

Write your name here

Surname

Other names

**Pearson Edexcel**  
**International**  
**Advanced Level**

Centre Number

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Candidate Number

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# Chemistry

**Advanced**

**Unit 6: Chemistry Laboratory Skills II**

Thursday 26 January 2017 – Afternoon

**Time: 1 hour 15 minutes**

Paper Reference

**WCH06/01**

**Candidates may use a calculator.**

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.
- Keep an eye on the time.
- Try to answer every question.
- 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 The inorganic compound **A** has two cations and one anion. Complete the table.

	Test	Observation	Inference	
(a)	Note the appearance of solid <b>A</b> .	Pale green crystals.	One of the elements present in <b>A</b> must be found in the part of the Periodic Table called ..... .....	(1)
(b)	Mix a spatula measure of solid <b>A</b> , with 20 cm <sup>3</sup> of distilled water.	Solid <b>A</b> dissolved easily to form a very pale green solution.	The <b>formula</b> of the cation responsible for the pale green colour is likely to be .....	(1)
(c)	To about 5 cm <sup>3</sup> of the solution of <b>A</b> , add 1 cm <sup>3</sup> of dilute sodium hydroxide.	A green precipitate formed which turned brown on standing.	The green precipitate is ..... The brown solid is .....	(2)
(d)	Gently warm the mixture obtained in (c) and test the gas evolved.  Test the gas evolved by ..... .....	Result of test. .....	The gas evolved is ammonia.  Therefore the <b>formula</b> of the second cation present in <b>A</b> is .....	(3)
(e)	To about 5 cm <sup>3</sup> of a fresh sample of the solution of <b>A</b> , add a few drops of ..... ..... .....  and then ..... .....	..... .....	The anion present is a sulfate.	(3)

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(f) What is the **formula** of compound **A**?

(1)

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(Total for Question 1 = 11 marks)

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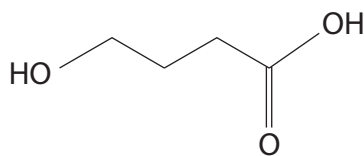
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- 2 4-hydroxybutanoic acid is a naturally occurring substance found in the human central nervous system, as well as in wine, beef and citrus fruits. 4-hydroxybutanoic acid is a sticky solid with a melting temperature of 48–50 °C.

The structure of 4-hydroxybutanoic acid is



- (a) About 5 g of 4-hydroxybutanoic acid was placed in a test tube and melted by heating in a hot water bath. A small piece of sodium was added to the molten 4-hydroxybutanoic acid.

- (i) Suggest why the flammability of 4-hydroxybutanoic acid would **not** present a significant risk in this experiment, even if a Bunsen burner were used.

(1)

- (ii) Suggest **one** reason why a water bath was used in this experiment rather than a Bunsen burner.

(1)

- (iii) Describe the observation that shows a reaction is occurring.

(1)



(iv) Give the equation for this reaction. Use a **skeletal** formula for the organic product. State symbols are not required.

(2)

(b) A spatula measure of 4-hydroxybutanoic acid was added to a solution of sodium hydrogencarbonate in a test tube. Vigorous effervescence was observed.

(i) Name the gas formed.

(1)

(ii) State the test that you would use to confirm the identity of the gas formed. Give the result of the test.

(2)

(iii) Draw a diagram of the apparatus you would use to carry out the test that you have given in 2(b)(ii).

(2)

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(c) Identifying the functional groups present is a vital part of the determination of the structure of an organic compound.

- (i) Explain fully whether or not the tests mentioned in 2(a) and 2(b) allow the two functional groups of 4-hydroxybutanoic acid to be identified.

(2)

- (ii) Use the data in the table to explain how the infrared spectrum of 4-hydroxybutanoic acid could be used to identify its two functional groups. State the relevant wavenumber ranges.

(2)

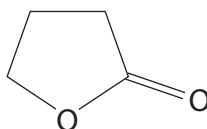
Group & vibration type	Type of compound	Wavenumber range / $\text{cm}^{-1}$
O—H stretching	Alcohols and phenols	3750–3200
	Carboxylic acids	3300–2500
C—O stretching	Esters: methanoates	1200–1180
	ethanoates	1250–1230
	propanoates	1200–1150
	benzoates	1310–1250 and 1150–1100
C=O stretching	Aldehydes	1740–1720
	Ketones	1700–1680
	Carboxylic acids: alkyl aryl	1725–1700 1700–1680
	Esters	1750–1735



(iii) Explain whether or not infrared spectra could be used to distinguish 4-hydroxybutanoic acid from its isomer, 3-hydroxybutanoic acid.

(1)

(d) 4-hydroxybutanoic acid reacts on heating in the presence of a catalyst to form 4-butyrolactone which is used in food flavouring, and as a superglue remover. The structure of 4-butyrolactone is



(i) By considering the functional group present in 4-butyrolactone, name the type of reaction which occurs when 4-hydroxybutanoic acid forms 4-butyrolactone.

(1)

(ii) Identify a suitable catalyst for this reaction.

(1)

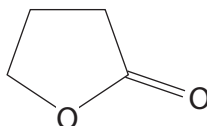


(iii) There are three proton environments in 4-butyrolactone.

Circle each of these proton environments on the structure below and label them X, Y and Z.

Complete the table to give the relative areas under the three peaks and the splitting pattern expected for each peak in the high resolution proton nmr spectrum of this compound.

(3)



Proton environment	Relative peak height	Splitting pattern
X		
Y		
Z		

(Total for Question 2 = 20 marks)

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- 3 The first stage in a preparation of an azo dye is the formation of benzenediazonium chloride by the reaction of phenylamine (aniline) with nitrous acid at about 5 °C. The equation for the reaction is



- (a) (i) Nitrous acid is unstable at room temperature, so it is prepared only when it is needed. Identify the **two** reagents required to prepare nitrous acid for this reaction. (2)

- (ii) State how a temperature of 'about 5 °C' would be maintained for this preparation. (1)

- (b) If the benzenediazonium chloride is allowed to warm up, it decomposes:



One way of following the progress of this reaction in a rates experiment is to use a continuous monitoring method, such as measuring the volume of nitrogen produced.

- (i) Suggest an advantage of using a continuous monitoring method rather than a sampling method. (1)



- (ii) Draw a diagram of an apparatus suitable for measuring the volume of nitrogen produced at various times during the decomposition of benzenediazonium chloride at 45 °C.

(3)

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P 4 8 3 6 9 A 0 1 1 1 6

- (c) Data from the experiment described in 3(b)(ii) are given in the table. The initial concentration of the benzenediazonium chloride was  $0.071 \text{ mol dm}^{-3}$  and the concentrations of the benzenediazonium chloride as the reaction proceeded were calculated from the volumes of nitrogen collected.

Time / min	Volume nitrogen / $\text{cm}^3$	$1000 \times [\text{C}_6\text{H}_5\text{N}_2\text{Cl}] / \text{mol dm}^{-3}$
0	0	71.0
3	10.8	57.8
6	19.3	
9	26.3	39.0
12	32.4	31.5
18	41.3	20.7
24	46.5	14.4
30	50.4	9.6
$\infty$	58.3	0

$\infty$  = time when reaction is complete.

- (i) How would you know when the reaction was complete?

(1)

- (ii) After a given time, the fraction of nitrogen produced is equal to the fraction of the benzenediazonium chloride that is used up. For example, when  $\frac{1}{4}$  of the nitrogen is produced,  $\frac{3}{4}$  of the benzenediazonium chloride is left. This is used to calculate the concentrations of the benzenediazonium chloride in the table. Calculate the concentration of benzenediazonium chloride at 6 min. You must show your working.

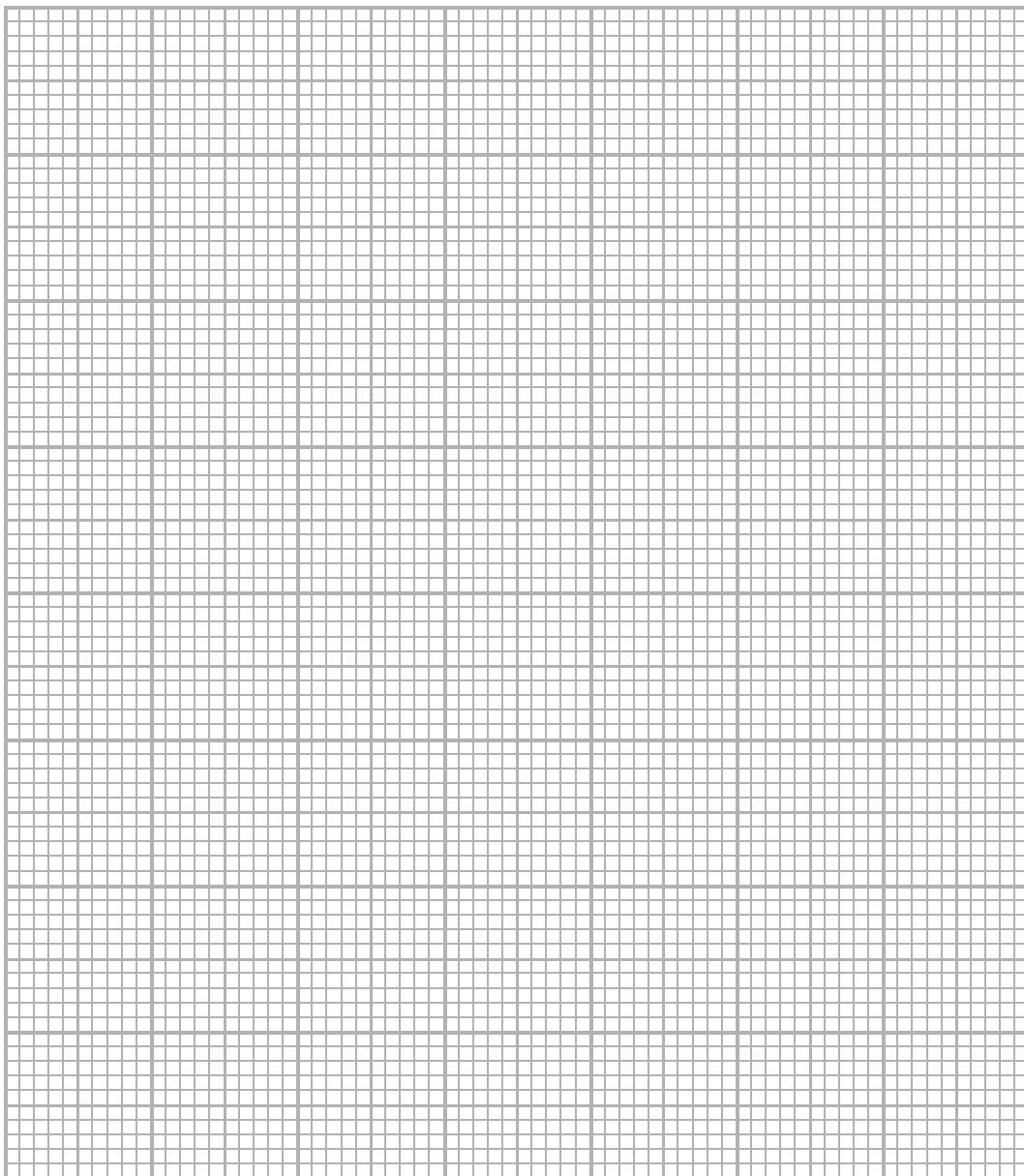
(1)

$[\text{C}_6\text{H}_5\text{N}_2\text{Cl}]$  at 6 min = .....  $\text{mol dm}^{-3}$



(iii) Plot a graph of  $1000 \times [\text{C}_6\text{H}_5\text{N}_2\text{Cl}]$  (on the vertical axis) against time.  
Use appropriate scales, and label the axes of the graph.

(3)



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(iv) From the graph, estimate **two** half lives of this reaction. Show your working on the graph.

(1)

(v) Use the half lives that you have estimated to deduce the order of the reaction. Justify your answer.

(1)

(d) Benzenediazonium chloride can be converted into an azo dye by mixing it with phenol in an alkaline solution. Pure crystals of the dye may be obtained by recrystallisation of the impure solid using ethanoic acid as the solvent.

(i) Phenol is an extremely caustic compound. Suggest **one** safety precaution, apart from eye protection and wearing a laboratory coat, that would reduce the risk of using phenol.

(1)

(ii) In the first stage of recrystallisation, the impure solid is dissolved in the minimum volume of hot solvent. Explain why it is important to use the **minimum** volume.

(1)

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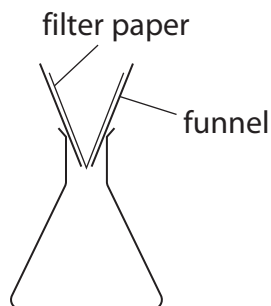
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(iii) In the second stage of recrystallisation, the hot solution is filtered using simple (or gravity) filtration. A filter funnel without a stem is often used (see diagram). Explain the advantage of using a funnel like this.

(1)



(iv) When crystallisation is complete, the mixture is filtered under reduced pressure (vacuum filtration). State the type of impurities which are removed at this stage and explain why this method of filtration is preferred to gravity filtration.

(2)

**(Total for Question 3 = 19 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)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)		
	6.9 <b>Li</b> lithium 3	9.0 <b>Be</b> beryllium 4	45.0 <b>Sc</b> scandium 21	47.9 <b>Ti</b> titanium 22	50.9 <b>V</b> vanadium 23	52.0 <b>Cr</b> chromium 24	54.9 <b>Mn</b> manganese 25	55.8 <b>Fe</b> iron 26	58.9 <b>Co</b> cobalt 27	58.7 <b>Ni</b> nickel 28	63.5 <b>Cu</b> copper 29	65.4 <b>Zn</b> zinc 30	10.8 <b>B</b> boron 5	12.0 <b>C</b> carbon 6	14.0 <b>N</b> nitrogen 7	16.0 <b>O</b> oxygen 8	19.0 <b>F</b> fluorine 9	4.0 <b>He</b> helium 2		
	23.0 <b>Na</b> sodium 11	24.3 <b>Mg</b> magnesium 12	88.9 <b>Y</b> yttrium 39	91.2 <b>Zr</b> zirconium 40	92.9 <b>Nb</b> niobium 41	95.9 <b>Mo</b> molybdenum 42	[98] <b>Tc</b> technetium 43	101.1 <b>Ru</b> ruthenium 44	102.9 <b>Rh</b> rhodium 45	106.4 <b>Pd</b> palladium 46	107.9 <b>Ag</b> silver 47	112.4 <b>Cd</b> cadmium 48	27.0 <b>Al</b> aluminium 13	28.1 <b>Si</b> silicon 14	31.0 <b>P</b> phosphorus 15	32.1 <b>S</b> sulfur 16	35.5 <b>Cl</b> chlorine 17	39.9 <b>Ar</b> argon 18		
	39.1 <b>K</b> potassium 19	40.1 <b>Ca</b> calcium 20	88.9 <b>Y</b> yttrium 39	91.2 <b>Zr</b> zirconium 40	92.9 <b>Nb</b> niobium 41	95.9 <b>Mo</b> molybdenum 42	101.1 <b>Ru</b> ruthenium 44	102.9 <b>Rh</b> rhodium 45	106.4 <b>Pd</b> palladium 46	107.9 <b>Ag</b> silver 47	112.4 <b>Cd</b> cadmium 48	114.8 <b>In</b> indium 49	69.7 <b>Ga</b> gallium 31	72.6 <b>Ge</b> germanium 32	74.9 <b>As</b> arsenic 33	79.0 <b>Se</b> selenium 34	79.9 <b>Br</b> bromine 35	83.8 <b>Kr</b> krypton 36		
	85.5 <b>Rb</b> rubidium 37	87.6 <b>Sr</b> strontium 38	138.9 <b>La*</b> lanthanum 57	178.5 <b>Hf</b> hafnium 72	180.9 <b>Ta</b> tantalum 73	183.8 <b>W</b> tungsten 74	186.2 <b>Re</b> rhenium 75	190.2 <b>Os</b> osmium 76	192.2 <b>Ir</b> iridium 77	195.1 <b>Pt</b> platinum 78	197.0 <b>Au</b> gold 79	200.6 <b>Hg</b> mercury 80	204.4 <b>Tl</b> thallium 81	207.2 <b>Pb</b> lead 82	209.0 <b>Bi</b> bismuth 83	[209] <b>Po</b> polonium 84	[210] <b>At</b> astatine 85	[222] <b>Rn</b> radon 86		
	[223] <b>Fr</b> francium 87	[226] <b>Ra</b> radium 88	[227] <b>Ac*</b> actinium 89	[261] <b>Rf</b> rutherfordium 104	[262] <b>Db</b> dubnium 105	[266] <b>Sg</b> seaborgium 106	[264] <b>Bh</b> bohrium 107	[277] <b>Hs</b> hassium 108	[268] <b>Mt</b> meitnerium 109	[271] <b>Ds</b> darmstadtium 110	[272] <b>Rg</b> roentgenium 111	Elements with atomic numbers 112-116 have been reported but not fully authenticated								
* Lanthanide series	140 <b>Ce</b> cerium 58	141 <b>Pr</b> praseodymium 59	144 <b>Nd</b> neodymium 60	147 <b>Pm</b> promethium 61	150 <b>Sm</b> samarium 62	152 <b>Eu</b> europium 63	157 <b>Gd</b> gadolinium 64	159 <b>Tb</b> terbium 65	163 <b>Dy</b> dysprosium 66	165 <b>Ho</b> holmium 67	167 <b>Er</b> erbium 68	173 <b>Yb</b> ytterbium 70	175 <b>Lu</b> lutetium 71							
* Actinide series	232 <b>Th</b> thorium 90	[231] <b>Pa</b> protactinium 91	238 <b>U</b> uranium 92	[237] <b>Np</b> neptunium 93	[242] <b>Pu</b> plutonium 94	[243] <b>Am</b> americium 95	[247] <b>Cm</b> curium 96	[245] <b>Bk</b> berkelium 97	[251] <b>Cf</b> californium 98	[254] <b>Es</b> einsteinium 99	[253] <b>Fm</b> fermium 100	[256] <b>Md</b> mendelevium 101	[254] <b>No</b> nobelium 102	[257] <b>Lr</b> lawrencium 103						

1.0	<b>H</b>
	hydrogen
	1

relative atomic mass
<b>atomic symbol</b>
name
atomic (proton) number



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