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Candidate surname	Other names

Pearson Edexcel
International
Advanced Level

Centre Number | | | | | |

Candidate Number | | | | |

Wednesday 17 June 2020

Morning (Time: 1 hour 15 minutes) | Paper Reference **WCH06/01**

Chemistry

Advanced

Unit 6: Chemistry Laboratory Skills 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.
- A Periodic Table is printed 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 give units where appropriate.
- Check your answers if you have time at the end.

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

1 A transition metal **M** has two oxides.

One oxide is a black solid. This solid reacts with dilute nitric acid to form a blue solution **X**.

(a) Tests are carried out on the solution **X**. Complete the table.

Test	Observation	Inference	
(i) To 1 cm^3 of **X** in a test tube, add a few drops of sodium hydroxide solution followed by an excess	A pale blue precipitate forms which does not dissolve in excess sodium hydroxide solution	The **formula** of the transition metal cation in **X** is	**(1)**
(ii) To 1 cm^3 of **X** in a test tube, add a few drops of dilute ammonia solution followed by an excess	After adding a few drops of dilute ammonia solution: .... After adding excess ammonia solution:	This confirms the inference made in (i)	**(2)**
(iii) A few drops of **X** are added to 3 cm^3 of **concentrated** hydrochloric acid and the colour of the mixture observed	.....	The colour seen is caused by a species with the **formula**	**(2)**
(iv) To 1 cm^3 of **X** in a test tube, add a few drops of potassium iodide solution Then add a few drops of starch solution	A brown solution and a white solid form The brown solution turns blue black	Identify by name or formula: the substance causing the brown colour ..... the white solid	

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(b) A reagent containing a compound of **M** produces the second oxide of **M** when it is warmed with ethanal.

(i) Name a reagent which reacts with ethanal to produce this second oxide of **M**.

(1)

.....

(ii) Give the **formula** of this second oxide of **M**.

(1)

.....

(iii) Describe what you would **see** when carrying out this reaction.

(1)

.....

.....

(Total for Question 1 = 10 marks)

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2 This question is about butanoic acid, $CH_3CH_2CH_2COOH$, and one of its isomers.

(a) State what test you could use, other than adding an indicator or using a pH meter, to confirm that butanoic acid contains an acid group.

Give the result of the test.

(2)

Test .....

Result .....

.....

(b) Compound **A** is an organic liquid which is an isomer of butanoic acid.

There are two functional groups in **A**. Neither functional group is a carboxylic acid.

Tests were carried out on **A**.

(i) Dry phosphorus(V) chloride was added to **A**. Steamy fumes were produced which turned damp blue litmus paper red.

State what you can deduce about **A** from this test.

(1)

.....

(ii) **A** was tested with 2,4-dinitrophenylhydrazine solution (Brady's reagent). The result was **positive**.

State what you would see when a positive result is obtained in this test and what you would deduce from this result.

(2)

Observation .....

Deduction .....

.....

(iii) Another portion of **A** was then warmed with Tollens' reagent. No change was seen.

State what you can deduce about **A** from this test.

(1)

.....

.....

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(iv) **A** was warmed with iodine in the presence of sodium hydroxide.
Pale yellow crystals formed.

State what you can deduce about **A** from this test.

(1)

.....

.....

.....

(v) **A** is optically active. The carbon chain in **A** is not branched.

Draw the displayed formula for **A** which is consistent with this information and the deductions from (b)(i) to (b)(iv).

Circle the chiral centre.

(2)

(vi) State why the **low** resolution proton nmr spectrum of **A** has four peaks.

(1)

.....

(vii) State the number of singlets, doublets, triplets and quartets in the **high** resolution proton nmr spectrum of **A**.
Some of these numbers may be zero.

(3)

Number of singlets	Number of doublets	Number of triplets	Number of quartets

(Total for Question 2 = 13 marks)

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3 Ethyl ethanoate, $CH_3COOC_2H_5$, was hydrolysed by reacting it with hydrochloric acid.

10.0 cm^3 of the ester and 100 cm^3 of 1.00 mol dm^{-3} hydrochloric acid were placed in separate containers in a water bath at 40 °C.

The contents were allowed to reach the temperature of the water bath.

The ester was mixed with the hydrochloric acid and a timer was started.

At intervals, over a period of 60 minutes, 5.00 cm^3 samples of the mixture were withdrawn by pipette and added to a mixture of ice and water in a conical flask.

These samples were then titrated with 0.200 mol dm^{-3} sodium hydroxide solution added from a burette.

After 60 minutes the remaining mixture was heated under reflux for 15 minutes. Another 5.00 cm^3 sample was then withdrawn and the titration repeated.

(a) Write the equation for the hydrolysis of ethyl ethanoate.
State symbols are not required.

(1)

(b) Explain why the number of moles of hydrochloric acid in each 5 cm^3 sample remains constant.

(1)

(c) Give a reason why the samples were added to a mixture of ice and water.

(1)

(d) Phenolphthalein indicator was used in the titration.

State the colour change which was seen at the end-point.

(1)

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(e) The mixture remaining after 60 minutes was heated under reflux and another 5 cm^3 sample was titrated.

(i) By considering the products of the reaction, suggest what information this titre provides.

(1)

.....

.....

.....

.....

(ii) Draw a labelled diagram of the apparatus used to heat the reaction mixture under reflux.

(3)

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(f) The results of the experiment are shown.

Results

Time / min	Titre / cm^3	**V** = (45.00 – titre) / cm^3
0	22.70	22.30
10	28.50	16.50
20	32.50	12.50
30	35.95	9.05
40	37.90	7.10
50	39.75	5.25
60	41.20	3.80
After refluxing	45.00	

The quantity **V** is directly proportional to the concentration of the ester in the sample.

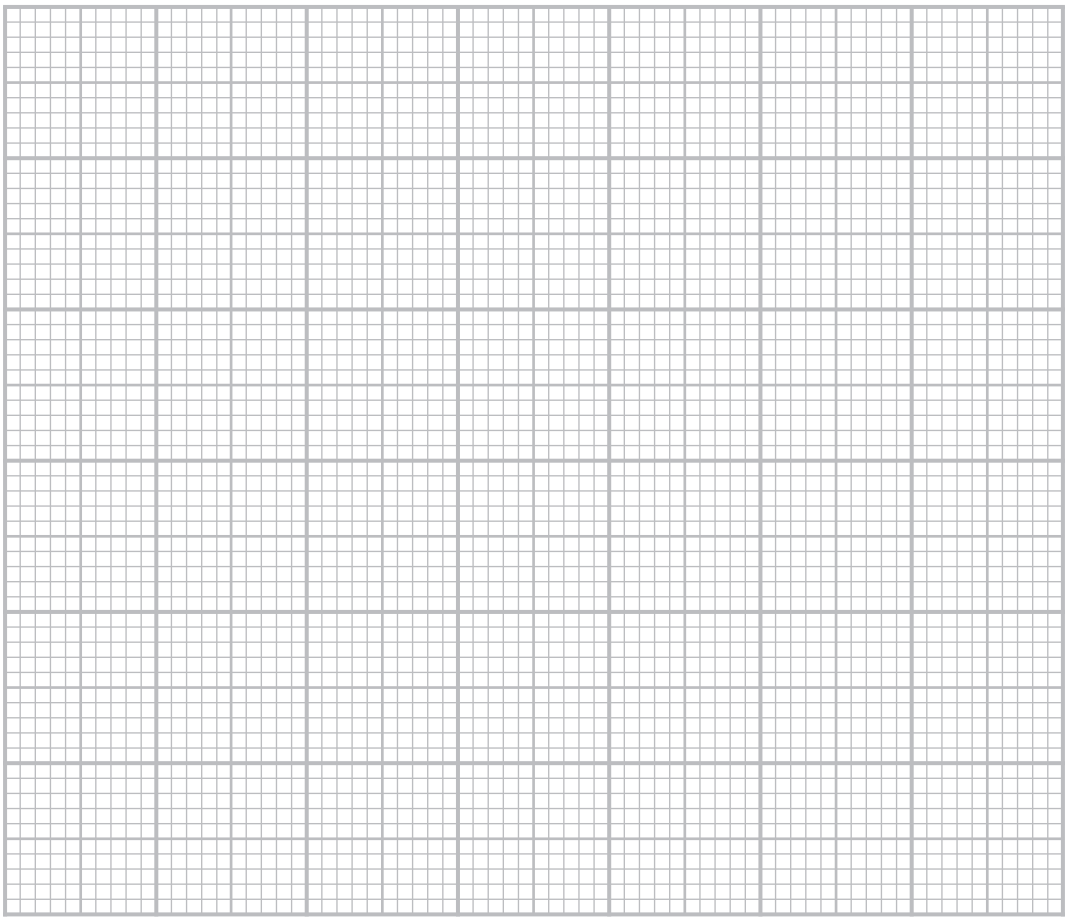
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(i) Plot a graph of **V** on the vertical axis against time on the horizontal axis.

(2)



(ii) Use your graph to determine the order of reaction by measuring two successive half-lives.

(2)

First half-life .....

Second half-life .....

Order of reaction .....

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(g) (i) Calculate the number of moles of ethyl ethanoate in the 10.0 cm^3 used in the reaction mixture.

Data for ethyl ethanoate:

Density	0.900 g cm^{-3}
Molar mass	88.1 g mol^{-1}

(1)

(ii) Give a reason why the number of moles of water present for hydrolysis does not have to be known when finding the order of the reaction.

(1)

(h) A student suggested that the order of the reaction could be found by plotting a graph of the pH of the mixture against time, and measuring half-lives.

Give **two** reasons why this method cannot be used.

(2)

(Total for Question 3 = 16 marks)

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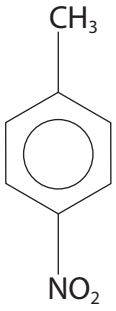
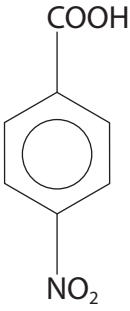
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4 This question is about the preparation of 4-nitrobenzoic acid from 1-methyl-4-nitrobenzene.

This reaction is one stage in the production of benzocaine, a local anaesthetic.

	
1-methyl-4-nitrobenzene $M_r = 137$	4-nitrobenzoic acid $M_r = 167$

Outline procedure

Step **1** Add 10.0 g of 1-methyl-4-nitrobenzene to a cold acidic solution of sodium dichromate(VI). Heat the mixture under reflux for an hour and allow it to cool.

Step **2** Pour the mixture onto ice in a large beaker. Filter off the solid under reduced pressure and wash it with distilled water.

Step **3** Transfer the solid to a beaker and add enough sodium hydroxide solution to dissolve the 4-nitrobenzoic acid.
Filter under reduced pressure to remove the chromium(III) compound which precipitates. Collect the filtrate.

Step **4** Add the filtrate to a mixture of concentrated hydrochloric acid and ice in a beaker and stir. Test the resulting mixture to ensure the solution is strongly acidic. (4-nitrobenzoic acid is not soluble in acidic solutions.)
Filter the resulting precipitate under reduced pressure and wash it with distilled water. Allow the precipitate to dry in a desiccator.

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(a) The solid sodium dichromate(VI), used to make the solution in Step **1**, is stored in a container labelled with the following symbols.

State the meaning of each symbol.

(2)

(b) Draw a labelled diagram showing the apparatus used to filter under reduced pressure in Steps **2**, **3** and **4**.

(3)

(c) Identify, by name or formula, the solid chromium(III) compound formed in Step **3** and state its colour.

(2)

Name or formula .....

Colour .....

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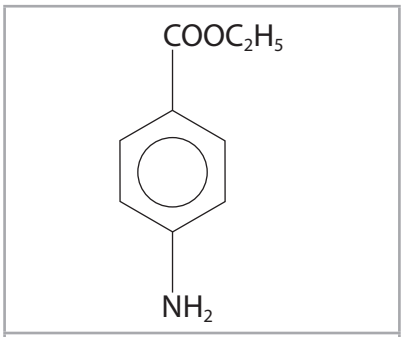
(d) Give a test and its positive result that would show the solution of 4-nitrobenzoic acid in Step **4** is **strongly** acidic.

(1)

.....

.....

(e) Benzocaine can be prepared from 4-nitrobenzoic acid by carrying out two further reactions.



Benzocaine

$M_r = 165$

Calculate the mass of 4-nitrobenzoic acid that is required to prepare 10.0 g of benzocaine. The yield in each of the two further reactions is 70%.

(3)

(Total for Question 4 = 11 marks)

TOTAL FOR PAPER = 50 MARKS

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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									(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

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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