Write your name here Surname	Other nan	nes				
Pearson Edexcel International Advanced Level	Centre Number	Candidate Number				
Chemistry Advanced Subsidiary Unit 3: Chemistry Laboratory Skills I						
Tuesday 10 May 2016 – Aft Time: 1 hour 15 minutes	ernoon	Paper Reference WCH03/01				
Candidates may use a calcula	tor.	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.

P 4 6 6 6 3 A 0 1 1 6

Turn over ▶



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)
	sult	
	(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	ОН
F	I
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)

Result

Test

(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 cm³ of a dilute aqueous solution of potassium manganate(VII) acidified with dilute sulfuric acid.
 - (i) State the colour change that occurs in this reaction.

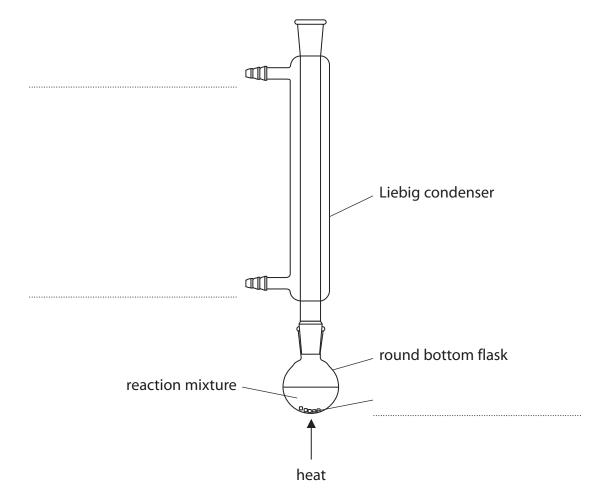
(1)

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 . Reagent	(2)
Conditions	
 (f) A student attempted to convert G to F using a standard method involving the add 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. 	dition (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.

ЕОН

(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.

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.

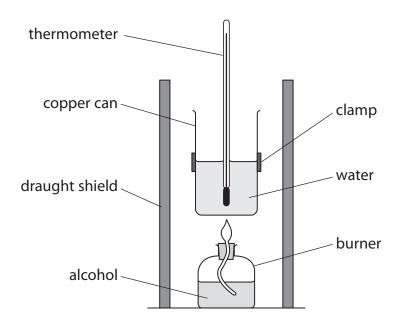
	distillation.	(3)
1		
2		
3		
	(ii) Suggest a suitable temperature range over which to collect the carboxylic acid distillate.	
		(1)
	(iii) The distillate contains a trace of water. Suggest a drying agent that could be used to remove this.	
		(1)

(Total for Question 2 = 24 marks)

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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 CH₃OH, 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 + CH₃OH (start) / g	151.65
Mass of burner + CH₃OH (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 \times mass of copper can) + (4.2 \times mass of water)] \times 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.

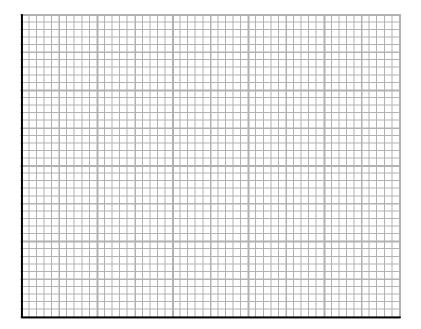
(3)

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

Alcohol	(–) Enthalpy change of combustion / kJ mol ⁻¹						
CH₃OH	450						
C₂H₅OH	800						
C₃H ₇ OH	No value obtained						
C₄H ₉ OH	1600						
C₅H 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).





(ii) Use your graph to estimate the enthalpy change of combustion of C₃H₇OH.

(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 CH₃OH is given below; you are **not** expected to write any other equations.

(2)

$$\begin{array}{c}
H \\
| \\
H - C - O - H + \frac{3}{2}O = O \longrightarrow O = C = O + 2H - O - H \\
| \\
H$$



(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 mag	arks)
TOTAL FOR PAPER = 50 MA	ARKS



The Periodic Table of Elements

0 (8)	(18)
7	
9	
2	
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	1.0
7	
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(18) 4.0 He	helium 2	20.2	Ne	neou 10	39.9	Αr	argon 18	83.8	Ā	krypton 24	ရ	131.3	Xe	xenon 54	[222]	R	radon 86		ted																	
2/2	(17)	19.0	L	fluorine 9	35.5	บ	chlorine 17	79.9	Br	bromine	23	126.9	Ι	iodine 53	[210]	Αt	astatine 85		seen repor																	
	(16)	16.0	0	oxygen 8	32.1	s	sulfur 16	79.0	Se	selenium	45	127.6	ъ	tellurium 52	[509]	8	polonium 84		116 have t	iticated																
	(15)	14.0	z	nitrogen 7	31.0	۵	phosphorus 15	74.9	As	arsenic	33	121.8	Sb	antimony 51	209.0	Bi	bismuth 83		mbers 112	but not fully authenticated																
	(14)	12.0	U	carbon 6	28.1	Si	silicon 14	72.6	g	germanium	32	118.7	Sn	20 ti	207.2	Ъ	lead 82		atomic nu	Dut not 1																
	(13)	10.8	В	boron 5	27.0	¥	aluminium 13	2.69	Ga	gallium	3	114.8	ī	indium 49	204.4	F	thallium 81		Elements with atomic numbers 112-116 have been reported																	
							(12)	65.4	Zu	zinc	30	112.4	5	cadmium 48	200.6	H	mercury 80		Elen																	
							(11)	63.5	J	copper	67	107.9	Ag	silver 47	197.0	PΠ	gold 79	[272]	Rg	roentgenium 111																
							(10)	58.7	ï	nickel	87	106.4	Ь	palladium 46	195.1	4	platinum 78	[271]	Os	damstadtium 110																
							(6)	58.9	ပိ	cobalt	/7	102.9	윤	rhodium 45	192.2	Ļ	iridium 77	[368]	۸ŧ	meitnerium 109																
1.0 H	1						(8)	55.8	Fe	11000-0	97	101.1	Ru	ruthenium 44	190.2	o	osmium 76	[277]	Hs	hassium 108																
							(7)	54.9	Wn	chromium manganese	Ç7	[88]	卢	molybdenum technetium 42 43	186.2	Re	rhenium 75	[264]	B	bohrium 107																
		mass	pol	number			(9)	52.0	ъ	chromium	74	95.9	Wo	molybdenum 42	183.8	≯	tungsten 74	[366]	Sg	seaborgium 106																
	Key	ve atomic i	relative atomic mass	ve atomic	ve atomic	ve atomic	ve atomic	ve atomic	ve atomic	ve atomic	ve atomic	ve atomic	ve atomic	ve atomic	ve atomic	ve atomic	ve atomic	atomic symbol	name atomic (proton) number			(5)	50.9	>	vanadium	57	92.9	£	niobium 41	180.9	Тa	tantalum 73	[292]	g	dubnium 105	
		relat	ato	atomic			(4)	47.9	ï	titanium	77	91.2	Zr	zirconium 40	178.5	Ξ	hafnium 72	[261]	₹	nutherfordium 104	l															
							(3)	45.0	S	scandium	1.7	88.9	>	yttrium 39	138.9	La*	lanthanum 57	[227]	Ac*	actinium 89																
	(2)	9.0	Be	beryllium 4	24.3	Mg	magnesium 12	40.1	S	calcium	707	87.6	'n	strontium 38	137.3	Ba	barium 56	[526]	Ra	radium 88																
	(1)	6.9	ï	lithium 3	23.0	Na	sodium 11	39.1	¥	potassium	61	85.5	&	rubidium 37	132.9	ర	caesium 55	[223]	Ŀ	francium 87																
																					-															

^{*} Lanthanide series

16

^{*} Actinide series

Tm
 Yb
 Lu

 thulium
 ytterbium
 lutetium

 69
 70
 71
 Md No Lr mendelevium nobelium lawrencium [257] 103 [254] 102 [326] Md 101 [253] Fm fermium 167 **Er** erbium 68 100
 141
 144
 [147]
 150
 152
 157
 159
 163
 165

 Pr
 Nd
 Pm
 Sm
 Eu
 Gd
 Tb
 Dy
 Ho

 xassoodymium promethium promet 67 99 65 **Cm** curium 96 4 63 62 61 uranium 92 238 **U** 9 protactinium [231] Pa 29 9 **Th** thorium 90 **Ge** 140 232 28