Aldehydes and Ketones
Lecture 4
By
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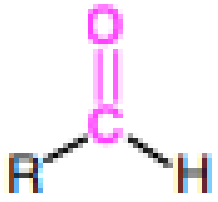
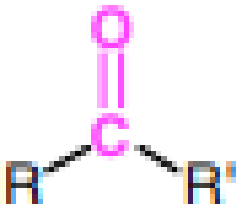
Aldehydes and Ketones

Carbonyl compounds are molecules containing the carbonyl group, C=O. These include:

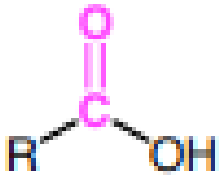
- Aldehydes
- Ketones
- Carboxylic acid derivatives:
- Esters
- Anhydrides
- Acid halides
- Amides



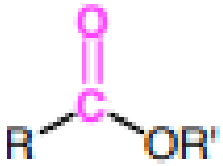
Aldehydes



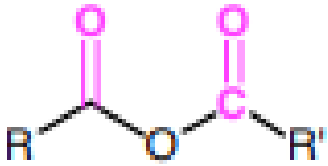
Ketones



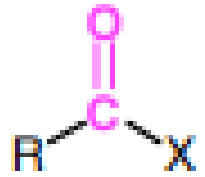
Carboxylic acid



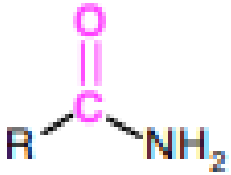
Esters



Anhydrides

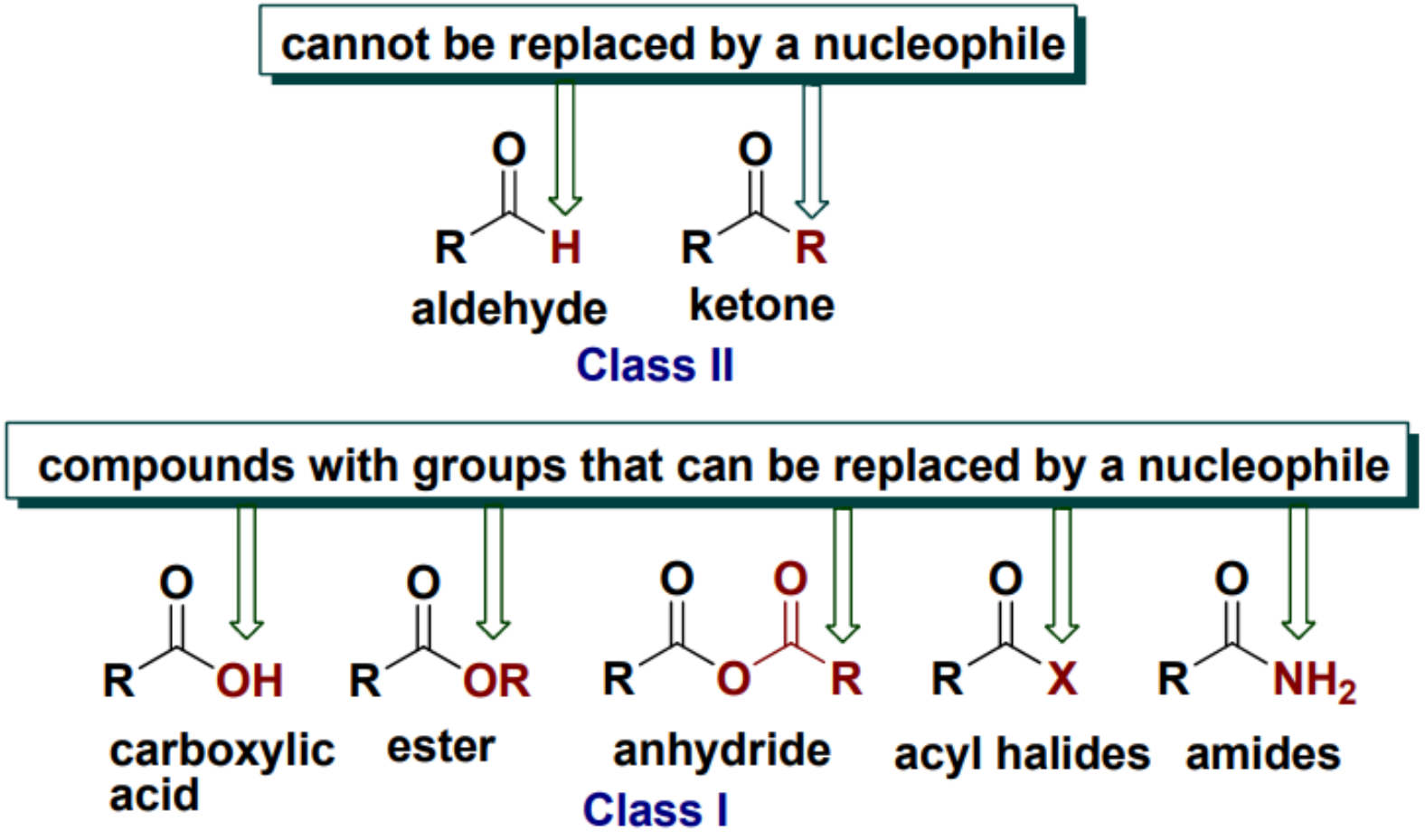


Acid halides

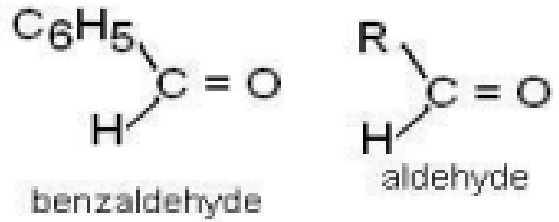


Amides

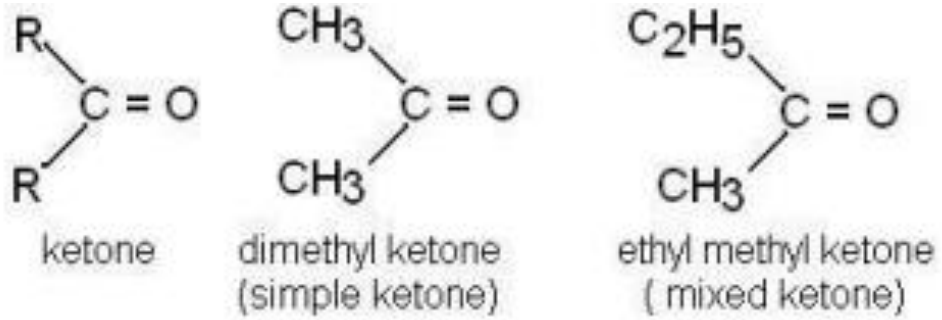
Carbonyl compounds are often classified as Class I or Class II depending if they have a group on the C=O that can be replaced by a nucleophile or not.



Aldehydes, the carbonyl group is linked to either two hydrogen atom or one hydrogen atom and one carbon containing group such as alkyl, aryl or aralkyl group Examples



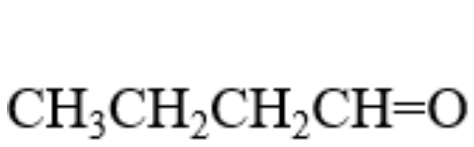
ketones, the carbonyl group is linked to two carbon containing groups which may be same or different alkyl, aryl group. If two R and R' groups are same, the ketone is called simple or symmetrical ketone and if R and R' are different, then ketone is known as mixed or an unsymmetrical ketone.



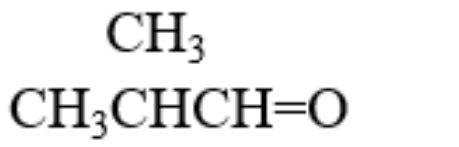
Nomenclature of Aldehydes and Ketones

Aldehydes, IUPAC nomenclature:

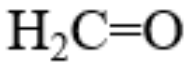
Parent chain = longest continuous carbon chain containing the carbonyl group; alkane, drop –e, add –al. (note: no locant, -CH=O is carbon #1.)



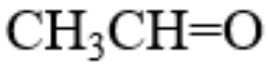
butanal



2-methylpropanal



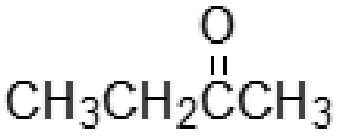
methanal



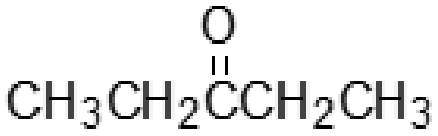
ethanal

Ketones: IUPAC nomenclature:

Parent = longest continuous carbon chain containing the carbonyl group. Alkane, drop –e, add –one. Prefix a locant for the position of the carbonyl using the principle of lower number.



2-butanone



3-pentanone

2-pentanone

Physical Properties

Structure of Aldehydes and Ketones

The carbonyl carbon of an aldehyde or ketone is sp2-hybridized.

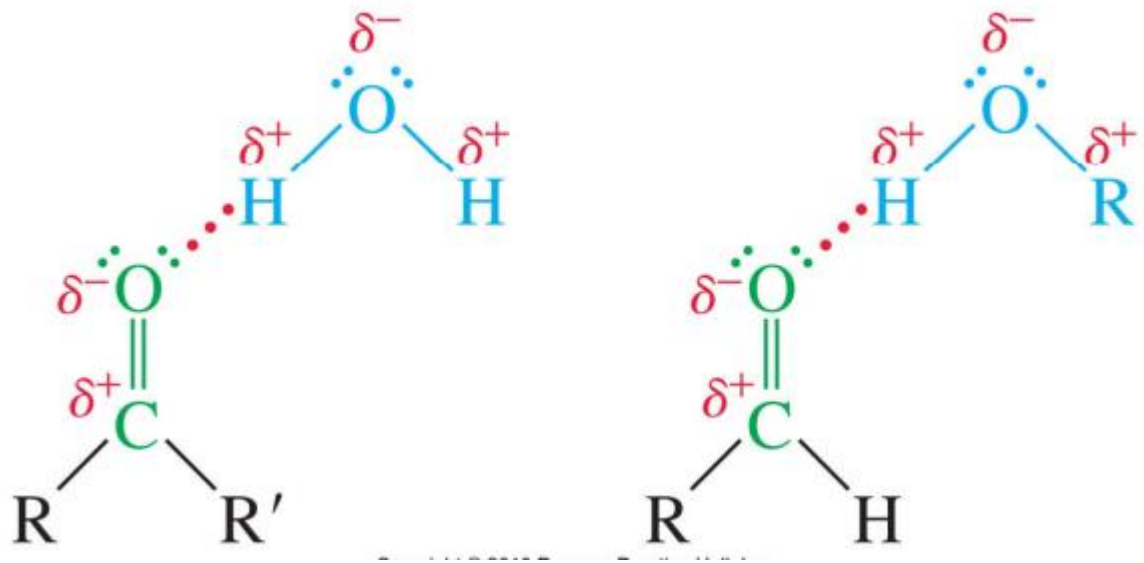
- The bond angle is close to 120° (trigonal planar).
- The carbon-oxygen double bond consists of:

– A σ C-O bond

– A π C=O bond

Boiling point: since there are no hydrogen bonding in aldehydes or ketones, the boiling point will be lower than those of alcohols of similar molecular weights but higher than those non-polar molecules like alkanes, ethers, etc…because of the strong dipole.

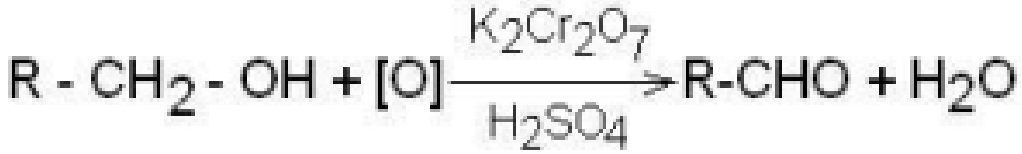
While aldehydes and ketones do not H-bond with themselves, they can hydrogen bond with other molecules bearing acidic hydrogen. They are therefore very good solvent for alcohols and amines.

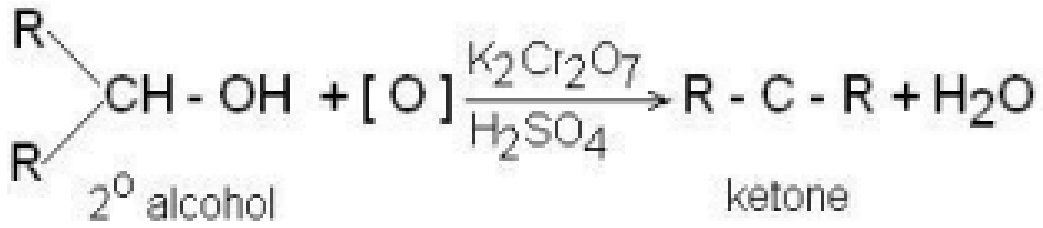


GENERAL METHODS OF PREPARATION OF ALDEHYDES AND KETONES

1) From alcohol

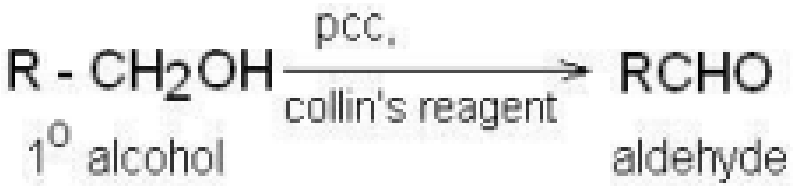
i. Oxidation of alcohol



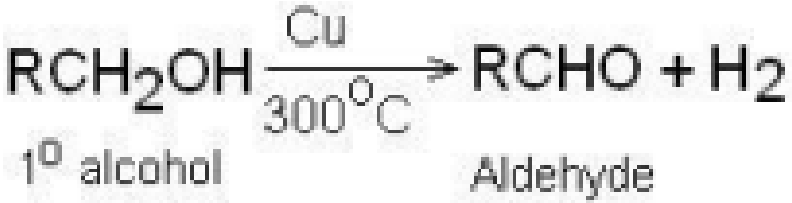


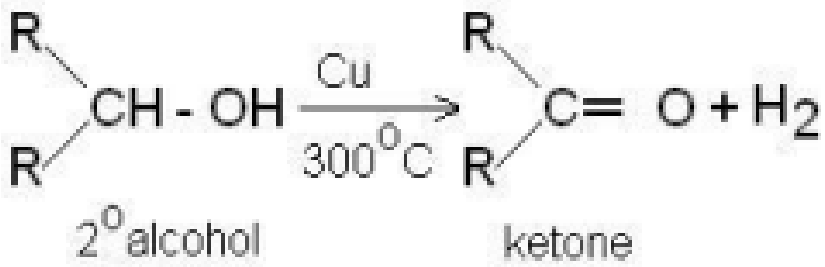
Since the oxidizing agent used in the above reactions is a strong oxidizing agent, it oxidizes aldehydes and ketone further to carboxylic acids

To prevent further oxidation, a mild oxidizing agent such as pyridinium chlorochromate (pcc), CrO3.C5H5N·HCl or CrO3NH+CrO3Cl- are used Collin's reagent [(C5H5N)2 ·CrO3] can also used.



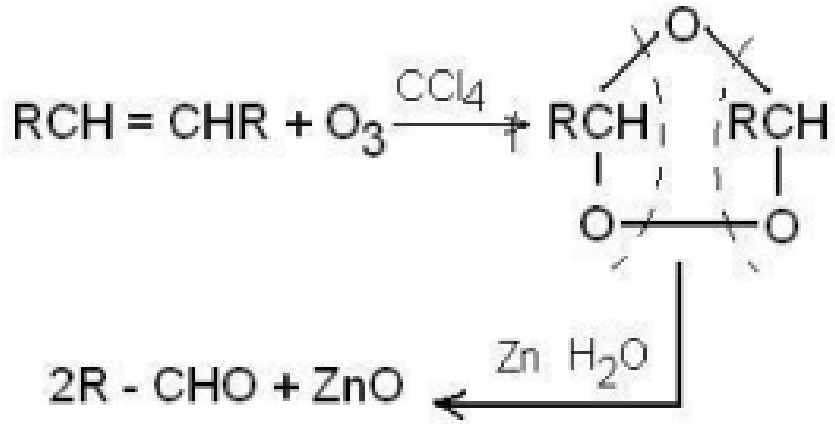
(ii) Catalytic dehydrogenation of alcohols



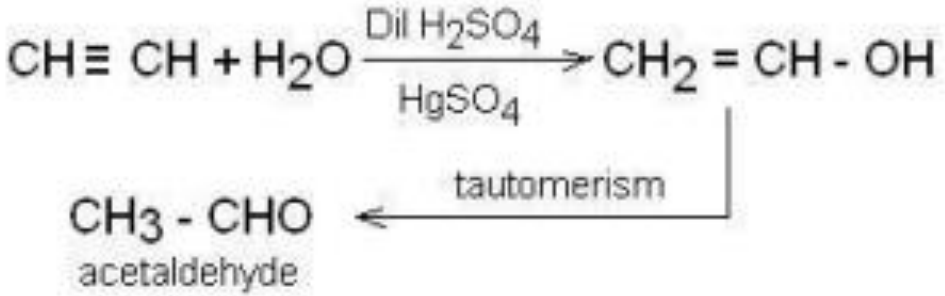


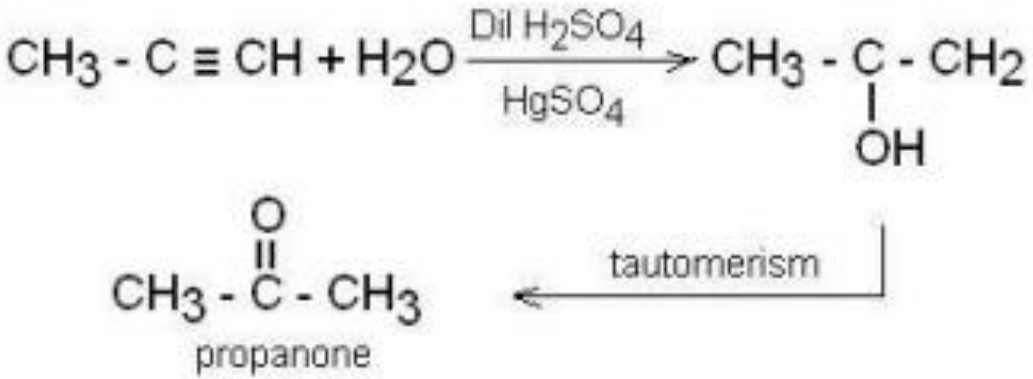
From alkenes

(i) Reductive ozonolysis of alkenes



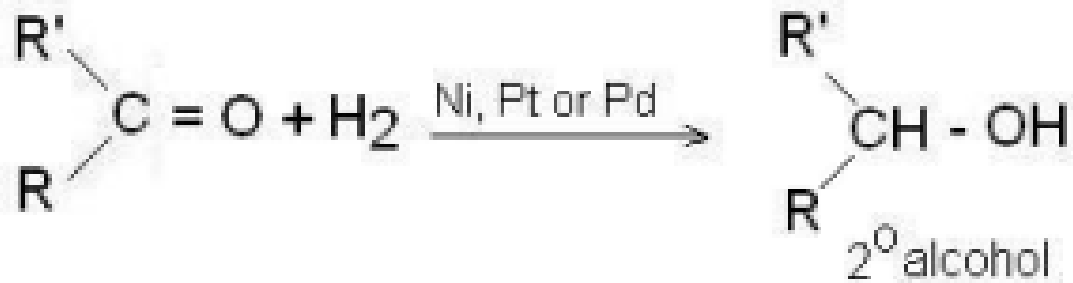
From alkynes





Reduction reactions

I. Catalytic reduction to alcohol



USES OF ALDEHYDES AND KETONES

(a) Uses of formaldehyde

i. The 40% solution of formaldehyde in water (formalin) is used as disinfectant, germicide and antiseptic. It is used for the preservation of biological specimens
ii. It is used for silvering of mirrors
iii. It is used for making synthetic plastics, like Bakelite, urea- formaldehyde resin …..etc

(b) Uses of acetaldehyde

i. It is used in preparation of acetic acid, dyes, drugs, etc
ii. As an antiseptic inhalant in nose troubles

(c) Uses of benzaldehyde

i. As flavoring agent in perfume industry
ii. In manufacture of dyes.

(d) Uses of acetone

i. As a solvent for cellulose acetate, resin etc.
ii. As a nail polish remover
iii. In the preparation of an artificial scent and synthetic rubber