

CARBONYL COMPOUNDS

= substances containing the carbonyl group

Aldehydes have the C=O group at the end of the chain, the aldehydic group is then

Naming of aldehydes:

In the systematic name there is a suffix after the stem indicating the number of carbon atoms **including** the one for the carbonyl group.

1. Fill in the table

HCHO			octanal
	ethanal		pentanal
C ₃ H ₇ CHO		C ₆ H ₁₃ CHO	
C ₂ H ₅ CHO			hexanal

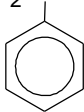
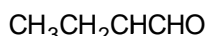
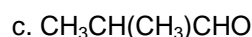
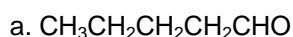
Ketones have the oxygen on a non-terminal carbon atom in the chain, keto group is

Systematic name: suffix after a stem indicating the **overall** number of carbon atoms + the number indicating the position of the carbonyl group in the chain

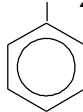
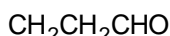
2. Fill in the table

CH ₃ -CO-CH ₃			heptan-3-one
	butanone	C ₃ H ₇ COC ₂ H ₅	
CH ₃ COCH ₂ CH ₂ CH ₃			hexan-2-one
	pentan-3-one	CH ₃ COC ₅ H ₁₁	

3. Name the following carbonyl compounds:



d.



e.



4. Write down the structural formulae for the following compounds:



5. Of the compounds in 1 and 2, which are structural isomers?

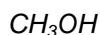


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The nature of the - CO group

Physical properties

6. Estimate the type and the extent of interactive forces between C_2H_6 ($M_R = 30$), CH_3OH ($M_R = 30$) and $HCHO$ ($M_R = 30$) and put these compounds in order with respect to increasing boiling point.



Methanal is a gas, other important carbonyl compounds are

Early members are soluble in water due to between hydrogen from water and oxygen from the carboxylic group.

As the length of the non-polar chain increases the influence of C=O group on the properties

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Chemical properties

The charge on the carbon atom makes carbonyl compounds attractive towards

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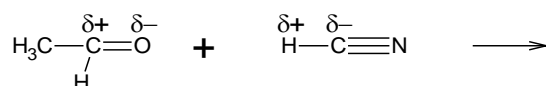
1. addition A.....

The readiness to undergo A_N decreases with increasing number of carbon atoms, ketones are generally less reactive than aldehydes. This is caused by alkyl groups that tend to electrons to the carbon atom of the carbonyl group. The positive charge on it is cancelled somewhat.

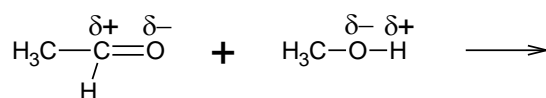
7. Put $HCHO$, CH_3COCH_3 and CH_3CHO in order with respect to decreasing reactivity.

Benzyldehyde C_6H_5CHO is even less reactive because of the delocalization of the positive charge over the benzene ring.

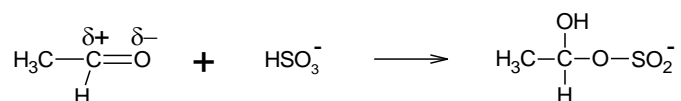
a. reaction with HCN \rightarrow hydroxynitriles



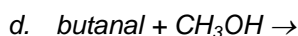
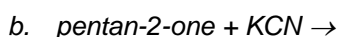
b. reactions with alcohols \rightarrow hemiacetals



c. reactions with hydrogensulphites → sulphites



8. Give the name and structural formula of the organic product formed in each of the following reactions:



2. Redox reactions

- **reduction** (hydrogenation)

Aldehydes are reduced to alcohols, ketones are reduced to alcohols. The most common reducing agents: LiAlH₄ (lithium tetrahydridoaluminum), NaBH₄ (sodium borohydride) or H₂ in the presence of a nickel catalyst.

- **oxidation**

Ketones are resistant towards oxidation while aldehydes may be oxidised to This is the principle way to recognize aldehydes from ketones.

Tollens' reaction

aldehyde + Tollens reagent (AgNO₃ + NH₃(aq)) → carboxylic acid + Ag

Fehling's reaction

aldehyde + Fehling reagent (CuSO₄ in alkaline conditions) → carboxylic acid + Cu₂O

9. From the following compounds select those that will react with

a. Tollens' reagent

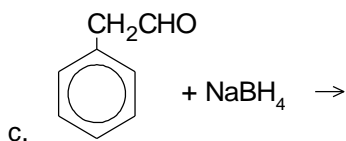
b. Fehling's solution

ethanal, propanone, phenylethanone, propanal, methanal

10. Give the names and formulae of the organic products formed in each of the following reactions:

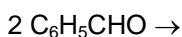
a. (CH₃)₂CHCHO + Tollens' reagent →

b. 3-methylbutan-2-one + LiAlH₄ →



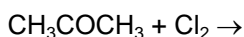
Cannizaro's reaction

It is a disproportionation reaction that takes place on aldehydes with no H atoms on the α -carbon. E.g. methanal is in the presence of NaOH simultaneously oxidised to and reduced to.....



3. Reactions on the α -carbon

- a. halogenation → α -halogeno compounds



- b. haloform reaction, takes place in alkaline conditions with an excess of halogen. Iodoform reactions are used for testing for the presence of $-\text{COCH}_3$ group.



This reaction is positive also with $-\text{CHOH-CH}_3$ group because it is oxidised by iodine to

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11. By drawing the structures of the following compounds, state which will give a positive iodoform test:

a. benzaldehyde

d. butanone

f. phenylethanone

b. propanal

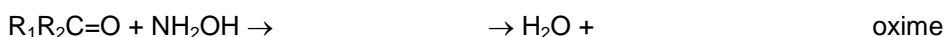
e. 2-methylpropan-2-ol

g. propan-2-ol

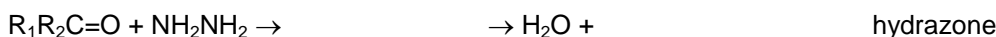
c. ethanol

4. Addition – elimination reaction

- a. reactions with hydroxylamine → oximes



- b. reactions with hydrazine → hydrazones



Tautomerism

enol form

keto form (more stable)



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Manufacture and preparation

- oxidation of alcohols
aldehydes: primary alcohols
ketones: secondary alcohols
12. Give the names and formulae of the alcohols which can be oxidised to give the following carbonyl compounds:
 - butanal
 - 3-methylbutan-2-one
 - 2-methylpropanal
 - cyclohexanone
 - benzaldehyde
 - 3-phenylbutanal
 - pentan-2-one
 - phenylethanone
- acetaldehyde is made by hydration of ethyne
- acetone is produced by oxidation of cumene

Uses of carbonyl compounds

Methanal (formaldehyde)

Ethanal

Propanone

Benzaldehyde

Cyclohexanone