

Friday 27 May 2022 – 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 **24** pages.

ADVICE

- Read each question carefully before you start your answer.

2
SECTION A

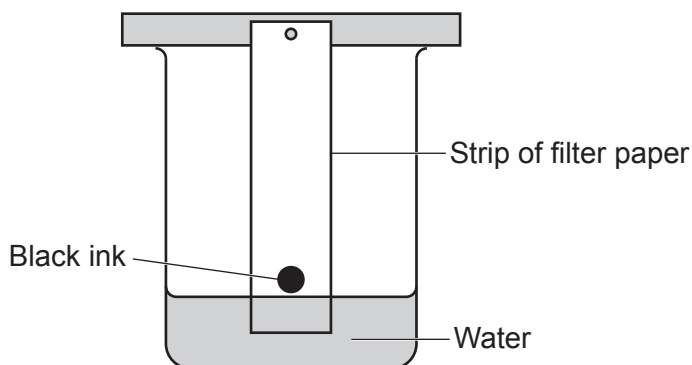
Answer **all** the questions.

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

Write your answer to each question in the box provided.

- 1** A black ink is a mixture of different colours.

The diagram shows how the colours in the black ink can be separated.



What is the name of this method of separation?

- A** Chromatography
- B** Crystallisation
- C** Distillation
- D** Filtration

Your answer

[1]

- 2** What is the test for **oxygen** gas?

- A** It goes 'pop' when lit.
- B** It relights a glowing splint.
- C** It turns damp red litmus paper blue.
- D** It turns limewater cloudy.

Your answer

[1]

- 3 The table shows the start and end temperatures of four different reactions.

Reaction	Start temperature (°C)	End temperature (°C)
A	−3	9
B	14	37
C	20	16
D	23	23

Which reaction is **endothermic**?

Your answer

[1]

- 4 Which particles in an aqueous solution of sodium hydroxide, NaOH(aq), make it alkaline?

A H^+

B H_2O

C OH^-

D Na^+

Your answer

[1]

- 5 The table shows the colours of universal indicator in solutions of different pH.

pH	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Colour	red		orange		yellow		green	blue			purple			

A sample of water has a pH of 7. A small amount of dilute hydrochloric acid is added to the water.

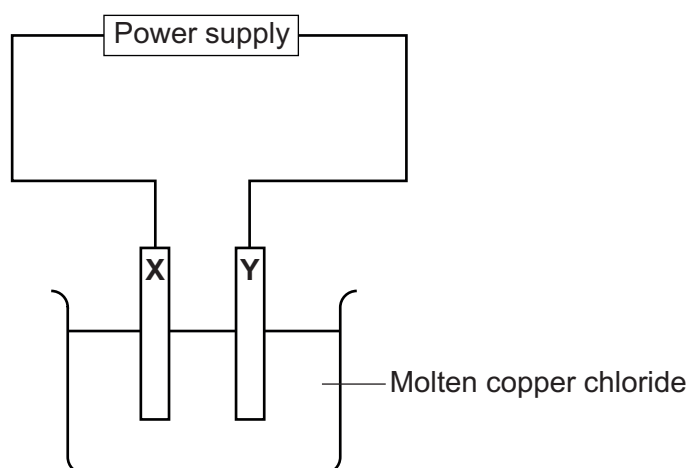
Which colour does universal indicator turn in this solution?

- A** Blue
B Green
C Orange
D Purple

Your answer

[1]

- 6 The diagram shows the electrolysis of molten copper chloride, CuCl_2 .



Chlorine is formed at electrode **X** and copper is formed at electrode **Y**.

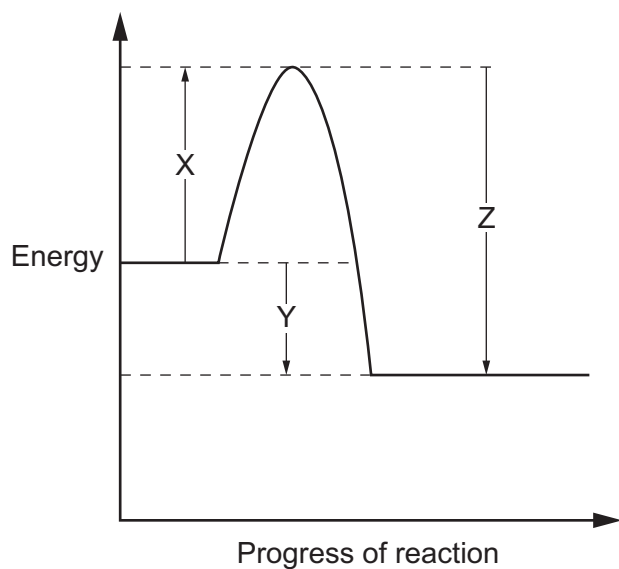
Which row in the table describes electrodes **X** and **Y**?

	Electrode X	Electrode Y
A	anode	cathode
B	anion	cation
C	cathode	anode
D	cation	anion

Your answer

[1]

- 7 The diagram shows the reaction profile for a reaction.



Which row represents the **activation energy** and the **energy change** for the reaction?

	Activation energy	Energy change
A	X	Y
B	X	Z
C	Z	X
D	Z	Y

Your answer

[1]

- 8 Which particles in a metal allow it to **conduct electricity**?

- A** Atoms
- B** Electrons
- C** Ions
- D** Protons

Your answer

[1]

- 9 A molecule of glucose has the molecular formula $C_6H_{12}O_6$.

What is the **empirical formula** of glucose?

- A CHO
- B CH_2O
- C $C_6H_{12}O_6$
- D $(CO_6)H_{12}$

Your answer

[1]

- 10 The equation shows the reaction between carbon dioxide, CO_2 , and hydrogen, H_2 .



What is the **oxidising agent** in the reaction?

- A CO
- B CO_2
- C H_2
- D H_2O

Your answer

[1]

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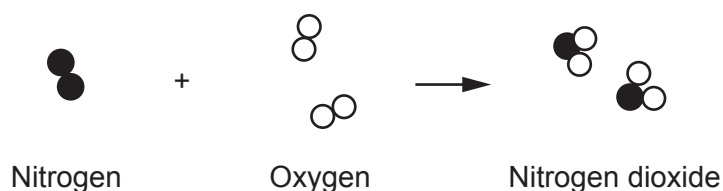
SECTION B

Answer **all** the questions.

- 11 Nitrogen dioxide, NO_2 , is formed when nitrogen, N_2 , reacts with oxygen, O_2 .

Fig. 11.1 shows the particle model diagram for the formation of nitrogen dioxide.

Fig. 11.1



- (a) Complete each sentence to describe the formation of nitrogen dioxide.

Use the words or phrases in the list.

break apart
change of state
chemical change
dissolve
freeze
join together
physical change

The molecules of nitrogen and oxygen

The atoms then to form nitrogen dioxide.

This is called a

[3]

- (b) The equation shows the formation of nitrogen dioxide.



Complete the **balanced symbol** equation for the reaction.
Use Fig. 11.1.

[1]

- (c) The table shows the melting point and boiling point of pure nitrogen dioxide.

Melting point (°C)	Boiling point (°C)
−9	21

- (i) Which state symbol shows the physical state of nitrogen dioxide at −2 °C?

Tick (✓) **one** box.

g	☐
l	☐
s	☐

[1]

- (ii) A scientist measures the melting point of a sample of nitrogen dioxide.

The result shows that the sample of nitrogen dioxide is impure.

Which temperature could be the melting point of the impure nitrogen dioxide?

Tick (✓) **one** box.

−11 °C	☐
−9 °C	☐
23 °C	☐

[1]

- (d) A molecule of nitrogen dioxide has the formula NO_2 .

Calculate the **relative formula mass** for nitrogen dioxide.

Relative atomic mass (A_r): N = 14.0 O = 16.0

Relative formula mass = [2]

- (e) Nitrogen dioxide is made from the reaction of nitrogen with oxygen.

Fig. 11.2 shows the bonding in a molecule of oxygen, O_2 .

Fig. 11.2

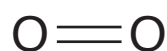
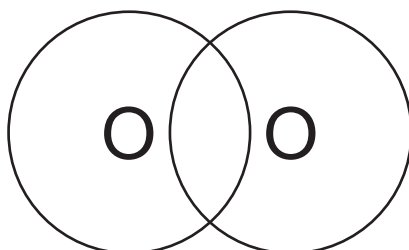


Fig. 11.3 shows an incomplete dot and cross diagram for oxygen.

Fig. 11.3



Complete **Fig. 11.3** to show the arrangement of the electrons in a molecule of oxygen. [2]

12 Atoms are made from protons, neutrons and electrons.

(a) The table shows the relative mass and relative charge of a proton, neutron and electron.

Particle	Relative mass	Relative charge
proton	1	
neutron		0
electron		

Complete the table.

Write your answers in the three boxes in the table.

[3]

(b) The mass of a proton is 1.673×10^{-27} kg.

The mass of an electron is 9.109×10^{-31} kg

What is the **relative mass** of an electron compared to a proton?

Tick (✓) **one** box.

1.672×10^{-27}

☐

1.837×10^3

☐

5.445×10^{-4}

☐

[1]

(c) An atom of helium contains:

- 2 protons
- 2 neutrons
- 2 electrons.

Draw a **labelled** diagram to show the arrangement of protons, neutrons and electrons in an atom of helium.

[3]

(d) The table shows some information about the atoms of six elements, **A** to **F**.

Element	Number of protons	Number of neutrons	Number of electrons	Arrangement of electrons
A	11	12	11	2, 8, 1
B	10	10	10	2, 8
C	12	12	12	2, 8, 2
D	6	7	6	2, 4
E	19	20	19	2, 8, 8, 1
F	6	6	6	2, 4

Answer the following questions. Choose your answers from the elements **A**, **B**, **C**, **D**, **E** or **F**.

Each letter can be used once, more than once or not at all.

(i) Which **two** elements are in **Group 1** of the Periodic Table?

Elements = and [1]

(ii) Which element is in **Period 4** of the Periodic Table?

Element = [1]

(iii) Which element has a mass number of 12?

Element = [1]

(iv) Which **two** elements are isotopes?

Elements = and [1]

(v) Which element forms an ion with a 2+ charge?

Element = [1]

- (e) Aluminium forms an Al^{3+} ion and chlorine forms a Cl^- ion.

Three students write down the formula of aluminium chloride.

Student **A**: AlCl

Student **B**: AlCl_3

Student **C**: Al_3Cl

Which student is correct?

Explain your answer.

Student

Reason

.....

.....

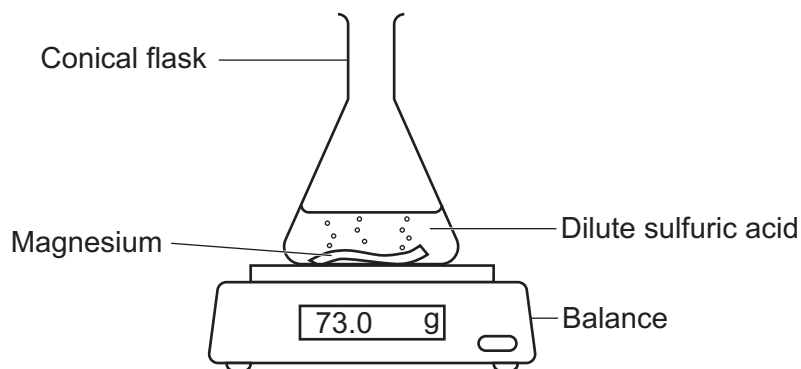
..... [2]

15
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- 13** A student investigates how the mass changes as magnesium reacts with excess dilute sulfuric acid.

The diagram shows the apparatus they use.



The student measures the mass every minute for 8 minutes.

Table 13.1 shows their results.

Table 13.1

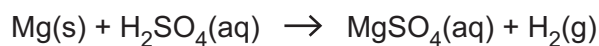
Time (minutes)	Mass (g)
0	73.0
1	71.5
2	70.5
3	
4	69.6
5	69.4
6	69.3
7	69.3
8	69.3

- (a)** Complete the table with an estimate of the missing mass at **3 minutes**.

Write your answer in the box in **Table 13.1**.

[1]

- (b) The equation shows the reaction between magnesium, Mg, and dilute sulfuric acid, H_2SO_4 .



Describe and explain how the mass changes during the reaction.

Use information in **Table 13.1** and the equation in your answer.

.....

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.....

..... [3]

- (c) The student thinks that the results show that all the magnesium had reacted.

Explain why the student is correct. Use data from **Table 13.1**.

.....

..... [1]

- (d) The student repeats the experiment three times.

Table 13.2 shows the results of the three experiments at 1 minute.

Table 13.2

Mass in experiment 1 (g)	Mass in experiment 2 (g)	Mass in experiment 3 (g)
71.5	71.4	71.8

Calculate the **mean** mass in the three experiments.

Give your answer to **1** decimal place.

Mean mass = g [3]

Diagram illustrating the titration setup:

- On the left, a test tube contains 10 cm^3 dilute sulfuric acid + 2 cm^3 of indicator.
- Two 2 cm^3 portions of sodium hydroxide solution are added to the test tube.
- A large arrow indicates the reaction mixture is transferred to a boiling tube.
- On the right, the solution formed in the boiling tube is shown.

- Describe the mistakes the student has made and how their method could be improved to produce a **pure dry** sample of **sodium chloride**.

..... [6

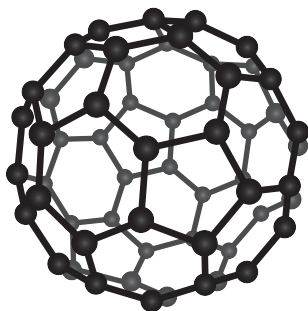
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15 Fullerenes are allotropes of carbon that have many uses.

Fig. 15.1 shows a molecule of a fullerene.

Fig. 15.1



(a) (i) Which group of allotropes contain this fullerene?

Tick **one** (✓) box.

Inorganic

☐

Organic

☐

Physical

☐

[1]

(ii) What is the approximate size of a molecule of this fullerene?

Tick **one** (✓) box.

$1 \times 10^{-15}\text{m}$

☐

$1 \times 10^{-10}\text{m}$

☐

$1 \times 10^{-5}\text{m}$

☐

[1]

(b) The carbon atoms in fullerenes are joined by covalent bonds.

(i) Explain how two atoms of carbon form a covalent bond.

.....

.....

.....

..... [2]

(ii) How many covalent bonds does one atom of carbon form in a molecule of fullerene, as shown in **Fig. 15.1**?

..... [1]

(c) The model used to show the molecule of fullerene in **Fig. 15.1** has limitations.

The table shows some statements about the model.

Which statements about this model are **true**, and which are **false**?

Tick (✓) **one** box in each row.

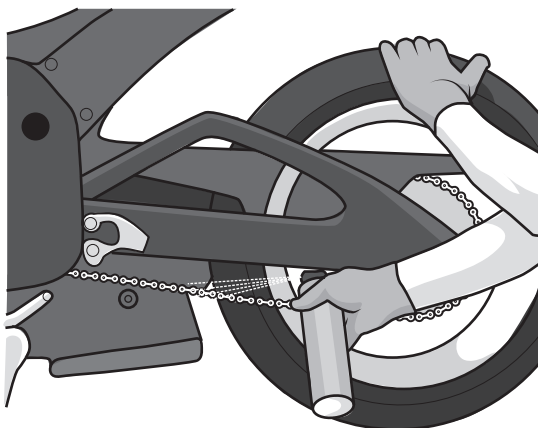
	True	False
It shows the length of the covalent bonds.		
It shows the size of the carbon atoms.		
It shows the three-dimensional shape of the molecule.		

[2]

- (d) Fullerenes can be used as lubricants. Lubricants reduce the friction between moving parts.

Fig. 15.2 shows a lubricant being sprayed onto the chain of a motorbike.

Fig. 15.2



- (i) Explain why fullerenes can be used as lubricants.

Use ideas about the structure and bonding of the fullerene shown in **Fig. 15.1** in your answer.

.....

.....

.....

..... [2]

- (ii) A lubricant may need to be used at high temperatures.

Explain why fullerenes can be used at high temperatures.

Use ideas about the structure and bonding of the fullerene shown in **Fig. 15.1** in your answer.

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.....

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.....

..... [3]

END OF QUESTION PAPER

[illegible]

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