

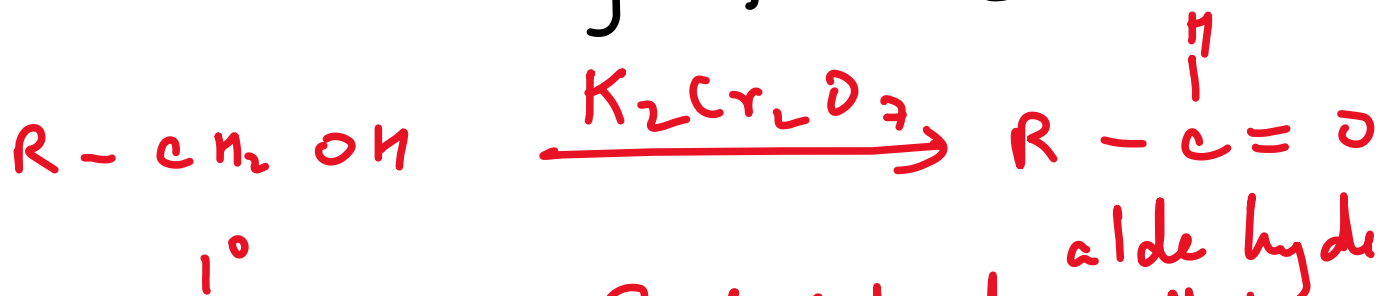
REVISION NOTES

(ALDEHYDE, KETONE & CARBOXYLIC ACID)

Aldehydes & Ketones.

1. Preparation of aldehydes.

a. Oxidation of primary alcohol



(special distillation method)

(possibility of further oxidation to acid)

Primary 1° alcohol

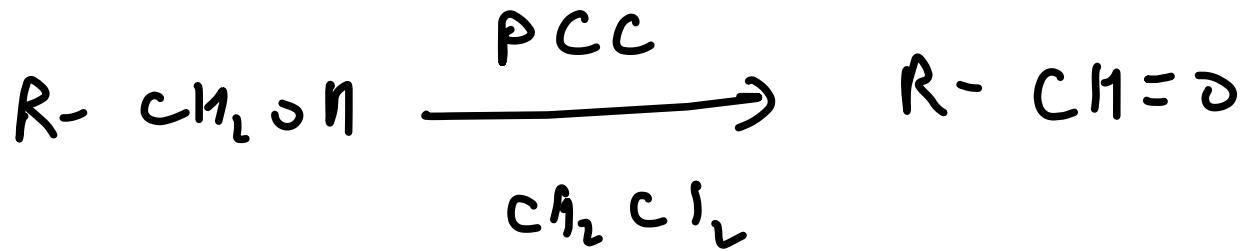
↓ [O]

aldehyde


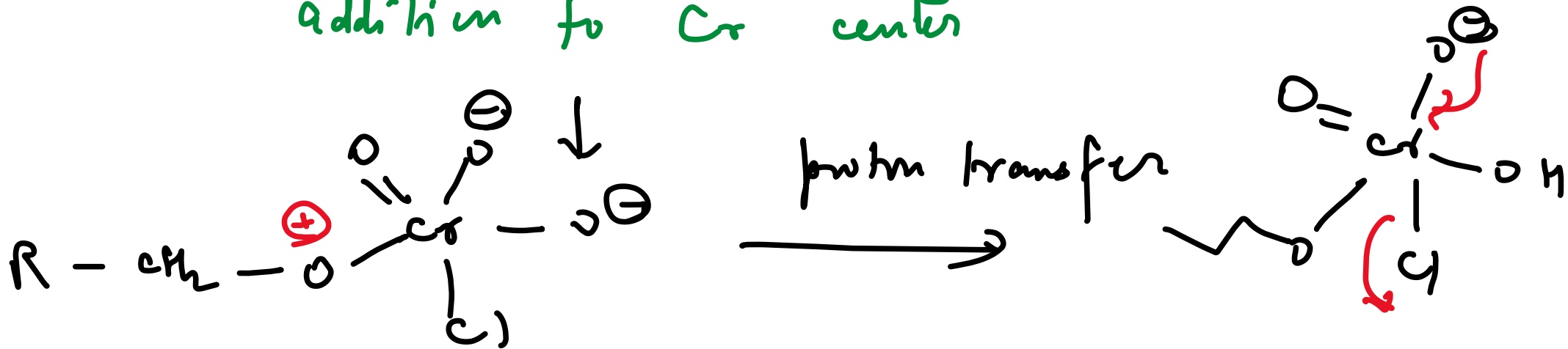
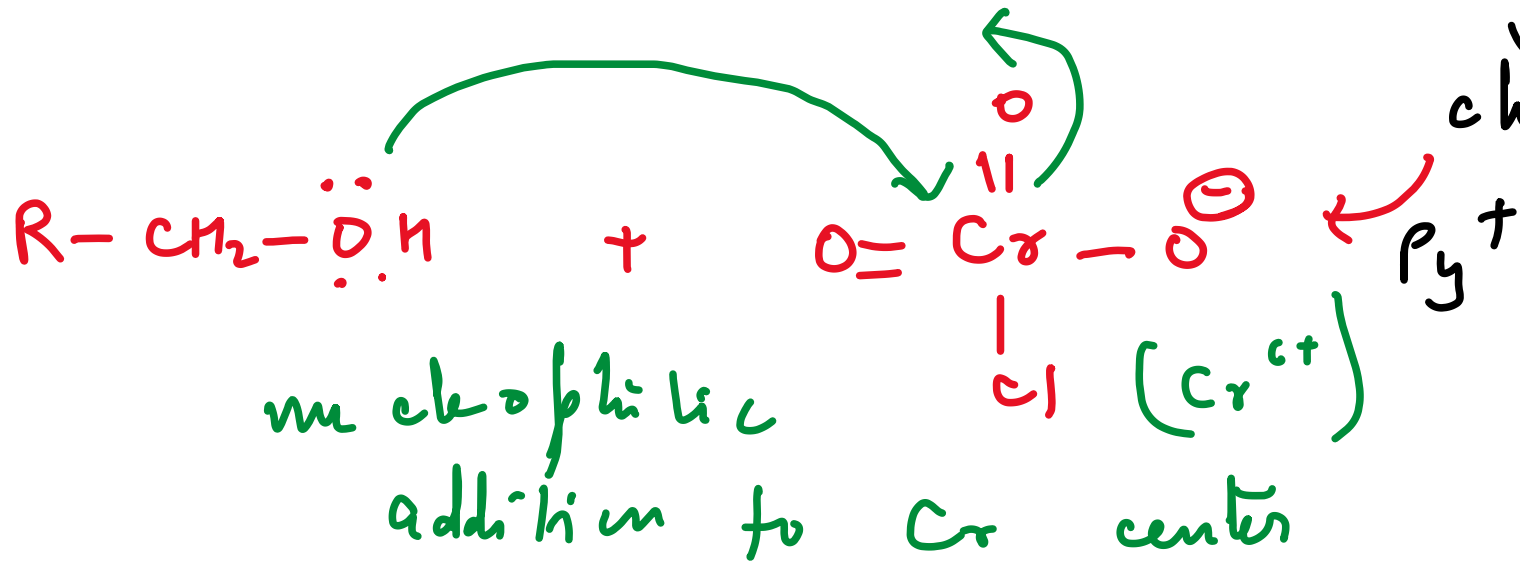
Secondary 2°

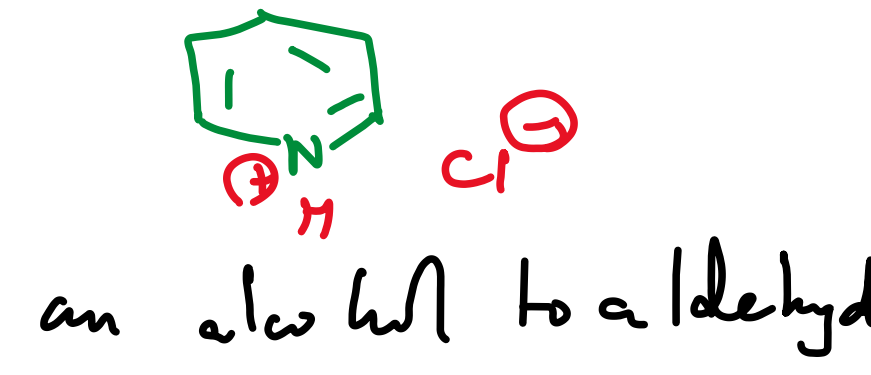
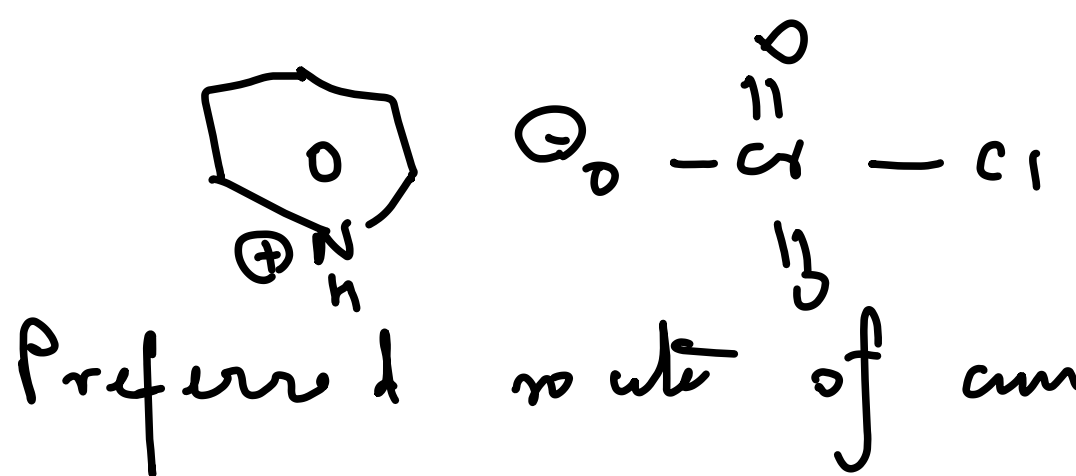
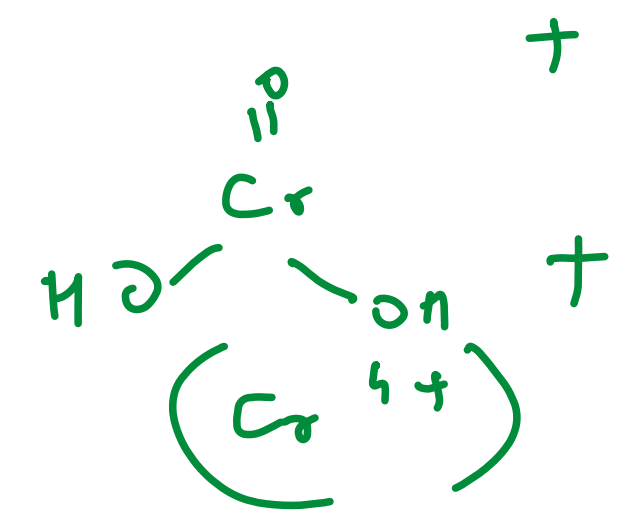
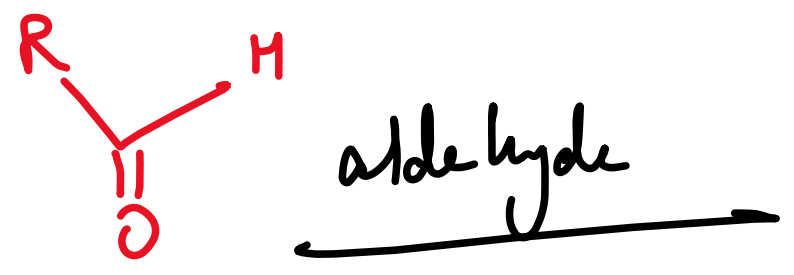
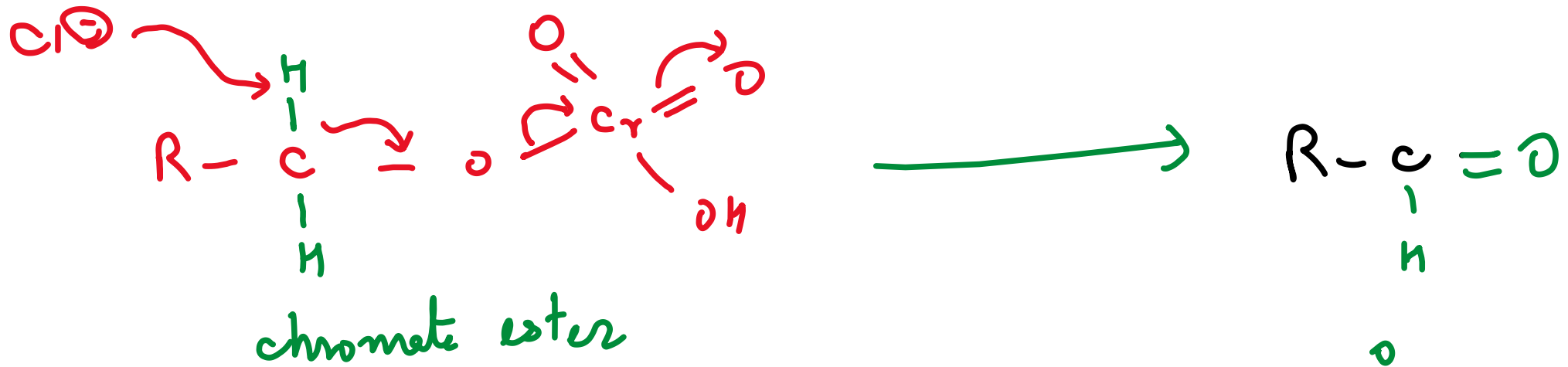
↓

Ketone

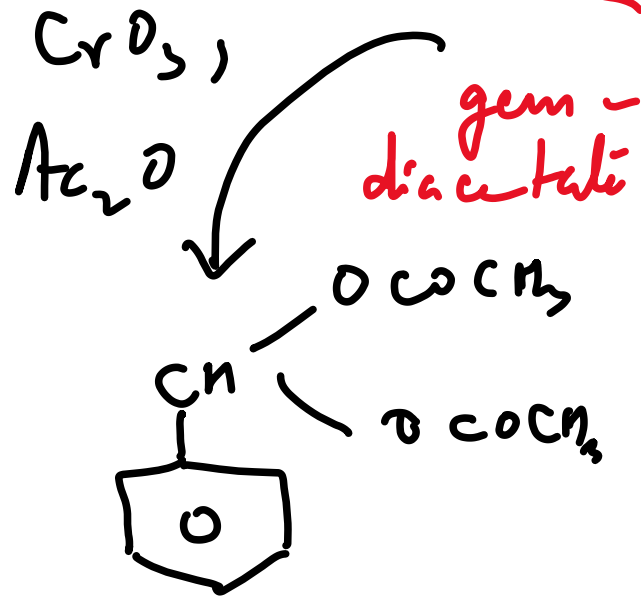
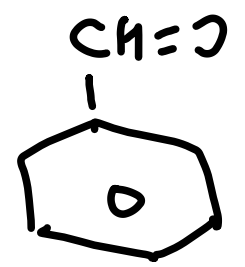
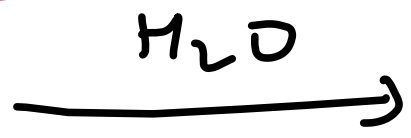
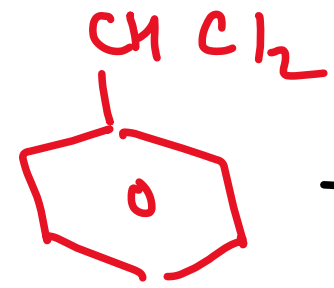


PCC = Pyridinium
chloro chromate

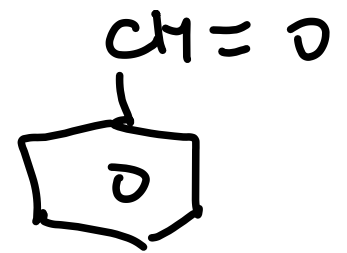





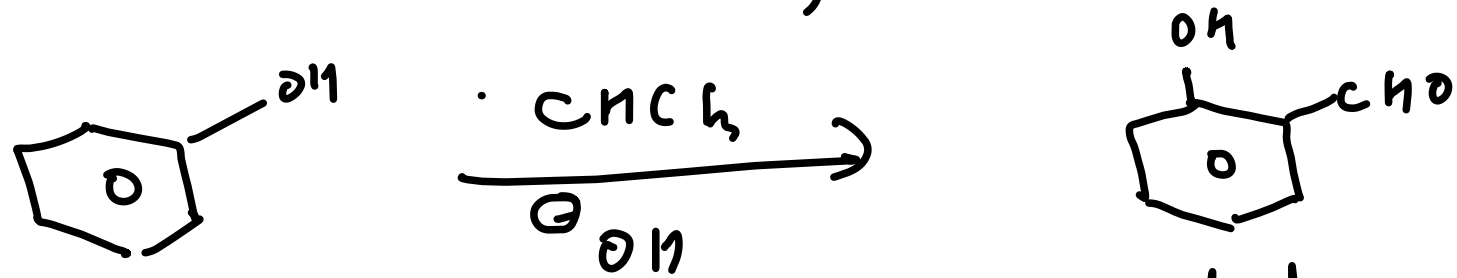
b) Oxidation of methyl benzenes



free radical substitution =
 reaction is unselective
 and does not stop at
 monochlorination stage



c) Reimer - Tiemann synthesis .

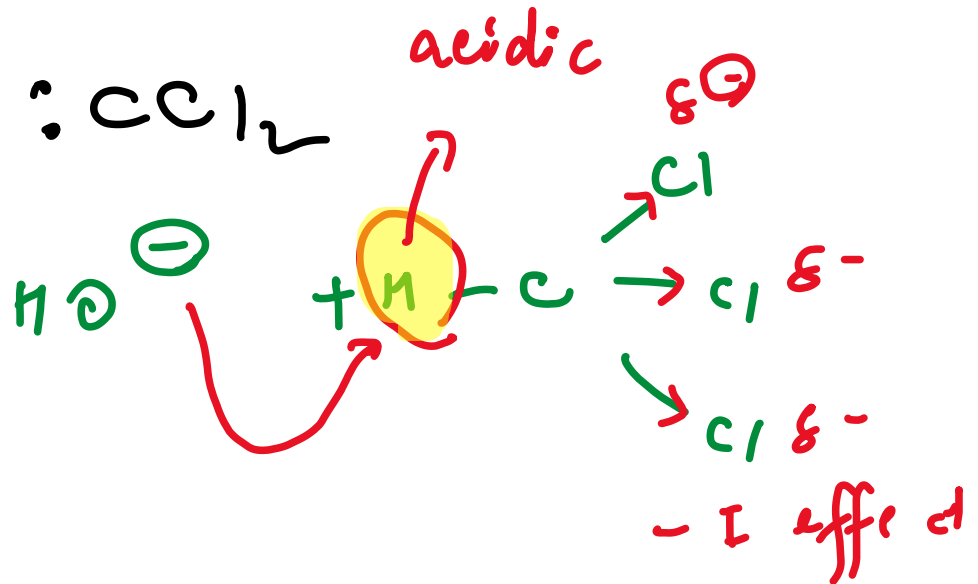
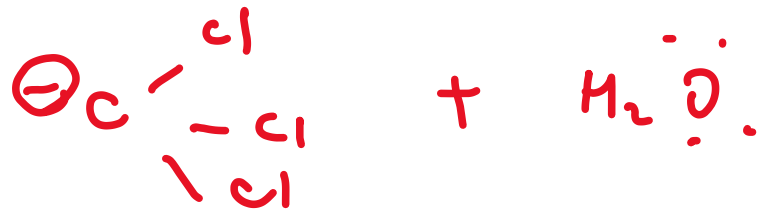


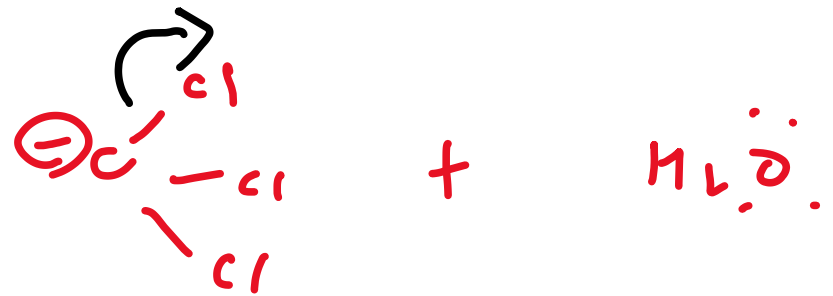
o - hydroxy benzene -

In the reaction, the electrophile is dichlorocarbene

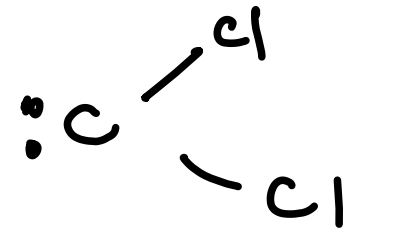
Mechanism

Step I:

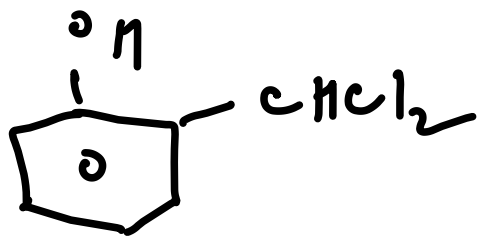
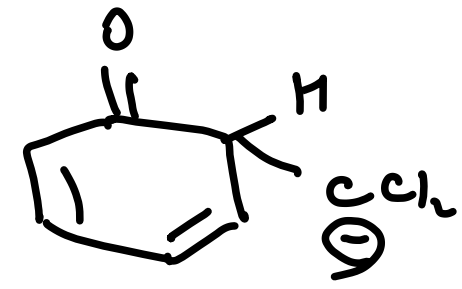
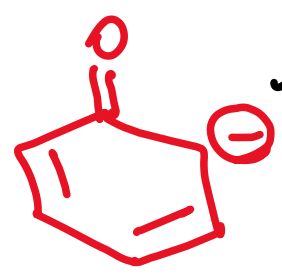
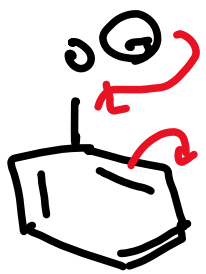




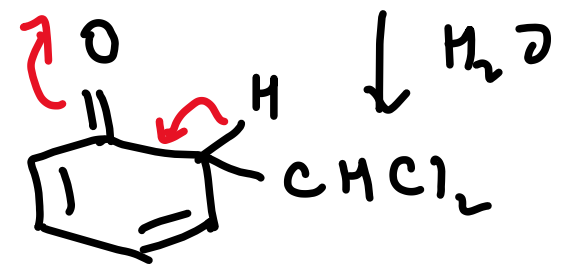
↓ slow

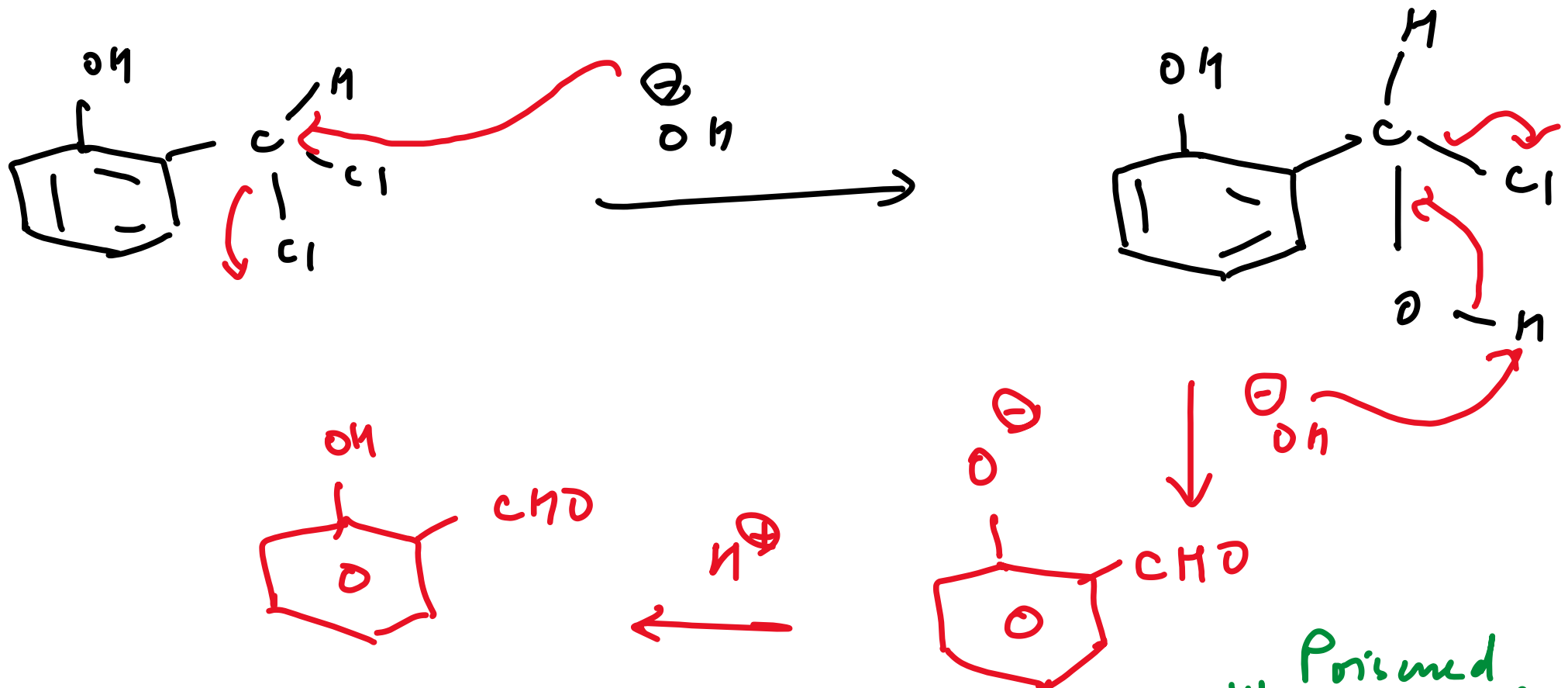


dichloro carbene



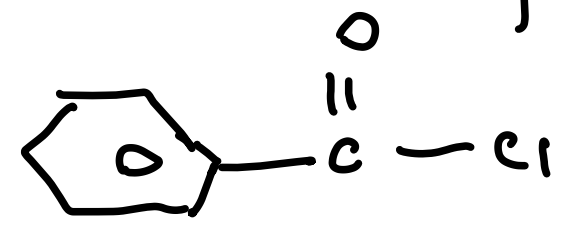
Tautomerization -



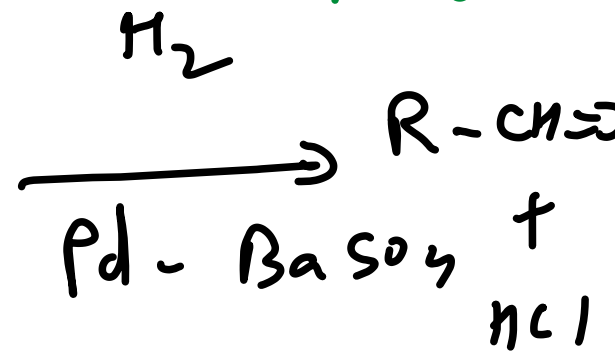
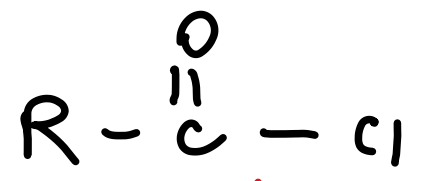


d)

Reduction of acid chlorides:

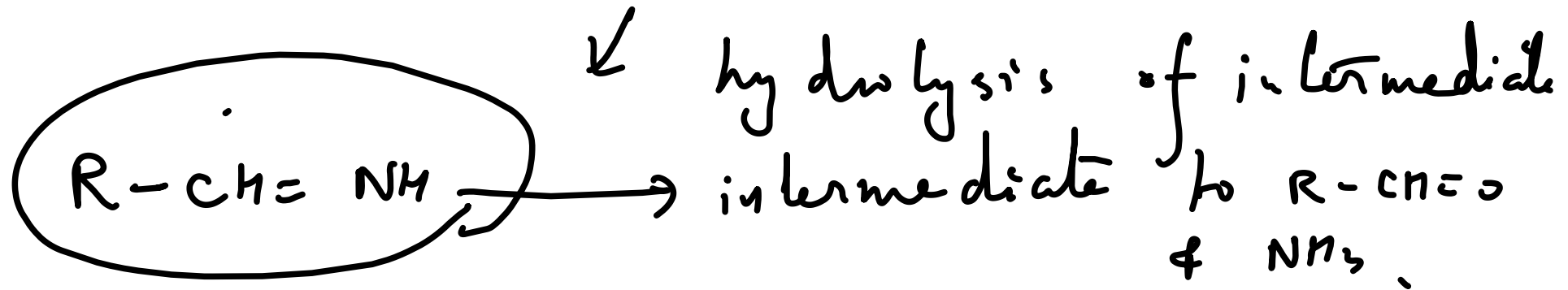
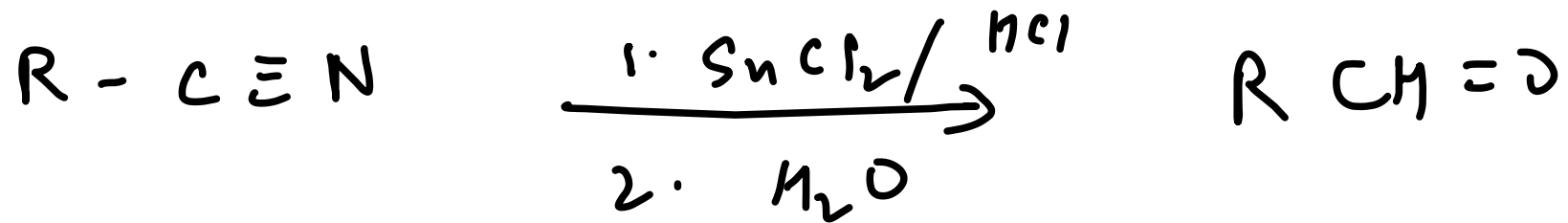


Rosenmund reduction -



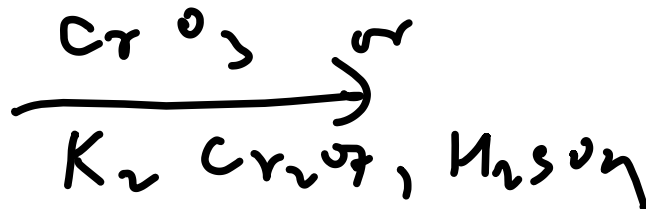
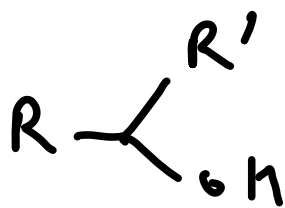
with poisoned quinoline trace -

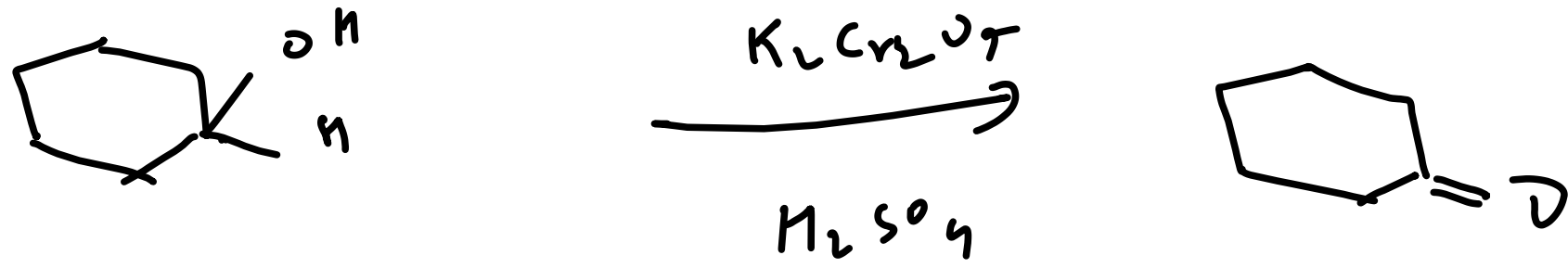
e) Stephen's method



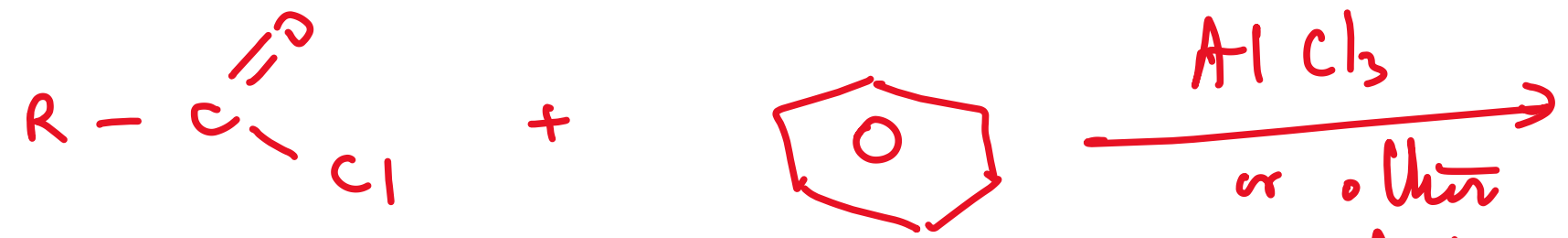
2. Preparation of Ketones

a) Oxidation of secondary alcohols:

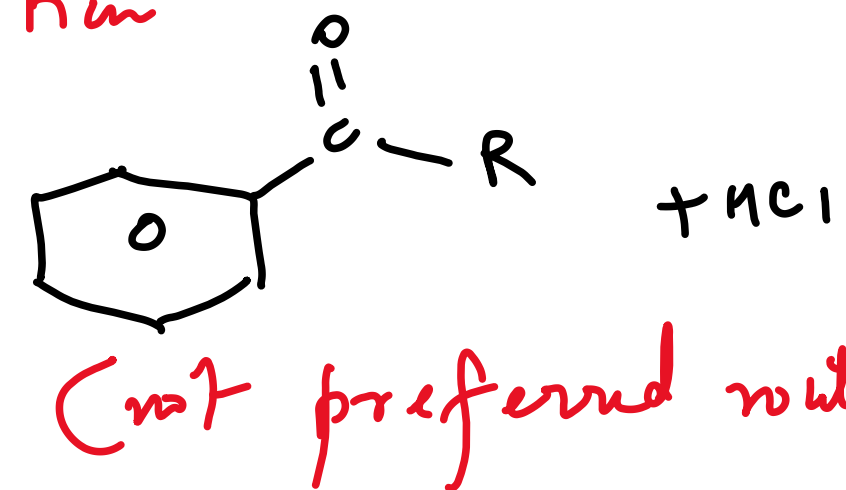
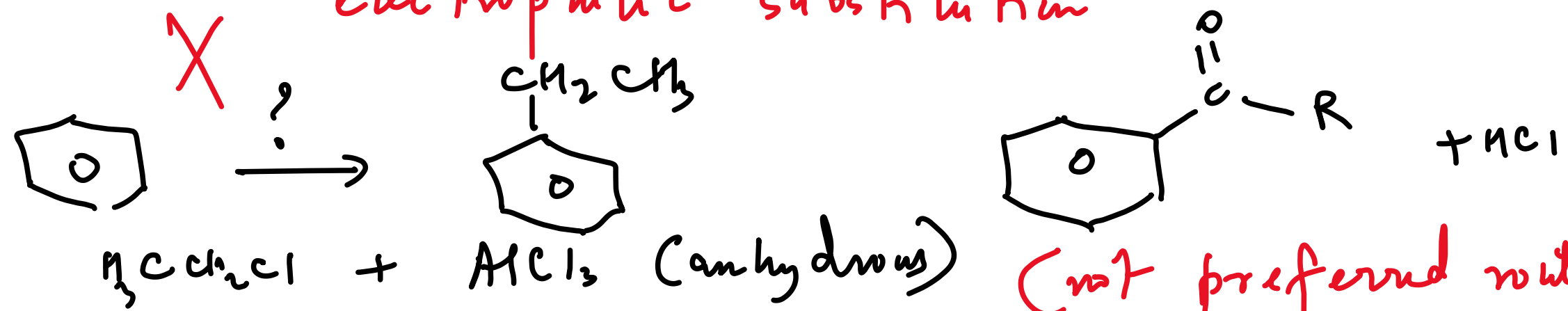


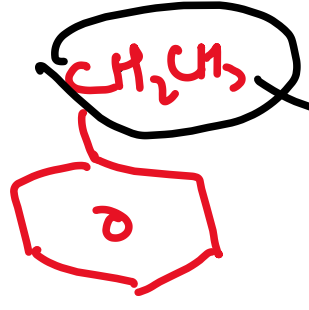
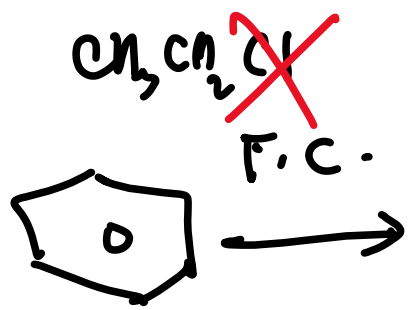


b) Friedel-Craft's acylation - - -



electrophilic substitution L.A.

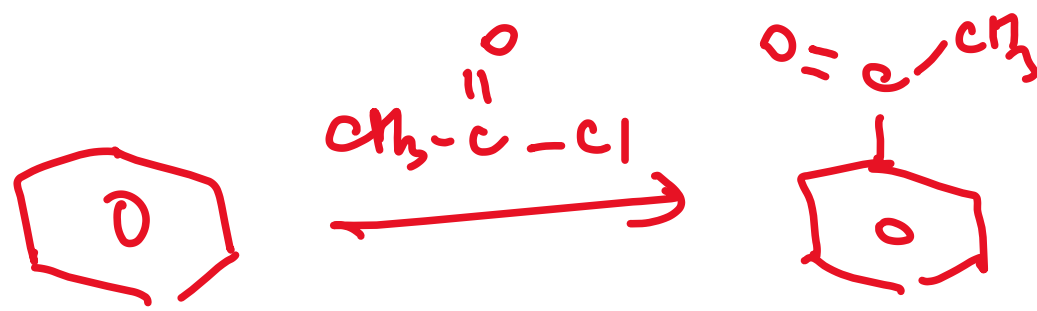




+ F group (activating group)

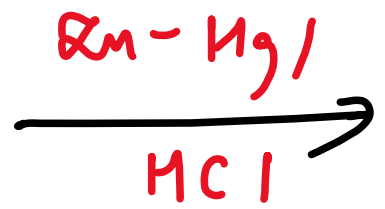
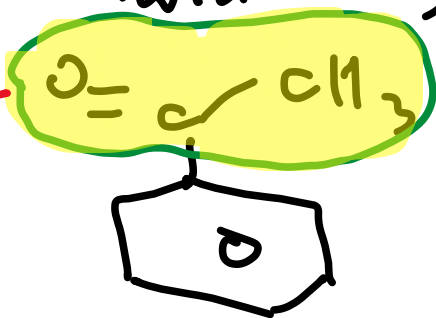
Once CH₃ group is introduced into the benzene ring, the ring becomes highly activated and undergoes further electrophilic substitution to form polyalkylated products i.e. - the reaction will not freeze at the desired mono-alkylation step.

F.C. acylation:

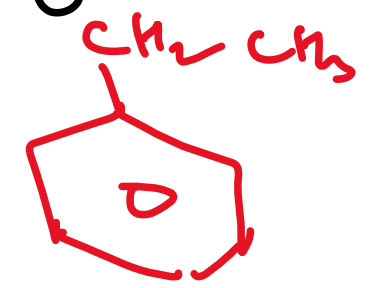


In contrast to $-CH_3$ group $-C(=O)-CH_3$ is a highly deactivating group. So the reaction will stop at monoalkylation stage.

$-I$ group
deactivating
influence
benzene ring.



Clemmensen
reduction

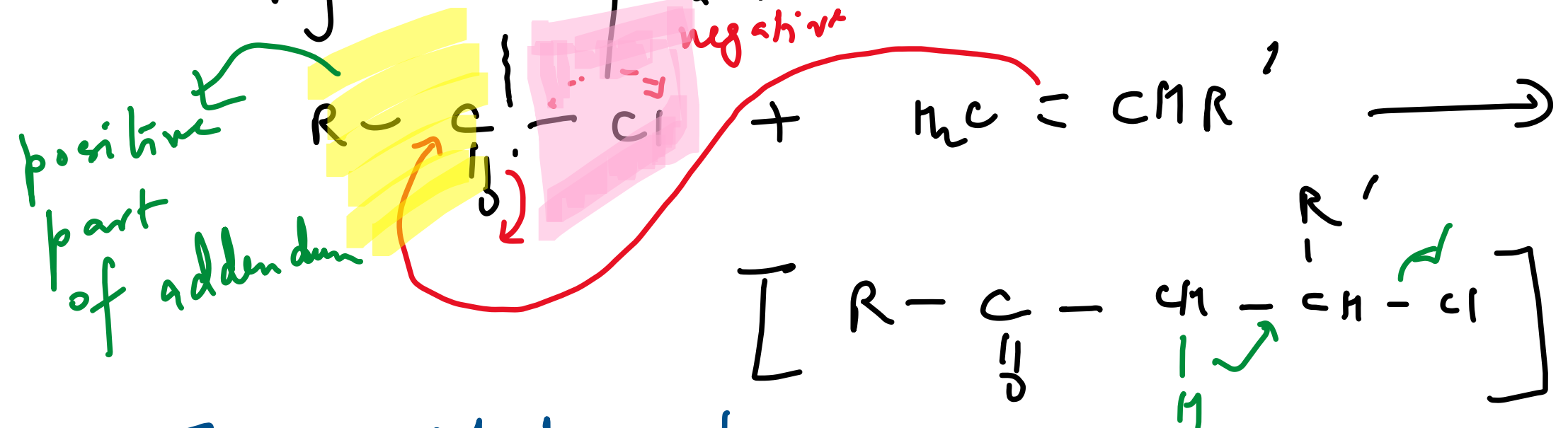


Cleaner reaction
(no mixture of
polyalkylated products are not formed)

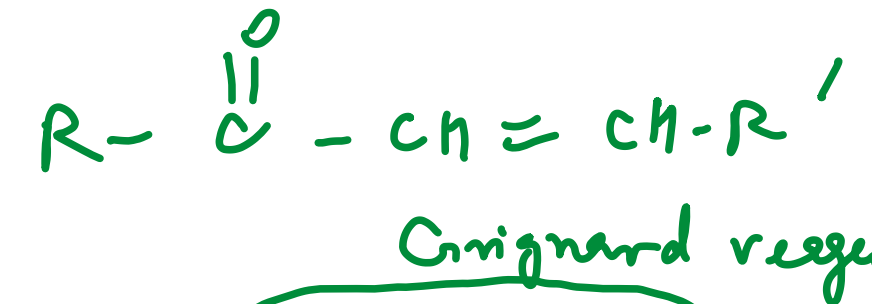
polyalkylated

products are not formed

c) Acylation of alkenes:



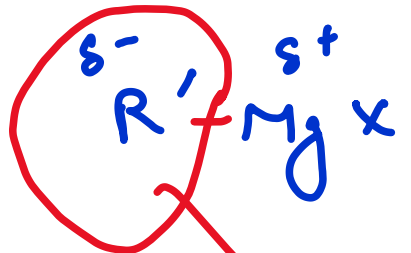
This is Markownikov addition initiated by $R-\overset{\oplus}{C}(=O)$, an acylium cation.



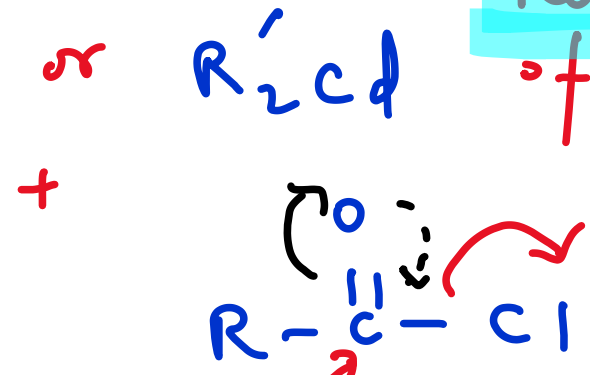
d) With organometallics -
organocadmium $\longleftrightarrow R_2R'Cd$



Reversal of priority



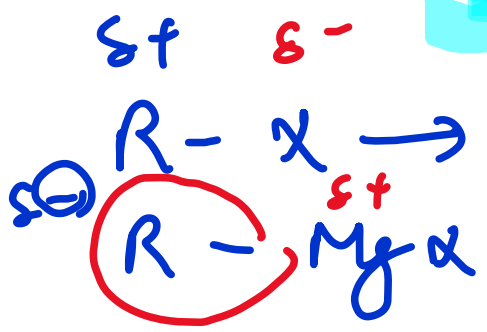
nucleophilic addition



synthetically very useful

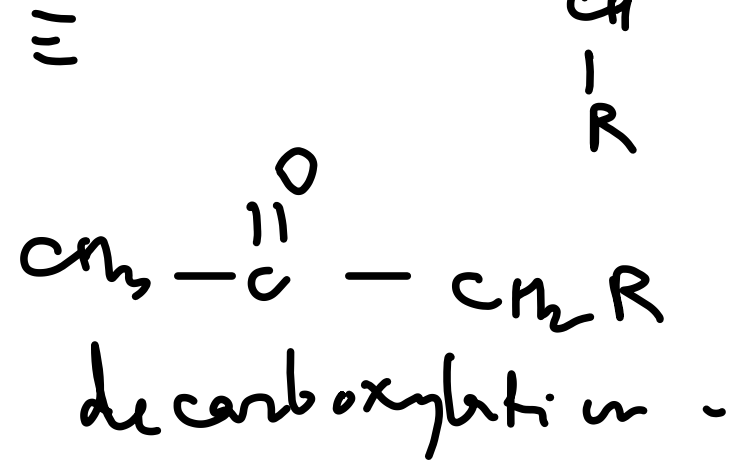
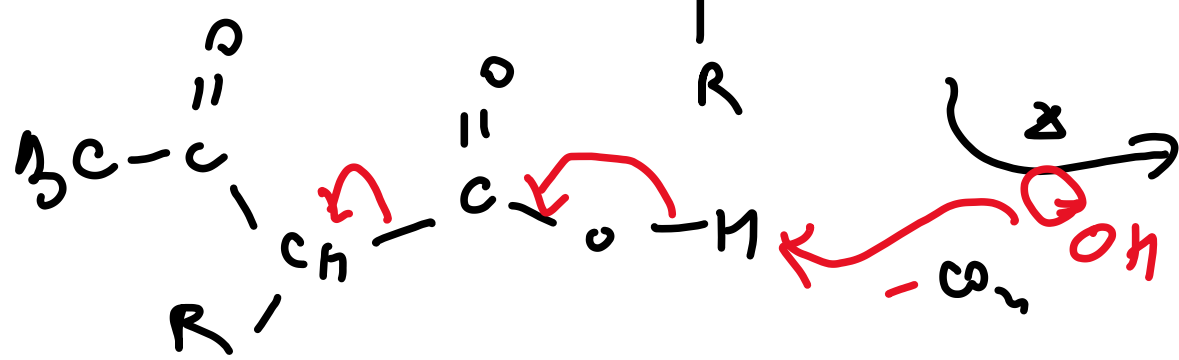
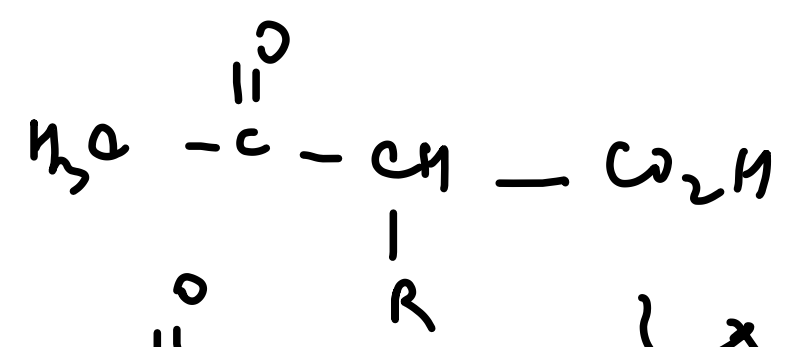
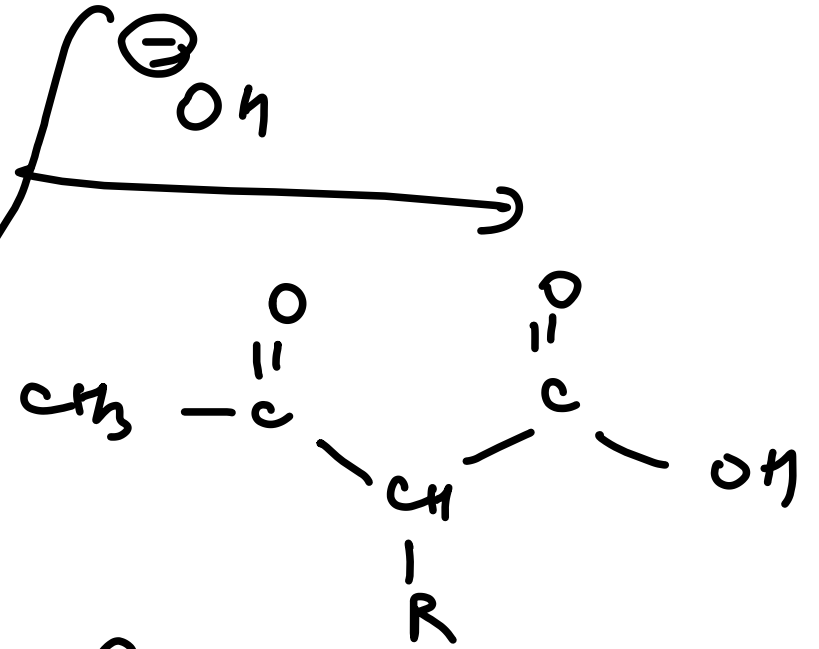
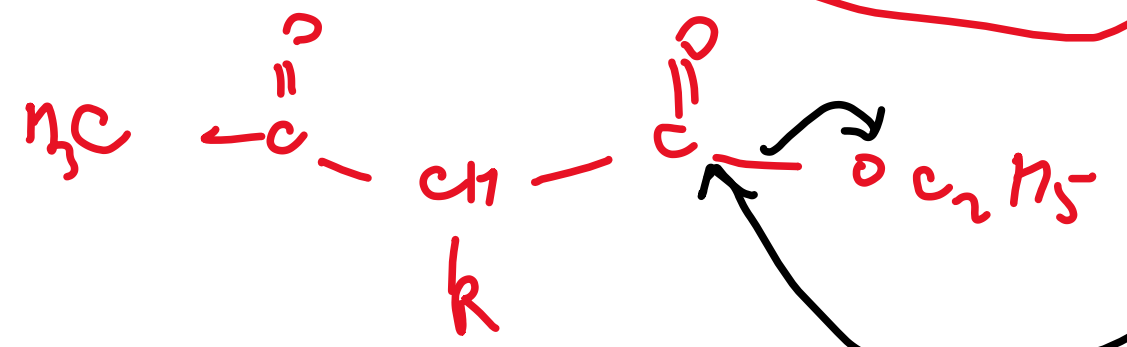
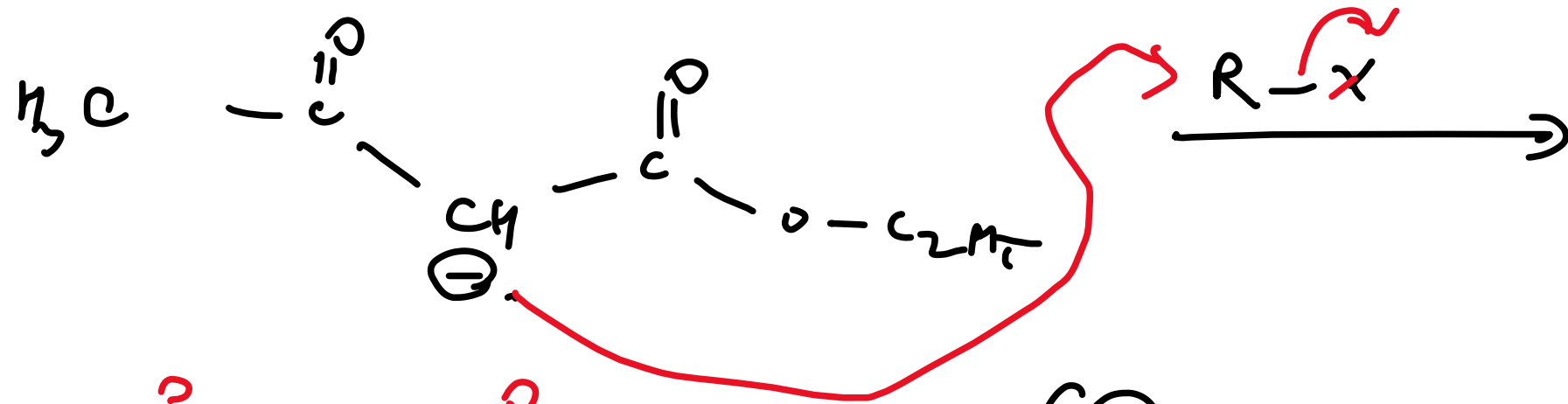


Unimproving



an aryl or primary alkyl group - R' must be

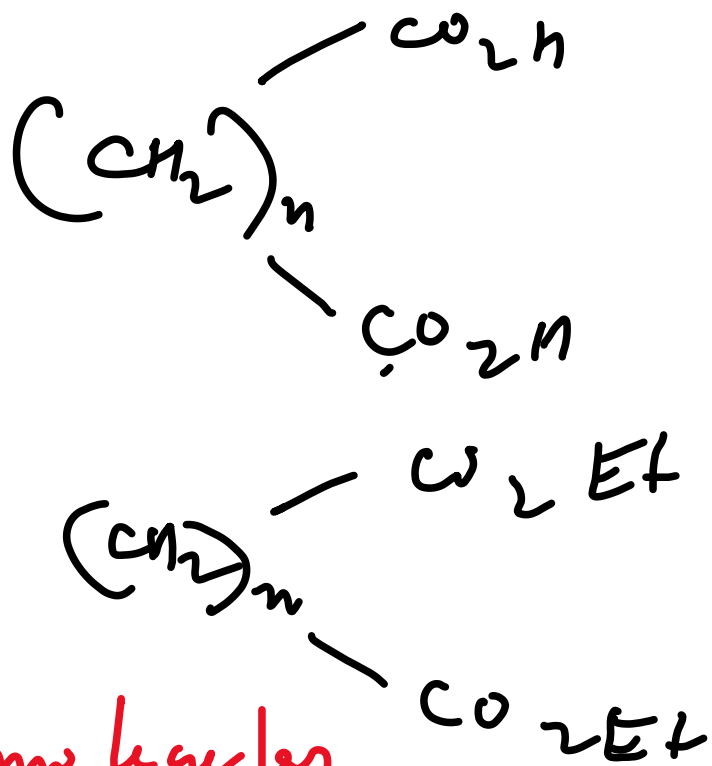
e) By heating the calcium salt of monocarboxylic acid other than formic acid.



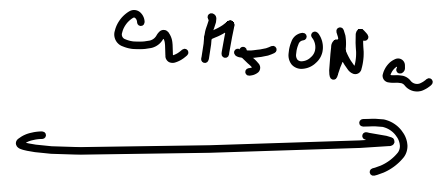
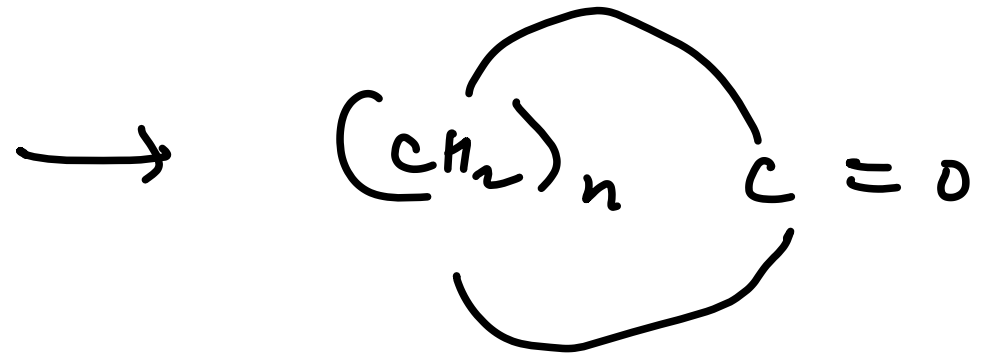
g) Ring ketones from dicarboxylic acids & their derivatives.

$n = 6, 7, 8$

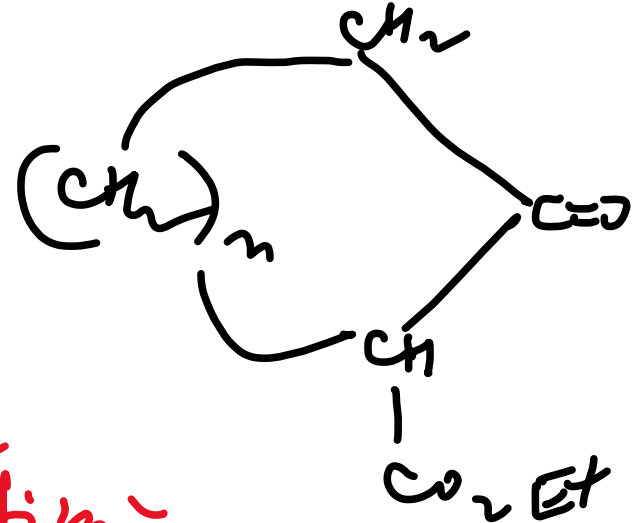
↓
Stable ring of 5, 6, or 7 C.

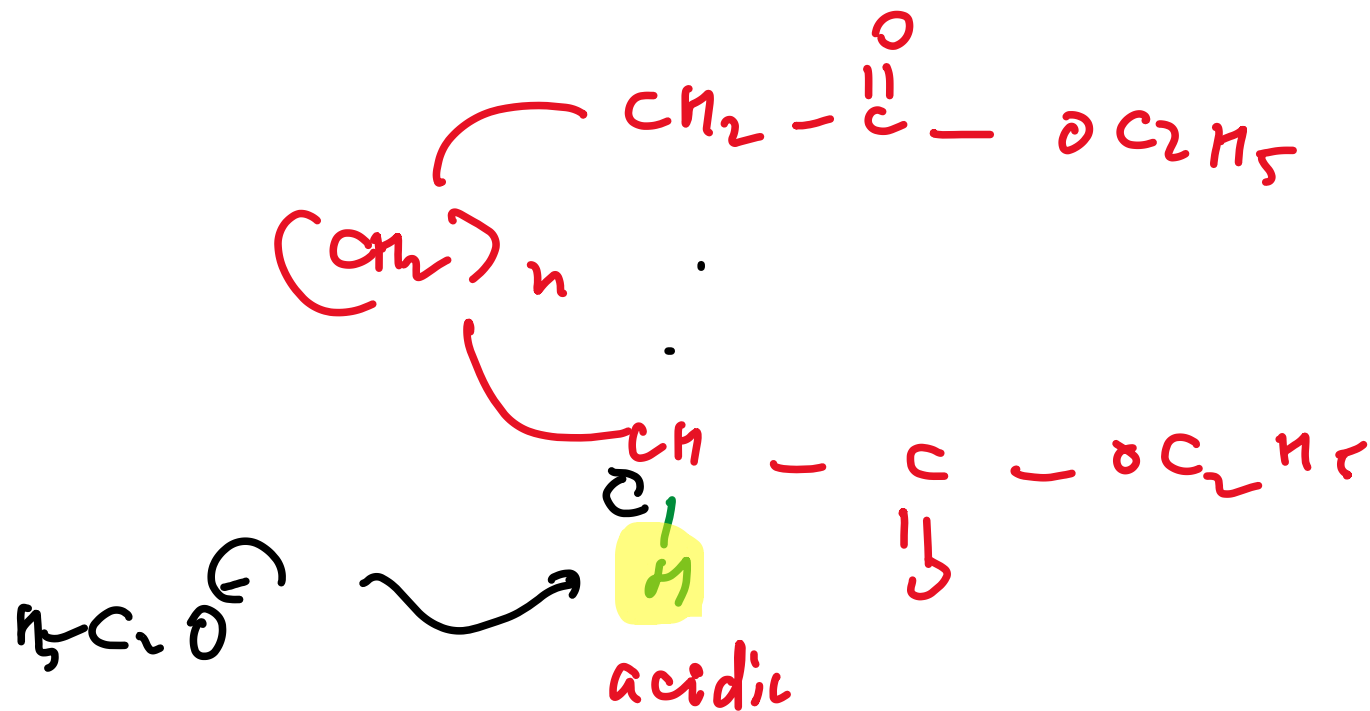


Intramolecular
Claisen condensation.



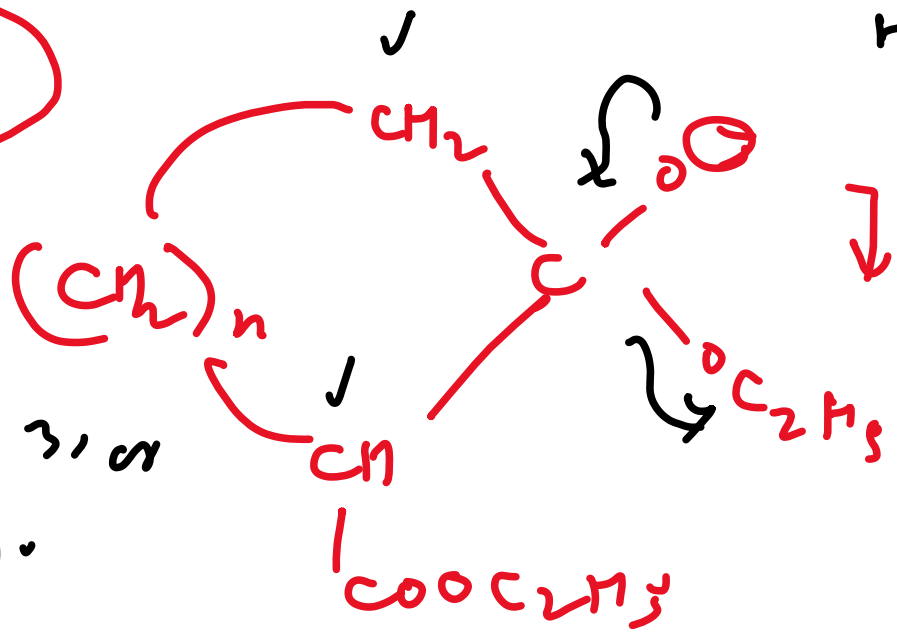
Dieckmann reaction.





Cyclic ketone

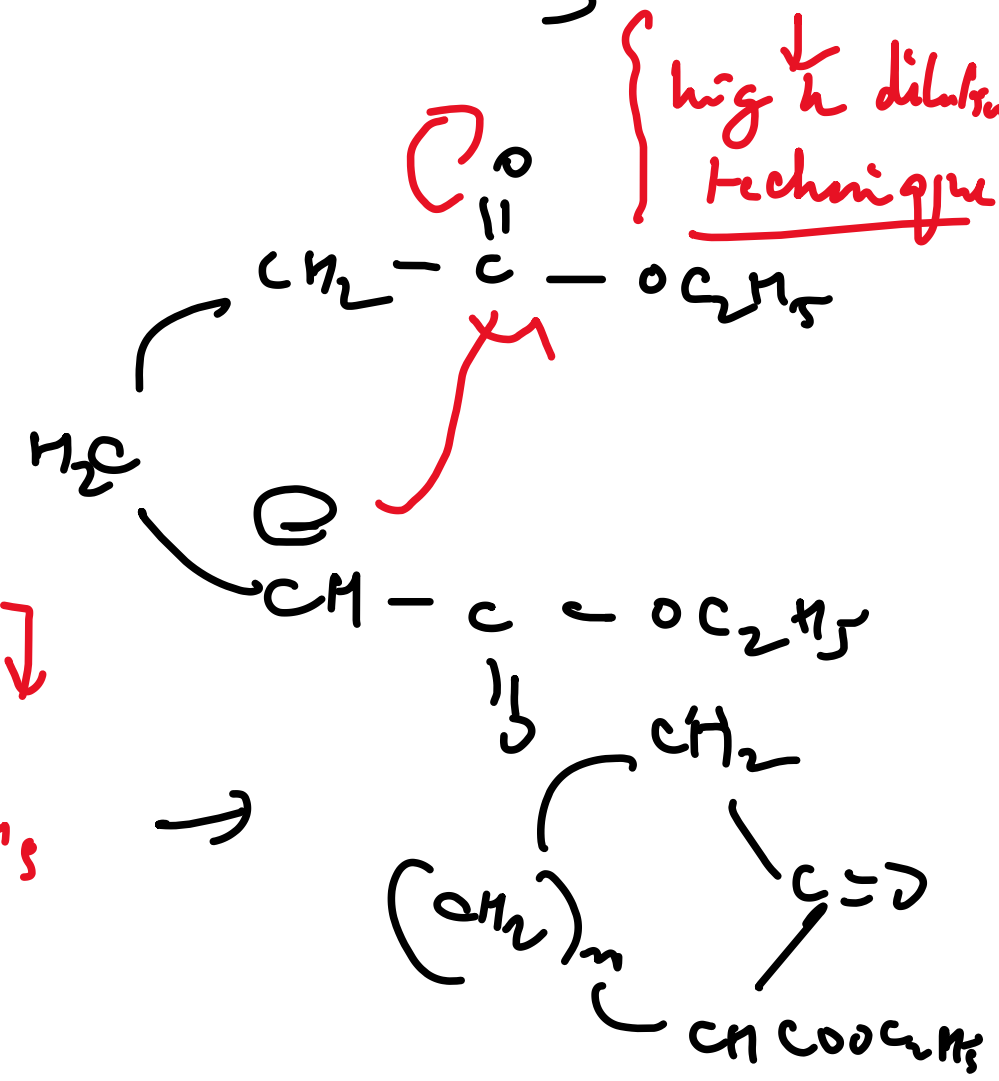
Where $n = 2, 3, \text{ or } 4$.



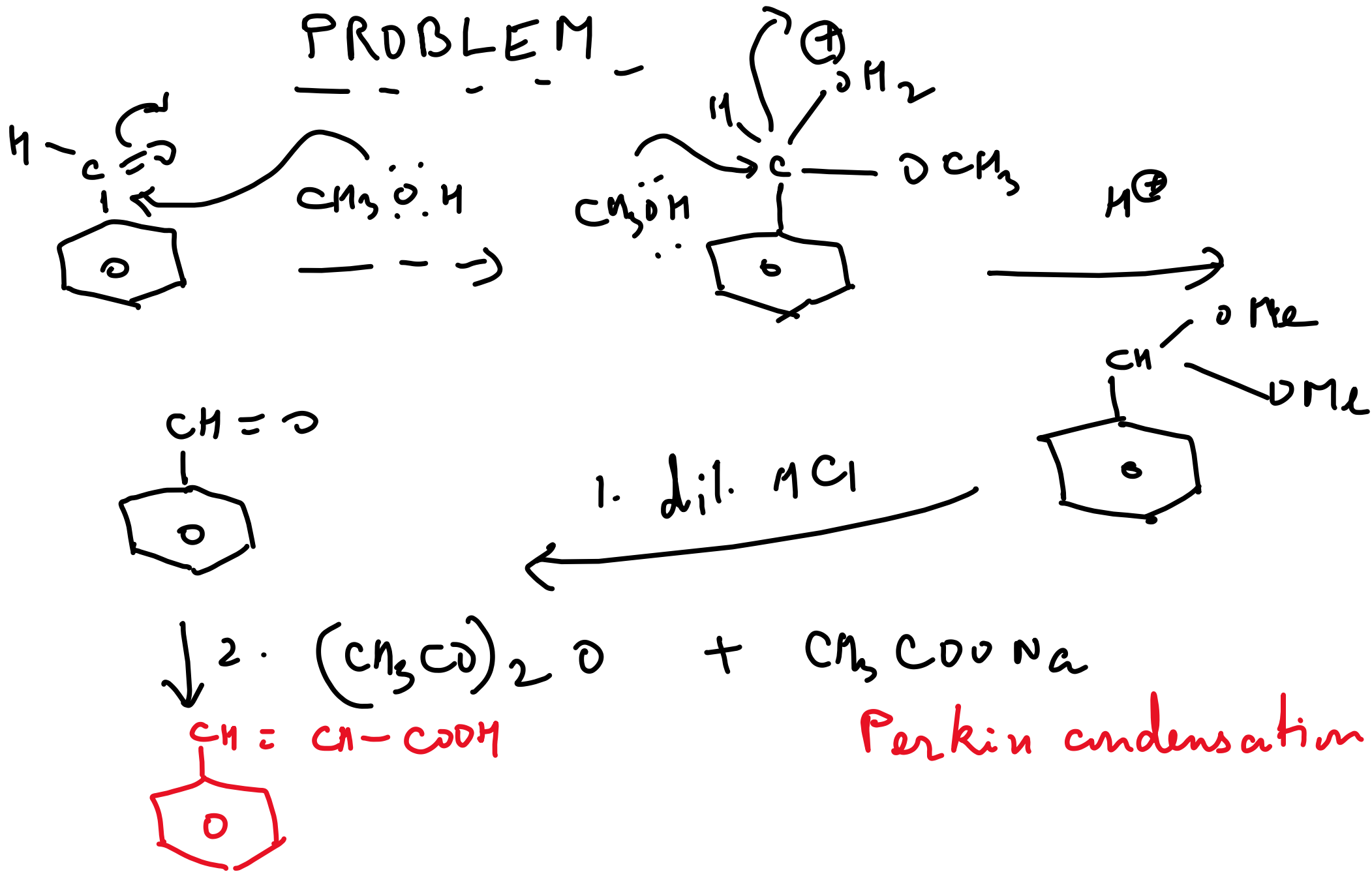
Yields for ring 9 - 12 C are very low

C_2H_5ONa

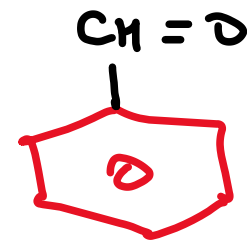
high dilution technique



PROBLEM



Mechanism of Perkin reaction (extension of aldehyde insertion)



Benzaldehyde

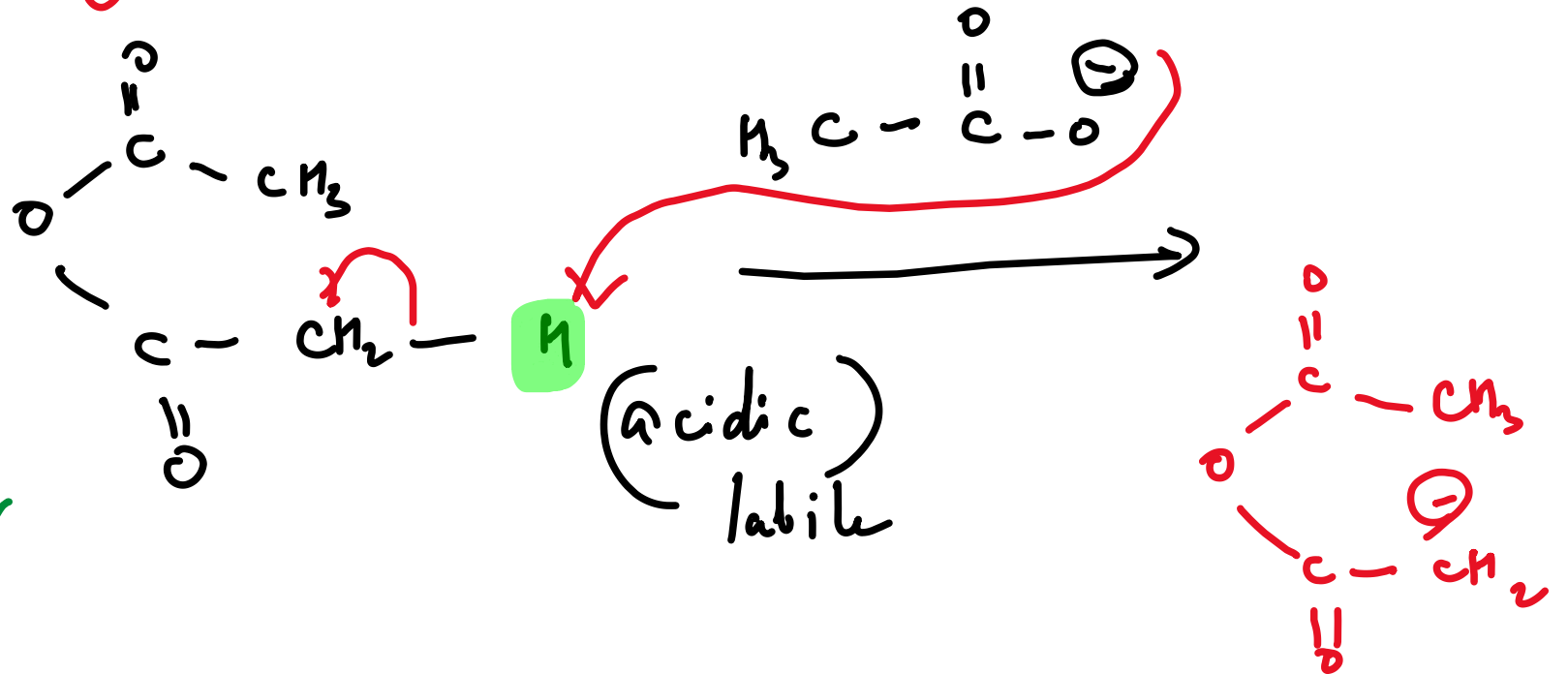


Cinnamic acid

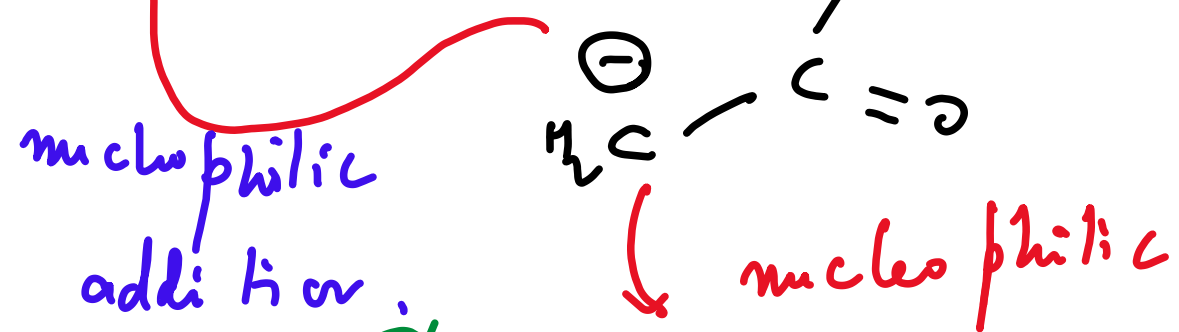
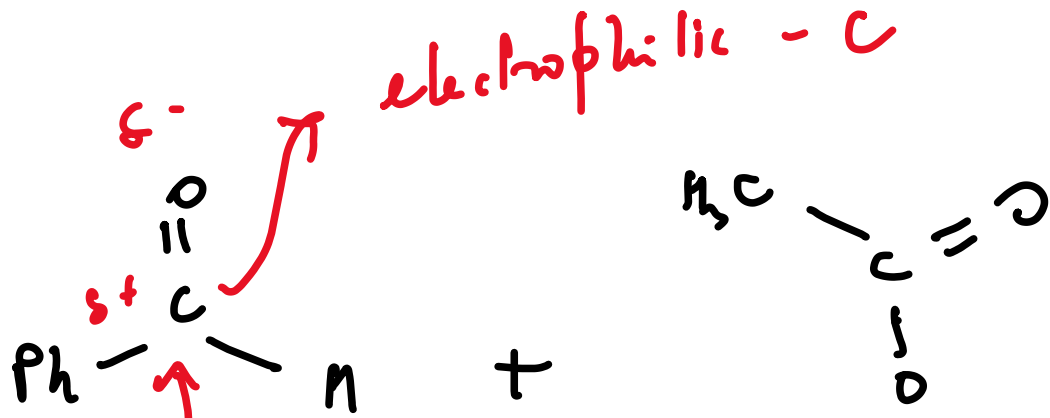
α, β -unsaturated acid.

Step I:

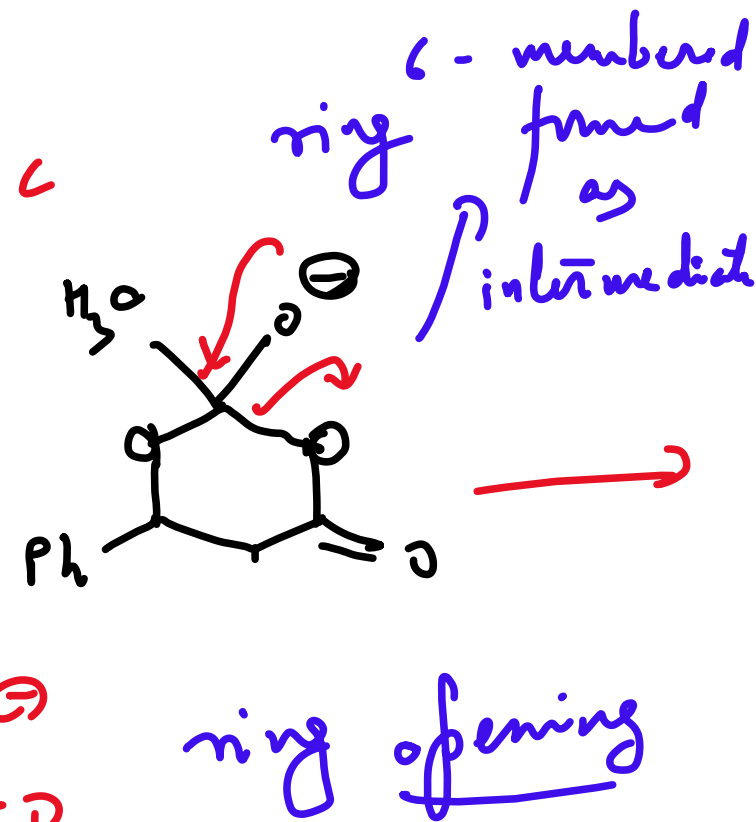
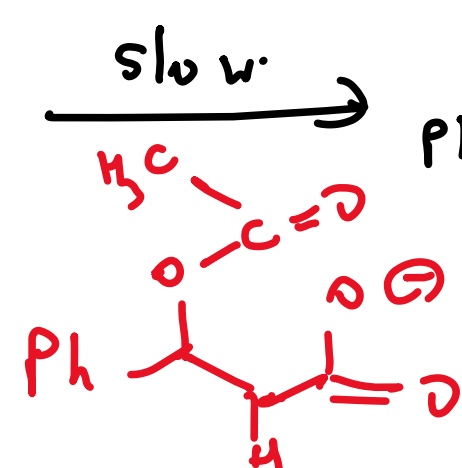
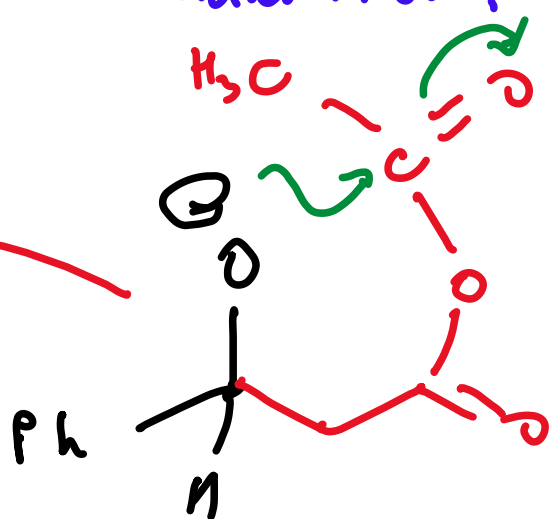
carbanion generation.



Step II: -



intramolecular nucleophilic addition



Step III :



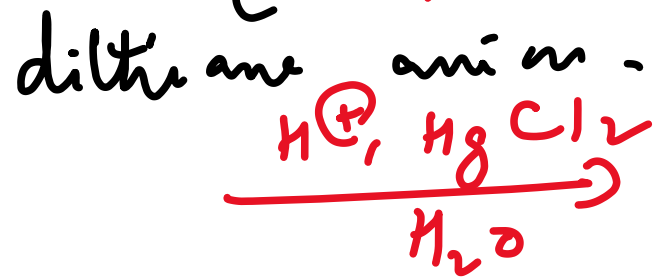
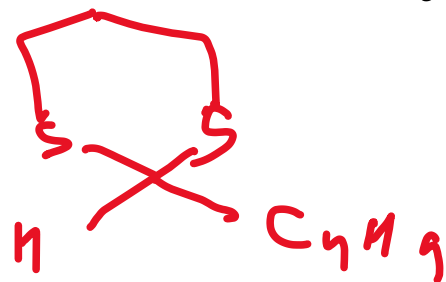
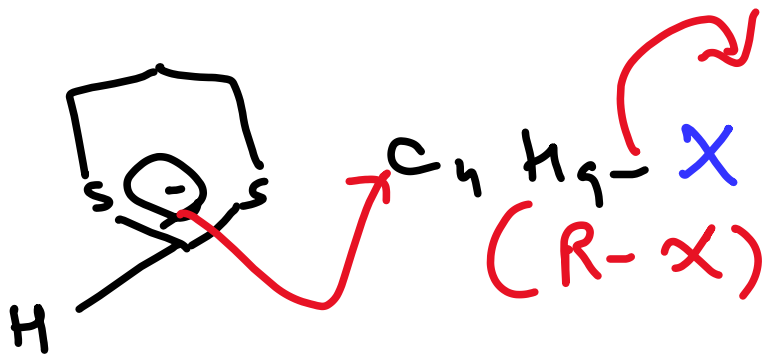
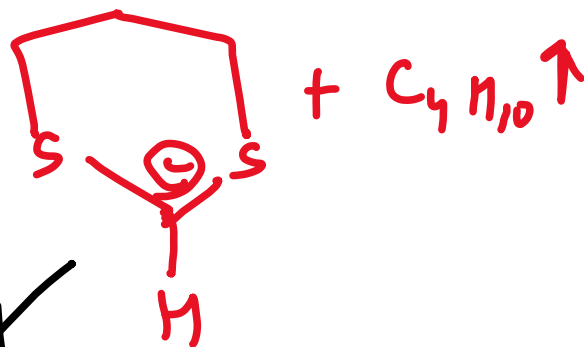
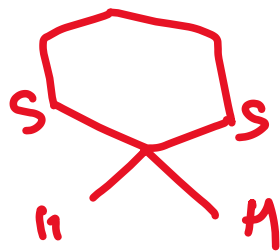
Aldol condensation of an aromatic aldehyde & an acid anhydride in presence of alkali salt of the acid -

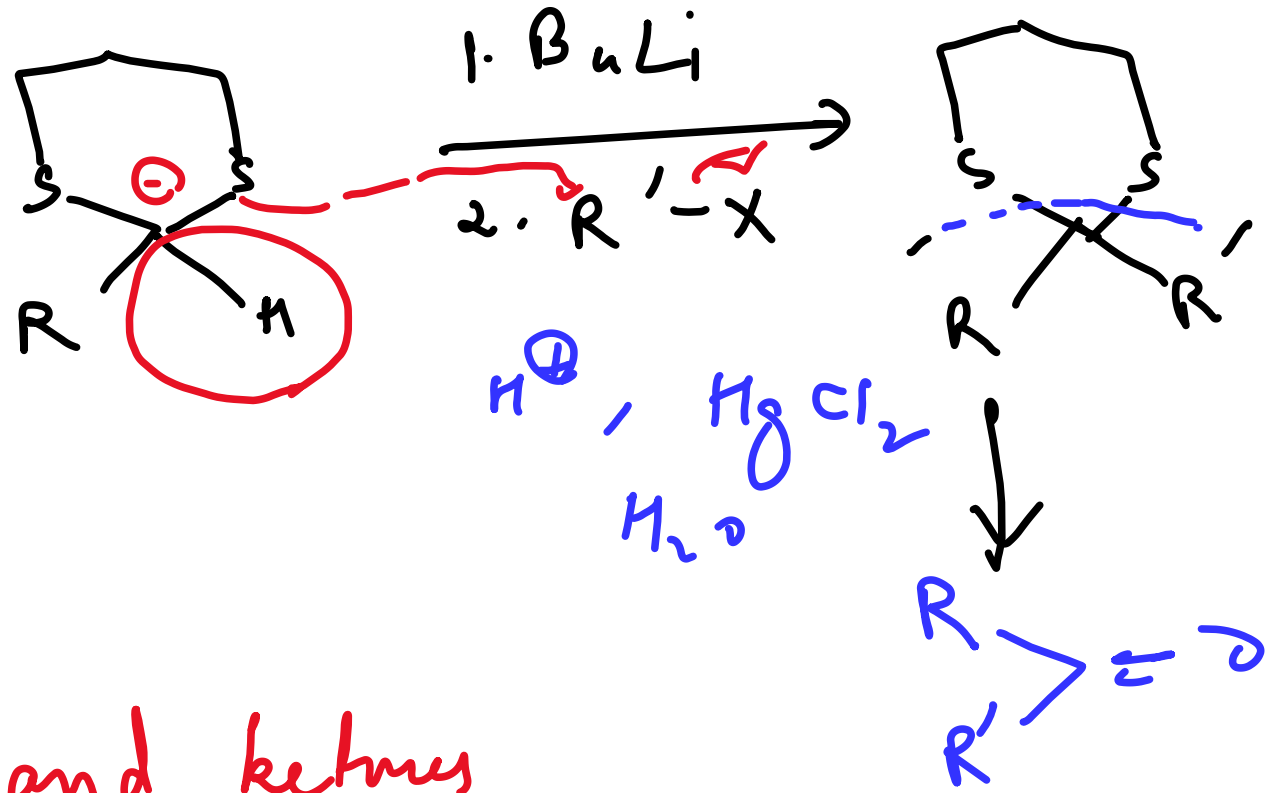
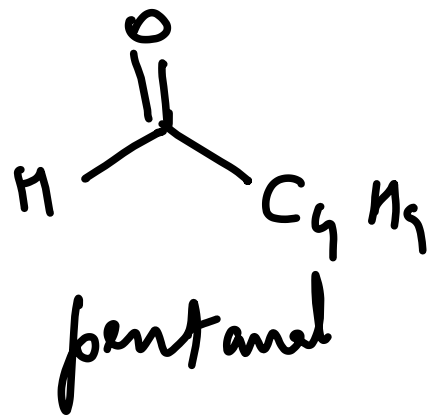
REVISION NOTES

Aldehydes, Ketones & Carboxylic acids

Synthesis of aldehydes & ketones using 1,3-dithianes -

n butyl lithium.



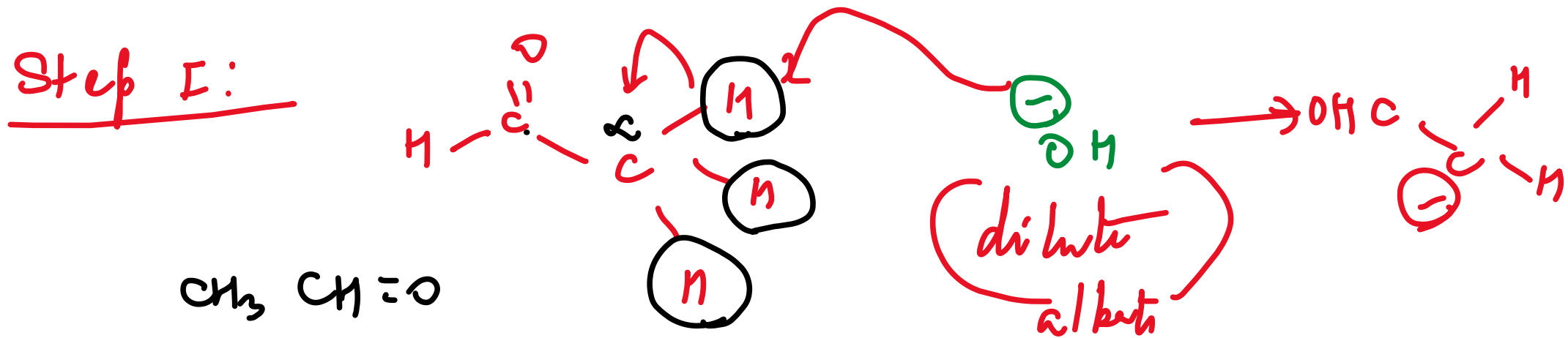
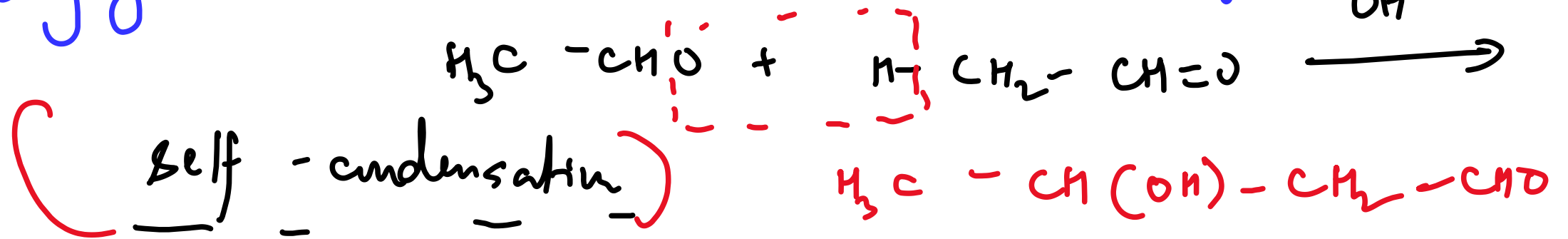


Thioacetal route

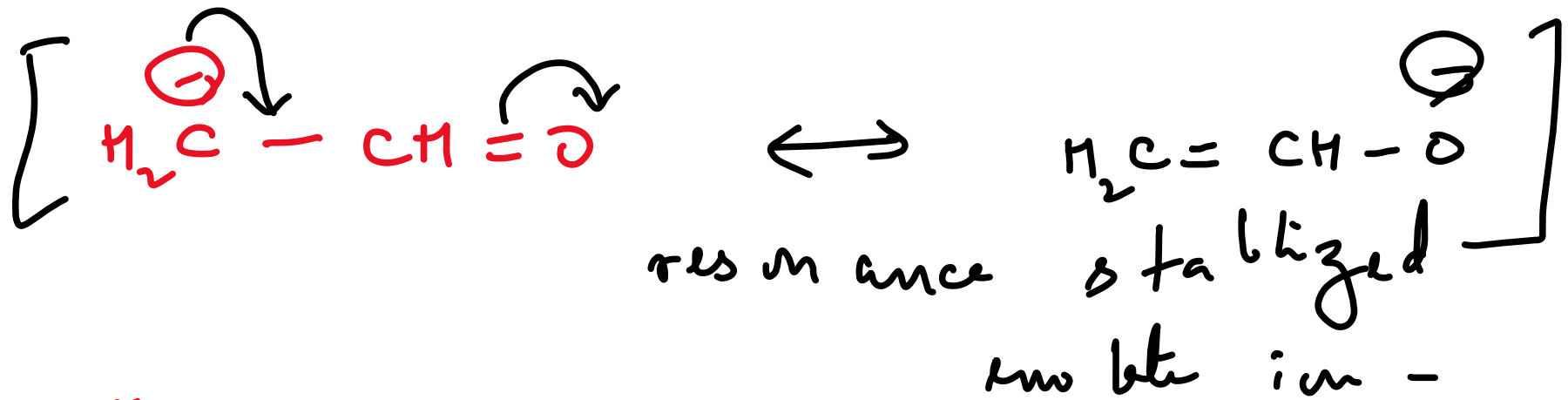
Reactions of aldehydes and ketones

- a) Aldol Condensation aldehydes with α hydrogen respond to aldol condensation
- b) Cannizzaro reaction - aldehydes & ketones having no α hydrogen atom responds.

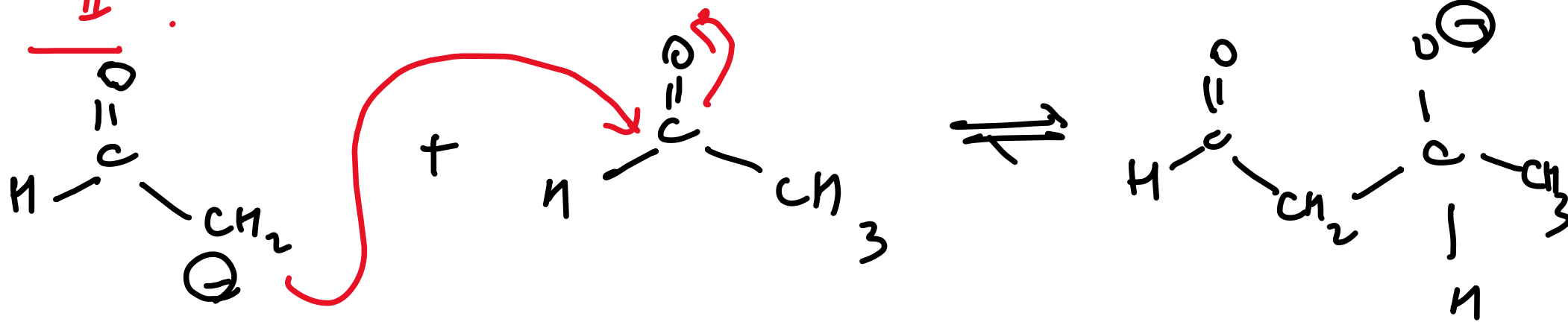
a) Aldol Condensation: An enolate ion reacts with another carbonyl compound to form a conjugate enone.



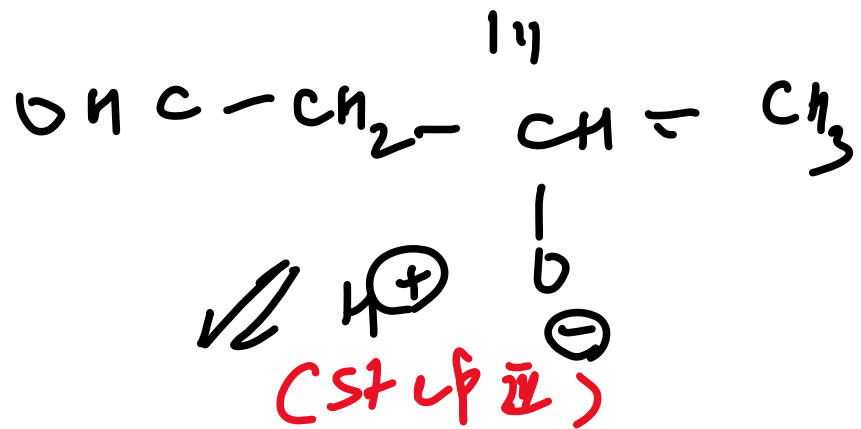
Deprotonation of the α -carbon to generate enolate ion



Step - II :

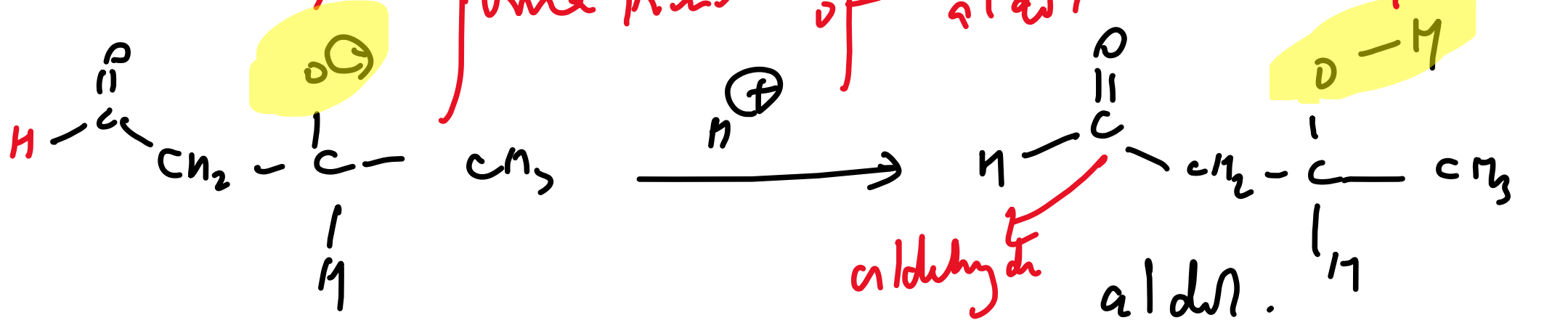


Nucleophilic addition of the enolate ion to the carbonyl group.

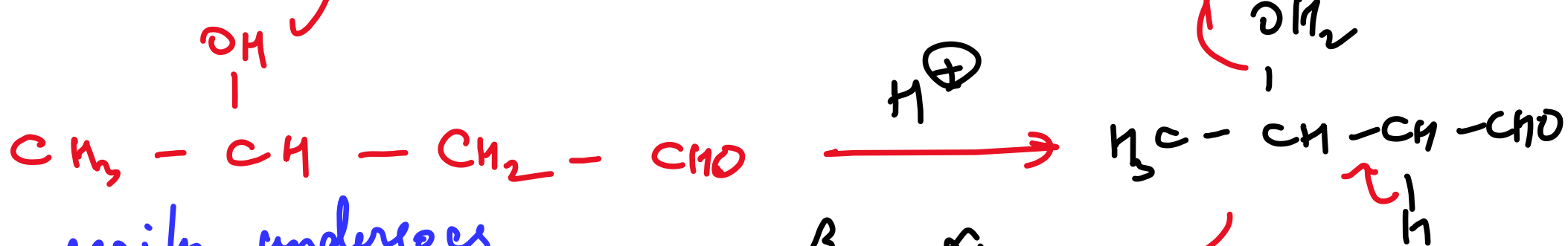


Step II:
intermediate

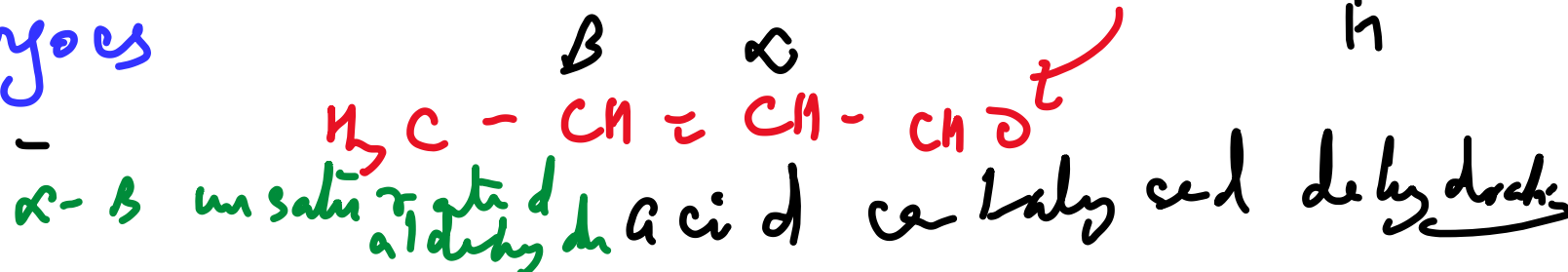
Protonation of the tetrahedral
formation of aldol -



aldehyde + alcohol = aldol.



aldol easily undergoes
dehydration

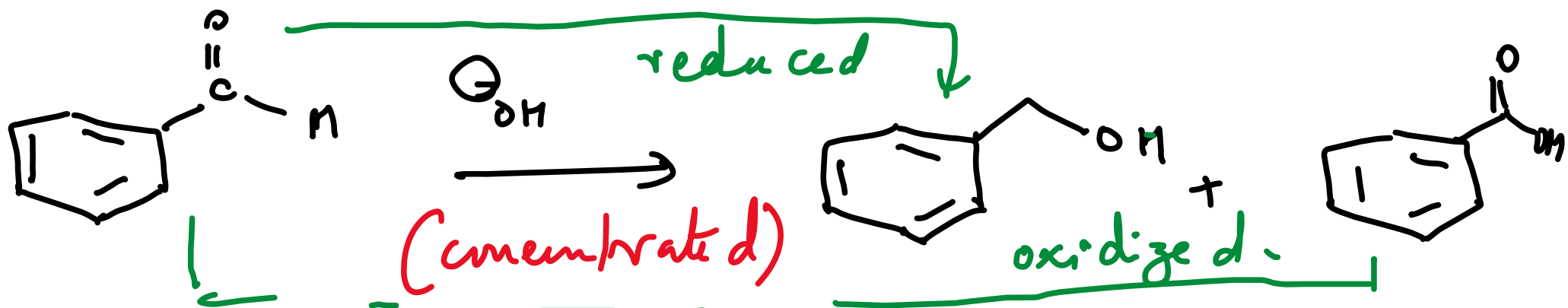


When aldol condensation occurs between same aldehyde or ketone, it is called self-condensation

When the reaction occurs betn. diff. aldehyde or ketone, it is called crossed-aldol condensation

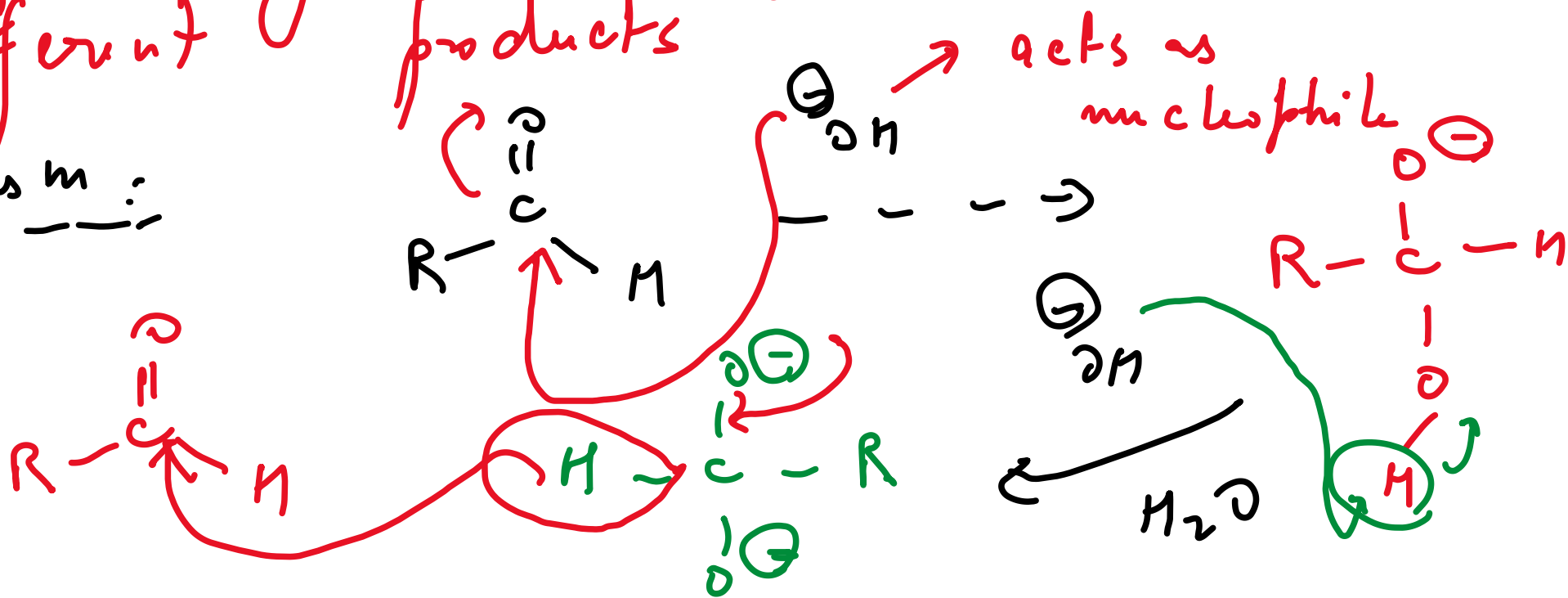
If a molecule has two carbonyl groups with at least one having α -hydrogen then intramolecular aldol reaction occurs.

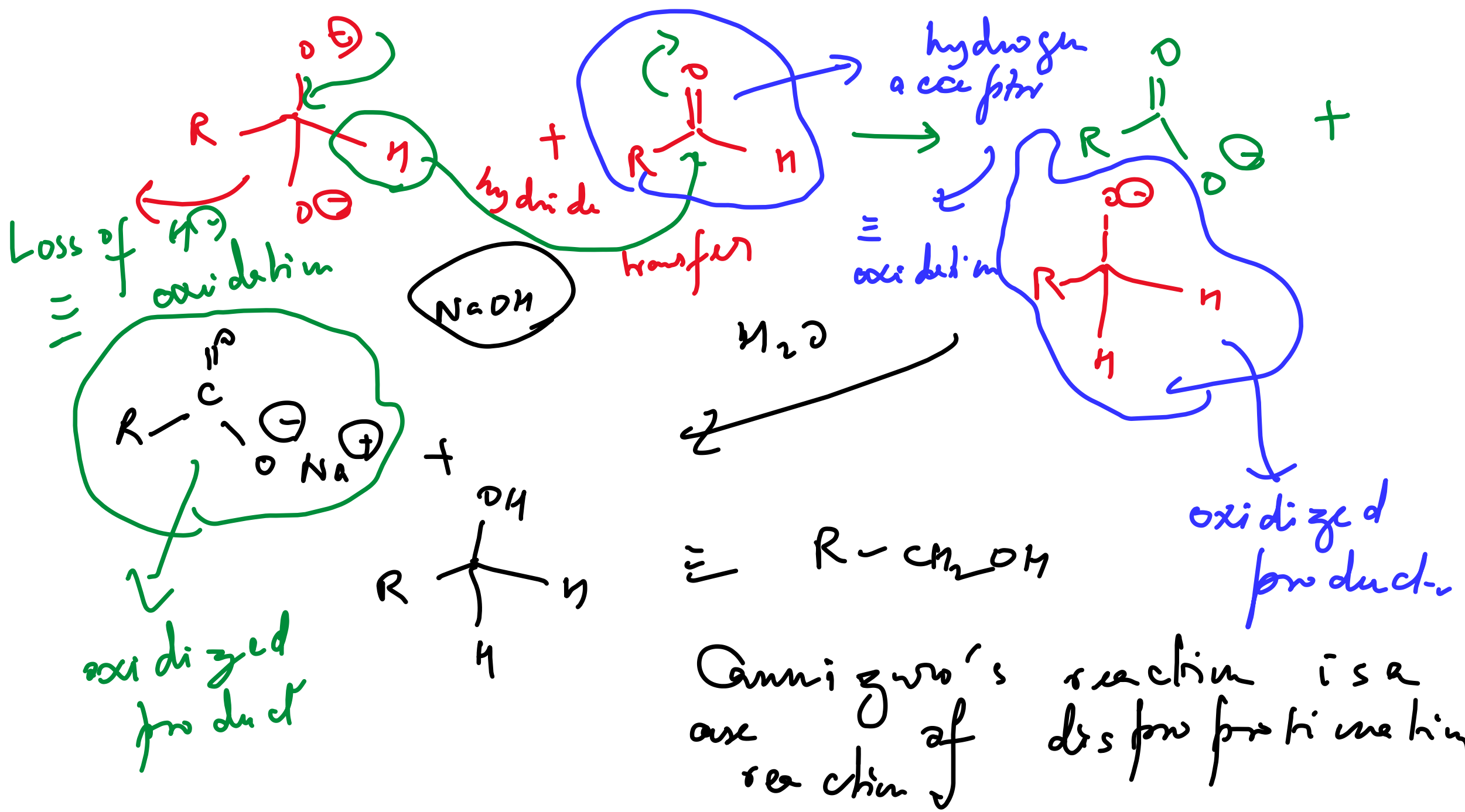
6) Cannizzaro reaction - - - Applicable to aldehydes & ketones having no α hydrogen



Case of disproportionation i.e. the same molecule gets oxidized & reduced to two different products

Mechanism:





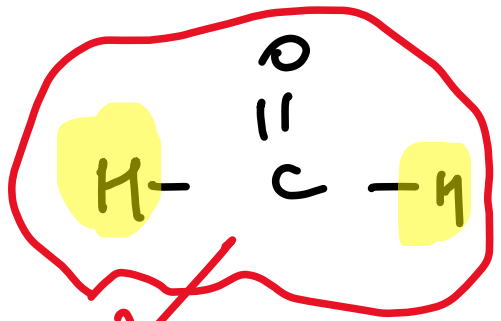
Aldol Condensation

- i) α - H necessary
- ii) Dilute alkali
i.e. milder condition
- iii) Nucleophilic addition
of enolate anion to
another $>C=O$
- iv) Condensation reaction

Cannizzaro reaction.

- i) No α -hydrogen -
- ii) Concentrated alkali
more harsh condition
- iii) Hydride transfer
from one carbonyl
compound to another -
- iv) Disproportionation
reaction -

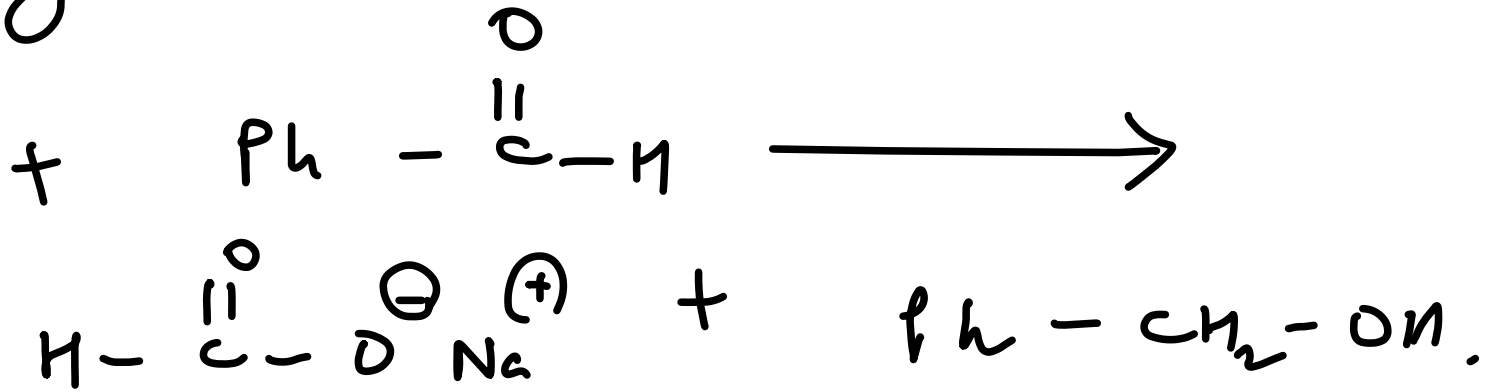
Crossed Cannizzaro reaction:



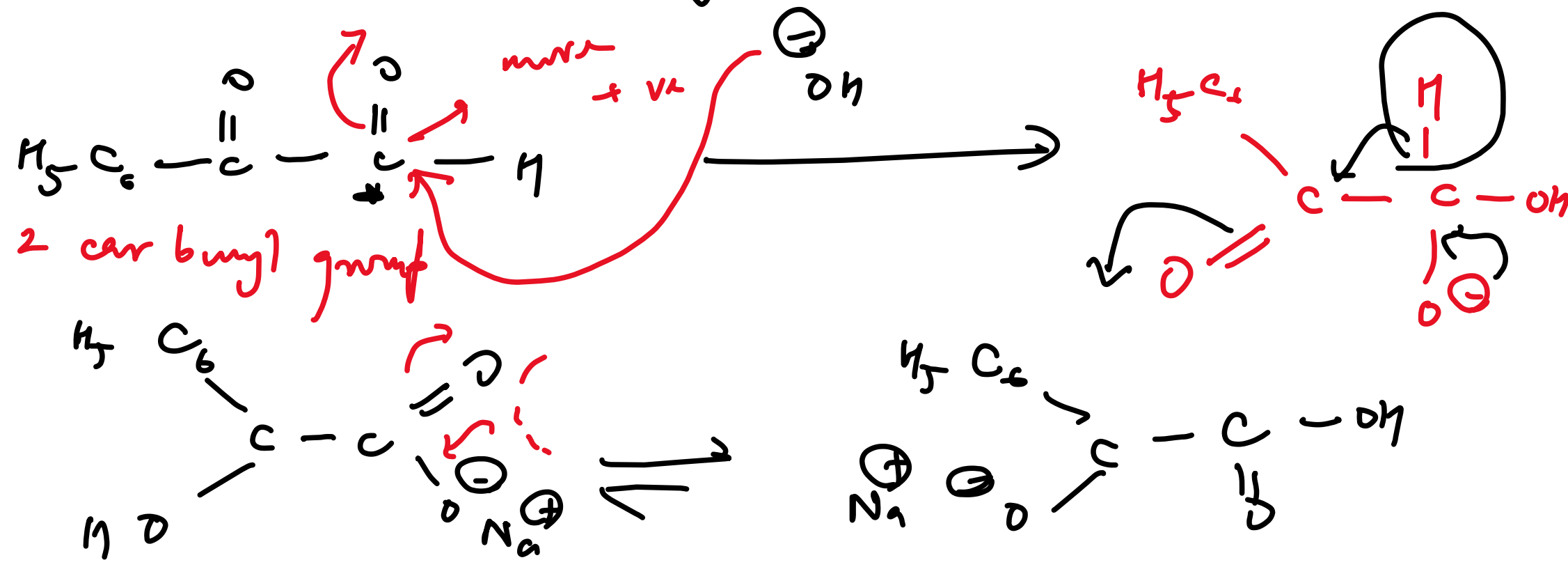
strong reducing agent

is more prone to oxidation as this is a better hydride (H^-) donor

In a crossed-Cannizzaro reaction where formaldehyde is involved it will preferably get oxidized to formic acid/formate anion-



Intramolecular Cannizzaro reaction.



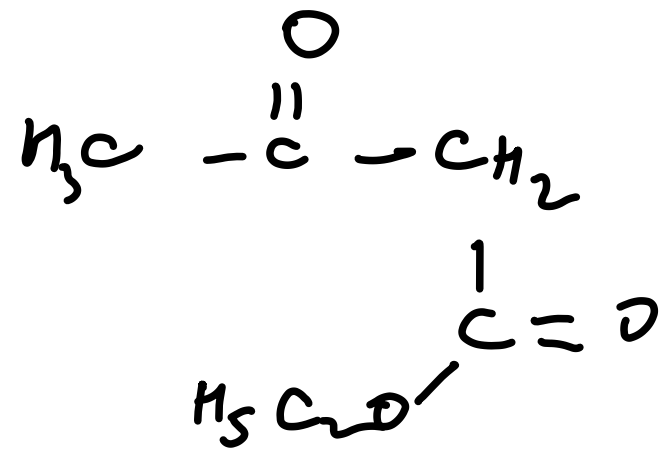
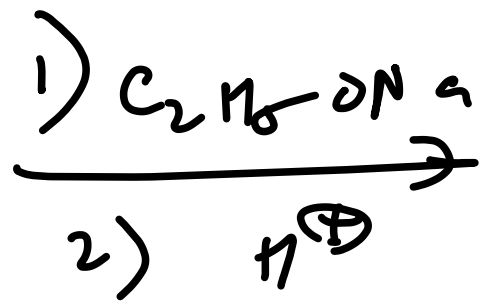
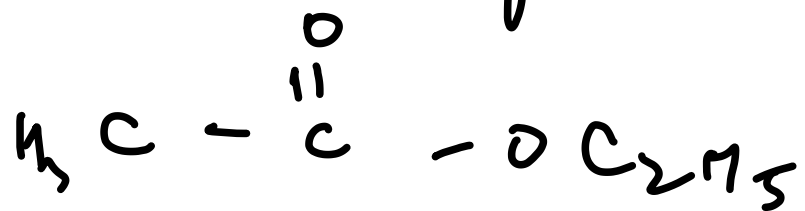
OH^- will attack more electrophilic carbon.

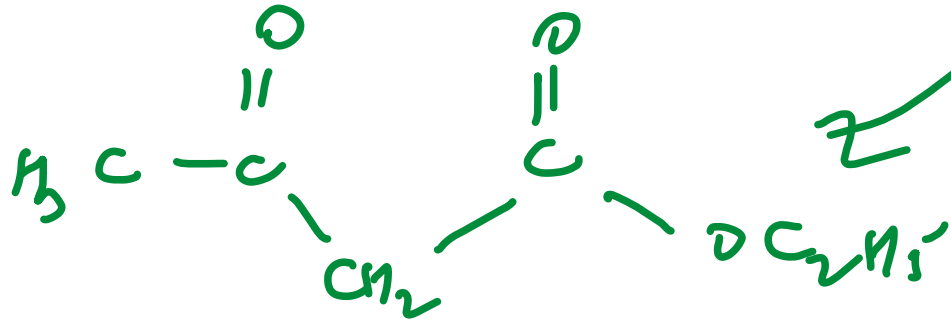
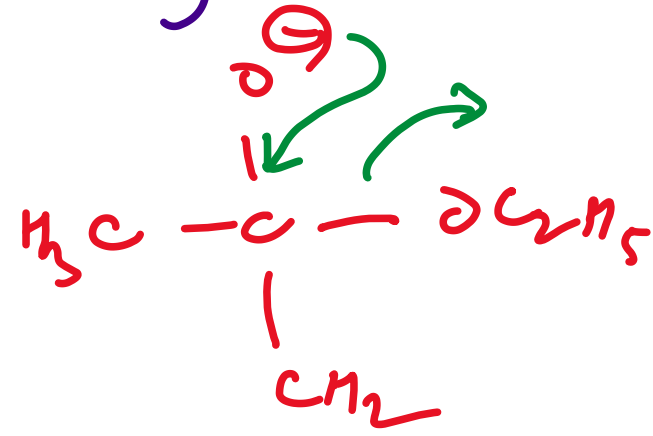
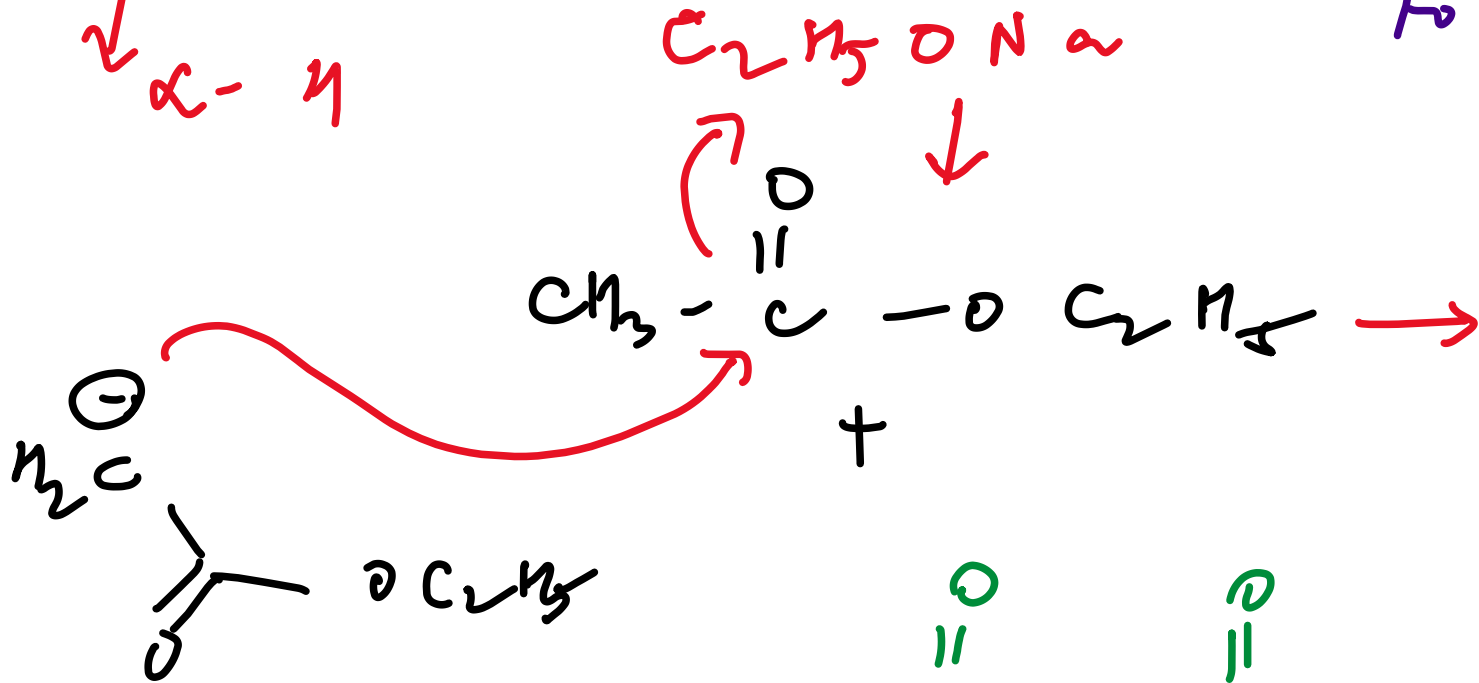
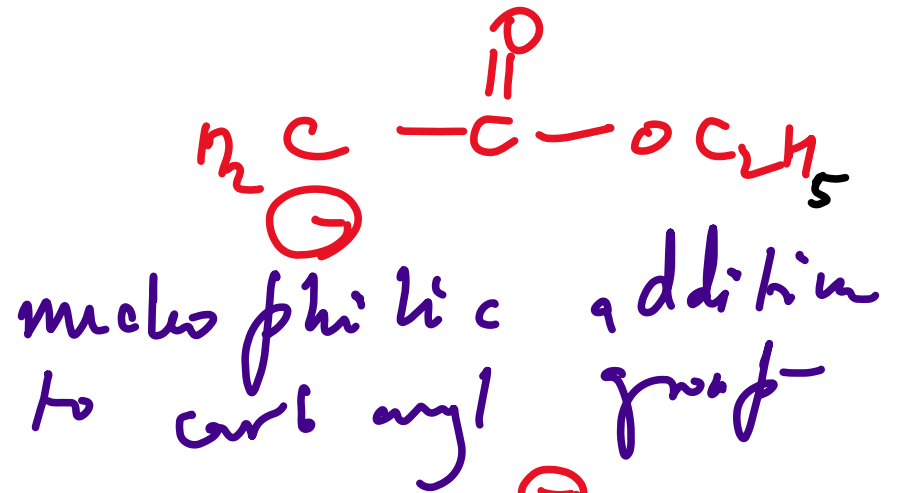
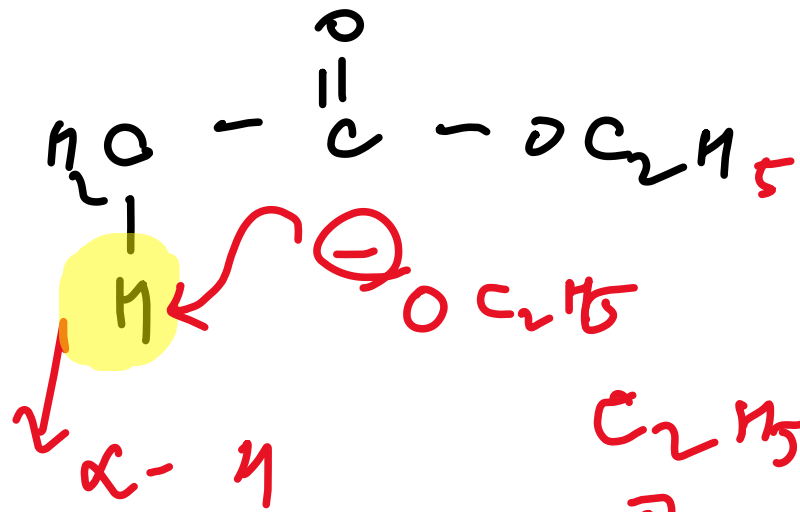
c) Formation of keto esters-

Claisen condensation

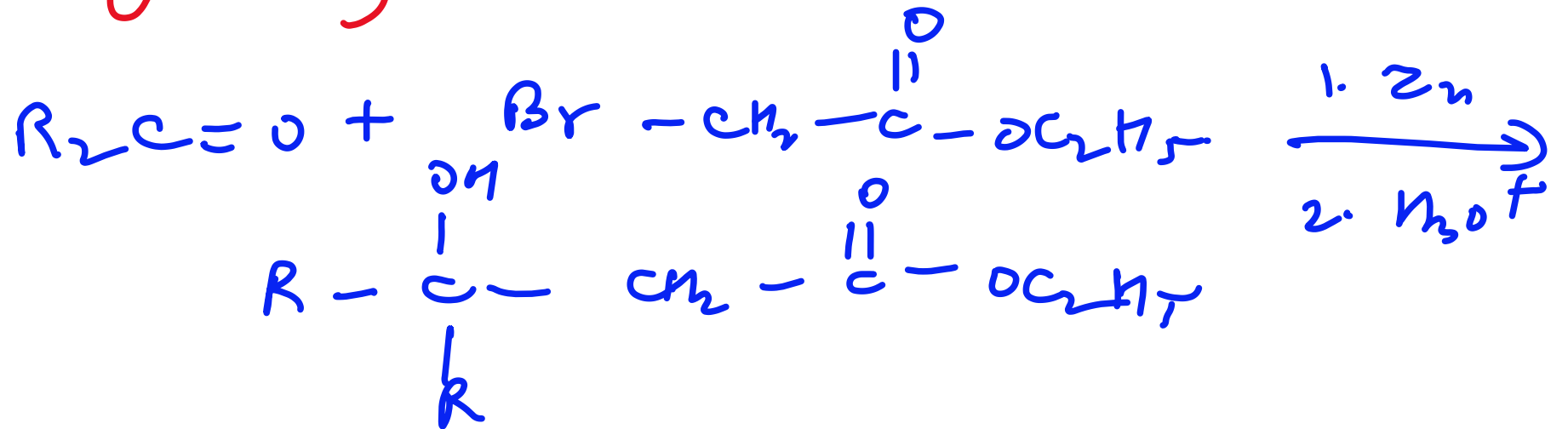
Esters having an α -hydrogen on treatment with a strong base e.g. C_2H_5ONa undergoes self condensation to produce β -keto esters.

extension of aldol reaction





d) Reformatsky reaction In this reaction a halo-ester, usually an α -bromo ester reacts with an aldehyde or ketone in the presence of Zn metal to produce β -hydroxy ester



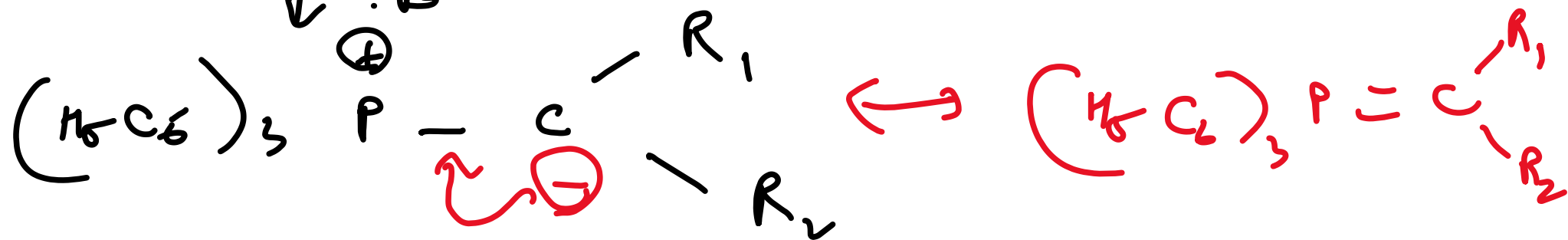
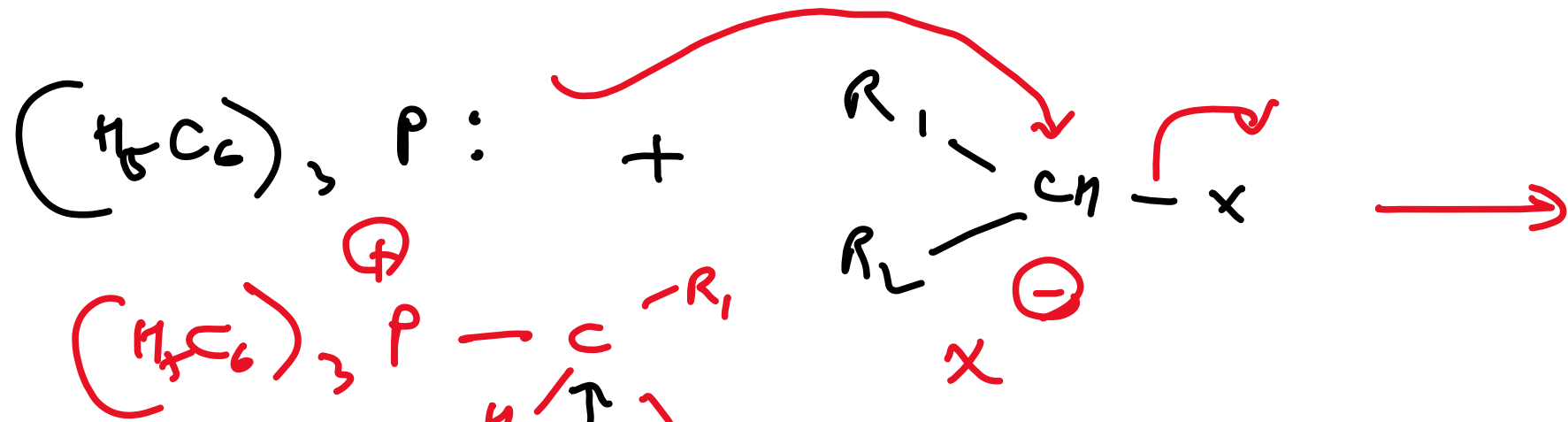
f)

Wittig Ylide Reaction

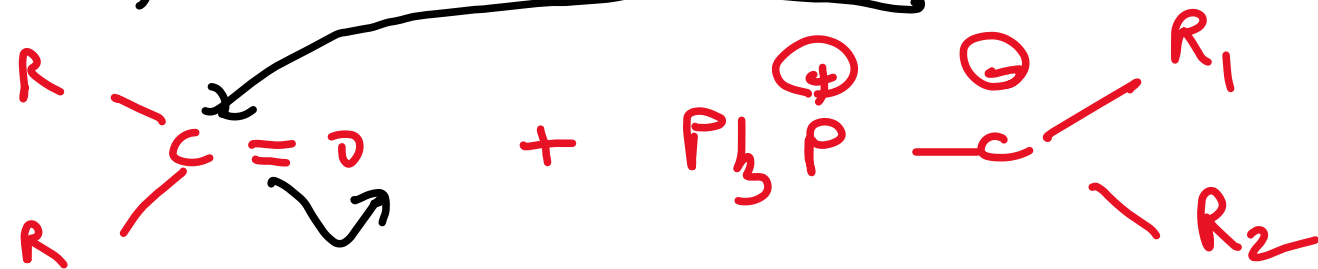
Aldehyde & ketones react with phosphorous ylides to yield alkenes & triphenyl phosphine oxide.

An ylide is a neutral molecule bearing a negative carbon adjacent to the hetero atom. Phosphorous ylides are also called phosphoranes.

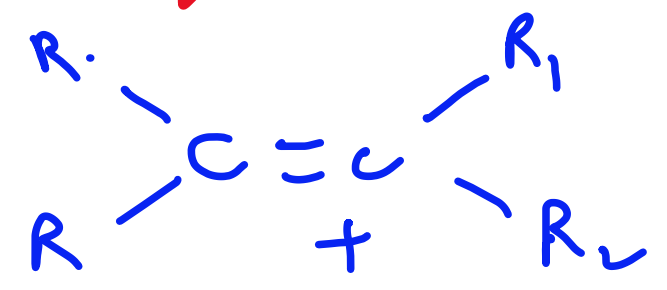
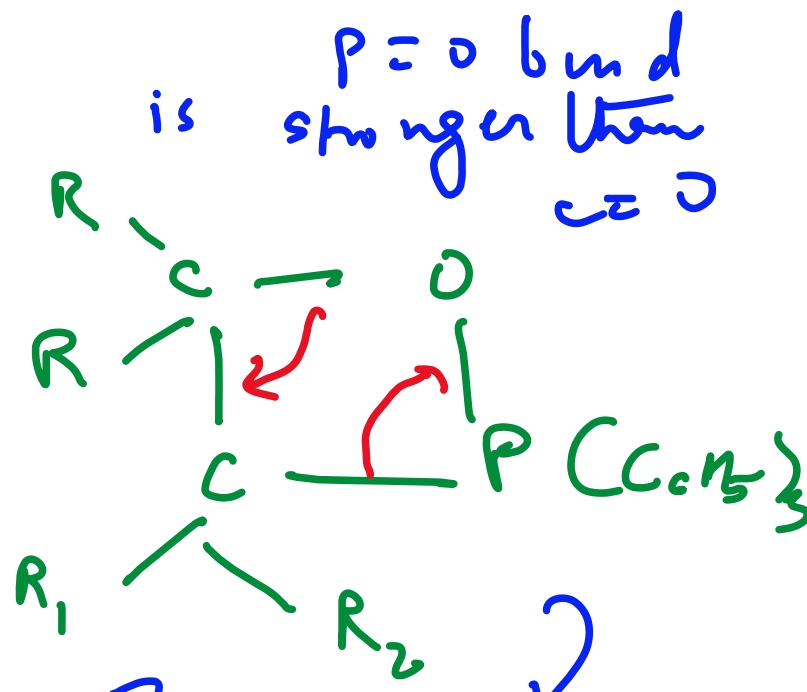
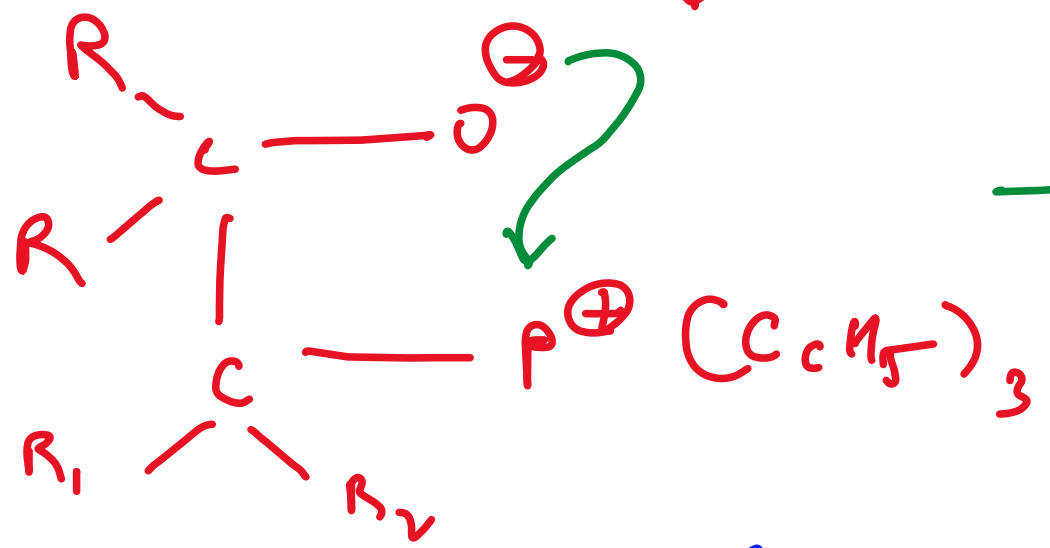
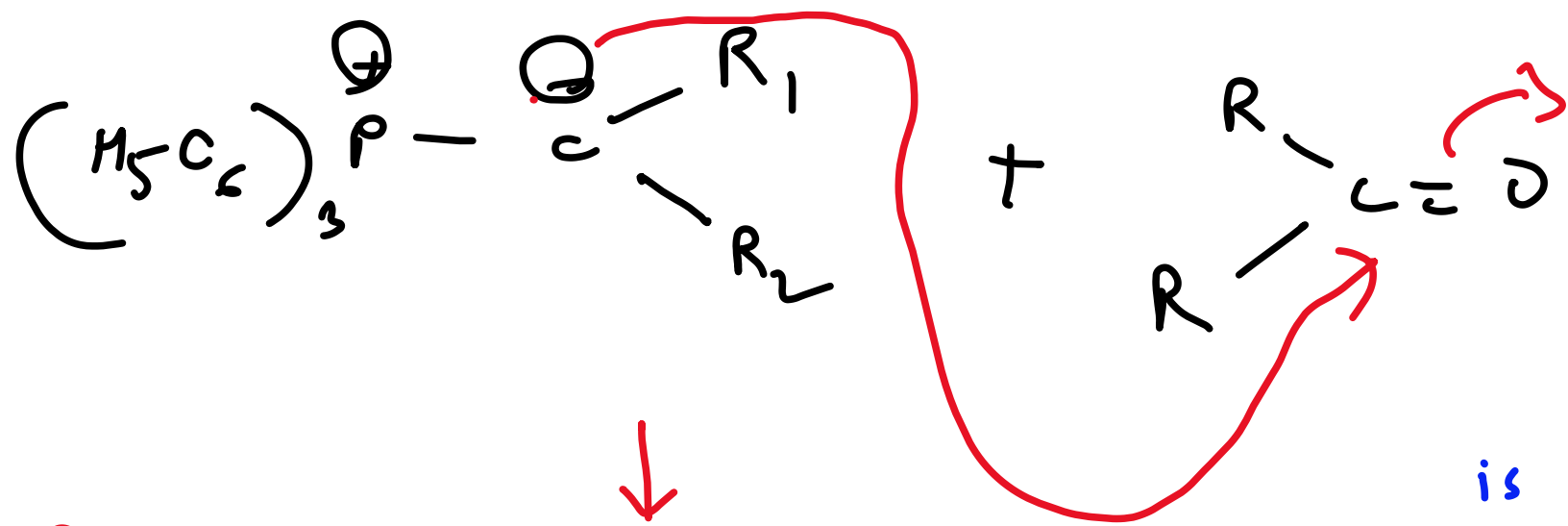




Reaction of Ylide with $>\text{C}=\text{O}$



nucleophilic addition of ylide.



2
 Cleavage occurs like this

REVISION NOTES

Carbonyl Compound

Aldehydes, Ketones & Carboxylic acids

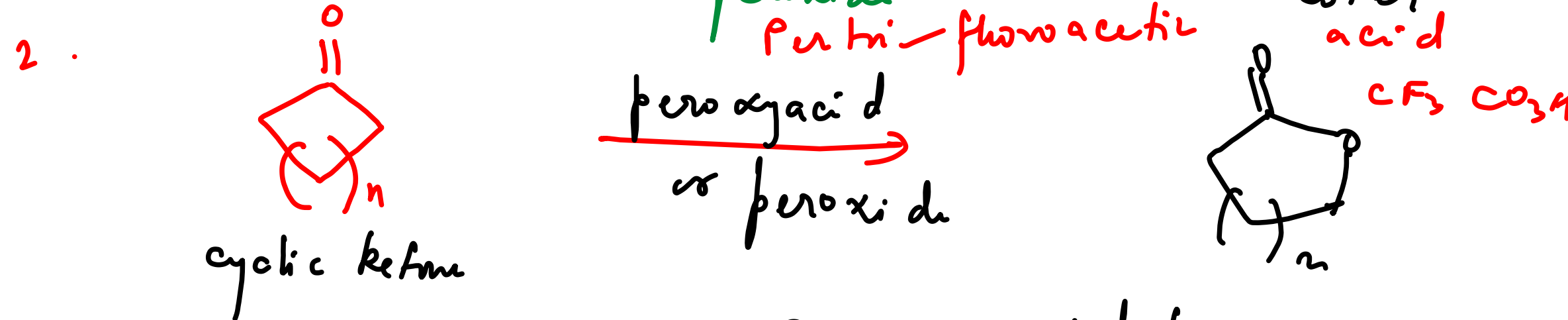
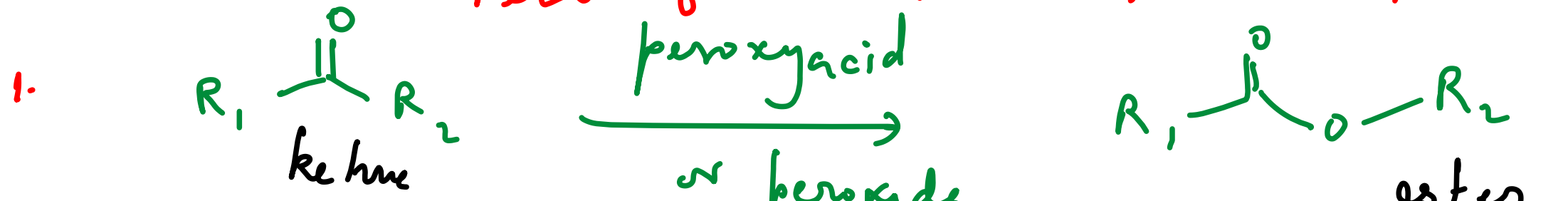
Bayer Villiger Oxidation

Adolf von Baeyer
Victor Villiger
1899

Organic reaction that forms an ester
from ketone or a lactone from cyclic ketone

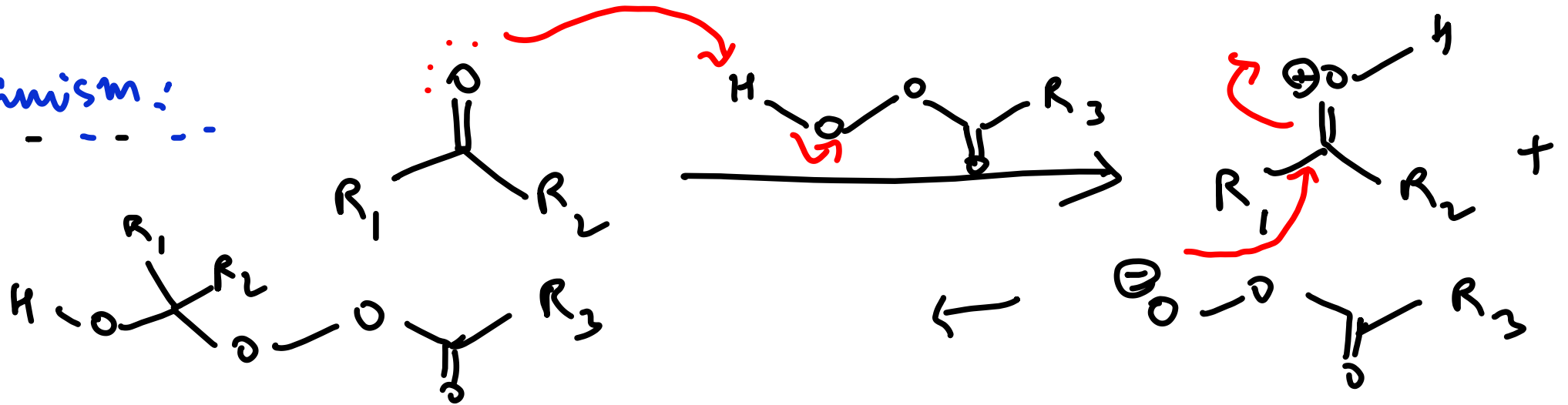
Reagent: Peroxy acids, Peroxides are
used as oxidant.

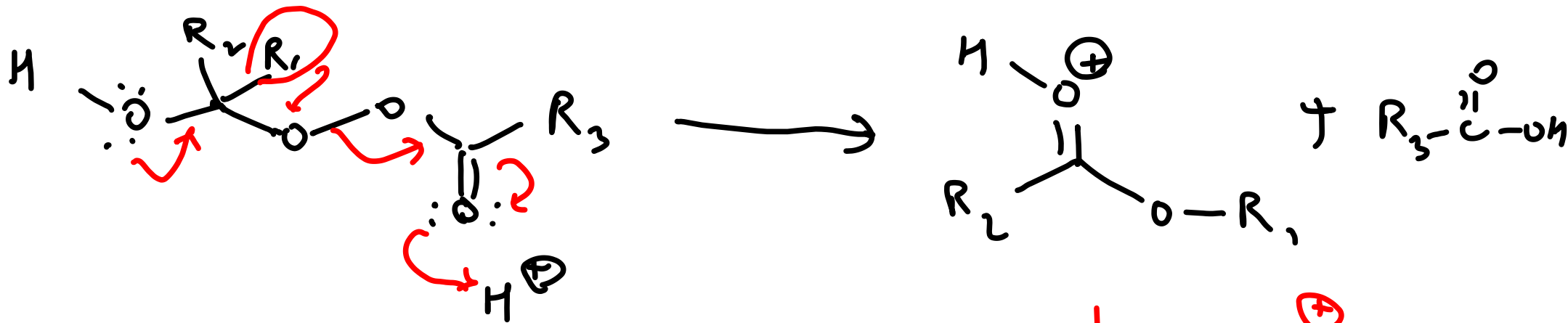
Perbenzoic acid. $C_6H_5-C(=O)-O-O-H$



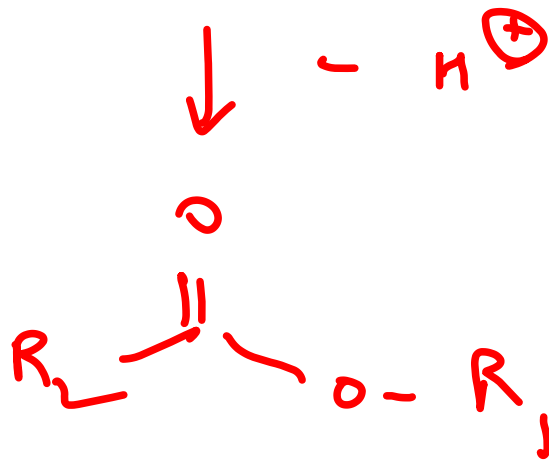
B. v. oxidation.

Mechanism:





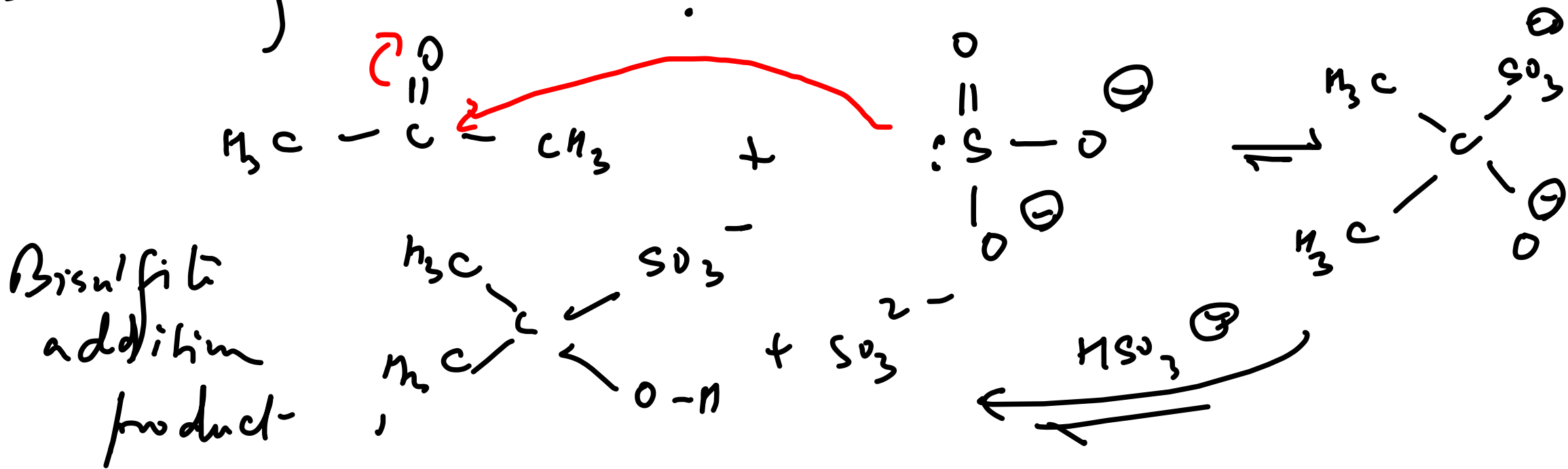
The migratory aptitude of
 tertiary > secondary >
 aryl > primary. Allylic ($\text{CH}_2 = \text{CH} - \text{CH}_2$)
 are more apt to migrate than primary
 alkyl groups but less than secondary & aryl



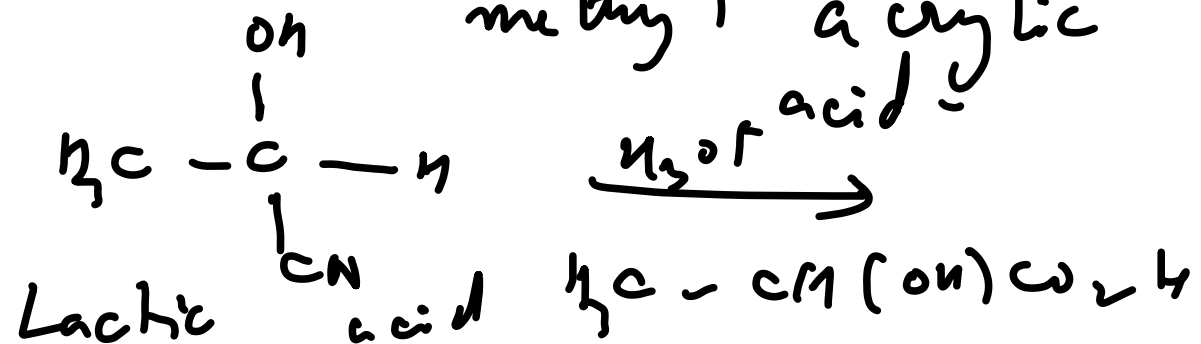
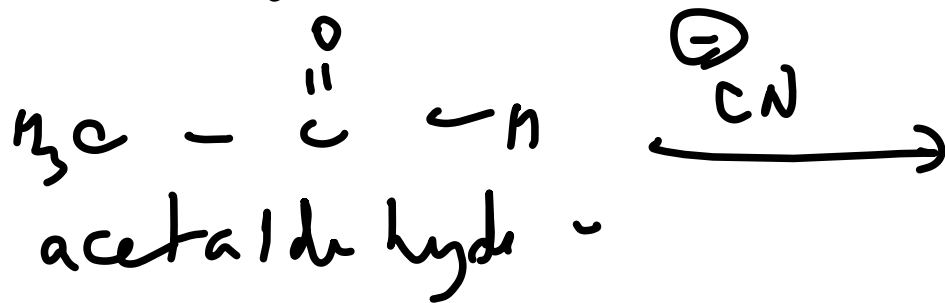
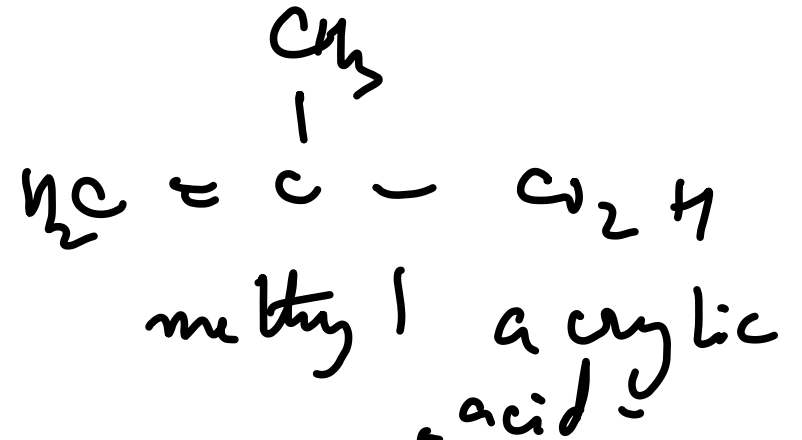
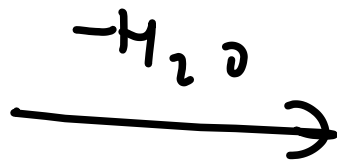
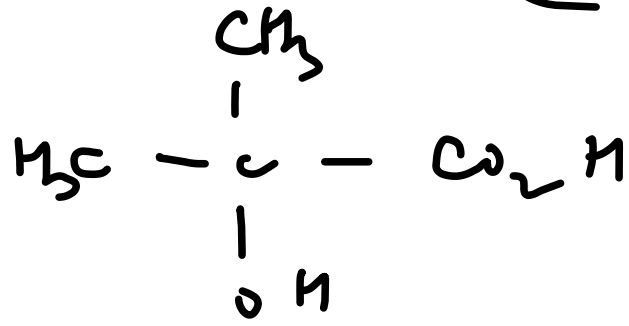
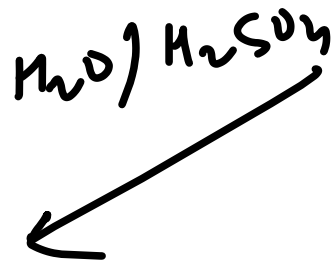
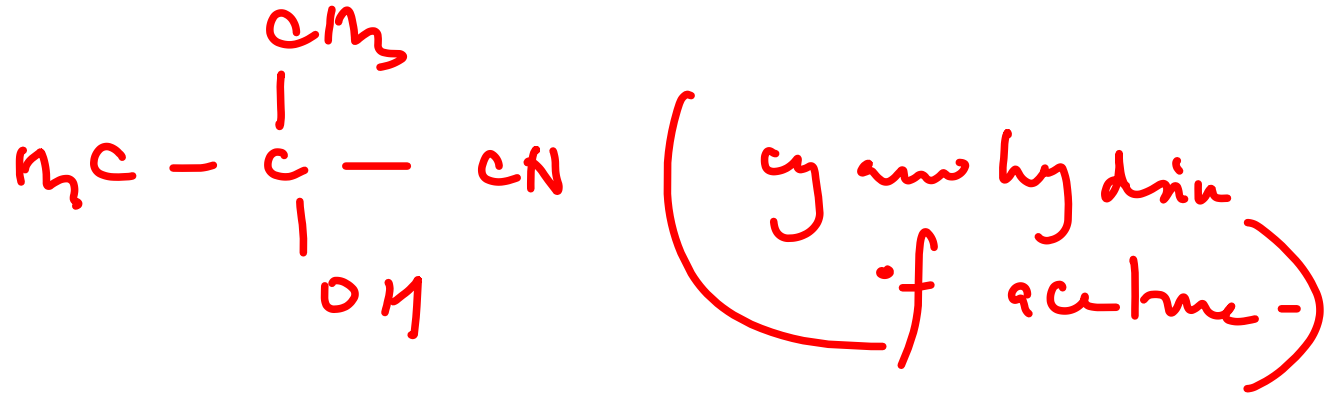
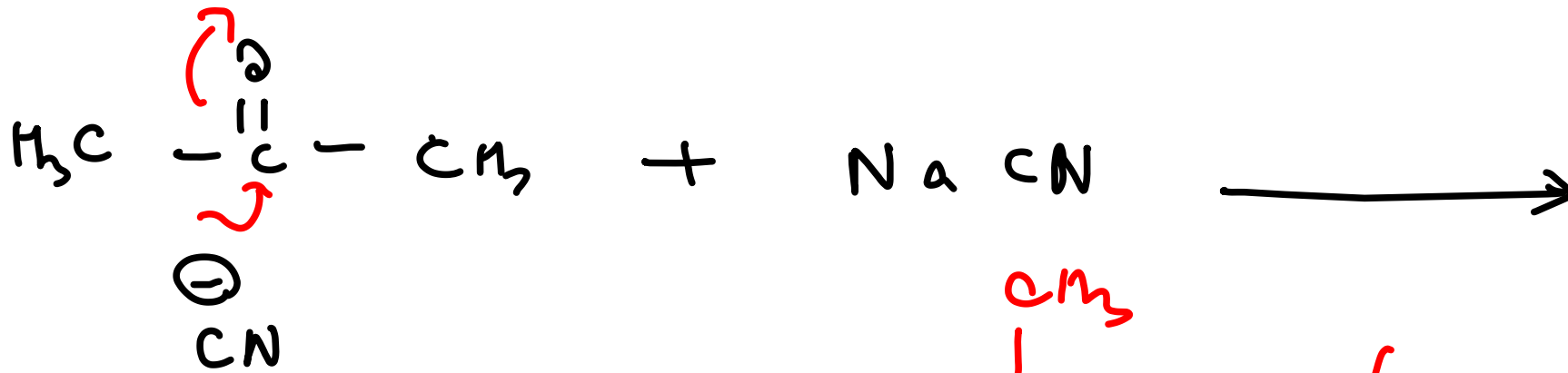
Electron withdrawing groups on the substituents
 i.e. R_1 & R_2 decrease the rate of migration

f) Nucleophilic addition to $>C=O$

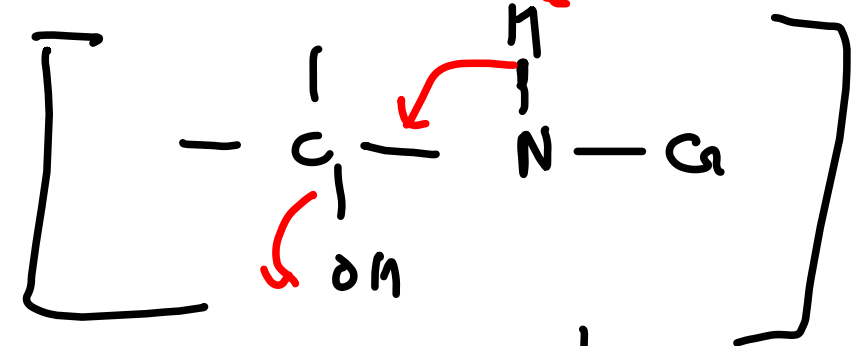
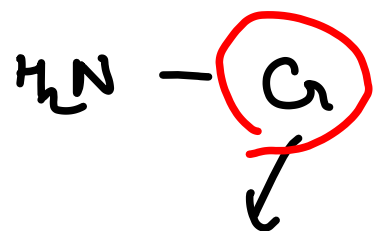
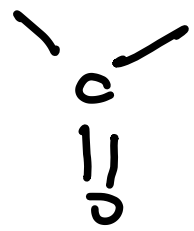
i) Bisulfite addition:



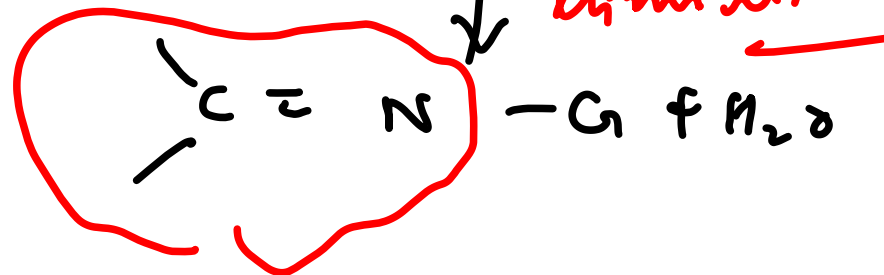
ii)



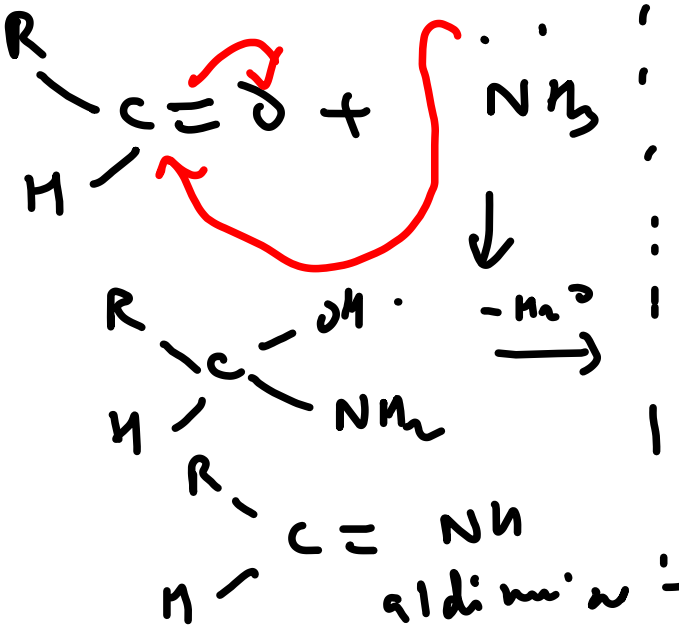
iii) Addition of derivatives of ammonia



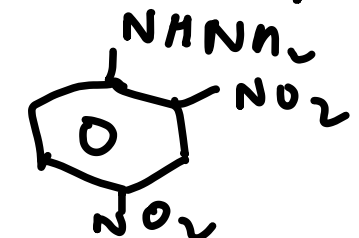
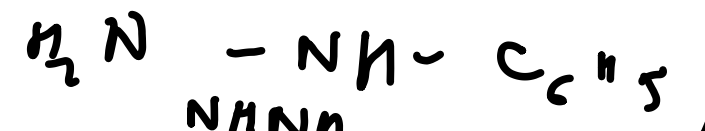
functional group

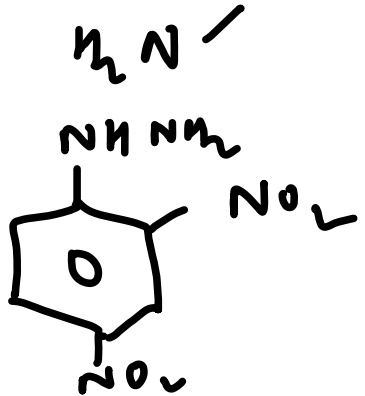
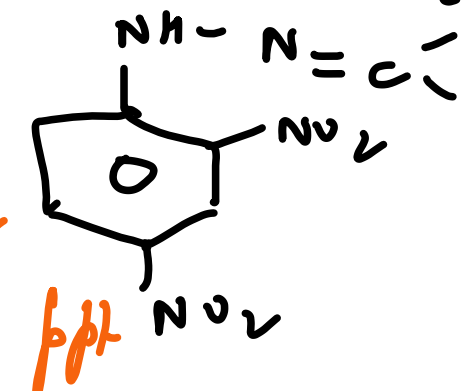


If G = H
i.e. NH_3 is used



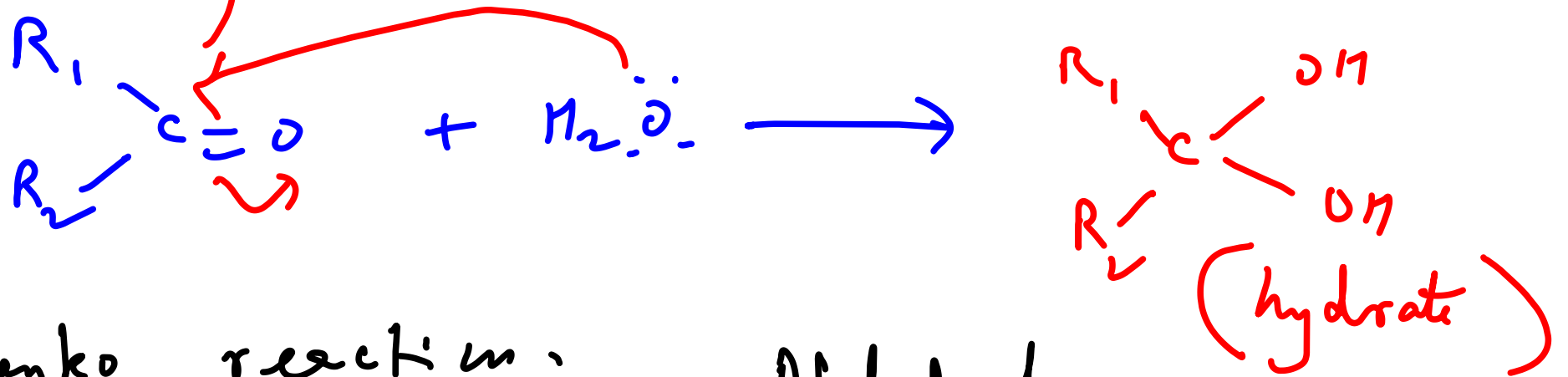
Derivatives of NH_3 :



Reagent	$H_2N - G$	Product (Structure)	Name of the product
$H_2N OH$	Hydroxyl amine	$>C = N - OH$ $\left[>C = \overset{\uparrow}{O} + H_2N OH \right]$	Oxime
$H_2N - NH_2$	Hydrazine	$>C = N - NH_2$	Hydrazone
$H_2N - NH - C_6H_5$	Phenyl hydrazine	$>C = N - NH - C_6H_5$	Phenyl hydrazone
$H_2N - NH$ $\quad \quad \quad \backslash$ $\quad \quad \quad C = O$	Semicarbazide	$>C = N - NH - \overset{O}{\parallel} C - NH_2$	Semicarbazone
	2,4-Dinitrophenyl hydrazine	<p>Bright orange or yellow ppt</p> 	2,4 dinitrophenyl hydrazone.

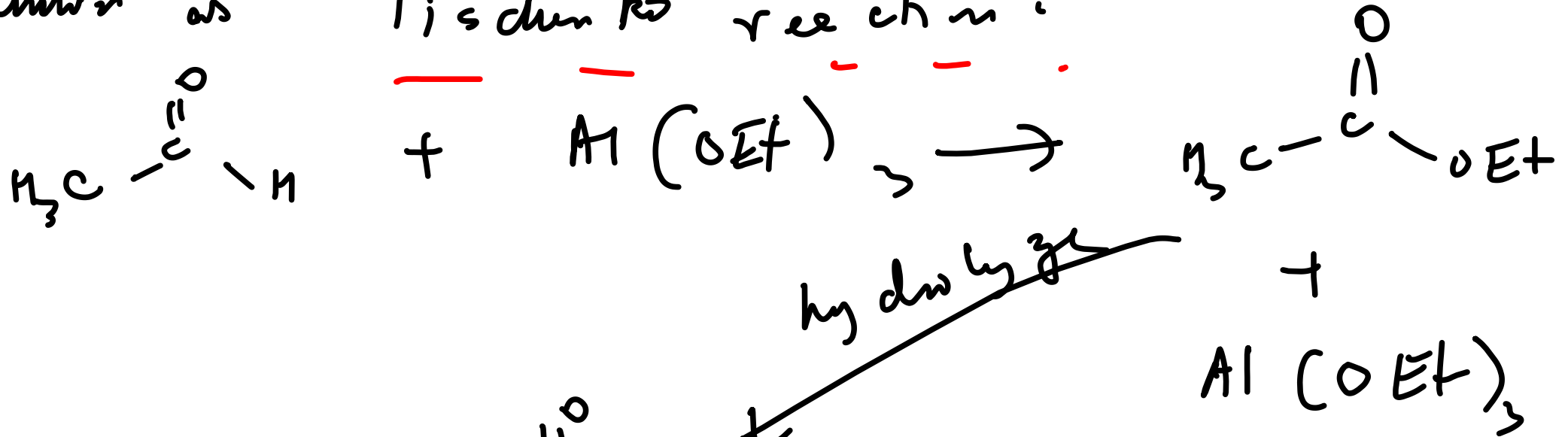
acetals are stable in neutral or basic media,
they are often used to protect $-CH=O$ group.

v) Addition of water

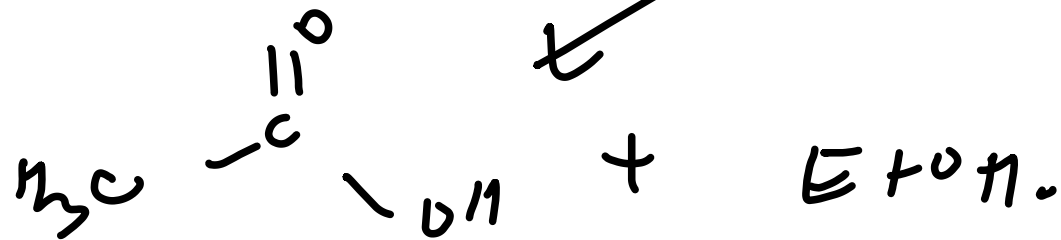


h) Tischenko reaction: — Aldehydes can
be made to undergo the Cannizzaro reaction
by treatment with aluminum alkoxide.
Under these conditions acids & alcohols

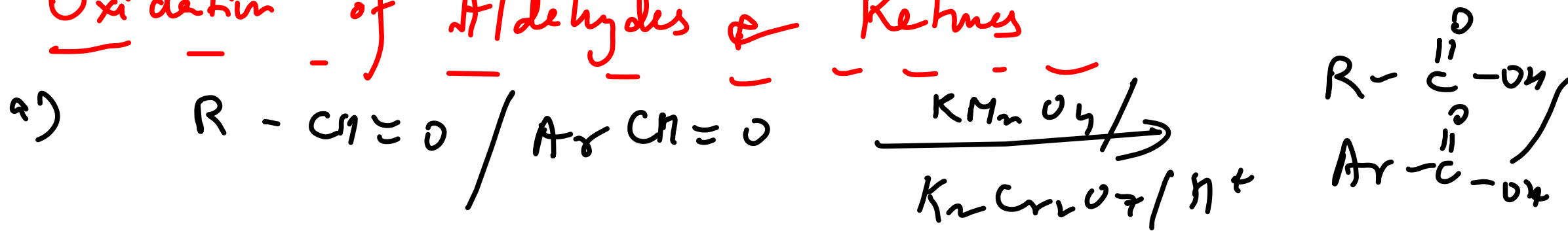
are combined as the ester & the reaction is known as Tishchenko reaction.



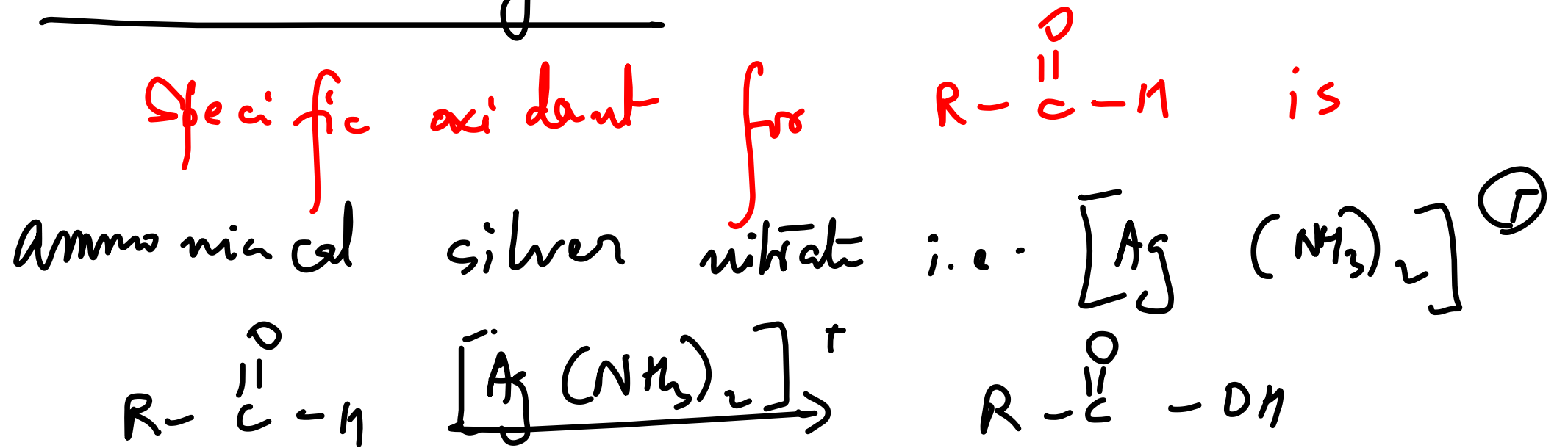
~~hydrolysis~~



Oxidation of Aldehydes & Ketones

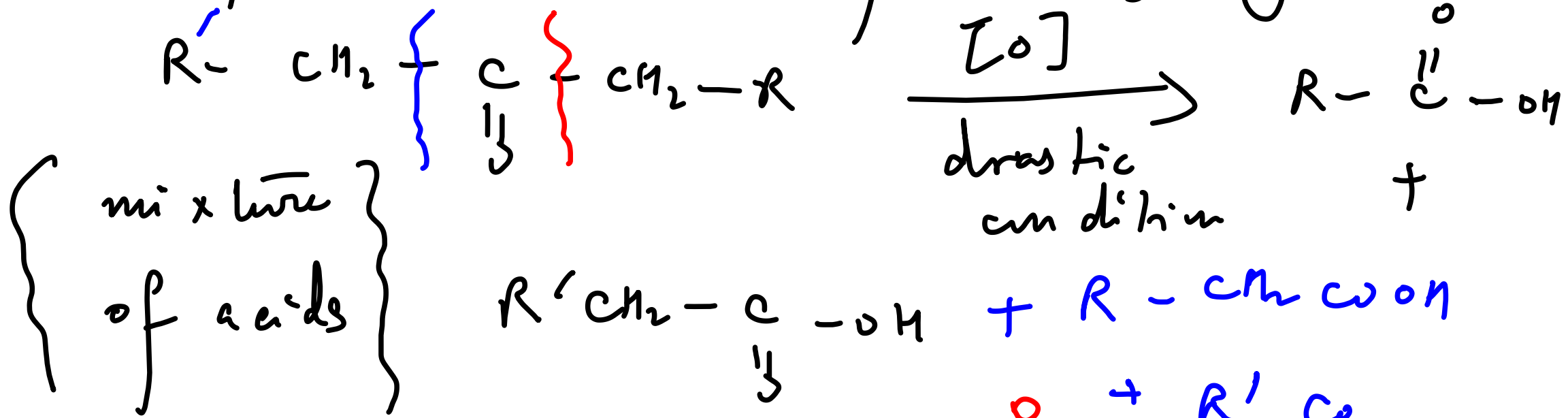


b) Tollen's reagent



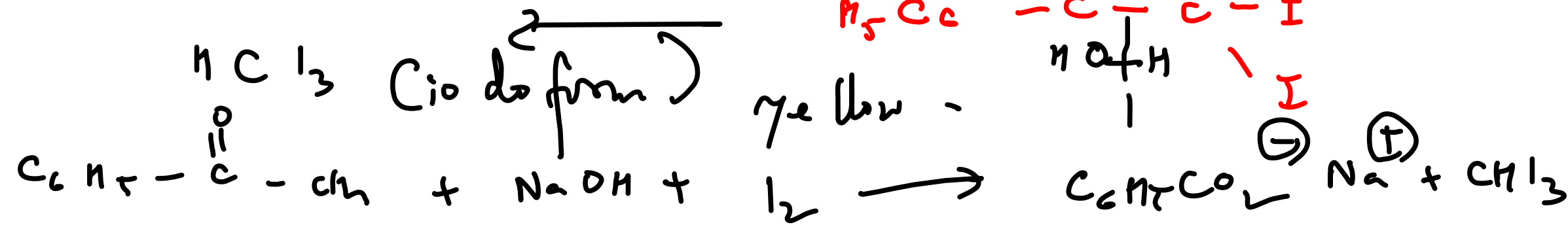
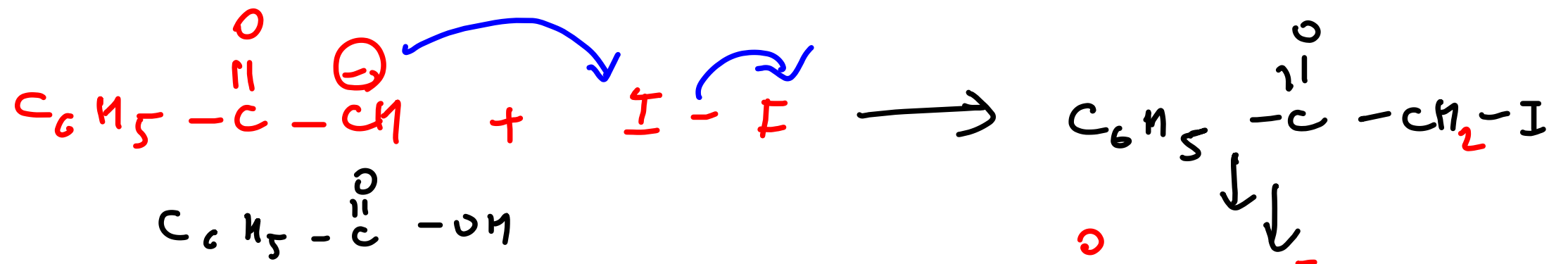
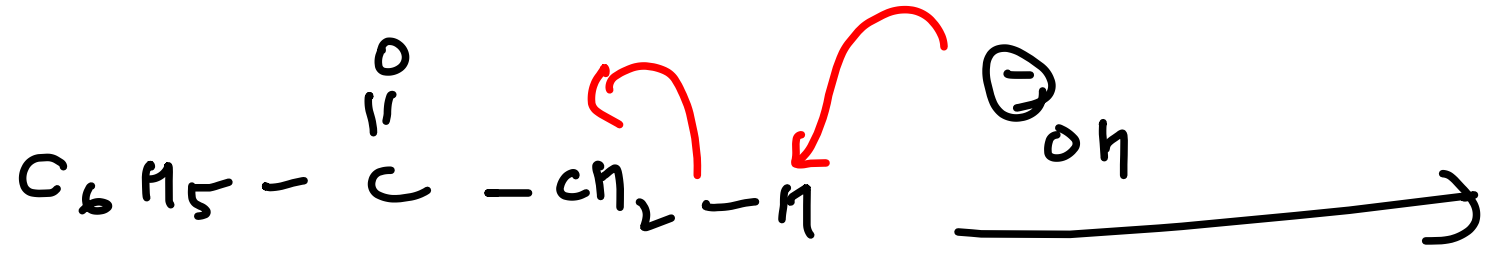
Tollen's reagent is primarily used for detection/identification of aldehydes.
Tollen's reagent does not oxidize $>C=C<$
double bond

Ketones are usually resistant to mild oxidation. However, with strong oxidants at high temperature they undergo cleavage of C-C bonds on either side of either sides of carbonyl group.



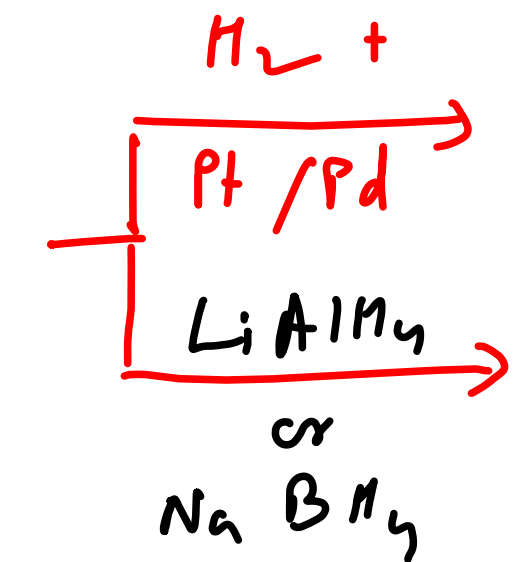
Haloform Reaction - $\text{CH}_3 - \overset{\text{O}}{\parallel}{\text{C}} - \text{R}$ are readily

oxidised by NaOH & I₂ (NaOI) to iodoform,
 CHI₃ & R-C(=O)-ONa



Reduction of aldehydes & ketones

a) Reduction to



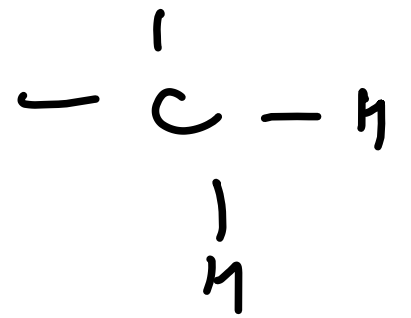
Aldehyde \rightarrow 1^o alcohol

Ketone \rightarrow 2^o alcohol

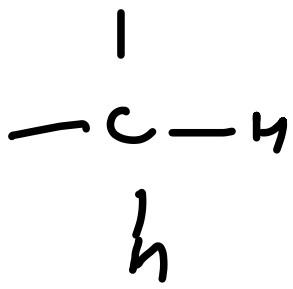
b) Reduction to hydrocarbon



Clemmensen reduction



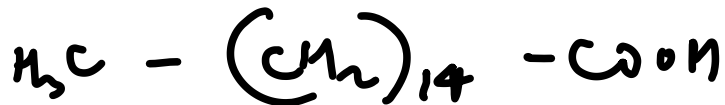
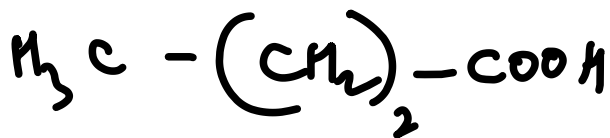
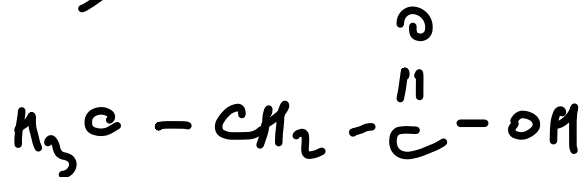
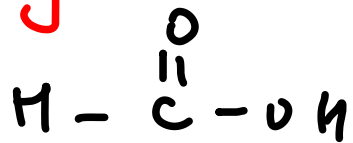
Wolff-Kishner reduction



REVISION NOTES: CARBONYL COMPOUNDS

Carboxylic Acids

Carboxylic acid



Common names -

Formic acid

Acetic acid

Propionic acid

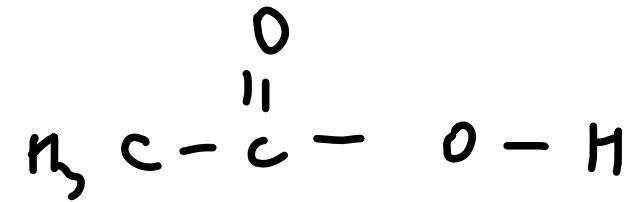
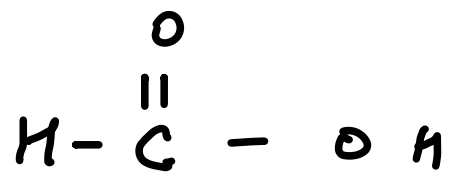
Butyric acid

Valeric acid

Palmitic acid

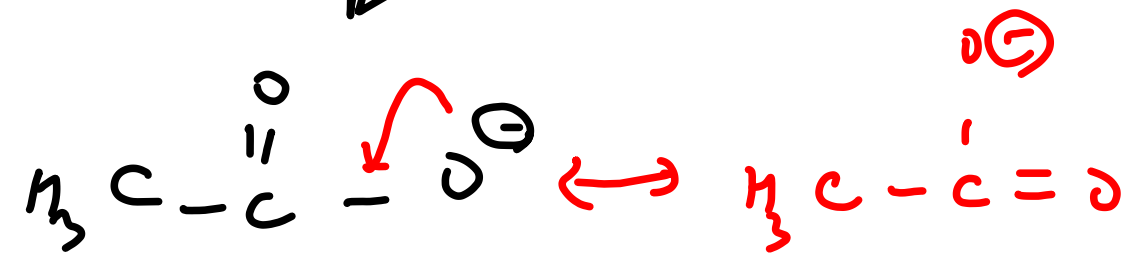
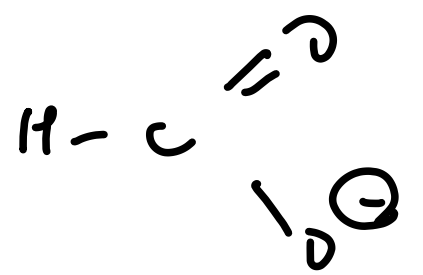
Stearic acid

Formic acid is stronger than acetic acid.



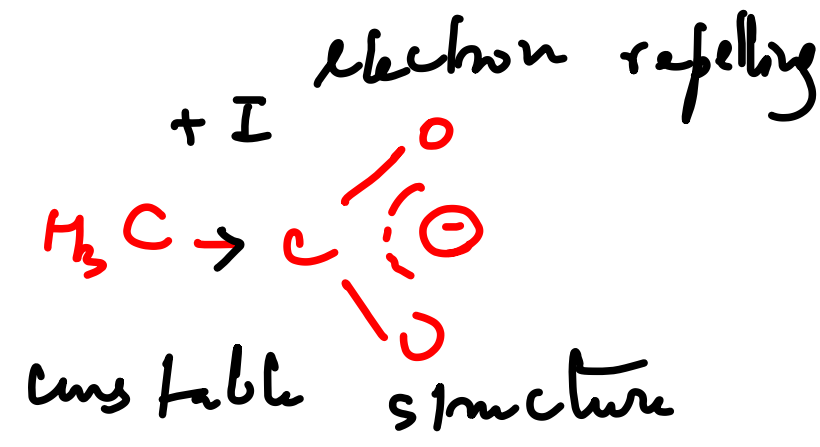
$-\text{H}^+$ \rightleftharpoons conjugate base

$-\text{H}^+$



Higher the stability of conjugate base, stronger the acid is.

+I effect of $-\text{CH}_3$ group increases electron density making the c. B. unstable

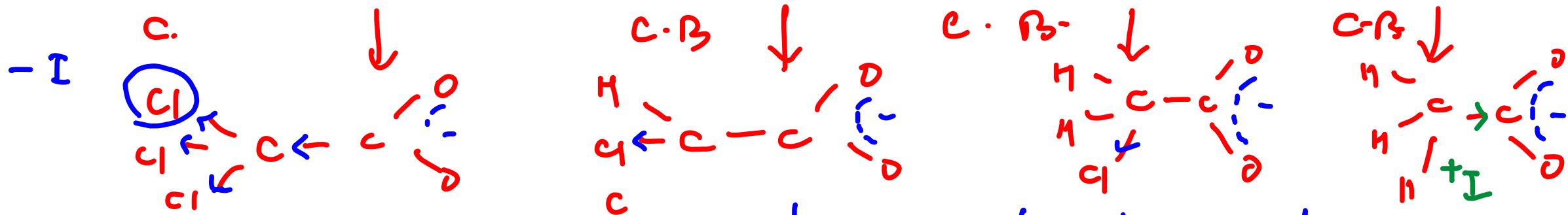
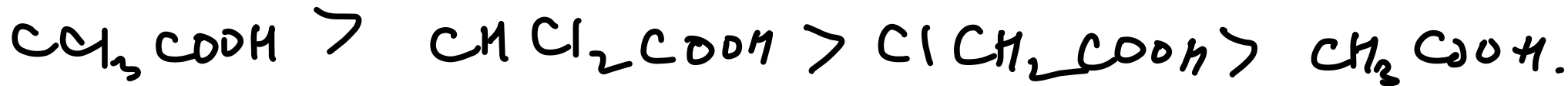


Physical Properties

1. The first three acids are colourless, pungent smelling liquids.
2. First 4 members are well miscible in water due to the existence of intermolecular H-bonding. Higher members are, however, miscible in non-polar solvents like ether, benzene or ethanol but immiscible in water due to the increase in the size of the hydrophobic alkyl chain.

3. The b.p. of carboxylic acids are higher than alcohols because carboxylic acids exist as dimers due to the presence of intermolecular H-bonding.

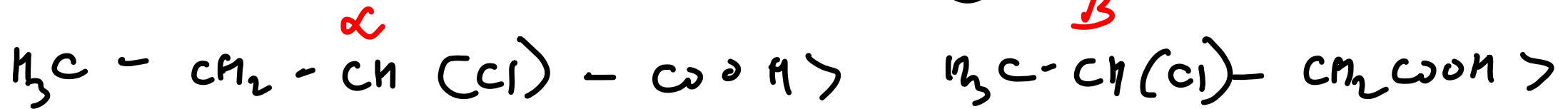
4. Increase in the no. of halogen atoms on α position increases the acidity, e.g.



Electron withdrawing group in α position stabilises C.B.

Electron donating group in the α position will destabilize the conjugate base.

⑤ Increase in the distance of halogen from COOH will decrease the acidity.



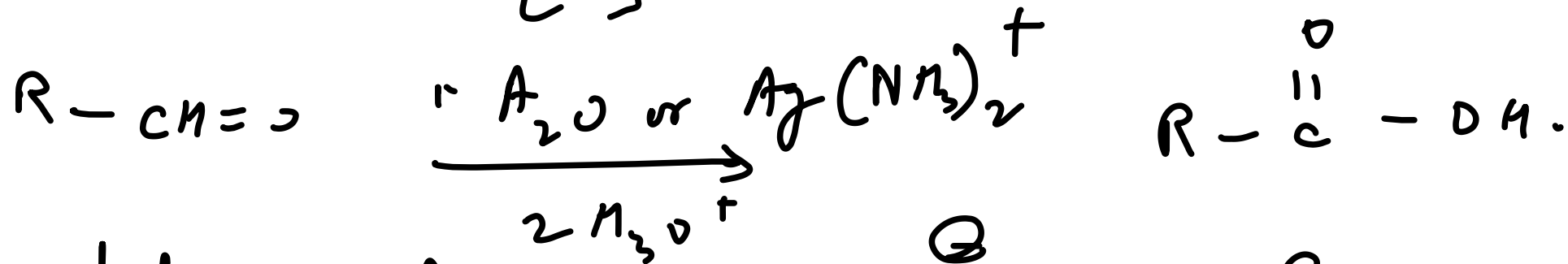
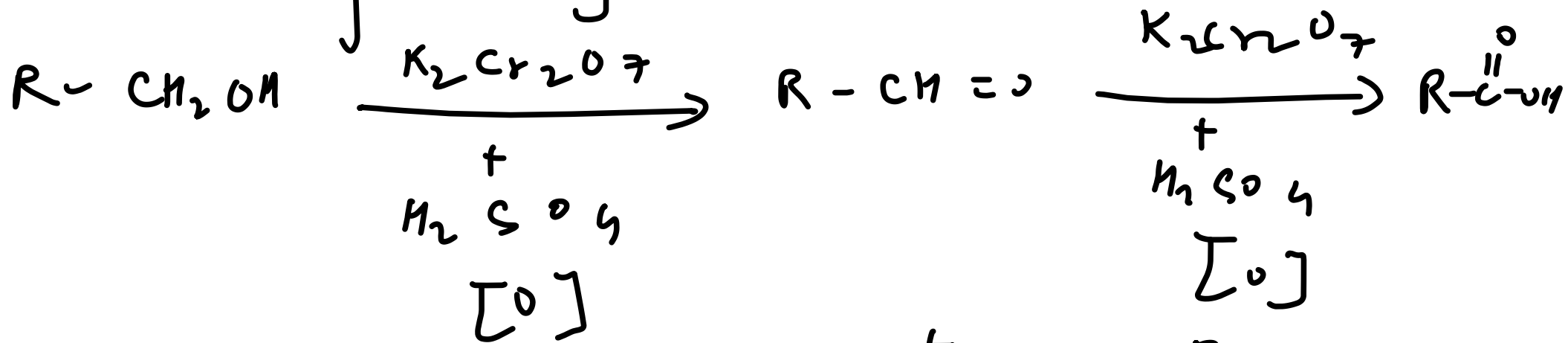
(Proximity effect)

⑥ Increase in the electronegativity of halogen increases the acidity

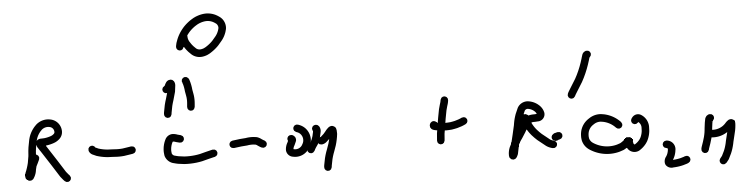


Methods of Preparation

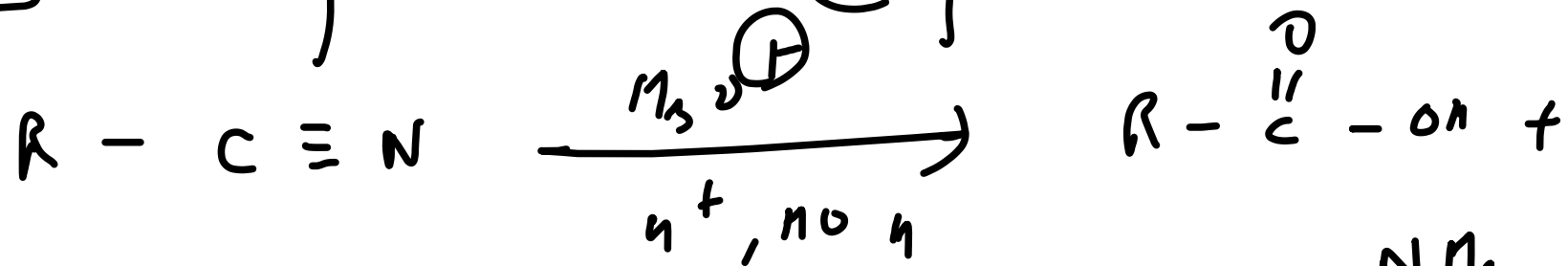
a. Oxidation of aldehydes & ketones -



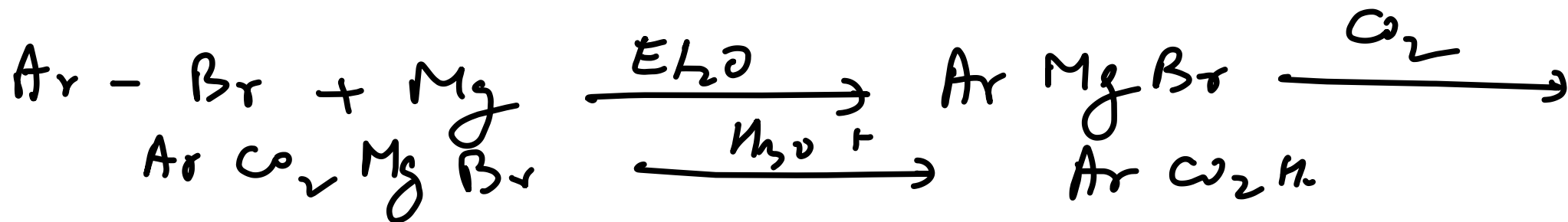
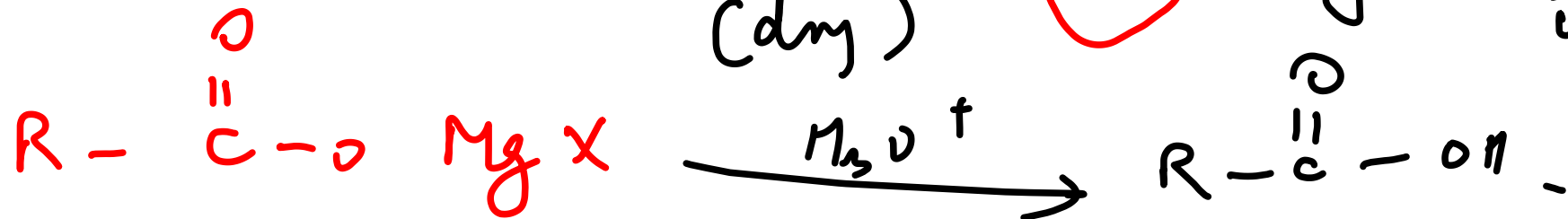
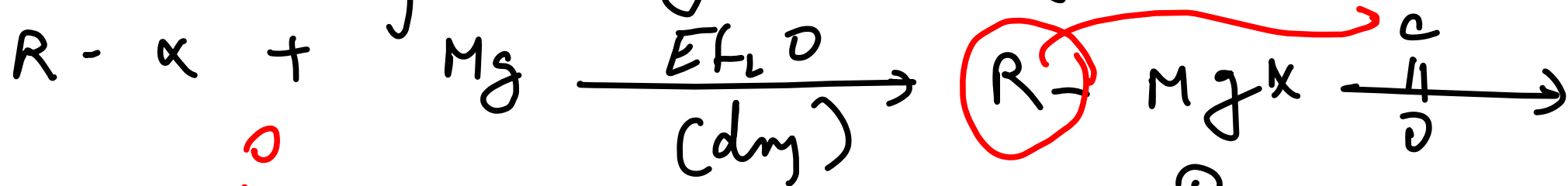
b. Oxidation of alkenes

$$R-CH=CH-R' \xrightarrow[2. \Delta, H_2O]{1. KMnO_4} R-C(=O)OH + R'-C(=O)H$$


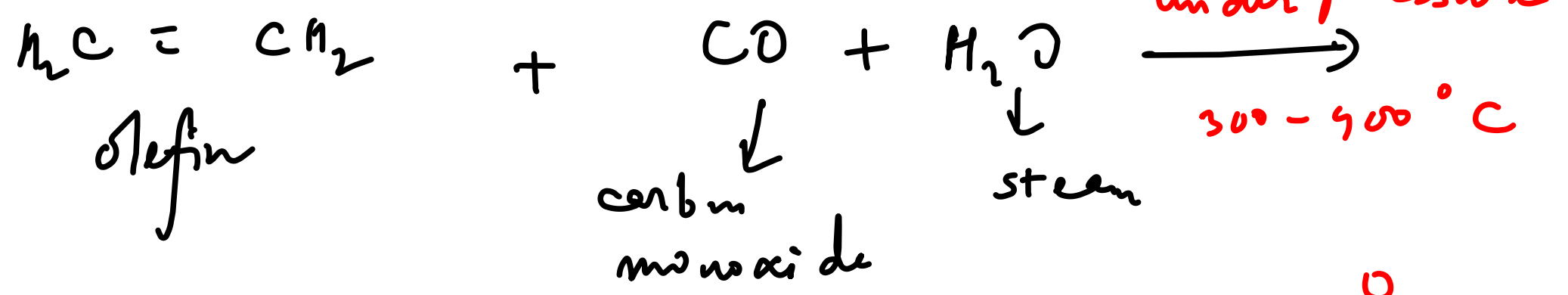
c) Hydrolysis of nitriles (cyanide)



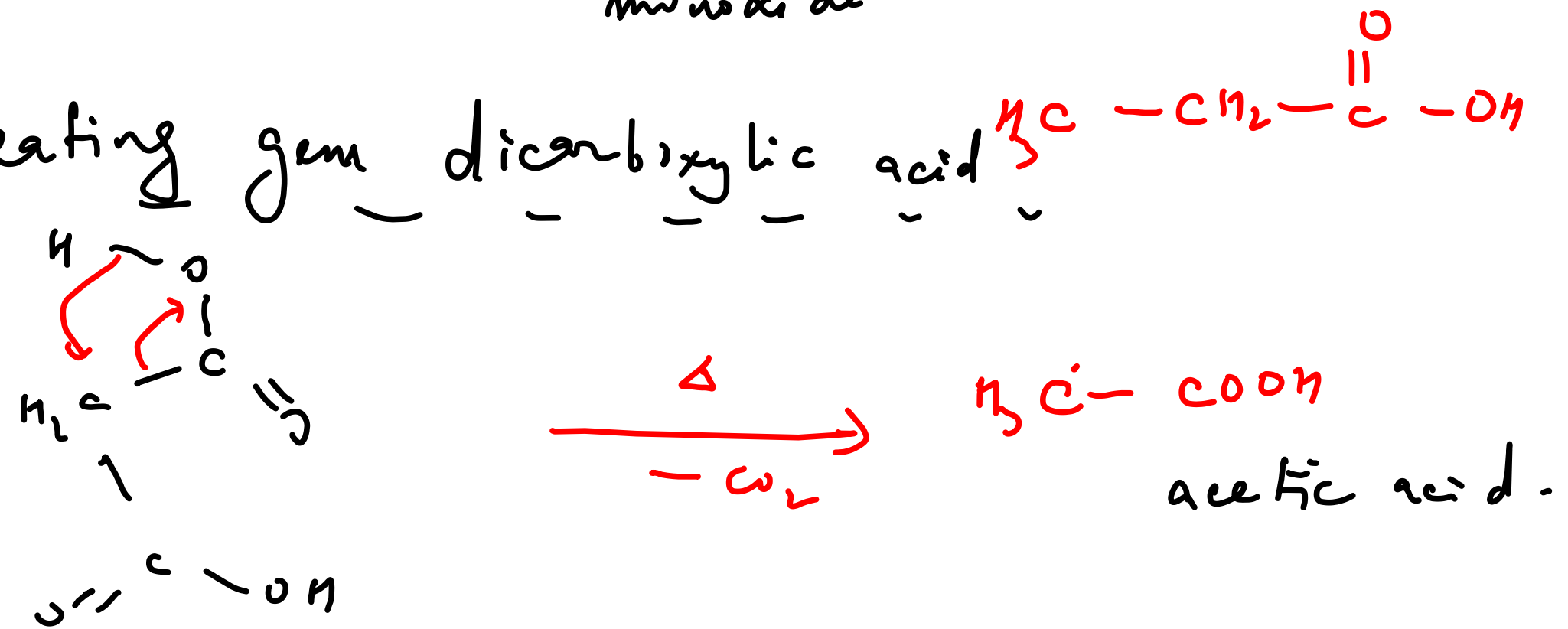
d) Carboxylation of Grignard reagent.



e. Koch reaction.



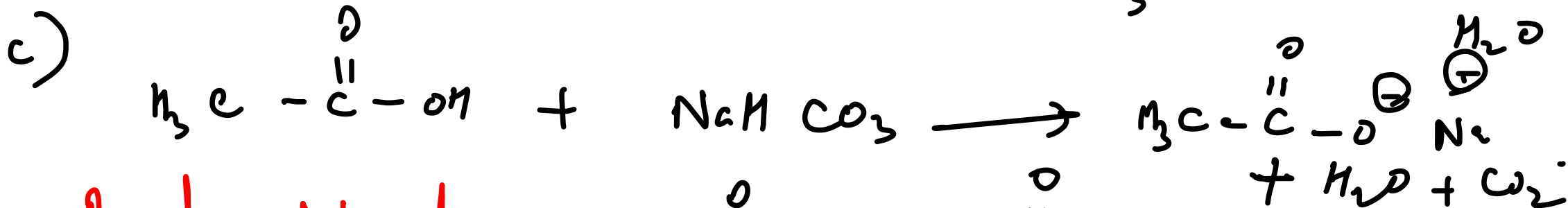
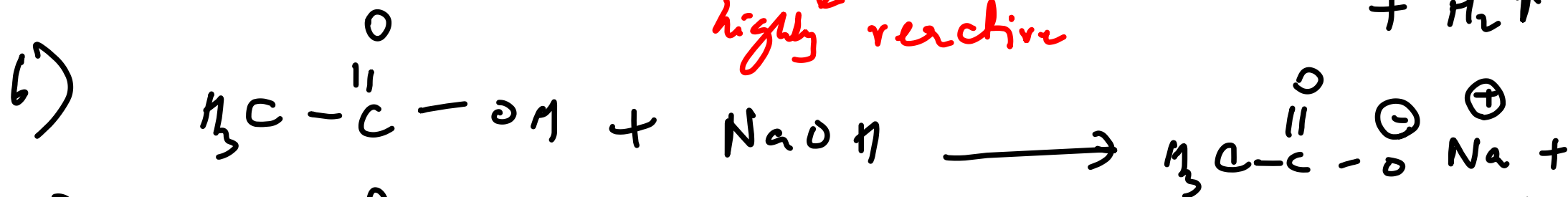
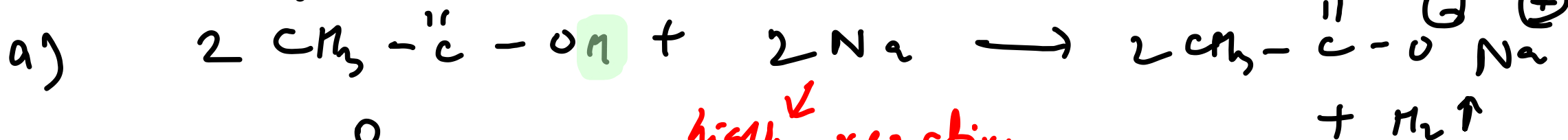
f. Heating gem-dicarboxylic acid



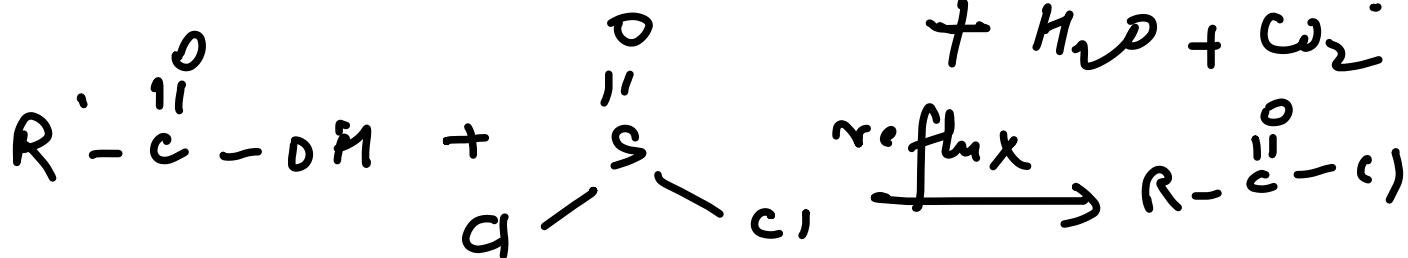
Chemical Reactions of Carboxylic Acids

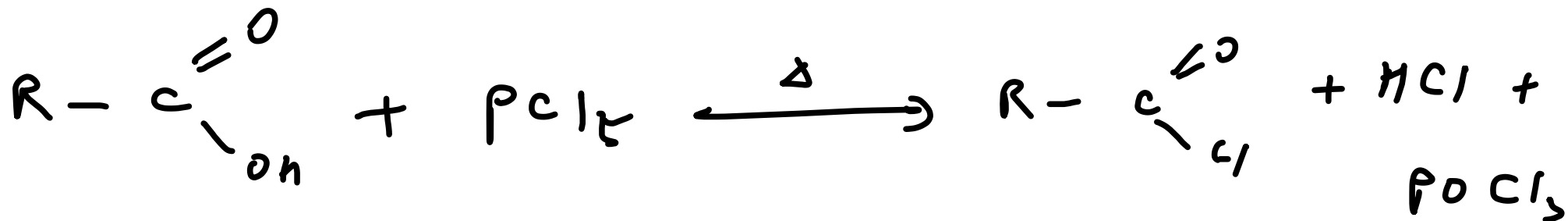
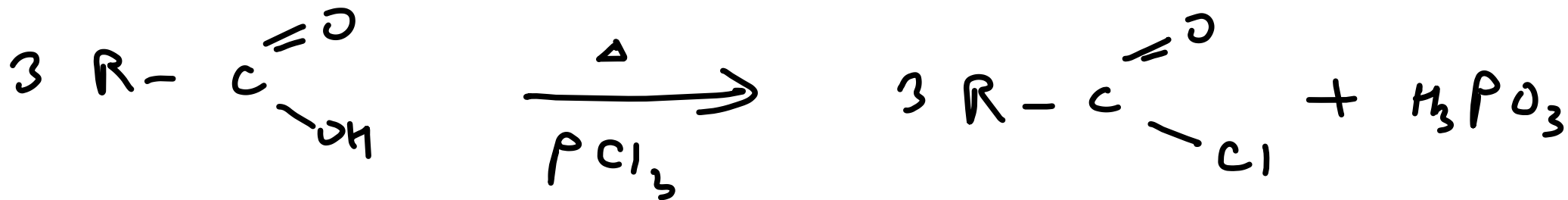
1. Salt formation:

C by two gen replacement (by H)

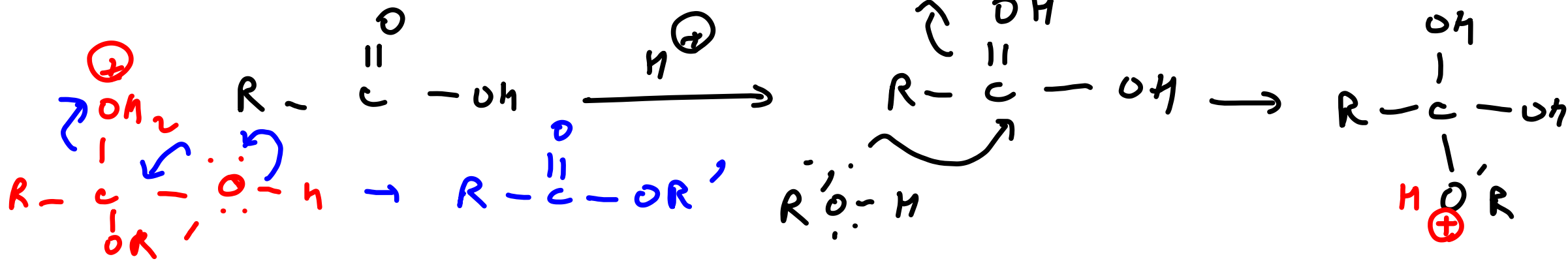
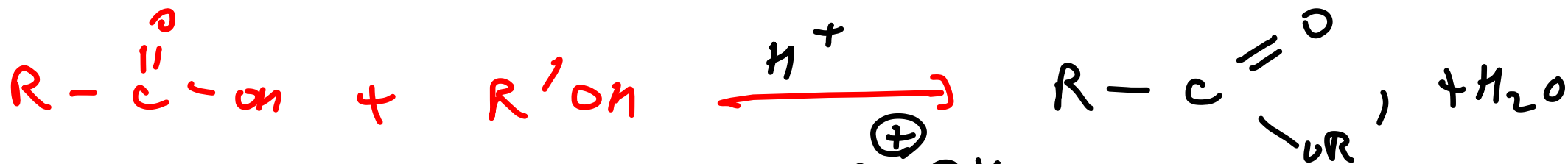


2. Acid chloride:

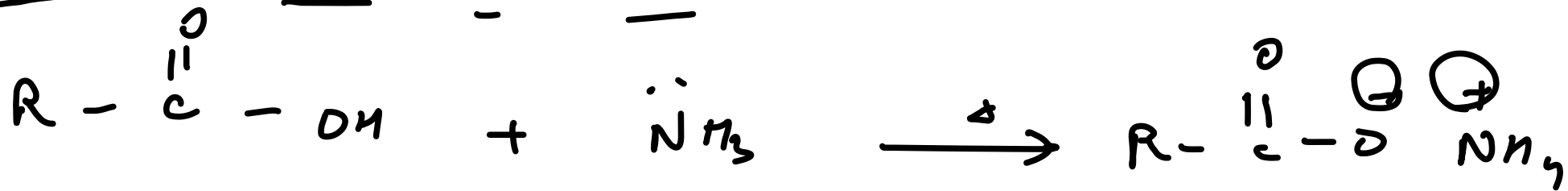




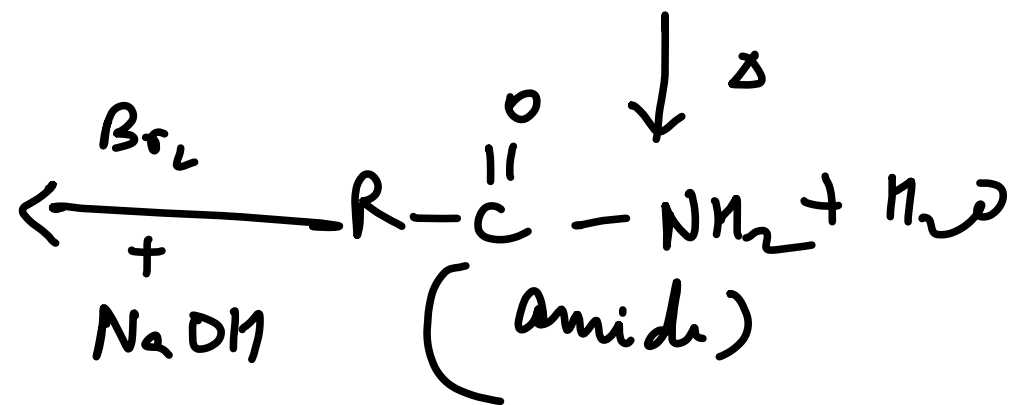
c. Conversion into esters.



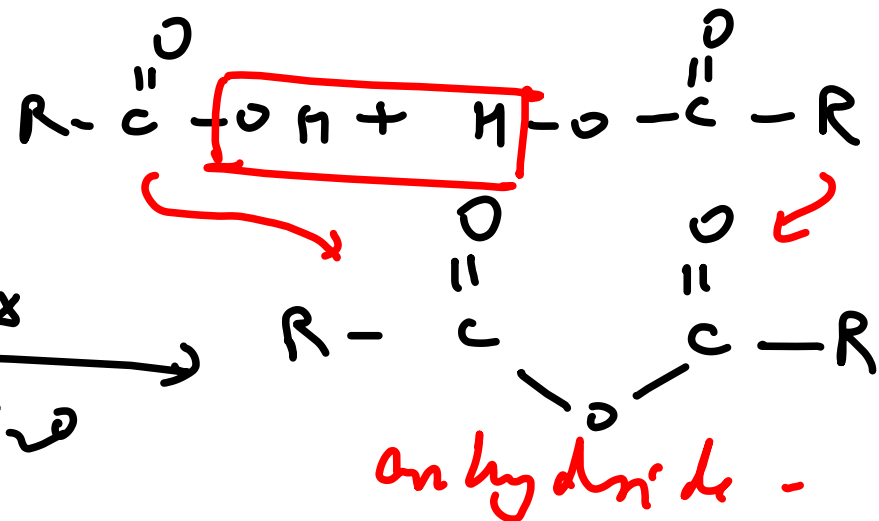
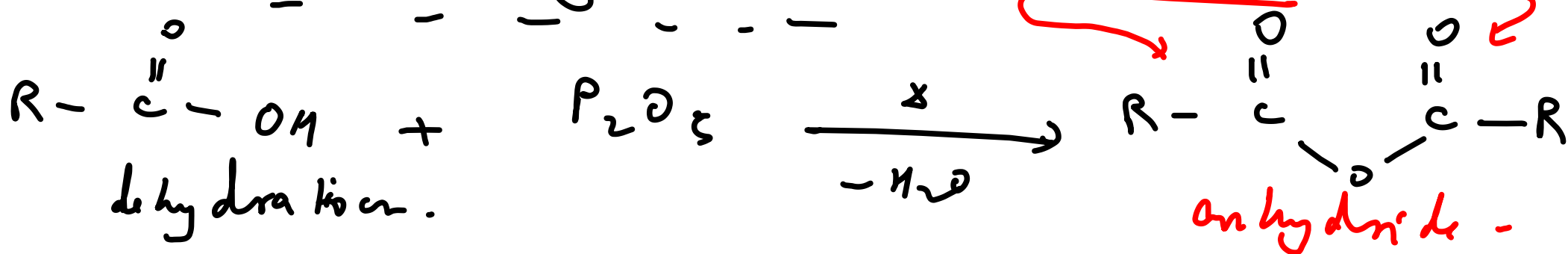
d. Conversion into amides

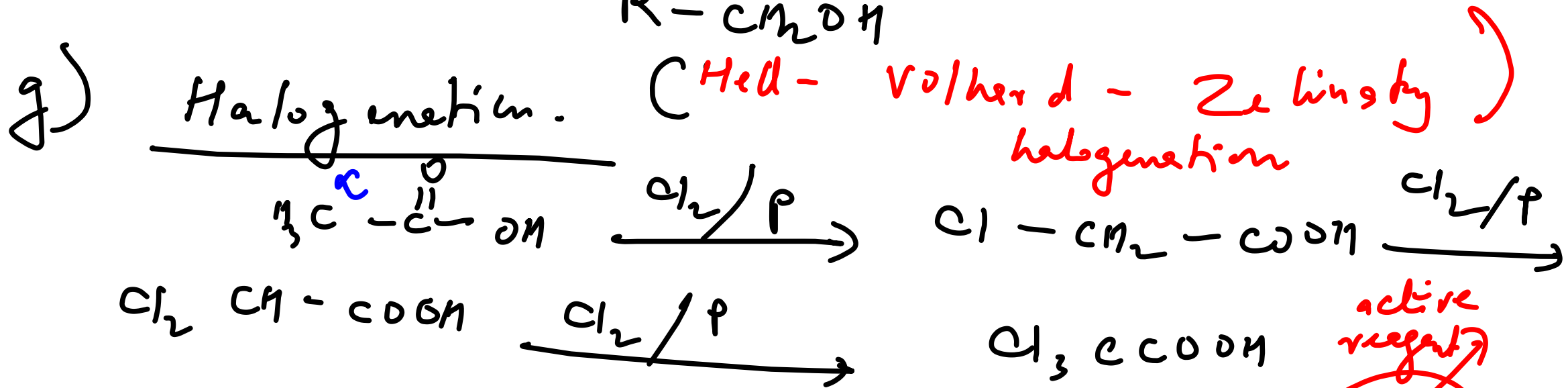
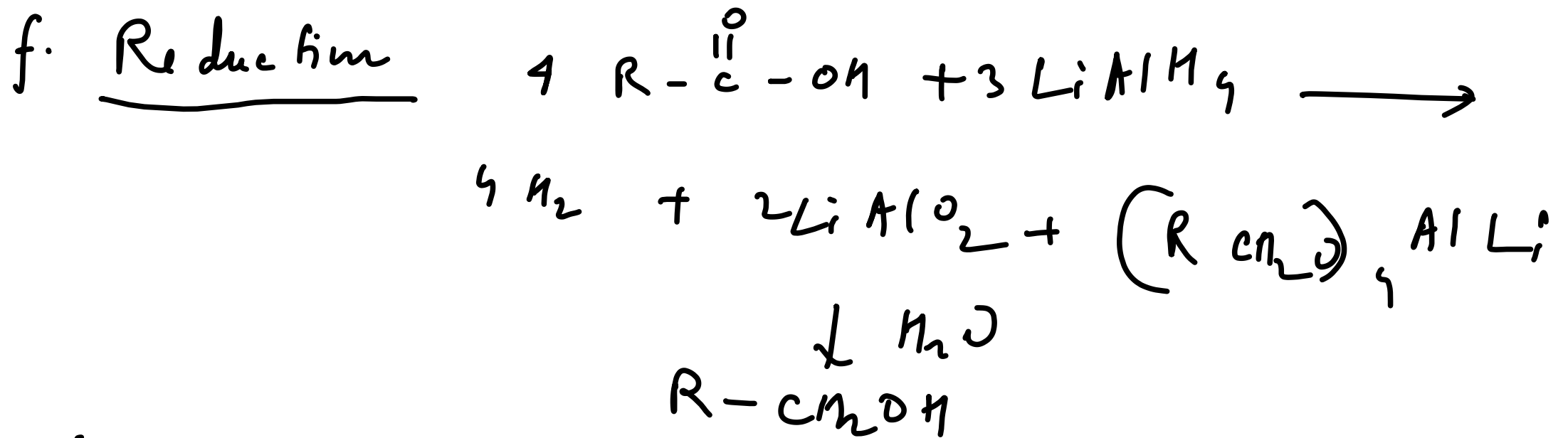


Hoffmann's degradation
 $R-NH_2$

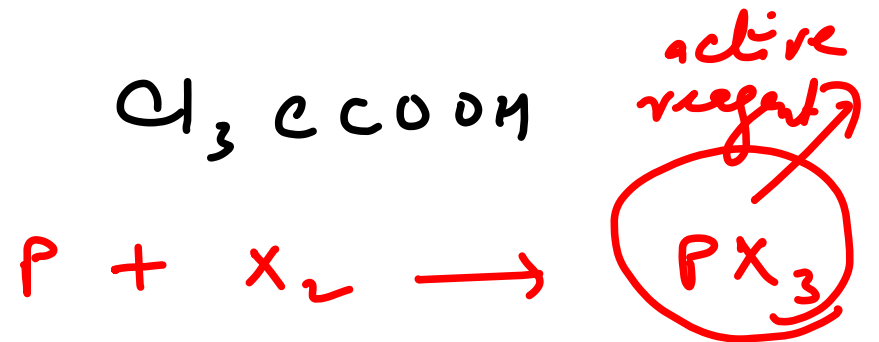


e. Conversion into anhydrides





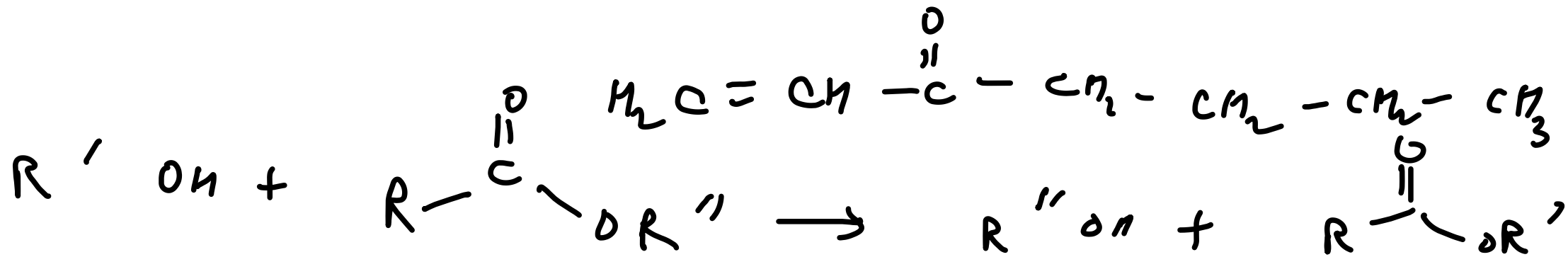
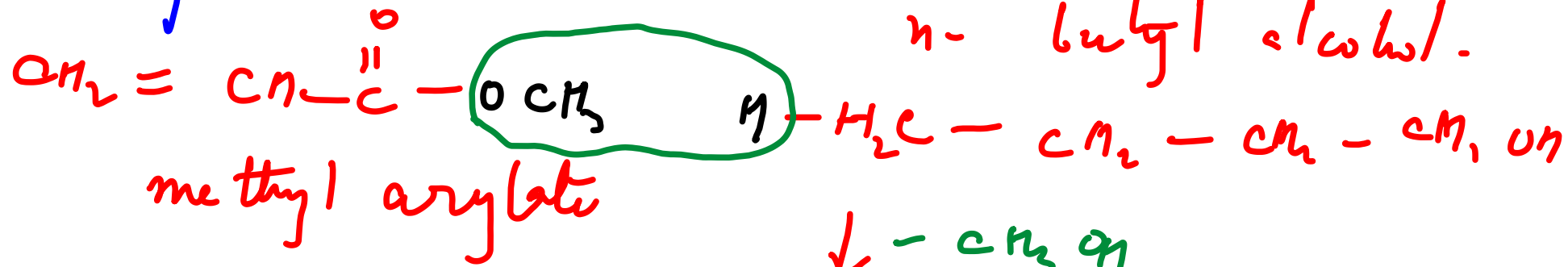
α -halogenation reaction, HVZ reaction



Esters

a) Trans esterification:

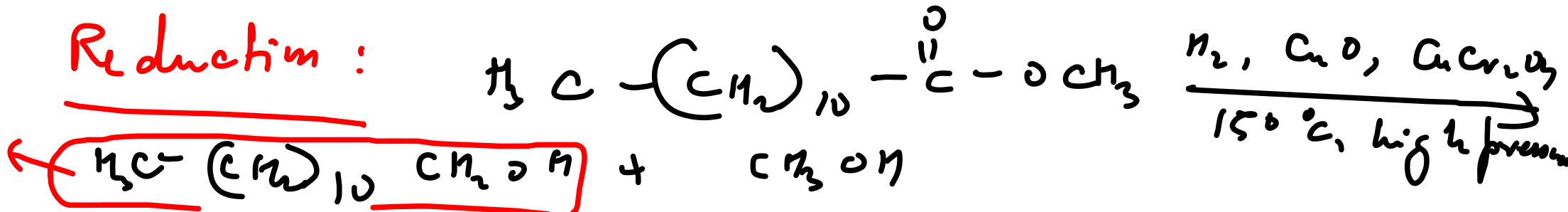
Refers to the process of exchanging the organic group of R'' of an ester with the R' group of alcohol.

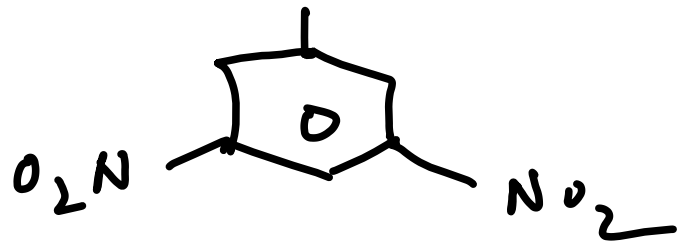
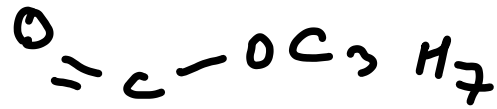
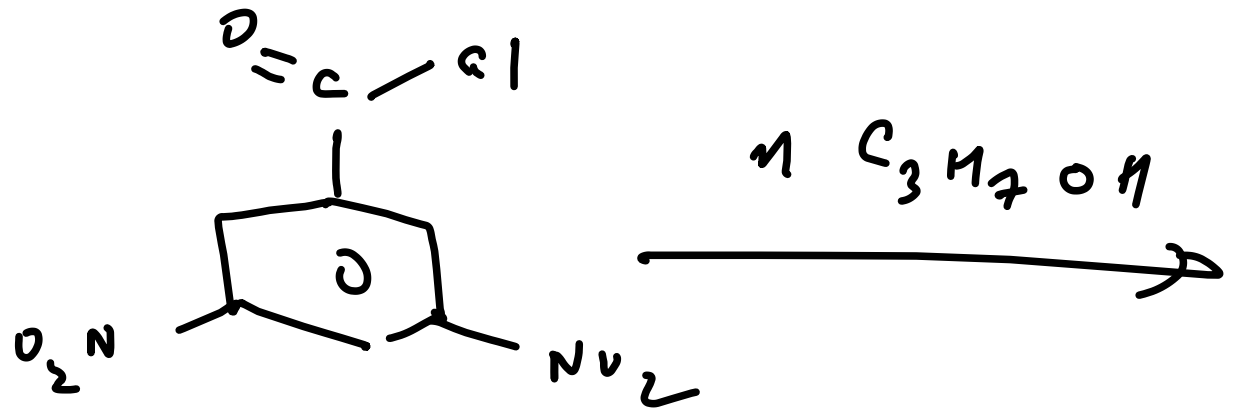
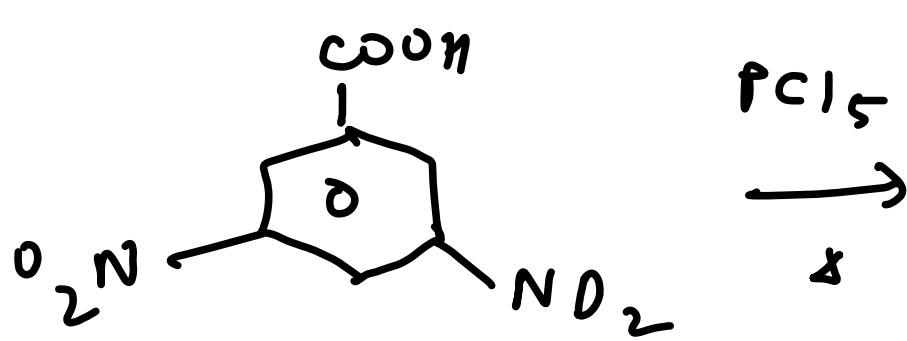


6)

Reduction:

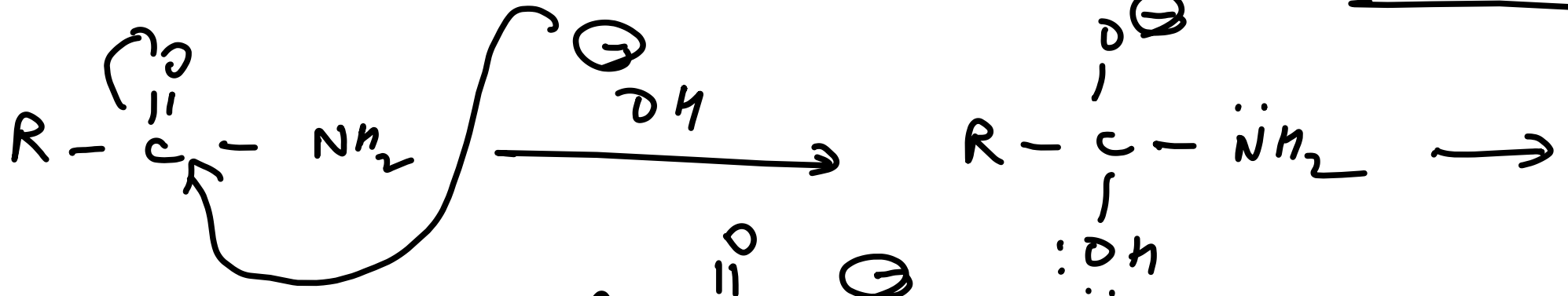
lauryl alcohol.





Amides

→ fully basic nature



Acidic character:

