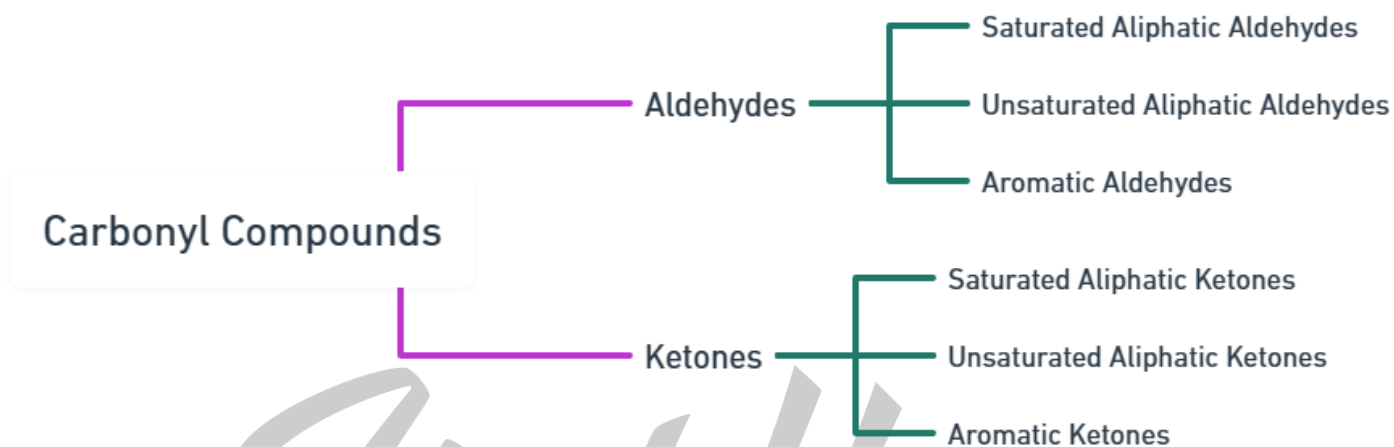


Carbonyl compounds

Carbonyl compounds (Aldehydes and ketones)

- Carbonyl compounds are a significant class of organic compounds, including aldehydes and ketones, characterized by the presence of a carbonyl group ($C=O$).
- This group, comprising a carbon atom double-bonded to an oxygen atom, contributes to their reactivity and polarity.
- Aldehydes and ketones play vital roles in various industrial and synthetic applications due to their distinctive chemical properties.



Aldehydes

- Aldehydes feature a carbonyl group attached to at least one hydrogen atom and either an alkyl or aryl group.
- They are classified based on the nature of the attached carbon chain or ring:

1. Saturated Aliphatic Aldehydes:

- These have a saturated hydrocarbon chain connected to the carbonyl group.
- Examples include formaldehyde ($HCHO$) and acetaldehyde (CH_3CHO).

2. Unsaturated Aliphatic Aldehydes:

- Characterized by one or more double bonds within the hydrocarbon chain attached to the carbonyl group.
- Examples are acrolein ($CH_2=CHCHO$) and crotonaldehyde ($CH_3CH=CHCHO$).

3. Aromatic Aldehydes:

- An aryl group is connected to the carbonyl function.
- Examples include benzaldehyde (C_6H_5CHO) and cinnamaldehyde ($C_6H_5CH=CHCHO$).

Applications of Aldehydes:

- Solvents:** Formaldehyde serves as a solvent in some chemical reactions.

- **Chemical Synthesis Intermediates:** Used in manufacturing plastics, dyes, and perfumes.
- **Preservatives:** Formaldehyde's antimicrobial properties make it useful in medical preservation.
- **Flavorings and Fragrances:** Aromatic aldehydes like cinnamaldehyde and vanillin enhance flavors and scents.

Ketones

- Ketones are characterized by a carbonyl group bonded to two alkyl or aryl groups.
- Their classification is similar to aldehydes but focuses on the nature of the carbonyl-flanking groups:

1. Saturated Aliphatic Ketones:

- These ketones have saturated hydrocarbon chains on both sides of the carbonyl group, with acetone (CH_3COCH_3) and butanone ($\text{CH}_3\text{CH}_2\text{COCH}_3$) being common examples.

2. Unsaturated Aliphatic Ketones:

- These contain at least one unsaturated hydrocarbon chain. Methyl vinyl ketone ($\text{CH}_3\text{COCH}=\text{CH}_2$) and mesityl oxide ($\text{CH}_3\text{C}(\text{O})\text{CH}=\text{C}(\text{CH}_3)_2$) exemplify this category.

3. Aromatic Ketones:

- Here, one or both alkyl groups are replaced with aryl groups. Benzophenone ($\text{C}_6\text{H}_5\text{COC}_6\text{H}_5$) and acetophenone ($\text{CH}_3\text{COC}_6\text{H}_5$) are notable aromatic ketones.

Applications of Ketones

- **Solvents:** Acetone and methyl ethyl ketone are key solvents in paints, coatings, and adhesives.
- **Organic Synthesis Intermediates:** Ketones are pivotal in producing pharmaceuticals, dyes, and polymers.
- **Flavorings and Fragrances:** Muscone and civetone, for example, are used for their unique scents in the fragrance industry.
- **Laboratory Reagents:** Ketones serve as essential reagents in Grignard reactions, aldol condensations, and other laboratory processes.

physical and chemical properties of Carbonyl compounds (Aldehydes and ketones)

Physical Properties

1. Molecular Structure:

- The carbonyl group consists of a carbon atom double-bonded to an oxygen atom, creating a site of high electron density.
- In aldehydes, the carbonyl group is bonded to a hydrogen atom and an alkyl or aryl group. In ketones, it is bonded to two alkyl or aryl groups.

2. Polarity:

- The carbon-oxygen bond is highly polar due to the electronegativity difference between the atoms, resulting in a significant dipole moment.

3. Boiling Points:

- Aldehydes and ketones have higher boiling points than hydrocarbons of similar molecular weight due to dipole-dipole interactions.
- Their boiling points are lower than alcohols and carboxylic acids, as they cannot form hydrogen bonds as effectively.

4. Solubility:

- They are generally soluble in organic solvents and somewhat soluble in water.
- Lower molecular weight aldehydes and ketones are more water-soluble because they can form hydrogen bonds with water molecules.

Chemical Properties

1. Nucleophilic Addition:

- The electrophilic carbon in the carbonyl group is susceptible to attack by nucleophiles.
- This forms the basis of many reactions, such as with amines, hydrides, and cyanides.

2. Oxidation and Reduction:

- Aldehydes are easily oxidized to carboxylic acids by oxidizing agents like KMnO_4 or $\text{K}_2\text{Cr}_2\text{O}_7$.
- Ketones are more resistant to oxidation but can be reduced to alcohols using reducing agents like NaBH_4 or LiAlH_4 .

3. Formation of Hemiacetals and Acetals:

- Aldehydes and ketones can react with alcohols to form hemiacetals and acetals under acid catalysis.

4. Aldol Condensation:

- Aldehydes and ketones can undergo aldol condensation in the presence of a base or acid, forming β -hydroxy aldehydes or ketones.

5. Cannizzaro Reaction:

- Aldehydes without an α -hydrogen undergo the Cannizzaro reaction with strong bases, producing a mixture of a carboxylic acid and an alcohol.

Preparation of Carbonyl compounds (Aldehydes and ketones)

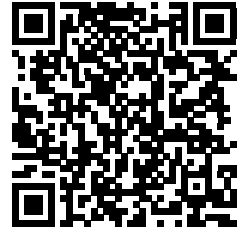


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