Centre No.					Pape	r Refer	ence			Surname	Initial(s)
Candidate No.			6	C	H	0	2	/	1	Signature	

Paper Reference(s)

# 6CH02/1 **Edexcel GCE**

## **Chemistry**

## **Advanced Subsidiary**

Unit 2: Application of Core Principles of Chemistry

Time: 1 hour 15 minutes

Materials required for examination	Items included with question paper
Nil	Nil

#### **Instructions to Candidates**

In the boxes above, write your centre number, candidate number, your surname, initial(s) and signature. Check that you have the correct question paper. Answer ALL the questions. Write your answers in the spaces provided in this question paper.

Some questions must be answered with a cross in a box (X). If you change your mind, put a line through the box  $(\boxtimes)$  and then mark your new answer with a cross  $(\boxtimes)$ .

Do not use pencil. Use black or blue ink.

#### **Information for Candidates**

The marks for individual questions and the parts of questions are shown in round brackets: e.g. (2). There are 28 questions in this question paper. The total mark for this paper is 80. There are 28 pages in this question paper. Any blank pages are indicated. Candidates may use a calculator.

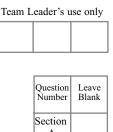
### **Advice to Candidates**

Quality of written communication will be taken into account in the marking of your responses to Questions 26(b)(ii), 27(a)(vi), 27(b), 28(b)(i), 28(b)(iv) and 28(b). These questions are indicated with an asterisk. Quality of written communication includes clarity of expression, the structure and presentation of ideas and grammar, punctuation and spelling.

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Section B	
Section C	
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Turn over



Each  1. W	es on thr of the Thich A B	LL the questions in this section. You should aim to spend no more than 30 this section. Put a cross in the box (⋈). If you change your mind, put a line rough the box (⋈) and then mark your new answer with a cross (⋈).  The questions or incomplete statements is followed by four suggested answers.  Select the BEST answer in each case.  The following best describes the molecular shape of carbon dioxide, CO₂?  Innear trigonal planar triangular  v-shaped  (Total 1 mark)	Q1
1. W	Thich of A B C	Select the BEST answer in each case.  of the following best describes the molecular shape of carbon dioxide, CO <sub>2</sub> ?  linear  trigonal planar  triangular  v-shaped	Q1
× × ×	A B C	linear trigonal planar triangular v-shaped	Q1
	B C	trigonal planar triangular v-shaped	Q1
×	C	triangular v-shaped	Q1
<b>X</b>		v-shaped	Q1
	D	•	Q1
2. W		(Total 1 mark)	
2. W			
	hich	of the following species is polar?	
×	A	$NH_3$	
×	В	$BF_3$	
×	C	$SO_3$	
$\times$	D	$CO_3^{2-}$	Q2
		(Total 1 mark)	
of	the li	quids are affected by electric fields. For which of the following liquids would a jet iquid be affected by an electric field?	
X		hexane	
X	В	cyclohexane	
×		cyclohexene	02
×	D	cyclohexanol	Q3
		(Total 1 mark)	

	****		Leave blank
4.		re the intermolecular forces in methanal, HCHO?	
	⊠ A	London forces only	
	■ B	hydrogen bonds and London forces	
		permanent dipole – permanent dipole only	
	<b>■ D</b>	permanent dipole – permanent dipole and London forces	Q4
		(Total 1 mark)	
5.	Which	of the following substances is likely to be insoluble in water?	
	$\triangle$ A	methanol, CH <sub>3</sub> OH	
	$\blacksquare$ B	ethanol, CH <sub>3</sub> CH <sub>2</sub> OH	
		fluoromethane, CH <sub>3</sub> F	
	<b>■</b> D	hydrogen fluoride, HF	<b>Q5</b>
		(Total 1 mark)	
6.	likely t  A B	lowing liquids have a similar number of electrons per molecule. Suggest which is o have the highest boiling point?  CH <sub>3</sub> CH <sub>2</sub> CH <sub>2</sub> CH <sub>2</sub> CH <sub>3</sub> (CH <sub>3</sub> ) <sub>3</sub> COH  CH <sub>3</sub> CH <sub>2</sub> CH(OH)CH <sub>3</sub> CH <sub>3</sub> CH <sub>2</sub> CH <sub>2</sub> CH <sub>2</sub> OH	<b>Q6</b>
		(Total 1 mark)	
Ī	Use this	space for any rough working. Anything you write in this space will gain no credit.	

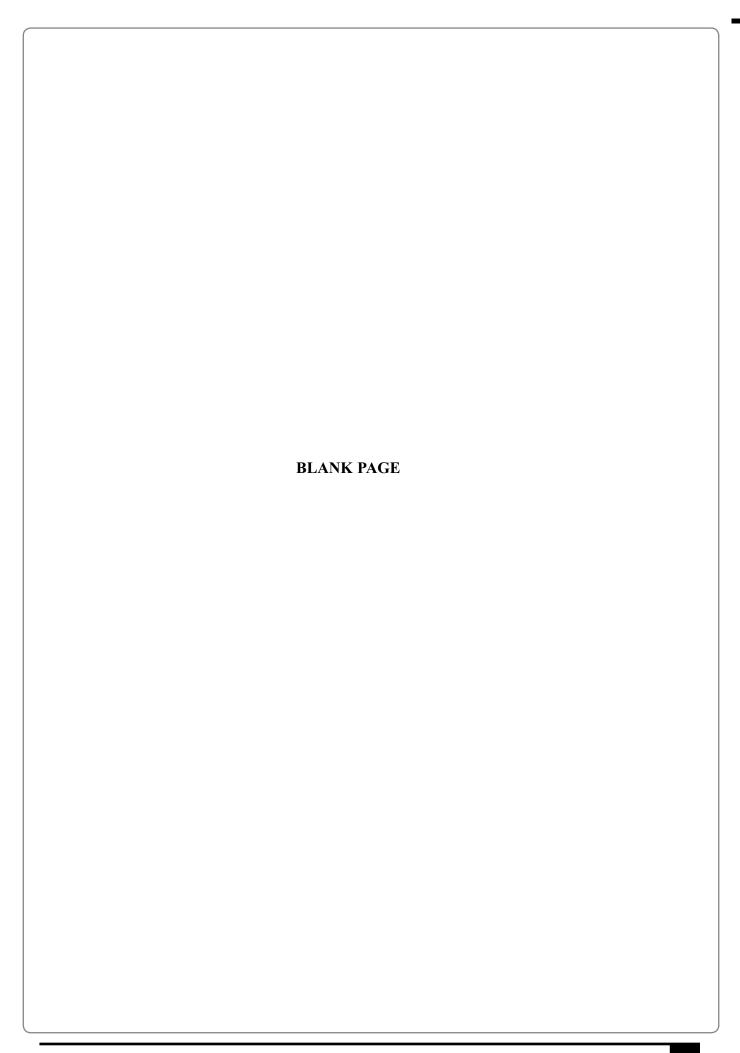
7.			concentrated acid should be used to dissolve a carbonate of a Group 2 metal to	
			at a flame test?	
	X	A	ethanoic acid	
	X	В	hydrochloric acid	
	X	C	nitric acid	
	X	D	sulfuric acid	
			(Total 1 mark)	
8.	Wh	at c	olour does a barium salt give in a flame test?	
	X	A	colourless	
	X	В	green	
	X	C	red	
	X	D	yellow-red	
			(Total 1 mark)	
	×	A B	1 2	
	X	B	2	
	X	C	3	
	$\times$	C D	3 4	
				(
			4	
			4	
			4	
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			4	
			4	
			4	
			4	

<b>10.</b> A Group 2 element reacts vigorously with water to produce a soluble hydroxide, which forms a white precipitate when neutralised by sulfuric acid and forms a carbonate which	Leave blank
is very stable to heat. The element could be	
■ A magnesium	
B calcium	
C strontium	
<b>D</b> barium	Q10
(Total 1 mark)	
11. The Group 2 metals, considered in order of increasing atomic number, show a decrease in	
■ A first ionisation energy	
■ B nuclear charge	
C chemical reactivity	
<b>D</b> ionic radius	Q11
(Total 1 mank)	
(Total 1 mark)	
12. When a Group 1 metal nitrate is heated, brown fumes are observed. The metal could be	
■ A lithium	
■ B sodium	
<ul><li>■ B sodium</li><li>■ C rubidium</li></ul>	
	012
<ul><li>☑ C rubidium</li><li>☑ D caesium</li></ul>	Q12
<ul><li>☑ C rubidium</li><li>☑ D caesium</li><li>(Total 1 mark)</li></ul>	Q12
<ul><li>☑ C rubidium</li><li>☑ D caesium</li></ul>	Q12
<ul> <li>□ C rubidium</li> <li>□ D caesium</li> <li>(Total 1 mark)</li> <li>Use this space for any rough working. Anything you write in this space will gain no</li> </ul>	Q12
<ul> <li>□ C rubidium</li> <li>□ D caesium</li> <li>(Total 1 mark)</li> <li>Use this space for any rough working. Anything you write in this space will gain no</li> </ul>	Q12
<ul> <li>□ C rubidium</li> <li>□ D caesium</li> <li>(Total 1 mark)</li> <li>Use this space for any rough working. Anything you write in this space will gain no</li> </ul>	Q12
<ul> <li>□ C rubidium</li> <li>□ D caesium</li> <li>(Total 1 mark)</li> <li>Use this space for any rough working. Anything you write in this space will gain no</li> </ul>	Q12
<ul> <li>□ C rubidium</li> <li>□ D caesium</li> <li>(Total 1 mark)</li> <li>Use this space for any rough working. Anything you write in this space will gain no</li> </ul>	Q12
<ul> <li>□ C rubidium</li> <li>□ D caesium</li> <li>(Total 1 mark)</li> <li>Use this space for any rough working. Anything you write in this space will gain no</li> </ul>	Q12
<ul> <li>□ C rubidium</li> <li>□ D caesium</li> <li>(Total 1 mark)</li> <li>Use this space for any rough working. Anything you write in this space will gain no</li> </ul>	Q12

		orange is red in acidic solutions and yellow in alkaline solutions. What is the	
		of the indicator at the end point of a titration of aqueous sodium hydroxide solution drochloric acid?	
X	A	red	
X	В	pink	
	C		
X		orange	
X	D	yellow	
		(Total 1 mark)	
		dume, in cm <sup>3</sup> , of 0.25 mol dm <sup>-3</sup> hydrochloric acid required to neutralise 100 cm <sup>3</sup> of nol dm <sup>-3</sup> barium hydroxide solution, Ba(OH) <sub>2</sub> (aq), is	
X	A	25	
X	В	50	
X	C	100	
X	D	200	
		(Total 1 mark)	
		the oxidation number of <b>sulfur</b> in sodium tetrathionate, $Na_2S_4O_6$ ? $-\frac{1}{2}$ $+\frac{1}{2}$	
X	C	+2½	
X	D	+5	
		(Total 1 mark)	

	Leave blank							
<b>16.</b> Which of the following statements is FALSE?								
■ A iodine is more electronegative than bromine.								
<b>B</b> fluorine is more electronegative than chlorine.								
C metallic elements tend to react by loss of electrons.								
<b>D</b> chlorine is more electronegative than sulfur.	Q16							
(Total 1 mark)								
17. A commercial production of iodine involves the reduction of a solution of iodate(V) ions, IO <sub>3</sub> <sup>-</sup> , with hydrogen sulfite ions, HSO <sub>3</sub> <sup>-</sup> . The equation for the reaction may be written								
$xIO_3^- + yHSO_3^ \longrightarrow$ $zSO_4^{2-} + I_2 + 3H^+ + H_2O$								
What are the balancing numbers x, y and z?								
<b>■ B</b> 2,5,2								
<b>■ D</b> 5,5,2	Q17							
(Total 1 mark)								
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S	odi	ium	anic compound is found to react with sodium metal and to react with acidified dichromate(VI), but not to decolourise bromine water, nor to neutralise sodium te solution. The liquid could be	Le bla
×	<	A	ethanol	
×	<	В	ethane	
×	(	C	ethanoic acid	
X	<	D	ethene	Q1
			(Total 1 mark)	
_			of the following is <b>not</b> a greenhouse gas?	
×	_	A B	$\mathrm{CH_4}$ $\mathrm{CO_2}$	
×	_		$H_2O$	
×	_		$N_2$	01
		D		Q1
			(Total 1 mark)	
<b>20.</b> V	Whi	ich (	of the following fuels has the smallest carbon footprint?	
20. V	_		of the following fuels has the smallest carbon footprint?  petrol made from crude oil	
_	<	A		
×		A	petrol made from crude oil	
×		A B	petrol made from crude oil hydrogen made from methane	Q2
×		A B C	petrol made from crude oil hydrogen made from methane ethanol made from sugar	Q2
21. V	Whi	A B C D	petrol made from crude oil hydrogen made from methane ethanol made from sugar coal  (Total 1 mark)  of the following would not lead to a greater sustainability in an industrial	Q2
21. V	Whi	A B C D	petrol made from crude oil hydrogen made from methane ethanol made from sugar coal  (Total 1 mark)  of the following would not lead to a greater sustainability in an industrial	Q2
21. V	Whi	A B C D	petrol made from crude oil hydrogen made from methane ethanol made from sugar coal  (Total 1 mark)  of the following would not lead to a greater sustainability in an industrial?	Q2
21. V p	Whi	A B C D	petrol made from crude oil hydrogen made from methane ethanol made from sugar coal  (Total 1 mark)  of the following would not lead to a greater sustainability in an industrial using a catalyst that improves atom economy	Q2
21. V p	Whi	A B C D ich cess A B	petrol made from crude oil hydrogen made from methane ethanol made from sugar coal  (Total 1 mark)  of the following would not lead to a greater sustainability in an industrial using a catalyst that improves atom economy running the reaction at a higher temperature	Q2 Q2



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The following questions deal with situations. Each situation is followed by a set of questions. Select the best answer for each question.

**22.** This question concerns the preparation of 1-bromobutane from butan-1-ol, 50% sulfuric acid and sodium bromide. The mixture was placed in a flask and heated under reflux for ten minutes.

	Boiling temperature
1-bromobutane	100
butan-1-ol	118

(a)	The reason that 50% su	furic acid wa	as used rather	than concer	ntrated sulfurio	acid is
	because concentrated su	lfuric acid				

<b>S</b>	<b>A</b>	1.1	. 1.		C /1	bromide		1	•
	Δ	would	OVIGISE	SOME	Of the	nromide	10ng 1	nro	mıne

X	B	would	cause	the	reaction	to	go	too	fast
---	---	-------	-------	-----	----------	----	----	-----	------

**(1)** 

(b) The reaction mixture was distilled. The impure distillate did not contain

X	A	butan-1-ol
		outuil i oi

**(1)** 

Use this space for any rough working. Anything you write in this space will gain no credit.

			Leave blank					
(c)	The impure 1-bromobutane was washed with concentrated hydrochloric acid and shaken in a tap funnel with a base to remove acidic impurities. Which of the following would remove acidic impurities without reacting with the 1-bromobutane.							
$\times$	A	calcium hydroxide solution						
$\boxtimes$	В	sodium hydroxide solution						
$\boxtimes$	C	calcium chloride solution						
	D	sodium hydrogencarbonate solution (1)						
(d)		e 1-bromobutane was washed with water, dried and distilled. Which of the owing is the correct procedure?						
$\boxtimes$	A	heat the liquid to 118 °C and collect the substance given off						
$\times$	В	heat the liquid to 100 °C and collect the substance given off						
$\times$	C	boil the liquid and collect the fraction that boils off between 116 and 120 $^{\circ}\mathrm{C}$						
$\boxtimes$	D	boil the liquid and collect the fraction that boils off between 98 and $102^{\circ}\text{C}$ (1)	Q22					
		(Total 4 marks)						
		(Total 4 marks)						
		(Total 4 marks)						
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23. Almost two thirds of the world's ethanoic acid is made using the following equilibrium reaction, with the aid of an iridium complex as a catalyst.

$$CH_3OH(1) + CO(g) \rightleftharpoons CH_3COOH(1)$$
  $\Delta H = -135 \text{ kJ mol}^{-1}$ 

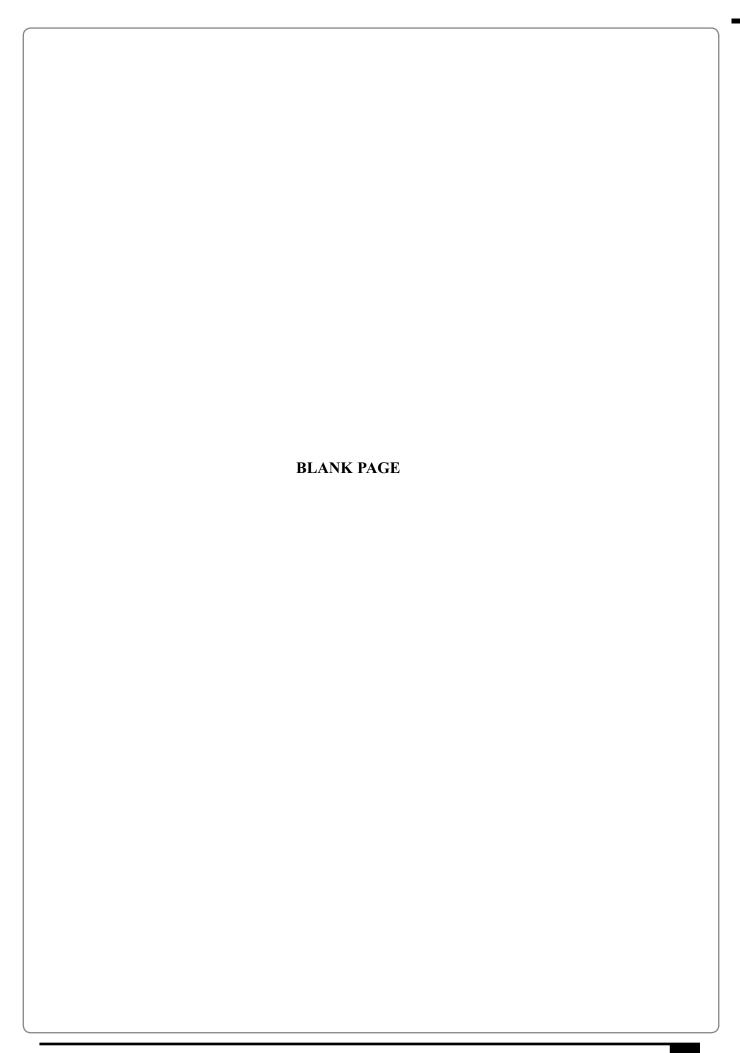
Which of the following changes in conditions would increase the equilibrium yield of ethanoic acid?

- **B** decrease pressure
- C increase temperature
- **D** add a catalyst

**Q23** 

(Total 1 mark)

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- **24.** Some absorptions by chemical bonds in the infrared spectrum are given below.
  - **A** O—H stretching in alcohols at 3750–3200 cm<sup>-1</sup>
  - **B** C—H stretching in alkanes at 2962–2853 cm<sup>-1</sup>
  - C C=O stretching in aldehydes at 1740–1725 cm<sup>-1</sup>
  - **D** C=O stretching in ketones at 1700–1680 cm<sup>-1</sup>

From A–D above, select which feature of the infrared spectrum would enable you to distinguish between the following compounds:

propanone, CH<sub>3</sub>COCH<sub>3</sub>,

propanal, CH<sub>3</sub>CH<sub>2</sub>CHO

propan-1-ol, CH<sub>3</sub>CH<sub>2</sub>CH<sub>2</sub>OH

- (a) propanone from propanal and propan-1-ol
- $\boxtimes$  A
- $\boxtimes$  B
- $\square$  D

(1)

- (b) propanal from propanone and propan-1-ol
- $\mathbf{X}$  A
- $\boxtimes$  B
- $\square$  C
- $\boxtimes$  D

**(1)** 

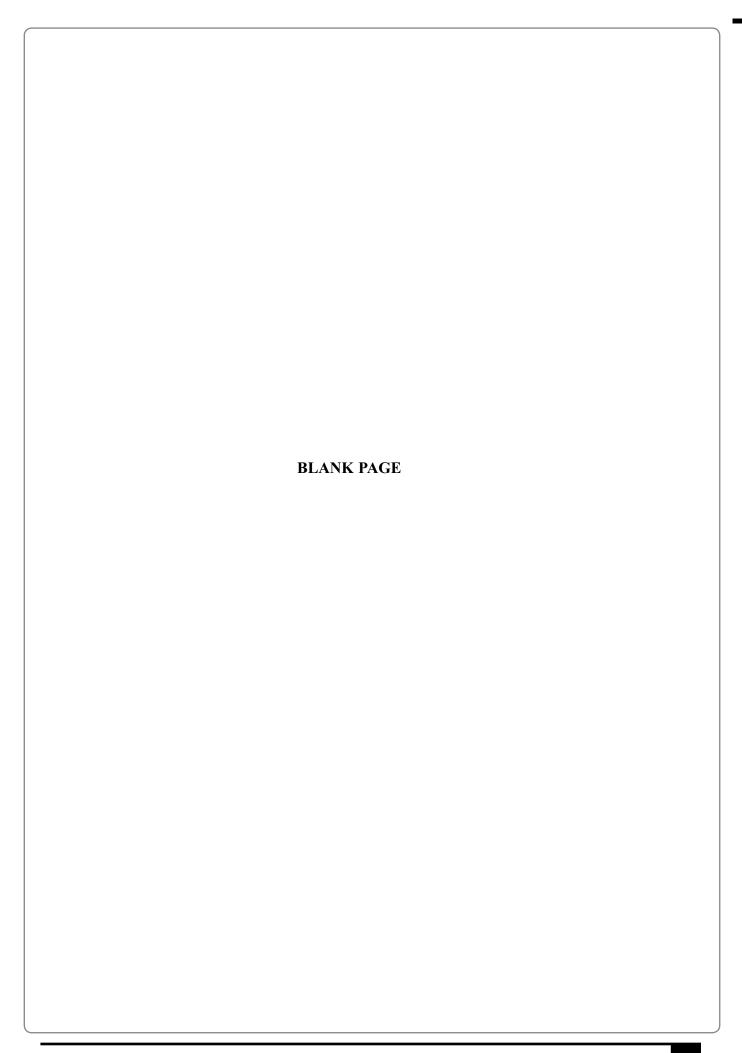
	Leave blank
(c) propan-1-ol from propanal and propanone	
$oxed{\square}$ <b>A</b>	
lacktriangledown $lacktriangledown$ $lacktriangledown$	
(1)	Q24
(Total 3 marks)	
TOTAL FOR SECTION A: 29 MARKS	
Use this space for any rough working. Anything you write in this space will gain no credit.	

### **SECTION B**

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

- 25. This question is about organic compounds with the molecular formula C<sub>3</sub>H<sub>8</sub>O.

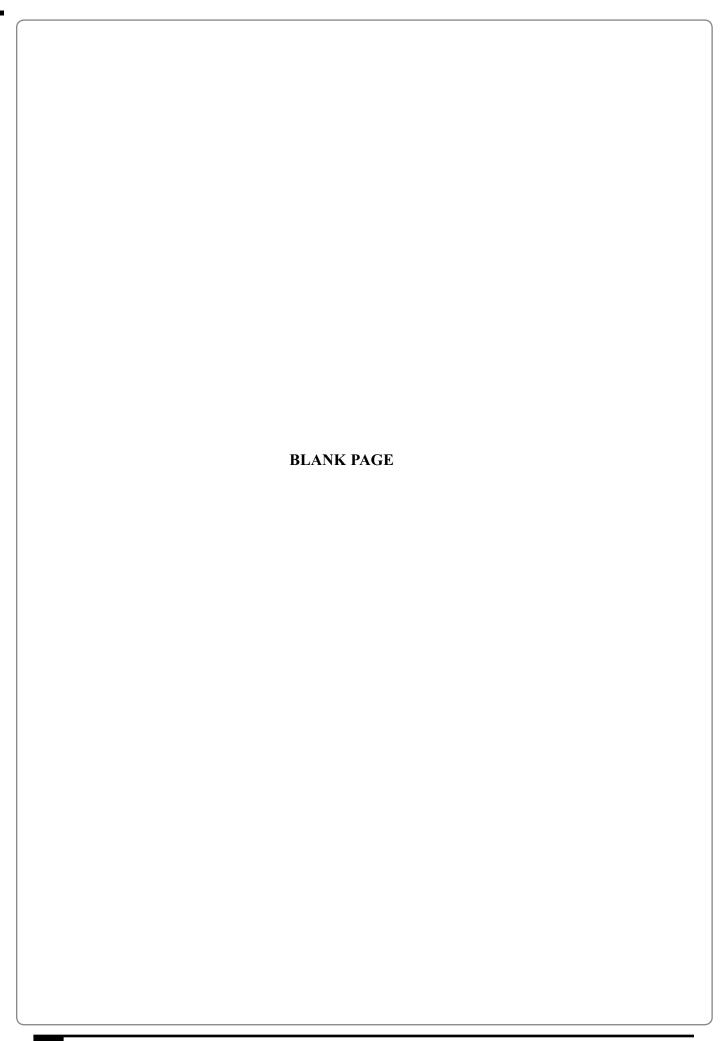
		ve the names of these alcohols.	i molecular formula C <sub>3</sub> H <sub>8</sub> O
		Alcohol 1	Alcohol 2
	Structural formula		
	Name		(4)
(b) Pri	mary alcohols can be	e oxidised to carboxylic acids.	
(i)		I structural formula of the carbo $H_8O$ is fully oxidised.	xylic acid formed when the
	Name		
	Structural formula		
			(2)
(ii)	State the reagents u	used for this oxidation.	
	Reagent 1		
	Reagent 2		
			(2)
			(Total 8 marks)



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<ul> <li>(ii) Draw a diagram to show this bonding. Use displayed formulae of two water molecules. Clearly mark and label the bond angle between the water molecules.</li> <li>(2)</li> <li>(b) (i) Draw the boron trichloride molecule, BCl<sub>3</sub>, making its shape clear. Mark the bond angle on your diagram.</li> <li>(2)</li> <li>*(ii) Explain why boron trichloride has this shape.</li> </ul>
(b) (i) Draw the boron trichloride molecule, BCl <sub>3</sub> , making its shape clear. Mark the bond angle on your diagram.
(b) (i) Draw the boron trichloride molecule, BCl <sub>3</sub> , making its shape clear. Mark the bond angle on your diagram.
bond angle on your diagram.  (2)
*(ii) Explain why boron trichloride has this shape.

	ii) Explain why a B–Cl bond is polar.	b
(i	v) Explain why a BCl <sub>3</sub> molecule is non-polar.	
(v	(1) Name the strongest intermolecular force between boron trichloride molecules.	
	(1) (Total 11 marks)	
	(Total 11 marks)	
		- 1



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<b>27.</b> (a)	This	s part of the question is about the hydrolysis of halogenoalkanes.			
	2 cm <sup>3</sup> of ethanol is added to each of three separate test-tubes.				
	Three drops of 1-chlorobutane are added to the first, three drops of 1-brothe second, and three drops of 1-iodobutane are added to the third test-transfer.				
	2 cn	n <sup>3</sup> portions of hot aqueous silver nitrate solution are added to each test-tube.			
	recipitate forms immediately in the third test-tube, slowly in the second tester and extremely slowly in the first test-tube. In each reaction the precipitate is need by silver ions, $Ag^+(aq)$ , reacting with halide ions formed by hydrolysis of the ogenoalkane.				
	(i)	Why was ethanol added to each test-tube?			
		(1)			
	(ii)	The mechanism of this reaction is similar to that of the reaction between halogenoalkanes and aqueous hydroxide ions.			
		What feature of a water molecule enables it to act as a nucleophile in this reaction? Suggest the mechanism for the reaction between water and 1-iodobutane. (You may represent 1-iodobutane as RCH <sub>2</sub> I).			
		Feature of water molecule			
		Mechanism			

**(4)** 

Leave blank (iii) What is the colour of the precipitate in the third test-tube? **(1)** (iv) Name the precipitate which forms slowly in the first test-tube. **(1)** (v) Ammonia solution is added to the precipitate in the **first** test-tube. Describe what you would observe. **(1)** \*(vi) Suggest, why the rates of hydrolysis of the three halogenoalkanes are different, in terms of bonding and kinetics.

**(3)** 

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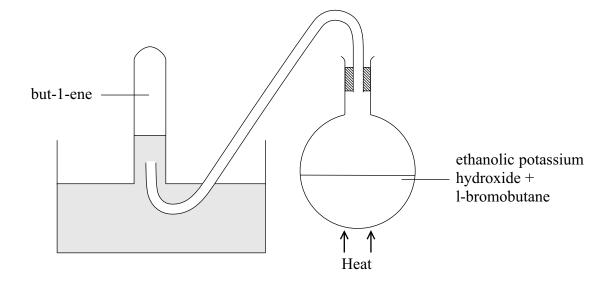
\*(b) One method of the manufacture of alcohols is to react steam with an alkene. For example

$$C_2H_4(g) + H_2O(g) \longrightarrow C_2H_5OH(l)$$

Suggest TWO reasons why this method is preferred to the hydrolysis of halogenoalkanes.

**(2)** 

(c) 1-bromobutane reacts with an ethanolic solution of potassium hydroxide on heating to form but-1-ene. A diagram of the apparatus that could be used to carry out this reaction and to collect the gaseous but-1-ene is shown below.



(i) State the hazard when the heating is stopped.

.....

(1)

(ii) How would you minimise the risk associated with this hazard?

.....

 $(1) \quad | \quad \mathbf{Q27}$ 

(Total 15 marks)

**TOTAL FOR SECTION B: 34 MARKS** 

#### **SECTION C**

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

28. Chlorine was used in swimming pools as a bactericide.

The amount of chlorine present can be determined by adding excess potassium iodide solution to a known volume of swimming pool water. This reacts to form iodine:

$$Cl_2(aq) + 2I^-(aq) \rightarrow I_2(aq) + 2Cl^-(aq)$$

The amount of iodine formed is then found by titration with sodium thiosulfate solution of known concentration.

The ionic equation for the reaction between iodine and sodium thiosulfate in aqueous solution is

$$I_2(aq) + 2S_2O_3^{2-}(aq) \rightarrow S_4O_6^{2-}(aq) + 2I^{-}(aq)$$

A student carried out the determination of chlorine in a sample of swimming pool water. A record of the measurements obtained is given below:

Volume of water sample tested  $= 1000 \text{ cm}^3$ 

Final reading of burette  $= 16.3 \text{ cm}^3$ 

Initial reading of burette  $= 7 \text{ cm}^3$ 

Volume added from burette =  $9.3 \text{ cm}^3$ 

Concentration of sodium thiosulfate solution =  $0.00500 \text{ mol dm}^{-1}$ 

(a) (i) The record of measurements reveals faults both in the procedure and the recording of measurements. State **one** fault in each of these.

Procedure .....

Recording of measurements.....

(2)

(ii) Calculate the number of moles of sodium thiosulfate used in the titration.

**(1)** 

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blank

(iii) Use your answer to (ii) to calculate the number of moles of iodine which reacted.
(iv) Deduce the concentration of chlorine, in mol dm <sup>-3</sup> , in the swimming pool water.
(1)
(b) The disinfecting action of chlorine in swimming pools is due to the presence of chloric(I) acid, HClO, formed by the reaction of chlorine with water.
In many swimming pools, chemicals other than chlorine are used to form chloric(I) acid. This is partly because the use of chlorine gas causes much more corrosion of metal parts in swimming pools than does chloric(I) acid.
Compounds used to chlorinate swimming pool water in this way include calcium chlorate(I) and chlorine dioxide.
*(i) State and explain the type of reaction that occurs when chlorine attacks a metal, using the example of iron.
(2)
(ii) Suggest <b>one</b> other reason why the use of chlorine is undesirable in swimming pools.
(1)
(iii) Give the formula for calcium chlorate(I).
(1)

Leave					
blank					

	$4\text{ClO}_2 + 2\text{H}_2\text{O} \rightarrow \text{HClO} + 3\text{HClO}_3$
Explain, reaction.	in terms of oxidation numbers, why this is a disproportionation
••••••	(2

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(6)	Q28
(Total 17 marks)	
TOTAL FOR SECTION C: 17 MARKS TOTAL FOR PAPER: 80 MARKS	
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(18) 4.0 <b>He</b> hetium 2	20.2 <b>Ne</b> neon 10	39.9 <b>Ar</b> argon 18	83.8 <b>Kr</b> krypton 36	<b>Xe</b> xenon 54	[222] <b>Rn</b> radon 86	ted
(71)	19.0 <b>F</b> fluorine 9	35.5 Cl chlorine 17	79.9  Br bromine 35	126.9 	[210] At astatine 85	oeen repor
(16)	16.0 O oxygen 8	32.1 <b>S</b> sulfur 16	Se selenium 34	127.6 Te tellurium 52	Po Polonium 84	116 have b
(15)	14.0 N nitrogen 7	31.0 P phosphorus 15	74.9 AS arsenic 33	Sb antimony 51	209.0 <b>Bi</b> bismuth 83	tomic numbers 112-116 hav but not fully authenticated
(14)	12.0 <b>C</b> carbon 6	Si silicon	72.6 <b>Ge</b> germanium 32	118.7 Sn tin 50	207.2 <b>Pb</b> tead 82	atomic nun but not fu
(13)	10.8 <b>B</b> boron 5	27.0 Al aluminium 13	Ga gallium 31	114.8 Indium 49	204.4 <b>TI</b> thallium 81	Elements with atomic numbers 112-116 have been reported but not fully authenticated
		(12)	65.4 <b>Zn</b> zinc 30	112.4 <b>Cd</b> cadmium 48	200.6 <b>Hg</b> mercury 80	Elem
		(11)	63.5 <b>Cu</b> copper 29	107.9 <b>Ag</b> silver 47	197.0 <b>Au</b> gold 79	Rg roentgenium 111
		(10)	58.7 <b>Ni</b> nickel	Pd Palladium 46	Pt Pt platinum 78	[268]   [271]   [272]
		(6)	58.9 Co cobalt	102.9 <b>Rh</b> rhodium 45	192.2 <b>Ir</b> iridium 77	Mt Mt meitnerium 109
1.0 <b>H</b> hydrogen		(8)	55.8 <b>Fe</b> iron 26	Ru ruthenium 44	190.2 <b>Os</b> osmium 76	Hs Hsssium r
		(2)	54.9 Mn nanganese 25		186.2 <b>Re</b> rhenium 75	[264] <b>Bh</b> bohrium 107
	mass <b>ool</b> umber	(9)	50.9 52.0 54.9  V Cr Mn vanadium chromium manganese 23 24 25	95.9 [98]  Mo Tc  molybdenum technetium 38 43	183.8 <b>W</b> tungsten 74	Sg seaborgium 106
Key	relative atomic mass atomic symbol name atomic (proton) number	(5)	50.9 <b>V</b> vanadium 23	92.9 Nb niobium 41	180.9 Ta tantalum 73	[262] <b>Db</b> dubnium 105
	relati <b>ato</b> atomic	(4)	47.9 Ti titanium	a E	178.5 <b>Hf</b> hafnium 72	[261] Rf nutherfordium 104
		(3)	45.0 Sc scandium 21	a E	138.9 <b>La*</b> lathanum 57	Ac* actinium 89
(2)	9.0 <b>Be</b> beryllium 4	24.3 Mg magnesium 12	Ca calcium 20	87.6 Sr strontium 38	137.3 <b>Ba</b> barium 56	[226] <b>Ra</b> radium 88
$\hat{E}$	6.9 Li lithium 3	23.0 Na sodium 11	39.1 <b>K</b> potassium 19	85.5 <b>Rb</b> rubidium 37	132.9 <b>Cs</b> caesium 55	[223] <b>Fr</b> francium 87

<sup>\*</sup> Lanthanide series

<sup>\*</sup> Actinide series