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

Chemistry
UNIT: 4CH1
Science (Double Award) 4SD0
PAPER: 1C

Monday 22 May 2023 – Morning

Time: 2 hours

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

Surname	
Other names	

Centre Number					
Candidate Number					

Q71950A

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 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.

There may be spare copies of some diagrams.

A periodic table is provided as a separate insert.

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   Look at the list for Question 1 in the Diagram Booklet. It gives some methods that are involved in the separation of mixtures.

    (a) Use words from the list to identify the method involved in each of these separations.

        (i)   Give the best method for obtaining gasoline from crude oil.
        (1 mark)

_____

_____

        (ii) Give the best method for separating the dyes in black ink.
        (1 mark)

_____

_____

Turn over

1(a) continued.

      (iii) Give the best method for obtaining pure water from seawater.
           (1 mark)

_____

_____

(continued on the next page)

1 continued.

(b) A sample of solid hydrated copper(II) sulfate can be obtained from a mixture of copper(II) oxide and copper(II) sulfate.

Look again at the list for Question 1 in the Diagram Booklet. Complete the passage by using words from the list.
(4 marks)

The mixture of copper(II) oxide and

copper(II) sulfate can be separated by first

_____

the copper(II) sulfate in distilled water.

The copper(II) oxide is then removed by

_____ .

(continued on the next page)

1(b)   continued.

Some of the water from the copper(II) sulfate

solution is then removed by

_____.

A pure sample of hydrated

copper(II) sulfate is then obtained by

_____.

(Total for Question 1 = 7 marks)

2   **This question is about the reactions of iron.**

(a) **Iron rusts when exposed to water and oxygen.**

(i)   **Give the chemical name of the compound that forms when iron rusts.**
(1 mark)

_____

_____

(ii) **What type of reaction occurs when iron rusts?**
(1 mark)

☐   **A   combustion**

☐   **B   decomposition**

☐   **C   neutralisation**

☐   **D   oxidation**

Turn over

2(a)   continued.

        (iii) Galvanising is a method used to prevent iron from rusting.

               Give the name of the metal used to galvanise iron.
               (1 mark)

_____

_____

    (b) When iron reacts with dilute sulfuric acid, the products are iron(II) sulfate and hydrogen.

        (i)   Give a chemical equation for the reaction between iron and sulfuric acid.
             (1 mark)

_____

        (ii) Give a test for hydrogen.
             (1 mark)

_____

_____

Turn over

2 continued.

(c) An excess of iron is added to copper(II) sulfate solution.

(i) Name the type of reaction that occurs.
(1 mark)

_____

_____

(ii) State the appearance of the solid that forms in the reaction.
(1 mark)

_____

_____

(d) Give the reason why no reaction occurs when iron is added to magnesium sulfate solution.
(1 mark)

_____

_____

_____

(Total for Question 2 = 8 marks)

Turn over

3 **Look at the table for Question 3 in the Diagram Booklet. It gives some information about three substances, X, Y and Z.**

    (a) **Write your answers to A, B, C and D by giving the missing information below.**
        (4 marks)

A _____

_____

B _____

_____

C _____

_____

D _____

_____

(continued on the next page)

3 continued.

(b) **Explain why substance X has a low melting point.**
     (2 marks)

_____

_____

_____

_____

_____

_____

_____

_____

(Total for Question 3 = 6 marks)

4   This question is about unsaturated hydrocarbons.

(a) Ethene (C_2H_4) is a member of the homologous series of alkenes.

(i)   Give two characteristics of a homologous series.
(2 marks)

1 _____

_____

_____

2 _____

_____

_____

(continued on the next page)

4(a)   continued.

(ii) Draw a dot-and-cross diagram to show the bonding in a molecule of ethene.

Show outer electrons only.
(2 marks)

Turn over

4   continued.

(b) **Propene (C_3H_6) is another member of the homologous series of alkenes.**

(i)   **State why the empirical formula of all alkenes in this homologous series is CH_2**
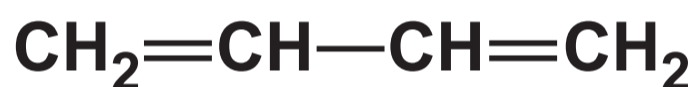(1 mark)

_____

_____

(continued on the next page)

4(b)   continued.

   (ii) Propene can be polymerised to
         form poly(propene).

         Look at the diagram for Question 4(b)(ii) in
         the Diagram Booklet. Draw the displayed
         formula of propene and the repeat unit
         of poly(propene).
         (2 marks)

(c) This is the structural formula of another
     hydrocarbon compound.

$$CH_2{=}CH{-}CH{=}CH_2$$

   (i) Give the molecular formula and the empirical
        formula of this compound.
        (2 marks)

molecular formula

_____

_____

empirical formula

_____

_____

(continued on the next page)   **Turn over**

4(c) **continued.**

      (ii) **Explain why this compound is an unsaturated hydrocarbon.**
            (3 marks)

_____

_____

_____

_____

_____

_____

_____

(continued on the next page)

4(c)   continued.

(iii) **Describe a test to show that this hydrocarbon is unsaturated.**
(2 marks)

_____

_____

_____

_____

_____

_____

(Total for Question 4 = 14 marks)

5   This question is about lithium and some of
     its compounds.

(a) A small piece of lithium is added to a trough
     containing water.

     The lithium floats on the surface of the water and a
     vigorous reaction occurs.

     (i)   Give two other observations when lithium
            reacts with water.
            (2 marks)

1 _____

_____

_____

2 _____

_____

_____

(continued on the next page)

5(a)   continued.

(ii)   A few drops of methyl orange are added to the solution in the trough.

Explain the final colour of the solution.
(2 marks)

_____

_____

_____

_____

_____

(continued on the next page)

Turn over

5   continued.

(b) **An unlabelled bottle containing a white powder is found in a laboratory.**

Describe tests to show that the white powder in the bottle is lithium carbonate.
(5 marks)

Answer space continues on the next page.

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_____

5(b)   continued.

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(continued on the next page)

Turn over

5 continued.

(c) Lithium carbonate has ionic bonding.

State what is meant by the term IONIC BONDING. (2 marks)

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_____

_____

_____

_____

_____

(Total for Question 5 = 11 marks)

Turn over

6   When solutions of lead(II) nitrate and potassium chloride are mixed, a precipitate of lead(II) chloride forms.

(a) (i) Complete the equation for the reaction by adding the state symbols.
(1 mark)

$Pb(NO_3)_2$(_____) + $2KCl$(_____) $\longrightarrow$

$PbCl_2$(_____) + $2KNO_3$(_____)

(ii) Give the formula of each ion in lead(II) nitrate.
(1 mark)

lead ion

_____

_____

nitrate ion

_____

_____

(continued on the next page)

Turn over

6(a) **continued.**

    (iii) **Calculate the relative formula mass (M_r) of lead(II) nitrate, $Pb(NO_3)_2$**
        (2 marks)

        M_r = _____

(continued on the next page)

6 continued.

(b) A student investigates the height of the precipitate formed when lead(II) nitrate solution is added to potassium chloride solution.

This is the student's method.

STEP 1 pour $15 \cdot 0\,cm^3$ of potassium chloride solution into a boiling tube

STEP 2 add $2 \cdot 0\,cm^3$ of lead(II) nitrate solution and allow the precipitate to settle

STEP 3 measure the height of the precipitate

Repeat steps 2 and 3 until a total of $14 \cdot 0\,cm^3$ of lead(II) nitrate solution has been added.

The table shows the student's results.

Volume of lead(II) nitrate in cm^3	2·0	4·0	6·0	8·0	10·0	12·0	14·0
Height of precipitate in cm	0·8	1·6	2·9	3·2	3·6	3·6	3·6

Look at the grid for Question 6(b) in the Diagram Booklet.

(i) Plot the results on the grid.
(1 mark)

Turn over

6(b) continued.

> (ii) Draw a circle around the anomalous result.
> (1 mark)
>
> (iii) Draw a line of best fit through the first four points and another line of best fit through the last three points. Make sure that the lines cross.
> (2 marks)
>
> (iv) Give two possible mistakes the student could have made to cause the anomalous result.
> (2 marks)

1 _____

_____

_____

2 _____

_____

_____

(continued on the next page)

6(b) continued.

(v) **State why the first line of best fit should pass through the origin.**
(1 mark)

_____

_____

_____

(vi) **Use your graph to determine the volume of lead(II) nitrate solution needed to react completely with 15·0 cm^3 of potassium chloride solution.**
(1 mark)

volume = _____ cm^3

(Total for Question 6 = 12 marks)

Turn over

7   This question is about the three halogens, bromine, chlorine and iodine.

(a) Give the number of protons and the number of neutrons in an atom of iodine–127
     (2 marks)

number of protons

_____

_____

number of neutrons

_____

_____

(continued on the next page)

7 continued.

(b) **A sample of bromine contains two isotopes.**

- **Br–79 with relative abundance 52·8%**

- **Br–81 with relative abundance 47·2%**

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

Give your answer to three significant figures.
(3 marks)

A_r = _____

(continued on the next page)

7   continued.

(c) Aluminium reacts with chlorine to form aluminium chloride.

This is the equation for the reaction.

$$2Al \ + \ 3Cl_2 \ \longrightarrow \ 2AlCl_3$$

Calculate the minimum mass of chlorine needed to form 26·7 g of aluminium chloride.
(3 marks)

[for Cl_2, M_r = 71   for $AlCl_3$, M_r = 133·5]

minimum mass of chlorine = _____ g

(continued on the next page)

7   continued.

(d) A student mixes the following pairs of solutions.

Pair 1   bromine solution and
potassium chloride solution

Pair 2   bromine solution and
potassium iodide solution

Explain how the student can use the results
of these experiments to show the order of
reactivity of the three halogens, bromine, chlorine
and iodine.

Include observations in your answer.
(6 marks)

Answer space continues on the next 2 pages.

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7(d)   continued.

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Turn over

7(d)   continued.

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(Total for Question 7 = 14 marks)

8   Look at the diagram for Question 8(a) in the Diagram Booklet. A student uses this apparatus to find the molar enthalpy change (ΔH) of combustion for the liquid fuel, pentanol.

This is the student's method.

- find the initial mass of the spirit burner and pentanol

- add $100 \, cm^3$ of water to the copper can

- record the initial temperature of the water

- light the wick of the spirit burner to heat the water

- stir the water until the temperature rises by 35·0 °C

- extinguish the flame and immediately find the final mass of the spirit burner and pentanol

(a) (i)   State why the student stirs the water.
(1 mark)

_____

_____

_____

(continued on the next page)

8(a) **continued.**

(ii) Suggest why it is important that the student immediately finds the final mass of the spirit burner and pentanol.
(1 mark)

_____

_____

_____

_____

_____

(continued on the next page)

Turn over

8 continued.

(b) Look at the diagram for Question 8(b) in the Diagram Booklet. It shows the initial temperature of the water.

Complete the table to show the temperature readings.

Give both values to the nearest 0·1 °C.
(2 marks)

Initial temperature of water in °C	
Final temperature of water in °C	
Temperature change in °C	35·0

(continued on the next page)

8   continued.

(c)   (i)   Show by calculation that the heat
energy (Q) supplied by the pentanol is
approximately 15 000 J.
(2 marks)

[for water, c = 4·2 J/g/°C]

[for 1·0 cm^3 of water, mass = 1·0 g]

(continued on the next page)

8(c)   continued.

(ii) Look at the table for Question 8(c)(ii) in the Diagram Booklet. It gives the initial and final mass readings.

Use your answer to part (c)(i) and the information in the table to calculate the molar enthalpy change (ΔH) of combustion, in kJ/mol, for pentanol.

[for pentanol, M_r = 88]

Include a sign in your answer.
(5 marks)

Answer space continues on the next page.

8(c)(ii)   continued.

[for pentanol, M_r = 88]

ΔH for pentanol = _____ kJ / mol

(continued on the next page)

8 continued.

(d) The formula of pentanol is $C_5H_{11}OH$

Write a chemical equation for the complete combustion of pentanol.
(2 marks)

_____

_____

(Total for Question 8 = 13 marks)

Turn over

9   This question is about different hydrated forms of sodium sulfate.

(a) A compound has the formula $Na_2SO_4 \cdot 7H_2O$

(i)   How many different elements are there in the formula $Na_2SO_4 \cdot 7H_2O$?
(1 mark)

☐ A   3

☐ B   4

☐ C   5

☐ D   10

(ii) What is the total number of atoms in the formula $Na_2SO_4 \cdot 7H_2O$?
(1 mark)

☐ A   10

☐ B   22

☐ C   27

☐ D   28

(continued on the next page)

9   continued.

(b) Another hydrated form of sodium sulfate has the formula $Na_2SO_4 \cdot xH_2O$

Look at the diagram for Question 9(b) in the Diagram Booklet. A student uses this apparatus to find the value of x.

This is the student's method.

- find the mass of an empty tube

- add solid hydrated sodium sulfate to the tube

- find the mass of the tube and hydrated sodium sulfate

- heat the tube for several minutes

- allow the tube to cool and find the mass of the tube and contents

(i)   Describe what the student should do next to make sure that all the water is removed from the hydrated sodium sulfate.
(2 marks)

Answer space continues on the next page.

9(b)(i) continued.

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_____

_____

_____

        (ii) Explain the role of the ice in the beaker. (2 marks)

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_____

_____

9(b)   continued.

      (iii) Describe how the student could prove that the liquid collected is pure water.
      (2 marks)

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_____

_____

_____

(continued on the next page)

9 continued.

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

Use the student's results to calculate the value of x.
(5 marks)

[for Na_2SO_4, $M_r = 142$ for H_2O, $M_r = 18$]

Answer space continues on the next page.

9(c) **continued.**

[for Na$_2$SO$_4$, M$_r$ = 142   for H$_2$O, M$_r$ = 18]

x = _____

(Total for Question 9 = 13 marks)

10 Zinc reacts with dilute hydrochloric acid to form zinc chloride and hydrogen gas.

This is the equation for the reaction.

$$Zn(s) \ + \ 2HCl(aq) \ \longrightarrow \ ZnCl_2(aq) \ + \ H_2(g)$$

(a) In an experiment, $20\,cm^3$ of hydrochloric acid containing $0.0036\,mol$ are reacted with $1.3\,g$ of zinc granules at a temperature of $30\,°C$.

(i) Show by calculation that the zinc is in excess. (2 marks)

(continued on the next page)

10(a) continued.

    (ii) The volume of hydrogen collected is measured at regular time intervals.

        Look at the diagram for Question 10(a)(ii) in the Diagram Booklet. Curve A shows the results of this experiment.

        The experiment is repeated using 1·3 g of zinc powder instead of zinc granules.

        All other conditions are kept the same.

        On the grid, draw the curve you would expect to obtain.
        (2 marks)

10 continued.

(b) In the original experiment, $20\,cm^3$ of hydrochloric acid containing $0{\cdot}0036\,mol$ were reacted with $1{\cdot}3\,g$ of zinc granules at a temperature of $30\,°C$ and curve A was obtained.

Look at the diagram for Question 10(b) in the Diagram Booklet. The student does two more experiments and obtains curves B and C.

(i) In one of these experiments the student repeats the original method but at a temperature of $20\,°C$.

Explain in terms of particle collision theory why the curve obtained could be curve B. (4 marks)

Answer space continues on the next page.

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_____

10(b)(i) continued.

_____

_____

_____

_____

_____

_____

(continued on the next page)

10(b) continued.

(ii) In the other experiment the student repeats the original method but uses 20 cm^3 of hydrochloric acid containing 0·0018 mol.

Explain why curve C shows the results the student obtained.
(2 marks)

_____

_____

_____

_____

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_____

Turn over

10 continued.

(c) Catalysts can be used to speed up reactions.

Describe how a catalyst works.
(2 marks)

_____

_____

_____

_____

_____

(Total for Question 10 = 12 marks)

TOTAL FOR PAPER = 110 MARKS
END OF PAPER