

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

**Chemistry**

**UNIT: 4CH1**

**PAPER: 2C**

Total Marks
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**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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Turn over

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)

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

(continued on the next page)

Turn over

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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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.**

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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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**(continued on the next page)**



**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.

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)

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

$$\text{C} = 40\% \quad \text{H} = 6.7\% \quad \text{O} = 53.3\%$$

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

(continued on the next page)

Turn over

5 continued.

- (ii) Draw the structural formula of a compound with the molecular formula  $C_2H_4O_2$  (1 mark)

(continued on the next page)

**5 continued.**

**(b) Methanoic acid (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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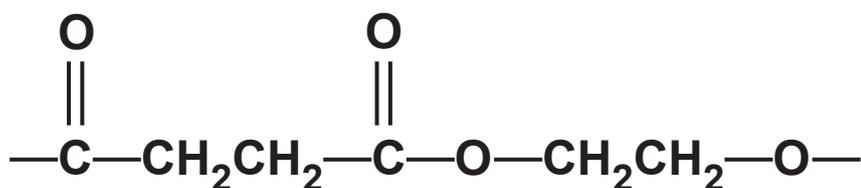
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5 continued.

- (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 ( $\text{TiO}_2$ ) can be converted into titanium metal in two stages.

Stage 1 titanium dioxide is converted into titanium(IV) chloride ( $\text{TiCl}_4$ )

Stage 2 titanium(IV) chloride is converted into titanium

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



Calculate the volume, in  $\text{dm}^3$ , 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 =  $10^6$  g       $M_r$  of  $\text{TiO}_2$  = 80]

[molar volume of chlorine gas at rtp =  $24 \text{ dm}^3$ ]

6 continued.

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

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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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**Turn over**

**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**