Please check the examination details below before entering your candidate information

Candidate surname	Other names

Pearson Edexcel
International
Advanced Level

Centre Number | | | | | |

Candidate Number | | | | |

Wednesday 17 June 2020

Morning (Time: 1 hour 20 minutes) | Paper Reference **WCH16/01**

Chemistry

International Advanced Level
Unit 6: Practical Skills in Chemistry II

Candidates must have: Scientific calculator
Ruler

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 ▶

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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)

Precipitate **B** .....

Complex 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 **B** and the mixture warmed.

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)

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

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

1 cm^3 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	Ions
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 This question is about three organic compounds **P**, **Q** and **R**.
These compounds are isomers with the molecular formula $C_4H_8O_2$.

(a) Compound **P** is a colourless liquid with a sweet fruity smell.

When a sample of **P** was heated with sodium hydroxide, a volatile product was formed which had a molecular ion peak in its mass spectrum at $m / z = 46$.

The mass spectrum of **P** has a strong peak at $m / z = 43$.

Deduce the structure of **P**. Justify your answer using all this information.

(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)

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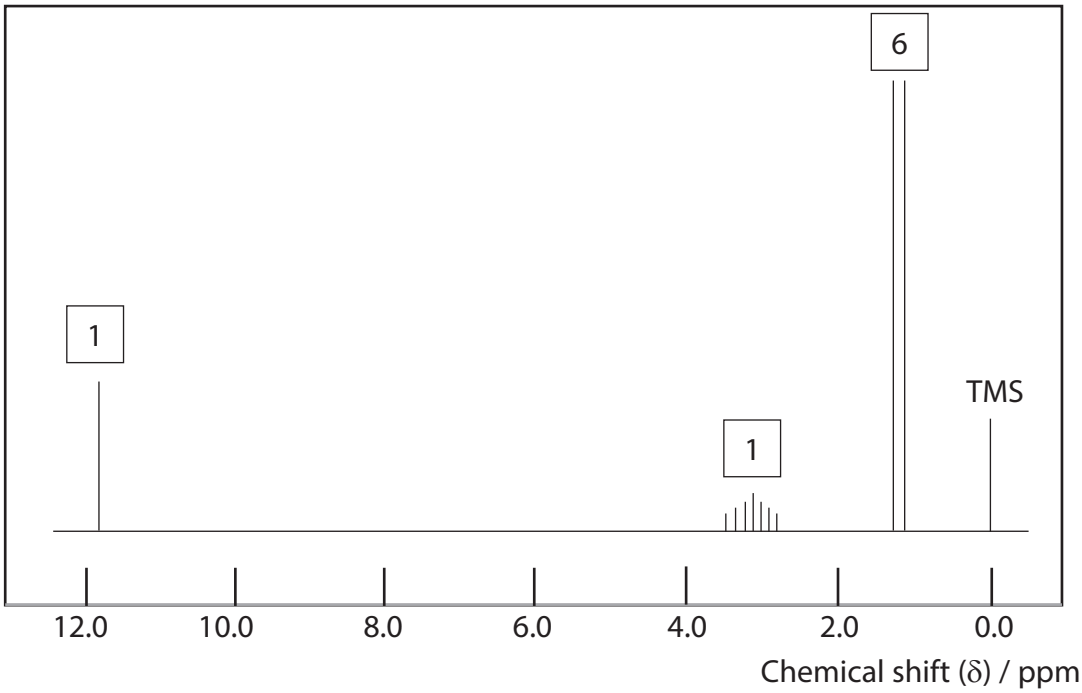
(ii) A simplified high resolution proton NMR spectrum of **Q** is shown.
The relative peak areas are given above each set of peaks.



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 cm^3 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 cm^3 of aqueous potassium bromide and 10.0 cm^3 of dilute sulfuric acid to the boiling tube. The mixture turns red (the acid colour of methyl red).

Step **3** Measure 15.0 cm^3 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 cm^3.

(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*) / s	$\frac{1}{t}$ / s^{-1}
	$BrO_3^-(aq)$	$Br^-(aq)$	$H_2SO_4(aq)$	$H_2O(l)$		
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)

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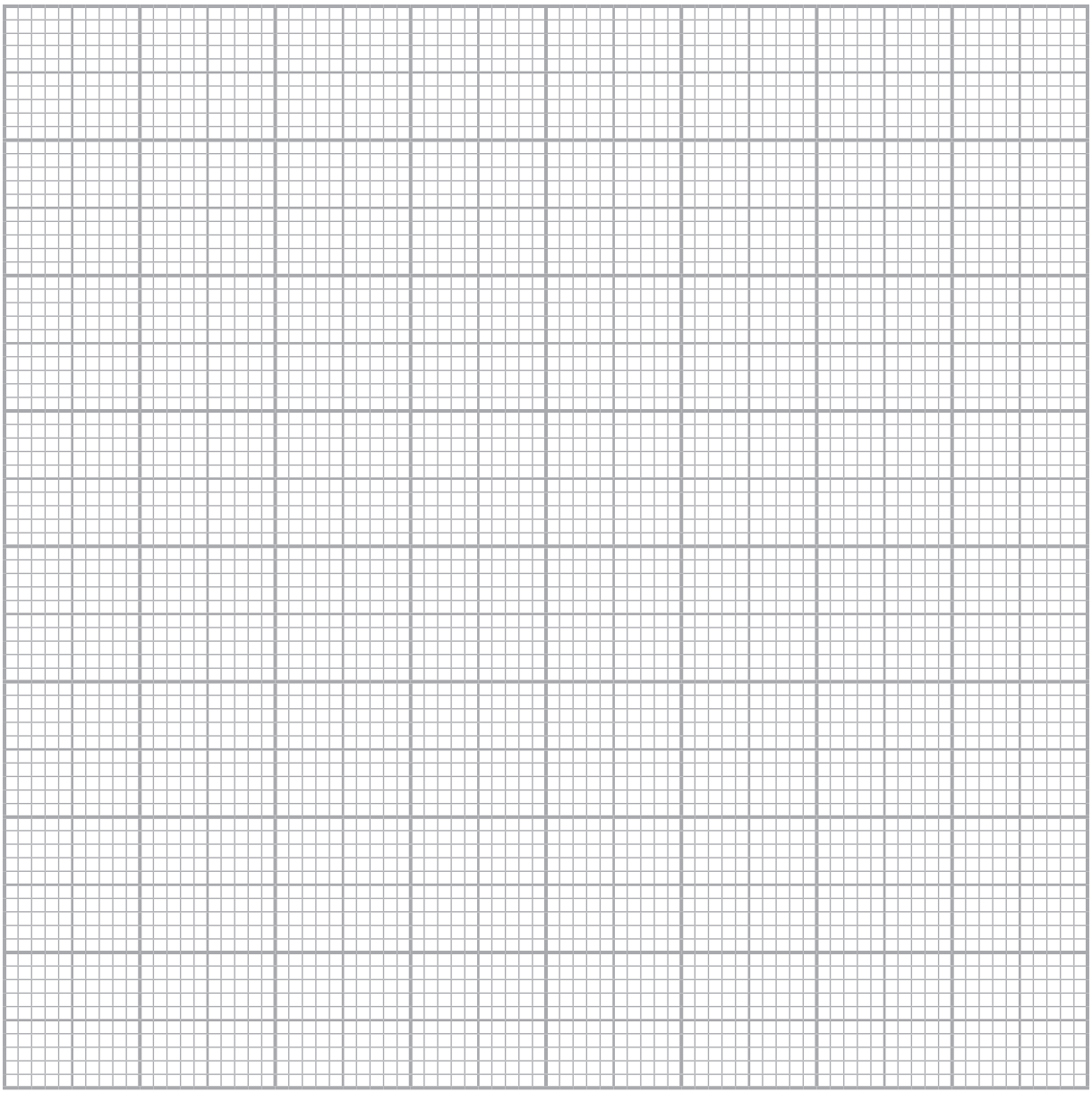
(ii) Plot a graph of reciprocal time (1/*t*) against volume of bromate(V) solution.

(3)



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(iii) State the order of reaction with respect to bromate(V) ions. Justify your answer.

(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 cm^3 of potassium bromate(V) rather than 8.0 cm^3 in Run 4.

Explain whether or not this portion of potassium bromate(V) should be discarded.

(2)

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(e) All the volume measurements in this experiment were made using a 50 cm^3 burette.

(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)

(ii) Give **two** reasons why Run 1 has the **lowest** uncertainty in the volume measurements.

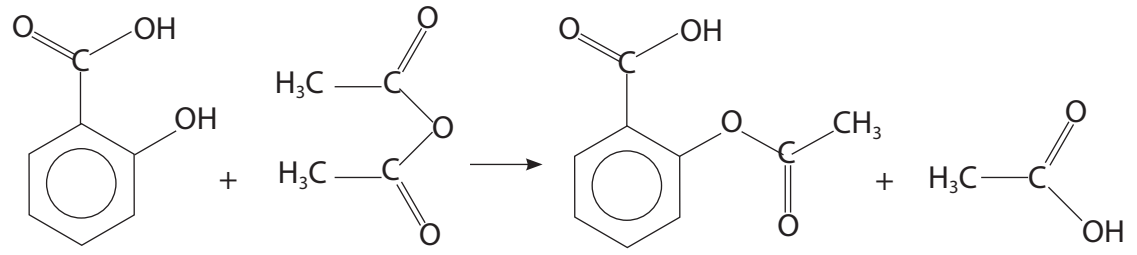
(2)

(f) 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)

(Total for Question 3 = 17 marks)

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



2-hydroxybenzoic acid + ethanoic anhydride → aspirin + $H_3C-C(=O)-OH$

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 cm^3 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 cm^3 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.

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(a) Give a reason for placing the flask in cold water in Step **1**.

(1)

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.....

(b) Suggest the purpose of the concentrated sulfuric acid added in Step **2**.

(1)

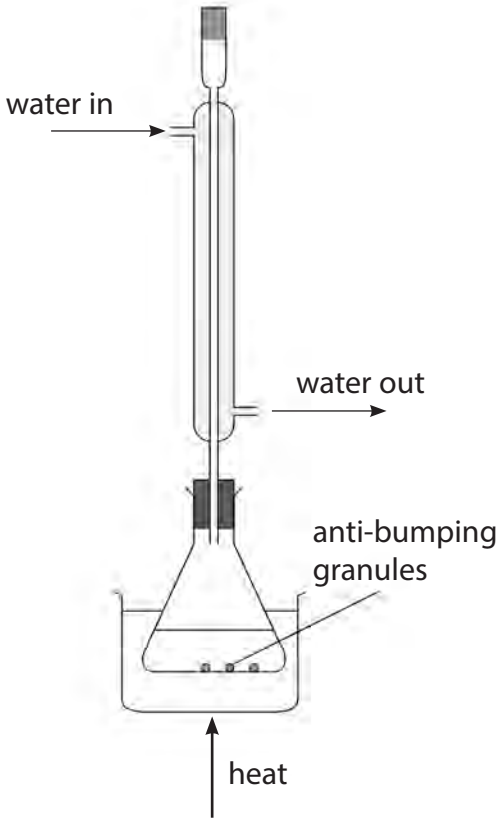
.....

.....

(c) Show, by calculation, that the ethanoic anhydride is in excess in this preparation.

(3)

(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.

(3)

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

(1)

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(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 marks)

TOTAL FOR PAPER = 50 MARKS

The Periodic Table of Elements

1	2											3	4	5	6	7	0 (8)
							1.0 H hydrogen 1										(18) 4.0 He helium 2
(1)	(2)		Key: relative atomic mass / atomic symbol / name / atomic (proton) number									(13)	(14)	(15)	(16)	(17)	
6.9 Li lithium 3	9.0 Be beryllium 4											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

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
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

* Lanthanide series

* Actinide series

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PMT