

**Paper Reference(s) 4CH1/2C**  
**Pearson Edexcel International GCSE (9–1)**

**Chemistry**

**UNIT: 4CH1**

**PAPER: 2C**

**Total Marks**

**Time: 1 hour 15 minutes**

**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 70.**

**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 This question is about gases in the atmosphere.**

**Look at the list for Question 1(a) in the Diagram Booklet. It gives the names of some gases.**

**(a) Choose gases from the list to answer these questions.**

**(i) Identify the least reactive gas in the atmosphere.  
(1 mark)**

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**1 continued.**

- (ii) Identify the most abundant gas in the atmosphere.  
(1 mark)**

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- (iii) Identify the gas that is not normally found in the atmosphere.  
(1 mark)**

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- (b) State an environmental problem caused by increasing amounts of carbon dioxide in the atmosphere.  
(1 mark)**

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**1 continued.**

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

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

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- 2 (a) Look at the diagram for Question 2(a) in the Diagram Booklet. It shows two pieces of apparatus, X and Y.

- (i) Give the name of each piece of apparatus.  
(2 marks)

X \_\_\_\_\_

\_\_\_\_\_

Y \_\_\_\_\_

\_\_\_\_\_

- (ii) In a titration, a student adds  $25.0\text{ cm}^3$  of barium hydroxide solution to a conical flask.

Give a reason why it is better to use Y rather than X.

(1 mark)

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

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**2 continued.**

**(b) The student uses methyl orange indicator in the titration.**

**(i) State the colour of methyl orange in barium hydroxide solution.  
(1 mark)**

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**(ii) Give a reason why universal indicator is NOT suitable for use in a titration.  
(1 mark)**

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**Turn over**



2 continued.

- (c) The student adds some dilute nitric acid to a burette and does the titration.

The equation for the reaction is



The student finds that  $21.50 \text{ cm}^3$  of nitric acid of concentration  $0.600 \text{ mol/dm}^3$  neutralises  $25.0 \text{ cm}^3$  of barium hydroxide solution.

Calculate the concentration, in  $\text{mol/dm}^3$ , of the barium hydroxide solution.

(3 marks)

concentration = \_\_\_\_\_  $\text{mol/dm}^3$

**2 continued.**

**(d) State why sulfuric acid would not be a suitable acid to use in this titration.**

**(1 mark)**

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

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**3 This question is about Group 7, the halogens.**

**(a) Which halogen has the palest colour?  
(1 mark)**

☐ **A astatine**

☐ **B bromine**

☐ **C fluorine**

☐ **D iodine**

**(b) Which halogen is a solid at room temperature?  
(1 mark)**

☐ **A astatine**

☐ **B bromine**

☐ **C chlorine**

☐ **D fluorine**

**(continued on the next page)**

**3 continued.**

- (c) Look at the table for Question 3(c) in the Diagram Booklet. It shows the electronic configurations of a fluorine atom and a chlorine atom.**

**Explain the relative reactivities of fluorine and chlorine using the information in the table.  
(4 marks)**

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**3 continued.**

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**(d) Lithium reacts with chlorine to form lithium chloride.**

**(i) Write a chemical equation for the reaction of lithium with chlorine.  
(1 mark)**

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**3 continued.**

**(ii) Describe tests to show that the product of the reaction is lithium chloride.**  
**(5 marks)**

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**3 continued.**

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**(Total for Question 3 = 12 marks)**

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**4 This question is about magnesium and magnesium compounds.**

**(a) Magnesium burns in oxygen to form magnesium oxide.**

**State two observations that would be seen during the reaction.**

**(2 marks)**

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

\_\_\_\_\_

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

\_\_\_\_\_

**(continued on the next page)**



**4 continued.**

- (b) Look at the diagram for Question 4(b) in the Diagram Booklet. It shows the electron configurations of a magnesium atom and an oxygen atom.**

**Describe the changes in the electronic configurations when magnesium reacts with oxygen to form the ionic compound magnesium oxide, MgO  
(2 marks)**

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**4 continued.**

**(c) Magnesium can be produced by the electrolysis of molten magnesium chloride.**

**(i) State why magnesium cannot be produced by heating magnesium oxide with carbon.  
(1 mark)**

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**4 continued.**

- (ii) Explain the different ways that magnesium and magnesium chloride conduct electricity. (4 marks)**

**magnesium**

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4 continued.

magnesium chloride

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4 continued.

- (d) During the electrolysis of molten magnesium chloride, magnesium is formed at the negative electrode.

The ionic half-equation for the reaction is



- (i) State why this is a reduction reaction.  
(1 mark)

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- (ii) Write an ionic half-equation for the formation of chlorine at the positive electrode.  
(1 mark)

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(Total for Question 4 = 11 marks)

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- 5 (a) An organic compound has this percentage composition by mass.

C = 40 %      H = 6.7 %      O = 53.3 %

- (i) Show that the empirical formula of the compound is  $\text{CH}_2\text{O}$   
(2 marks)

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**5 continued.**

- (ii) Draw the structural formula of a compound with the molecular formula  $\text{C}_2\text{H}_4\text{O}_2$  (1 mark)**

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**5 continued.**

**(b) Methanoic acid ( $\text{HCOOH}$ ) reacts with sodium carbonate solution to give three products.**

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

**(ii) State what you would observe in this reaction.  
(1 mark)**

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5 continued.

- (c) Methanoic acid also reacts with propanol to form an ester.

The equation for the reaction is



- (i) Give the name of the ester that forms.  
(1 mark)

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- (ii) State what is meant by the  $\rightleftharpoons$  symbol.  
(1 mark)

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**5 continued.**

**(iii) When this reaction occurs in a sealed container, the reaction can reach dynamic equilibrium.**

**Give one characteristic of a reaction at dynamic equilibrium.  
(1 mark)**

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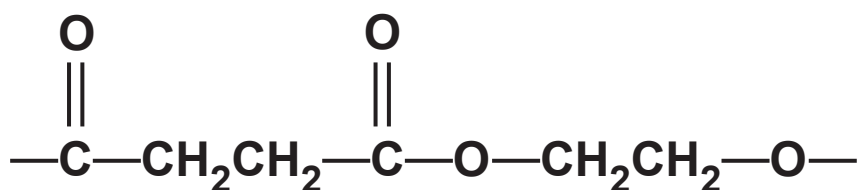
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5 continued.

- (d) A polyester forms when butanedioic acid reacts with ethanediol.

The diagram shows the repeat unit of the polyester that forms.



- (i) Give the name of this type of polymerisation.  
(1 mark)

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- (ii) Look at the diagram for Question 5(d)(ii) in the Diagram Booklet. Draw the structural formulae of the two monomers used to make this polyester.  
(2 marks)

(Total for Question 5 = 12 marks)

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**6 Titanium is an important metal in industry.**

**Titanium dioxide (TiO<sub>2</sub>) can be converted into titanium metal in two stages.**

**Stage 1 titanium dioxide is converted into titanium(IV) chloride (TiCl<sub>4</sub>)**

**Stage 2 titanium(IV) chloride is converted into titanium**

**(a) This is the equation for the reaction in stage 1.**



**Calculate the volume, in dm<sup>3</sup>, of chlorine gas at rtp needed to react completely with 20 tonnes of titanium dioxide.**

**(4 marks)**

**Give your answer in standard form.**

**[1 tonne = 10<sup>6</sup> g      M<sub>r</sub> of TiO<sub>2</sub> = 80]**

**[molar volume of chlorine gas at rtp = 24 dm<sup>3</sup>]**

**6 continued.**

**volume of chlorine gas = \_\_\_\_\_ dm<sup>3</sup>**

**(continued on the next page)**

6 continued.

- (b) In stage 2, titanium(IV) chloride vapour is passed through molten magnesium in a container filled with argon.

This is the equation for the reaction in stage 2.



Explain why the container is filled with argon rather than air.

(2 marks)

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**6 continued.**

**(c) Aeroplanes are made of an alloy containing aluminium and titanium.**

**Explain why the alloy is stronger than pure titanium metal.**

**You may include diagrams in your answer.  
(3 marks)**

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**6 continued.**

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**(Total for Question 6 = 9 marks)**

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- 7 Look at the diagram for Question 7 in the Diagram Booklet. A student uses this apparatus to find the heat energy supplied by a liquid fuel.**

**The student burns some fuel to heat the water in the copper container and measures the change in temperature.**

- (a) The student notices that the bottom of the container turns black.**

**Give the name of the black substance that forms on the bottom of the container.**

**(1 mark)**

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**7 continued.**

**(b) In one experiment, the student burns 0.92 g of ethanol.**

**The student calculates that the heat energy absorbed by the water is 18.2 kJ.**

**Show that the results of this experiment give an approximate value for the enthalpy of combustion of ethanol of  $\Delta H = -900 \text{ kJ/mol}$ .  
(2 marks)**

**[ $M_r$  of ethanol = 46]**

**7 continued.**

**(c) The data book value of  $\Delta H$  for the combustion of ethanol is  $-1367 \text{ kJ/mol}$ .**

**Give two reasons why the student's value is much lower than the data book value.**

**(2 marks)**

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

\_\_\_\_\_

\_\_\_\_\_

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

\_\_\_\_\_

\_\_\_\_\_

**(continued on the next page)**

**7 continued.**

**(d) The equation shows the combustion of methane.**



**Look at the equation for Question 7(d) in the Diagram Booklet. This is the equation showing the displayed formulae.**

**Look at the table for Question 7(d) in the Diagram Booklet. It shows the bond energies for O=O, C=O and O—H**

- (i) Calculate the bond energy of the C—H bond, using information from the equation and the table.  
(4 marks)**

**7 continued.**

**C—H bond energy = \_\_\_\_\_ kJ/mol**

- (ii) Look at the diagram for Question 7(d)(ii) in the Diagram Booklet. Complete the energy level diagram to show the products and  $\Delta H$ .  
(2 marks)**

**(Total for Question 7 = 11 marks)**

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**TOTAL FOR PAPER = 70 MARKS**

**END OF PAPER**