

**Chemistry**  
**UNIT: 4CH1**  
**Science (Double Award) 4SD0**  
**PAPER: 1C**

Total Marks
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**Time: 2 hours**

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

<b>Surname</b>					
<b>Other names</b>					
<b>Centre Number</b>					
<b>Candidate Number</b>					

**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.**

**Show all the steps in any calculations and state the units.**

**INFORMATION**

**The total mark for this paper is 110.**

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

**There may be spare copies of some diagrams.**

**ADVICE**

**Read each question carefully before you start to answer it.**

**Write your answers neatly and in good English.**

**Try to answer every question.**

**Check your answers if you have time at the end.**

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**Answer ALL questions.**

**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 the diagram for Question 1 in the Diagram Booklet. It shows the electronic configuration of an atom of an element.**

**(a) Name the part of the atom that contains the protons and neutrons.**

**(1 mark)**

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**(b) Give the number of protons in this atom.**

**(1 mark)**

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**(c) Give the number of the group that contains this element.**

**(1 mark)**

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**Turn over**

**1 continued.**

**(d) Give the number of the period that contains this element.  
(1 mark)**

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**(e) Give the charge on the ion formed from this atom.  
(1 mark)**

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**(Total for Question 1 = 5 marks)**

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**2 (a) The list below shows some changes of state.**

**boiling**

**condensation**

**evaporation**

**freezing**

**melting**

**sublimation**

**Look at the table for Question 2(a) in the Diagram Booklet. It lists some physical changes.**

**Complete the table using words from the list to show the change of state for each physical change.**

**(4 marks)**

**(continued on the next page)**

**2 continued.**

**(b) A student plans to obtain salt crystals from a mixture of salt and sand.**

**The student adds pure water to the mixture to dissolve the salt.**

**(i) State two things the student could do to make the salt dissolve quickly.  
(2 marks)**

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

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

**(continued on the next page)**

**2 continued.**

- (ii) State what the student should do next to separate the sand from the salt solution.  
(1 mark)**

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- (iii) Describe how the student can obtain pure dry crystals of salt from the salt solution.  
(4 marks)**

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**(Total for Question 2 = 11 marks)**

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**3 Crude oil is an important source of organic compounds.**

**(a) Look at the diagram for Question 3(a) in the Diagram Booklet. It shows how crude oil can be separated into fractions by fractional distillation.**

**(i) State what happens to the crude oil when it is in X.  
(1 mark)**

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**(ii) Give the name of fraction E.  
(1 mark)**

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**(continued on the next page)**

**3 continued.**

**(iii) Give a use for fraction A.  
(1 mark)**

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**(b) One of the compounds in fraction D is tridecane ( $C_{13}H_{28}$ ) which can be cracked to form shorter-chain hydrocarbons.**

**(i) State the catalyst and temperature used in this cracking reaction.  
(2 marks)**

**catalyst**

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**temperature**

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**3 continued.**

**(ii) The equation shows an example of a catalytic cracking reaction.**



**Give two reasons why this reaction is important.  
(2 marks)**

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

\_\_\_\_\_

\_\_\_\_\_

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

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\_\_\_\_\_

### 3 continued.

**(c) Sulfur is an impurity in crude oil.**

**Explain why this is a problem for the environment.**

**(3 marks)**

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

**Turn over**

- 4 A student uses the reaction between iron and oxygen to find the percentage of oxygen in air.**

**Look at the diagram for Question 4(a) in the Diagram Booklet. It shows the apparatus the student uses.**

- (a) (i) State why the iron powder needs to be wet.  
(1 mark)**

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- (ii) State the colour of the compound formed in the reaction between iron and oxygen.  
(1 mark)**

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**4 continued.**

**(iii) Give the formula of the compound formed.  
(1 mark)**

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**(iv) Explain the advantage of using iron powder  
rather than pieces of iron.  
(2 marks)**

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**4 continued.**

- (b) Look at the diagram for Question 4(b) in the Diagram Booklet. It shows a close up of the scale on the gas syringe shown in the diagram for 4(a). The syringe in the diagram shows the reading at the end of the experiment.**

**Look at TABLE 1 for Question 4(b) in the Diagram Booklet. Complete table 1 to show the readings on the syringe.**

**Give both values to the nearest  $1\text{ cm}^3$ .  
(2 marks)**

**(continued on the next page)**



**4 continued.**

- (c) The student repeats the experiment and obtains a different set of results.**

**Look at TABLE 2 for Question 4(c) in the Diagram Booklet. It shows these results.**

**Use the results from table 2 to calculate the percentage by volume of oxygen in the air.  
(3 marks)**

**percentage by volume of oxygen in air = \_\_\_\_\_ %**

**(Total for Question 4 = 10 marks)**

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**Turn over**

**5 This question is about alkanes and alkenes.**

**(a) The alkane  $\text{C}_5\text{H}_{12}$  has three isomers.**

**(i) State what is meant by the term ISOMERS.  
(2 marks)**

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**(ii) Calculate the relative formula mass ( $M_r$ )  
of  $\text{C}_5\text{H}_{12}$   
(1 mark)**

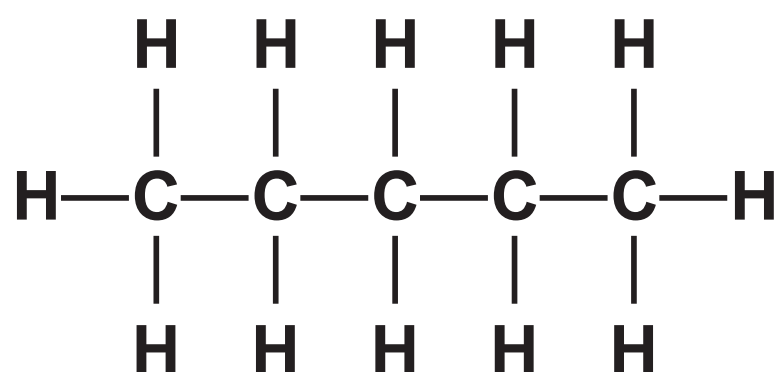
$M_r$  of  $\text{C}_5\text{H}_{12}$  = \_\_\_\_\_

**(continued on the next page)**

**Turn over**

**5 continued.**

**(iii) This is the displayed formula of one of the isomers.**



**Give the name of this isomer.  
(1 mark)**

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**(iv) Look at the diagram for Question 5(a)(iv) in the Diagram Booklet. Draw the displayed formulae of the other two isomers.  
(2 marks)**

**(continued on the next page)**

**5 continued.**

**(b) Ethane ( $\text{C}_2\text{H}_6$ ) and ethene ( $\text{C}_2\text{H}_4$ ) both react with bromine.**

**Describe the differences in the reactions of ethane and ethene with bromine.**

**Refer to the conditions, the products and the types of reaction involved.**

**(5 marks)**

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

**Turn over**

- 6 Look at the diagram for Question 6 in the Diagram Booklet. A student uses this apparatus to investigate the reaction between magnesium and dilute hydrochloric acid.

(a) The word equation for the reaction is

magnesium + hydrochloric acid  $\longrightarrow$   
magnesium chloride + hydrogen

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



\_\_\_\_\_ + \_\_\_\_\_

- (ii) Give the test for hydrogen.  
(1 mark)

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**6 continued.**

**(iii) The student uses 0.090 g of magnesium and 0.025 mol of hydrochloric acid.**

**Show by calculation that the hydrochloric acid is in excess.**

**(2 marks)**

**(continued on the next page)**

**6 continued.**

- (b) The student measures the volume of hydrogen collected at regular intervals until the reaction stops.**

**The table shows the student's results.**

<b>Time in s</b>	<b>0</b>	<b>15</b>	<b>30</b>	<b>45</b>	<b>60</b>	<b>75</b>
<b>Volume of hydrogen in cm<sup>3</sup></b>	<b>0</b>	<b>40</b>	<b>68</b>	<b>80</b>	<b>88</b>	<b>88</b>

**For the following questions, look at the grid for Question 6(b) and 6(c) in the Diagram Booklet.**

- (i) Plot the student's results.  
(1 mark)**
- (ii) Draw a curve of best fit.  
(1 mark)**
- (iii) Determine the volume of hydrogen collected in the first 10 seconds.**

**Show on the graph how you obtained your answer.  
(2 marks)**

**volume of hydrogen = \_\_\_\_\_ cm<sup>3</sup>**



**6 continued.**

- (iv) Explain why the rate of reaction is greatest at the start of the reaction.  
(2 marks)**

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**6 continued.**

- (c) The student repeats the experiment at a temperature 5 °C higher than the original temperature.**

**All other conditions are kept the same.**

- (i) Look again at the grid for Question 6(b) and 6(c) in the Diagram Booklet. On the grid, draw the curve you would expect the student to obtain. (2 marks)**
- (ii) Explain, in terms of particle collision theory, how increasing the temperature affects the rate of reaction. (3 marks)**

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**6 continued.**

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**(Total for Question 6 = 15 marks)**

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**7 This question is about copper and copper compounds.**

**(a) A sample of copper contains two isotopes.**

- Cu-63 with relative abundance 69.5%**
- Cu-65 with relative abundance 30.5%**

**(i) State what is meant by the term ISOTOPES.  
(2 marks)**

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**7 continued.**

- (ii) Calculate the relative atomic mass ( $A_r$ ) of this sample of copper.**

**Give your answer to three significant figures.  
(3 marks)**

**$A_r$  of copper = \_\_\_\_\_**

**(continued on the next page)**

**7 continued.**

**(b) When copper(II) carbonate is heated, copper(II) oxide and carbon dioxide are formed.**

**(i) What is the name of this type of reaction?  
(1 mark)**

☐ **A decomposition**

☐ **B neutralisation**

☐ **C oxidation**

☐ **D reduction**

**(ii) Which colour change occurs during this reaction?  
(1 mark)**

☐ **A blue to black**

☐ **B blue to white**

☐ **C green to black**

☐ **D green to orange**

**(continued on the next page)**

**Turn over**

**7 continued.**

- (c) Look at the diagram for Question 7(c) in the Diagram Booklet. A student uses this apparatus to find the value of  $x$  in the formula  $\text{CuSO}_4 \cdot x\text{H}_2\text{O}$**

**This is the student's method.**

- find the mass of an empty boiling tube**
- add hydrated copper(II) sulfate to the tube and record the new mass**
- heat the hydrated copper(II) sulfate until it changes colour**
- allow the tube to cool and record the mass again**

**Look at the table for Question 7(c) in the Diagram Booklet. It shows the student's results.**

- (i) Calculate the mass of  $\text{CuSO}_4$  formed.  
(1 mark)**

**mass of  $\text{CuSO}_4$  = \_\_\_\_\_ g**

**(continued on the next page)**

**7 continued.**

- (ii) Calculate the mass of water formed.  
(1 mark)**

**mass of water = \_\_\_\_\_ g**

- (iii) Show that the value of x is approximately 4  
(3 marks)**

**[ $M_r$  of  $\text{CuSO}_4$  = 159.5       $M_r$  of  $\text{H}_2\text{O}$  = 18]**

**(continued on the next page)**

**Turn over**



**7 continued.**

**(iv) The actual value of  $x$  is 5**

**Give a reason why the calculated value of  $x$  is lower than the actual value.**

**(1 mark)**

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**(Total for Question 7 = 13 marks)**

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- 8 Diamond and graphite are giant covalent structures made of carbon atoms.**

**Look at the diagram for Question 8(a) in the Diagram Booklet. It shows their structures.**

- (a) Discuss the differences between diamond and graphite.**

**Refer to structure and bonding, electrical conductivity and hardness in your answer.  
(6 marks)**

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**8 continued.**

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**8 continued.**

**(b)  $C_{60}$  fullerene is a simple molecular substance made of 60 carbon atoms.**

**Look at the diagram for Question 8(b) in the Diagram Booklet. It shows its structure.**

**Look at the table for Question 8(b) in the Diagram Booklet. It shows the approximate melting points of diamond, graphite and  $C_{60}$  fullerene.**

**Explain why  $C_{60}$  fullerene has a much lower melting point than diamond and graphite.  
(4 marks)**

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(Total for Question 8 = 10 marks)

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**9 This question is about the oxides of lead.**

**(a) Yellow lead oxide (PbO) can be reacted with hydrogen to produce lead.**

**(i) Complete the equation for the reaction by adding the missing state symbols.  
(1 mark)**



**(ii) What is the charge on the lead ion in PbO?  
(1 mark)**

☐ **A 1–**

☐ **B 1+**

☐ **C 2–**

☐ **D 2+**

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**9 continued.**

**(iii) Explain why the reaction of yellow lead oxide with hydrogen is a redox reaction.  
(2 marks)**

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**9 continued.**

**(iv) Describe a physical test to show that the water produced in this reaction is pure.  
(2 marks)**

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9 continued.

- (b) When red lead oxide ( $\text{Pb}_3\text{O}_4$ ) is heated, yellow lead oxide forms.

The equation for the reaction is



A scientist heats a known mass of red lead oxide in a crucible in a fume cupboard.

The scientist leaves the crucible to cool, then records the total mass of the crucible and its contents.

- (i) Describe what the scientist should do next to make sure that all the red lead oxide has reacted.  
(2 marks)

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Turn over

**9 continued.**

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9 continued.

- (ii) The red lead oxide used in the reaction has a mass of 5.48 g.

Calculate the maximum mass of yellow lead oxide that could form.  
(3 marks)

[ $M_r$  of  $\text{Pb}_3\text{O}_4 = 685$        $M_r$  of  $\text{PbO} = 223$ ]

maximum mass of  $\text{PbO} =$  \_\_\_\_\_ g

(Total for Question 9 = 11 marks)

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Turn over

**10 This question is about ammonia and ammonium compounds.**

**(a) Ammonia ( $\text{NH}_3$ ) is a simple covalent molecule.**

**Draw a dot-and-cross diagram to show the bonding in a molecule of ammonia.**

**(2 marks)**

**(continued on the next page)**

**10 continued.**

**(b) Look at the table for Question 10(b) in the Diagram Booklet. It shows the names and formulae of some ammonium compounds.**

**(i) Complete the table by giving the missing information.**

**(2 marks)**

**(ii) When ammonia reacts with sulfuric acid, ammonium sulfate is formed.**

**Write a chemical equation for this reaction.**

**(1 mark)**

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**10 continued.**

**(iii) Describe a test for ammonium ions.  
(3 marks)**

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**(continued on the next page)**

**10 continued.**

**(c) Look at the table for Question 10(c) in the Diagram Booklet. It gives some information about ammonia and ammonium compounds.**

**(i) Calculate the percentage of nitrogen in ammonium nitrate.  
(2 marks)**

**[ $M_r$  of  $\text{NH}_4\text{NO}_3 = 80$ ]**

**percentage of nitrogen = \_\_\_\_\_ %**

**(continued on the next page)**

**Turn over**



**10 continued.**

- (ii) Fertilisers add nitrogen to the soil to help plants grow.**

**Ammonia and ammonium sulfate can both be used as fertilisers.**

**Discuss the advantages and disadvantages of using each of these compounds as fertilisers.**

**Use information from the table in your answer.  
(4 marks)**

**[pH of rainwater is approximately 5·6]**

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10 continued.

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(Total for Question 10 = 14 marks)

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TOTAL FOR PAPER = 110 MARKS  
END OF PAPER