OCR
Oxford Cambridge and RSA

Friday 17 May 2024 – Morning

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

J250/09 Chemistry (Higher Tier)

Time allowed: 1 hour 10 minutes

H

You must have:
- a ruler (cm/mm)
- the Data Sheet for GCSE (9–1) Combined Science A (Chemistry) (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 | | | | | | Candidate number | | | | |

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.

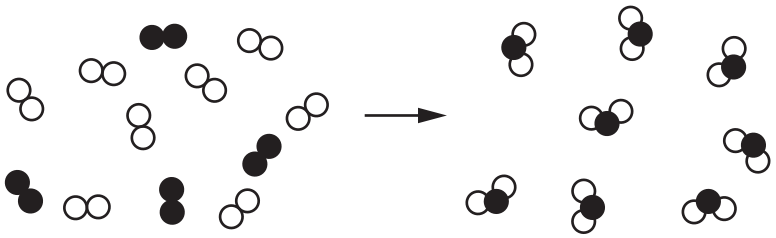
ADVICE
- Read each question carefully before you start your answer.

Section A

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

Write your answer to each question in the box provided.

1 The diagram represents the particle model for a change in the arrangement of some particles.



Which row describes this change?

	Type of change	Explanation
A	chemical	The particles break up and then join together in a different way.
B	chemical	The particles stay the same but are arranged in a different way.
C	physical	The particles break up and then join together in a different way.
D	physical	The particles stay the same but are arranged in a different way.

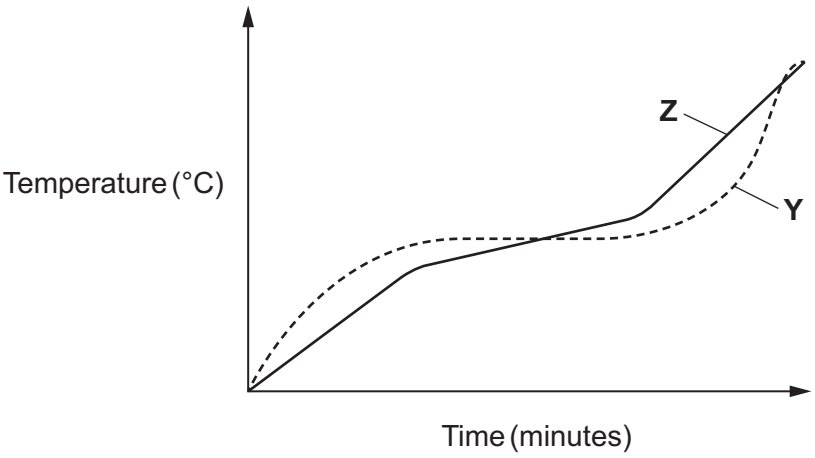
Your answer ☐ **[1]**

2 Which element in the table is a **non-metal**?

	Appearance at room temperature	Melting point (°C)	Electrical conductivity
A	silver liquid	–39	high
B	orange-red solid	1083	high
C	yellow solid	113	low
D	silvery-white	3422	high

Your answer ☐ **[1]**

3 The graph shows how the temperature of two samples of a substance, **Y** and **Z**, changes as they melt from solids to liquids.



Which row describes **Y** and **Z**?

	Y	Z
A	impure	impure
B	impure	pure
C	pure	impure
D	pure	pure

Your answer ☐ **[1]**

4 This is the equation for the reaction between copper carbonate and dilute hydrochloric acid:

$CuCO_3(s) + 2HCl(aq) \longrightarrow CuCl_2(\ldots) + CO_2(g) + H_2O(l)$

What is the state symbol for $CuCl_2$?

A aq

B g

C l

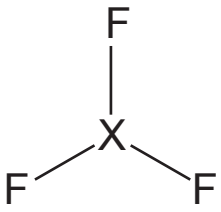
D s

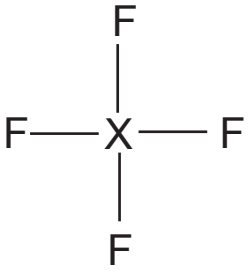
Your answer ☐ **[1]**

5 In which molecule is **X** an atom of carbon?

A 

B 

C 

D 

Your answer ☐ **[1]**

6 Boron, B, is in Group 3 of the Periodic Table and chlorine, C*l*, is in Group 7 of the Periodic Table.

What is the formula of the compound formed when boron reacts with chlorine?

A BC*l*

B BCl_3

C B_3Cl

D B_3Cl_7

Your answer ☐ **[1]**

7 The equation shows the reaction of zinc carbonate when it is heated.

$ZnCO_3(s) \longrightarrow ZnO(s) + CO_2(g)$

- 5.0 g of zinc carbonate is heated in a test tube for 10 minutes.
- The mass of the test tube decreases by 0.6 g.

How does the law of conservation of mass explain this decrease in mass?

A 0.6 g of carbon dioxide is produced.

B 0.6 g of zinc oxide is produced.

C 4.4 g of carbon dioxide is produced.

D 5.6 g of zinc oxide is produced.

Your answer ☐ **[1]**

8 Which statement describes the **mole**?

A The mole is defined relative to carbon-14.

B The mole is the unit for the amount of a substance.

C The number of particles in one mole of a substance depends on the substance.

D One mole contains 1.67×10^{-27} particles.

Your answer ☐ **[1]**

9 Magnesium reacts very slowly with oxygen at room temperature.

When magnesium is heated in a Bunsen burner flame it burns very brightly after only a few seconds.

Which statement is correct?

A The activation energy for the reaction is high.

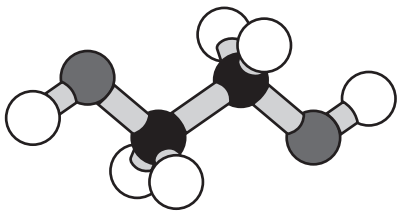
B The reaction is endothermic.

C Magnesium is an unreactive metal.

D Magnesium only reacts at very high temperatures.

Your answer ☐ **[1]**

10 What is the empirical formula of this compound?



Key:
● = Carbon
○ = Hydrogen
● = Oxygen

A CHO

B CH_3O

C $C_2H_6O_2$

D $HOCH_2CH_2OH$

Your answer ☐ **[1]**

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Section B

11 Lithium reacts with oxygen to form lithium oxide.

The symbols for lithium and oxygen on the Periodic Table are:

3
Li
6.9

8
O
16.0

(a) Explain how the positions of lithium and oxygen in the Periodic Table are used to decide that lithium is a metal and oxygen is a non-metal.

Use the Periodic Table on the Data Sheet.

.....

..... **[1]**

(b) Lithium reacts with oxygen to make lithium oxide.

Complete the **balanced symbol** equation for the reaction.

$$.....Li + O_2 \rightarrow .....Li_2O$$

[2]

(c) Write the electron arrangement for an atom of lithium.

..... **[1]**

(d) When an atom of lithium reacts with oxygen it forms a lithium ion, Li^+.

Describe how an atom of lithium forms a lithium ion.

.....

..... **[2]**

(e) A student thinks that sodium reacts in a similar way to lithium.

Explain why they are **correct**.

Use the Periodic Table on the Data Sheet.

.....

..... **[1]**

(f) Lithium can exist as two isotopes.

3 **Li** 6	3 **Li** 7

Explain what **isotope** means.

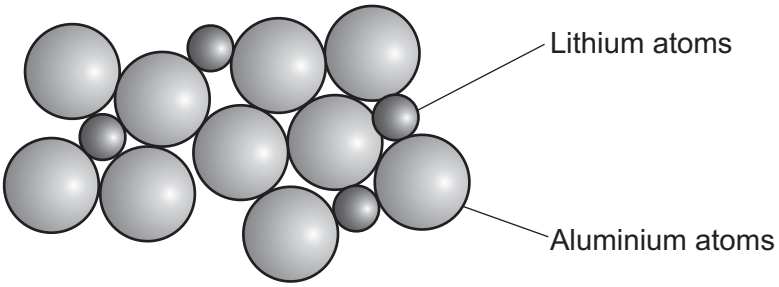
.....

.....

..... **[2]**

(g) Lithium can be added to aluminium to make an alloy. One alloy contains 2% lithium.

A student draws a diagram of the alloy.



(i) Calculate the percentage of lithium atoms in the alloy drawn by the student.

Percentage of lithium atoms in the alloy = ... % **[2]**

(ii) Suggest a reason why the student's diagram is **incorrect**.

.....

..... **[1]**

12 Potassium bromide is an ionic compound. It contains potassium ions, K^+, and bromide ions, Br^-.

For electrolysis to happen, an electric current must be passed through **molten** potassium bromide.

(a) Describe what happens when solid potassium bromide is heated up until it melts into a liquid.

Use ideas about the particle model.

.....

.....

.....

.....

.....

..... **[3]**

(b) Explain why potassium bromide must be **molten** for electrolysis to happen.

.....

..... **[1]**

(c) State the product made at the **cathode** and write the half equation for the reaction.

Product .....

Half equation .....

[2]

(d) The electrolysis is repeated with a **solution** of potassium bromide.

A student thinks that the **same** product will be formed at the cathode.

Explain why the student is **incorrect**.

Name of the different product formed .....

Reason .....

.....

[2]

13* A student has samples of three solids labelled **A**, **B** and **C**.

They think:
- **A** is calcium carbonate
- **B** is sodium carbonate
- **C** is sodium chloride.

They know the following information.

Solid	Solubility in water	Reaction with dilute hydrochloric acid
Calcium carbonate	insoluble	reacts to produce carbon dioxide
Sodium carbonate	soluble	reacts to produce carbon dioxide
Sodium chloride	soluble	no reaction

Describe simple test tube experiments the student could do using water **and** dilute hydrochloric acid to show the solids have been labelled correctly.

Describe any observations that the student would see in these experiments **and** how they help show the labels are correct.

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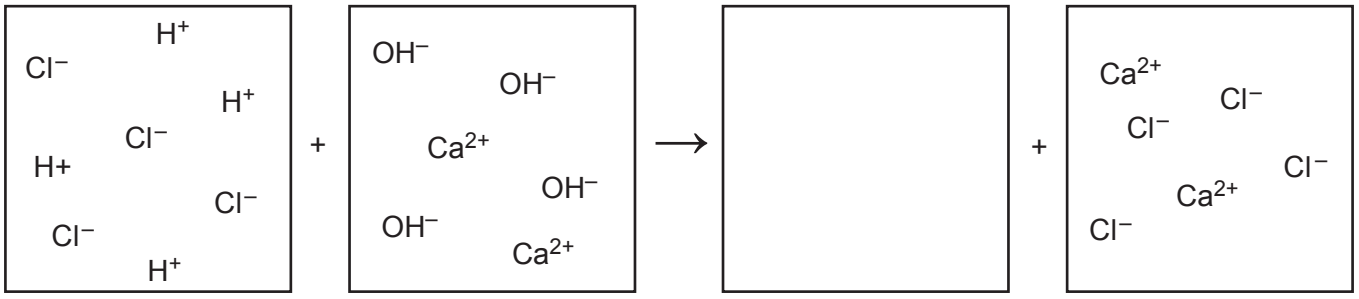
..... **[6]**

14 The diagram shows a reaction between two solutions **P** and **Q**.



P **Q** **R** **S**

(a) Write the formula of the molecules in the box for **R** to show a **balanced** reaction. **[2]**

(b) Write the name and the formula of the compound in solution **S**.

Name .....

Formula .....

[2]

(c) Name the type of reaction which happens between solutions **P** and **Q**.

..... **[1]**

(d) Which of the solutions in the diagram shows a strong acid?

Tick (✓) **one** box.

P ☐

Q ☐

S ☐

Give **two** reasons for your answer.

1 .....

.....

2 .....

.....

[3]

(e) A student dissolves 2 g of a strong acid in 250 cm^3 of water.

Calculate the concentration of the solution formed in **g / dm^3**.

Concentration of the solution = ... g / dm^3 **[3]**

15 Copper can be made by reacting copper oxide, CuO, with carbon, C.

$2CuO + C \longrightarrow 2Cu + CO_2$

When 2.00 g of copper oxide reacts with 1.00 g of carbon, copper oxide is the limiting reactant.

(a) Explain the effect of a limiting reactant on a reaction.

.....

..... **[1]**

(b) Calculate the number of moles in 2.00 g of copper oxide and 1.00 g of carbon.

Give your answers to **3** decimal places.

Relative atomic mass (A_r): C = 12.0 O = 16.0 Cu = 63.5

Number of moles in 2.00 g of copper oxide = ... mol

Number of moles in 1.00 g of carbon = ... mol

[3]

(c) Use your answers in part **(b)** to explain why copper oxide is the limiting reactant.

.....

.....

..... **[1]**

(d) The number of moles in a different mass of copper oxide is 0.045.

$2CuO + C \longrightarrow 2Cu + CO_2$

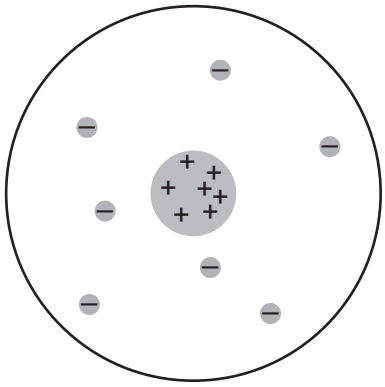
Calculate the maximum mass of copper, Cu, that can be made from 0.045 moles of copper oxide.

Give your answer to **2** significant figures.

Relative atomic mass (A_r): Cu = 63.5

Maximum mass of copper = ... g **[3]**

16 The diagram shows the model of the atom developed by Rutherford.



(a) The model developed by Rutherford was based on the results of an experiment performed whilst working with Geiger and Marsden.

They fired positively charged alpha particles at very thin gold foil.

State **two** observations made in the experiment and the conclusion Rutherford reached.

Observation 1 .....

.....

Observation 2 .....

.....

Conclusion .....

.....

[3]

(b) Describe how Bohr improved Rutherford's model of the atom.

.....

..... **[1]**

(c) What is the typical atomic radius size of an atom in metres?

Give your answer in **standard form**.

..... m **[1]**

END OF QUESTION PAPER

EXTRA ANSWER SPACE

If you need extra space use these lined pages. You must write the question numbers clearly in the margin.