Please check the examination details belo	ow before entering your candidate information
Candidate surname	Other names
Pearson Edexcel International Advanced Level	tre Number Candidate Number
Wednesday 17	June 2020
Morning (Time: 1 hour 20 minutes)	Paper Reference WCH16/01
Chemistry International Advanced Le Unit 6: Practical Skills in Cl	
Candidates must have: Scientific ca Ruler	Iculator Total Marks

Instructions

- Use black ink or black 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.
- There is a Periodic Table on the back cover of this paper.

Advice

- Read each question carefully before you start to answer it.
- Show all your working in calculations and include units where appropriate.
- Check your answers if you have time at the end.

Turn over ▶





Answer ALL the questions.

Write your answers in the spaces provided.

1 Compound **A** is a green solid containing one cation and one anion.

A sample of compound **A** was dissolved in distilled water, forming a green solution.

Aqueous sodium hydroxide was added to the solution of **A** until there was no further change. A pale blue precipitate **B** and a yellow solution **C** were formed.

- (a) The pale blue precipitate **B** was separated and tested.
 - (i) **B** dissolved in excess ammonia to form a deep blue solution containing a complex ion **D**.

Identify, by name or formula, **B** and **D**.

(2)

Precipi	tate B	
Compl	ex ion D	
	(ii) When another portion of B was heated gently, the solid turned black.	
	Suggest the name or formula of the black solid.	(1)
	(iii) Excess concentrated hydrochloric acid was added to a further portion of the mixture warmed.	B and

The precipitate dissolved to form a different yellow solution **E**.

Identify, by name or formula, the complex ion responsible for the yellow colour in **E**.

(1)

(b) The yellow solution **C** was tested.

 $5\,\mathrm{cm^3}$ of dilute sulfuric acid was added to the same volume of **C**, and the mixture turned orange.

1 cm³ of ethanol was added to the orange mixture which was heated gently. The mixture turned green.

(i) Identify, by name or formula, the ions responsible for the colours observed.

(3)

Observation	lons
yellow colour of solution C	
orange colour on adding dilute sulfuric acid to C	
green colour of the mixture after heating with ethanol	

(ii) Suggest the name or formula of the organic product formed in the green mixture.

(1)

(c) Give the name or formula of compound **A**.

(1)

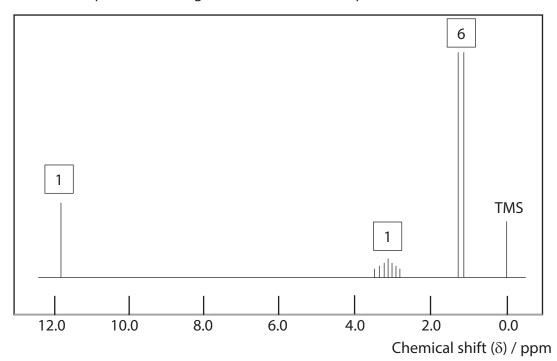
(d) Give a possible reason why compound **A** is green.

(1)

(Total for Question 1 = 10 marks)

2		uestion is about three organic compounds P , Q and R . compounds are isomers with the molecular formula $C_4H_8O_2$.	
		npound P is a colourless liquid with a sweet fruity smell.	
		nen a sample of P was heated with sodium hydroxide, a volatile product was	
		med which had a molecular ion peak in its mass spectrum at $m / z = 46$.	
	The	e mass spectrum of P has a strong peak at $m / z = 43$.	
	De	duce the structure of P . Justify your answer using all this information.	(4)
			(4)
•••••			
•••••			
	(b) (i)	When sodium hydrogencarbonate solution is added to separate samples of Q and R , effervescence occurs and a gas is evolved which turns limewater milky.	
		Deduce the two possible structures of Q and R .	
		Justify your answer using all this information.	(2)
			(2)
•••••			

(ii) A simplified high resolution proton NMR spectrum of $\bf Q$ is shown. The relative peak areas are given above each set of peaks.



Deduce the structure of **Q**. Fully justify your answer by referring to the number of peaks, the relative peak areas and the splitting patterns in the proton NMR spectrum.

(4)

(
(Total for Question 2 = 10 marks)

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3 A group of students carried out an experiment to determine the rate equation for the reaction between bromide and bromate(V) ions in acid conditions.

The equation for this reaction is

$$BrO_3^-(aq) + 5Br^-(aq) + 6H^+(aq) \rightarrow 3Br_2(aq) + 3H_2O(l)$$

Procedure (to determine the order of reaction with respect to bromate(V) ions)

- Step **1** Measure 10.0 cm³ of aqueous phenol solution into a boiling tube and add five drops of methyl red indicator. The mixture turns yellow (the alkaline colour of methyl red).
- Step 2 Add 5.0 cm³ of aqueous potassium bromide and 10.0 cm³ of dilute sulfuric acid to the boiling tube. The mixture turns red (the acid colour of methyl red).
- Step 3 Measure 15.0 cm³ of aqueous potassium bromate(V) into a second boiling tube.
- Step 4 Mix the contents of the two boiling tubes and start a timer.
- Step **5** Record the time (*t*) when the colour of the methyl red is bleached from red to colourless by excess bromine.
- Step 6 Repeat the experiment using different volumes of aqueous potassium bromate(V), adding distilled water so that the total volume of the reacting solution is always 40.0 cm³.
- (a) Two of the hazard warning signs for phenol are





State the most important hazard associated with phenol in this experiment and the precaution you would take to reduce the risk, apart from wearing safety goggles and a laboratory coat.

(1)

(b) Explain the purpose of the phenol in this experiment.	(2)
(c) Suggest a way of making the disappearance of the methyl red colour easier to see	(1)

(d) A student's results are shown.

Run	Volumes added to 10 cm ³ of phenol / cm ³				time (t)	$\frac{1}{t}$
	BrO₃⁻(aq)	Br ⁻ (aq)	H ₂ SO ₄ (aq)	H ₂ O(l)	/ s	/ s ⁻¹
1	15.0	5.0	10.0	0.0	40	0.025
2	12.0	5.0	10.0	3.0	51	0.020
3	10.0	5.0	10.0	5.0	62	0.016
4	8.0	5.0	10.0	7.0	74	0.014
5	6.0	5.0	10.0	9.0	100	0.010
6	4.0	5.0	10.0	11.0	154	0.0065

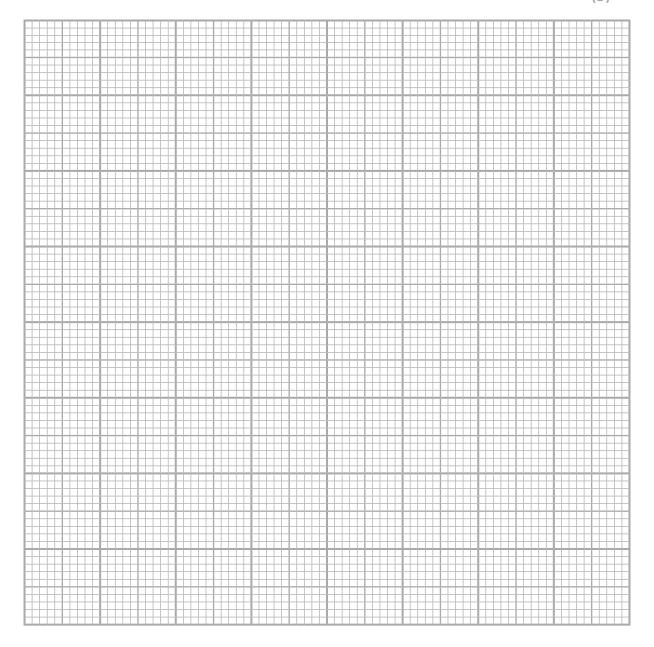
(i) State why the total volume of the mixture is kept constant.

(1)



(ii) Plot a graph of reciprocal time (1/t) against volume of bromate(V) solution.

(3)



(iii) State the order of reaction with respect to bromate(V) ions. Justify your answer	er. (1)
(iv) Reciprocal time $(1/t)$ is used as a measure of rate in this experiment.	
Suggest the assumption on which this depends. Refer in your answer to the shape of a typical graph of reactant concentration against time.	(1)
(v) Another student accidentally measured 8.5 cm³ of potassium bromate(V) rather than 8.0 cm³ in Run 4.	
Explain whether or not this portion of potassium bromate(V) should be disca	rded. (2)

(i	Give a reason why the potassium bromate(V) solution is first measured into a separate boiling tube rather than directly into the reaction mixture.	(1)
(i	ii) Give two reasons why Run 1 has the lowest uncertainty in the volume measurements.	(2)
	tate the changes that you would make to the procedure to obtain the data	
n	state the changes that you would make to the procedure to obtain the data needed to determine the overall rate equation for the reaction between bromide and bromate(V) ions in acid conditions.	(2)
n	needed to determine the overall rate equation for the reaction between bromide	(2)
n	needed to determine the overall rate equation for the reaction between bromide	(2)
n	needed to determine the overall rate equation for the reaction between bromide	



4 A group of students prepared aspirin from 2-hydroxybenzoic acid using ethanoic anhydride.

Data

Compound	Molar mass / g mol ⁻¹	Density of liquid / g cm ⁻³	Melting temperature /°C
2-hydroxybenzoic acid	138.0	_	159
ethanoic anhydride	102.0	1.082	_
aspirin	180.0	_	136

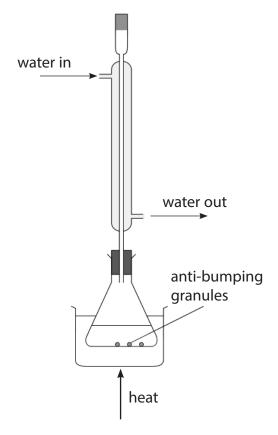
Procedure

- Step 1 Weigh 2.00 g of 2-hydroxybenzoic acid and put it in a pear-shaped flask. Clamp the flask and suspend it in a water bath containing cold water.
- Step 2 Add 5.0 cm³ of ethanoic anhydride to the 2-hydroxybenzoic acid. Add five drops of concentrated sulfuric acid to the mixture in the flask. Add anti-bumping granules and fix a reflux condenser on the flask.
- Step **3** Warm the mixture by heating the water bath using a Bunsen burner. Gently swirl the mixture until all the solid has dissolved.
- Step 4 Continue warming the mixture for another 10 minutes.
- Step **5** Remove the flask from the hot water bath and add 10 cm³ of crushed ice and some distilled water.
- Step **6** Stand the flask in a beaker of iced water until no more aspirin crystals form.
- Step **7** Filter off the aspirin crystals using a Büchner funnel and suction apparatus.
- Step 8 Wash the aspirin crystals with the minimum volume of iced water.
- Step **9** Recrystallise the aspirin crystals using a mixture of ethanol and water.

(a) Give a reason for placing the flask in cold water in Step 1.	(1)
 (b) Suggest the purpose of the concentrated sulfuric acid added in Step 2.	(1)
 (c) Show, by calculation, that the ethanoic anhydride is in excess in this preparation.	(3)

(3)

(d) One student drew a diagram of the apparatus used for reflux in Step 4.



Identify the three errors in the student's diagram.

Assume that the apparatus is clamped correctly.

(e) Suggest the purpose of adding crushed ice and distilled water in Step 5 .	(4)
	(1)

(f) The filtration in Step 7 is carried out under reduced pressure. State two advantages of this method compared with ordinary (gravity) filtration.	(2)
(g) Describe how the purity of the recrystallised aspirin could be tested. Experimental details are not required.	(2)
(Total for Question 4 = 13 ma	rks)

TOTAL FOR PAPER = 50 MARKS



The Periodic Table of Elements

9
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2
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(8)	4.0 He hetium 2	20.2 Ne neon 10	39.9 Ar argon 18	83.8 Kr krypton 36	Xe xenon 54	[222] Rn radon 86	÷
0 (8)	4. T ^{ja}	20 Z e T	39 arg	8 × 55 c	£ × š c	[2]	orted
7	(77)	19.0 F fluorine 9	35.5 Cl chlorine 17	Promine 35	126.9 I iodine 53	[210] At astatine 85	овен герс
9	(16)	16.0 O oxygen 8	32.1 S sulfur 16	Se selenium 34	Te Te tellurium 52	[209] Po polonium 84	116 have b
2	(15)	14.0 N nitrogen 7	31.0 P phosphorus 15	74.9 As arsenic 33	Sb Sb antimony 51	209.0 Bi bismuth 83	tomic numbers 112-116 hav but not fully authenticated
4	(14)	12.0 C carbon 6	28.1 Si silicon	72.6 Ge germanium 32	118.7 Sn tin 50	207.2 Pb lead 82	atomic nu but not f
e	(13)	10.8 B boron 5	27.0 Al atuminium 13	69.7 Ga gallium 31	114.8 In indium 49	204.4 Tl thallium 81	Elements with atomic numbers 112-116 have been reported but not fully authenticated
	·		(12)	5 5.4 Zn zinc 30	Cd Cadmium 48	200.6 Hg mercury 80	Elen
			(11)	63.5 Cu copper 29	107.9 Ag silver 47	197.0 Au gold 79	Rg roentgenium 111
			(10)	58.7 Ni nickel 28	Pd palladium 46	195.1 Pt platinum 78	[268] [271] [272]
			(6)	Co cobalt	Rh rhodium 45	192.2 Ir iridium 77	[268] Mt meitnerium 109
	1.0 H hydrogen		(8)	55.8 Fe iron 26	Ru Ru ruthenium 44	190.2 Os osmium 76	[277] Hs hassium 108
			(7)	Mn manganese 25	[98] Tc technetium 43	Re rhenium 75	[264] Bh bohrlum 107
		mass bol umber	(9)	52.0 54.9 Cr Mn chromium manganese 24 25	95.9 [98] Mo TC molybdenum technetium 42 43	183.8 W tungsten 74	[262] [266] Db Sg dubnium seaborgium 105
	Key	relative atomic mass atomic symbol name atomic (proton) number	(5)	50.9 V vanadium 23	92.9 Nb niobium 41	180.9 Ta tantalum 73	[262] Db dubnium 105
		relati ato atomic	(4)	47.9 Ti titanium 22	91.2 Zr zirconium 40	178.5 Hf hafnium 72	Ac* Rf actinium nutherfordium 89 104
			(3)	Sc scandium 21	88.9 Y yttrium 39	138.9 La* lanthanum 57	[227] Ac* actinium 89
2	(2)	9.0 Be beryllium 4	24.3 Mg magnesium 12	Ca calcium 20	87.6 Sr strontium 38	137.3 Ba barium 56	[226] Ra radium 88
-	(1)	6.9 Li (ithium	Na sodium 11	39.1 K potassium 19	85.5 Rb rubidium 37	132.9 Cs caesium 55	[223] Fr francium 87

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140	141	144	[147]	150	152	157	159	163	165	167	169	173	175
ç	<u>ڄ</u>	Ž	Pm	Sm	En	В	4	Š	운	ц	Ē	ХÞ	Ľ
erium	praseodymium	ē	promethium	samarium	europium	gadolinium	terbium	dysprosium	holmium	erbium	thulium	ytterbium	lutetium
28	59		61	62	63	4	65	99	29	89	69	70	71
232	232 [231]	238	[237]	[242]	[243]	[247]	[245]	[251]	[254]	[253]	[256]	[254]	[257]
두	Pa		å	Pu	Am	5	쑮	ຽ	Es	Fn	ΡW	ž	ב
horium	protactinium	uranium	neptunium	plutonium	americium	arrium	berkelium	californium	einsteinium	fermium	mendelevium	nobelium	lawrencium
06	91	92	93	94	95	%	46	86	66	100	101	102	103