

# Reactions of Carbonyl Compounds

List important reactions in carbonyl compounds. Preparations and properties



Here are the important reactions, preparation methods, and properties of carbonyl compounds (aldehydes and ketones):

## Important Reactions:

### 1. Nucleophilic Addition Reactions:

- **Addition of HCN:** Carbonyl compounds react with hydrogen cyanide to form cyanohydrins. Example: Ethanal forms 2-hydroxypropanenitrile (cyanohydrin).
- **Addition of NaHSO<sub>3</sub>:** Aldehydes and ketones form bisulfite addition compounds with sodium bisulfite, useful for purification.
- **Addition of Alcohols:** Aldehydes react with alcohols in the presence of acid to form hemiacetals and acetals. Example: Acetaldehyde reacts with methanol to give 1,1-dimethoxyethane .
- **Aldol Condensation:** Aldehydes or ketones having  $\alpha$ -hydrogens react in the presence of base to form  $\beta$ -hydroxy aldehydes or ketones (aldols), which may undergo dehydration to form  $\alpha,\beta$ -unsaturated compounds. Example: Acetaldehyde gives crotonaldehyde (but-2-enal) .

### 2. Oxidation Reactions:

- **Oxidation of Aldehydes:** Aldehydes are easily oxidized to carboxylic acids using oxidizing agents such as KMnO<sub>4</sub> or K<sub>2</sub>Cr<sub>2</sub>O<sub>7</sub>. Ketones are less reactive towards oxidation but under drastic conditions, they can be cleaved to form carboxylic acids .

### 3. Reduction Reactions:

- **Reduction to Alcohols:** Aldehydes are reduced to primary alcohols, and ketones are reduced to secondary alcohols using reducing agents like NaBH<sub>4</sub> or LiAlH<sub>4</sub>. Example: Acetone is reduced to isopropanol .
- **Clemmensen Reduction:** Carbonyl compounds are reduced to hydrocarbons using zinc amalgam and hydrochloric acid .

4. **Haloform Reaction:** Methyl ketones undergo halogenation in the presence of base to form haloforms (CHX<sub>3</sub>). Example: Acetone reacts with halogen and NaOH to form chloroform .

5. **Cannizzaro Reaction:** Aldehydes without  $\alpha$ -hydrogens undergo disproportionation in the presence of strong base to form alcohols and carboxylates. Example: Benzaldehyde forms benzyl alcohol and sodium benzoate .

## Preparation of Carbonyl Compounds:

### 1. Oxidation of Alcohols:

- Primary alcohols oxidize to aldehydes, and secondary alcohols to ketones using reagents like PCC, KMnO<sub>4</sub>, or K<sub>2</sub>Cr<sub>2</sub>O<sub>7</sub> .

### 2. Catalytic Dehydrogenation of Alcohols:

- Vapors of alcohols passed over metal catalysts like copper at high temperatures give aldehydes or ketones .

### 3. Ozonolysis of Alkenes:

- Reductive ozonolysis of alkenes produces aldehydes or ketones, depending on the substituents on the alkene .

## Properties of Carbonyl Compounds:

### 1. Physical State:

- Lower aldehydes are volatile liquids, and formaldehyde is a gas at room temperature. Higher aldehydes and ketones are generally solids .

### 2. Boiling Points:

- Carbonyl compounds have higher boiling points than hydrocarbons due to dipole-dipole interactions but lower than alcohols due to the absence of hydrogen bonding.

### 3. Solubility:

- Lower aldehydes and ketones are soluble in water due to hydrogen bonding, but solubility decreases as the alkyl chain length increases .