

# Aldehydes and Ketones

**Aldehydes and ketones** are two related categories of organic compounds that both contain the carbonyl group.



**Aldehydes** have at least one hydrogen atom bonded to the carbonyl group; the other group may be either a hydrogen or an alkyl group.

In **ketones**, the carbonyl group is bonded to two alkyl groups. Ketone does not have a hydrogen atom attached to the carbonyl group.

## Physical Properties

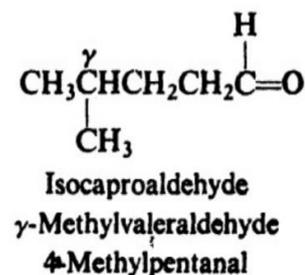
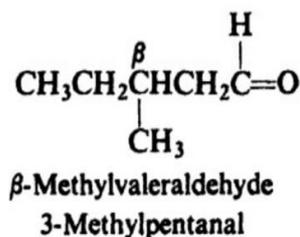
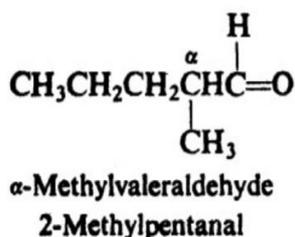
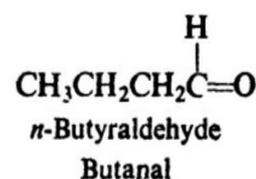
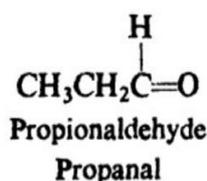
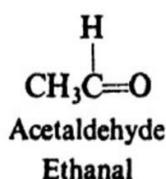
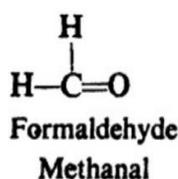
1. All aldehydes and ketones are typically liquids at room temperature, except for:
  - Formaldehyde, which exists as a gas.
  - Paraformaldehyde (the polymeric form of formaldehyde) which is a solid with a melting point of 120°C.
  - Benzophenone, which is also a solid (melting point: 48°C).
2. Aldehydes and ketones are usually colorless, except for benzaldehyde, which has a pale yellow color.
3. The boiling points of aldehydes and ketones are generally lower than those of the alcohols from which they are derived.
4. Aliphatic aldehydes and ketones burn with a blue flame, emitting no smoke, while aromatic ones burn with a yellow, smoky flame.
5. Low M.wt. aldehydes and ketones are significantly soluble in water.
6. Aldehydes and ketones do not have the ability to form hydrogen bonds, unlike alcohols.

## Chemical Properties

- Both aldehydes and ketones are neutral compounds that don't change the color of litmus paper.
- All reactions of aldehydes and ketones are related to the carbonyl group (the active group).
- Aldehydes contain a hydrogen atom attached to its carbonyl while ketones don't. This difference in the chemical structure affects their chemical properties in two ways:
  - Aldehydes are easily oxidized to the corresponding acids & have reducing properties while ketones are not oxidized under similar conditions.
  - Aldehydes are usually more reactive than ketones towards nucleophilic addition, the characteristic reaction of carbonyl group.

## IUPAC Nomenclature for Aldehydes

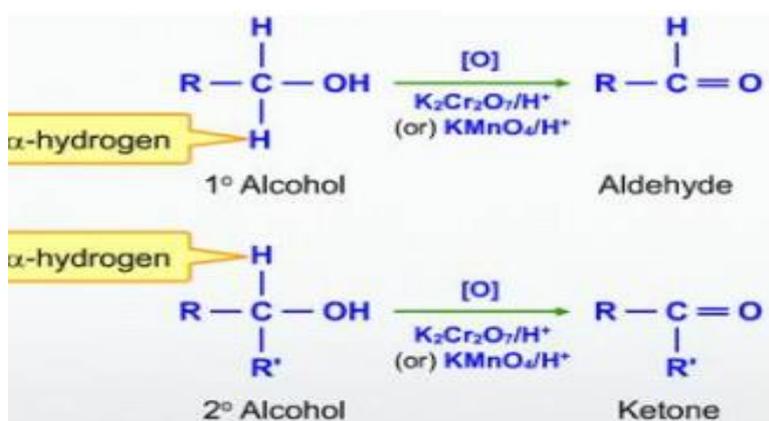
- Open Chain Aliphatic Aldehydes: Replace the '-ane' ending of alkanes with '-al'.
- Numbering: Start from the aldehyde carbon to give the lowest numbers to the substituents.
- Substituents: Prefix them in alphabetical order with their position numbers.



## Preparation of Aldehydes

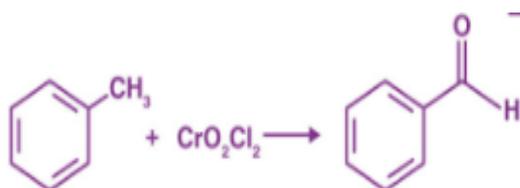
There are various methods that can be used to prepare aldehydes depending upon the type and requirement of the compounds. Following are some important methods of preparation of aldehydes.

**1- By Oxidation of Alcohol:** After the oxidation of primary and secondary alcohols, we can get both aldehydes and ketones. The oxidation of primary alcohols results in the formation of aldehydes while the oxidation of secondary alcohols produces ketones. The general chemical reaction for oxidation of primary and secondary alcohol is shown as:



**2- By Oxidation of Methylbenzene:** Toluene can be oxidised by strong oxidising agents to benzoic acid. The oxidation can be stopped at the aldehyde stage by using those suitable reagents to convert the methyl group to an intermediate that cannot be oxidised further.

- By using chromyl chloride ( $\text{CrO}_2\text{Cl}_2$ ): The reaction of toluene with chromyl chloride results in the formation of a chromium complex which on further hydrolysis produces benzaldehyde. This reaction is called the **Etard reaction**.

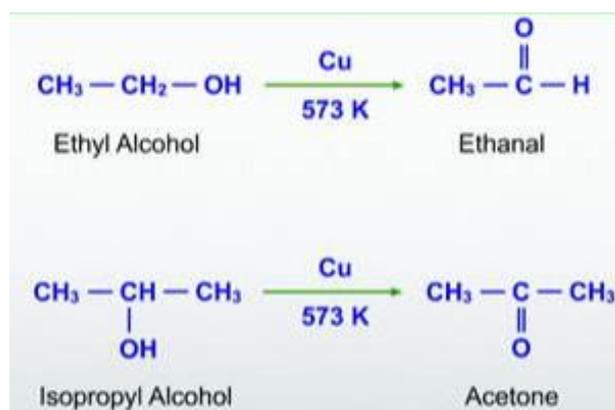


- By using chromic oxide (CrO<sub>3</sub>): The reaction of substituted toluene in the presence of chromic acid in acetic anhydride produces benzylidene diacetate. Then the benzylidene diacetate on hydrolysis gives the corresponding benzaldehyde.
- By Gatterman–Koch reaction: The treatment of carbon monoxide and hydrogen chloride with benzene or its derivative in the presence of aluminium chloride gives benzaldehyde or substituted benzaldehyde. This is called **Gatterman –Koch reaction**.



### 3- By Dehydrogenation of Alcohols

Dehydrogenation means removal of hydrogen. In this method, a primary alcohol is passed over metal catalysts like Copper which results in the formation of an aldehyde. For example, the reaction of ethyl alcohol and isopropyl alcohol with **Cu** as a catalyst produces ethanal and acetone respectively.



### **IUPAC nomenclature for Ketones**

- Find the longest carbon chain containing the carbonyl group.
- Replace the ‘-ane ’in the alkane name with ‘-one’.
- Number the chain so that the carbonyl group has the lowest possible number.
- If there are substituents, name them and their position on the chain.



## Uses of Aldehydes and Ketones

Formaldehyde is the simplest aldehyde whereas acetone is the smallest ketone. There are a number of aldehydes and ketones which find application due to their chemical properties. A few uses of Aldehydes and Ketones are listed below.

### Uses of Aldehydes

- Formaldehyde is a gas. With 40% solution in water, it forms Formalin which is used in preserving biological specimens.
- Formaldehyde is used in preparing glues and polymeric products, as germicides, insecticides, and fungicides for plants.
- When reacted with phenol, formaldehyde forms Bakelite, which is used in plastics, coatings, and adhesives.
- Acetaldehyde is largely used for the production of acetic acid and pyridine derivatives.
- Benzaldehyde is used in perfumes, cosmetic products, and dyes.

### Uses of Ketones

- The most common ketone is acetone which is an excellent solvent for a number of plastics and synthetic fibres.
- Methyl ethyl ketone (MEK), chemically butanone, is a common solvent. It is used in the production of textiles, varnishes, plastics, paint remover, paraffin wax, etc.
- Cyclohexanone is another important ketone which is primarily used in the production of nylon.
- Ketones can be used as fuel additives or even as standalone fuels in some cases.