
Carbonyl Compounds
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Carbonyl functional group: >C=O

- **carbonyl- = oxo- group**
- polar, planar, 2 free pairs of electrons (:O:)
- it is found in aldehydes and ketones
- **ALDEHYDES:** terminal carbon; -CHO **-al**
- in addition to a parent chain: **-carbaldehyde**
- *prefix:* **formyl-** (1,2,3-propane tricarbaldehyde)
- **KETONES:** middle carbon; -CO- **- one**
- *prefix:* **oxo- or keto-**

Carbonyl compounds

- **names:** systematic or common (trivial)
- **aldehydes:** substitution principle
  or name derived from the common name of
  a corresponding acid
- **ketones:** substitution principle / radical function
  principle or common names
- **properties:**
  - formation of H-bonds with water $\rightarrow$ solubility of low MW carbonyl compounds in water (C_1-C_4)
  - sharp and irritant odour ($\downarrow$ MW) – toxic comp., alergy;
    or pleasant smell ($\uparrow$ MW)

Carbonyl compounds

- **important aldehydes:**
  - methanal = **formaldehyde**
  - ethanal = **acetaldehyde**
  - 2,3-dihydroxypropanal = **glyceraldehyde**
  - benzaldehyde *(bitter almond odour, little toxic)*
- **important ketones:**
  - propanone = dimethyl ketone = **acetone**
  - 1,3-dihydroxypropanone = **dihydroxyacetone**

ketones are more narcotic than aldehydes

Carbonyl compounds

Aromatic ketones

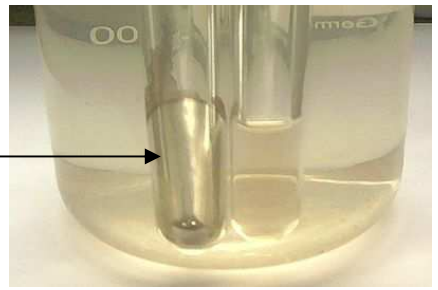
- with phenyl group: **phenones** (-ophenone)
- with naphtyl group: **naphtones** (-naphtone)
- *root of acyl* name (= rest of a carboxylic acid)
  + the suffix
  - acetophenone = methyl phenyl ketone
  - benzophenone = diphenyl ketone
  - 2-acetonaphtone = methyl 2-naphtyl ketone

Carbonyl compounds - REACTIONS

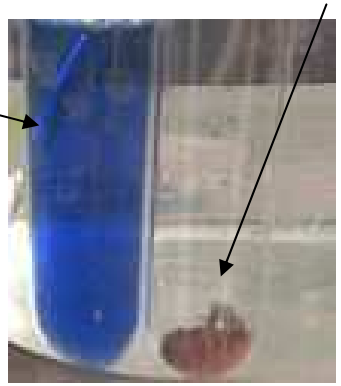
1. oxidation

- prim. alcohol → aldehyde → carboxylic acid
- sec. alcohol → ketone → no more oxidized

Tollens´ reagent: $[Ag(NH_3)_2]^+ \rightarrow Ag$



Benedict´s or ***Fehling´s solution:*** $Cu^{2+}(l) \rightarrow Cu_2O\ (s)$



2. reduction

- aldehyde → primary alcohol
- ketone → secondary alcohol

Carbonyl compounds - REACTIONS

3. addition reactions

a) **<u>addition of water</u>**
hydrate is formed (it exists only in aqueous solution)
e.g. formalin

b) **<u>addition of alcohols</u>**
hemiacetal or hemiketal is formed (see saccharides)
= unstable compounds; but cyclic products are stable
If 2nd alcohol reacts → acetals or ketals
(e.g. disaccharides)
reversible reaction: ***hydrolysis***

c) **<u>addition of nitrogen compounds</u>**
imine is formed (it is important in biochemistry)

Carbonyl compounds - REACTIONS

4. reactions of alpha carbon atom (= 2nd C)

- the carbon is somewhat acidic

a) keto-enol tautomers *(constitutional isomers)*
aldehydes and ketones exist in an equilibrium mixture of the keto and enol forms

b) aldol condensation
= reaction between two molecules of carbonyl compounds
→ β-hydroxyaldehyde („**aldol**") is formed

EXERCISE

- cyclohexanol
- cyclohexane carbaldehyde
- cyclohexanone
- dicyclohexyl ether
- diphenyl ether
- phenol
- β-naphtol
- benzyl alcohol
- phenyl propyl ether
- ethyl methyl ketone
- propanal
- methyl phenyl ether
- methyl phenyl ketone
- 2-methylcyclopentanone
- 1-hydroxybutanone
- benzaldehyde