Additional Assessment Materials

Summer 2021

Pearson Edexcel GCE in Chemistry 8CH0

Resource Set 2 – Topic Group 3

Topics included:

Topic 6: Organic Chemistry I

Topic 7: Modern Analytical Techniques I

(Public release version)

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Additional Assessment Materials, Summer 2021

General guidance to Additional Assessment Materials for use in 2021

Context

- Additional Assessment Materials are being produced for GCSE, AS and A levels (with the exception of Art and Design).
- The Additional Assessment Materials presented in this booklet are an **optional** part of the range of evidence teachers may use when deciding on a candidate's grade.
- 2021 Additional Assessment Materials have been drawn from previous examination materials, namely past papers.
- Additional Assessment Materials have come from past papers both published (those materials available publicly) and unpublished (those currently under padlock to our centres) presented in a different format to allow teachers to adapt them for use with candidate.

Purpose

- The purpose of this resource to provide qualification-specific sets/groups of questions covering the knowledge, skills and understanding relevant to this Pearson qualification.
- This document should be used in conjunction with the mapping guidance which will map content and/or skills covered within each set of questions.
- These materials are only intended to support the summer 2021 series.

5 This question concerns alkenes and some halogen compounds.

(a) The alkene, propene, reacts with hydrogen chloride.

(i) This reaction is best described as

(1)

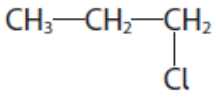
☒ **A** electrophilic substitution

☐ **B** electrophilic addition

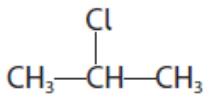
☒ **C** nucleophilic substitution

☐ **D** nucleophilic addition

(ii) The reaction of propene with hydrogen chloride can produce two isomeric products:



1-chloropropane



2-chloropropane

1-chloropropane and 2-chloropropane are

(1)

☒ **A** *cis-trans* isomers

☒ **B** *E/Z* isomers

☒ **C** structural isomers

☐ **D** stereoisomers

(iii) Draw the mechanism for the reaction of propene with hydrogen chloride to produce 2-chloropropane. Include curly arrows, and any relevant dipoles and lone pairs.

(4)

(b) The halogenoalkane chloroethene is used to make the important polymer poly(chloroethene), PVC.

(i) Draw a **displayed** formula of two repeat units of poly(chloroethene).

(1)

(ii) Some polymers are disposed of by incineration. Ignoring any economic considerations, explain why incineration is **not** a suitable method for the disposal of poly(chloroethene).

(2)

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(iii) Chloroethene has a boiling temperature of 260 K and is known to be carcinogenic. Use these facts to state **one** precaution that chemists should take when using this compound.

(1)

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Total for Question 5 = 10 marks

5 The following procedure may be used to prepare 2-chloro-2-methylpropane.

Step 1 Place 15 cm^3 of 2-methylpropan-2-ol in a separating funnel and slowly add 30 cm^3 of concentrated hydrochloric acid (an excess), while swirling the funnel.

Step 2 When all the hydrochloric acid has been added, leave the mixture to stand for 20 minutes, shaking it gently at intervals.

Step 3 Once the organic and aqueous layers have completely separated, discard the aqueous layer.

Step 4 Add saturated sodium hydrogencarbonate solution, a little at a time, to the organic layer. After each addition, invert the separating funnel and open the tap.

Step 5 Discard the aqueous layer.

Step 6 Transfer the organic layer to a small flask, add a solid drying agent and swirl the flask.

Step 7 Decant the liquid into a clean flask and distil it to collect pure 2-chloro-2-methylpropane.

Some data on the organic reactant and product are given in the table.

Data	2-methylpropan-2-ol	2-chloro-2-methylpropane
molar mass / g mol^{-1}	74.0	92.5
boiling temperature / °C	82	51
density / g cm^{-3}	0.79	0.84

(a) Draw a diagram of a separating funnel, labelling the aqueous layer and the layer of 2-chloro-2-methylpropane that would be observed at the end of **Step 2**.

(2)

(b) Give the reason why sodium hydrogencarbonate solution is added to the organic layer in **Step 4** and why it is important to open the tap after adding this solution.

(2)

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(c) Which one of these anhydrous compounds may be used as a drying agent in **Step 6**?

(1)

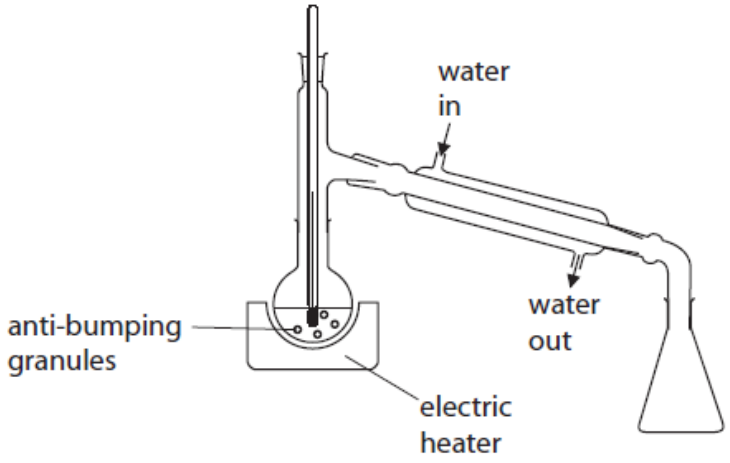
☒ **A** sodium chloride

☒ **B** sodium hydroxide

☒ **C** sodium nitrate

☒ **D** sodium sulfate

(d) A student set up this apparatus for distillation in **Step 7** as shown.



(i) Describe **three** ways in which this apparatus must be modified for safe and efficient use. Assume the apparatus is suitably clamped.

(3)

(ii) Give a suitable temperature range over which to collect the final product during the distillation.

(1)

(e) In the preparation, 15 cm^3 of 2-methylpropan-2-ol produced 6.9 cm^3 of 2-chloro-2-methylpropane.

The equation for the reaction is

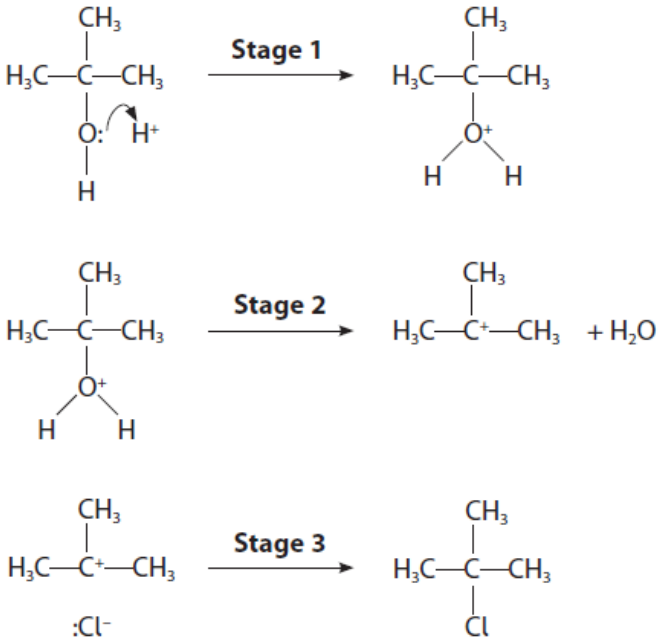
$$(CH_3)_3COH + HCl \rightarrow (CH_3)_3CCl + H_2O$$

Calculate the percentage yield of 2-chloro-2-methylpropane, using data from the table.

Data	2-methylpropan-2-ol	2-chloro-2-methylpropane
molar mass / g mol^{-1}	74.0	92.5
boiling temperature / °C	82	51
density / g cm^{-3}	0.79	0.84

(3)

(f) The mechanism for the reaction is in three stages.

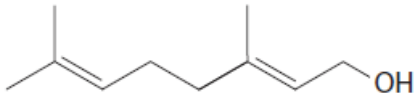


Add curly arrows to the reactants in **Stages 2** and **3** to complete the mechanism.

(2)

(Total for Question 5 = 14 marks)

4 (a) The characteristic smell of pine wood is due, partly, to the presence of a group of compounds called terpenes. One of the simpler terpenes is a compound called geraniol, which is an oily liquid at room temperature and pressure. The structure of geraniol is



Deduce the molecular formula of geraniol. Use your answer to calculate the molar mass of geraniol in g mol^{-1}.

(2)

(b) The mass spectrum of geraniol is shown.

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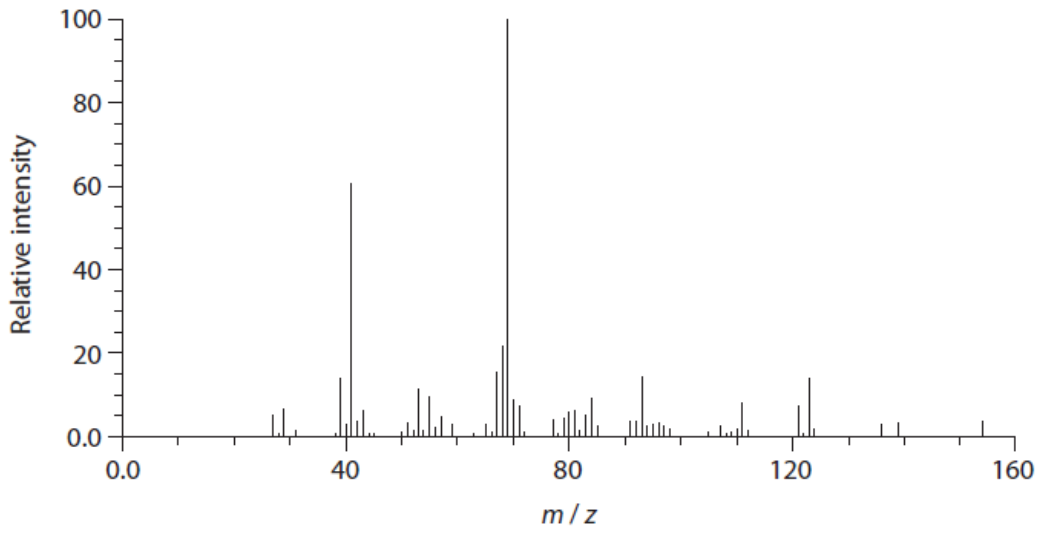

(i) Show that this mass spectrum can be used to confirm the molar mass of geraniol.

(1)

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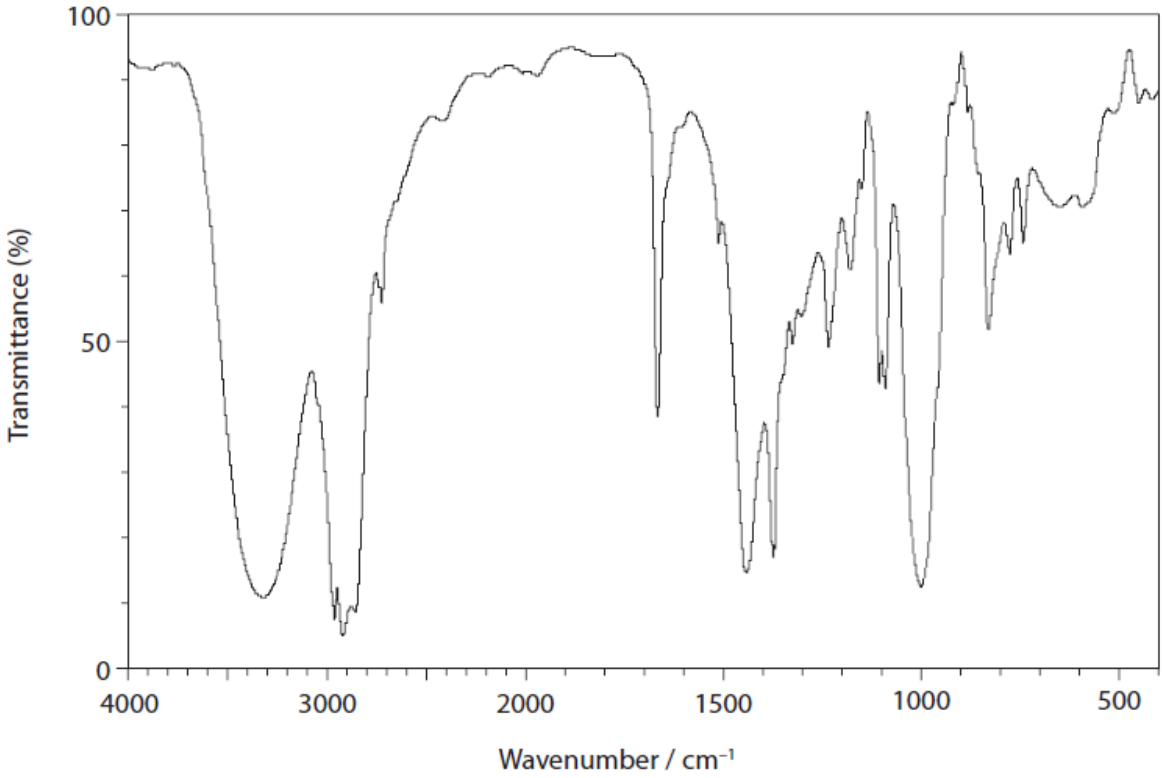
(ii) Identify an ion that could be responsible for the peak at $m/z = 69$.

(1)

(c) The infrared spectrum of geraniol is shown.



Using the table of absorptions from the Data Booklet and the infrared spectrum, give the **names** of the two functional groups present in geraniol.
To confirm these functional groups, give the wavenumber ranges and their corresponding bonds.

(2)

First functional group .....

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Second functional group .....

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(d) Give **one** chemical test that you could use to confirm the presence of each of the two functional groups suggested in part (c). Predict a result for each test.

(4)

Test and result for first functional group .....

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Test and result for second functional group .....

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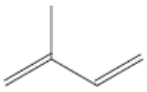
(e) Some plants are able to make terpenes by linking together several molecules of 2-methylbuta-1,3-diene, also known as isoprene.
The skeletal formula of 2-methylbuta-1,3-diene is



Predict the number of isoprene molecules that would be needed to make a single geraniol molecule. Justify your answer.

(2)

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(f) 2-methylbuta-1,3-diene can react with hydrogen bromide.

When 2-methylbuta-1,3-diene reacts with **excess** hydrogen bromide, several isomeric products are possible. Give the structures of **four** isomeric products.

(4)

(Total for Question 4 = 16 marks)

Total for Test = 40 marks