OXFORD

INTERNATIONAL
AQA EXAMINATIONS

Please write clearly in block capitals.

Centre number | | | | | | Candidate number | | | | |

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I declare this is my own work.

INTERNATIONAL GCSE
COMBINED SCIENCE

C

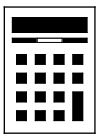
Paper 2 Chemistry Core

Thursday 4 November 2021 07:00 GMT Time allowed: 1 hour 45 minutes

Materials

For this paper you must have:

- a pencil and a ruler
- a scientific calculator
- the periodic table (enclosed).



Instructions

- Use black ink or black ball-point pen.
- Fill in the boxes at the top of this page.
- Answer **all** questions.
- You must answer the questions in the spaces provided. Do not write outside the box around each page or on blank pages.
- If you need extra space for your answer(s), use the lined pages at the end of this book. Write the question number against your answer(s).
- All working must be shown.
- Do all rough work in this book. Cross through any work you do not want to be marked.

For Examiner's Use	
Question	Mark
1	
2	
3	
4	
5	
6	
7	
8	
9	
10	
TOTAL	

Information

- The marks for questions are shown in brackets.
- The maximum mark for this paper is 100.
- You are expected to use a scientific calculator where appropriate.
- The periodic table is provided as a loose insert.

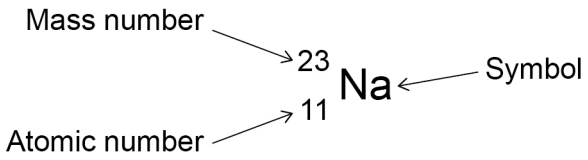
Answer **all** questions in the spaces provided.

Do not write outside the box

0 1 This question is about atoms and elements.

Figure 1 shows information about the element sodium.

Figure 1



0 1 . 1 How many protons are in an atom of sodium?

Use **Figure 1**.

[1 mark]

Tick (✓) **one** box.

11 ☐

12 ☐

23 ☐

33 ☐

0 1 . 2 What is the relative electrical charge on a proton?

[1 mark]

Tick (✓) **one** box.

–1 ☐

0 ☐

+1 ☐

Do not write outside the box

0 1 . 3 Complete the sentence.

Choose the answer from the box.

[1 mark]

atom	**ion**	**molecule**	**nucleus**

The mass number of sodium is the total number of sub-atomic particles

in the _____.

0 1 . 4 Give the symbol of an element that is in the same group in the periodic table as sodium.

Use the periodic table.

[1 mark]

_____

Question 1 continues on the next page

Do not write outside the box

Table 1 gives information about four elements.

Table 1

Element	Mass number	Density in g/cm^3	Type of bonding in element
Sodium	23	0.97	metallic
Magnesium	24	1.74	metallic
Aluminium	27	2.70	metallic
Silicon	28	2.30	covalent

0 1 . 5 Describe how the density of elements with metallic bonding changes as the mass number increases.

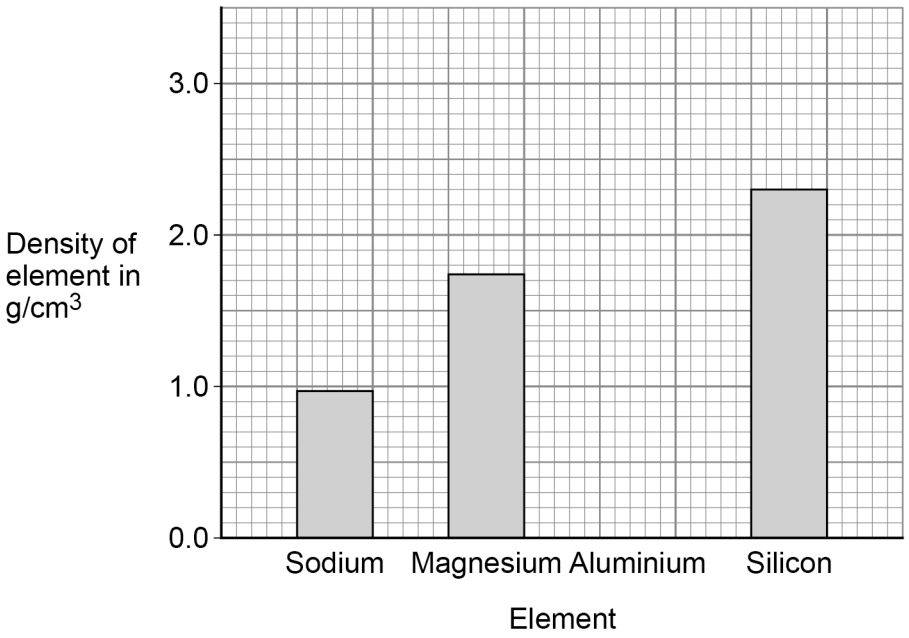
Use **Table 1**.

[1 mark]

Do not write outside the box

0 1 . 6 **Figure 2** shows the densities of three of the elements in **Table 1**.

Figure 2



Complete **Figure 2** to show the density of aluminium.

Use **Table 1**.

[1 mark]

Question 1 continues on the next page

A student tested a sample of one of the elements in **Table 1**.

The student measured the mass and the volume of the sample.

Table 2 shows the results.

Table 2

Mass of sample in grams	8.7
Volume of sample in cm^3	5.0

0 1 . 7 Which piece of equipment is used to measure the mass of a sample of an element?

[1 mark]

Tick (✓) **one** box.

Balance ☐

Beaker ☐

Measuring cylinder ☐

Ruler ☐

0 1 . 8 Calculate the density of the sample the student measured.

Use the data in **Table 2** and the equation:

$$\text{Density} = \frac{\text{mass}}{\text{volume}}$$

[2 marks]

Density = _____ g/cm^3

Do not write outside the box

0 1 . 9 Suggest the name of the element the student tested.

Use your answer from **Question 01.8** and **Table 1**.

Table 1 is repeated below.

Table 1

Element	Mass number	Density in g/cm^3	Type of bonding in element
Sodium	23	0.97	metallic
Magnesium	24	1.74	metallic
Aluminium	27	2.70	metallic
Silicon	28	2.30	covalent

[1 mark]

10

Name of element = _____

Turn over for the next question

Do not write outside the box

0 2 This question is about elements, compounds and mixtures.

Table 3 gives information about the gases in a sample of air.

Table 3

Name of gas	Formula	Boiling point in °C	Percentage (%) by volume of the gas in the sample of air
Argon	Ar	–186	0.91
Carbon dioxide	CO_2	–78	0.04
Nitrogen	N_2	–196	76.21
Oxygen	O_2	–183	**X**
Water vapour	H_2O	100	2.45

0 2 . 1 The percentage (%) by volume of oxygen in the air is represented by **X** in **Table 3**.

Calculate value **X** in **Table 3**.

[2 marks]

X = _____ %

0 2 . 2 Which gas in **Table 3** is a noble gas?

[1 mark]

_____

Do not write outside the box

0 2 . 3 Which is the best description of the sample of air?

[1 mark]

Tick (✓) **one** box.

Mixture of compounds ☐

Mixture of elements ☐

Mixture of elements and compounds ☐

0 2 . 4 The sample of air is cooled to –100 °C.

Which **two** substances in **Table 3** are **not** gases at –100 °C?

[2 marks]

1 _____

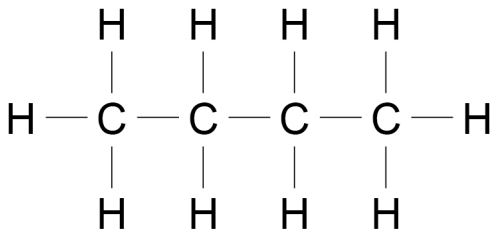
2 _____

Question 2 continues on the next page

Do not write outside the box

Figure 3 shows the displayed structure of a hydrocarbon.

Figure 3



0 2 . 5 Complete the molecular formula of the hydrocarbon in **Figure 3**.

[1 mark]

C ____ H ____

0 2 . 6 Which of the following describes the hydrocarbon in **Figure 3**?

[1 mark]

Tick (✓) **one** box.

Giant structure ☐

Ionic lattice ☐

Simple molecule ☐

Do not write outside the box

0 2 . 7 Crude oil is a mixture of hydrocarbons.

Which process is used to separate the hydrocarbons in crude oil?

[1 mark]

Tick (✓) **one** box.

- Chromatography ☐
- Crystallisation ☐
- Filtration ☐
- Fractional distillation ☐

0 2 . 8 Which **two** substances are produced during the complete combustion of a hydrocarbon?

[2 marks]

Tick (✓) **two** boxes.

- Argon ☐
- Carbon dioxide ☐
- Nitrogen ☐
- Oxygen ☐
- Water ☐

11

Do not write outside the box

0 3 This question is about the reactions of metal compounds.

0 3 . 1 Iron oxide reacts with an acid to produce iron sulfate solution.

What is the name of the acid?

[1 mark]

Tick (✓) **one** box.

Hydrochloric acid ☐

Nitric acid ☐

Sulfuric acid ☐

0 3 . 2 Iron oxide is insoluble.

Complete the sentence.

Choose the answer from the box.

[1 mark]

chromatography	**crystallisation**	**electrolysis**	**filtration**

Excess iron oxide can be removed from iron sulfate solution

using _____.

Do not write outside the box

Iron sulfate solution reacts with sodium hydroxide solution to produce a precipitate of iron hydroxide.

0 3 . 3 Complete the word equation for this reaction.

[1 mark]

iron sulfate + sodium hydroxide ⟶ iron hydroxide + _____

0 3 . 4 The iron hydroxide precipitate is iron(III) hydroxide.

What is the colour of this precipitate?

[1 mark]

Tick (✓) **one** box.

Blue ☐

Brown ☐

Green ☐

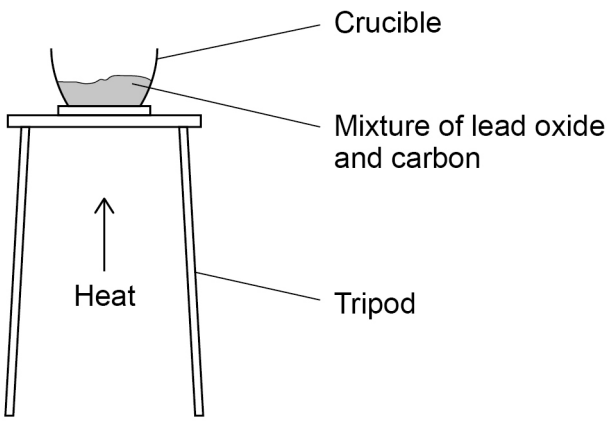
White ☐

Question 3 continues on the next page

A student heated a mixture of lead oxide and carbon.

Figure 4 shows the apparatus.

Figure 4



The word equation for the reaction is:

lead oxide + carbon ⟶ lead + gas **X**

0 3 . 5 Suggest the name of gas **X**.

[1 mark]

_____

0 3 . 6 The student recorded the mass of the crucible and mixture at the start and at the end of the experiment.

What happens to the mass of the crucible and mixture during the experiment?

[1 mark]

Tick (✓) **one** box.

Mass decreases ☐

Mass stays the same ☐

Mass increases ☐

Do not write outside the box

0 3 . 7 Complete the sentence.

Choose the answer from the box.

[1 mark]

neutralised	**oxidised**	**precipitated**	**reduced**

When lead oxide reacts with carbon to produce lead,

the lead oxide is _____.

0 3 . 8 Calculate the percentage by mass of lead in lead oxide (PbO).

Give your answer to 3 significant figures.

Relative atomic mass (A_r): Pb = 207

Relative formula mass (M_r): PbO = 223

[3 marks]

_____

_____

_____

_____

_____

Percentage by mass (3 significant figures) = _____ %

10

Do not write outside the box

0 4 This question is about alkenes.

0 4 . 1 Which statement about alkenes is correct?

[1 mark]

Tick (✓) **one** box.

Alkenes are obtained by cracking alkanes. ☐

Alkenes are saturated hydrocarbons. ☐

Alkenes make up a large proportion of crude oil. ☐

0 4 . 2 Bromine water is added to an alkene.

Complete the sentence.

Choose the answer from the box.

[1 mark]

blue	**colourless**	**red**	**white**

When bromine water is added to an alkene the bromine water turns from orange to _____.

Do not write outside the box

Table 4 gives information about the first four members of the homologous series of alkenes.

Table 4

Name of alkene	Formula	Relative formula mass (M_r)
Ethene	C_2H_4	28
Propene	C_3H_6	**Y**
Butene	**X**	56
Pentene	C_5H_{10}	70

0 4 . 3 The formula of butene is represented by **X** in **Table 4**.

Determine the formula of butene.

[1 mark]

0 4 . 4 The relative formula mass of propene (C_3H_6) is represented by **Y** in **Table 4**.

Calculate value **Y** in **Table 4**.

Relative atomic masses (A_r): C = 12 H = 1

[2 marks]

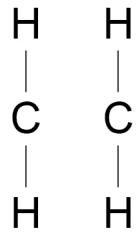
Y = _____

Do not write outside the box

Many molecules of ethene join together to produce poly(ethene).

0 4 . 5 Complete the displayed structure of a molecule of ethene (C_2H_4).

[1 mark]



0 4 . 6 What name is given to the molecules that join together to produce a polymer?

[1 mark]

Tick (✓) **one** box.

Alloys ☐

Catalysts ☐

Isotopes ☐

Monomers ☐

Do not write outside the box

0 4 . 7 The relative formula mass (M_r) of a poly(ethene) molecule is 84 000

The relative formula mass (M_r) of an ethene molecule is 28

Calculate the number of ethene molecules needed to produce one molecule of poly(ethene).

[2 marks]

Number of ethene molecules = _____

0 4 . 8 Poly(ethene) is used to make plastic bags.

Suggest **one** reason why the disposal of plastic bags causes problems.

[1 mark]

10

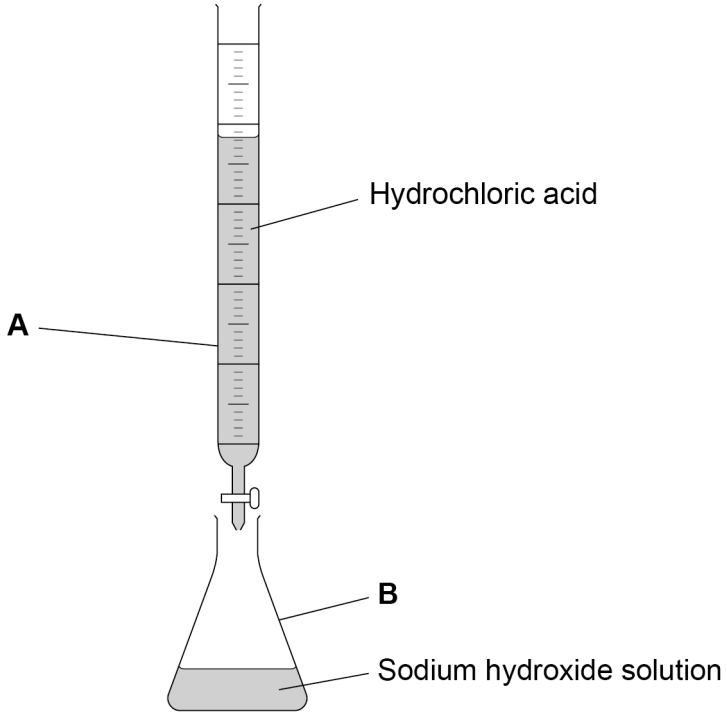
Turn over for the next question

Do not write outside the box

0 5 A student titrated hydrochloric acid against a known volume of sodium hydroxide solution.

Figure 5 shows the apparatus.

Figure 5



0 5 . 1 Two pieces of equipment are labelled **A** and **B** in **Figure 5**.

Draw **one** line from each label to the name of the piece of equipment.

[2 marks]

Label	Name of equipment
	Beaker
A	Burette
	Conical flask
B	Funnel
	Pipette

Do not write outside the box

0 5 . 2 What type of substance is added to the sodium hydroxide solution before the start of the titration?

[1 mark]

Tick (✓) **one** box.

Alkali ☐

Base ☐

Indicator ☐

Solvent ☐

0 5 . 3 The sodium hydroxide solution had a concentration of 0.15 mol/dm^3.

The volume of sodium hydroxide solution used in the titration was 0.025 dm^3.

Calculate the number of moles of sodium hydroxide used.

Use the equation:

number of moles = concentration × volume of solution

[2 marks]

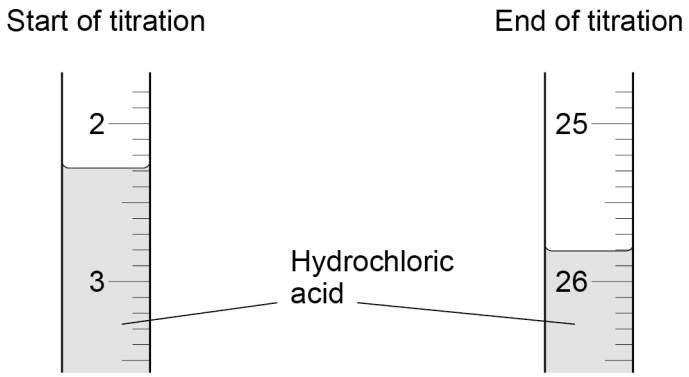
Number of moles = _____

Do not write outside the box

0 5 . 4 Equipment **A** is used to measure the volume of hydrochloric acid in cm^3.

Figure 6 shows the scale on equipment **A** at the start and at the end of the titration.

Figure 6



Determine the volume of hydrochloric acid added to the sodium hydroxide solution.

Use **Figure 6**.

[2 marks]

Volume of hydrochloric acid = _____ cm^3

0 5 . 5 What should the student do to get an accurate result?

[1 mark]

Tick (✓) **one** box.

- Ask a different person to repeat the titration ☐
- Repeat the titration to obtain consistent results ☐
- Repeat the titration using a different acid ☐
- Repeat the titration using a smaller volume of sodium hydroxide solution ☐

Do not write outside the box

0 5 . 6 The reaction between hydrochloric acid and sodium hydroxide is a neutralisation reaction.

Name the salt produced by this reaction.

[1 mark]

9

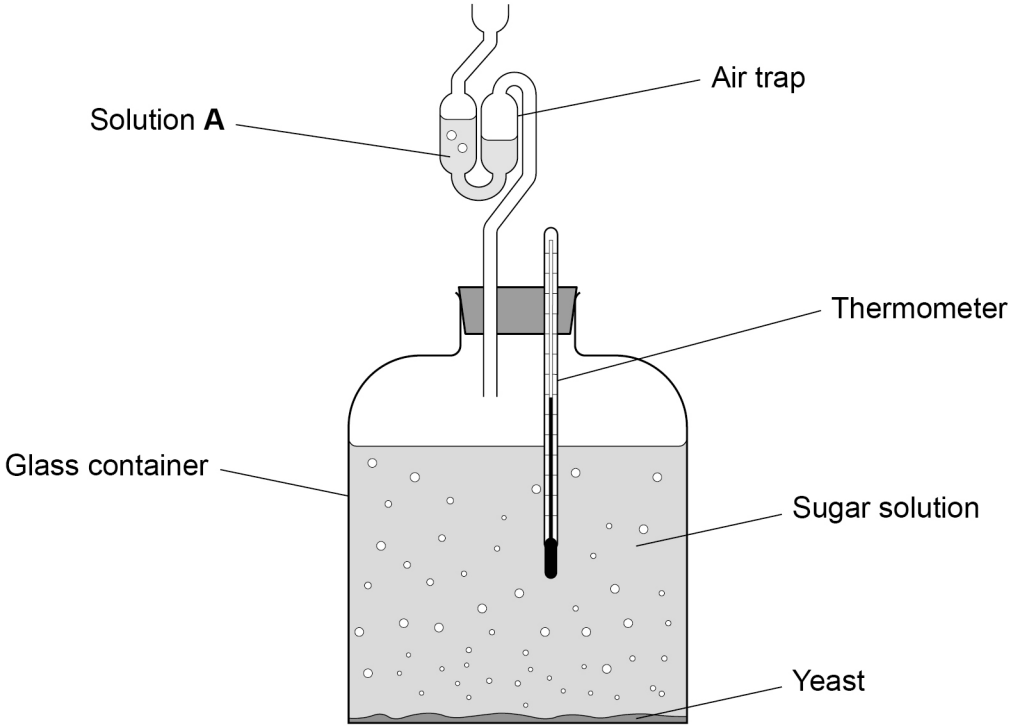
Turn over for the next question

Do not write outside the box

0 6 Ethanol can be produced by the fermentation of sugar solution.

Figure 7 shows the apparatus.

Figure 7



The word equation for the reaction is:

sugar ⟶ ethanol + carbon dioxide

0 6 . 1 Yeast contains a substance that lowers the activation energy of the reaction.

Which type of substance lowers the activation energy of a reaction?

[1 mark]

Tick (✓) **one** box.

Acid ☐

Catalyst ☐

Product ☐

Reactant ☐

Do not write outside the box

0 6 . 2 Which temperature range should be used for fermentation?

[1 mark]

Tick (✓) **one** box.

Between 0 °C and 15 °C ☐

Between 20 °C and 35 °C ☐

Between 50 °C and 65 °C ☐

Between 90 °C and 105 °C ☐

0 6 . 3 Balance the equation for the fermentation reaction.

[1 mark]

$$C_6H_{12}O_6 \rightarrow 2\,C_2H_5OH + \_\_\_\_\,CO_2$$

0 6 . 4 Solution **A** in **Figure 7** turns cloudy white during the fermentation.

Suggest the name of solution **A**.

[1 mark]

_____

Question 6 continues on the next page

Do not write outside the box

0 6 . 5 The fermentation produces a solution containing 340 g of ethanol dissolved in 4000 cm^3 of solution.

Calculate the concentration of ethanol in the solution.

Give your answer in g/dm^3.

[3 marks]

Concentration of ethanol in the solution = _____ g/dm^3

0 6 . 6 Ethanol produced by fermentation is described as a biofuel.

Complete the sentence.

Choose the answer from the box.

[1 mark]

crude oil	**ores**	**plants**	**seawater**

Ethanol is described as a biofuel because ethanol is produced from

a substance that is obtained from _____.

Do not write outside the box

0 6 . 7 Ethanol is used as a fuel.

Which of the following is another use of ethanol?

[1 mark]

Tick (✓) **one** box.

Bleach ☐

Dye ☐

Indicator ☐

Solvent ☐

0 6 . 8 The air trap in **Figure 7** stops microbes entering the apparatus.

Some microbes oxidise ethanol to produce a carboxylic acid.

Name the carboxylic acid produced by the oxidation of ethanol.

[1 mark]

_____

10

Turn over for the next question

Do not write outside the box

0 7 This question is about copper and copper compounds.

0 7 . 1 Give **one** use for copper.

[1 mark]

0 7 . 2 Copper can be extracted from low-grade copper ores by bioleaching.

Complete the sentence.

Choose the answer from the box.

[1 mark]

bacteria	**carbon**	**heat**	**plants**

During bioleaching, a leachate solution containing copper compounds is produced by _____.

Do not write outside the box

Iron displaces copper from copper sulfate solution.

0 7 . 3 Complete the equation for the displacement reaction by adding the state symbols of the products.

[2 marks]

$$Fe(s) + CuSO_4(aq) \longrightarrow FeSO_4(\_\_\_\_) + Cu(\_\_\_\_)$$

0 7 . 4 Copper ions are reduced when iron displaces copper.

Which is the correct half equation for the reduction of copper ions?

[1 mark]

Tick (✓) **one** box.

$Cu + 2e^- \longrightarrow Cu^{2+}$ ☐

$Cu \longrightarrow Cu^{2+} + 2e^-$ ☐

$Cu^{2+} + 2e^- \longrightarrow Cu$ ☐

$Cu^{2+} \longrightarrow Cu + 2e^-$ ☐

0 7 . 5 1 mole of iron produces 1 mole of copper.

Calculate the mass of copper produced by 12 moles of iron.

Relative atomic mass (A_r): Cu = 63.5

Use the equation:

mass = number of moles × relative atomic mass

[2 marks]

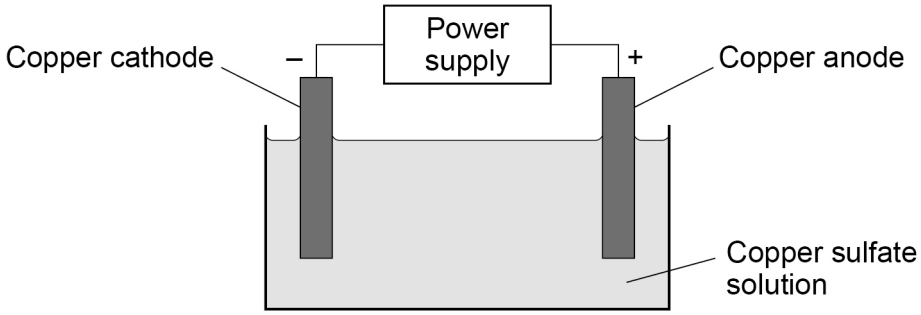
Mass of copper = _____ g

Do not write outside the box

A student did an electrolysis experiment.

Figure 8 shows the apparatus.

Figure 8



This is the method used:

1. Record the mass of the copper cathode.
2. Set up the apparatus shown in **Figure 8**.
3. Turn on the power supply for 5 minutes.
4. Remove and dry the copper cathode.
5. Record the mass of the copper cathode.

0 7 . 6 Give the name of the electrolyte used in this experiment.

[1 mark]

0 7 . 7 Why must the copper cathode be dried before recording the mass?

[1 mark]

Do not write outside the box

0 7 . 8 What happens to the mass of the copper cathode during the electrolysis experiment?

[1 mark]

Tick (✓) **one** box.

Mass decreases ☐

Mass stays the same ☐

Mass increases ☐

10

Turn over for the next question

Do not write outside the box

0 8 This question is about the halogens.

0 8 . 1 Which halogen has the highest boiling point?

Use the periodic table.

[1 mark]

Tick (✓) **one** box.

Bromine ☐

Chlorine ☐

Fluorine ☐

Iodine ☐

0 8 . 2 Give the total number of electrons and the number of outer shell electrons in a chlorine atom.

Use the periodic table.

[2 marks]

Total number of electrons in a chlorine atom = _____

Number of outer shell electrons in a chlorine atom = _____

0 8 . 3 Which halogen atoms gain electrons most easily?

Use the periodic table.

[1 mark]

Tick (✓) **one** box.

Bromine atoms ☐

Chlorine atoms ☐

Fluorine atoms ☐

Iodine atoms ☐

Do not write outside the box

Chlorine reacts with potassium to produce potassium chloride (KCl).

0 8 . 4 Potassium chloride contains potassium ions and chloride ions.

Give the symbols for the ions in potassium chloride.

[2 marks]

Potassium ion _____

Chloride ion _____

0 8 . 5 The equation for the reaction is:

$$2\,K + Cl_2 \longrightarrow 2\,KCl$$

What is the maximum number of moles of potassium chloride that could be produced from 0.5 moles of potassium and 0.2 moles of chlorine?

[1 mark]

Tick (✓) **one** box.

0.2 ☐

0.4 ☐

0.5 ☐

0.7 ☐

0 8 . 6 Potassium chloride is an ionic compound.

What is the appearance of pure potassium chloride at 25 °C?

[1 mark]

Tick (✓) **one** box.

Colourless liquid ☐

Colourless solid ☐

White liquid ☐

White solid ☐

Turn over ►

Do not write outside the box

Compound **R** is produced when a metal combines with a halogen.

Table 5 gives the results of two tests on a solution of compound **R**.

Table 5

	Method	Result
Test 1	Dip a wire loop into a solution of compound **R**. Hold the loop in the flame of a Bunsen burner.	Red flame colour
Test 2	Add a few drops of a solution to test for the halide ion in compound **R**.	Cream precipitate

0 8 . 7 A wire loop is used in **Test 1**.

The metal used to make the wire loop has the following properties:

- good conductor of heat
- easily bent into shape
- unreactive.

Suggest **one** other important property of the metal used to make the wire loop.

[1 mark]

0 8 . 8 **Test 1** identifies the metal in compound **R**.

What is the name of the metal?

[1 mark]

Tick (✓) **one** box.

Barium ☐

Calcium ☐

Potassium ☐

Sodium ☐

Do not write outside the box

0 8 . 9 Name the solution added to test for the halide ion in **Test 2**.

[1 mark]

0 8 . 1 0 **Test 2** identifies the halogen in compound **R**.

Name the halogen.

[1 mark]

12

Turn over for the next question

Do not write outside the box

There are no questions printed on this page

DO NOT WRITE ON THIS PAGE
ANSWER IN THE SPACES PROVIDED

Do not write outside the box

0 9 Heating a hydrated salt produces an anhydrous compound.

This is a reversible reaction.

0 9 . 1 Heating hydrated copper sulfate produces anhydrous copper sulfate.

Give the colour change when hydrated copper sulfate is heated.

[2 marks]

Colour change from _____ to _____

0 9 . 2 Heating hydrated sodium thiosulfate produces anhydrous sodium thiosulfate and one other compound.

Complete the word equation for this reaction.

Include the symbol for a reversible reaction.

[2 marks]

hydrated sodium thiosulfate _____ anhydrous sodium thiosulfate + _____

Question 9 continues on the next page

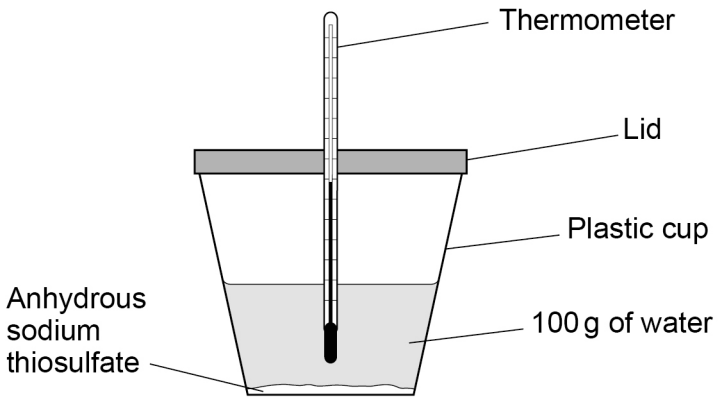
Do not write outside the box

A student did an experiment using anhydrous sodium thiosulfate.

The student dissolved 15.8 g of anhydrous sodium thiosulfate in 100 g of water.

Figure 9 shows the apparatus.

Figure 9



The student recorded:

- the temperature of the water before adding the anhydrous sodium thiosulfate
- the temperature of the solution when all the anhydrous sodium thiosulfate had disappeared.

Table 6 shows the results.

Table 6

Temperature of 100 grams of water before anhydrous sodium thiosulfate was added in °C	21.9
Temperature of the solution when all the anhydrous sodium thiosulfate had disappeared in °C	23.6

0 9 . 3 The student dissolved the anhydrous sodium thiosulfate as quickly as possible.

Describe **one** method the student could use to dissolve the anhydrous sodium thiosulfate quickly.

[1 mark]

Do not write outside the box

0 9 . 4 Suggest why a lid is put on the plastic cup in **Figure 9**.

[1 mark]

0 9 . 5 Which is the best description of the energy change when anhydrous sodium thiosulfate dissolves in water?

Use **Table 6**.

[1 mark]

Tick (✓) **one** box.

- Endothermic because energy is transferred from the surroundings ☐
- Endothermic because energy is transferred to the surroundings ☐
- Exothermic because energy is transferred from the surroundings ☐
- Exothermic because energy is transferred to the surroundings ☐

0 9 . 6 Calculate the energy change when 15.8 g of anhydrous sodium thiosulfate dissolves in 100 g of water.

Use **Table 6** and the equation:

energy change (J) = mass of water (g) × 4.2 (J/g °C) × temperature change (°C)

[3 marks]

Energy change = _____ J

10

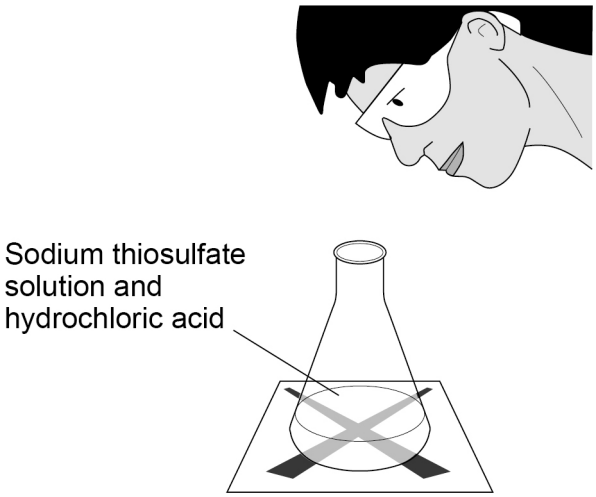
Do not write outside the box

1 0 A student investigates the reaction between sodium thiosulfate solution and hydrochloric acid.

When hydrochloric acid is added to sodium thiosulfate solution at room temperature, the mixture slowly becomes cloudy.

Figure 10 shows how the student can judge when the mixture becomes cloudy.

Figure 10



1 0 . 1 The equation for the reaction is:

$$Na_2S_2O_3(aq) + 2\,HCl(aq) \longrightarrow 2\,NaCl(aq) + H_2O(l) + SO_2(g) + S(s)$$

Explain why the mixture becomes cloudy.

[2 marks]

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1 0 . 2 The student investigates how temperature affects the time taken for a mixture of hydrochloric acid and sodium thiosulfate to become cloudy.

Describe a method for the investigation.

[6 marks]

8

END OF QUESTIONS

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