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

Chemistry
PAPER: 2C

Time: 1 hour 15 minutes plus your additional time allowance

In the boxes below, write your name, centre number and candidate number.

Surname					
Other names					
Centre Number					
Candidate Number					

Q66059RA

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 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.

A Periodic Table is provided.

Turn over

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   Use the Periodic Table to help you answer
    this question.

    (a) Identify the element with atomic number 7
         (1 mark)

    _____

    (b) Identify a solid non-metallic element in Period 3
         (1 mark)

    _____

    (c) Name an element in Group 7 that is a liquid at
         room temperature.
         (1 mark)

    _____

    (d) State the relative atomic mass of the element that
         is in Group 4 and Period 4
         (1 mark)

    _____

(continued on the next page)

Turn over

1   **continued.**

(e) **Which row shows the most reactive element in Group 1 and Group 7?**
     (1 mark)

	Most reactive element in Group 1	Most reactive element in Group 7
☐ A	lithium	fluorine
☐ B	francium	astatine
☐ C	lithium	astatine
☐ D	francium	fluorine

(Total for Question 1 = 5 marks)

2   (a)   Below is a list of words that may be used to explain the term **saturated solution.**

solute

solvent

temperature

Explain, using all the words in the box, the term **saturated solution.**
(2 marks)

_____

_____

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(continued on the next page)

2 **continued.**

(b) Look at the diagram for Question 2(b) in the Diagram Booklet. It shows the apparatus a student uses to make a saturated solution.

This is the student's method.

Step 1 add 4·5 g of solid to a boiling tube

Step 2 measure exactly 10·0 cm^3 of pure water and pour into the boiling tube

Step 3 place the boiling tube in the beaker of water and heat gently, stirring the mixture continuously until all the solid dissolves

Step 4 remove the boiling tube from the beaker and allow it to cool

Step 5 record the temperature when crystals start to form in the boiling tube

The recorded temperature shows when the solution becomes saturated.

2   continued.

    (i)   Name the piece of apparatus that the student
         should use in Step 2 to measure exactly
         $10 \cdot 0 \, \text{cm}^3$ of pure water.
         (1 mark)

_____

    (ii)   Suggest why the boiling tube is not heated
         directly using a Bunsen burner in Step 3.
         (1 mark)

_____

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_____

(continued on the next page)

2   continued.

(iii) **Suggest how the student could improve the reliability of her recorded temperature in Step 5.**
(1 mark)

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(continued on the next page)

2   **continued.**

      (iv) In Step 5, crystals start to form at 26 °C.

          Calculate the solubility of the solid, in g per 100 g of water, at 26 °C.

          [1·0 cm^3 of pure water has a mass of 1·0 g]
          (2 marks)

solubility = _____ g per 100 g of water

(continued on the next page)

2 **continued.**

    (c) **Look at the grid for Question 2(c) in the Diagram Booklet. The solubility curves for two solids, A and B, are shown on the grid.**

        (i) **State the temperature when A and B have the same solubility.**
        (1 mark)

        temperature = _____ °C

        (ii) **Calculate the mass of B that will dissolve in 250 g of water at 60 °C.**

        Show your working.
        (2 marks)
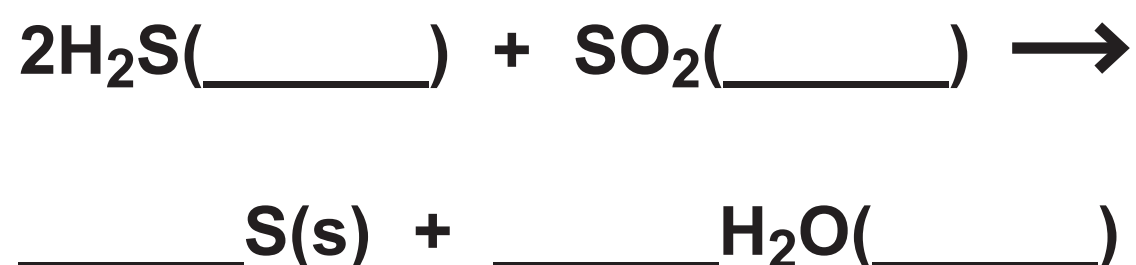
        mass = _____ g

(continued on the next page)

2   continued.

      (iii) Suggest why the values for the solubility of A and B may be less accurate at 95 °C than at lower temperatures.
            (1 mark)

_____

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_____

(Total for Question 2 = 11 marks)

3   **Sulfur dioxide (SO_2) and hydrogen sulfide (H_2S) are both gases.**

The two gases react together to form solid sulfur and water.

(a) (i)   Complete the chemical equation for the reaction.
(2 marks)

$2H_2S$(_____) + SO_2(_____) $\longrightarrow$

_____S(s) + _____H_2O(_____)

(ii) State why the sulfur dioxide is reduced in the reaction.
(1 mark)

_____

_____

(continued on the next page)

3   continued.

(b) Look at the diagram for Question 3(b) in the
     Diagram Booklet. It shows apparatus used to
     compare the speed at which particles of the
     two gases diffuse.

     The two pieces of cotton wool and rubber bungs
     are put in position at the same time.

     A pale yellow solid soon forms.

(continued on the next page)

3 **continued.**

> **(i)** **Explain how the diagram shows that hydrogen sulfide gas diffuses more quickly than sulfur dioxide gas.**
> **(2 marks)**

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(continued on the next page)

3   continued.

    (ii) **Deduce a relationship between the relative formula mass (M_r) of a gas and the speed at which a gas diffuses.**

        Use the A_r values to help you.

        [A_r values: H = 1   S = 32   O = 16]
        (3 marks)

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(Total for Question 3 = 8 marks)

Turn over

4 **This question is about ionic compounds.**

(a) **State the formula of the cation and the anion in magnesium sulfate.**
(2 marks)

cation _____

anion _____

(continued on the next page)

4   continued.

(b) Look at the diagram for Question 4(b) in the Diagram Booklet. It shows the electronic configuration of a potassium atom and an oxygen atom.

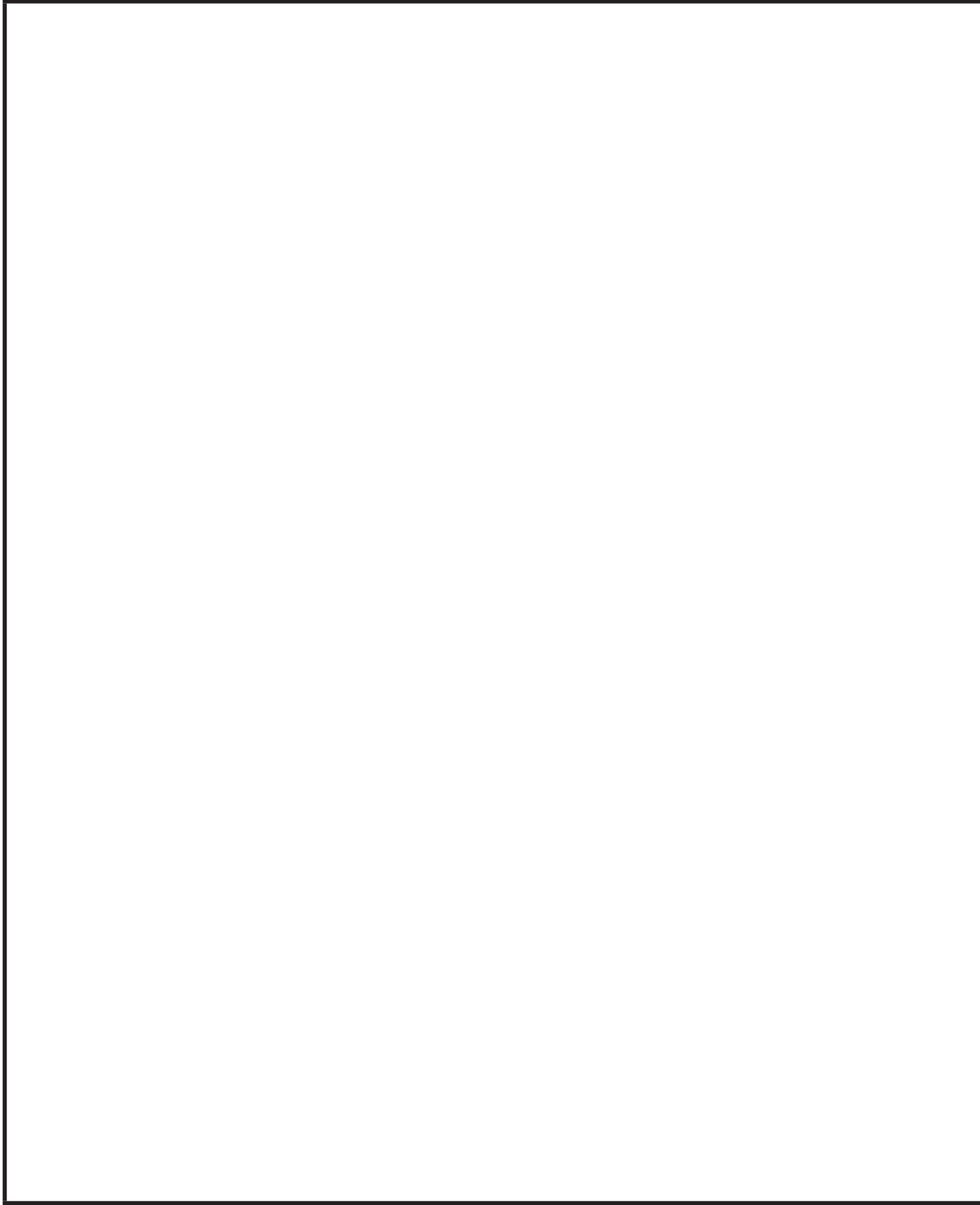Potassium oxide (K_2O) is an ionic compound.

On the next two pages, draw the electronic configuration of a potassium ion and an oxide ion.

Show the charge on each ion.
(3 marks)

(begin your answer on the next page)
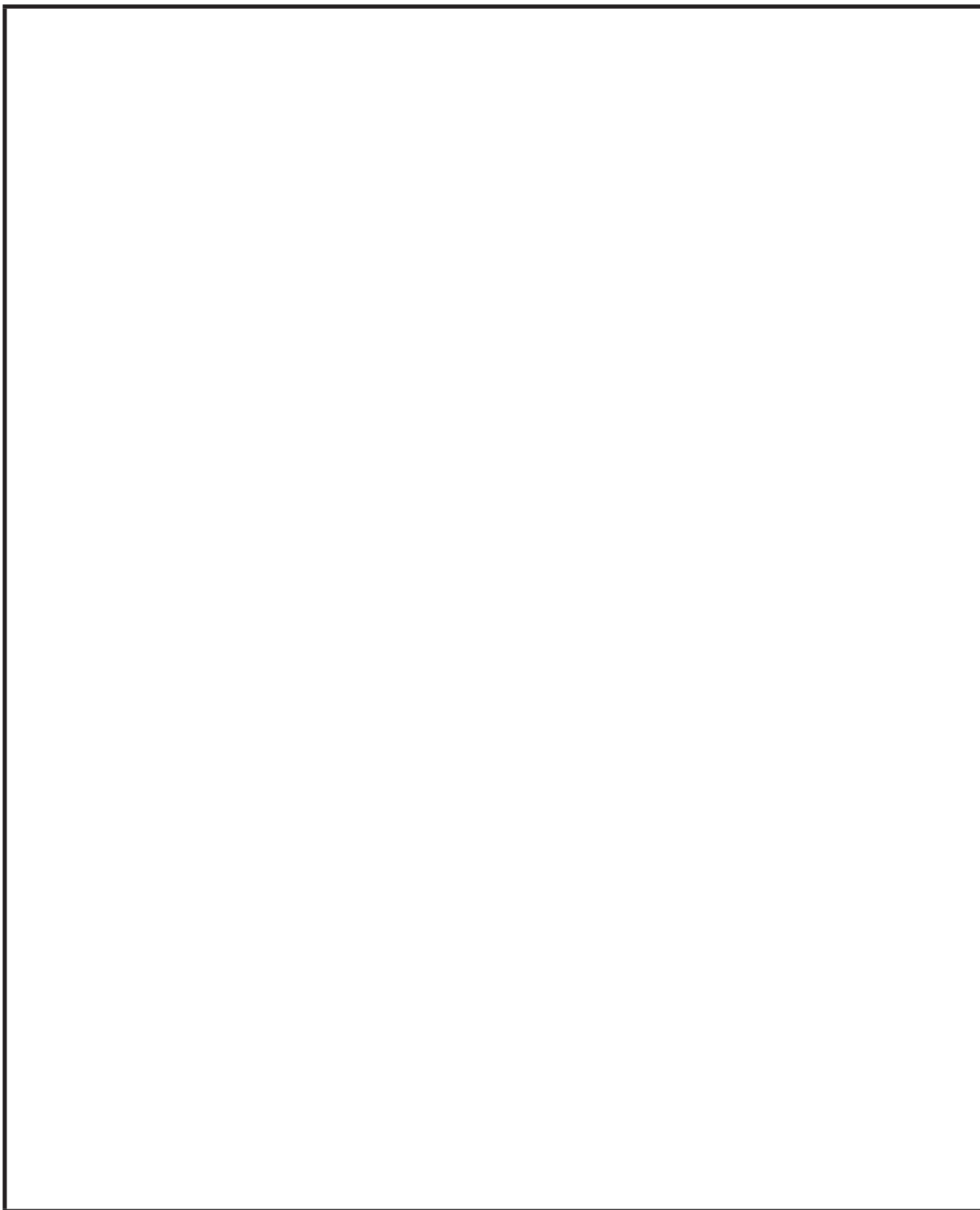
4 **continued.**

potassium ion

(continued on the next page)

4   continued.

oxide ion

(continued on the next page)

4   continued.

(c) A sample of solid potassium oxide is added to water.

A reaction occurs and a colourless solution forms.

When a few drops of phenolphthalein indicator are added to the solution it turns pink.

(i)   Identify the ion responsible for the colour change.
(1 mark)

_____

_____

(ii)   Give a chemical equation for the reaction between potassium oxide and water.
(1 mark)

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(continued on the next page)

Turn over

4 **continued.**

(d) **Explain why ionic compounds conduct electricity when molten or in aqueous solution, but not when in the solid state.**
(2 marks)

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(continued on the next page)

Turn over

4   continued.

(e) Look at the diagram for Question 4(e) in the Diagram Booklet. It shows the apparatus a teacher uses to demonstrate the electrolysis of a concentrated aqueous solution of sodium chloride.

During the electrolysis two gases, X and Y, are formed. One of the gases produces a squeaky pop when tested with a lighted splint.

Use ionic half-equations to identify X and Y.
(4 marks)

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(continued on the next page)

Turn over

4 continued.

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(Total for Question 4 = 13 marks)

5 Metals are found in the Earth's crust either as uncombined elements or in metal compounds in rocks.

The method of extraction of a metal is related to its position in the reactivity series.

Look at the list for Question 5 in the Diagram Booklet. The list shows the positions of some metals and carbon in the reactivity series.

(a) (i) State the name given to rocks that contain metal compounds used in the extraction of metals.
(1 mark)

_____

_____

(ii) Name a metal that is found as an uncombined element in the Earth's crust.
(1 mark)

_____

_____

(continued on the next page)

5   continued.

(b) Carbon extraction and electrolysis are two
     methods of obtaining a metal from a compound.

     (i)   Explain, without giving practical details, which
            method is most suitable to obtain calcium
            from calcium chloride.
            (2 marks)

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(continued on the next page)

5   continued.

(ii) Explain, without giving practical details, which method is most suitable to obtain lead from lead oxide.
(2 marks)

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(continued on the next page)

5   continued.

(c) Explain, using a labelled diagram, why lead metal
is malleable.
(3 marks)

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(continued on the next page)

Turn over

5   continued.

(d) Aluminium is extracted from aluminium oxide.

The overall equation for the process is

$$2Al_2O_3 \longrightarrow 4Al + 3O_2$$

Calculate the maximum mass, in grams, of aluminium that could be obtained from 1·275 kg of aluminium oxide.
(3 marks)

mass = _____ g

(Total for Question 5 = 12 marks)

Turn over

6 This question is about alcohols, carboxylic acids and esters.

(a) Ethanol can be manufactured by reacting ethene with steam in the presence of a phosphoric acid catalyst.

Which row gives the correct conditions of temperature and pressure for this reaction?
(1 mark)

	Temperature in °C	Pressure in atmospheres
☐ A	35	300
☐ B	65	300
☐ C	300	65
☐ D	300	35

(continued on the next page)

6 **continued.**

(b) **Give the displayed formula of butanol.**
   (1 mark)

(continued on the next page)

6   continued.

(c) Ethanoic acid (CH_3COOH) is a carboxylic acid present in vinegar.

   (i)   The concentration of CH_3COOH in vinegar can be found by titration with aqueous potassium hydroxide (KOH).

         The equation for the reaction is

         $CH_3COOH + KOH \longrightarrow CH_3COOK + H_2O$

         In a titration, a $25{\cdot}0\,cm^3$ sample of vinegar is neutralised by $45{\cdot}00\,cm^3$ of KOH solution of concentration $0{\cdot}400\,mol/dm^3$.

         Calculate the concentration, in mol/dm^3, of CH_3COOH in this sample of vinegar.
         (2 marks)

concentration = _____ mol/dm^3

(continued on the next page)

6   continued.

(ii) A sample of vinegar containing 0·0030 mol of CH_3COOH is poured into a flask.

Calculate the maximum volume, in cm^3, of carbon dioxide gas formed at rtp when excess sodium carbonate is added to the flask.

The equation for the reaction is

$$2CH_3COOH + Na_2CO_3 \longrightarrow 2CH_3COONa + H_2O + CO_2$$

[Assume that the molar volume of carbon dioxide at rtp is $24\,000\,cm^3$]
(2 marks)

volume = _____ cm^3

(continued on the next page)

6   continued.

(d) Alcohols react with carboxylic acids to form esters.

Which alcohol could react to form the ester ethyl propanoate?
(1 mark)

☐ A CH_3OH

☐ B C_2H_5OH

☐ C C_3H_7OH

☐ D C_4H_9OH

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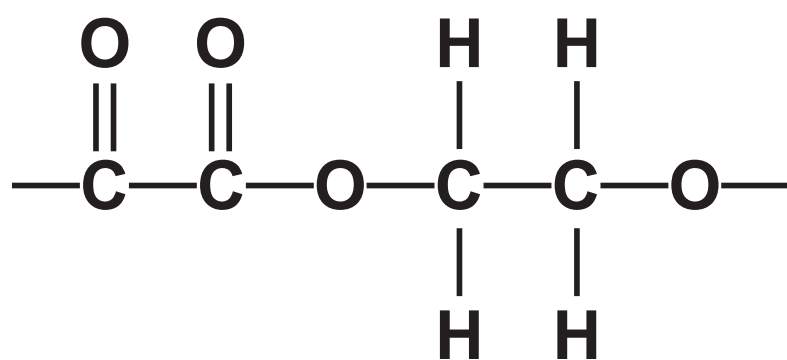
6 **continued.**

(e) **Polyesters are formed in condensation polymerisation reactions between dicarboxylic acids and diols.**

    (i) **State one difference between condensation polymerisation and addition polymerisation. (1 mark)**

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_____

(continued on the next page)

6   continued.

   (ii) The repeat unit of a polyester is

$$\begin{array}{c} \quad\;\; O \;\;\; O \quad\quad\;\; H \;\;\; H \\ \quad\;\; \parallel \;\;\; \parallel \quad\quad\;\; | \;\;\;\; | \\ -C-C-O-C-C-O- \\ \quad\quad\quad\quad\quad\quad\;\; | \;\;\;\; | \\ \quad\quad\quad\quad\quad\quad H \;\;\; H \end{array}$$

(continued on the next page)

6   continued.

Give the displayed formula of each of the two monomers needed to form this polyester.
(2 marks)

6   continued.

       (iii) Give one advantage of biopolyesters.
           (1 mark)

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(Total for Question 6 = 11 marks)

7   Hydrogen gas and iodine gas react together to form hydrogen iodide gas.

$$H_2(g) \ + \ I_2(g) \ \rightleftharpoons \ 2HI(g)$$

(a) (i)   The pressure of an equilibrium mixture of the three gases is increased.

Predict the effect of this change on the yield of hydrogen iodide at equilibrium, giving a reason for your answer.
(2 marks)

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(continued on the next page)

7   continued.

(ii) A catalyst is added to an equilibrium mixture of the three gases.

Predict the effect of the catalyst on the yield of hydrogen iodide at equilibrium, giving a reason for your answer.
(2 marks)

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(continued on the next page)

Turn over

7 **continued.**

(b) Hydrogen gas reacts with fluorine gas to form hydrogen fluoride gas.

$$H_2(g) \ + \ F_2(g) \longrightarrow 2HF(g)$$

The table gives some bond energies.

Bond	Bond energy in kJ/mol
H—H	436
F—F	158
H—F	562

(continued on the next page)

7   continued.

Use the equation and the data in the table to calculate the enthalpy change (ΔH) in kJ / mol, for the reaction.

Include a sign in your answer.
(3 marks)

ΔH = _____ kJ / mol

(continued on the next page)

7   continued.

(c) Look at the diagram for Question 7(c) in the Diagram Booklet. Draw an energy level diagram for the reaction between hydrogen and fluorine.

Label the enthalpy change, ΔH.
(3 marks)

(Total for Question 7 = 10 marks)

TOTAL FOR PAPER = 70 MARKS
END OF PAPER