Higher Chemistry: Unit 2 – Nature's Chemistry

Part B – Alcohols, Oxidation and Esters

Lesson 3 – Distinguishing between aldehydes and ketones and summary of oxidation

Learning Outcomes

By the end of this lesson you should know:

1. How to distinguish between an aldehyde and ketone in the laboratory
2. The names of three oxidising agents for aldehydes.
3. That when aldehydes oxidise, they can produce carboxylic acids. Ketones do not oxidise.
4. How to draw and name carboxylic acids.

Success Criteria

You will have been successful in this lesson if you:

1. Read and learn the notes given
2. Watch the links provided
3. Complete questions provided
4. EXTENSION: There is also a further reading section to help you gain more depth of understanding for this section.

If you have any questions about the content of this lesson, you should ask your class teacher either through your class MS team or via email. The teams will be monitored through the week and someone will get back to you as soon as they can.

Links to Prior Knowledge

You may wish to revise the following to help you understand this lesson:

- National 5 chemistry – alcohols and carboxylic acids

You may wish to have a copy of the data booklet handy for this lesson. Download or print a copy of the Higher Chemistry Data Booklet from MS Teams or the SQA website - https://www.sqa.org.uk/sqa/files_ccc/ChemistryDataBooklet_NewH_AH-Sep2016.pdf

Notes - Check your class notes - you may have already covered this in class. If so, you do not need to copy this lesson, as it is just a revision of what you covered in school. You may wish to add to your notes with the content below.

If you have not covered this in school, then you should either copy, print or save the notes below.

A full copy of these notes are available on the Higher Chemistry Teams site and you will receive a paper copy when we return to school.

Distinguishing between Aldehydes and Ketones

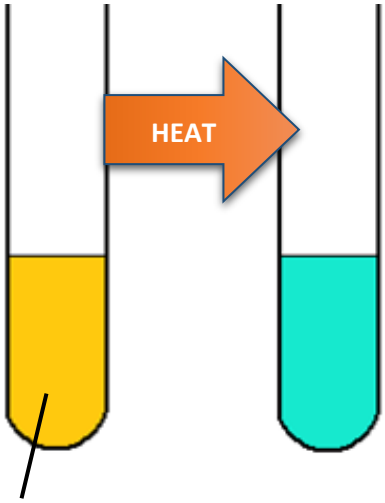
Click here for a 5 minute PowerPoint with voice recording from Ms Hastie for this lesson

Distinguishing between Aldehydes and Ketones

Aldehydes can undergo further oxidation to produce carboxylic acids. Ketones cannot undergo further oxidation. In an experiment, the following oxidising agents can be used to oxidise aldehydes.

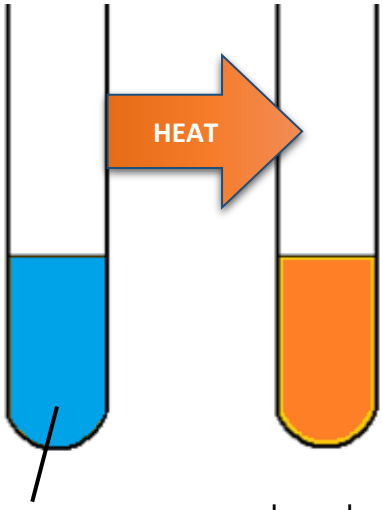
Oxidising Agent	Colour Change
acidified dichromate, $Cr_2O_7^{2-}$	orange to green-blue
Fehling's solution (Benedict's solution)	blue to brick red
Tollens' reagent	Colourless to silver mirror

1. Oxidation of propanal (aldehyde) using acidified dichromate solution and Fehling's solution.



propanal in acidified dichromate solution

colour change from orange to blue-green

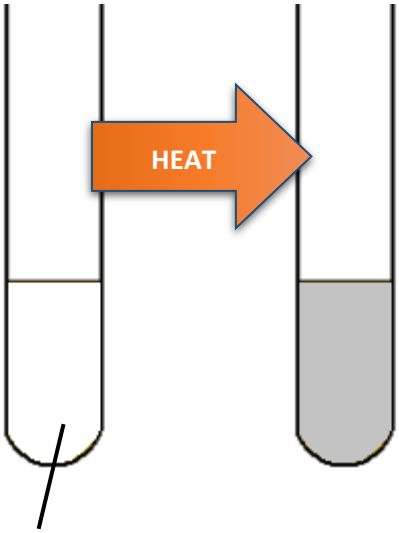


propanal in Fehling's solution

colour change from blue to a brick red precipitate

These reactions would both produce propanoic acid. If the reaction was repeated using propanone (ketone), no change would take place in either experiment.

2. Oxidation of butanal (aldehyde) using Tollen's Reagent



butanal in Tollens' reagent

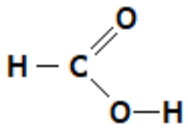
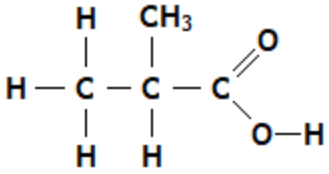
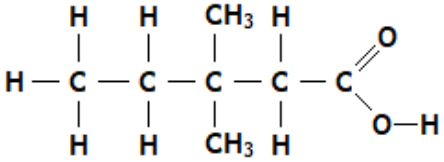
A silver mirror appears

This reaction would produce butanoic acid.

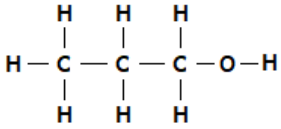
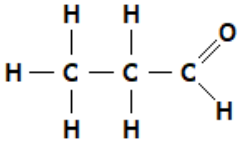
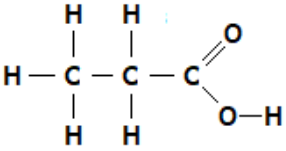
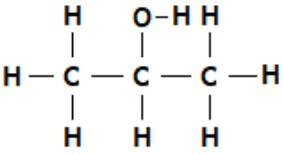
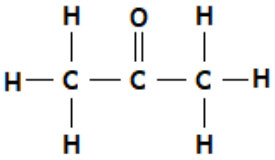
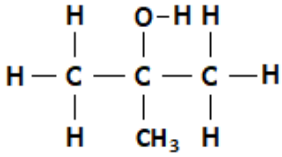
If the reaction was repeated using butanone (ketone), no change would take place.

Carboxylic Acids

The carboxylic acids are a homologous series with the general formula $C_nH_{2n+1}COOH$. Carboxylic acids are identifiable by their carboxyl functional group (-COOH), which is always positioned on the end of the carbon chain. A selection of carboxylic acids are shown below:

Name	Molecular formula	Extended structural formula	Shortened structural formula
methanoic acid	HCOOH		HCOOH
methylpropanoic acid	C_3H_7COOH		$CH_3CH(CH_3)COOH$
3,3-dimethylpentanoic acid	$C_6H_{13}COOH$		$CH_3CH_2C(CH_3)_2CH_2COOH$

SUMMARY OF OXIDATION REACTIONS

Starting Alcohol	Oxidising Agent	Product of Oxidation	Oxidising Agent	Product of Further Oxidation
Primary alcohol  propan-1-ol	hot copper oxide (black to red/brown)	Aldehyde  propanal	acidified dichromate solution (orange to green-blue)	Carboxylic acid  propanoic acid
Secondary alcohol  propan-2-ol	acidified dichromate solution (orange to green)	Ketone  propanone	 Fehling's solution (blue to brick red)	**NO REACTION**
Tertiary alcohol  methylpropan-2-ol		**NO REACTION**	Tollens' Reagent (silver mirror appears)	

SUMMARY

1. Oxidising agents for aldehydes include:

   acidified dichromate solution – changes from orange to green

   Fehling's solution – changes from blue to brick red

   Tollens' Reagent – a silver mirror appears

2. **Aldehydes** can be oxidised to **carboxylic acids.**
3. **Ketones cannot be** oxidised.
4. Carboxylic acids are the products of oxidation of primary alcohols and aldehydes.

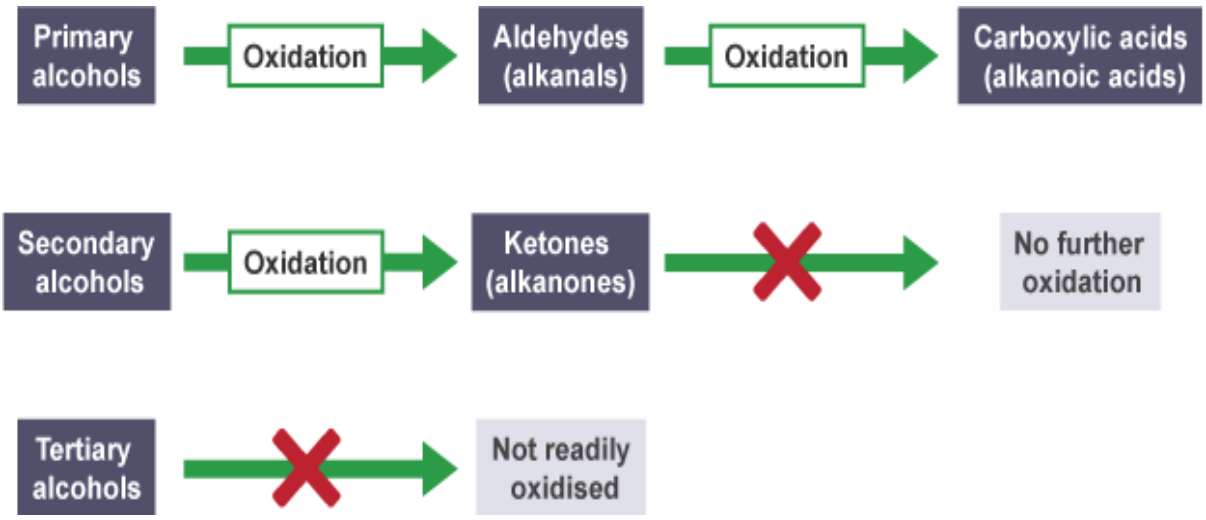


Image from BBC bitesize

Learning Outcomes

You should now know:

1. How to distinguish between an aldehyde and ketone in the laboratory
2. The names of three oxidising agents for aldehydes.
3. That when aldehydes oxidise, they can produce carboxylic acids. Ketones do not oxidise.
4. How to draw and name carboxylic acids.

Further Reading

To learn more about oxidation of alcohols, try the following online resources:

BBC Bitesize: https://www.bbc.co.uk/bitesize/guides/zyq22hv/revision/2

Scholar: Log in through GLOW

Higher Chemistry → Nature's chemistry → Oxidation of food → read content 9.6

Evans2 chem web: https://www.evans2chemweb.co.uk/login/index.php#

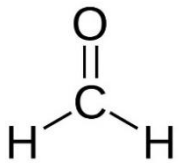
Username: snhs password: giffnock

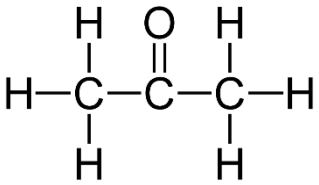
Select any teacher → revision material → CfE Higher → Unit 2: Nature's Chemistry → Oxidation of food

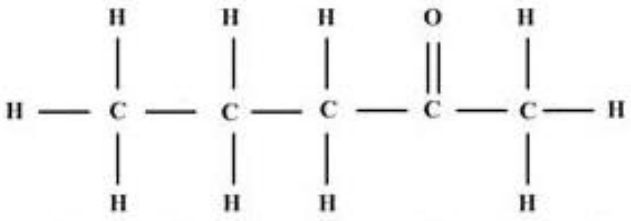
Check your understanding – Answers the questions below in you class jotter

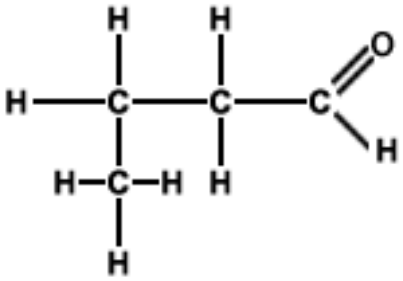
2.5 Aldehydes and Ketones (i)

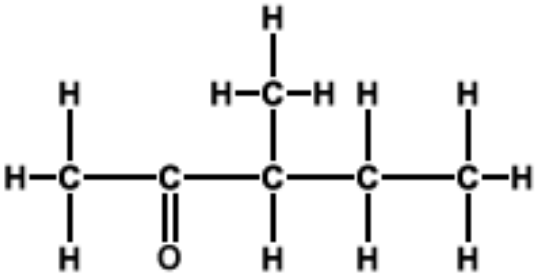
1. For the compounds below:
(i) name and give the shortened structural formula
(ii) name the alcohols that would be oxidised to form them.

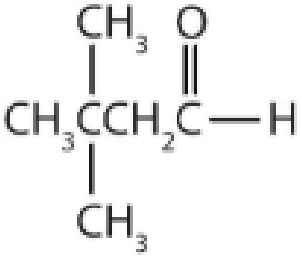
a) 

b) 

c) 

d) 

e) 

f) 

2. Give the extended structural formula **and** name for the following compounds.

a) CH_3CHO
b) $CH_3COCH_2CH_3$
c) $CH_3CH_2CH_2CH_2COCH_3$
d) $CH_3C(CH_3)_2CHO$
e) $CH_3CH(CH_3)CH_2CH(CH_3)CH_2CHO$
f) $CH_3C(CH_3)_2COCH_3$

2.6 Aldehydes and Ketones (ii)

1. A student carried out the "silver mirror" test to investigate which solution was an aldehyde or ketone.

a) **Explain** what substance will be identified from the positive test?
b) Name 2 other chemicals and colour changes(before and after) that could be used in the above investigation.

2. Butanal has 2 isomers.

a) Name and draw the full structural formula of each isomer.
b) Both structures contain the same functional group. Draw the structure and name this group.

3. Name the **final** substance present for each of the experimental conditions given below:

a) Propan-1-ol treated with acidified potassium dichromate solution.
b) Pentan-2-one treated with Fehling's solution.
c) Butan-2-ol treated with hot copper(II) oxide.
c) 2-methyl propan-2-ol treated with acidified potassium dichromate solution.
d) Methanal treated with Tollen's reagent.

4. Identify the reaction types below as oxidation or reduction.

a) ethanol → ethanal
b) propanoic acid → propan-1-ol
c) methanal → methanol
d) pentan-1-ol → pentanoic acid
e) $CH_3CH(OH)CH_3 \rightarrow CH_3COCH_3$
f) $CH_3C(CH_3)_2CHO \rightarrow CH_3C(CH_3)_2CH_2OH$

5. The boiling points and solubility of propanal and butane are shown in the table below:

Substance	Boiling point (°C)	Soluble in water
Propanal	49	Yes
butane	-1	no

a) **Explain** why it is fair to use the boiling point of butane rather than propane when comparing with propanal?
b) **Explain** why propanal has a higher boiling point than butane.
c) **Explain** the solubility results in the above table.

EXTENSION WORK

If you have already completed the above exercises in school, you should completed the following blue book questions:

Carbonyl compounds page 51 Q1-5

Oxidation of carbon compounds Page 55 Q11-14

ANSWERS TO EXERCISES WILL BE POSTED ON WEDNESDAY FOR YOU TO CHECK YOUR WORK