Aldehydes & ketones

Lecture-1

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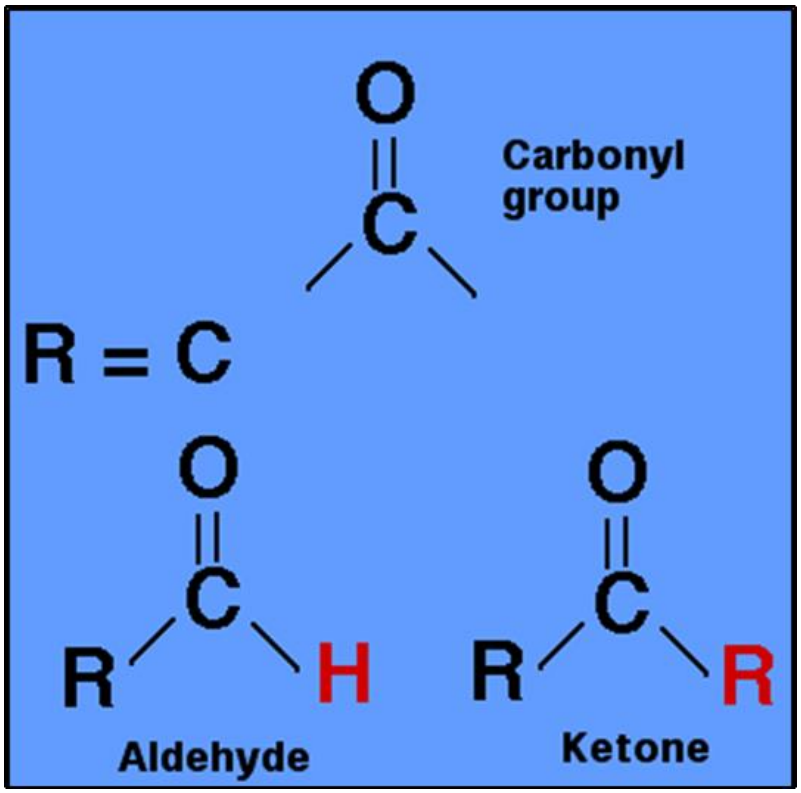
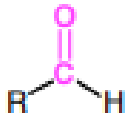

O
C
Carbonyl group
R = C
O
C
R
H
Aldehyde
O
C
R
R
Ketone

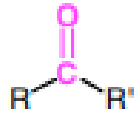
Aldehydes and Ketones

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

- **Aldehydes**

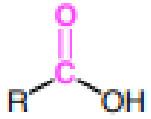


- **Ketones**



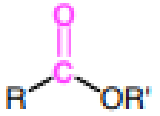
Note: two bonds to heteroatoms

- Carboxylic acids

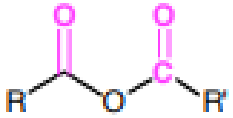


Carboxylic acid derivatives:

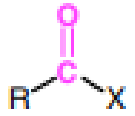
- Esters



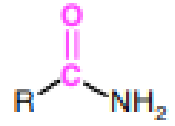
- Anhydrides



- Acid halides

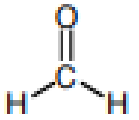


- Amides

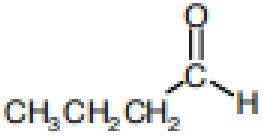


Nomenclature of Aldehydes and Ketones

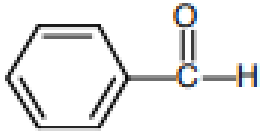
Common names are used for the simplest aldehydes and ketones:



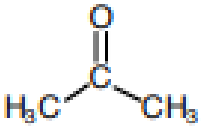
formaldehyde



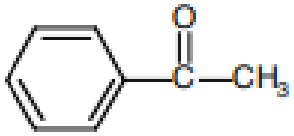
butyraldehyde



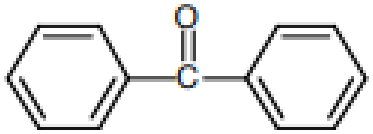
benzaldehyde



acetone

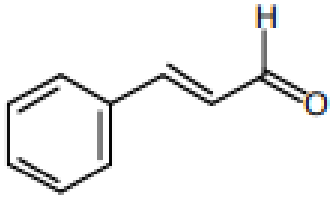


acetophenone

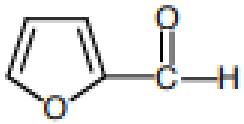


benzophenone

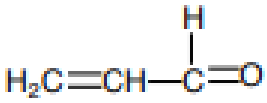
Traditional names are used for a great many aldehydes and ketones which were recognized as substances long before systems of nomenclature were developed:



cinnamaldehyde

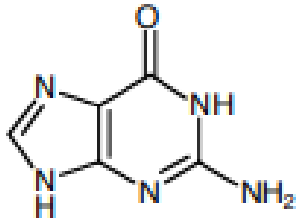


furfural

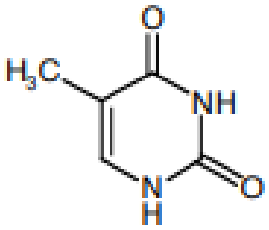


acrolein

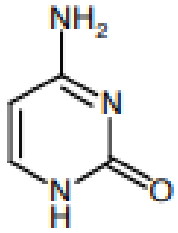
Three of the four bases which comprise DNA contain carbonyl groups:



guanine (G)



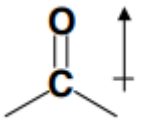
thymine (T)



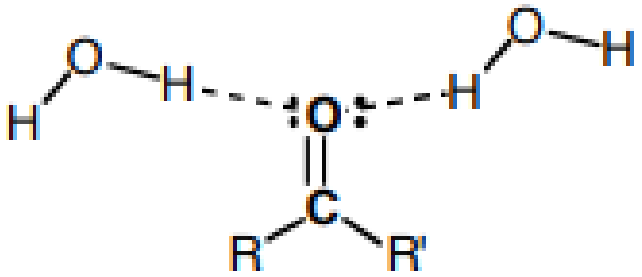
cytosine (C)

Properties of Aldehydes and Ketones

Aldehydes and ketones are polar molecules because the C=O bond has a dipole moment:



• Their polarity makes aldehydes and ketones have higher boiling points than alkenes of similar molecular weight.
• Aldehydes and ketones are not hydrogen bond donors (they can't donate a proton); therefore, they have lower boiling points than alcohols of similar molecular weight.
• Aldehydes and ketones are hydrogen bond acceptors; this makes them have considerable solubilities in water.



Ketones such as acetone are good solvents because they dissolve both aqueous and organic compounds Recall that acetone is a polar, aprotic solvent.

Reactions of Aldehydes and Ketones:

The reactions of aldehydes and ketones can be divided into two main categories:

- Reactions of the carbonyl group
- Reactions involving the Alpha-carbon

Carbonyl group reactions fall into three main groups:

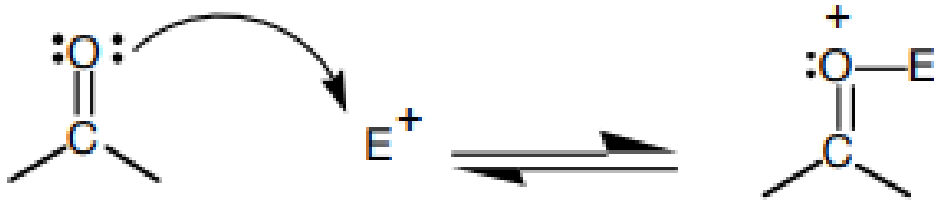
- Reactions with acids
- Addition reactions
- Oxidation

Carbonyl Group Reactions

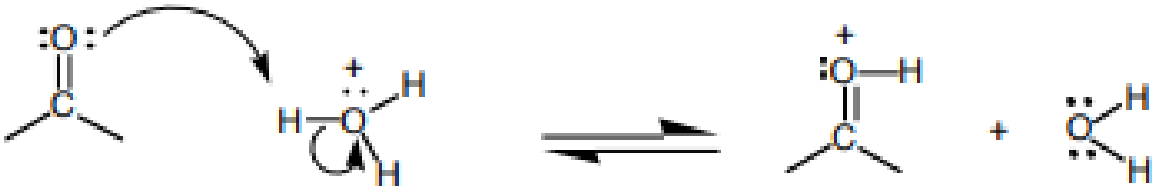
Reactions with acids:

– The carbonyl oxygen is weakly basic.

– Both Bronsted and Lewis acids can interact with a lone pair of electrons on the carbonyl oxygen.



For example, when the Bronsted acid H3O+ is used:



Addition Reactions :

– Carbonyl groups in aldehydes and ketones undergo addition reactions.

– This is one of the most important reactions of the carbonyl group.

Addition reactions occur by two different mechanisms:

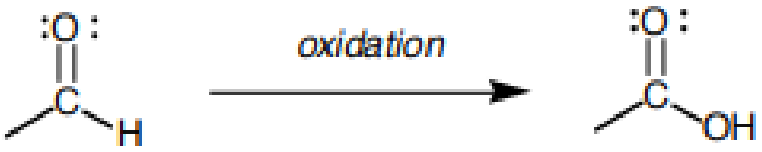
– Base-catalyzed addition (under basic or neutral conditions)

– Acid-catalyzed addition (under acidic conditions)

In some cases, we can carry out the same overall reaction using either set of conditions (acidic or basic).

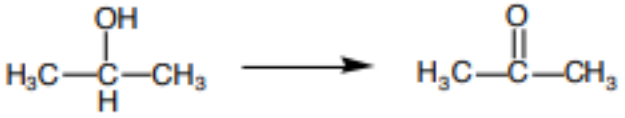
Carbonyl Group Reactions

Carbonyl groups in aldehydes and ketones may be oxidized to form compounds at the next "oxidation level", that of carboxylic acids.



Alcohols are oxidized to aldehydes and ketones (example: biological oxidation of ethanol to acetaldehyde)

• The carbonyl group may be further oxidized to carboxylic acids



alcohol to aldehyde: two electron oxidation

alcohol to carboxylic acid: four electron oxidation

aldehyde to carboxylic acid: two electron oxidation