

GCE AS / A LEVEL – CHEMISTRY UNIT 2 QUESTION PACK

1092-01 (Legacy CH2) · New spec Unit 2 Topic 5 · AS unit, first sat 2016, 80 marks, 1h 30min paper

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CHEMISTRY – UNIT 2 · ALCOHOLS & MDASH; OXIDATION, DEHYDRATION & ESTERIFICATION

Topic 2.7 – Alcohols: oxidation by acidified dichromate, dehydration to alkenes, esterification and functional-group tests

Alcohol chemistry: oxidation of primary alcohols to aldehydes then carboxylic acids and secondary alcohols to ketones (acidified $K_2Cr_2O_7$), dehydration to alkenes, esterification with carboxylic acids, and using functional-group tests including IR spectroscopy.

Legacy 2008 specification**Estimated time for entire question pack: ~2 h 22 min**

Derived from the legacy CH2 paper's pace of ~1.1 min/mark, padded for long-prose answers (89 marks over 10 questions).

*You are advised to **not** attempt to complete all of this in one sitting.*

ABOUT THIS QUESTION PACK

This is a **comprehensive practice question pack**, not a single mock paper. It contains every question from the legacy WJEC CH2 papers (2008 modular spec, Jan 2010 – Jun 2016) that maps onto the new-spec AS Unit 2 Topic 2.7.

Questions are ordered by source paper date.

INSTRUCTIONS

Use black ink or black ball-point pen. Show all working – quality of written communication will affect marks. A calculator is allowed. You may need the WJEC Periodic Table / Data Booklet.

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Q	Source	Max	Mark
1	Jun 09 Q8	15	
2	Jan 10 Q9	12	
3	Jan 11 Q1	2	
4	Jun 11 Q6	3	
5	Jan 12 Q4	15	

Q	Source	Max	Mark
6	Jun 12 Q11	9	
7	Jun 13 Q8	16	
8	Jun 15 Q5	2	
9	Jun 16 Q6	1	
10	Jun 16 Q8	14	
Total		89	

Alcohols – Oxidation, Dehydration & Esterification – what the new spec asks

WJEC GCE AS / A Level Chemistry (from 2015) · Unit 2: Energy, Rate & Chemistry of Carbon Compounds · Topic 2.7.

Alcohols – classification

- Primary: -OH on C with one carbon neighbour.
- Secondary: -OH on C with two carbon neighbours.
- Tertiary: -OH on C with three carbon neighbours.
- Naming: parent chain + -ol with locant.

Oxidation

- Oxidising agent: acidified $\text{K}_2\text{Cr}_2\text{O}_7 / \text{H}_2\text{SO}_4$.
- Primary: alcohol \rightarrow aldehyde (distil off) \rightarrow carboxylic acid (reflux).
- Secondary: alcohol \rightarrow ketone (no further oxidation).
- Tertiary: not oxidised.
- Colour change: orange Cr(VI) \rightarrow green Cr(III).

Dehydration

- Alcohol + conc. H_2SO_4 (or Al_2O_3) \rightarrow alkene + H_2O .
- Elimination type reaction.
- Useful synthesis of alkenes from biomass-derived ethanol.

Esterification & H-bonding

- Alcohol + carboxylic acid $\xrightarrow{[\text{conc. H}_2\text{SO}_4]}$ ester + H_2O .
- Reversible; conc. H_2SO_4 catalyses and dehydrates.
- -OH gives extensive H-bonding \Rightarrow high boiling temp, water solubility.

Alcohols – Oxidation, Dehydration & Esterification in one page

Quick-reference notes – revisit before each question.

Classification quick

Count carbons attached to the C bearing OH: 1° (1 C), 2° (2 C), 3° (3 C).

Oxidation summary

1° → aldehyde (distil) → acid (reflux).
2° → ketone.
3° → no reaction.
Reagent: $K_2Cr_2O_7/H_2SO_4$. Orange → green.

Distil vs reflux

Distil: remove aldehyde as it forms (stops at aldehyde).
Reflux: keep in flask to oxidise fully to acid.

Dehydration

Alcohol $\xrightarrow{[conc. H_2SO_4, 170^\circ C]}$ alkene + H_2O . Removes -OH and a β -H.

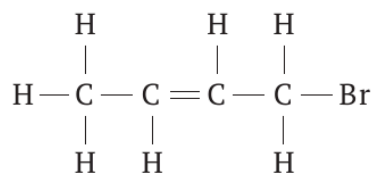
Esterification

$R-OH + R'COOH \xrightarrow{[conc. H_2SO_4, warm]}$
 $R'COOR + H_2O$.
Reversible; sulfuric acid removes water + catalyses.

Why H-bonding matters

-OH gives high b.p., good solubility in water for short chains. Lost as chain length grows (alkyl tail dominates).

8. (a) As part of a project, two students were asked to report on tests for functional groups present in the compound below.



Nia reported that, in testing for the C = C group,

- aqueous bromine should be added to the compound and if the test is positive, the colour of the mixture changes from purple to colourless;
- the name of the compound formed in this test is 2,3,4-tribromobutane.

- (i) Correct the two mistakes in her report.

I. [1]

II. [1]

David reported that, in testing for the $\begin{array}{c} \diagup \\ \text{C} \\ \diagdown \end{array} - \text{Br}$ group,

- dilute hydrochloric acid should be added to the compound;
- aqueous silver nitrate should then be added;
- you should then see a cream precipitate that dissolves completely in dilute aqueous ammonia.

- (ii) I. State what chemical should be added before adding any acid. [1]

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II. Why is it wrong to use dilute hydrochloric acid? [1]

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III. State the error in the third statement. [1]

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- (b) 1-Bromobut-2-ene can be made from but-2-en-1-ol.



boiling temperatures/°C 121

98

- (i) Use the infrared absorption frequencies given in the Data Sheet to explain how you would know if a sample of 1-bromobut-2-ene contains unreacted but-2-en-1-ol. [2]

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- (ii) Use your understanding of intermolecular forces to explain why but-2-en-1-ol has a higher boiling temperature than 1-bromobut-2-ene.
Your answer should include:
- a description of all the intermolecular forces present for each compound;
 - the relative strengths of the intermolecular forces present. [6]

(QWC) [2]

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Total [15]

Examiner
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9. (a) Compound **A** contains carbon, hydrogen and oxygen only. It has a molar mass of 88.1 g mol^{-1} . Quantitative analysis of the compound shows that its percentage composition by mass contains 54.5% carbon and 9.10% hydrogen. Calculate both the empirical and molecular formulae of compound **A**. [4]

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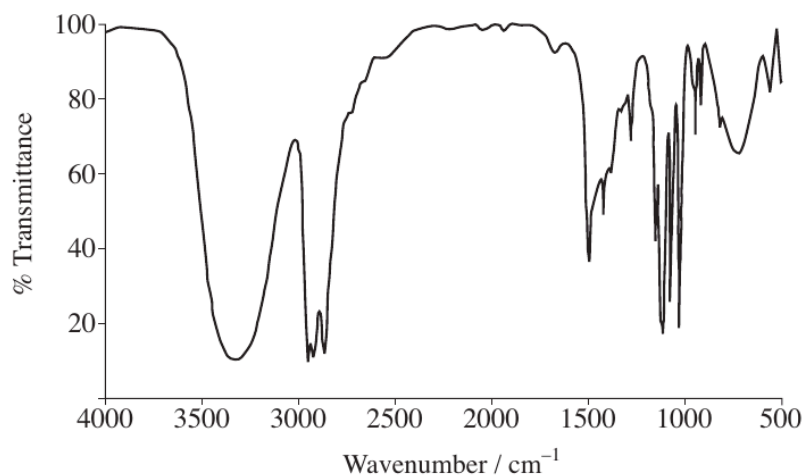
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- (b) Propan-1-ol has the infrared spectrum below.



- (i) Using the data sheet, state how this spectrum confirms which functional group is present in propan-1-ol. [1]

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- (ii) Propan-1-ol can be completely oxidised to form compound **B**. Name compound **B** and state how you would expect its infrared spectrum to differ from that of propan-1-ol. [2]

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- (c) Propan-1-ol can also form propene by a dehydration reaction. Name a suitable reagent for this reaction. [1]

Examiner
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- (d) Describe a test, including reagents and expected observations, to show that propene contains a C = C double bond. [2]

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.....

- (e) Propene can be polymerised to form poly(propene).
Give the formula of the repeating unit in poly(propene). [1]

- (f) Substituted alkenes can also be polymerised to give useful polymers.
Name an important polymer formed from a substituted alkene. [1]

.....

Total [12]

SECTION A

Answer **all** questions in the spaces provided.

1. (a) Ethanol is present in many intoxicating drinks. Give **one** health problem associated with the consumption of excess ethanol. [1]

.....

- (b) Ethanol can be converted to ethanoic acid in an oxidation reaction. Give suitable reagents for this reaction. [1]

.....

2. Calcium compounds are important in many biological systems. Give an example of where a calcium compound is used in a living organism. [1]

.....

3. State which one of the following species has the smallest bond angle. [1]

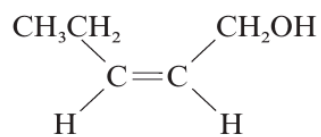


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4. Write a chemical equation for the displacement reaction that occurs when chlorine gas is bubbled through a solution of sodium bromide, NaBr. [1]

.....

6. The compound below has a cherry odour and is used in the manufacture of fragrance agents.



- (a) Name the functional groups present in this compound. [2]

.....

- (b) State the **molecular** formula of the compound. [1]

.....

Section A Total [10]

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SECTION A

Answer **all** questions in the spaces provided.

1. 'Smart' alloys have an increasing importance in many applications. State how 'smart' alloys differ from other alloys in the way in which they act when used for a particular purpose. [2]

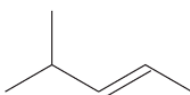
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2. A small piece of sodium metal is added to water. Give the equation for this reaction and suggest a pH value for the resulting solution. [2]

Equation

pH of solution

3. The skeletal formula of a hydrocarbon is shown below.



Give the **systematic name** of this hydrocarbon. [1]

.....

4. Police use a breathalyser to test motorists for the presence of alcohol.

(a) An early type of breathalyser required the motorist to breathe into a tube that contained acidified potassium dichromate. The alcohol in their breath was oxidised to ethanal and ethanoic acid. State the colour change that occurred if the test was positive. [1]

..... to

(b) Modern breathalysers use infrared spectroscopy to detect and measure the concentration of alcohol in breath. An absorption frequency at 2940cm^{-1} is used rather than the frequency caused by the O—H bond, as this is also present in water.

(i) Use the Data Sheet to identify the bond that causes the absorption at 2940cm^{-1} . [1]

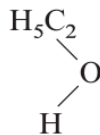
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0 2

11. Ethanol, C_2H_5OH , is the alcohol that is present in alcoholic drinks.

- (a) Ethanol is soluble in water. Complete the diagram below to show why ethanol is soluble in water. You should include relevant lone pairs and dipoles and label the bond responsible for this solubility. [3]



- (b) If it is suspected that a driver has been drinking alcohol they can be tested in several ways.
- (i) One method previously used to test for ethanol in breath involved blowing through acidified potassium dichromate(VI). A positive test was shown by the colour change from orange to green.

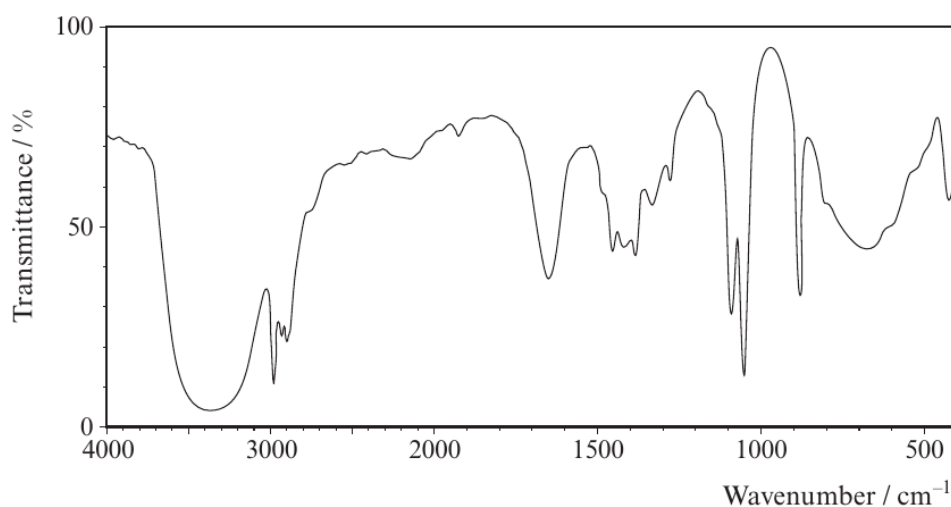
What type of reaction causes this colour change?

[1]



Examiner
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- (ii) Another method uses IR spectroscopy. The IR spectrum for ethanol is shown below.



- I State which functional group is shown to be present in ethanol by the absorption at about 3350 cm^{-1} . [1]
-
- II A student suggested that this absorption should be used to test for the presence of ethanol in breath. Give a reason why this suggestion is not valid. [1]
-
-
- (c) If ethanol, in a drink such as wine, is left in an open bottle and exposed to air it becomes 'sour' and unpleasant to taste. This is because it forms ethanoic acid.
- (i) Draw the **displayed** formula of ethanoic acid. [1]
- (ii) What significant change would be noticed if the IR spectrum of this product was compared with that of ethanol? Give the reason for this change. [2]
-
-

Total [9]



1 5

Turn over.

Examiner
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8. (a) In March 2012 the UK Government proposed a minimum price of 40p per unit of alcohol in an effort to ‘turn the tide’ against binge drinking.

State **one** effect on the human body and **one** effect on society of the excessive use of alcoholic drinks. [2]

Effect on the human body

.....

Effect on society

.....

- (b) Butan-1-ol can be prepared by warming 1-chlorobutane with aqueous sodium hydroxide.

- (i) Classify the type of reaction occurring and give the mechanism for the reaction. [4]

Reaction type

Mechanism

- (ii) Use the infrared absorption frequencies given in the Data Sheet to explain how you would know if all the 1-chlorobutane has been converted into butan-1-ol. [2]

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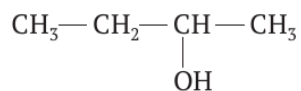
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Examiner
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(c) Butan-1-ol has the molecular formula $C_4H_{10}O$.

Two other isomers of $C_4H_{10}O$ are butan-2-ol and methylpropan-1-ol.



butan-2-ol

(i) Draw the **skeletal** formula of methylpropan-1-ol. [1]

(ii) Name the type of isomerism shown by these isomers. [1]

(iii) Butan-1-ol can be oxidised by acidified potassium dichromate(VI) to form butanoic acid. State what you would **observe** during this reaction. [1]

(iv) Butan-1-ol can also be dehydrated. Name a suitable dehydrating agent and write an equation for this reaction. [2]

Dehydrating agent

Equation

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Examiner
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(d) 1-Chlorobutane is an example of a halogenoalkane. One group of halogenoalkanes (CFCs) has been shown to play a role in ozone depletion. Most of these ozone-depleting substances contain chlorine. Halogenoalkanes containing only fluorine do not harm the ozone layer.

Due to the Montreal Protocol of 1987, CFCs have been largely banned and have been replaced in many applications by HFCs, which contain fluorine as the only halogen.

(i) Explain why CFCs deplete the ozone layer, but HFCs do not. [2]

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(ii) Suggest a reason why there is still concern about ozone depletion. [1]

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Total [16]



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Examiner
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5. State the reagent(s) used and the colour change seen when a primary alcohol is oxidised to give a carboxylic acid. [2]

Reagent(s)

Colour change from to

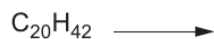
6. State the systematic name of the compound shown below. [1]



.....

7. On cracking, one molecule of $\text{C}_{20}\text{H}_{42}$ can produce one molecule of pentene, one molecule of hexene and one molecule of another product.

Complete the equation for this reaction. [1]



8. Draw the repeat unit of the polymer formed from the monomer $\text{CH}_3\text{CH}_2\text{CH}=\text{CHCH}_3$. [1]

Total Section A [10]

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Examiner only

4. (a) Place the following elements in order of their increasing first ionisation energy. [1]

sodium magnesium aluminium silicon chlorine

Lowest Highest

(b) Place the following elements in order of their increasing melting temperature. [1]

sodium magnesium aluminium silicon chlorine

Lowest Highest

5. Decane (C₁₀H₂₂) may be used to produce ethene in a cracking reaction. Write an equation for this process. [1]

.....

6. Give the reagent(s) required for the oxidation of ethanol to form ethanoic acid. [1]

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7. A saturated solution of calcium sulfate at 20 °C was cooled to 0 °C and 0.11 g of solid calcium sulfate was obtained. Use the data below to calculate the volume of the calcium sulfate solution. [2]

Temperature / °C	Solubility of CaSO ₄ / g dm ⁻³
0	2.10
20	2.39

Volume = dm³

Total Section A [10]

SECTION B

Answer **all** questions in the spaces provided.

Examiner
only

8. Ethanol can be produced from many different sources.

- (a) The original route for producing ethanol was by fermentation of sugars by yeast to produce an aqueous solution of ethanol.

Explain why ethanol is soluble in water. [1]

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- (b) In industry, most ethanol is produced from ethene. Give the reagents and conditions for this process. [2]

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.....

- (c) Ethanol can be produced from chloroethane in a nucleophilic substitution reaction using aqueous sodium hydroxide.

- (i) Use the infrared absorption frequencies given in the data sheet to explain how you could check spectroscopically that this reaction had converted **all** the chloroethane into ethanol. [1]

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- (ii) Chloroethane can be produced in a similar way to chloromethane.

- I. The first stage in the mechanism of this reaction involves homolytic bond fission. Explain what is meant by the term *homolytic bond fission*. [1]

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- II. Complete the equation for the propagation stage below. [1]



Examiner
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III. This process often produces mixtures of chloroethane, dichloroethane and trichloroethane. State how pure samples of these substances could be obtained from the mixture. [1]

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(iii) Under different conditions sodium hydroxide can react with chloroethane to produce ethene.

I. Give the conditions needed for this reaction. [2]

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II. Classify the mechanism of this reaction. [1]

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III. Describe the structure and bonding present in an ethene molecule. [3]
QWC [1]

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Total [14]

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END OF QUESTION PACK

10 questions · 89 marks · ~2 h 22 min
Source: WJEC CH2 (2008 modular spec, Jan 2010 – Jun 2016)
Curated for WJEC Chemistry 2015 spec AS Unit 2 – Topic 5 (2.7)

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