

Monday 22 May 2023 – Morning

GCSE (9–1) Combined Science (Chemistry) A (Gateway Science)

J250/03 Paper 3 (Foundation Tier)

Time allowed: 1 hour 10 minutes



You must have:

- a ruler (cm/mm)
- the Data Sheet for GCSE (9–1) Combined Science (Chemistry) A (inside this document)

You can use:

- a scientific or graphical calculator
- an HB pencil



Please write clearly in black ink. **Do not write in the barcodes.**

Centre number

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Candidate number

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First name(s) _____

Last name _____

INSTRUCTIONS

- Use black ink. You can use an HB pencil, but only for graphs and diagrams.
- Write your answer to each question in the space provided. If you need extra space use the lined pages at the end of this booklet. The question numbers must be clearly shown.
- Answer **all** the questions.
- Where appropriate, your answer should be supported with working. Marks might be given for using a correct method, even if your answer is wrong.

INFORMATION

- The total mark for this paper is **60**.
- The marks for each question are shown in brackets [].
- Quality of extended response will be assessed in questions marked with an asterisk (*).
- This document has **20** pages.

ADVICE

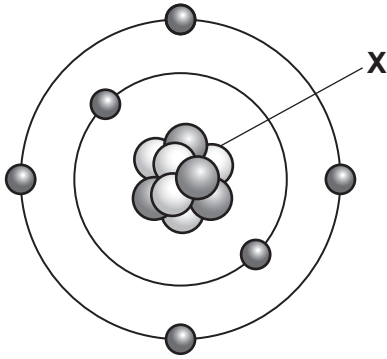
- Read each question carefully before you start your answer.

2
Section A

You should spend a **maximum of 20 minutes** on this section.

Write your answer to each question in the box provided.

1 What is the part of the atom labelled **X** called?



- A** Core
- B** Ion
- C** Nucleus
- D** Shell

Your answer

[1]

2 The table shows the properties of four different substances.

Which substance is a metal?

Substance	Appearance at room temperature	Melting point and boiling point	Conducts heat?
A	green gas	low	no
B	colourless solid	high	no
C	shiny red-orange solid	high	yes
D	white solid	high	no

Your answer

[1]

3 Which is an example of a **neutralisation** reaction?

- A A metal reacting with an acid
- B A non-metal reacting with oxygen
- C A salt dissolving in water
- D An acid reacting with an alkali

Your answer

[1]

4 Lead has a melting point of 328°C . Mercury has a melting point of -39°C .

Which row describes the state of lead and mercury at 100°C ?

	State of lead	State of mercury
A	liquid	liquid
B	liquid	solid
C	solid	liquid
D	solid	solid

Your answer

[1]

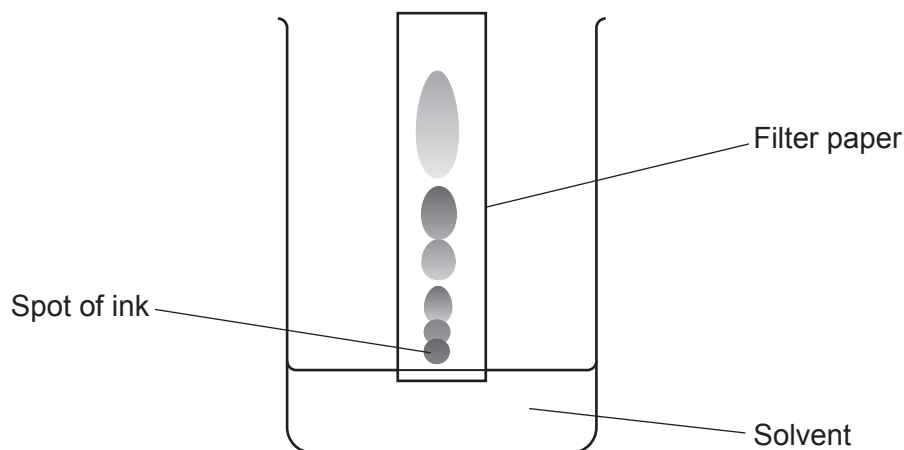
5 Which element forms compounds with covalent molecules consisting of chains and rings?

- A Argon
- B Carbon
- C Hydrogen
- D Oxygen

Your answer

[1]

- 6 The diagram shows how paper chromatography can be used to separate the colours in an ink.



What is the **solvent** called?

- A The baseline
- B The mobile phase
- C The reference phase
- D The stationary phase

Your answer

[1]

- 7 The **law of conservation of mass** states that the total mass stays the same during a chemical reaction.

Which is an explanation for the law of conservation of mass?

- A All the atoms in a chemical reaction are the same size.
- B All the atoms in a chemical reaction have the same mass.
- C No atoms are created or destroyed during a chemical reaction.
- D The atoms of each reactant and product have the same mass.

Your answer

[1]

- 8 Sodium sulfite contains Na^+ ions and SO_3^{2-} ions.

What is the **formula** of sodium sulfite?

- A NaSO_3
- B $\text{Na}(\text{SO}_3)_2$
- C Na_2SO_3
- D $\text{Na}_2(\text{SO}_3)_2$

Your answer

[1]

- 9 Which substance is described as **pure** by a scientist?

- A A solution of sodium chloride
- B An alloy
- C Dilute sulfuric acid
- D Distilled water

Your answer

[1]

- 10 A metal oxide has the formula X_2O , where **X** is a Group 1 metal.

The relative formula mass of the metal oxide is 94.2.

Relative atomic mass (A_r): O = 16.0

What is the name of **X**?

- A Lithium
- B Potassium
- C Rubidium
- D Sodium

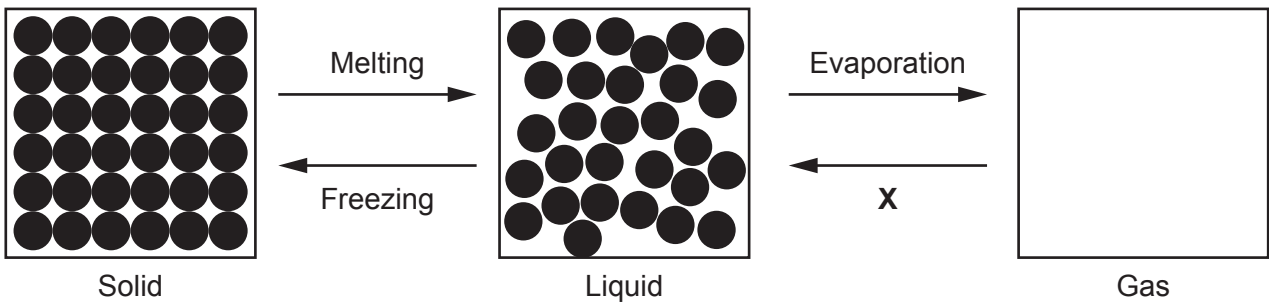
Your answer

[1]

6
Section B

11 (a) Fig. 11.1 shows the particle model for an element.

Fig. 11.1



(i) Complete Fig. 11.1 by drawing in the particles of the element when it is a gas. [1]

(ii) Describe how the particles of the element move in a solid.

..... [1]

(iii) Name the change of state labelled X on Fig. 11.1.

..... [1]

(b) The table shows the state of the element chlorine at three different temperatures.

State of chlorine	Temperature (°C)
solid	-165
liquid	-90
gas	-20

Use the information in the table to estimate the melting point of chlorine.

Tick (✓) **one** box.

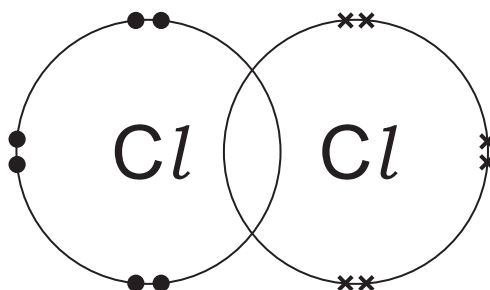
- 170 °C
- 101 °C
- 43 °C
- 2 °C

[1]

(c) A particle of chlorine has the formula Cl_2 .

Fig. 11.2 shows some of the outer electrons in a particle of chlorine.

Fig. 11.2



(i) Complete Fig. 11.2 by drawing in the missing outer electrons.

[1]

(ii) Complete the sentences about the bonding in a particle of chlorine.

Put a ring around each correct option.

The particles of chlorine are called **isotopes** / **molecules** / **polymers**.

The atoms of chlorine are joined together by a **covalent** / **ionic** / **metallic** bond.

[2]

(d) Which test is used to identify chlorine?

Tick (✓) **one** box.

It goes 'pop' when lit.

It relights a glowing splint.

It turns limewater cloudy white.

It turns damp litmus paper white.

[1]

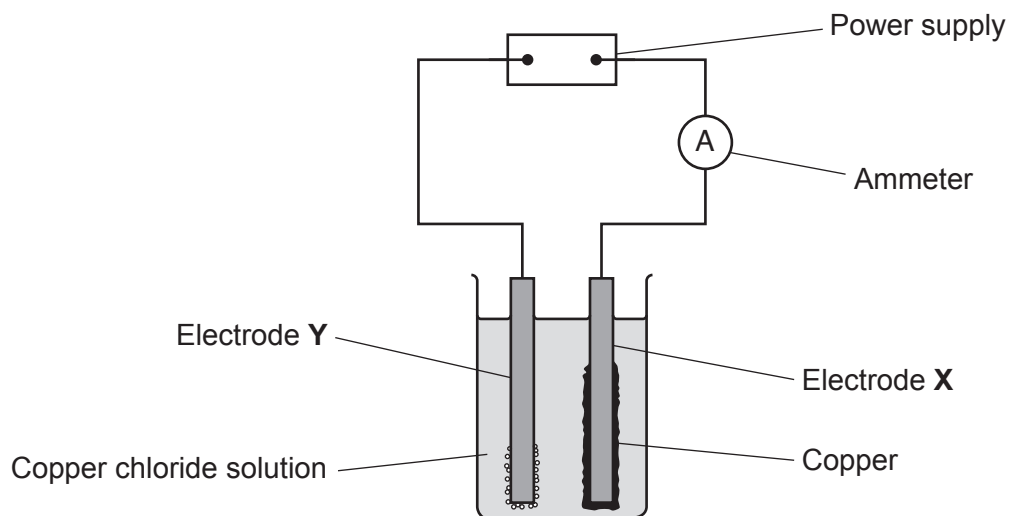
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12 Copper can be produced from copper chloride solution by electrolysis.

A student investigates how changing the current used changes the mass of copper produced.

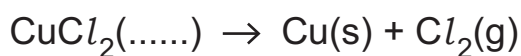
The diagram shows the apparatus the student uses.



The table shows the student's results.

Current (A)	Mass of copper produced (g)
1	0.03
2	0.06
3	0.19
4	0.12
5	0.15

(a) The equation for the reaction is



Complete the balanced symbol equation for the reaction by writing in the missing **state symbol** for copper chloride solution. [1]

(b) The student thinks that the experiment shows that electrode **X** is the cathode.

Explain why the student is **correct**. Use the diagram.

.....

.....

..... [2]

- (c) Use the data in the table to show that the mass of copper produced doubles as the current doubles.

.....

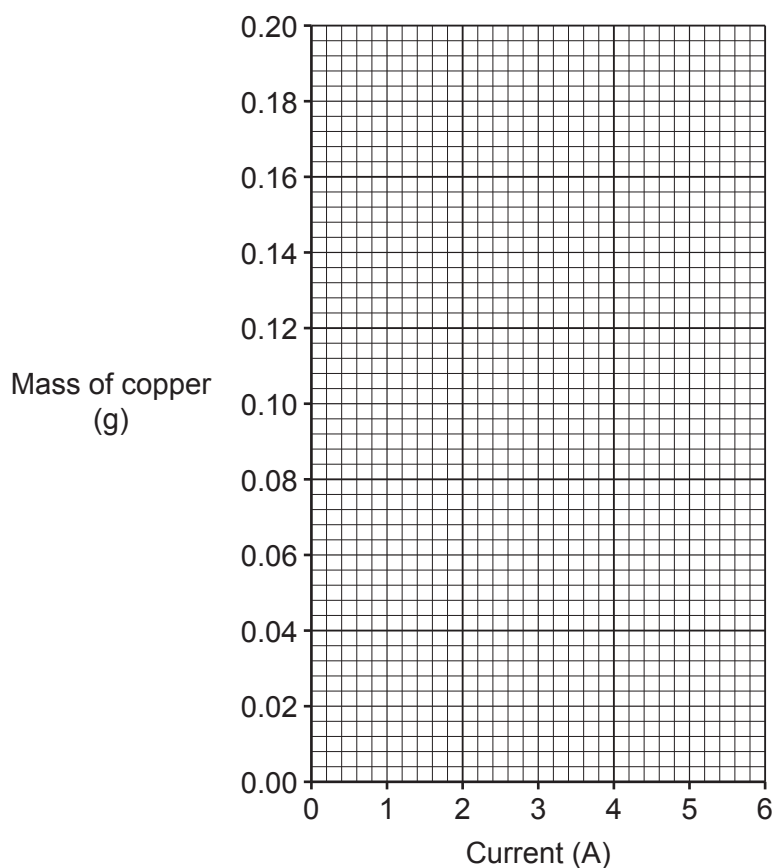
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.....

..... [2]

- (d) (i) Plot a graph of the results on the grid. [2]

- (ii) Draw a line of best fit. [1]



- (iii) The student thinks that the result for the mass of copper produced at 3A is **incorrect**.

Explain how the student knows this result is **incorrect**.

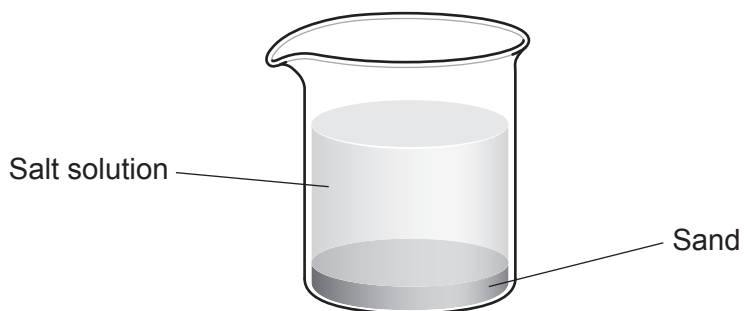
.....

..... [1]

- (iv) Use your graph to predict the mass of copper that should have been produced at 3A.

Mass of copper produced = g [1]

13* A student has a mixture of sand and a salt solution.



They do a **two stage** experiment to obtain a sample of pure salt from the mixture.

Describe the two stages of the student's experiment.

Include labelled diagrams of how the equipment is set up in each stage.

.....

.....

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[6]

13
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14 Zinc, Zn, reacts with sulfuric acid, H_2SO_4 , to form the salt, ZnSO_4 , and hydrogen.

(a) Write the **balanced symbol** equation for the reaction of zinc with sulfuric acid.

..... [1]

(b) Name the salt, ZnSO_4 , made from zinc and sulfuric acid.

..... [1]

(c) To make sure **all** the sulfuric acid reacts, an excess of zinc is used.

Describe how universal indicator could be used to show that **all** the sulfuric acid has reacted.

.....

 [2]

(d) (i) Calculate the relative formula mass of ZnSO_4 .

Relative atomic mass (A_r): O = 16.0 S = 32.1 Zn = 65.4

Relative formula mass of ZnSO_4 = [1]

(ii) The percentage mass of an element in a compound can be calculated using the formula

$$\text{percentage mass of an element} = \frac{\text{total relative atomic mass of the element}}{\text{relative formula mass of the compound}} \times 100$$

Calculate the percentage mass of zinc in ZnSO_4 .

Give your answer to 1 decimal place.

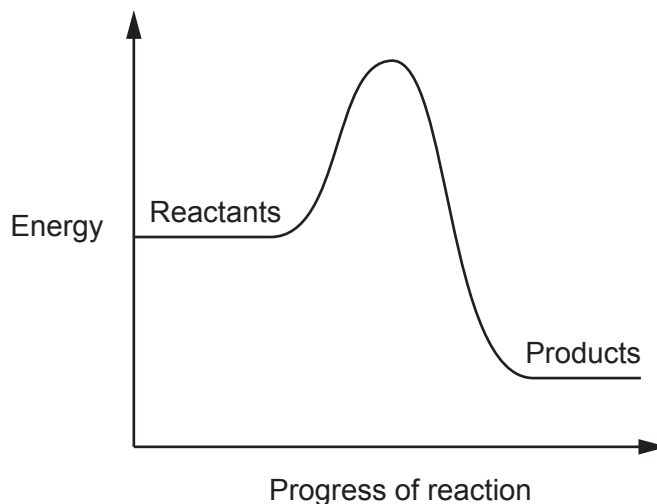
Percentage mass of zinc = % [3]

(e) The reaction between zinc and sulfuric acid is **exothermic**.

(i) Explain what is meant by an **exothermic** reaction.

.....
 [1]

(ii) The diagram shows the reaction profile for the reaction.



Label the activation energy on the diagram. [1]

(iii) Explain the term activation energy.

.....
 [1]

(f) The table shows the temperature changes in four reactions.

The reaction between zinc and sulfuric acid is **slightly** exothermic.

Which shows the reaction between zinc and dilute sulfuric acid?

Give a reason for your answer.

Reaction	Start temperature (°C)	End temperature (°C)
A	20	19
B	20	64
C	20	22
D	20	20

Reaction

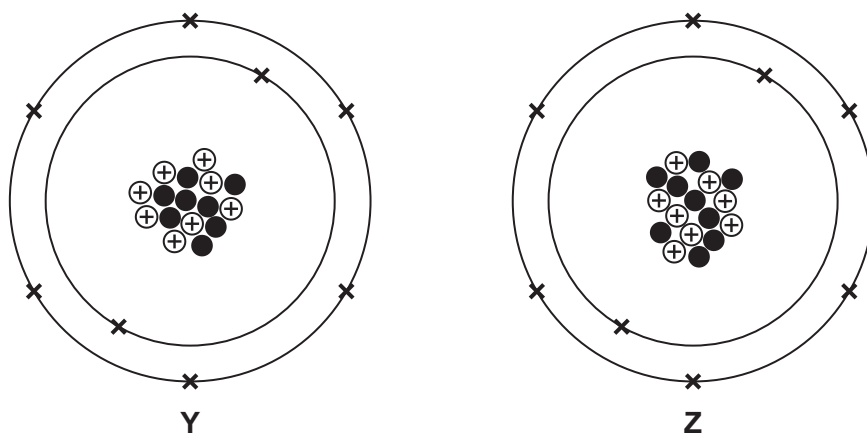
Reason

..... [3]

15 Atoms of the same element can have different structures.

Fig. 15.1 shows the structure of two different atoms, **Y** and **Z**, of the same element.

Fig. 15.1



(a) What name is given to different atoms of the same element such as **Y** and **Z**?

..... [1]

(b) Write the number of protons, neutrons and electrons in an atom of **Z**.

Number of protons =

Number of neutrons =

Number of electrons = [2]

(c) Write the **mass number** of an atom of **Z**.

Mass number of an atom of **Z** = [1]

(d) Write the name of the element that contains atoms of **Y** and **Z**.

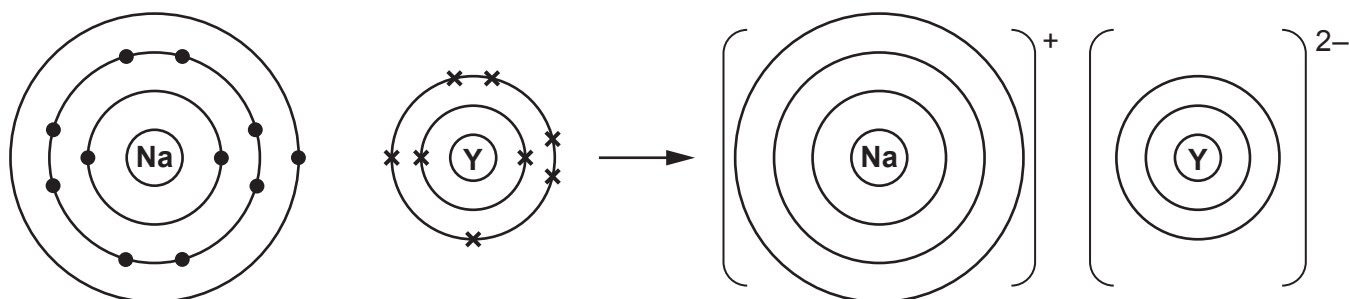
Use the Periodic Table.

..... [1]

(e) Atoms of sodium react with atoms of **Y** to form an ionic compound.

Fig. 15.2 shows the ions formed when an atom of sodium reacts with an atom of **Y**.

Fig. 15.2



(i) Complete **Fig. 15.2** to show the arrangement of electrons in the ions. [2]

(ii) What is the formula of the ionic compound formed when atoms of sodium react with atoms of **Y**?

Tick (✓) **one** box.

NaY₂

Na₂Y

Na₂Y₂

[1]

(iii) Why does sodium react with **Y** and **Z** in a similar way?

Tick (✓) **one** box.

Atoms of **Y** and **Z** have the same number of electrons.

Atoms of **Y** and **Z** have the same number of neutrons.

Atoms of **Y** and **Z** have the same number of protons.

[1]

(iv) The ionic compound formed in **Fig. 15.2** has a high melting point.

Explain why. Use ideas about structure and bonding.

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..... [3]

END OF QUESTION PAPER

ADDITIONAL ANSWER SPACE

If additional space is required, you should use the following lined page(s). The question number(s) must be clearly shown in the margin(s).

A large area of lined paper for writing answers. It features a vertical margin line on the left side and horizontal dotted lines for writing. The lines are evenly spaced and extend across the width of the page.

A large area of the page is reserved for writing, featuring a vertical solid line on the left side and horizontal dotted lines extending across the page.

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