

Chemistry  
Science (Double Award) 4SD0  
PAPER 1C

Total Marks
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Time: 2 hours plus your additional time allowance

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 – there may be more space than you need.**

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

**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 ☐.**

**Turn over**

## **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.**

**A Periodic Table is provided.**

## **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.**

**Good luck with your examination.**

## **Answer ALL questions.**

- 1 The list below shows the names of some substances.**

**bromine**

**carbon dioxide**

**copper**

**iodine**

**methane**

**nitrogen**

**sulfur dioxide**

**water**

- (a) Look at the table for Question 1(a) in the Diagram Booklet. Complete the table by choosing substances from the list above that match the description.**

**Each substance may be used once, more than once or not at all.**

**(5 marks)**

**(continued on the next page)**

**Turn over**

**1 continued.**

**(b) Describe a test for carbon dioxide.  
(2 marks)**

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**(Total for Question 1 = 7 marks)**

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**Turn over**

- 2 (a) Look at Table 1 for Question 2(a) in the Diagram Booklet. It gives some information about three subatomic particles.**
- (i) Complete Table 1 by giving the missing information.  
(3 marks)**
- (ii) Give the name of the part of the atom containing protons and neutrons.  
(1 mark)**
- 
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**(continued on the next page)**

**2 continued.**

**(b) Look at Table 2 for Question 2(b) in the Diagram Booklet. It shows the numbers of protons, neutrons and electrons in the species U, V, W, X, Y and Z.**

**Use the information in Table 2 to answer these questions.**

**Each species may be used once, more than once or not at all.**

**(i) Give the letter of the species that has six electrons in its outer shell.  
(1 mark)**

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**(ii) Give the mass number of Z.  
(1 mark)**

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**(continued on the next page)**

**Turn over**

**2 continued.**

**(iii) Give the letter of the species that is a positive ion.  
(1 mark)**

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**(iv) Give the letters of the two species that are isotopes of the same element.  
(1 mark)**

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**(continued on the next page)**

**Turn over**



**2 continued.**

**(c) A sample of neon contains**

**two isotopes,  $^{20}\text{Ne}$  and  $^{22}\text{Ne}$**

**The relative abundances of the two isotopes in the sample are**

$^{20}\text{Ne}$	91.2%	$^{22}\text{Ne}$	8.80%
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**Turn over**

**2 continued.**

**Calculate the relative atomic mass of this sample of neon.**

**Give your answer to one decimal place.  
(3 marks)**

**relative atomic mass =**

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

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**Turn over**

- 3 Some sugar is added to cold water in a beaker.**

**After some time, all the sugar dissolves and spreads throughout the water.**

- (a) (i) Name the process that occurs which causes the sugar to spread throughout the water.  
(1 mark)**

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**(continued on the next page)**

**3 continued.**

**(ii) State two ways to make the sugar dissolve more quickly.  
(2 marks)**

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

\_\_\_\_\_

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

\_\_\_\_\_

**(continued on the next page)**

**Turn over**

**3 continued.**

**(b) Look at the apparatus for Question 3(b) in the Diagram Booklet. Pure water can be obtained from the sugar solution using this apparatus.**

**(i) Name the process used to obtain pure water from the sugar solution.  
(1 mark)**

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**(continued on the next page)**

**3 continued.**

**(ii) Explain the purpose of the piece of apparatus labelled X.  
(2 marks)**

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**(Total for Question 3 = 6 marks)**

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**Turn over**

- 4 A student uses paper chromatography in an experiment to separate the dyes in four different food colourings, E, F, G and H.**

**Look at the diagram for Question 4 in the Diagram Booklet. It shows the appearance of the paper before and after the experiment.**

- (a) (i) Describe how the student should complete the experiment after putting a spot of each food colouring on the paper.  
(3 marks)**

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**Turn over**

**4 continued.**

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**Turn over**



**4 continued.**

**(ii) Deduce the number of dyes in food colouring H.  
(1 mark)**

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**(iii) Suggest why food colouring F does not move during the experiment.  
(1 mark)**

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**Turn over**

**4 continued.**

**(iv) Explain which two food colourings contain the dye that is likely to be the most soluble in the solvent.  
(2 marks)**

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**Turn over**

**4 continued.**

**(b) Determine which food colouring contains a dye with  $R_f$  value closest to 0.67**

**Show your working.  
(3 marks)**

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

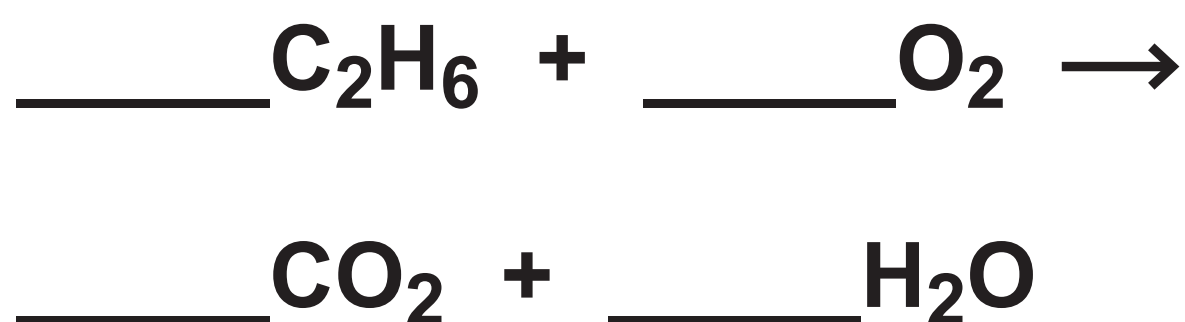
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**Turn over**

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

**(a) (i) Look at the table for Question 5(a)(i) in the Diagram Booklet. Complete the table by giving the missing information about the alkane with the molecular formula  $C_2H_6$  (3 marks)**

**(ii) Complete the chemical equation for the complete combustion of the alkane  $C_2H_6$  (1 mark)**



**(continued on the next page)**

**5 continued.**

**(iii) Incomplete combustion occurs when the air supply is limited.**

**Give the names of two products of incomplete combustion.  
(2 marks)**

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

\_\_\_\_\_

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

\_\_\_\_\_

**(continued on the next page)**

**Turn over**

**5 continued.**

**(b) An alkene with molecular formula  $C_4H_8$  reacts with bromine to form a compound with molecular formula  $C_4H_8Br_2$**

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

☐ **A addition**

☐ **B decomposition**

☐ **C precipitation**

☐ **D substitution**

**(continued on the next page)**

**Turn over**

**5 continued.**

**(ii) Look at the table for Question 5(b)(ii) in the Diagram Booklet. Draw displayed formulae for two different alkenes with the molecular formula  $C_4H_8$  (2 marks)**

**(iii) State the term used for compounds with the same molecular formula but different structural formulae. (1 mark)**

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**5 continued.**

**(c) The alkene  $\text{C}_3\text{H}_6$  can be polymerised to form the polymer poly(propene).**

**(i) Look at the equation for Question 5(c)(i) in the Diagram Booklet. Complete the equation for this polymerisation reaction. (2 marks)**

**(continued on the next page)**



**5 continued.**

**(ii) Two ways of disposing of polymers such as poly(propene) are**

- **burying them in landfill sites**
- **burning them to release heat energy**

**Discuss the environmental problems caused by these two methods of disposal.  
(3 marks)**

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**Turn over**

**5 continued.**

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**(Total for Question 5 = 15 marks)**

**Turn over**

**6 This question is about some of the Group 1 elements and their compounds.**

**(a) A teacher adds a small piece of lithium to water in a trough.**

**(i) Give three observations that are made when lithium reacts with water.  
(3 marks)**

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

\_\_\_\_\_

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

\_\_\_\_\_

**3** \_\_\_\_\_

\_\_\_\_\_

**(continued on the next page)**

**Turn over**

**6 continued.**

- (ii) After the reaction has finished, the teacher adds a few drops of universal indicator to the solution in the trough.**

**Explain the colour of the universal indicator after it is added to the solution.  
(2 marks)**

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**Turn over**

**6 continued.**

**(iii) Write a chemical equation for the reaction of lithium with water.  
(2 marks)**

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**Turn over**

**6 continued.**

**(b) A student does a flame test to see if a white solid contains sodium ions.**

**She cleans a platinum wire before using it for the flame test.**

**(i) Explain why the student needs to clean the platinum wire.  
(2 marks)**

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**Turn over**

**6 continued.**

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**6 continued.**

**(ii) Which of these is the colour of the flame if the solid contains sodium ions?  
(1 mark)**

☐ **A green**

☐ **B lilac**

☐ **C red**

☐ **D yellow**

**(continued on the next page)**

**Turn over**



**6 continued.**

**(c) Potassium sulfate ( $K_2SO_4$ ) is an ionic compound.**

**(i) Give the formula of each ion in potassium sulfate.  
(1 mark)**

**potassium ion**

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**sulfate ion**

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**(continued on the next page)**

**Turn over**

**6 continued.**

**(ii) The melting point of potassium sulfate is 1069 °C.**

**Explain why potassium sulfate has a high melting point.**

**Refer to structure and bonding in your answer.  
(4 marks)**

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**Turn over**

6 continued.

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Turn over

**6 continued.**

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

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- 7 A student investigates the reaction between magnesium and hydrochloric acid.**

**He uses this method.**

- Step 1    add 25 cm<sup>3</sup> of dilute hydrochloric acid to a polystyrene cup**
- Step 2    record the temperature of the acid**
- Step 3    find the mass of a 10 cm strip of magnesium ribbon**
- Step 4    add the magnesium ribbon to the hydrochloric acid**
- Step 5    when all the magnesium has reacted, record the highest temperature reached**

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**7 continued.**

- (a) Complete the word equation for the reaction.  
(1 mark)**

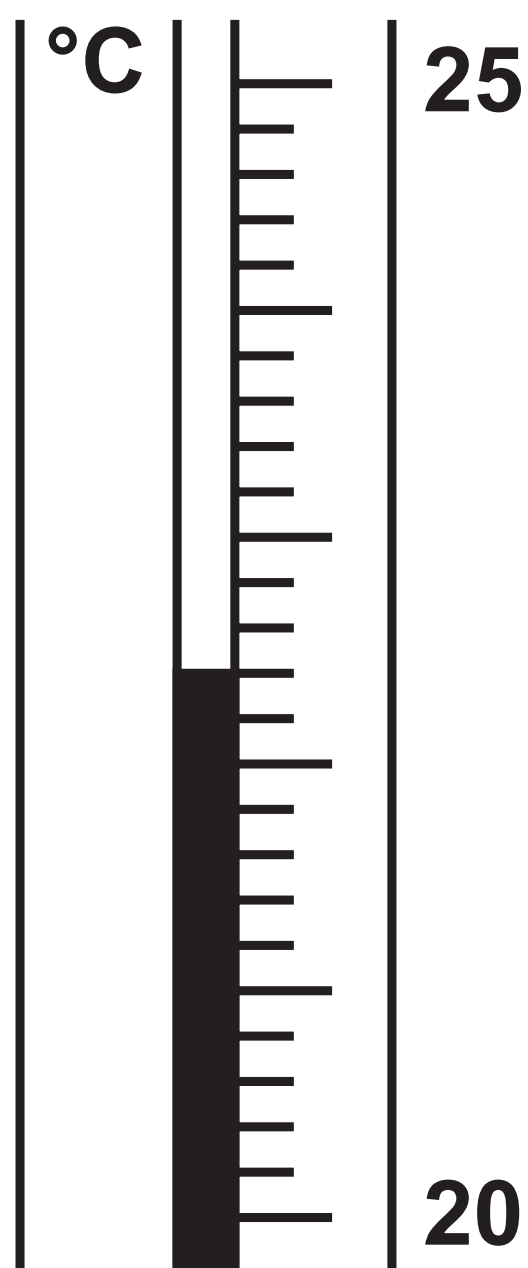
**magnesium + hydrochloric acid →**

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

**(continued on the next page)**

**7 continued.**

**(b) The thermometer shows the temperature of the acid at the start of the experiment.**



**(i) Look at the table for Question 7(b)(i) in the Diagram Booklet. Complete the table by giving the temperatures to the nearest 0.1 °C.  
(2 marks)**

**(continued on the next page)**

**Turn over**

**7 continued.**

**(ii) Show that the heat energy change (Q) for this reaction is about 2200 J.**

**[mass of  $1.0\text{ cm}^3$  of solution  
=  $1.0\text{ g}$ ]**

**[for the solution,  $c = 4.2\text{ J/g/}^\circ\text{C}$ ]  
(2 marks)**

**(continued on the next page)**

**Turn over**



**7 continued.**

**(iii) The mass of magnesium used by the student was 0.12 g.**

**Calculate the value of the enthalpy change ( $\Delta H$ ), in kilojoules per mole of magnesium, for the reaction between magnesium and hydrochloric acid.**

**Include a sign in your answer.  
(4 marks)**

**(continued on the next page)**

**Turn over**

**7 continued.**

**$\Delta H =$**

**\_\_\_\_\_ kJ/mol**

**(Total for Question 7 = 9 marks)**

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**Turn over**

- 8 (a) A scientist finds an unlabelled bottle on a shelf.

She thinks the bottle contains a solution of ammonium sulfate,  $(\text{NH}_4)_2\text{SO}_4$

Describe tests the scientist could do to show that the solution is ammonium sulfate.  
(6 marks)

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**8 continued.**

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**8 continued.**

**(b) Ammonium sulfate is often used as a fertiliser.**

**It is prepared by reacting ammonia ( $\text{NH}_3$ ) with sulfuric acid ( $\text{H}_2\text{SO}_4$ ).**

**(i) Name the type of reaction that occurs between ammonia and sulfuric acid.  
(1 mark)**

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**8 continued.**

**(ii) Write a chemical equation for the reaction of ammonia with sulfuric acid.  
(1 mark)**

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**8 continued.**

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

**Show outer electrons only.  
(2 marks)**

**(Total for Question 8 = 10 marks)**

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**Turn over**



- 9 Look at the apparatus for Question 9 in the Diagram Booklet. A student uses this apparatus to investigate the rate of reaction between marble chips and dilute hydrochloric acid.**

**The equation for the reaction is**



**(a) During the reaction the mass of the contents of the flask decreases.**

- (i) State why the mass of the contents of the flask decreases.  
(1 mark)**

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**(continued on the next page)**

**9 continued.**

**(ii) State the purpose of the  
cotton wool.  
(1 mark)**

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**Turn over**

**9 continued.**

**(iii) Explain why sulfuric acid is not a suitable acid to use in this investigation.  
(2 marks)**

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**Turn over**

**9 continued.**

**(b) Look at the graph for Question 9(b) in the Diagram Booklet. It shows the student's results.**

**(i) In the investigation the marble chips are in excess.**

**Explain the shape of the graph.  
(4 marks)**

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**Turn over**

**9 continued.**

- (ii) The student repeats the experiment using the same volume of hydrochloric acid but of half the concentration of the original acid. All other conditions are kept the same.**

**On the grid for Question 9(b) in the Diagram Booklet, draw the curve the student would obtain.  
(2 marks)**

**(continued on the next page)**

**9 continued.**

**(c) Explain, using particle collision theory, how increasing the temperature affects the rate of a reaction.  
(4 marks)**

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## 9 continued.

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**(Total for Question 9 = 14 marks)**

**Turn over**



- 10 (a) Look at the diagram for Question 10(a) in the Diagram Booklet. It shows the apparatus a teacher uses to determine the formula of an oxide of lead.**

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

- Step 1    find the mass of the reduction tube**
- Step 2    add some of the lead oxide to the reduction tube**
- Step 3    find the mass of the reduction tube and lead oxide**
- Step 4    pass hydrogen gas over the lead oxide and ignite the hydrogen at the hole**
- Step 5    heat the lead oxide strongly for 10 minutes**

**(continued on the next page)**

**10 continued.**

**Step 6** keep passing hydrogen through the reduction tube until the tube and contents are cool

**Step 7** find the new mass of the reduction tube and its contents

- (i) Give a reason why hydrogen is passed through the reduction tube until the tube and contents are cool.  
(1 mark)**
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**(continued on the next page)**

**Turn over**

**10 continued.**

- (ii) Describe what the teacher should do next to make sure all the lead oxide has been reduced to lead.  
(2 marks)**

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**Turn over**

**10 continued.**

**(b) The teacher completes the experiment and obtains these results.**

**mass of reduction tube = 23.50 g**

**mass of tube + lead oxide = 28.64 g**

**mass of tube + lead = 28.16 g**

**(i) Calculate the mass of lead formed.  
(1 mark)**

**mass of lead =**

**\_\_\_\_\_ g**

**(continued on the next page)**

**Turn over**

**10 continued.**

- (ii) Calculate the mass of oxygen removed from the lead oxide.  
(1 mark)**

**mass of oxygen =**

**\_\_\_\_\_ g**

**(continued on the next page)**

**10 continued.**

**(iii) Determine the empirical formula  
of the lead oxide.  
(4 marks)**

**empirical formula of the  
lead oxide =**

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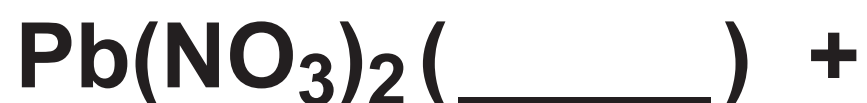
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**Turn over**

**10 continued.**

**(c) The insoluble salt lead(II) chloride ( $\text{PbCl}_2$ ) can be prepared by reacting a solution of lead(II) nitrate with dilute hydrochloric acid.**

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



**(continued on the next page)**

**Turn over**

**10 continued.**

**(ii) Show that the maximum mass of lead(II) chloride that can be made from 0.0370 mol of hydrochloric acid is about 5 g.**

**[ $M_r$  of  $\text{PbCl}_2 = 278$ ]  
(3 marks)**

**maximum mass =**

**\_\_\_\_\_ g**

**(Total for Question 10 = 13 marks)**

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**TOTAL FOR PAPER = 110 MARKS  
END**