

Combined Science  
PAPER 2  
Foundation Tier

Total Marks
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Friday 17 May 2024 – 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, Periodic Table (enclosed)**

## **YOU WILL BE GIVEN**

**Diagram Booklet**

## **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.**

**(continued on the next page)**

**Turn over**

**INFORMATION** continued.

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 Look at Figure 1 for Question 1 in the Diagram Booklet. It shows a test tube being heated in a beaker of water.**

**The test tube contains solid wax.**

**As the test tube was heated, the solid wax changed to liquid wax.**

**After heating, the wax was allowed to cool to room temperature.**

- (a) Look at Figure 2 for Question 1(a) in the Diagram Booklet. It shows the arrangement of particles in liquid wax.**

**Look at Figure 3 for Question 1(a) in the Diagram Booklet. Draw the arrangement of particles in solid wax in the box.**

**(1 mark)**

**(continued on the next page)**

**1 continued.**

**(b) When the wax cools, it changes from a liquid back to a solid. This change is a PHYSICAL CHANGE.**

**(i) What name is given to the change of a liquid to a solid?**

**(1 mark)**

☐ **A    condensing**

☐ **B    evaporating**

☐ **C    freezing**

☐ **D    melting**

**(continued on the next page)**

**1(b) continued.**

- (ii) Explain why the change from a liquid to a solid is a physical change rather than a chemical change.  
(2 marks)**

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**(continued on the next page)**

**1 continued.**

**(c) Another physical change is when a liquid changes into a gas.**

**(i) Which row shows the movement and arrangement of the particles in a gas?  
(1 mark)**

	<b>movement of particles</b>	<b>arrangement of particles</b>
<input type="checkbox"/> <b>A</b>	slow	regular
<input type="checkbox"/> <b>B</b>	slow	random
<input type="checkbox"/> <b>C</b>	fast	regular
<input type="checkbox"/> <b>D</b>	fast	random

**(continued on the next page)**

**1(c) continued.**

- (ii) Suggest why the wax did NOT change into a gas when the test tube was heated in the beaker of water.**

**(1 mark)**

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**(Total for Question 1 = 6 marks)**

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**2 Water treatment is needed to make most sources of water suitable for drinking.**

**(a) Water treatment includes the processes of CHLORINATION, FILTRATION and SEDIMENTATION.**

**Place these processes in the order that they take place during water treatment.**

**(2 marks)**

<b>first</b>		<b>last</b>

**(continued on the next page)**

**2 continued.**

**(b) Some tap water contains chloride ions.**

**(i) Explain, in terms of electrons, how a chlorine atom,  $\text{Cl}$ , forms a chloride ion,  $\text{Cl}^-$  (2 marks)**

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**(continued on the next page)**

**2(b) continued.**

**(ii) Why is chlorine added to water during water treatment?**

**(1 mark)**

- ☐ **A to clean the water**
- ☐ **B to dissolve insoluble substances in the water**
- ☐ **C to increase the pH of the water to 11**
- ☐ **D to kill any bacteria in the water**

**(iii) State why tap water is not suitable for use in chemical analysis.**

**(1 mark)**

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**(continued on the next page)**

**2 continued.**

**(c) A student was asked to distil a sample of tap water.**

**Look at Figure 4 for Question 2(c) in the Diagram Booklet. It shows the apparatus the student used.**

**(i) The student made an error when setting up the apparatus in Figure 4.**

**This error meant that pure water could NOT be collected in the test tube.**

**Explain what the student needs to change so that pure water can be collected in the test tube.**

**(2 marks)**

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**2(c) continued.**

- (ii) State what the student should use to heat the water.  
(1 mark)**

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**(Total for Question 2 = 9 marks)**

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- 3 (a) Look at Figure 5 for Question 3(a) in the Diagram Booklet. It shows some information about an atom of chlorine.**

**State the number of protons, neutrons and electrons in this atom.**

**(3 marks)**

**number of protons = \_\_\_\_\_**

**number of neutrons = \_\_\_\_\_**

**number of electrons = \_\_\_\_\_**

**(continued on the next page)**

**3 continued.**

**(b) Chlorine reacts with silicon to form silicon chloride.**

**A sample of silicon chloride contains 1.4 g of silicon atoms and 7.1 g of chlorine atoms.**

**Calculate the empirical formula of this sample of silicon chloride.**

**(relative atomic masses: Si = 28, Cl = 35.5)  
(3 marks)**

**Answer space continues on the next page.**

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**Turn over**

**3(b) continued.**

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**empirical formula = \_\_\_\_\_**

- (c) The modern periodic table is organised into groups and periods.**

**State in which group and in which period of the periodic table silicon is found.**

**You should use the periodic table to help you answer this question.**

**(2 marks)**

**group = \_\_\_\_\_**

**period = \_\_\_\_\_**

**(continued on the next page)**



**3 continued.**

- (d) Describe TWO differences between Mendeleev's periodic table and the modern periodic table.  
(2 marks)**

**1** \_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

**2** \_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

**(Total for Question 3 = 10 marks)**

\_\_\_\_\_

- 4 (a) A  $250 \text{ cm}^3$  solution of copper sulfate contains  $6.52 \text{ g}$  of dissolved solid.

Calculate the concentration of this copper sulfate solution in  $\text{g dm}^{-3}$

$$\text{concentration (g dm}^{-3}\text{)} = \frac{\text{mass of solid (g)}}{\text{volume of solution (dm}^3\text{)}}$$

(2 marks)

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concentration = \_\_\_\_\_  $\text{g dm}^{-3}$

(continued on the next page)

**4 continued.**

**(b) Sodium hydroxide solution and copper sulfate solution were reacted together completely.**

**The result was a mixture of a precipitate of copper hydroxide in a solution of sodium sulfate.**

**Describe how to obtain**

- **a pure sample of solid copper hydroxide from the mixture**
  - **a pure sample of solid sodium sulfate from the mixture.**
- (4 marks)**

**Answer space continues on the next page.**

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**4(b) continued.**

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**4 continued.**

- (c) Look at Figure 6 for Question 4(c) in the Diagram Booklet. It shows the equipment used to electrolyse a sample of sodium sulfate solution.**

**Graphite electrodes are used in the electrolysis.**

- (i) Give TWO reasons why graphite is a suitable material for the electrodes.  
(2 marks)**

**1** \_\_\_\_\_

\_\_\_\_\_

**2** \_\_\_\_\_

\_\_\_\_\_

**(continued on the next page)**

**4(c) continued.**

**(ii) Sodium sulfate solution contains ions.**

**Which ions are attracted to the positive electrode during the electrolysis?**

**(1 mark)**

- ☐ **A     $\text{H}^+$  ions only**
- ☐ **B     $\text{OH}^-$  ions only**
- ☐ **C     $\text{H}^+$  and  $\text{Na}^+$  ions**
- ☐ **D     $\text{SO}_4^{2-}$  and  $\text{OH}^-$  ions**

**(iii) Look at the table for Question 4(c)(iii) in the Diagram Booklet. Draw ONE straight line from each electrode to the product formed at that electrode during the electrolysis of sodium sulfate solution.**

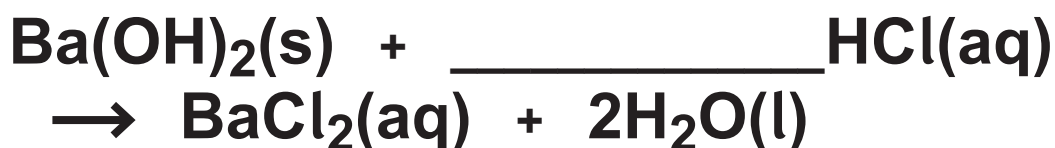
**(2 marks)**

**(Total for Question 4 = 11 marks)**

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5 Barium hydroxide reacts with dilute hydrochloric acid to form barium chloride solution and water.

- (a) (i) Complete the balanced equation for the reaction by adding a NUMBER in front of  $\text{HCl(aq)}$ .  
(1 mark)



- (ii) State what you would SEE during the reaction.  
(1 mark)

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(continued on the next page)

**5 continued.**

- (b) A student investigated how the pH of the mixture changed as barium hydroxide was added to dilute hydrochloric acid.**

**The student used this method.**

- STEP 1** measure out **50 cm<sup>3</sup>** of dilute hydrochloric acid into a beaker using a measuring cylinder
- STEP 2** use a glass rod to place a drop of the acid onto a piece of universal indicator paper and record the pH
- STEP 3** add one spatula measure of barium hydroxide to the acid in the beaker and stir
- STEP 4** use the glass rod to place a drop of the mixture onto a new piece of universal indicator paper and record the pH again
- STEP 5** repeat steps 3 and 4 until there is no further change in the pH.

**(continued on the next page)**



**5(b) continued.**

- (i) Name a piece of equipment that could be used to measure the pH of a substance more accurately than universal indicator paper.  
(1 mark)**

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- (ii) Explain why, in step 3, the mixture was stirred after adding the barium hydroxide.  
(2 marks)**

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**(continued on the next page)**

5(b) continued.

(iii) Figure 7 shows the student's results.

**FIGURE 7**

<b>number of spatula measures of barium hydroxide</b>	<b>pH of mixture</b>
<b>0</b>	<b>1</b>
<b>1</b>	<b>1</b>
<b>2</b>	<b>1</b>
<b>3</b>	<b>1</b>
<b>4</b>	<b>3</b>
<b>5</b>	<b>8</b>
<b>6</b>	<b>12</b>
<b>7</b>	<b>13</b>
<b>8</b>	<b>13</b>

Look at the graph for Question 5(b)(iii) in the Diagram Booklet. Plot a graph of the pH of the mixture against the number of spatula measures of barium hydroxide.  
(3 marks)

(continued on the next page)

5(b) continued.

- (iv) Use the graph to find the pH of the mixture when 4.5 spatula measures of barium hydroxide are added.  
(1 mark)

pH of the mixture = \_\_\_\_\_

- (c) Look at Figure 8 for Question 5(c) in the Diagram Booklet. It shows a hazard symbol on the container of barium hydroxide.

What is the meaning of the hazard symbol in Figure 8?  
(1 mark)

- ☐ A corrosive
- ☐ B health hazard
- ☐ C oxidising
- ☐ D toxic

(continued on the next page)

**5 continued.**

**(d) The barium hydroxide was measured in spatulas.**

**State ONE way that the measuring of the  
barium hydroxide could be improved.**

**(1 mark)**

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

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6 Sodium carbonate has the formula  $\text{Na}_2\text{CO}_3$

(a) Sodium carbonate contains  $\text{Na}^+$  ions and  $\text{CO}_3^{2-}$  ions.

(i) The atomic number of sodium is 11

What is the electronic configuration of the  $\text{Na}^+$  ion?  
(1 mark)

- ☐ A 1
- ☐ B 2.8
- ☐ C 2.8.1
- ☐ D 2.8.2

(continued on the next page)

**6(a) continued.**

- (ii) Explain why solid sodium carbonate CANNOT conduct electricity but a solution of sodium carbonate CAN conduct electricity.  
(3 marks)**

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**(continued on the next page)**

6 continued.

(b) Calculate the percentage by mass of sodium in sodium carbonate,  $\text{Na}_2\text{CO}_3$

percentage by mass of element =

$$\frac{\text{total relative atomic mass of element}}{\text{relative formula mass of compound}} \times 100$$

(relative atomic masses: C = 12, O = 16, Na = 23)

(3 marks)

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percentage by mass of sodium = \_\_\_\_\_

(continued on the next page)

**6 continued.**

**\*(c) A student has three solids, A, B and C.**

**The solids are sodium carbonate, powdered zinc and copper oxide, but the student does not know which solid is which.**

**The student reacted each solid with dilute sulfuric acid.**

**Look at Figure 9 for Question 6(c) in the Diagram Booklet. It shows the student's observations and the results of tests on any gases produced.**

**Use the observations and results in Figure 9 to identify which solid is which.**

**Your answer should include**

- how each test result helps you to identify the solid**
- word equations to support your answer.  
(6 marks)**

**Answer space continues on the next 4 pages.**



**6(c) continued.**

[illegible]

**Turn over**

**6(c) continued.**

[illegible]

**Turn over**

**6(c) continued.**

[illegible]

**Turn over**

**6(c) continued.**

[illegible]

**(Total for Question 6 = 13 marks)**

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