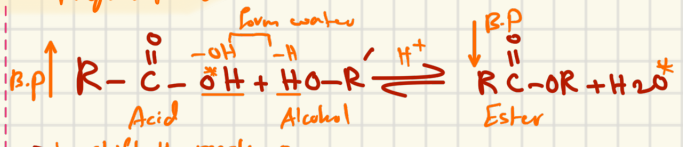
- Ester R-C(=O)OR'
- Acyl halide R-C(=O)X
- Acid anhydride R-C(=O)-O-C(=O)R
- Primary amide R-C(=O)NH2

Esters

Naming: R or OR is named first then the name of the acid instead of -ic, -ate



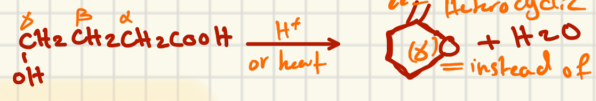
Preparations



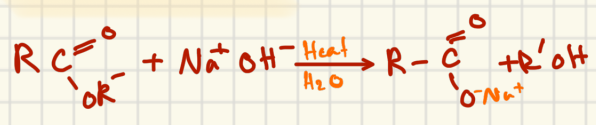
→ to shift the reaction:
 ↳ Using large excess of alcohols.
 ↳ Distillation, by removing water.

Lactones:

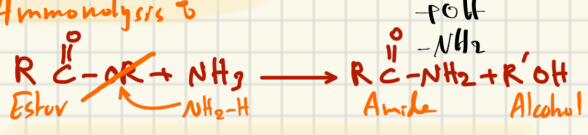
Cyclic Esters instead of carboxylic acid instead of Alcohol



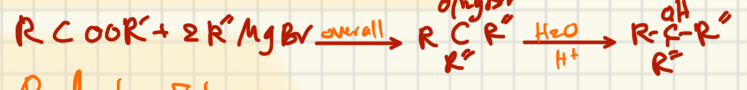
Saponification:



Ammonolysis:



Reaction with Grignard Reagents (Irreversible Nu attack)



Reduction Esters:

