Surname	Centre Number	Candidate Number
Other Names		0

GCSE

3410U20-1

S19-3410U20-1

THURSDAY, 16 MAY 2019 – MORNING

CHEMISTRY – Unit 2:
Chemical Bonding, Application of Chemical Reactions and Organic Chemistry

FOUNDATION TIER

1 hour 45 minutes

For Examiner's use only		
Question	**Maximum Mark**	**Mark Awarded**
1.	**4**	
2.	**9**	
3.	**8**	
4.	**13**	
5.	**7**	
6.	**11**	
7.	**8**	
8.	**9**	
9.	**7**	
10.	**4**	
Total	**80**	

3410U201
01

ADDITIONAL MATERIALS

In addition to this examination paper you will need a calculator and a ruler.

INSTRUCTIONS TO CANDIDATES

Use black ink or black ball-point pen. Do not use gel pen or correction fluid.

Write your name, centre number and candidate number in the spaces at the top of this page.

Answer **all** questions.

Write your answers in the spaces provided in this booklet. If you run out of space, use the additional page at the back of the booklet, taking care to number the question(s) correctly.

INFORMATION FOR CANDIDATES

The number of marks is given in brackets at the end of each question or part-question.

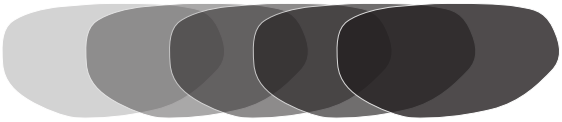
Question **6***(a)* is a quality of extended response (QER) question where your writing skills will be assessed.

The Periodic Table is printed on the back cover of this paper and the formulae for some common ions on the inside of the back cover.

Answer **all** *questions*.

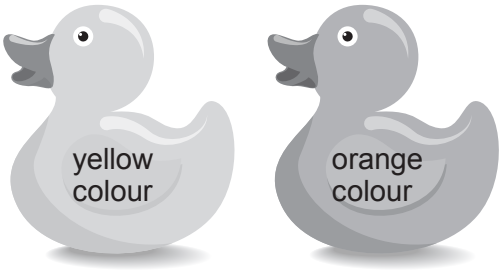
1. *(a)* The diagrams show some uses of smart materials which rely on their unusual properties.

sunglasses



cloudy sunny

baby bath thermometer



cold hot

car bumpers

nappies

Examiner only

The box contains the names of four types of smart material.

thermochromic pigment	**shape memory polymer**
hydrogel	**photochromic pigment**

Use the information given to complete the table. [2]

Unusual property	Use	Type of smart material
it regains its original shape on heating	car bumpers	shape memory polymer
it changes colour with changing temperature	.....	.....
it can absorb up to 1000 times its volume of water	.....	.....

Examiner only

(b) Draw a line to link the use of each nano-material to its property. [2]

Use	Property
nano-silver in dressings for cuts and burns	antibacterial
	blocks harmful UV light
nano-titanium dioxide in sunscreen creams	breaks down dirt
	strong and light

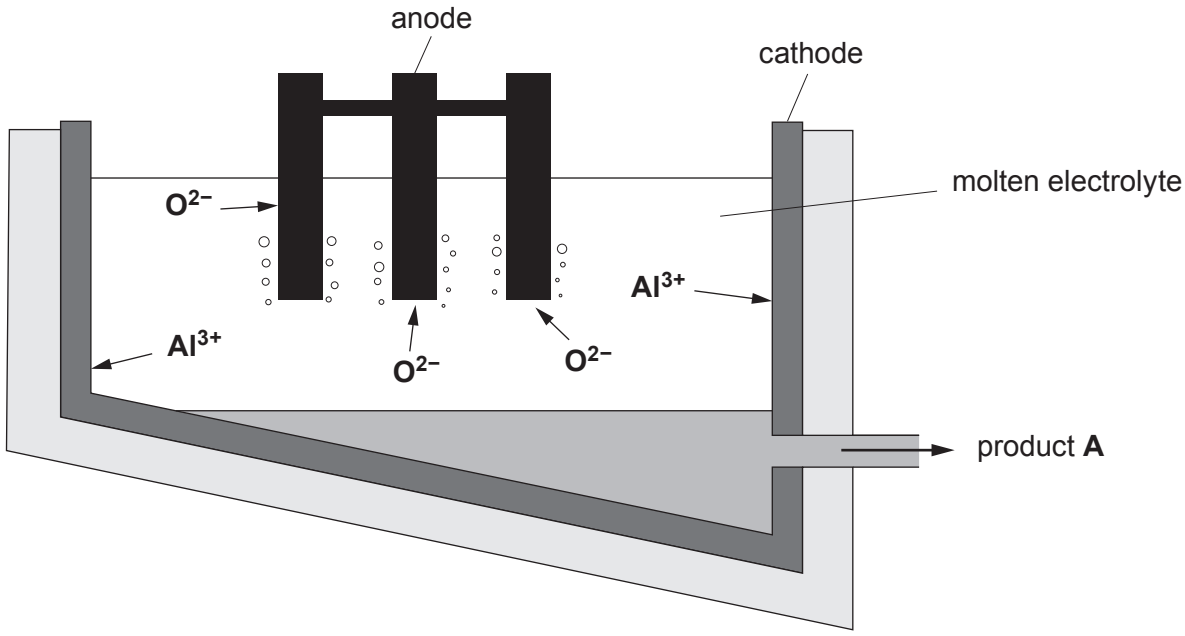
4

BLANK PAGE

PLEASE DO NOT WRITE ON THIS PAGE

Examiner only

2. The diagram shows an electrolysis cell used in the extraction of aluminium from alumina.



bauxite	**electrical**	**molten alumina**		**positive**
negative	**cryolite**	**molten aluminium**	**oxygen**	**light**

(a) Choose words from the box to complete the following sentences. [5]

The molten electrolyte is a mixture of alumina and ..... .

Product **A** is ..... .

Oxygen is formed at the anode which is the ..... electrode.

Alumina is obtained from an ore called ..... .

The process of extracting aluminium is expensive because it uses a lot of

..... energy.

(b) Balance the symbol equation that shows the overall reaction. [1]

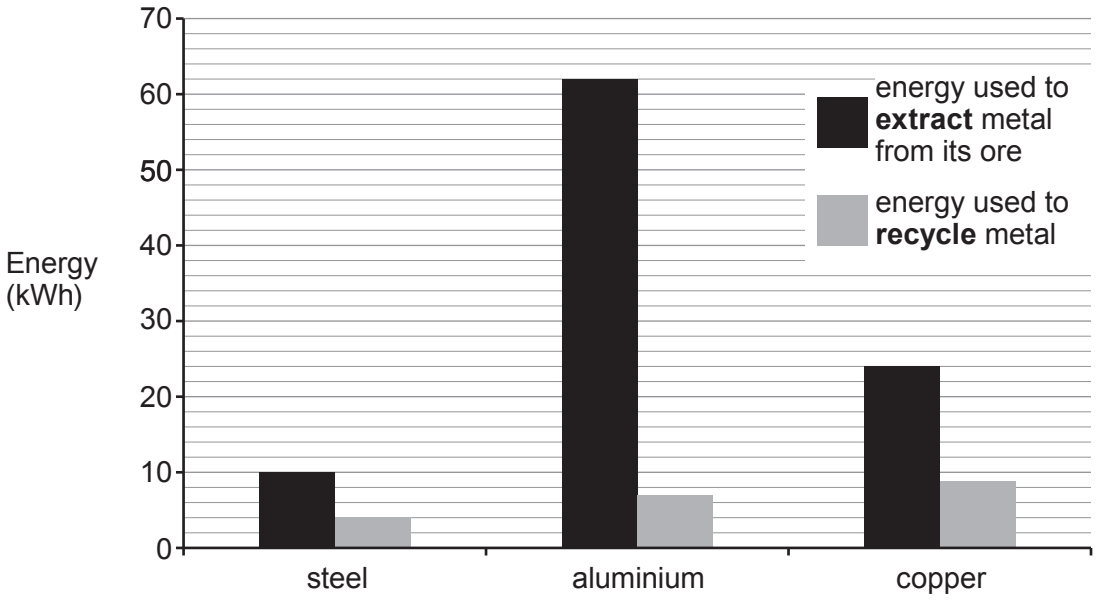
$$2Al_2O_3 \longrightarrow \square\ Al + 3O_2$$

Examiner only

(c) 250 tonnes of an aluminium ore can produce 195 tonnes of alumina.
Calculate the percentage of alumina in the ore. [2]

Percentage = ... %

(d) The chart compares the amount of energy used to extract and to recycle three metals.



Use the information in the chart to answer the following question.

Put a tick (✓) in the box next to the statement that describes why it is more cost effective to recycle aluminium than steel and copper. [1]

The energy used to extract metals is greater than that used in recycling them ☐

The difference between the energy used to extract and the energy used to recycle is the greatest ☐

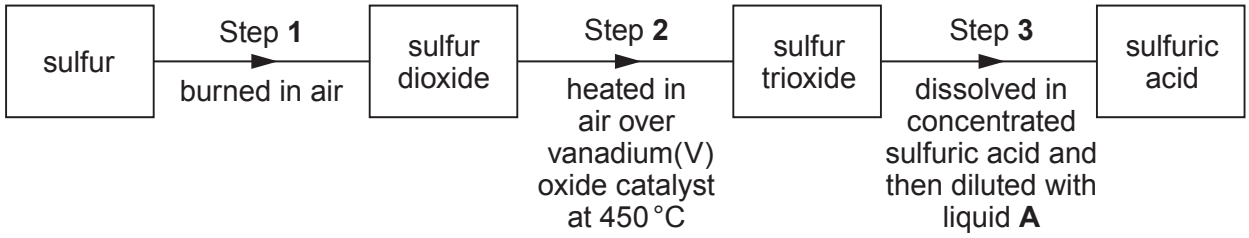
The energy used in recycling is less than for copper but greater than for steel ☐

9

3410U201
07

Examiner only

3. *(a)* The flow diagram shows steps in the manufacture of sulfuric acid using the Contact Process.



(i) Name the **element** in the air which reacts with sulfur in step **1**. [1]

.....

(ii) State the purpose of the catalyst in step **2**. [1]

.....

(iii) Name liquid **A** used to dilute the concentrated sulfuric acid in step **3**. [1]

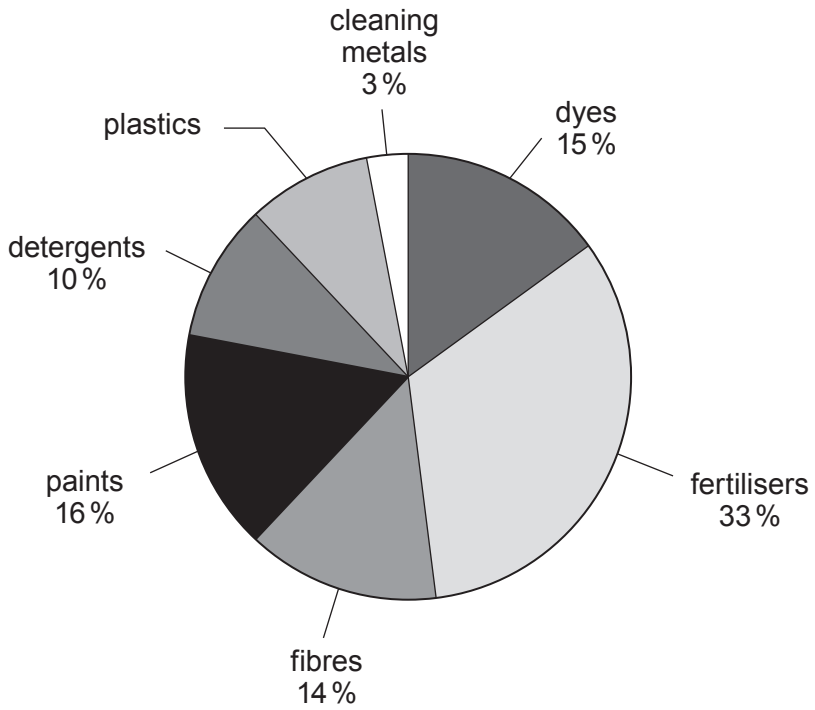
.....

(iv) Complete and balance the symbol equation for the reaction in step **2**. [2]

$$2SO_2 + O_2 \rightleftharpoons \square \text{.....}$$

Examiner only

(b) The pie chart shows the main uses of sulfuric acid.



Calculate the percentage of sulfuric acid used for making plastics. [2]

Percentage = ... %

(c) One important use of sulfuric acid is in the production of the fertiliser ammonium sulfate, $(NH_4)_2SO_4$.

Complete the following word equation for the production of ammonium sulfate. [1]

sulfuric acid + ... ⟶ ammonium sulfate

8

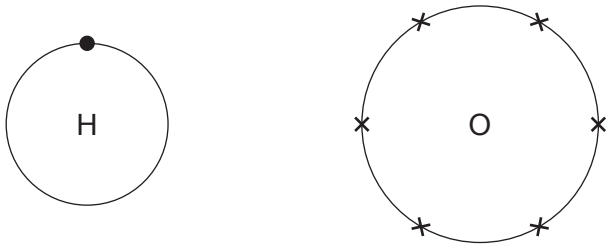
3410U201
09

Examiner only

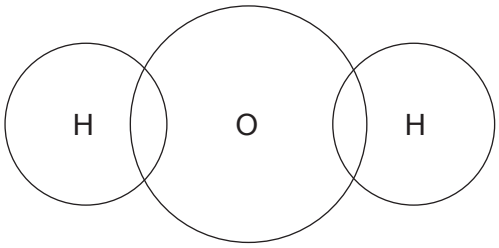
4. *(a)* The table shows the electronic structure of the elements present in water.

Element	Electronic structure
hydrogen	1
oxygen	2,6

The diagrams show the outer shell electrons in an atom of hydrogen and an atom of oxygen.

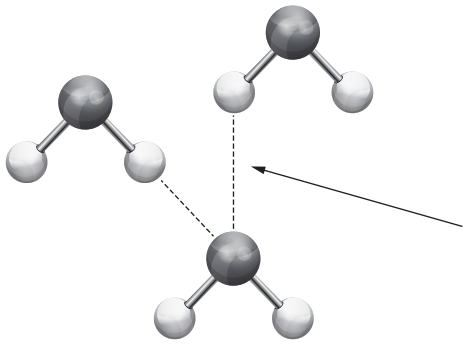


(i) Complete the diagram to show the outer shell electrons in a molecule of water. [2]



Examiner only

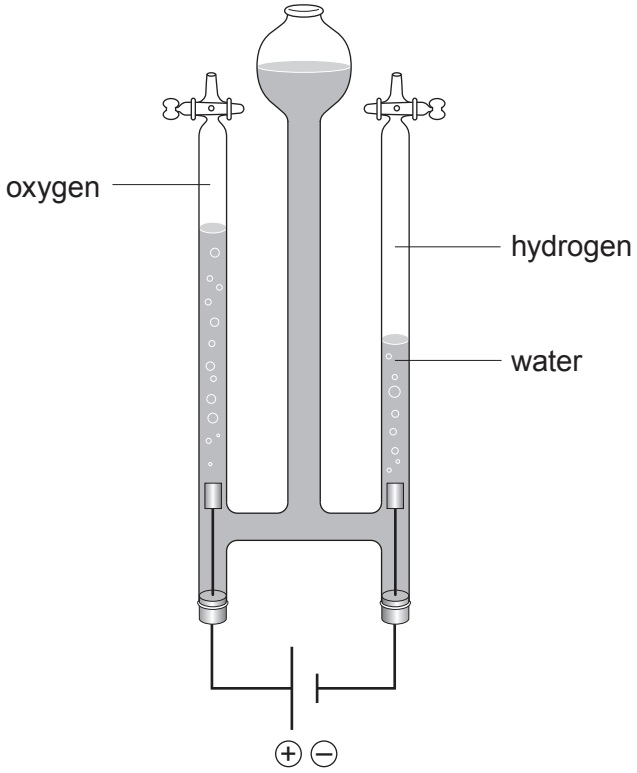
(ii) The diagram shows some water molecules and the weak forces between them.



Put a tick (✓) in the box next to the property of water which can be explained by the weak forces between water molecules. [1]

poor conductor of electricity	
colourless	
good conductor of heat	
low melting point and boiling point	

(b) The diagram shows the apparatus used by a group of students to investigate the volume of hydrogen and oxygen gas formed during the electrolysis of water.



The overall equation for the electrolysis of water is as follows.

$$2H_2O \longrightarrow 2H_2 + O_2$$

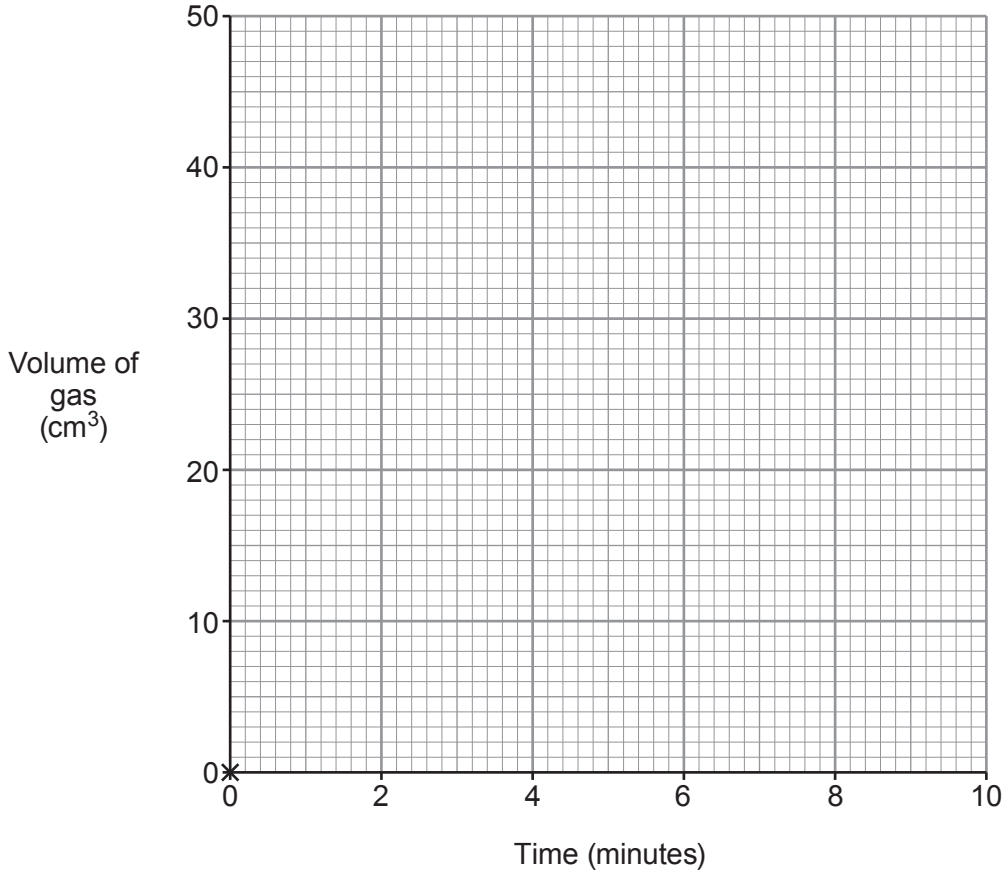
(i) The table shows the total volume of hydrogen formed over 10 minutes.

Time (minutes)	0	2	4	6	8	10
Volume of hydrogen (cm^3)	0	10	20	30	40	50

Examiner only

I. Plot the values from the table on the grid. Draw a suitable line. Label this line '**hydrogen**'.

(0,0) has been plotted for you. [2]



II. Using a ruler, draw a second line **on the grid** to show the volume of oxygen that would be collected during the same 10 minutes. Label this line '**oxygen**'. [1]

III. Describe the relationship between the volume of hydrogen and the volume of oxygen formed during electrolysis. [2]

.....

.....

.....

3410U201
13

Turn over.

Examiner only

(ii) Electrolysis of water can be represented by the following equation.

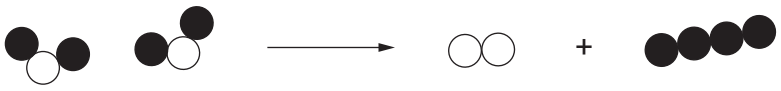
$$2H_2O \longrightarrow 2H_2 + O_2$$

Give the **letter**, **A**, **B**, **C** or **D**, of the diagram which also represents this reaction. [1]

A

B

C

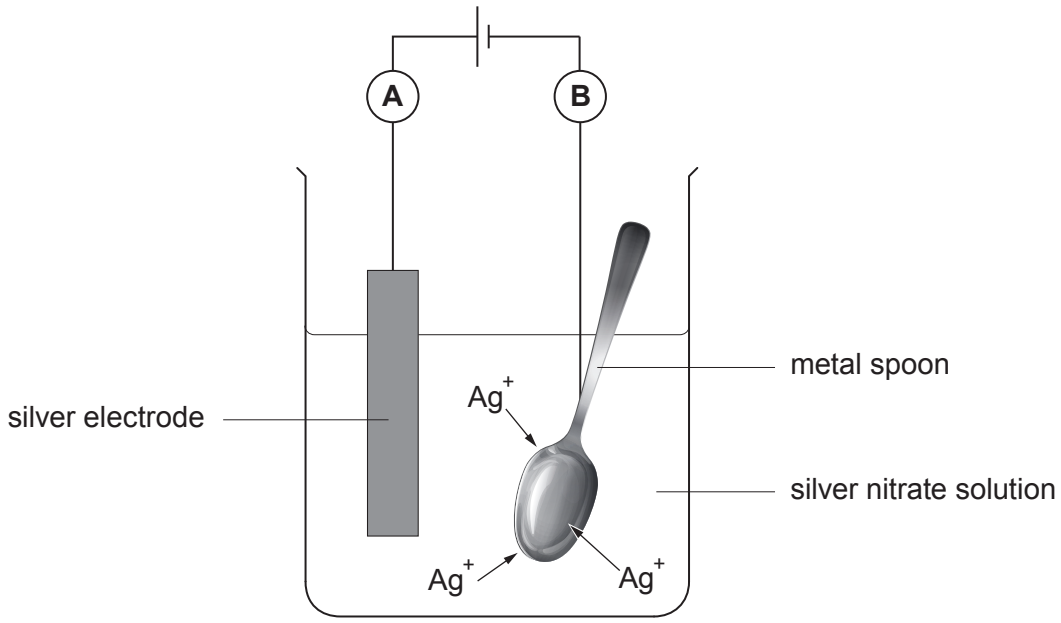


D

Letter .....

Examiner only

(c) One use of electrolysis is in electroplating. The diagram shows the silver plating of a metal spoon.



(i) State why this process does not work for a plastic spoon. [1]

.....

(ii) Explain why the silver ions move towards the spoon. [2]

.....

.....

(iii) Put a tick (✓) in the box next to the electrode equation for the reaction at electrode **B**. [1]

$2Ag^+ + 2e^- \longrightarrow Ag$ ☐

$Ag^+ + e^- \longrightarrow Ag$ ☐

$Ag^+ - e^- \longrightarrow Ag$ ☐

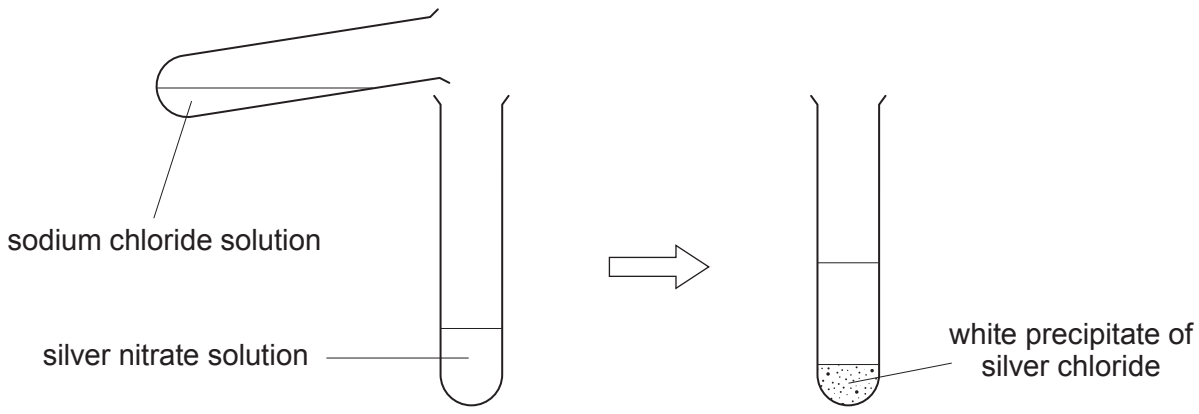
$Ag^+ + 2e^- \longrightarrow Ag$ ☐

13

3410U201
15

Examiner only

5. *(a)* Dafydd was asked to make some silver chloride. He formed a white precipitate of silver chloride by mixing solutions of sodium chloride and silver nitrate.



(i) Complete the symbol equation for this reaction. [1]

$NaCl + AgNO_3 \longrightarrow$ ..... + ...

(ii) Put a tick (✓) in the box next to the statement which describes why this method works. [1]

silver is more dense than sodium ☐

silver chloride is soluble ☐

silver chloride is insoluble ☐

silver is below sodium in the reactivity series ☐

(iii) Give the name of the process that you would use to separate the precipitate of silver chloride from the reaction mixture. [1]

.....

Examiner only

(b) Calculate the relative formula mass (M_r) of silver nitrate, $AgNO_3$. [2]

A_r(O) = 16 A_r(N) = 14 A_r(Ag) = 108

M_r = ...

(c) The relative formula mass (M_r) of sodium chloride, NaCl, is 58.5.

Calculate the percentage of sodium in sodium chloride. Give your answer to **1 decimal place**. [2]

A_r(Na) = 23

Percentage = ... %

7

Turn over.

BLANK PAGE

PLEASE DO NOT WRITE ON THIS PAGE

Examiner only

6. *(a)* Plastics have replaced many traditional materials. The diagrams show plastics being used for three different types of food and drink packaging and containers.

Fruit packaging

Drinks containers

Take-away meal containers

Describe the advantages and disadvantages of using plastics in these examples.

[6 QER]

(b) **Microplastics in the Ocean**

Plastics are used in many areas of modern life.
Figure 1 shows the amount of plastic production between 1950 and 2013.

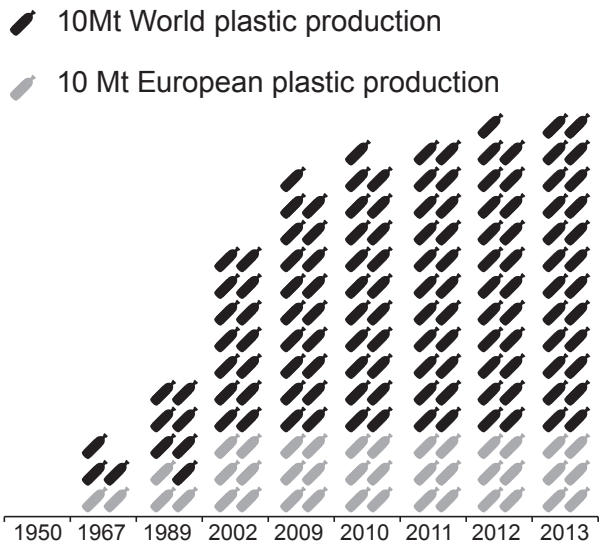
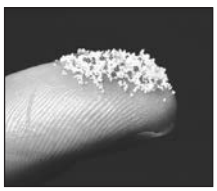


Figure 1

One of plastic's greatest properties, its durability, is also one of the main reasons that plastics present a threat to the marine environment.

The term 'microplastic' is used to describe plastic particles that are less than 5 millimetres in diameter, which includes particles as small as 10 nanometres. Microplastics can be found in some cosmetic products, toothpastes and soaps.



Microplastics are spread throughout the oceans and are found on shorelines from the Arctic to Antarctica. **Figure 2** shows the number of microplastic pieces found in sea ice at four Arctic sites during a survey in 2014.

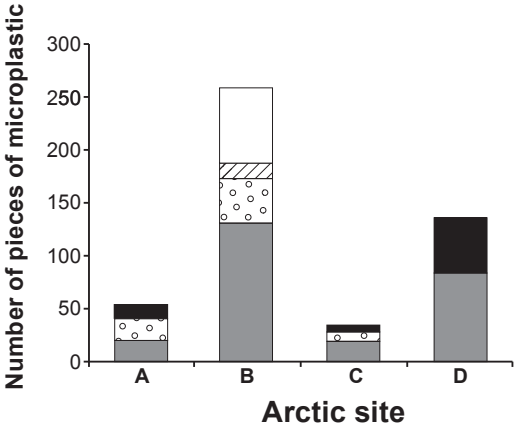
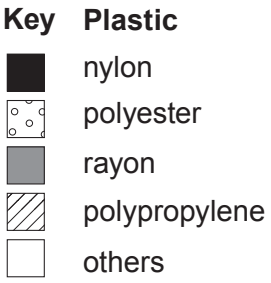


Figure 2



Microplastics have been found inside the bodies of marine animals. Microplastics often contain chemicals that can absorb poisons such as pesticides from the surrounding seawater. There is strong evidence of transfer of poisons from eaten microplastics into animal tissues. Nano-size microplastics have been shown to cross cell membranes, under laboratory conditions, causing tissue damage.

Public awareness of the potential for microplastics to damage marine animals is low compared with that of the impact of plastic litter in our seas and oceans. Effective education of society is essential to raise awareness of the damaging effects of microplastics.

Examiner only

(i) Put a tick (✓) in the box next to the size of microplastics. [1]

less than 10 mm ☐

between 5 mm and 10 nm ☐

greater than 5 mm and less than 10 nm ☐

between 5 mm and 10 mm ☐

(ii) Put a tick (✓) in the box next to the statement that best describes the amount of plastic produced in Europe since 2002. [1]

plastic production has remained constant ☐

plastic production has increased ☐

plastic production has decreased ☐

(iii) Name the type of plastic most often found in the Arctic microplastic survey. [1]

.....

(iv) Put a tick (✓) in the box next to a hypothesis which needs further testing by scientists. [1]

the quantity of microplastics found in the Earth's oceans is increasing ☐

microplastics carry contaminants from sea water into animals ☐

microplastics cause tissue damage in marine animals ☐

microplastics are a greater problem near land than in deep water ☐

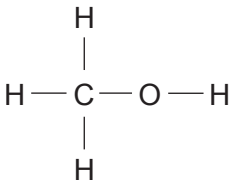
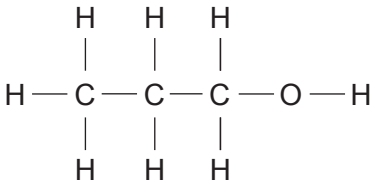
(v) Suggest a method of educating people of the hazards of microplastics. [1]

.....

11

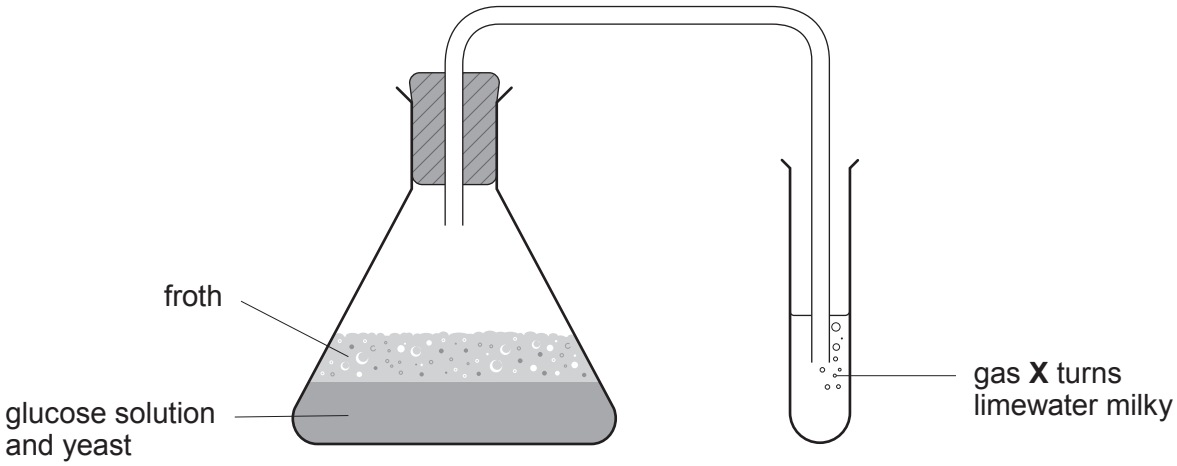
Examiner only

7. *(a)* The table shows the names, molecular formulae and structural formulae of some alcohols. Complete the table. [3]

Name	Molecular formula	Structural formula
methanol	.....	
ethanol	C_2H_5OH	.....
.....	C_3H_7OH	

Examiner only

(b) The diagram shows apparatus that can be used to make ethanol by fermentation.



(i) Complete and balance the symbol equation for the reaction. [2]

$$C_6H_{12}O_6 \xrightarrow{\text{yeast}} 2C_2H_5OH + \square \quad \text{.....}$$

glucose solution — ethanol — gas **X**

(ii) Yeast acts as a catalyst in the process. Give the reason why catalysts are written above the arrow in equations. [1]

.....

Examiner only

(c) In Brazil sugar cane is used to make ethanol which can be used instead of petrol in cars. Many people see ethanol as the fuel of the future but others are concerned with environmental and social issues.

The table shows information relating to the burning of 1 dm^3 of ethanol and petrol.

	Ethanol	Petrol
Source	sugar cane	crude oil
Energy released (MJ)	23.5	33.0
CO_2 released (kg)	1.5	2.2

Use the information in the table and your knowledge to answer the following question.

Explain **one** advantage and **one** disadvantage of using ethanol instead of petrol in cars. [2]

Advantage .....

.....

.....

Disadvantage .....

.....

.....

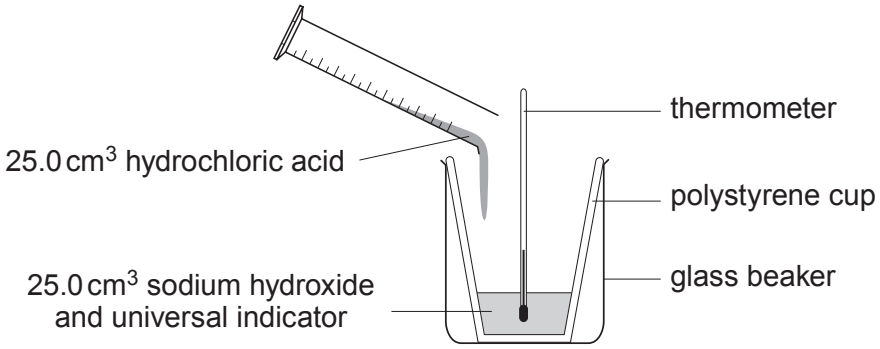
8

BLANK PAGE

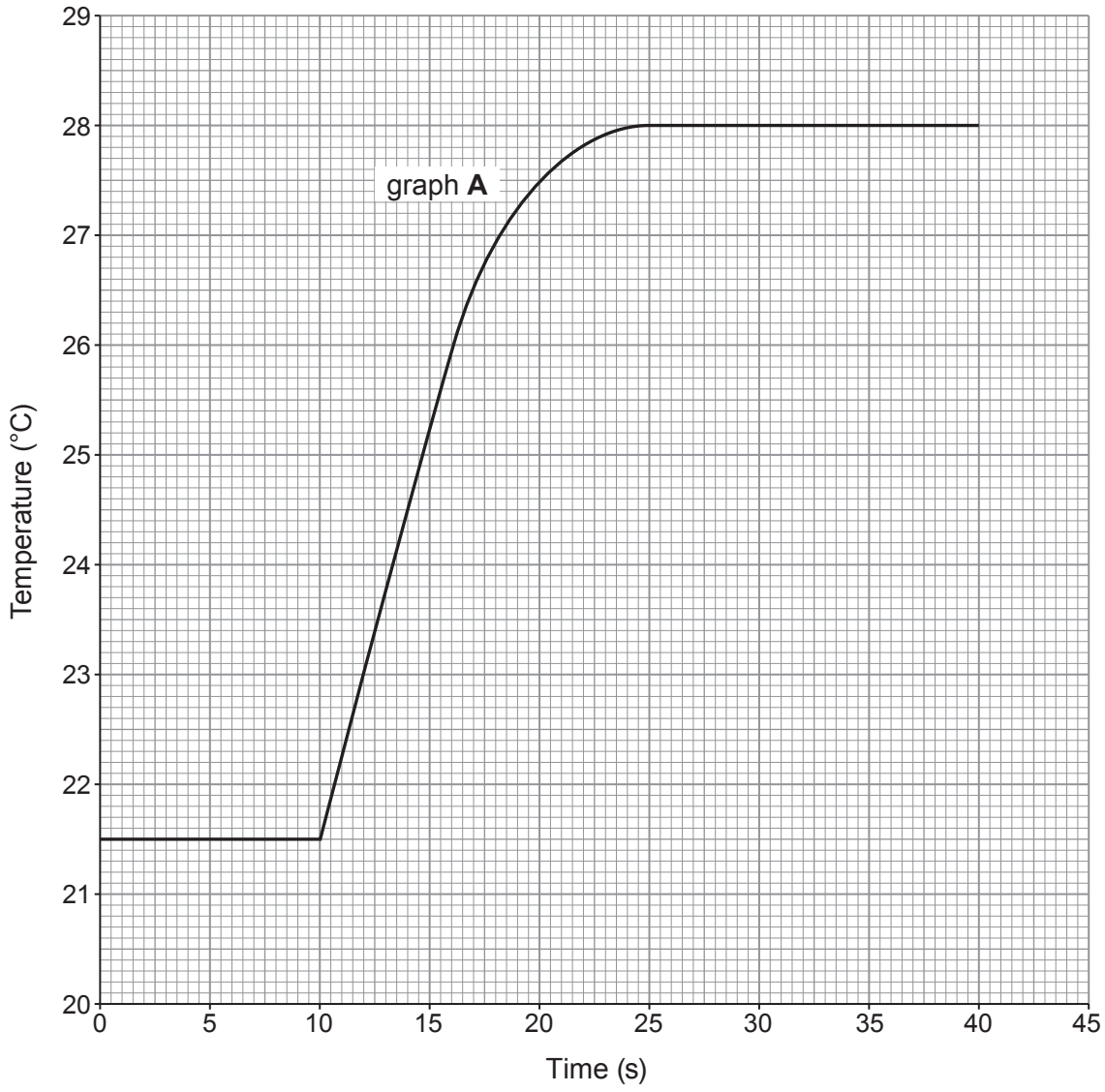
PLEASE DO NOT WRITE ON THIS PAGE

Examiner only

8. A student investigated the temperature rise during a neutralisation reaction.



The student put 25.0 cm^3 of sodium hydroxide solution and 5 drops of universal indicator into a polystyrene cup and recorded the temperature of the alkali. After 10 seconds the student added 25.0 cm^3 of dilute hydrochloric acid to the alkali and recorded the temperature every 5 seconds for another 30 seconds. Graph **A** shows the results obtained.



Examiner only

(a) (i) Use the graph to find the maximum temperature rise during the reaction. [1]

Temperature rise = ... °C

(ii) The energy given out can be calculated using the following formula.

energy given out = **total** volume of reaction mixture × 4.2 × temperature rise

Calculate the energy given out during the reaction. [2]

Energy given out = ... J

(iii) The temperature of the contents in the cup was recorded after 2 hours. Give the final temperature reading you would expect. Give the reason for your answer. [1]

Final temperature ..... °C

Reason .....

.....

(b) The student repeated the experiment using 25.0 cm^3 of ethanoic acid of the same concentration as the hydrochloric acid. The table shows the results obtained.

Time (s)	0	5	10	15	20	25	30	35	40
Temperature (°C)	21.5	21.5	21.5	24.0	26.0	26.9	27.0	27.0	27.0

Plot the results on the grid on page 26. Draw a suitable line. Label your graph **B**. [2]

(c) Use the graphs to state which of the two acids is the stronger – hydrochloric acid or ethanoic acid. Give the reason for your choice. [1]

Acid .....

Reason .....

.....

Examiner only

(d) The temperature rises in both experiments were much **lower** than expected. The student suggested that using a temperature sensor instead of a thermometer would give temperature rises closer to the expected values.

(i) State why using a temperature sensor would still give a lower than expected temperature rise. [1]

.....

.....

(ii) What improvement to the apparatus would you suggest to the student to obtain temperature rises closer to the expected values? [1]

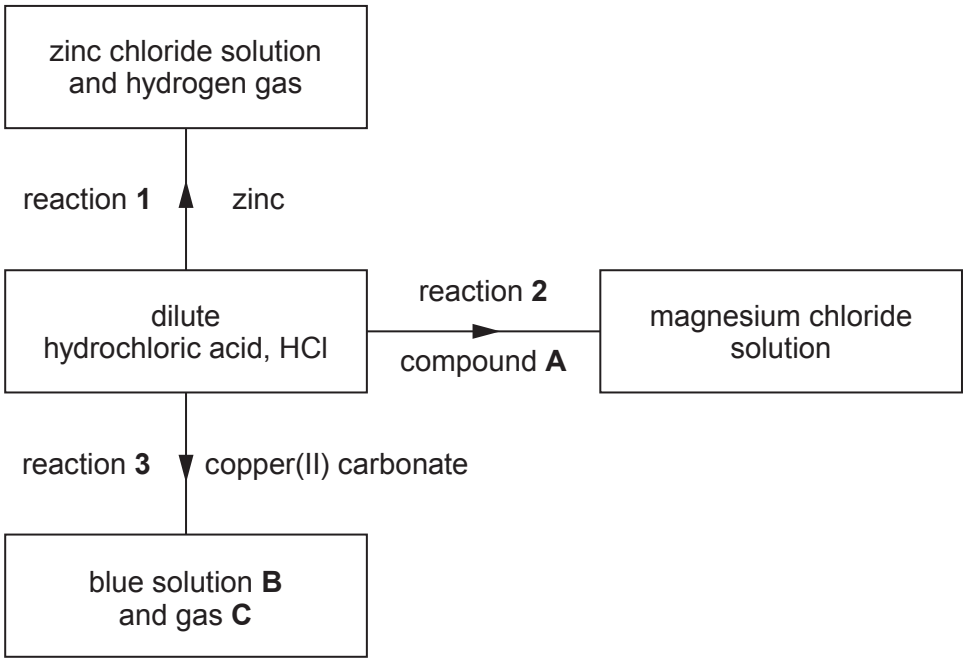
.....

.....

9

Examiner only

9. The diagram shows three reactions which are used to prepare soluble salts.



(a) (i) Name compound **A**. [1]

.....

(ii) Give the names of blue solution **B** and gas **C** formed in reaction **3**. [2]

blue solution **B** .....

gas **C** .....

(b) Write the balanced symbol equation for reaction **1**. [2]

.....

(c) Reaction **1** was repeated using magnesium instead of zinc. Explain the difference, if any, that you would expect to see. [2]

.....

.....

.....

7

Examiner only

10. The tables show the molecular formulae of some alkanes and alkenes.

Alkanes
CH_4
C_2H_6
C_3H_8
C_4H_{10}

Alkenes
C_2H_4
C_3H_6

(a) The general formula for the alkene family is C_nH_{2n}. Give the general formula for the alkane family. [1]

.....

(b) When alkanes and alkenes completely burn in air they form the same two products.

Give the chemical formulae for both products. [1]

..... and .....

(c) Draw the structural formula for propene. [1]

(d) Bromine water is used to distinguish alkenes from alkanes. Describe the colour **change** seen when bromine water is added to an alkene. [1]

.....

4

END OF PAPER

Question number	Additional page, if required. Write the question number(s) in the left-hand margin.

Examiner only

Question number	Additional page, if required. Write the question number(s) in the left-hand margin.

Examiner only

BLANK PAGE

PLEASE DO NOT WRITE ON THIS PAGE

BLANK PAGE

PLEASE DO NOT WRITE ON THIS PAGE

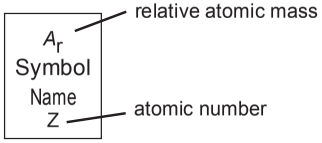
FORMULAE FOR SOME COMMON IONS

POSITIVE IONS		NEGATIVE IONS	
Name	**Formula**	**Name**	**Formula**
aluminium	Al^{3+}	bromide	Br^{-}
ammonium	NH_4^{+}	carbonate	CO_3^{2-}
barium	Ba^{2+}	chloride	Cl^{-}
calcium	Ca^{2+}	fluoride	F^{-}
copper(II)	Cu^{2+}	hydroxide	OH^{-}
hydrogen	H^{+}	iodide	I^{-}
iron(II)	Fe^{2+}	nitrate	NO_3^{-}
iron(III)	Fe^{3+}	oxide	O^{2-}
lithium	Li^{+}	sulfate	SO_4^{2-}
magnesium	Mg^{2+}		
nickel	Ni^{2+}		
potassium	K^{+}		
silver	Ag^{+}		
sodium	Na^{+}		
zinc	Zn^{2+}		

THE PERIODIC TABLE

1	2	Group										3	4	5	6	7	0
							1 H Hydrogen 1										4 He Helium 2
7 Li Lithium 3	9 Be Beryllium 4											11 B Boron 5	12 C Carbon 6	14 N Nitrogen 7	16 O Oxygen 8	19 F Fluorine 9	20 Ne Neon 10
23 Na Sodium 11	24 Mg Magnesium 12											27 Al Aluminium 13	28 Si Silicon 14	31 P Phosphorus 15	32 S Sulfur 16	35.5 Cl Chlorine 17	40 Ar Argon 18
39 K Potassium 19	40 Ca Calcium 20	45 Sc Scandium 21	48 Ti Titanium 22	51 V Vanadium 23	52 Cr Chromium 24	55 Mn Manganese 25	56 Fe Iron 26	59 Co Cobalt 27	59 Ni Nickel 28	63.5 Cu Copper 29	65 Zn Zinc 30	70 Ga Gallium 31	73 Ge Germanium 32	75 As Arsenic 33	79 Se Selenium 34	80 Br Bromine 35	84 Kr Krypton 36
86 Rb Rubidium 37	88 Sr Strontium 38	89 Y Yttrium 39	91 Zr Zirconium 40	93 Nb Niobium 41	96 Mo Molybdenum 42	99 Tc Technetium 43	101 Ru Ruthenium 44	103 Rh Rhodium 45	106 Pd Palladium 46	108 Ag Silver 47	112 Cd Cadmium 48	115 In Indium 49	119 Sn Tin 50	122 Sb Antimony 51	128 Te Tellurium 52	127 I Iodine 53	131 Xe Xenon 54
133 Cs Caesium 55	137 Ba Barium 56	139 La Lanthanum 57	179 Hf Hafnium 72	181 Ta Tantalum 73	184 W Tungsten 74	186 Re Rhenium 75	190 Os Osmium 76	192 Ir Iridium 77	195 Pt Platinum 78	197 Au Gold 79	201 Hg Mercury 80	204 Tl Thallium 81	207 Pb Lead 82	209 Bi Bismuth 83	210 Po Polonium 84	210 At Astatine 85	222 Rn Radon 86
223 Fr Francium 87	226 Ra Radium 88	227 Ac Actinium 89															

Key



36