Aldehydes and Ketones
1- Nomenclature, Properties and Applications

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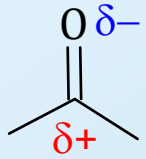
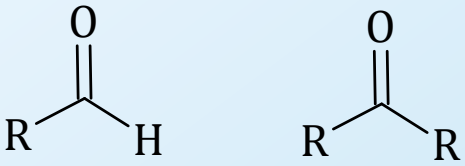
Carbonyl Compounds



Carbonyl carbon is sp^2 hybridized, thus having the properties of 120° bond angle and trigonal planar geometry.

C=O bond is polar with the carbon being the δ+ and the oxygen δ-.

Aldehydes have a H on the carbonyl and is a terminal group. Ketones have two C groups on the carbonyl and are internal groups.



Nomenclature Aldehydes - 1

For IUPAC nomenclature of aldehydes, replace corresponding alkane -*e* with –*al.*

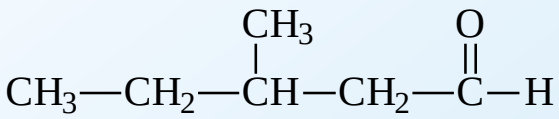
- Numbering always starts with the aldehyde carbon as number 1.
- General names are limited to the first four aldehydes, e.g., the first two carbonyls use "form" and "acet" as prefix. We will use this nomenclature for ketones, acids and amides.
- To name aldehydes use the general name prefix "form" and add -*aldehyde*. The general names are written in italics.

  - HCHO: *form**aldehyde* - methanal
  - CH_3CHO: *acet**aldehyde* - ethanal
  - CH_3CH_2CHO: *propion**aldehyde* - propanal
  - $CH_3CH_2CH_2CHO$: *butyr**aldehyde* - butanal

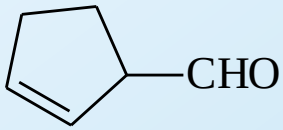
Nomenclature Aldehydes - 2

No matter how long the chain or large the ring, numbering always starts with the aldehyde carbon as number 1.

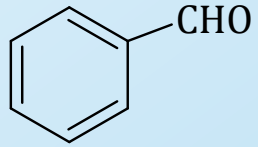
- If -CHO is attached to a ring, use the suffix -*carbaldehyde*.
- On a molecule with both aldehyde and ketone, the higher priority functional group is aldehyde CHO and C=O is *oxo*-.
- In compounds that have higher priority than aldehyde, and -CHO is named as *formyl.*



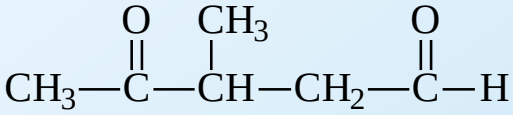
3-methylpentanal



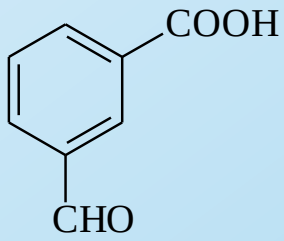
2-cyclopentenecarbaldehyde
cyclopent-2-en-1-carbaldehyde



benzaldehyde



3-methyl-4-oxopentanal

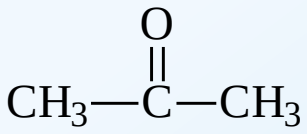


3-formylbenzoic acid

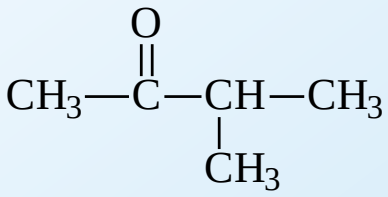
Nomenclature Ketones - 1

In ketone nomenclature replace the corresponding alkane -*e* with -*one*. Indicate the position of the carbonyl with a number.

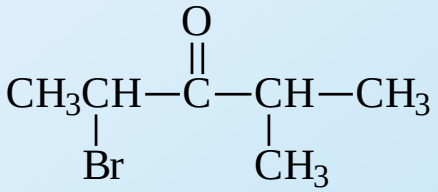
- Number the chain so that carbonyl carbon has the lowest number.
- The names given in italics are the general names.



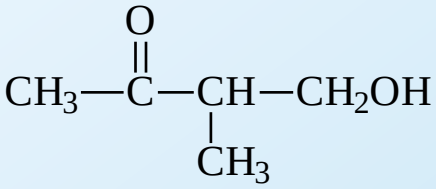
Propan-2-one
Acetone or
Dimethyl ketone



3-methylbutan-2-one
isopropyl methyl ketone



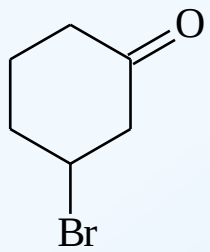
2-bromo-4-methylpentan-3-one
bromoethyl isopropyl ketone



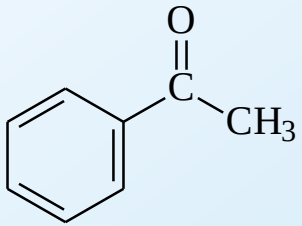
4-hydroxy-3-methylbutan-2-one

Nomenclature Ketones - 2

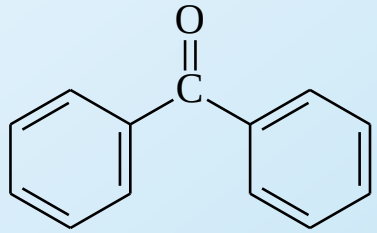
- For cyclic ketones the carbonyl carbon is assigned the number 1.
- The names given in italics are the general names.



3-bromocyclohexanone



Acetophenone
Methyl phenyl ketone



benzophenone

Physical Properties

1) <u>Boiling Points</u>**:** They have higher boiling points than alkanes because of polarity of the carbonyl. They cannot H-bond to each other, so lower boiling point than alcohols.

	$CH_3CH_2CH_2CH_3$	$CH_3OCH_2CH_3$	CH_3CH_2CHO	CH_3COCH_3	$CH_3CH_2CH_2OH$
	Butane	ethylmethylether	propanal	acetone	propanol
Bpt.	0^oC	8^oC	49^oC	56^oC	97^oC

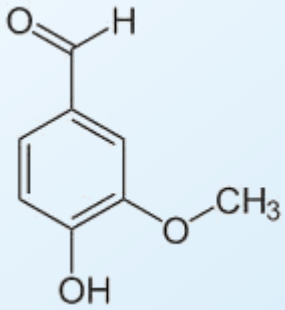
2) <u>Solubility</u>**:** Only small aldehyde and ketones are soluble in water e.g., acetone and acetaldehyde. They are both good solvent for alcohols since lone pair of electrons on oxygen of carbonyl can form a hydrogen bond from O-H or N-H.

3) <u>Odor</u>**:** Most ketones are sweet smelling and aldehydes have unique aroma and a number of them are used as flavoring agents in food e.g., vanillin (vanilla), benzaldehyde (almonds).

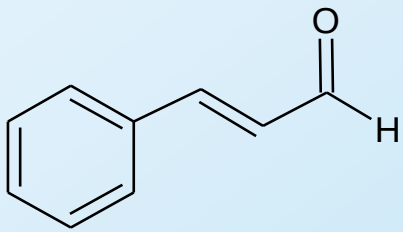
Applications of Aldehydes

- Formaldehyde – mixed with water to form formalin which is used as a preservative. Bakelite a polymer is made from formaldehyde and phenol. Some other polymers are formica and plywood.
- Aldehyde Odors– hexanal (fresh cut grass); heptanal (sage); octanal (citrus smell); nonanal (roses); benzaldehyde (almonds), vanillin (3-methoxy-4-hydroxybenzaldehyde), cinnamaldehyde.

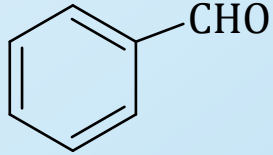
vanillin



cinnamaldehyde



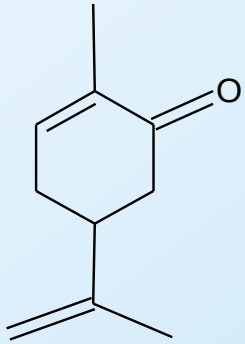
benzaldehyde



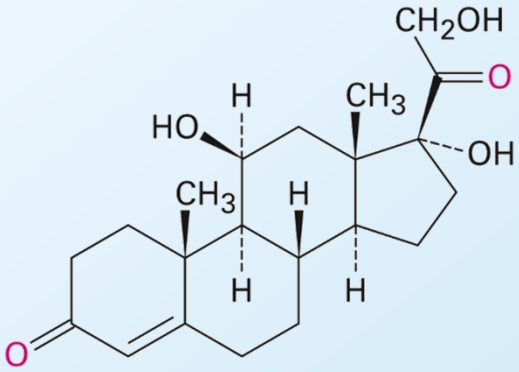
Applications of Ketones

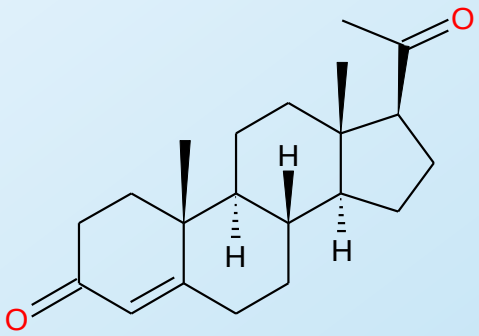
- Acetone – very common solvent
- Ketones in terpenes have sweet odors

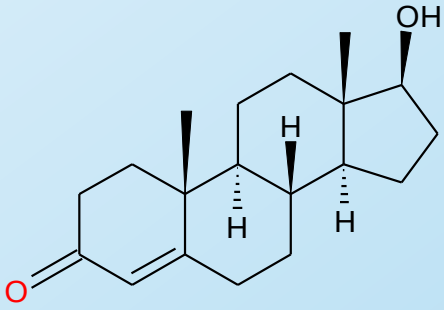
camphor 

carvone 

- Steroids – These are the hormones found in humans and animals.

Hydrocortisone 

progesterone 

testosterone 

Key Concepts

- Nomenclature of aldehydes and ketones
  - IUPAC
  - General
- Physical properties
  - Boiling points
  - Solubility in water