Paper Reference(s)   4CH1/1C 4SD0/1C
Pearson Edexcel International GCSE (9–1)

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

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 ☒.

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.

Answer ALL questions.

1   (a)   Look at the diagram for Question 1(a) in the
           Diagram Booklet. It shows the particles in
           four substances, A, B, C and D.

          (i)   Which substance contains single atoms of
                 one element?
                 (1 mark)

          ☐ A

          ☐ B

          ☐ C

          ☐ D

          (ii)   Which substance is a compound?
                 (1 mark)

          ☐ A

          ☐ B

          ☐ C

          ☐ D

(continued on the next page)

Turn over

1   **continued.**

   (iii) **Which substance could have the formula H_2?**
          (1 mark)

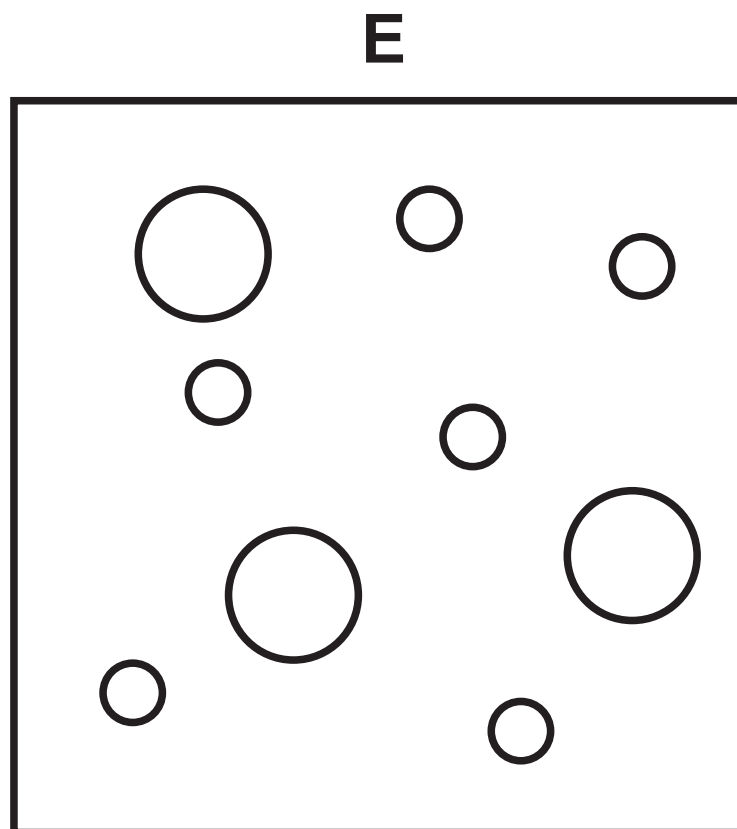   ☐ **A**

   ☐ **B**

   ☐ **C**

   ☐ **D**

(continued on the next page)

1 **continued.**

(b) **The diagram shows the particles in substance E.**

E

Give two reasons why substance E is a mixture.
(2 marks)

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(Total for Question 1 = 5 marks)

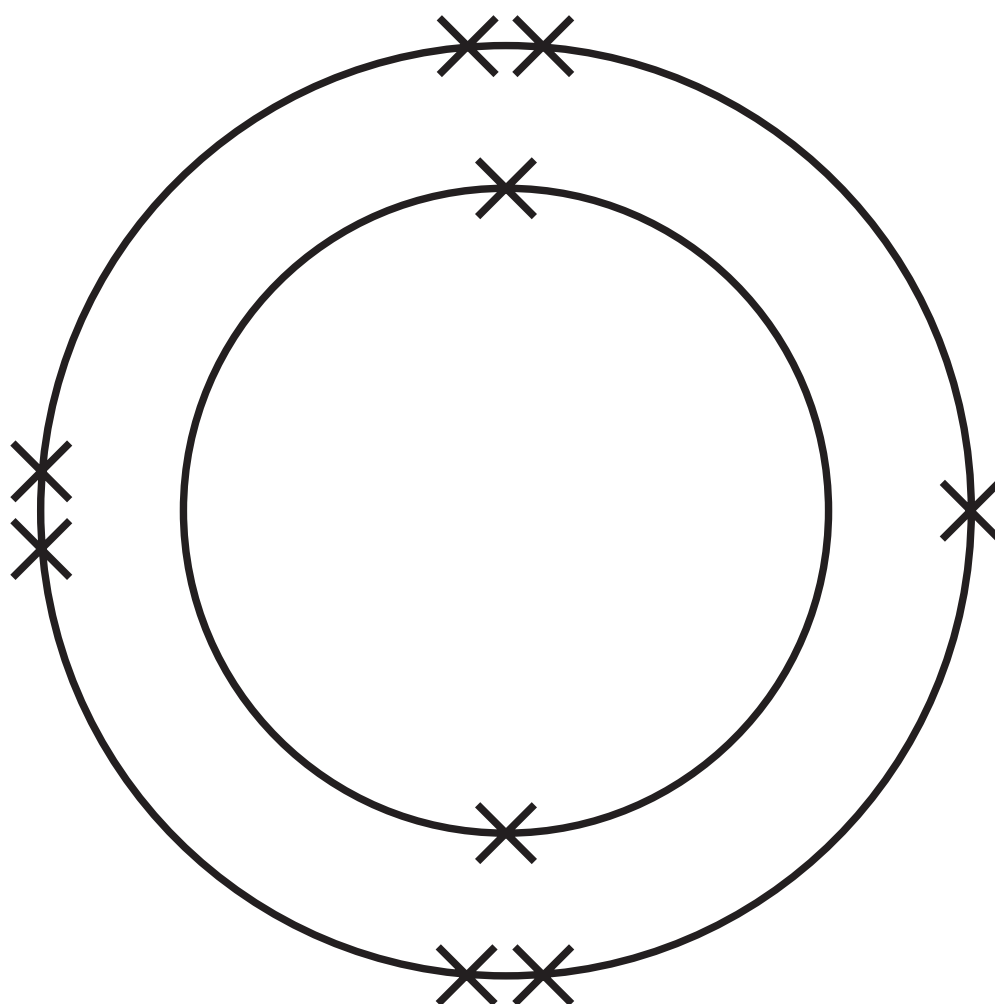2   This question is about Group 7 elements and their reactions.

(a) Fluorine has the smallest atoms in Group 7.

The diagram shows the electronic configuration of a fluorine atom.

(i)   State why fluorine has the smallest atoms in Group 7.
(1 mark)

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(continued on the next page)

Turn over

2   continued.

(ii) Which row gives the correct number of
occupied electron shells and the correct
number of outer shell electrons in an
atom of iodine?

Use the Periodic Table supplied to help you.
(1 mark)

	Number of occupied electron shells	Number of outer shell electrons
☐ A	4	5
☐ B	5	6
☐ C	5	7
☐ D	7	5

(continued on the next page)

2   continued.

    (b) (i)   Look at the table for Question 2(b)(i) in the Diagram Booklet. It gives descriptions of the reactions of some Group 7 elements with iron wool.

           Complete the table by giving a description of the reaction of fluorine with iron wool.
           (2 marks)

      (ii)   State the relationship between the reactivity of the Group 7 elements and the size of their atoms.
           (2 marks)

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(Total for Question 2 = 6 marks)

Turn over

3   This question is about the rusting of iron.

(a) Water is needed for iron to rust.

(i)   Name one other substance needed for iron
to rust.
(1 mark)

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_____

(ii) Give the chemical name for rust.
(1 mark)

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(continued on the next page)

Turn over

3   continued.

(b) Look at the diagram for Question 3(b) in the Diagram Booklet. It shows two methods used to prevent iron from rusting.

Method A will only work if the plastic coating is not damaged.

Method B will work even when the zinc coating is damaged.

(i)   Explain how method A prevents iron from rusting.
(2 marks)

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(continued on the next page)

Turn over

3   continued.

    (ii) Give the name of method B.
       (1 mark)

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    **(iii) Explain how method B prevents iron
        from rusting even when the zinc coating
        is damaged.**
        (2 marks)

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(Total for Question 3 = 7 marks)

Turn over

4 **(a)** **Look at the table for Question 4(a) in the Diagram Booklet. It shows the number of protons, neutrons and electrons in species F, G and H.**

    (i) **Give the mass number of F.**
        (1 mark)

_____

_____

    (ii) **Give the electronic configuration of G.**
        (1 mark)

_____

_____

(continued on the next page)

4 **continued.**

(iii) **Explain why F and G are isotopes of the same element.**

Refer to subatomic particles in your answer. (2 marks)

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(continued on the next page)

4   continued.

    (iv) Explain why H is a negative ion.

    Refer to subatomic particles and their charges in your answer.
    (2 marks)

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(continued on the next page)

Turn over

4   continued.

(b) A sample of carbon contains atoms of mass number 12 and 13

Look at the table for Question 4(b) in the Diagram Booklet. It shows the percentages of these atoms in the sample.

Calculate the relative atomic mass (A_r) of this sample of carbon.

Give your answer to two decimal places.
(2 marks)

relative atomic mass = _____

(Total for Question 4 = 8 marks)

5   Two experiments are done to determine the percentage composition by volume of a mixture of three gases, carbon dioxide, oxygen and argon.

(a) In experiment 1, a student bubbles the mixture of gases through limewater. Carbon dioxide reacts with limewater.

Look at the diagram for Question 5 in the Diagram Booklet. It shows the apparatus the student uses.

The student pushes the mixture of gases out of syringe A, but no gas bubbles appear in the limewater.

Give one change the student needs to make to the apparatus for gas bubbles to appear in the limewater.
(1 mark)

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(continued on the next page)

5   continued.

(b) When the apparatus in experiment 1 is set up
correctly, the mixture of gases is bubbled gently
through the limewater so that all the carbon
dioxide is removed.

The volume of the mixture of gases in syringe A at
the start is $76\,cm^3$.

The volume of the mixture of gases in syringe B at
the end is $66\,cm^3$.

(i)   Calculate the percentage by volume of
carbon dioxide in the mixture of gases in
syringe A.
(2 marks)

percentage of carbon dioxide = _____%

(continued on the next page)

Turn over

5 **continued.**

    (ii) **Give the change in the appearance of the limewater.**
        (1 mark)

_____

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    (iii) **Explain why the gas syringes in experiment 1 cannot be used to find the percentage of carbon dioxide in a typical sample of air.**
        (2 marks)

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(continued on the next page)

5   continued.

(c) In experiment 2, a teacher pushes the remaining gases over hot copper powder.

Look at the diagram for Question 5(c) in the Diagram Booklet. It shows the apparatus the teacher uses.

The copper powder turns black as it reacts with oxygen.

Argon is extremely unreactive, so it does not react with copper.

(i)   Name the black substance that forms on the copper powder.
(1 mark)

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(continued on the next page)

Turn over

5   continued.

      (ii) Suggest why the teacher uses copper powder instead of the same mass of large pieces of copper.
          (1 mark)

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(continued on the next page)

5   continued.

(iii) Explain why argon is extremely unreactive.
(2 marks)

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(Total for Question 5 = 10 marks)

6 **This question is about organic compounds.**

(a) **Look at the diagram for Question 6(a) in the Diagram Booklet. It shows the displayed formulae of five compounds, U, V, W, X and Y.**

(i) **Give the letter of the compound that is not a hydrocarbon.**
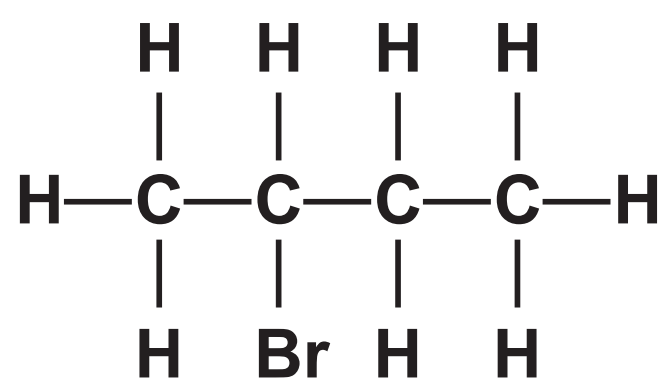**(1 mark)**

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(ii) **Give the letter of the compound that is a saturated hydrocarbon with the empirical formula CH_2**
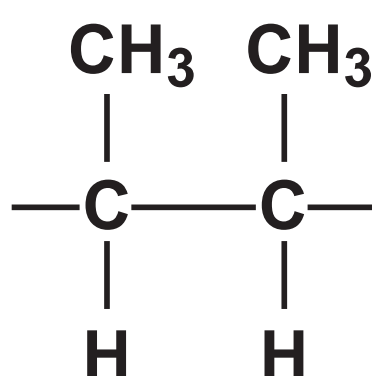**(1 mark)**

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(continued on the next page)

Turn over

6   continued.

(iii) **Give the letter of the compound that reacts with bromine in the presence of ultraviolet radiation to form this structure.**
(1 mark)

$$\begin{array}{cccccccc} & H & & H & & H & & H \\ & | & & | & & | & & | \\ H- & C & - & C & - & C & - & C & -H \\ & | & & | & & | & & | \\ & H & & Br & & H & & H \end{array}$$

(iv) **Give the letter of the compound that forms an addition polymer with this repeat unit.**
(1 mark)

$$\begin{array}{cccc} & CH_3 & & CH_3 \\ & | & & | \\ - & C & - & C & - \\ & | & & | \\ & H & & H \end{array}$$

(continued on the next page)

6   continued.

        (v)   **Give the displayed formula of an alkene that is an isomer of compound X.**
               (1 mark)

(continued on the next page)

6   continued.

(vi) **Compounds U and X are members of the same homologous series.**

Members of the same homologous series have the same functional group.

Give two other characteristics of compounds in the same homologous series.
(2 marks)

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2 _____

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(continued on the next page)

6 **continued.**

(b) Compound Z contains 38·7% carbon,
9·7% hydrogen and 51·6% oxygen by mass.

(i) Show by calculation that the empirical formula
of compound Z is CH_3O
(2 marks)

(continued on the next page)

6   continued.

(ii) **The relative formula mass (M$_r$) of compound Z is 62**

Deduce the molecular formula of compound Z. (2 marks)

molecular formula = _____ .

(Total for Question 6 = 11 marks)

7 This question is about nitrogen and some of its compounds.

(a) Nitrogen and oxygen do not react together at room temperature.

At the high temperatures in a car engine, nitrogen and oxygen react to form nitrogen monoxide, NO

(i) Give a chemical equation for this reaction.
(1 mark)

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(ii) Give a reason why this reaction only occurs at high temperatures.
(1 mark)

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(continued on the next page)

Turn over

7   continued.

     (iii) State why it is important that oxides of
            nitrogen are not released into the atmosphere.
            (1 mark)

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(continued on the next page)

7   continued.

(b) Nitrogen monoxide gas can be removed from car exhaust fumes when it reacts with carbon monoxide gas.

   (i)   The rate of the reaction is increased by passing the gases over a catalyst.

       Explain how a catalyst increases the rate of a reaction.
       (2 marks)

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(continued on the next page)

Turn over

7   **continued.**

   **(ii) Explain how increasing the pressure of gases
          increases the rate of reaction.
          (3 marks)**

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(continued on the next page)

7   continued.

(c) Ammonia is a simple molecule with the formula NH$_3$

(i)   Look at the diagram for Question 7(c)(i) in the Diagram Booklet. Complete the diagram to show the outer shell electrons in ammonia.
(2 marks)

(ii) The bonds in ammonia are covalent.

Describe the forces of attraction in a covalent bond.
(2 marks)

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Turn over

7   continued.

       **(iii) Explain why ammonia has a low boiling point.
            (2 marks)**

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(Total for Question 7 = 14 marks)

8   This question is about barium chloride.

(a) Barium chloride can be made by reacting barium carbonate with dilute hydrochloric acid.

The chemical equation for the reaction is

$$BaCO_3(s) \ + \ 2HCl(aq) \ \longrightarrow \ BaCl_2(aq) \ + \ H_2O(l) \ + \ CO_2(g)$$

Describe a method to produce dry crystals of hydrated barium chloride, starting with barium carbonate powder and dilute hydrochloric acid.
(6 marks)

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(continued on the next page)

8   continued.

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Turn over

8   continued.

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8 **continued.**

(b) **A colourless solution contains sodium carbonate and sodium sulfate.**

Describe a test using barium chloride to show that the colourless solution contains sulfate ions.
(2 marks)

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(Total for Question 8 = 8 marks)

Turn over

9 A student investigates the reaction between solid hydrated sodium carbonate and dilute hydrochloric acid.

(a) She uses this method to investigate the temperature change during the reaction.

Step 1 pour $25 \cdot 0 \, cm^3$ of dilute hydrochloric acid into a polystyrene cup

Step 2 record the temperature of the dilute hydrochloric acid

Step 3 add $0 \cdot 5 \, g$ of sodium carbonate and stir the mixture

Step 4 record the lowest temperature of the mixture

Step 5 add further $0 \cdot 5 \, g$ portions of sodium carbonate, one portion at a time, stir the mixture and record the lowest temperature each time

9   continued.

Look at the table for Question 9(a) in the Diagram Booklet. It shows the student's results.

(i)   Look at the grid for Question 9(a) in the Diagram Booklet. Plot the student's results on the grid. Five have been done for you.
(2 marks)

(ii)   Draw a curve of best fit, ignoring the anomalous result.
(1 mark)

(iii) Explain why it is better to use a polystyrene cup instead of a glass beaker in this experiment.
(2 marks)

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9   continued.

       (iv) Suggest a reason for the anomalous result.
            (1 mark)

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       (v) State how the results show that all the dilute
           hydrochloric acid has reacted.
           (1 mark)

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(continued on the next page)

9   continued.

   (vi) Use the results of the experiment to explain the type of reaction that occurs when sodium carbonate is added to dilute hydrochloric acid.
   (2 marks)

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(continued on the next page)

Turn over

9   **continued.**

(b) **The student does another experiment using the same reaction.**

   Look at the diagram for Question 9(b) in the Diagram Booklet. It shows the student's apparatus.

   The mass on the balance decreases as carbon dioxide gas escapes.

   (i)   **Give a reason for the cotton wool plug in the conical flask.**
   (1 mark)

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(continued on the next page)

Turn over

9   continued.

(ii) The student adds 2·12 g of sodium carbonate to an excess of dilute hydrochloric acid.

The chemical equation for the reaction is

$$Na_2CO_3(s) \ + \ 2HCl(aq) \longrightarrow 2NaCl(aq) \ + \ H_2O(l) \ + \ CO_2(g)$$

**Calculate the maximum mass, in g, of carbon dioxide formed in the reaction.
(3 marks)**

mass = _____ g

(continued on the next page)

9 continued.

(iii) Suggest why the mass of carbon dioxide produced is less than the calculated maximum mass.
(1 mark)

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(Total for Question 9 = 14 marks)

10 Look at the apparatus for Question 10 in the Diagram Booklet. A teacher uses this apparatus to separate a mixture of ethanol and water.

(a) (i) Name this method of separation.
          (1 mark)

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_____

(ii) Name the change of state taking place at A.
      (1 mark)

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(iii) Name the change of state taking place at B.
       (1 mark)

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(continued on the next page)

Turn over

10   continued.

(b) The mixture contains $15 \cdot 5 \, cm^3$ of ethanol.

$1 \cdot 0 \, cm^3$ of ethanol has a mass of $0 \cdot 79 \, g$.

One mole of ethanol contains
$6 \cdot 00 \times 10^{23}$ molecules.

[M_r of ethanol = 46]

(i)   Calculate the amount, in moles, of ethanol in
$15 \cdot 5 \, cm^3$ of ethanol.
(2 marks)

amount = _____ mol

(continued on the next page)

10   continued.

      (ii)   Calculate the number of molecules of ethanol in 15·5 cm^3 of ethanol.
             (1 mark)

number of molecules = _____

(continued on the next page)

10 continued.

(c) After five minutes, the teacher collects a sample of colourless liquid in a new beaker.

(i) Describe a chemical test to show that the colourless liquid contains water.
(2 marks)

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(continued on the next page)

10   continued.

(ii)   Describe a physical test to show if the colourless liquid is pure water.
(2 marks)

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(continued on the next page)

Turn over

10   continued.

(d)   Look at the apparatus for Question 10(d) in the Diagram Booklet. The teacher uses this apparatus to heat 100 g of water.

He records the temperature of the water before and after heating.

temperature of water before heating = 21·0 °C

temperature of water after heating = 70·5 °C

(i)   Calculate the heat energy change (Q) in joules.

[specific heat capacity of water is 4·2 J / g / °C]
(3 marks)

Q = _____ J

(continued on the next page)

Turn over

10   continued.

(ii)   The student burns 0·0200 mol of ethanol.

Use this information and your value for Q to calculate the molar enthalpy change (ΔH), in kJ / mol, for the combustion of ethanol.

Include a sign in your answer.
(2 marks)

ΔH = _____ kJ / mol

(Total for Question 10 = 15 marks)

Turn over

11 **This question is about the reactivity of metals.**

(a) **Look at the Table 1 for Question 11(a) in the Diagram Booklet. It shows whether a reaction occurs between a metal and an aqueous solution of a metal sulfate.**

    (i) **Name the type of reaction that occurs between manganese and chromium sulfate.**
    (1 mark)

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    (ii) **Look at the diagram for Question 11(a)(ii) in the Diagram Booklet. Use the information in Table 1 to complete the order of reactivity.**
    (1 mark)

(continued on the next page)

11 continued.

(b) Look at Table 2 for Question 11(b) in the Diagram Booklet. It shows the colours of four metals and the colours of their metal sulfate solutions.

When a metal is added to a metal sulfate solution there may be a colour change on the surface of the metal and in the solution.

Use the information in Table 2 and your knowledge of the reactivity series to explain any colour changes in these two experiments.
(5 marks)

copper added to magnesium sulfate solution

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(continued on the next page)

11 continued.

zinc added to iron sulfate solution_____

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(continued on the next page)

11 continued.

(c) **A different experiment can be used to place metals in order of reactivity.**

This is the method.

Step 1   **add 1 g of a metal to 25 cm^3 of dilute sulfuric acid**

Step 2   **measure the volume of gas produced in one minute**

(i)   **Give two variables that should be controlled in this experiment.**
(2 marks)

1 _____

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2 _____

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(continued on the next page)

11 continued.

(ii) A small piece of calcium is added to some dilute sulfuric acid in a beaker.

One of the products of the reaction, calcium sulfate, is insoluble in water.

Suggest why the reaction stops after a short time, even though the beaker still contains calcium and dilute sulfuric acid.
(1 mark)

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(continued on the next page)

Turn over

11   continued.

(d) 1·00 g of aluminium is added to 0·0600 mol of dilute sulfuric acid.

The equation for the reaction is

$2Al(s) + 3H_2SO_4(aq) \longrightarrow Al_2(SO_4)_3(aq) + 3H_2(g)$

Show by calculation that the sulfuric acid is in excess. **(2 marks)**

(Total for Question 11 = 12 marks)

TOTAL FOR PAPER = 110 MARKS
END OF PAPER