

Combined Science
PAPER 2
Foundation Tier

Total Marks

Monday 22 May 2023 – Morning

Time: 1 hour 10 minutes

In the boxes below, write your name, centre number and candidate number.

Surname					
Other names					
Centre Number					
Candidate Number					

YOU MUST HAVE

Calculator, ruler

YOU WILL BE GIVEN

Diagram Booklet, Periodic Table

INSTRUCTIONS

Answer ALL questions.

Answer the questions in the spaces provided in this Question Paper or in the separate Diagram Booklet – there may be more space than you need.

Calculators may be used.

Any diagrams may NOT be accurately drawn, unless otherwise indicated.

You must show all your working out with your answer clearly identified at the end of your solution.

INFORMATION

The total mark for this paper is 60.

The marks for EACH question are shown in brackets – use this as a guide as to how much time to spend on each question.

In questions marked with an *ASTERISK* (*), marks will be awarded for your ability to structure your answer logically, showing how the points that you make are related or follow on from each other where appropriate.

A periodic table is provided as a separate insert.

There may be spare copies of some diagrams.

ADVICE

Read each question carefully before you start to answer it.

Try to answer every question.

Check your answers if you have time at the end.

Answer ALL questions. Write your answers in the spaces provided.

Some questions must be answered with a cross in a box ☐. If you change your mind about an answer, put a line through the box ☒ and then mark your new answer with a cross ☐.

1 In an experiment, paper chromatography was used to separate the coloured dyes in four different inks, W, X, Y and Z.

(a) Look at Figure 1 for Question 1(a) in the Diagram Booklet. It shows the chromatogram at the end of the experiment.

(i) The chromatogram shows that only one of the inks contains a single dye.

Which ink contains a single dye?

(1 mark)

☐ A W

☐ B X

☐ C Y

☐ D Z

1(a) continued.

**(ii) Which ink contains the greatest number of dyes?
(1 mark)**

☐ **A W**

☐ **B X**

☐ **C Y**

☐ **D Z**

(continued on the next page)

1(a) continued.

(iii) The R_f value of a dye can be calculated using the equation

$$R_f = \frac{\text{distance moved by the dye}}{\text{distance moved by solvent front}}$$

At the end of the chromatography one dye had moved 3.60 cm and the solvent front had moved 9.20 cm.

Calculate the R_f value for this dye.

**Give your answer to 2 decimal places.
(2 marks)**

$R_f =$ _____

(continued on the next page)

1 continued.

- (b) The substance used as the solvent in the chromatography was heated for 8 minutes.**

Look at Figure 2 for Question 1(b) in the Diagram Booklet. It shows how the temperature of the substance changed with time.

From A to B the substance was a liquid.

From C to D the substance was a gas.

- (i) Give the name of the change when a liquid becomes a gas.**
(1 mark)

- (ii) Use Figure 2 to give the temperature of the substance at 4 minutes.**
(1 mark)

_____ °C

(continued on the next page)

1(b) continued.

- (iii) Use Figure 2 to give the time when the substance has completely changed into a gas.
(1 mark)**

_____ minutes

- (iv) The temperature of the substance at A was 25°C.**

**Calculate the temperature rise of the substance from A to D.
(1 mark)**

_____ °C

(Total for Question 1 = 8 marks)

2 This question is about electrolysis.

(a) Which statement describes what happens during electrolysis?

(1 mark)

- ☐ **A atoms are decomposed**
- ☐ **B ionic compounds are decomposed**
- ☐ **C mixtures are separated**
- ☐ **D molecules are separated**

(continued on the next page)

2 continued.

(b) Look at Figure 3 for Question 2(b) in the Diagram Booklet. It shows the electrolysis of copper chloride solution.

**(i) Use the words from the list below to complete the missing words A, B, C of the diagram in Figure 3.
(2 marks)**

**anode
cathode
electrolyte**

A _____

B _____

C _____

(continued on the next page)

2(b) continued.

- (ii) The products of the electrolysis shown in Figure 3 are solid X and gas Y.**

**Look at the diagram for Question 2(b)(ii) in the Diagram Booklet. Draw ONE straight line from each product to its name.
(2 marks)**

(continued on the next page)

2(b) continued.

(iii) The experiment is repeated using powdered solid copper chloride instead of copper chloride solution.

Nothing happens and no products are formed.

Explain why nothing happens and no products are formed.

(2 marks)

(Total for Question 2 = 7 marks)

- 3 (a) When lead nitrate solution and potassium chloride solution are mixed, potassium nitrate and a precipitate of lead chloride are formed.

- (i) Complete the word equation for this reaction.
(1 mark)

lead nitrate + _____ →
_____ + lead chloride

- (ii) Lead nitrate is toxic.

Look at the diagrams for Question 3(a)(ii) in the Diagram Booklet. Which hazard symbol should be on a container of lead nitrate?
(1 mark)

☐ A Diagram A

☐ B Diagram B

☐ C Diagram C

☐ D Diagram D

(continued on the next page)

3 continued.

- (b) A student put 5 cm^3 of potassium carbonate solution into a test tube and added 2 cm^3 of calcium nitrate solution.**

Look at Figure 4 for Question 3(b) in the Diagram Booklet. A precipitate formed and was allowed to settle as shown in Figure 4.

The height of the precipitate was measured.

- (i) Give the name of the piece of apparatus the student should use to find the volume of the potassium carbonate solution.
(1 mark)**

(continued on the next page)

3(b) continued.

(ii) The student repeated the experiment.

Look at Figure 5 for Question 3(b)(ii) in the Diagram Booklet. The results are shown in Figure 5.

**Use the data in Figure 5 to calculate the mean height of the precipitate.
(2 marks)**

mean height of precipitate = _____ cm

(continued on the next page)

3(b) continued.

- (iii) Describe how a pure, dry sample of the precipitate could be obtained from the mixture in the test tube.
(3 marks)**

(continued on the next page)

3(b) continued.

- (iv) The student investigated whether increasing the volume of calcium nitrate solution increased the height of the precipitate formed.**

They repeated the experiment using different volumes of calcium nitrate.

State ONE variable that should be controlled in this investigation.

(1 mark)

(Total for Question 3 = 9 marks)

4 (a) Magnesium is a metal.

**(i) State ONE physical property of magnesium.
(1 mark)**

**(ii) Which element is in the same group of the
periodic table as magnesium?
Use the periodic table to help you answer
this question.
(1 mark)**

- ☐ **A carbon**
- ☐ **B chromium**
- ☐ **C sodium**
- ☐ **D strontium**

(continued on the next page)

4 continued.

(b) (i) Magnesium atoms have 12 electrons.

Complete the electronic configuration of a magnesium atom.

(1 mark)

2.8._____

(ii) The electronic configuration of a chlorine atom is 2.8.7

Explain how the electronic configuration of chlorine is linked to its period in the periodic table.

(2 marks)

(continued on the next page)

Turn over

4 continued.

- (c) 1.20 g of magnesium reacts completely with 3.55 g of chlorine to form magnesium chloride.**

Calculate the empirical formula of the magnesium chloride.

(relative atomic masses: Mg = 24.0, Cl = 35.5)

**You must show your working.
(3 marks)**

Answer space continues on the next page.

4(c) continued.

empirical formula = _____

(continued on the next page)

4 continued.

- (d) Sodium reacts with chlorine to form sodium chloride, which contains ionic bonds.**

Hydrogen reacts with chlorine to form hydrogen chloride, which contains covalent bonds.

Look at Figure 6 for Question 4(d) in the Diagram Booklet. It shows dot and cross diagrams of these compounds.

Describe the differences between an ionic bond and a covalent bond.

(4 marks)

Answer space continues on the next page.

Turn over

4(d) continued.

(Total for Question 4 = 12 marks)

- 5 In an experiment, powdered calcium hydroxide was added to dilute hydrochloric acid and the pH was measured.**

The method used was

STEP 1 measure 200 cm³ dilute hydrochloric acid into a beaker

STEP 2 add 0.1 g of powdered calcium hydroxide to the beaker

STEP 3 find the pH of the mixture

STEP 4 repeat steps 2 and 3 until the pH stops changing.

- (a) State what should be done after STEP 2 to make sure that any reaction is complete.
(1 mark)**

(continued on the next page)

5 continued.

- (b) Complete the word equation for the reaction.
(2 marks)

calcium hydroxide + hydrochloric acid →

- (c) Which row of the table shows the state symbols for powdered calcium hydroxide and dilute hydrochloric acid in the balanced chemical equation?
(1 mark)

	calcium hydroxide	hydrochloric acid
<input type="checkbox"/> A	aq	l
<input type="checkbox"/> B	l	aq
<input type="checkbox"/> C	s	aq
<input type="checkbox"/> D	s	l

(continued on the next page)

5 continued.

(d) Look at Figure 7 for Question 5(d) in the Diagram Booklet. The results of the experiment are shown in Figure 7.

**(i) Using Figure 7, give the pH of the acid at the start of the experiment.
(1 mark)**

pH = _____

**(ii) Using Figure 7, give the mass of calcium hydroxide required to make a neutral mixture.
(1 mark)**

mass of calcium hydroxide = _____g

(continued on the next page)

5(d) continued.

- (iii) Explain why the pH starts at a low value and ends at a higher value.
(3 marks)**

(continued on the next page)

5 continued.

- (e) State what should be used to measure the pH of the mixture in this experiment.**

(1 mark)

- (f) The calcium hydroxide used is corrosive to the eyes and an irritant to skin.**

Using this information, state ONE safety precaution that should be taken during the experiment when using any corrosive substance.

(1 mark)

(Total for Question 5 = 11 marks)

6 Look at Figure 8 for Question 6 in the Diagram Booklet. It shows part of the reactivity series of metals.

**(a) Which metal reacts when added to cold water?
(1 mark)**

☐ **A calcium**

☐ **B copper**

☐ **C gold**

☐ **D silver**

(b) A student investigates the reactivity of four different metals.

The student adds an equal-sized piece of each metal to separate test tubes containing dilute hydrochloric acid.

Look at Figure 9 for Question 6(b) in the Diagram Booklet. The student's observations for zinc and copper are recorded in Figure 9.

(continued on the next page)

6(b) continued.

- (i) Use the information in Figure 8 and in Figure 9 to predict the observations for the reactions of magnesium and of iron with dilute hydrochloric acid.
(2 marks)**

magnesium

iron

(continued on the next page)

6(b) continued.

(ii) When metals react with acids, hydrogen gas is produced.

Describe the test to show that the gas is hydrogen.

(2 marks)

(continued on the next page)

6(b) continued.

- (iii) When magnesium reacts with hydrochloric acid, magnesium chloride and hydrogen are formed.

Complete the balanced equation for the reaction.
(2 marks)



(continued on the next page)

6 continued.

***(c) There are THREE common methods of obtaining metals from the Earth's crust:**

- mine the pure metal**
- mine the metal ore and heat it with carbon**
- mine the metal ore and electrolyse the molten compound.**

The method used to obtain a metal is linked to its position in the reactivity series of metals.

Aluminium, gold, iron, and silver are some commonly used metals.

**Look again at Figure 8 for Question 6 in the Diagram Booklet. Use the reactivity series in Figure 8 to state and explain the method chosen to obtain each of these four metals.
(6 marks)**

Answer space continues on the next 5 pages.

Turn over

6(c) continued.

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6(c) continued.

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6(c) continued.

(Total for Question 6 = 13 marks)

TOTAL FOR PAPER = 60 MARKS
END OF PAPER