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A' Level Chemistry

Year 1

Unit 10: Alcohols & Organic Analysis

Summer Examination Revision Pack

The questions in this pack should be attempted **AFTER** completing all other revision.

Grade Accelerator

Recall Definitions
Drawing Diagrams
Using Equations
Drawing Graphs

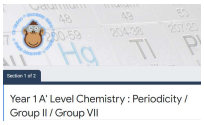
Quizlet

Quizlet Classes

Flashcard Based
Games
Tests & Quizzes
Keyword Spell Checker

Condensed Notes

Keywords & Definitions
Key Concepts
Application
Key Skills



Online Forms

Take Time to Answer
Use Paper & Calculator
Work It Out
Review Missed Marks

Use the 3 Wave Process when completing these revision packs.

1. Complete the questions without assistance
(Can't answer a question? Leave it and move on)
2. Use your notes to fill any gaps after step 1
3. Use the mark scheme to fill in any remaining gaps.

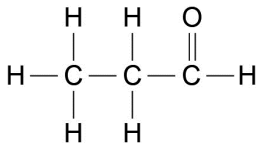
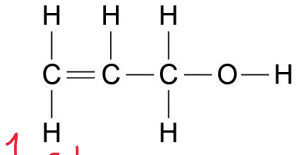
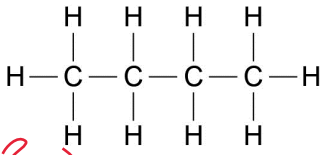
1. Having gaps after step 1 is normal, that's why we are doing revision!
2. If your notes don't help during step 2, they are not good enough!
(Change your note taking method and try to understand the problem)
3. If you don't understand why the mark scheme answer is correct, **see Andy.**

If you struggle with the questions in the pack, **STOP!** and complete some more revision.

If you come to a complete dead-end, **STOP!** and speak to **Andy** asap.

4 The compounds in **Table 2** all have a relative molecular mass of 58.0

Table 2

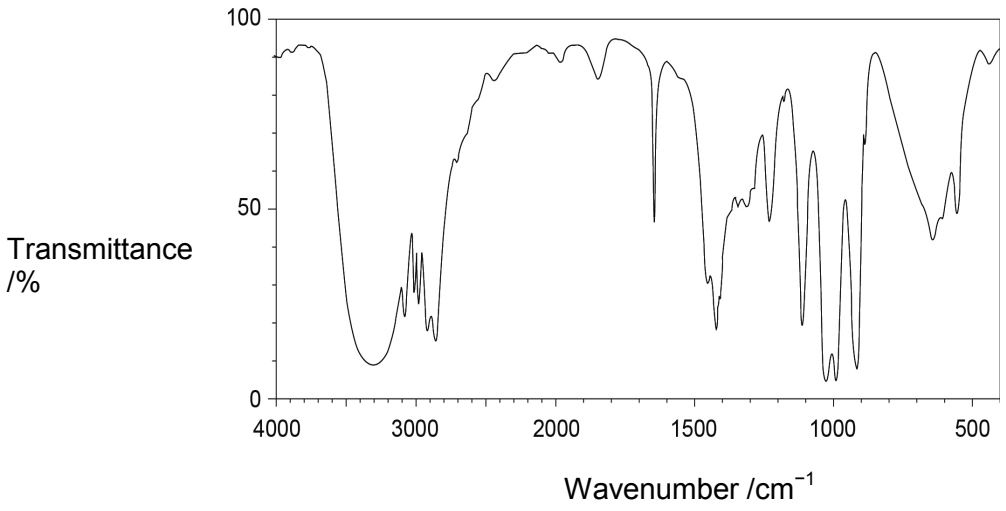
Name	Propanal	Prop-2-en-1-ol	Butane
Structure			

0 4 . 1 Explain why determining the precise relative molecular mass of propanal and prop-2-en-1-ol by mass spectrometry could not be used to distinguish between samples of these two compounds.

[2 marks]

0 4 . 2 The infrared spectrum of one of these three compounds is shown in **Figure 4**.

Figure 4



Use the spectrum to identify the compound.
State the bond that you used to identify the compound and give its wavenumber range. You should only consider absorptions with wavenumbers greater than 1500 cm^{-1}.

[2 marks]

Compound _____

Bond used to identify compound _____

Wavenumber range of bond used to identify compound _____ cm^{-1}

0 4 . 3 Predict the relative boiling points of these three compounds from the highest to the lowest boiling points.

Justify this order in terms of intermolecular forces.

[6 marks]

Question	Marking Guidance	Mark	Comments
04.1	M1 have the same molecular formula or are C_3H_6O or both have the same number/amount of each type of atom or same amount of each element or are isomers M2 identical / exactly the same / same precise (relative) molecular mass / formula mass / M_r	1 1	M1 not just the same atoms; M2 same (relative) molecular mass / formula mass / M_r is NOT enough got score M2 M2 allow same accurate (relative) molecular mass / formula mass / M_r M2 ignore reference to number of decimal places
04.2	M1 prop-2-en-1-ol M2 O(-)H (alcohol) and 3230–3550 (cm^{-1}), or C=C and 1620–1680 (cm^{-1})	1 1	M1 must refer to this compound clearly by name or structure (not to alcohol alone); ignore minor slips in name/structure M2 marked independently from M1 could score from bond labelled on correct signal on spectrum allow any value within these ranges if additional incorrect signals given penalise M2 ignore signals below 1500 cm^{-1} and C-H signals

<table>
<tr><td>04.3</td><td colspan="3">a) Determine the level by looking at the chemical content. (NB - If there is clear breakage of covalent bonds then max level 2 (max 3 marks).
b) The mark within that level is then determined by looking at how coherent and logical the answer is and by use of terminology; start at the higher mark and penalise poor terminology/explanation; examples of terminology that would reduce the mark to the lower one:
• reference to van der Waals ‘bonds’ or dipole-dipole ‘bonds in relevant compounds that are being credited
• uncertainty about whether hydrogen bonds are the O-H bonds within or are forces/bonds between molecules (if the alcohol is being credited)
• use of ‘vdw’ or ‘dip-dip’ unless these terms ‘van der Waals’ for ‘dipole-dipole’ have been used elsewhere in answer (note that IMF and H-bond would not be penalised)
c) If the answer does not achieve level 1, then 1 mark maximum could be scored for any correct point from the list of indicative content</td></tr>
<tr><td></td><td>Level 3
(5-6 marks)</td><td>• Relative order of boiling points of all three compounds
• Strongest intermolecular force of all three compounds identified
• Answer explains this coherently and logically and uses correct terminology for all three compounds</td><td rowspan="4">Indicative chemistry content:
• Correct order (highest to lowest) = prop-2-en-1-ol > propanal > butane
• Prop-2-en-1-ol has hydrogen bonds
• Propanal has (permanent) dipole-dipole forces
• Butane has van der Waals’ forces
• Strength of intermolecular forces: hydrogen bonds > dipole-dipole > van der Waals

(Note - actual values for reference are prop-2-en-1-ol 97°C, propanal 46°C and butane -1°C)</td></tr>
<tr><td></td><td>Level 2
(3-4 marks)</td><td>• Relative boiling points of two compounds correctly compared
• Strongest intermolecular force for these two compounds correctly identified
• Answer explains this coherently and logically and uses correct terminology for these two compounds</td></tr>
<tr><td></td><td>Level 1
(1-2 marks)</td><td>• One compound with the highest or lowest boiling point is correctly identified
• Strongest intermolecular force for that one compound identified
• Answer explains this coherently and logically and uses correct terminology for this one compound
• allow 1 mark for individual correct point from indicative content on the right if no other mark scored</td></tr>
<tr><td></td><td>Level 0
(0 marks)</td><td>None of the indicative chemistry content given.</td></tr>
</table>

6 Propane-1,2-diol has the structure $CH_2(OH)CH(OH)CH_3$. It is used to make polyesters and is one of the main substances in electronic cigarettes (E-cigarettes).

A sample of propane-1,2-diol was refluxed with a large excess of potassium dichromate(VI) and sulfuric acid.

0 6 . 1 Draw the skeletal formula of propane-1,2-diol.

[1 mark]

0 6 . 2 Write an equation for this oxidation reaction of propane-1,2-diol under reflux, using [O] to represent the oxidizing agent.

Show the displayed formula of the organic product.

[2 marks]

0 6 . 3 Draw a labelled diagram to show how you would set up apparatus for refluxing.

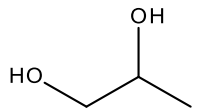
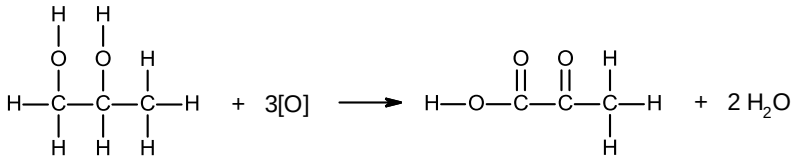
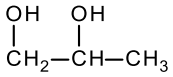
[2 marks]

0 6 . 4 Anti-bumping granules are placed in the flask when refluxing.
Suggest why these granules prevent bumping.

[1 mark]

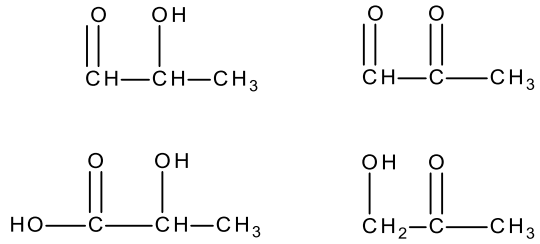
0 6 . 5 Draw the structure of a different organic product formed when the acidified potassium dichromate(VI) is not in excess.

[1 mark]

Question	Marking Guidance	Mark	Comments
06.1		1	Any correct skeletal formula (both OH groups must be shown)
06.2	M1 Displayed formula of correct product M2 Balanced equation   $CH_2OHCHOHCH_3$ $C_3H_8O_2$	1 1	Incorrect organic product CE=0 M1 must be displayed formula but can be shown separately or in the equation. M2 allow any correct structural formula (or molecular formula $C_3H_4O_3$) for product in balanced equation allow any correct formula of propane-1,2-diol (including its molecular formula $C_3H_8O_2$)

06.3	M1 flask with condenser vertically above it (without gaps between flask and condenser) M2 flask and condenser labelled	1 1	Distillation diagram CE = 0 M1 condenser must have outer tube for water that is sealed at top and bottom; condenser must have two openings for water in/out (that are open, although these openings do not need to be labelled) M1 penalise M1 if apparatus is sealed (a continuous line across the top and/or bottom of the condenser is penalised) M2 allow condensing tube for condenser label

06.4	form small(er) bubbles or prevent large bubbles	1	

06.5	Any one of these four structures: 	1	Allow any correct structural / displayed / skeletal formula For reference: Carbon 1 – Carbon 2 aldehyde – alcohol carboxylic acid – alcohol aldehyde – ketone alcohol – ketone

0 7 . 1 Four compounds, all colourless liquids, are

- butan-2-ol
- butanal
- butanone
- 2-methylpropan-2-ol

Two of these compounds can be identified using different test-tube reactions.

Describe these **two** test-tube reactions by giving reagents and observations in each case.
Suggest how the results of a spectroscopic technique could be used to distinguish between the **other** two compounds.

[6 marks]

6

<table>
<tr><td>7.1</td><td colspan="3">This question is marked using levels of response. Refer to the Mark Scheme Instructions for Examiners for guidance on how to mark this question.</td></tr>
<tr><td></td><td colspan="2">How to choose the level</td><td>Requirements for communication for higher mark</td><td>Stages</td></tr>
<tr><td>Level 3
5-6 marks</td><td>All three stages are covered and explanation of each stage is generally correct and virtually complete – leads to all four compounds being distinguished</td><td></td><td>• Answer communicates whole process coherently with logical progression
• Chemical tests (appear to) start with all compounds rather than selected compounds
• Chemical tests reagents and observations are complete and correct
• Chemical tests leave two compounds to be distinguished by spectroscopy
• Enough detail is given about the spectroscopy to distinguish these two compounds</td><td rowspan="4">Stage 1
Carries out a test-tube reaction to identify a compound (or to split the compounds into two groups).
1a reagent
1b observation with correct deduction

Stage 2
Carries out a second test-tube reaction to identify a second compound.
2a reagent
2b observation with correct deduction

Stage 3
Uses spectroscopy to distinguish two compounds.
3a suitable technique
3b data that will distinguish compounds

See next page for indicative content</td></tr>
<tr><td>Level 2
3-4 marks</td><td>All three stages are covered but the explanations of each stage may be incomplete or may contain inaccuracies</td><td>Two stages covered and explanations are generally correct and virtually complete</td><td>• Answer is mainly coherent
• Chemical tests reagents and observations are complete and correct
• Enough detail is given about the spectroscopy to distinguish these two compounds (if spectroscopy included)</td></tr>
<tr><td>Level 1
1-2 marks</td><td>Two stages covered but the explanations of each stage may be incomplete or may contain inaccuracies</td><td>One stage covered and explanation is generally correct and virtually complete</td><td>• Chemical tests reagents and observations are complete and correct (if awarded level 1 for one chemical test stage)
• Enough detail is given about the spectroscopy to distinguish these two compounds (if spectroscopy included)</td></tr>
<tr><td>0 marks</td><td colspan="2">Nothing valid to warrant a mark</td><td></td></tr>
</table>

Possible test tube reactions

Tollens' reagent [or Fehling's / Benedict's]

Identifies butanal – silver mirror (or black ppt) [or orange/brick/red ppt with Fehling's]

(No reaction with other compounds)

Acidified potassium dichromate

Reacts with butanal and butan-2-ol – goes green

(No reaction with other compounds)

Sodium *(not on specification but may be mentioned)*

Reacts with butan-2-ol and 2-methylpropan-2-ol – fizzes

(No reaction with other compounds)

Examples of incomplete/incorrect reagents include "Tolling's solution", no acid with potassium dichromate, wrong oxidation state for Cr in potassium dichromate if stated.

Examples of incomplete/incorrect observations include silver precipitate with Tollens', green ppt with acidified potassium dichromate

Possible spectroscopic methods for a pair

IR (infra-red) spectroscopy

If different functional groups: need to identify wavenumber and bond of key functional group signal (e.g. (alcohol) O-H 3230-3550 or C=O 1680-1750 (cm^{-1})).

If same functional group, need idea of using fingerprint region to look for match to known compounds / comparing region to samples in a database

Mass spectrometry

If different, can use different M_r values with values of M_r given

butanone 72(.0), 2-methylpropan-2-ol = 74(.0), butan-2-ol = 74(.0), butanal = 72(.0)

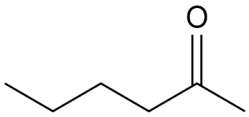
If compounds have same M_r, then would have to use idea that fragmentation patterns would be different *(not on specification but may be mentioned)*

Do not write outside the box

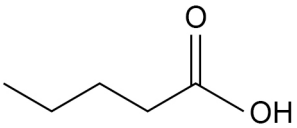
Section A

Answer **all** questions in this section.

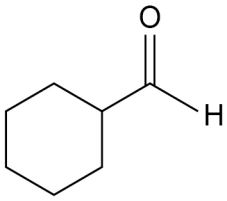
0 1 The structures of three organic compounds **A**, **B** and **C** are shown.



Compound **A**



Compound **B**



Compound **C**

These compounds can be distinguished by simple test-tube reactions.

For each pair of compounds in questions **01.1** and **01.2**, give a reagent (or combination of reagents) that could be added separately to each compound to distinguish between them.

State what is observed in each case.

0 1 . 1 Compounds **A** and **B**

[3 marks]

Reagent _____

Observation with **A** _____

_____

Observation with **B** _____

_____

0 1 . 2 Compounds **A** and **C**

[3 marks]

Reagent _____

Observation with **A** _____

_____

Observation with **C** _____

_____

6

Question	Marking guidance	Additional Comments/Guidelines	Mark
01.1	**M1** Named carbonate / hydrogencarbonate / bicarbonate (or Mg / Na) **M2** No (visible/observed) reaction/change**/**effect **M3** effervescence / bubbles (of gas) / fizzing ***OR*** **M1** universal indicator **M2** neutral / no change / pH7 **M3** orange / red / pH < 7 / acidic	Allow any correct chemical test. If no reagent or incorrect reagent in **M1**, **CE= 0** and no marks for **M2** or **M3** Allow name or formula of suitable reagent in **M1** In **M3** ignore reference to name/formula of correct gas, but penalise reference to name/formula of incorrect gas In **M3** allow reference to limewater going cloudy as an alternative Penalise incorrect formula of correct reagent (or incomplete reagent) in **M1**, but mark on for **M2** and **M3** Where there is no reaction, ignore “nothing (happens)” or “no observation” If use of named alcohol in **M1**, allow no reaction for **M2** and sweet smell for **M3** Allow use of other suitable indicators (e.g. litmus)	1 1 1

Question	Marking guidance	Additional Comments/Guidelines	Mark
01.2	**M1** Tollens' (reagent) OR ammoniacal silver nitrate OR a description of making Tollens' **M2** No (visible/observed) reaction/change or stays colourless **M3** silver mirror or black solid / precipitate **OR** **M1** Fehling's (solution) or Benedict's solution **M2** no (visible/observed) reaction/change or stays blue **M3** red <u>solid / precipitate</u> (credit orange or brown) ***OR*** **M1** acidified potassium dichromate or $K_2Cr_2O_7/H_2SO_4$ ***or*** $K_2Cr_2O_7/H^+$ ***or*** acidified $K_2Cr_2O_7$ **M2** no (visible/observed) reaction/change or stays orange **M3** (orange to) <u>green</u> solution ***or*** goes <u>green</u> ***OR*** **M1** acidified potassium manganate(VII) or $KMnO_4/H_2SO_4$ ***OR*** $KMnO_4/H^+$ ***OR*** acidified $KMnO_4$ **M2** no (visible/observed) reaction/change or stays purple **M3** (purple to) <u>colourless</u> solution **OR** goes <u>colourless</u>	Allow any correct chemical test. If no reagent or incorrect reagent in **M1**, **CE= 0** and no marks for **M2** or **M3** Allow name or formula of suitable reagent in **M1** Penalise incorrect formula of correct reagent in **M1**, but mark on for **M2** and **M3** For Tollens' reagent: for **M1** ignore either $AgNO_3$ or $[Ag(NH_3)_2^+]$ or "the silver mirror test" on their own, or "Tolling's reagent", but mark **M2** and **M3**; for **M3** allow silver precipitate/deposit For Fehling's/Benedict's solution: for **M1** Ignore $Cu^{2+}(aq)$ or $CuSO_4$ or "Fellings" on their own, but mark **M2** and **M3** For acidified potassium dichromate(VI): if "dichromate" or "(potassium) dichromate(IV)" or incorrect formula or no acid, penalise **M1** but mark **M2** and **M3;** for **M3** ignore dichromate described as "yellow" or "red". For acidified potassium manganate(VII): If "manganate" or "(potassium manganate(IV)" or incorrect formula or no acid, penalise **M1** but mark **M2** and **M3**. Credit alkaline / neutral $KMnO_4$ for possible full marks but **M3** gives <u>brown precipitate</u> or solution goes <u>green</u> Where there is no reaction, ignore "nothing (happens)" or "no observation"	1 1 1

Do not write outside the box

0 4 . 2 Pent-1-ene is formed by the elimination of water from pentan-2-ol.

State the reagent and condition for this reaction.

Outline the mechanism for this reaction.

[5 marks]

Reagent _____

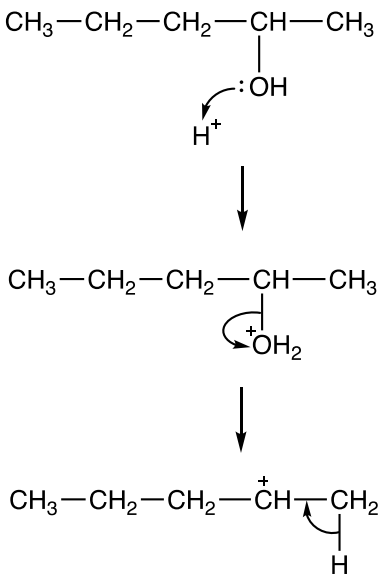
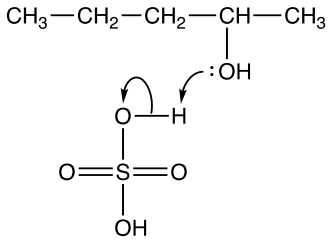
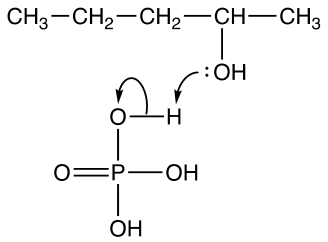
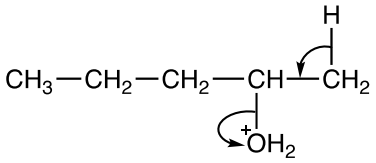
Condition _____

Outline of mechanism

8

Turn over for the next question

Question	Marking guidance	Additional Comments/Guidelines	Mark
04.2	**M1** reagent = <u>conc</u> sulfuric acid or <u>conc</u> phosphoric acid **M2** condition = hot / temperature in range 150-200°(C)	**M1** penalise incorrect name or formula (even if both name and formula are given) **M2** allow high temperature **M2** reagent must indicate an acid in some way in order for **M2** to be awarded **M1/2** allow 1 mark if H_2SO_4/H_3PO_4 given as reagent and conc(entrated) given as condition	1 1

04.2 (cont)	 **M3** curly arrow from lone pair on alcohol O to H^+ **M4** curly arrow from C-O bond to O on correct intermediate **M5** arrow from C-H bond on C1 to C-C bond between C1 and C2 on correct carbocation	**M3-5** penalise **M3/4/5** for any additional arrow(s) in addition to the correct one at each stage If incorrect reactant (or product if shown), maximum 2 marks of **M3-5** **Alternatives for M3**  or  allow **M4** and **M5** concurrent: 	1 1 1

Do not write outside the box

0 7 This question is about ethanedioic acid ($H_2C_2O_4$) which is a dicarboxylic acid.

0 7 . 1 Draw the skeletal formula of ethanedioic acid.

[1 mark]

0 7 . 2 Ethanedioic acid is formed by the oxidation of ethane-1,2-diol ($HOCH_2CH_2OH$).

State suitable reagent(s) and a condition for this reaction.

[2 marks]

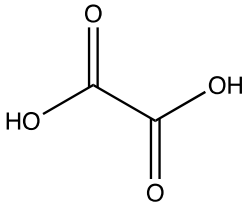
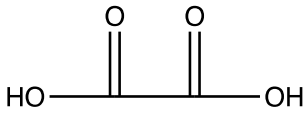
Reagent(s) _____

_____

Condition _____

_____

Question 7 continues on the next page

Question	Marking guidance	Additional Comments/Guidelines	Mark
07.1		Any correct skeletal representation, but alcohol H's should be shown and C atoms should not be shown 	1
07.2	**M1** acidified potassium dichromate(VI) or sulfuric acid & potassium dichromate(VI) **M2** reflux	**M1** H_2SO_4 and $K_2Cr_2O_7$ or H^+ and $K_2Cr_2O_7$ do not need (VI), but if oxidation state given it must be correct allow other strong acids **M2** need an attempt at an oxidising agent in **M1**	1 1

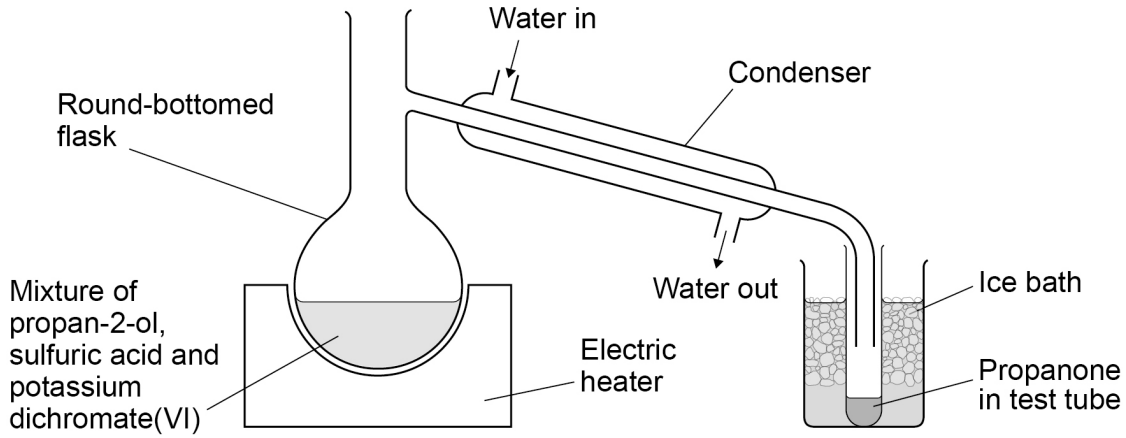
Do not write outside the box

0 3 Propanone can be made by reacting propan-2-ol with an excess of acidified potassium dichromate(VI).

The propanone is removed from the reaction mixture by distillation.

0 3 . 1 **Figure 2** shows the apparatus set up by a student to make propanone by this method. Suitable clamps are used to hold all the apparatus firmly in place.

Figure 2



There are **three** problems with the apparatus set up in **Figure 2**.

For each problem:

- identify the problem
- describe the issue it would cause
- suggest how the problem can be solved.

[6 marks]

Do not write outside the box

Turn over ►

<table>
<tr><th>Question</th><th colspan="2">Marking Guidance</th><th>Additional Comments/Guidelines</th><th>Mark</th></tr>
<tr><td rowspan="5">03.1</td><td colspan="2">This question is marked using levels of response. Refer to the Mark Scheme Instructions for Examiners for guidance on how to mark this question.</td><td rowspan="5">Stage 1
Anti-bumping granules
1a no anti-bumping granules / add anti-bumping granules
1b to create smaller bubbles / to prevent large bubbles / to prevent mixture jumping into condenser

Stage 2
Open system with no thermometer
2a system should be closed (above flask) to prevent gases escaping
2b should be closed with (bung +) thermometer
2c to allow collection of propanone (only) / to prevent distillation of other components / to stay in suitable temperature range

Stage 3
The water direction in the condenser
3a water flows in wrong direction through condenser / change water direction
3b condenser not cool enough / not full of water
3c product may not condense / comes through as gas</td><td rowspan="5">6</td></tr>
<tr><td>Level 3
(5–6 marks)</td><td>All stages are covered and each stage is generally correct and virtually complete
(6 v 5) Answer is well structured, with no repetition or irrelevant points, and covers all aspects of the question. Accurate and clear expression of ideas with no errors in use of technical terms.</td></tr>
<tr><td>Level 2
(3–4 marks)</td><td>All stages are covered but stage(s) may be incomplete or may contain inaccuracies OR
two stages are covered and are generally correct and virtually complete
(4 v 3) Answer has some structure and covers most aspects of the question. Ideas are expressed with reasonable clarity with, perhaps, some repetition or some irrelevant points. If any, only minor errors in use of technical terms.</td></tr>
<tr><td>Level 1
(1–2 marks)</td><td>Two stages are covered but stage(s) may be incomplete or may contain inaccuracies OR
only one stage is covered but is generally correct and virtually complete
(2 v 1) Answer includes statements which are presented in a logical order and/or linked.</td></tr>
<tr><td>0 marks</td><td>Insufficient correct chemistry to gain a mark.</td></tr>
</table>

Do not write outside the box

0 2 A student has samples of these four compounds but does not know which is which:

- butanoic acid
- 2-methylpropanal
- 2-methylpropanoic acid
- 2-methylpropan-1-ol

Step 1: Two of these compounds can be identified by simple chemical tests.

Step 2: The other two compounds, that contain the same functional group as each other, can then be distinguished using a spectroscopic technique.

Describe how these two steps could be used to identify which compound is which.

[6 marks]

Do not write outside the box

6

Turn over ►

<table>
<tr><th>Question</th><th colspan="2">Marking Guidance</th><th>Additional Comments/Guidelines</th><th>Mark</th></tr>
<tr><td rowspan="5">02</td><td colspan="2">This question is marked using levels of response. Refer to the Mark Scheme Instructions for Examiners for guidance on how to mark this question.</td><td rowspan="5">Stage 1
Identifying aldehyde / 2-methylpropanal
1a Tollens' or Fehling's
1b silver mirror or orange-red precipitate
Stage 2
Identifying alcohol / 2-methylpropan-1-ol
2a acidified potassium dichromate
2b (orange to) green
2c tests done in suitable sequence to distinguish aldehyde from alcohol, or to state that aldehyde would give same result if this test is done first
If aldehyde is identified, alcohol may be identified by elimination of the other two as acids using Na_2CO_3/$NaHCO_3$/Mg/indicator (2a = appropriate reagent, 2b = correct observations, 2c = in a suitable sequence)
Stage 3
Distinguishing the acids
3a using IR spectroscopy to distinguish the two acids (or other suitable technique)
3b use finger-print region of IR spectrum (feature of spectrum to use)
3c look for exact match to spectra of known compounds (what the difference is)</td><td rowspan="5">6

(4 x AO1, 2 x AO3)</td></tr>
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Do not write outside the box

0 7 In Europe, some of the glucose from crops is fermented to produce ethanol.

Use of a carbon-neutral fuel leads to no net emissions of carbon dioxide to the atmosphere.

0 7 . 1 The ethanol produced by fermentation of glucose may be regarded as a carbon-neutral fuel.

Justify this statement. Include the relevant chemical equations in your answer.

[4 marks]

Coffee beans from South America are exported to Europe in an outer layer called silverskin.

The waste silverskin can be fermented to produce a solution containing propanone, ethanol and butan-1-ol.

0 7 . 2 Suggest why ethanol produced in Europe using silverskin from South America is less likely to be carbon-neutral than ethanol produced from crops grown in Europe.

[1 mark]

Question	Marking guidance	Additional Comments/Guidelines	Mark
07.1	**M1** $6CO_2 + 6H_2O \rightarrow C_6H_{12}O_6 + 6O_2$ **M2** $C_6H_{12}O_6 \rightarrow 2C_2H_5OH + 2CO_2$ **M3** $2C_2H_5OH + 6O_2 \rightarrow 4CO_2 + 6H_2O$ **M4** explains with reference to relevant equations that formation of $C_6H_{12}O_6$ takes in $6CO_2$ and fermentation and combustion of ethanol gives out $6CO_2$	**M1/2/3** allow multiples Allow C_2H_6O for ethanol formula **M3** $C_2H_5OH + 3O_2 \rightarrow 2CO_2 + 3H_2O$ **M4** depends on having appropriate equations in **M1/2/3** showing 6 CO_2 in and out	1 1 1 1 (3 x AO1, 1 x AO3)

Question	Marking guidance	Additional Comments/Guidelines	Mark
07.2	transport (from South America to Europe) produces CO_2 / has C emissions / has larger C footprint	Process to separate ethanol from propanone and butan-1-ol produces CO_2 / has C emissions / has larger C footprint	1 (AO3)