Write your name here

Surname	Other names

Pearson Edexcel
International
Advanced Level

Centre Number | | | | | |

Candidate Number | | | | |

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 ▶

P46663A

5/5/5/5/1/

P 4 6 6 6 3 A 0 1 1 6

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)

(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**.

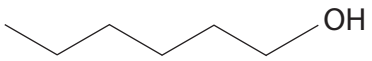
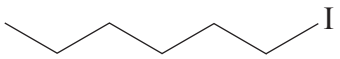
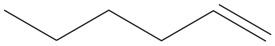
(1)

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

(2)

(Total for Question 1 = 10 marks)

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

E	
F	
G	

(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^3 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 .....

(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.

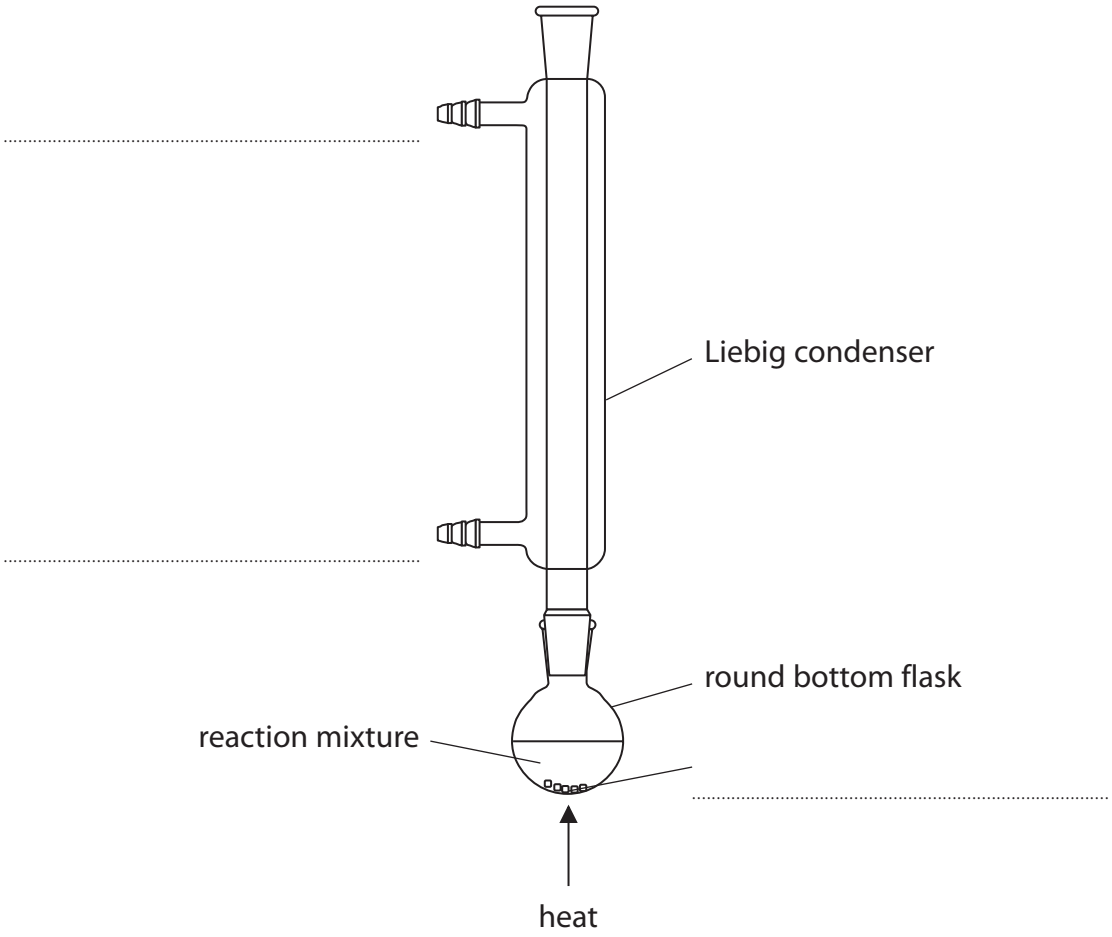
(1)

.....

.....

.....

(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)

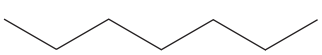
(ii) Name the technique that is carried out using this apparatus.

(1)

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

(2)

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

E	

(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)

.....

.....

.....

(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)

.....

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

(1)

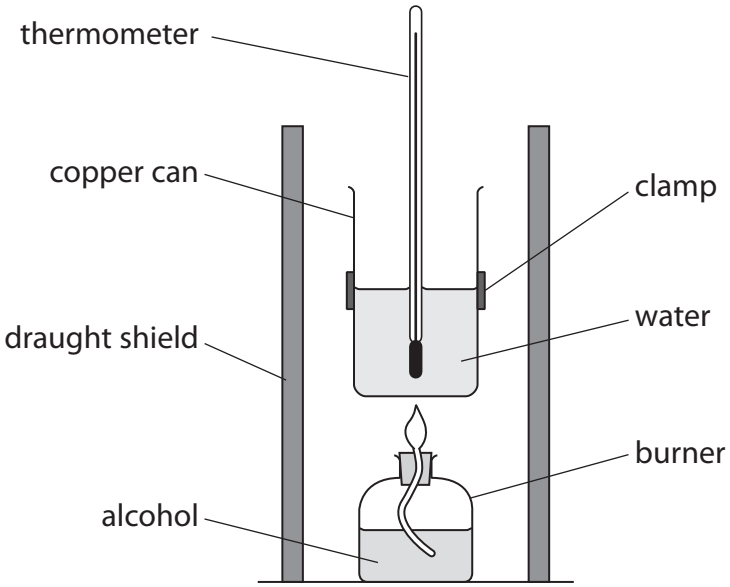
.....

.....

(Total for Question 2 = 24 marks)

BLANK PAGE

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 CH_3OH, 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 + CH_3OH (start) / g	151.65
Mass of burner + CH_3OH (finish) / g	150.00
Temperature of water (start) / °C	21.5
Temperature of water (finish) / °C	33.5

Data

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

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

heat energy transferred / J = [(0.39 × mass of copper can) + (4.2 × mass of water)] × temperature rise

(2)

(ii) Use your answer from (a)(i) to calculate the enthalpy change of combustion of CH_3OH.

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

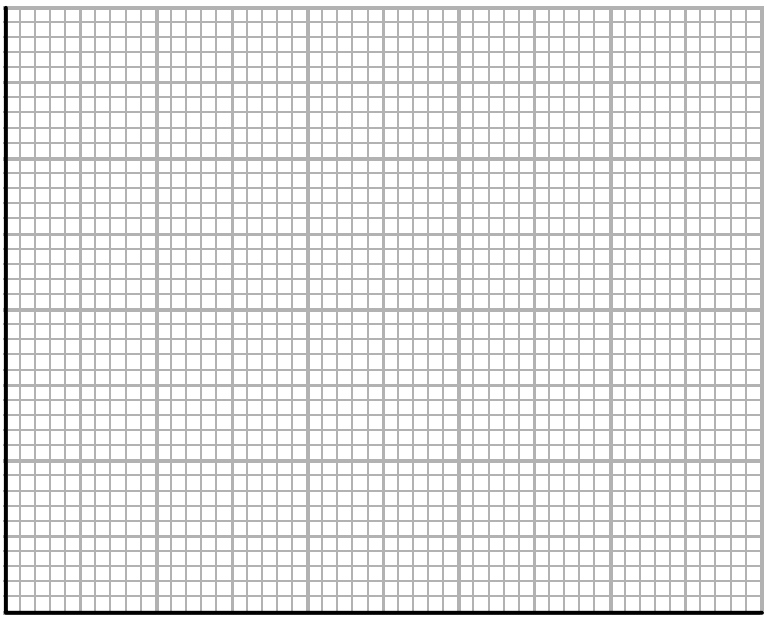
(3)

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

Alcohol	(–) Enthalpy change of combustion / kJ mol^{-1}
CH_3OH	450
C_2H_5OH	800
C_3H_7OH	No value obtained
C_4H_9OH	1600
$C_5H_{11}OH$	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)



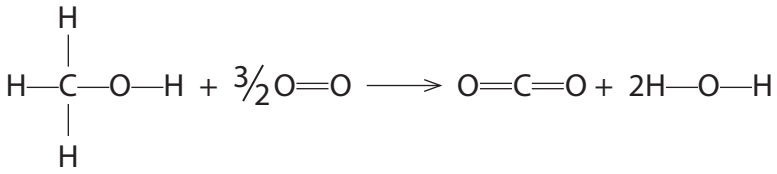
(ii) Use your graph to estimate the enthalpy change of combustion of C_3H_7OH.

(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_3OH is given below; you are **not** expected to write any other equations.

(2)



(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 C_2H_5OH is –1367.3 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 J g^{-1} K^{-1}) and water (4.2 J g^{-1} K^{-1}) are rounded (from 0.385 and 4.18 J g^{-1} 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 C_2H_5OH 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

The Periodic Table of Elements

1	2											3	4	5	6	7	0 (8)
																	(18)
							1.0 H hydrogen 1										4.0 He helium 2
(1)	(2)		Key									(13)	(14)	(15)	(16)	(17)	
6.9 Li lithium 3	9.0 Be beryllium 4		relative atomic mass atomic symbol name atomic (proton) number									10.8 B boron 5	12.0 C carbon 6	14.0 N nitrogen 7	16.0 O oxygen 8	19.0 F fluorine 9	20.2 Ne neon 10
23.0 Na sodium 11	24.3 Mg magnesium 12	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	27.0 Al aluminium 13	28.1 Si silicon 14	31.0 P phosphorus 15	32.1 S sulfur 16	35.5 Cl chlorine 17	39.9 Ar argon 18
39.1 K potassium 19	40.1 Ca calcium 20	45.0 Sc scandium 21	47.9 Ti titanium 22	50.9 V vanadium 23	52.0 Cr chromium 24	54.9 Mn manganese 25	55.8 Fe iron 26	58.9 Co cobalt 27	58.7 Ni nickel 28	63.5 Cu copper 29	65.4 Zn zinc 30	69.7 Ga gallium 31	72.6 Ge germanium 32	74.9 As arsenic 33	79.0 Se selenium 34	79.9 Br bromine 35	83.8 Kr krypton 36
85.5 Rb rubidium 37	87.6 Sr strontium 38	88.9 Y yttrium 39	91.2 Zr zirconium 40	92.9 Nb niobium 41	95.9 Mo molybdenum 42	[98] Tc technetium 43	101.1 Ru ruthenium 44	102.9 Rh rhodium 45	106.4 Pd palladium 46	107.9 Ag silver 47	112.4 Cd cadmium 48	114.8 In indium 49	118.7 Sn tin 50	121.8 Sb antimony 51	127.6 Te tellurium 52	126.9 I iodine 53	131.3 Xe xenon 54
132.9 Cs caesium 55	137.3 Ba barium 56	138.9 La* lanthanum 57	178.5 Hf hafnium 72	180.9 Ta tantalum 73	183.8 W tungsten 74	186.2 Re rhenium 75	190.2 Os osmium 76	192.2 Ir iridium 77	195.1 Pt platinum 78	197.0 Au gold 79	200.6 Hg mercury 80	204.4 Tl thallium 81	207.2 Pb lead 82	209.0 Bi bismuth 83	[209] Po polonium 84	[210] At astatine 85	[222] Rn radon 86
[223] Fr francium 87	[226] Ra radium 88	[227] Ac* actinium 89	[261] Rf rutherfordium 104	[262] Db dubnium 105	[266] Sg seaborgium 106	[264] Bh bohrium 107	[277] Hs hassium 108	[268] Mt meitnerium 109	[271] Ds darmstadtium 110	[272] Rg roentgenium 111							

Elements with atomic numbers 112-116 have been reported but not fully authenticated

* Lanthanide series	140 Ce cerium 58	141 Pr praseodymium 59	144 Nd neodymium 60	[147] Pm promethium 61	150 Sm samarium 62	152 Eu europium 63	157 Gd gadolinium 64	159 Tb terbium 65	163 Dy dysprosium 66	165 Ho holmium 67	167 Er erbium 68	169 Tm thulium 69	173 Yb ytterbium 70	175 Lu lutetium 71
* Actinide series	232 Th thorium 90	[231] Pa protactinium 91	238 U uranium 92	[237] Np neptunium 93	[242] Pu plutonium 94	[243] Am americium 95	[247] Cm curium 96	[245] Bk berkelium 97	[251] Cf californium 98	[254] Es einsteinium 99	[253] Fm fermium 100	[256] Md mendelevium 101	[254] No nobelium 102	[257] Lr lawrencium 103