OCR
Oxford Cambridge and RSA

Monday 22 May 2023 – Morning

GCSE (9−1) Chemistry B (Twenty First Century Science)

J258/01 Breadth in Chemistry (Foundation Tier)

Time allowed: 1 hour 45 minutes

You must have:
- a ruler (cm/mm)
- the Data Sheet for GCSE (9–1) Chemistry B (inside this document)

You can use:
- an HB pencil
- a scientific or graphical calculator

F

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 **90**.
- The marks for each question are shown in brackets **[ ]**.
- This document has **24** pages.

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

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1 The increase in global population means there is a greater need for drinking water.

(a) What is the correct term for drinking water?

Tick (✓) **one** box.

Ground water ☐

Potable water ☐

Sea water ☐

Waste water ☐

[1]

(b) One source of drinking water is salt water.

Describe a process that separates water from salt water.

.....

.....

.....

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

(c) Chlorine is added to drinking water.

(i) Why is chlorine added?

.....

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

(ii) Suggest **one** disadvantage of adding chlorine to drinking water.

.....

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

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(iii) Chlorine and other gases can be identified by simple tests.

Draw lines to connect each gas with its correct test.

Chlorine	It gives a ‘pop’ with a lighted splint.
Oxygen	It relights a glowing splint.
Carbon dioxide	It turns blue litmus paper red then bleaches it.
	It turns limewater milky.

[3]

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2 Alex tests some mineral water for calcium ions and chloride ions.

(a) The label on a bottle of mineral water states that 1000 cm^3 of the mineral water contains 40.5 mg of calcium.

Calculate the mass of calcium in 500 cm^3 of the mineral water.

1 g = 1000 mg

Give your answer in **grams**.

Mass of calcium = ... g **[3]**

(b) Alex heats 500 cm^3 of the mineral water to make it more concentrated.

Draw a labelled diagram of the apparatus that Alex uses.

[2]

(c) Alex tests for calcium ions by adding sodium hydroxide solution to the more concentrated mineral water.

Complete the word equation for the reaction.

$CaCl_2(aq)$ + $2NaOH(aq)$ → $Ca(OH)_2(s)$ + $2NaCl(aq)$

calcium chloride sodium hydroxide ..... sodium chloride

[1]

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(d) Alex tests the more concentrated mineral water for chloride ions. A white precipitate is seen.

Complete the word equation for the test.

calcium chloride + ... nitrate → .... + calcium .....
white precipitate

[2]

(e) An industrial laboratory tests for calcium using emission spectroscopy.

Describe the advantages of emission spectroscopy compared with a flame test.

.....

.....

.....

.....

.....

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

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3 Steel is made from iron. Some products made from steel contain recycled iron.

(a) Complete the sentence to explain why recycling iron is better than making more iron from iron ore.

Use words from the list.

air	**bacteria**	**energy**	**mining**	**transport**

Recycling uses less ..... and avoids use of ..... .

[2]

(b) One type of iron ore contains an oxide of iron, Fe_3O_4.

232 g of Fe_3O_4 contain 168 g of iron.

Calculate the percentage of iron, by mass, in Fe_3O_4.

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

Percentage of iron = ... % **[3]**

(c) A problem with products made from iron is that they rust.

Which **two** statements about rusting are correct?

Tick (✓) **two** boxes.

Rusting can be prevented by using a physical barrier. ☐

Rusting is a form of corrosion. ☐

Rusting is a reduction reaction. ☐

Rusting is caused by oxygen alone. ☐

[2]

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(d) Iron is a transition metal.

Which **two** statements about iron are correct?

Tick (✓) **two** boxes.

Iron forms coloured compounds. ☐

Iron forms ions with more than one charge. ☐

Iron has a low density. ☐

Iron has a low melting point. ☐

[2]

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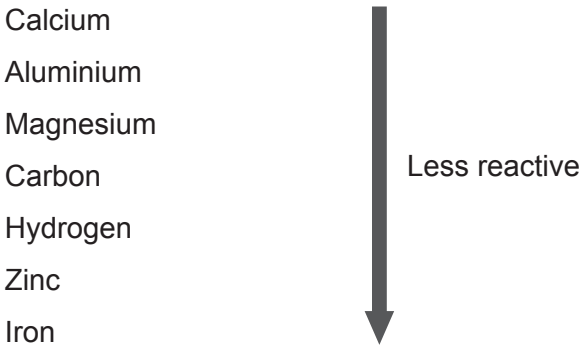
4 The reactivity series for some common elements is shown:



(a) Zinc can be extracted by reacting zinc oxide with carbon.
Aluminium **cannot** be extracted by reacting aluminium oxide with carbon.

Explain why these statements are correct.

Use the reactivity series.

.....

.....

.....

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

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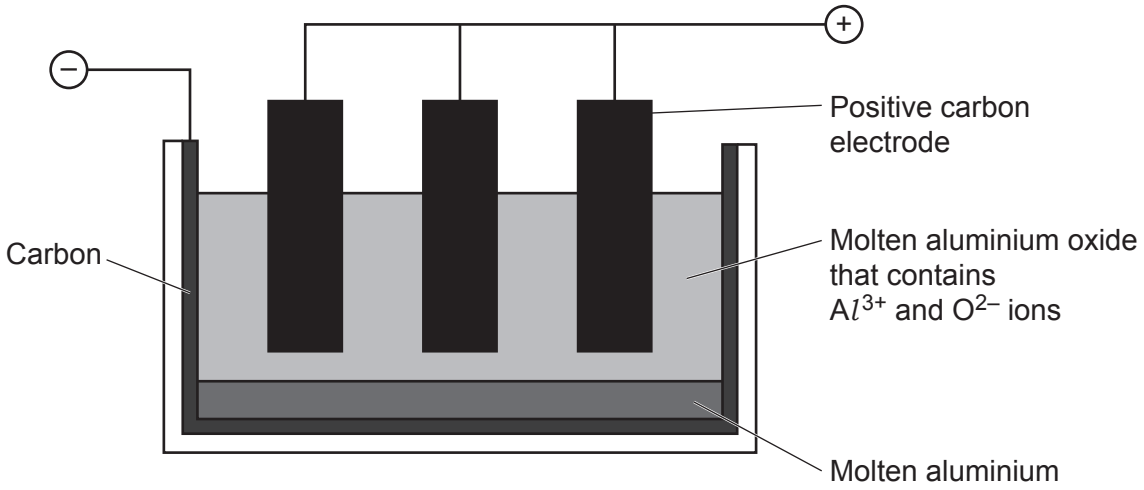
(b) The diagram shows how aluminium is made by the electrolysis of molten aluminium oxide.



(i) Which **two** statements about the electrolysis of aluminium oxide are correct?

Tick (✓) **two** boxes.

Al^{3+} ions move to the positive electrode. ☐

Oxygen is also formed. ☐

The aluminium oxide is molten so that the ions can move. ☐

The negative electrode is made of steel. ☐

[2]

(ii) Complete the sentence to explain how the aluminium is formed.

Use words from the list.

atoms	**ions**	**gain**	**lose**	**molecules**	**share**

Al^{3+} ions ..... electrons to form aluminium ..... .

[2]

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(c) (i) Why does the process of making aluminium by the electrolysis of molten aluminium oxide use a lot of energy?

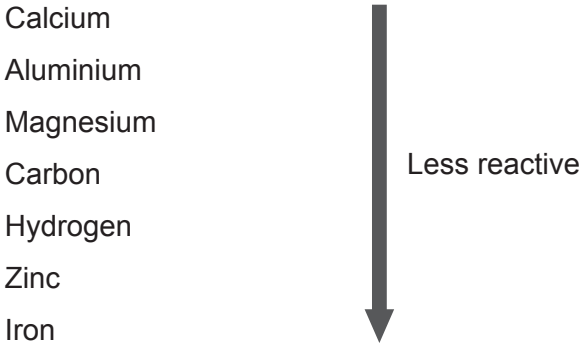
.....

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

(ii) A student states that aluminium can be extracted by the electrolysis of aluminium sulfate solution.

Explain why the student is **wrong**.

Use the reactivity series:



.....

.....

.....

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

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5 **Table 5.1** shows information about some elements and oxides from Period 3.

Table 5.1

Name	Formula	Melting point	Does it conduct electricity when molten?	Does it conduct electricity when solid?	Structure
Magnesium oxide	MgO	high	yes	.....	.....
Magnesium	Mg	high	yes	.....	.....
Silicon dioxide	SiO_2	.....	.....	no	giant covalent

(a) Complete **Table 5.1**. **[4]**

(b) Chlorine is a simple covalent molecule with a low melting point.

Which statements about chlorine and silicon dioxide are **true**, and which are **false**?

Tick (✓) **one** box in each row.

	True	False
Chlorine and silicon dioxide have atoms joined by shared pairs of electrons.		
The forces between chlorine molecules are strong.		
The bonds between silicon atoms and oxygen atoms are strong.		

[2]

(c) Both magnesium oxide and magnesium conduct electricity when molten.

Complete **Table 5.2** to show the particles that conduct electricity.

Use words from the list.

atoms	**electrons**	**ions**	**molecules**

Table 5.2

	Particles that conduct electricity
Magnesium oxide	.....
Magnesium	.....

[2]

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6 Carbon dioxide and methane are both greenhouse gases.

(a) The statements describe the greenhouse effect.

Write the numbers **2, 3, 4** to show the correct order of the greenhouse effect.

One has already been done for you.

Greenhouse gases absorb infrared radiation.	
Greenhouse gases emit infrared radiation in all directions.	
The Earth emits infrared radiation.	
Radiation from the Sun is absorbed by the Earth.	**1**

[1]

(b) Which statements about the greenhouse effect are **true**, and which are **false**?

Tick (✓) **one** box in each row.

	True	**False**
The proportion of greenhouse gases in the atmosphere has increased over the last 200 years.		
The greenhouse effect is only caused by carbon dioxide and methane.		
The Earth would be too hot to support life without the greenhouse effect.		
Most scientists think that recent climate change can be explained by increased greenhouse gas emissions.		

[3]

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7 Two polluting gases produced by petrol engines are carbon monoxide, CO, and nitrogen monoxide, NO.

(a) Describe how nitrogen oxide is produced in a petrol engine.

.....

.....

.....

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

(b) Nitrogen monoxide and carbon monoxide react together in a catalytic converter.

The equation for the reaction that happens is

$2NO + 2CO \longrightarrow N_2 + 2CO_2$

(i) State the product formed by oxidation.

Explain your answer.

.....

.....

.....

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

(ii) Riley says that the catalytic converter removes all gases which can harm the environment.

Explain why Riley is **wrong**.

.....

.....

.....

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

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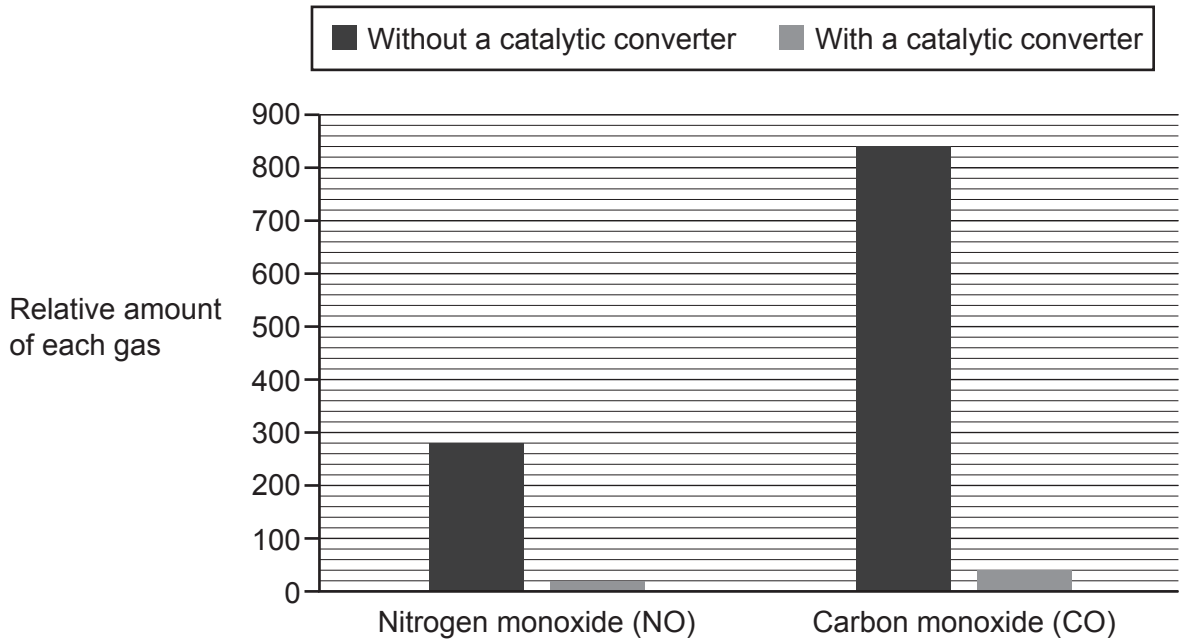
(c) The bar chart shows the relative amounts of the two polluting gases produced by a petrol engine without and with a catalytic converter.



(i) Give **three** conclusions you can make from the bar chart.

1. .....

.....

2. .....

.....

3. .....

.....

[3]

(ii) Calculate the value of the ratio:

$$\frac{\text{CO produced by a car without a catalytic converter}}{\text{NO produced by a car without a catalytic converter}}$$

.....

Ratio = ——————— **[2]**

.....

(d) Molecules of another oxide of nitrogen contain two nitrogen atoms and one oxygen atom.

Write the formula of this oxide of nitrogen.

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

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8 The Contact Process is used to produce sulfuric acid.

In the process, sulfur dioxide, SO_2, reacts with oxygen to make sulfur trioxide, SO_3:

..... + ... $\rightleftharpoons$ .....

(a) Complete the **balanced symbol** equation for this reaction. **[2]**

(b) The symbol $\rightleftharpoons$ indicates that the reaction is reversible and can reach equilibrium.

Which **two** statements are correct when the reaction reaches equilibrium?

Tick (✓) **two** boxes.

Rate of forward reaction = rate of reverse reaction ☐

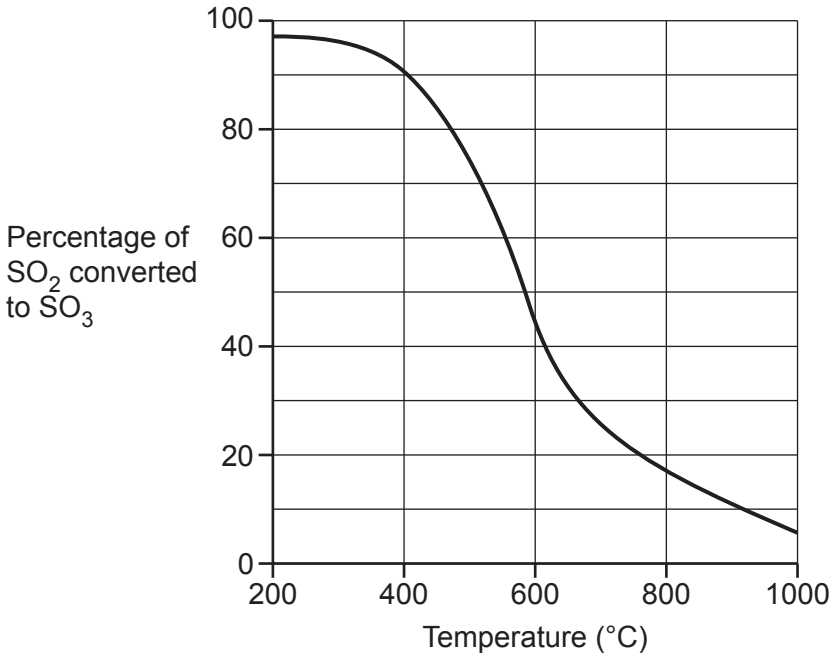
The reaction stops when equilibrium is reached. ☐

The reaction stops when there is 100% SO_3. ☐

There will always be some SO_2 left at equilibrium. ☐

[2]

(c) The graph shows the percentage of SO_2 converted to SO_3, at different temperatures.



(i) Describe the general trend of the graph.

.....

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

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(ii) Use the graph to estimate the percentage of SO_2 converted to SO_3 at 400 °C.

Percentage of SO_2 converted to SO_3 = ... % **[1]**

(iii) Use the graph to estimate the percentage of **SO_2 remaining** at 800 °C.

Percentage of SO_2 remaining = ... % **[2]**

(iv) Calculate the percentage of SO_2 converted to SO_3 when 20 g of SO_3 is made from 32 g of SO_2.

Use the equation:

mass of SO_2 × percentage of SO_2 converted to SO_3 = mass of SO_3 × 80

Percentage of SO_2 converted to SO_3 = ... % **[3]**

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9 Argon forms 1% of the air and is unreactive.

Argon is used as a replacement for nitrogen when nitrogen is too reactive.

(a) Argon is unreactive because it is in Group 0 of the Periodic Table.

State **one** other property of argon.

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

(b) Chlorine is very reactive. Argon is unreactive.

Explain how the reactivity of these two elements are related to the arrangement of electrons in their atoms.

.....

.....

.....

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

(c) An element **X** has two electron shells with one electron in its outer shell.

(i) Which statements about **X** are **true**, and which are **false**?

Tick (✓) **one** box in each row.

	True	**False**
X is a metal.		
X is in the first period of the Periodic Table.		
X forms X^- ions.		
X loses one electron when it reacts.		

[2]

(ii) Name **one** element that is more reactive than element **X**.

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

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(d) An argon atom has a mass number of 40.

Calculate the number of neutrons in its nucleus.

Use the Periodic Table.

Number of neutrons = ... **[1]**

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10 Formic acid is used to remove limescale from kettles.

(a) Formic acid is a carboxylic acid with the formula HCOOH.

(i) Draw the displayed formula of formic acid.

Show all the bonds.

[1]

(ii) The name of the carboxylic acid with the formula CH_3COOH is ethanoic acid.

What is the name of formic acid?

Tick (✓) **one** box.

Butanoic acid ☐

Methanoic acid ☐

Propanoic acid ☐

[1]

(b) Ling and Taylor dip a piece of universal indicator paper into a solution of formic acid.

What pH value could the solution of formic acid be?

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

(c) Limescale contains calcium carbonate.

A solution of formic acid fizzes when it reacts with calcium carbonate.

(i) Name the gas that causes the fizzing.

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

(ii) A salt called calcium formate is also formed when formic acid reacts with calcium carbonate.

The formula of the calcium ion is Ca^{2+}. The formula of the formate ion is $HCOO^-$.

Write the formula of calcium formate.

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

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(d) Calcium carbonate is insoluble in water. Calcium formate is soluble in water.

Sam wants to make some calcium formate crystals.

This is the method:
- stir calcium carbonate with a solution of formic acid
- stop adding calcium carbonate when no more reacts
- leave the mixture to crystallise.

An extra step is needed to make pure calcium formate crystals.

Name the extra step **and** explain why it is needed.

Extra step .....

.....

Explanation .....

.....

[2]

(e) **(i)** Umi and Zayn have a dilute solution of calcium formate.

They want to make **dry** crystals of calcium formate.

Name **one** separation technique they must use.

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

(ii) They use 20.0 g of calcium carbonate and get 7.8 g of pure calcium formate.

Chemists calculate that 10.0 g of calcium carbonate should make 13.0 g of calcium formate.

Calculate the percentage yield of calcium formate.

Use the formula: percentage yield = $\frac{\text{actual yield}}{\text{theoretical yield}} \times 100\%$

Percentage yield of calcium formate = ... % **[3]**

END OF QUESTION PAPER

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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).

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