

Write your name here

Surname

Other names

**Pearson Edexcel**  
**International**  
**Advanced Level**

Centre Number

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Candidate Number

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# Chemistry

**Advanced Subsidiary**

**Unit 3: Chemistry Laboratory Skills I**

Tuesday 10 May 2016 – Afternoon

**Time: 1 hour 15 minutes**

Paper Reference

**WCH03/01**

**Candidates may use a calculator.**

Total Marks

## Instructions

- Use **black** ink or ball-point pen.
- **Fill in the boxes** at the top of this page with your name, centre number and candidate number.
- Answer **all** questions.
- Answer the questions in the spaces provided  
– *there may be more space than you need.*

## Information

- The total mark for this paper is 50.
- The marks for **each** question are shown in brackets  
– *use this as a guide as to how much time to spend on each question.*
- You will be assessed on your ability to organise and present information, ideas, descriptions and arguments clearly and logically, including your use of grammar, punctuation and spelling.
- A Periodic Table is printed on the back cover of this paper.

## Advice

- Read each question carefully before you start to answer it.
- Keep an eye on the time.
- Try to answer every question.
- Check your answers if you have time at the end.

Turn over ►

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**PEARSON**

**Answer ALL the questions. Write your answers in the spaces provided.**

**1** Some tests are carried out on an inorganic compound **A**. Compound **A** is anhydrous and has one cation and one anion.

(a) Compound **A** gives a lilac colour in a flame test.

(i) Describe how to carry out a flame test.

(3)

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(ii) Identify, by name or formula, the cation present in **A**.

(1)

.....

(b) When a sample of solid **A** is placed in a test tube and heated, a gas and a vapour are evolved. The gas turns lime water cloudy and the vapour is identified as water.

(i) Identify the gas evolved.

(1)

.....

(ii) Give a test for the **presence** of water. State the positive result of the test.

(2)

Test.....

Result.....

(c) (i) Identify, by name or formula, the anion present in **A**.

(1)

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- (ii) Write the equation for the action of heat on **A**.  
Include state symbols in your equation.

(2)

**(Total for Question 1 = 10 marks)**

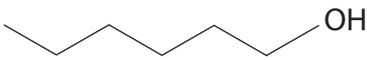
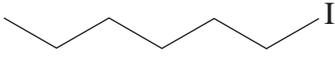
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2 The skeletal formulae of three organic compounds, **E**, **F** and **G**, are shown in the table.

<b>E</b>	
<b>F</b>	
<b>G</b>	

(a) Name compound **E**.

(1)

(b) Give a chemical test and its result that could be used to show the presence of the OH group in **E**.

(2)

Test.....

Result.....

(c) Give a chemical test and its result that could be used to show the presence of the iodine atom in **F**.

(2)

Test.....

Result.....

(d) A few drops of **G** are shaken with 2 cm<sup>3</sup> of a dilute aqueous solution of potassium manganate(VII) acidified with dilute sulfuric acid.

(i) State the colour change that occurs in this reaction.

(1)

From.....

to.....

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(ii) Draw the **skeletal** formula of the organic product of this reaction.

(1)

(e) State the reagent and give the essential conditions for the conversion of **F** to **G**.

(2)

Reagent.....

Conditions.....

(f) A student attempted to convert **G** to **F** using a standard method involving the addition of hydrogen iodide, HI, prepared *in situ*. However, very little of **F** was formed.

(i) Draw the structure of the **major** product obtained by the student.

(1)

(ii) Explain, by referring to the intermediate in the mechanism of the reaction, why **F** is only a minor product.

(1)

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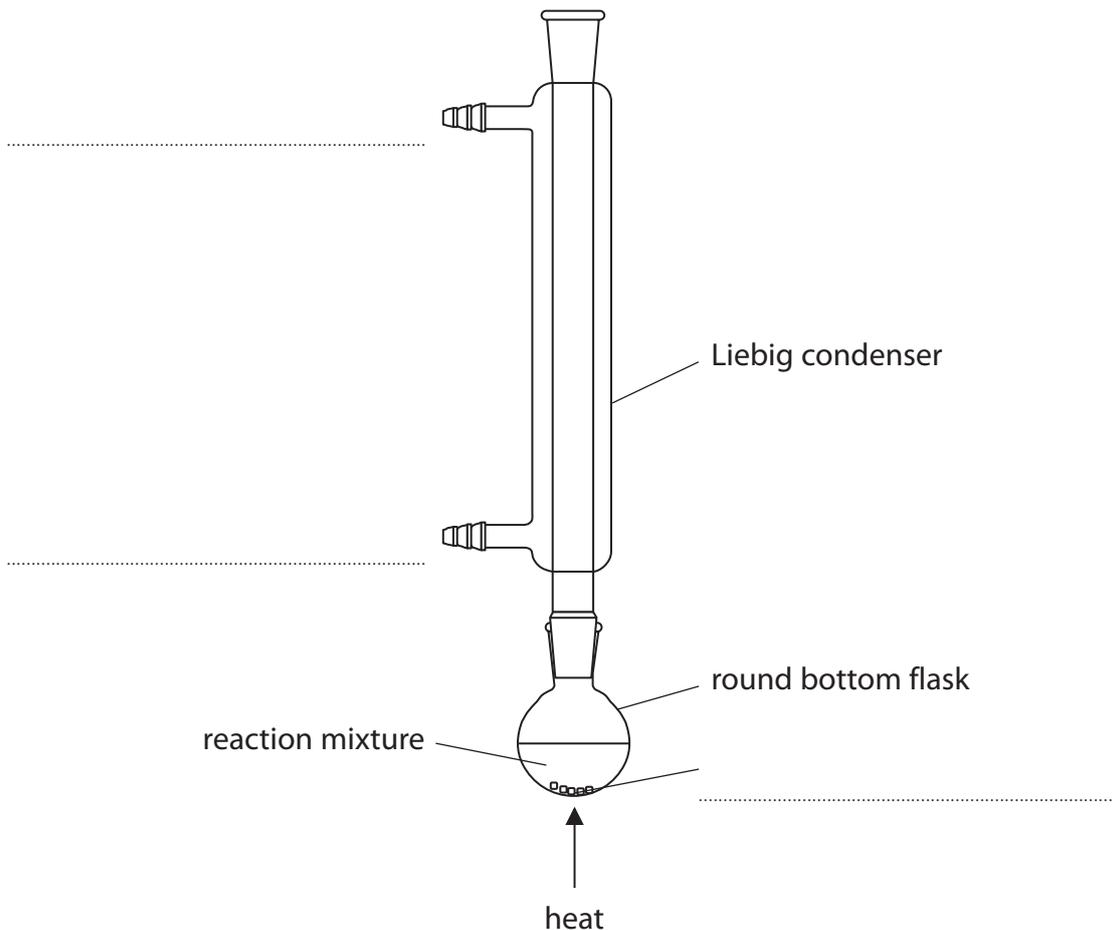


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(g) Compound **E** may be oxidized with potassium dichromate(VI) acidified with sulfuric acid, using the apparatus shown below. For clarity, clamps, stands and rubber tubing have been omitted from the diagram.



(i) Complete the labelling of this diagram. (2)

(ii) Name the technique that is carried out using this apparatus. (1)

(iii) Explain how the Liebig condenser works and its purpose in the apparatus shown. (2)

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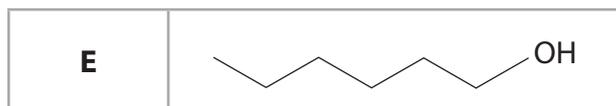
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(h) Oxidation of **E** can result in the formation of an aldehyde or a carboxylic acid.



(i) Give the skeletal or displayed formulae of these products.

(2)

Aldehyde

Carboxylic acid

(ii) By considering the bonds in these two products, explain how infrared spectroscopy can be used to distinguish between them. You are **not** expected to give specific wavenumbers.

(1)

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(i) The carboxylic acid produced by the oxidation of **E** is an oily liquid which boils at 206 °C. The carboxylic acid may be obtained from the reaction mixture by distillation.

(i) Name the **three** additional pieces of apparatus, apart from clamps and stands, which are essential to convert the apparatus shown at the start of part (g) for distillation.

(3)

1. ....

2. ....

3. ....

(ii) Suggest a suitable temperature range over which to collect the carboxylic acid distillate.

(1)

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(iii) The distillate contains a trace of water. Suggest a drying agent that could be used to remove this.

(1)

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**(Total for Question 2 = 24 marks)**



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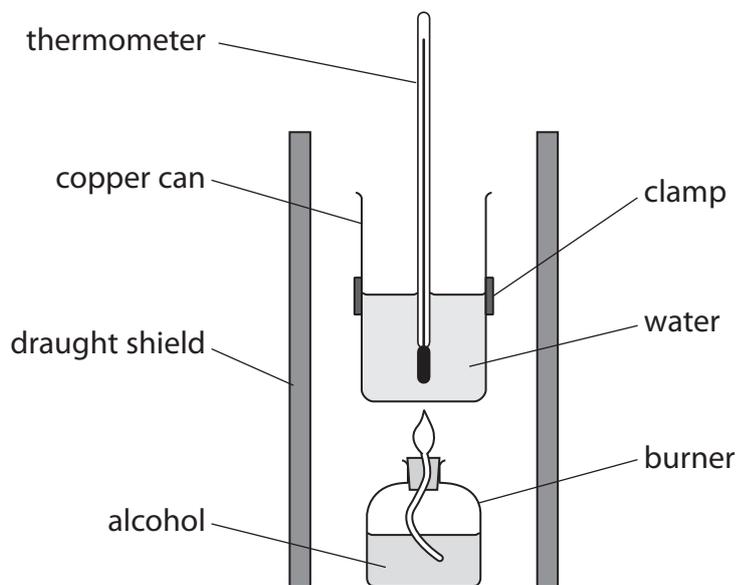
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- 3 The apparatus below was used in a series of experiments by a group of students to determine the enthalpy change of combustion of some alcohols.



- (a) In the experiment to determine the enthalpy change of combustion of  $\text{CH}_3\text{OH}$ , one student obtained the following results.

Measurement	Value
Mass of copper can / g	300.00
Mass of copper can + water / g	700.00
Mass of burner + $\text{CH}_3\text{OH}$ (start) / g	151.65
Mass of burner + $\text{CH}_3\text{OH}$ (finish) / g	150.00
Temperature of water (start) / $^{\circ}\text{C}$	21.5
Temperature of water (finish) / $^{\circ}\text{C}$	33.5

**Data**

Specific heat capacity of copper =  $0.39 \text{ J g}^{-1} \text{ }^{\circ}\text{C}^{-1}$   
 Specific heat capacity of water =  $4.2 \text{ J g}^{-1} \text{ }^{\circ}\text{C}^{-1}$



- (i) Calculate the heat energy transferred. Use the expression

$$\text{heat energy transferred / J} = [(0.39 \times \text{mass of copper can}) + (4.2 \times \text{mass of water})] \times \text{temperature rise}$$

(2)

- (ii) Use your answer from (a)(i) to calculate the enthalpy change of combustion of  $\text{CH}_3\text{OH}$ .

Give your answer in  $\text{kJ mol}^{-1}$  and include the appropriate sign.

(3)

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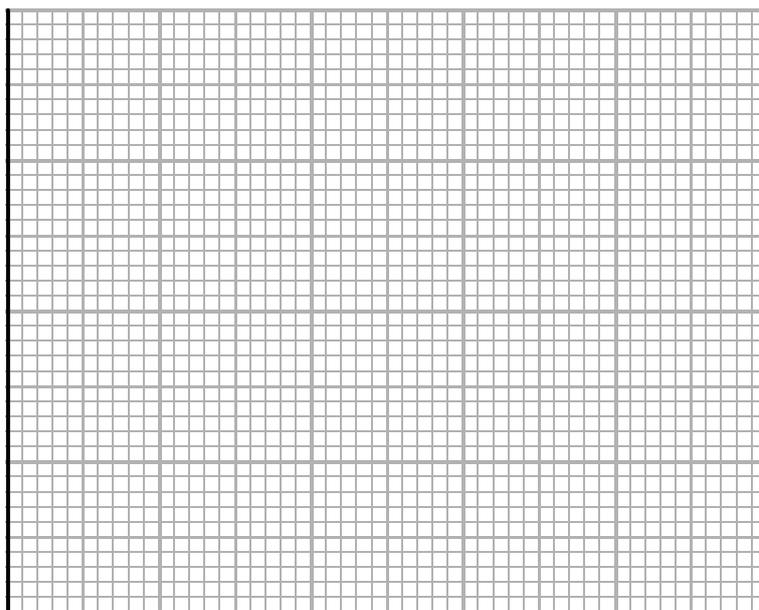


(b) The mean values obtained by the students were collected in a table.

Alcohol	(-) Enthalpy change of combustion / $\text{kJ mol}^{-1}$
$\text{CH}_3\text{OH}$	450
$\text{C}_2\text{H}_5\text{OH}$	800
$\text{C}_3\text{H}_7\text{OH}$	No value obtained
$\text{C}_4\text{H}_9\text{OH}$	1600
$\text{C}_5\text{H}_{11}\text{OH}$	2000

- (i) Label the axes below and plot a graph of (the magnitude of) the enthalpy change of combustion (on the vertical axis) against the number of carbon atoms in the alcohol (on the horizontal axis).

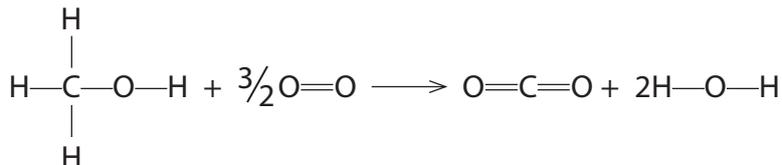
(2)



(ii) Use your graph to estimate the enthalpy change of combustion of C<sub>3</sub>H<sub>7</sub>OH. (1)

(iii) By considering the combustion equations for the alcohols, explain the trend shown by the graph in terms of the bond changes.

The equation for the combustion of CH<sub>3</sub>OH is given below; you are **not** expected to write any other equations. (2)



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- (c) The students then compared their results to the values in the Data Booklet. They found that the magnitudes were consistently much smaller; for example, the Data Booklet value for  $\text{C}_2\text{H}_5\text{OH}$  is  $-1367.3 \text{ kJ mol}^{-1}$ .

The students suggested a number of possible explanations for the discrepancy:

- I uncertainties in the measurement of mass and temperature
- II the values used for the specific heat capacities of copper ( $0.39 \text{ J g}^{-1} \text{ K}^{-1}$ ) and water ( $4.2 \text{ J g}^{-1} \text{ K}^{-1}$ ) are rounded (from  $0.385$  and  $4.18 \text{ J g}^{-1} \text{ K}^{-1}$ )
- III heat losses to the surroundings
- IV incomplete combustion of the alcohols

- (i) Calculate the percentage error in the students' mean value for the enthalpy change for combustion of  $\text{C}_2\text{H}_5\text{OH}$  compared with the Data Booklet value. Give your answer to **two** significant figures.

(2)



(ii) By considering your answer to (c)(i), evaluate the validity of each of the four reasons that the students put forward to explain the discrepancies between their values and those in the Data Booklet.

(4)

Suggestion I.....

Suggestion II.....

Suggestion III.....

Suggestion IV.....

**(Total for Question 3 = 16 marks)**

**TOTAL FOR PAPER = 50 MARKS**

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