

Combined Science  
PAPER 2  
Foundation Tier

Total Marks
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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.**

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**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)

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$R_f =$  \_\_\_\_\_

(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)**

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- (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)**

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**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)**

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**(Total for Question 2 = 7 marks)**

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- 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  $5\text{ cm}^3$  of potassium carbonate solution into a test tube and added  $2\text{ cm}^3$  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)**

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**(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)**

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**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)**

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**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)**

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**(Total for Question 3 = 9 marks)**

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**4 (a) Magnesium is a metal.**

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

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**(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)**

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**(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.**

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4(c) continued.

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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.**

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**Turn over**

**4(d) continued.**

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**(Total for Question 4 = 12 marks)**

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- 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 cm<sup>3</sup> 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)**

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**(continued on the next page)**



5 continued.

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

calcium hydroxide + hydrochloric acid →

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- (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)**

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**5 continued.**

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

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- (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)**

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**(Total for Question 5 = 11 marks)**

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**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**

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**iron**

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**(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)**

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**(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.**

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**Turn over**

**6(c) continued.**

[illegible]

**Turn over**

**6(c) continued.**

[illegible]

**Turn over**

**6(c) continued.**

[illegible]

**Turn over**

**6(c) continued.**

[illegible]

**Turn over**

6(c) continued.

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(Total for Question 6 = 13 marks)

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**TOTAL FOR PAPER = 60 MARKS**  
**END OF PAPER**