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.

Surname						
Other names						
Centre Number						
Candidate Number						

Q70947A

Pearson

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.

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)

(continued on the next page)

1 continued.

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

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

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

(continued on the next page)

1 continued.

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

(Total for Question 1 = 6 marks)

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 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)

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)

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

(continued on the next page)

2 continued.

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

The equation for the reaction is

$$Ba(OH)_2 + 2HNO_3 \longrightarrow Ba(NO_3)_2 + 2H_2O$$

The student finds that 21·50 cm^3 of nitric acid of concentration 0·600 mol/dm^3 neutralises 25·0 cm^3 of barium hydroxide solution.

Calculate the concentration, in mol/dm^3, of the barium hydroxide solution.
(3 marks)

concentration = _____ mol/dm^3

(continued on the next page)

2 continued.

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

(Total for Question 2 = 9 marks)

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)

(continued on the next page)

3 continued.

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

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

(continued on the next page)

3 continued.

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

(continued on the next page)

3 continued.

(Total for Question 3 = 12 marks)

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)

(continued on the next page)

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)

(continued on the next page)

4 continued.

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

magnesium

(continued on the next page)

4 continued.

magnesium chloride

(continued on the next page)

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

$$Mg^{2+} + 2e^- \longrightarrow Mg$$

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

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

(Total for Question 4 = 11 marks)

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 CH_2O
(2 marks)

(continued on the next page)

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)

(continued on the next page)

5 continued.

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

The equation for the reaction is

$$HCOOH + C_3H_7OH \rightleftharpoons HCOOC_3H_7 + H_2O$$

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

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

(continued on the next page)

5 continued.

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

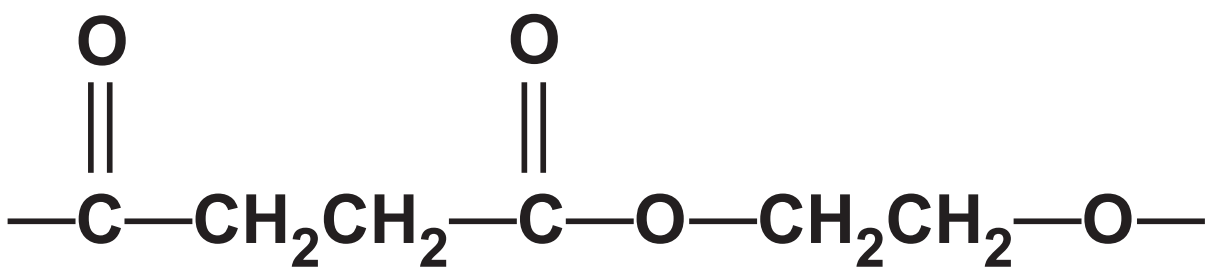
Give one characteristic of a reaction at dynamic equilibrium.
(1 mark)

(continued on the next page)

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)

(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_2) can be converted into titanium metal in two stages.

Stage 1 titanium dioxide is converted into titanium(IV) chloride ($TiCl_4$)

Stage 2 titanium(IV) chloride is converted into titanium

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

$$TiO_2 + 2Cl_2 + C \longrightarrow TiCl_4 + CO_2$$

Calculate the volume, in 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 TiO_2 = 80]

[molar volume of chlorine gas at rtp = 24 dm^3]

(continue your answer on the next page)

6 continued.

volume of chlorine gas = _____ dm^3

(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.

$$TiCl_4 + 2Mg \longrightarrow Ti + 2MgCl_2$$

Explain why the container is filled with argon rather than air.
(2 marks)

(continued on the next page)

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)

(continued on the next page)

6 continued.

(Total for Question 6 = 9 marks)

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)

(continued on the next page)

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 $\Delta H = -900\,kJ/mol$.
(2 marks)

[M_r of ethanol = 46]

7 continued.

(c) The data book value of ΔH for the combustion of ethanol is –1367 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.

$$CH_4 + 2O_2 \longrightarrow CO_2 + 2H_2O \qquad \Delta H = -890\,kJ/mol$$

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)

(continued on the next page)

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 ΔH.
(2 marks)

(Total for Question 7 = 11 marks)

TOTAL FOR PAPER = 70 MARKS

END OF PAPER