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

Total Marks

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

Tuesday 14 November 2023 – Morning

Time: 2 hours

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

Surname						
Other names						
Centre Number						
Candidate Number						

Q73423A

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 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 A substance can exist in three states of matter, solid, liquid or gas.

When a liquid evaporates at room temperature it changes into a gas.

(a) Look at the diagram for Question 1(a) in the Diagram Booklet. Complete the diagram to show the arrangement of another four particles in a gas. (1 mark)

(continued on the next page)

1 continued.

(b) Explain why heating a liquid causes it to evaporate more quickly.
(2 marks)

(continued on the next page)

1 continued.

(c) When the temperature decreases, water in the gas state changes to a liquid.

(i) Give the name of this change of state.
(1 mark)

(ii) Write an equation, including state symbols, to show the change of state of water from a gas to a liquid.
(1 mark)

(continued on the next page)

1 continued.

(d) Describe the arrangement and movement of particles in a solid.
(2 marks)

(Total for Question 1 = 7 marks)

2 (a) Look at Table 1 for Question 2(a) in the Diagram Booklet. It shows some relative masses and charges of subatomic particles.

Complete table 1 by giving the missing information.
(2 marks)

(b) Look at Table 2 for Question 2(b) in the Diagram Booklet. It gives the number of protons, neutrons and electrons in atoms and ions of some elements.

The letters are NOT the symbols of the elements.

(i) What is the atomic number of P in table 2?
(1 mark)

☐ A 2

☐ B 3

☐ C 4

☐ D 7

(continued on the next page)

2(b) continued.

(ii) What is the mass number of U in table 2?
(1 mark)

☐ A 8

☐ B 16

☐ C 18

☐ D 26

(iii) Give the letter in table 2 that represents an element in Group 5 of the Periodic Table.
(1 mark)

(continued on the next page)

2 continued.

(c) Q and R represent isotopes of the same element.

(i) Explain, in terms of subatomic particles, why Q and R are isotopes.
(2 marks)

(continued on the next page)

2(c) continued.

(ii) A sample containing the isotopes Q and R has this percentage composition by mass.

Q = 20·6% R = 79·4%

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

Give your answer to one decimal place.

(3 marks)

A_r = _____

(Total for Question 2 = 10 marks)

3 Crude oil is an important source of organic compounds.

(a) Look at the diagram for Question 3(a) in the Diagram Booklet. It shows how crude oil can be separated into useful mixtures of hydrocarbons.

(i) Give the name of this method of separation.
(1 mark)

(ii) State what happens to the crude oil when it is in X.
(1 mark)

(continued on the next page)

3(a) continued.

(iii) Give the letter of the mixture that is most likely to contain a hydrocarbon with six carbon atoms.
(1 mark)

(iv) Give the name of mixture D.
(1 mark)

(v) Give a use for mixture B.
(1 mark)

(continued on the next page)

3 continued.

(b) Explain, in terms of intermolecular forces, why a hydrocarbon in mixture B has a higher boiling point than a hydrocarbon in mixture D.
(3 marks)

Answer space continues on the next page.

3(b) continued.

(c) Catalytic cracking can be used to break down long-chain hydrocarbons to produce shorter-chain alkanes and alkenes.

(i) Give the name of a catalyst used in catalytic cracking.
(1 mark)

(ii) Complete the equation to show two different alkenes that could be produced in this cracking reaction.
(2 marks)

$C_{15}H_{32} \longrightarrow C_8H_{18} +$

_____ + _____

(continued on the next page)

3(c) continued.

(iii) Give one important use for short-chain alkenes.
(1 mark)

(Total for Question 3 = 12 marks)

4 This question is about gases.

(a) Look at the table for Question 4(a) in the Diagram Booklet. It gives information about five gases.

Use information from the table to answer these questions.
Each gas may be used once, more than once or not at all.

(i) Give the name of the gas that is about 79% of the atmosphere by volume.
(1 mark)

(ii) Give the name of the gas that is a compound.
(1 mark)

(continued on the next page)

4(a) continued.

(iii) Give the name of the least reactive gas.
(1 mark)

(iv) Give the name of the gas that is not normally found in the atmosphere.
(1 mark)

(v) Give the name of the gas that affects global warming.
(1 mark)

(continued on the next page)

4(a) continued.

(vi) Calculate the M_r for carbon dioxide.
(1 mark)

M_r = _____

(vii) Give a reason why it is not possible to give information for air in the table.
(1 mark)

_____

_____

_____

(continued on the next page)

4 continued.

(b) When copper(II) carbonate is heated, the products are copper(II) oxide and carbon dioxide.

(i) Give the name for this type of reaction.
(1 mark)

(ii) Give the colour change that occurs during this reaction.
(2 marks)

_____ to

_____

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

(Total for Question 4 = 11 marks)

5 This question is about alkanes and alkenes.

(a) The alkane C_4H_{10} exists as two isomers.

(i) State what is meant by the term ISOMERS.
(2 marks)

(ii) Look at the table for Question 5(a)(ii) in the Diagram Booklet. Draw the displayed formulae for the two isomers of C_4H_{10}
(2 marks)

(continued on the next page)

5 continued.

(b) Ethane (C_2H_6) can react with bromine.

(i) State the condition needed for ethane to react with bromine.
(1 mark)

(ii) Complete the equation for this reaction.
(1 mark)

$C_2H_6 + Br_2 \longrightarrow$

_____ + _____

(iii) Give the name for this type of reaction.
(1 mark)

(continued on the next page)

5 continued.

(c) Explain why ethane is described as a saturated compound.
(2 marks)

(continued on the next page)

5 continued.

(d) State what you would observe when ethane and ethene are added separately to two samples of bromine water.
(2 marks)

ethane

ethene

(continued on the next page)

5 continued.

(e) Explain why straight-chain alkenes always have the same empirical formula, but straight-chain alkanes have different empirical formulae.

Refer to the molecular formulae of the alkanes C_2H_6 and C_4H_{10} in your answer.
(3 marks)

Answer space continues on the next page.

5(e) continued.

(continued on the next page)

5 continued.

(f) An organic compound has this percentage composition by mass.

C = 19·2% H = 4·0% O = 12·8% Br = 64·0%

Calculate the empirical formula of this compound.
(3 marks)

empirical formula = _____

(Total for Question 5 = 17 marks)

6 Look at the diagram for Question 6 in the Diagram Booklet. A student uses this apparatus to investigate the decomposition of hydrogen peroxide solution.

This is the equation for the reaction.

$$2H_2O_2 \longrightarrow 2H_2O + O_2$$

(a) Give the test for oxygen.
(1 mark)

(b) Look at the dot-and-cross diagram for Question 6(b) in the Diagram Booklet. Complete the dot-and-cross diagram for a molecule of hydrogen peroxide.

Show outer electrons only.
(2 marks)

(continued on the next page)

6 continued.

(c) The student measures the volume of oxygen collected at regular intervals until the reaction stops.

The table shows the student's results.

Time in seconds	0	20	40	60	80	100	120	140	160
Volume of oxygen in cm^3	0	24	44	62	78	88	94	94	94

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

(i) Plot the student's results on the grid.
(1 mark)

(ii) Draw a curve of best fit.
(1 mark)

(continued on the next page)

6 continued.

(d) (i) Explain in terms of particle collision theory how decreasing the concentration affects the rate of a reaction.
(3 marks)

Answer space continues on the next page.

6(d)(i) continued.

_____

_____

_____

(ii) The student repeats the experiment using the same volume of hydrogen peroxide solution but with half the original concentration.

All other conditions are kept the same.

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

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

(continued on the next page)

6 continued.

(e) In this reaction, the manganese(IV) oxide acts as a catalyst.

Explain how a catalyst works.
(2 marks)

(Total for Question 6 = 12 marks)

7 (a) A technician needs to identify the solution in an unlabelled bottle.

The technician knows that the solution contains one of these compounds.

- iron(II) bromide
- iron(II) chloride
- iron(III) bromide
- iron(III) chloride

Describe how the technician can use chemical tests to identify the compound.
(6 marks)

Answer space continues on the next 2 pages.

7(a) continued.

7(a) continued.

(continued on the next page)

7 continued.

(b) When chlorine gas is passed over heated iron powder, iron(III) chloride forms.

This is the equation for the reaction.

$$2Fe + 3Cl_2 \longrightarrow 2FeCl_3$$

0·060 mol of chlorine gas is passed over 2·8 g of iron powder.

Show by calculation that the iron powder is in excess.
(3 marks)

(continued on the next page)

7 continued.

(c) When iron(III) chloride dissolves in water, an acidic solution forms.

(i) Give the colour of litmus in this solution.
(1 mark)

(ii) Give the formula of the ion that causes the solution to be acidic.
(1 mark)

(Total for Question 7 = 11 marks)

8 Diamond and graphite are made of carbon atoms, joined together by covalent bonds.

Look at the diagram for Question 8 in the Diagram Booklet. It shows their structures.

(a) State, in terms of electrostatic attractions, what is meant by a covalent bond.
(2 marks)

(continued on the next page)

8 continued.

(b) Explain why diamond has a high melting point.
(3 marks)

(continued on the next page)

8 continued.

(c) Explain why graphite is a good conductor of electricity.
(2 marks)

(continued on the next page)

8 continued.

(d) C_{60} fullerene is a molecule made of 60 carbon atoms.

Look at the diagram for Question 8(d) in the Diagram Booklet. It shows the structure of C_{60} fullerene.

One mole of atoms contains $6{\cdot}0 \times 10^{23}$ atoms.

Determine the number of atoms in one mole of C_{60} fullerene.

Give your answer in standard form.
(2 marks)

number of atoms = _____

(Total for Question 8 = 9 marks)

9 Look at the diagram for Question 9 in the Diagram Booklet. A scientist uses this apparatus in an experiment to reduce a metal oxide to a metal.

Before heating the mass of the empty tube and the mass of the tube and the metal oxide are recorded.

After heating, the tube is allowed to cool and the mass of the tube and its contents is recorded again.

(a) (i) State why the reaction of the metal oxide to form a metal is described as a reduction reaction.
(1 mark)

(continued on the next page)

9(a) continued.

(ii) State why it is important to relight the hydrogen at the end of the tube if the flame goes out.
(1 mark)

(iii) Explain why it is important to continue passing hydrogen into the tube and burning the hydrogen at the end of the tube until the contents have cooled.
(2 marks)

(continued on the next page)

9(a) continued.

(iv) Describe what should be done next to ensure that all the metal oxide has been converted into the metal.
(2 marks)

(continued on the next page)

9 continued.

(b) In this experiment a mass of 4·14 g of metal is formed from 4·46 g of the metal oxide.

(i) Calculate the amount, in moles, of oxygen atoms in the sample of the metal oxide.
(2 marks)

amount of oxygen atoms = _____ mol

(continued on the next page)

9(b) continued.

(ii) The formula of the metal oxide is MO, where M represents the symbol of the metal.

Deduce the amount, in moles, of M in the sample of the metal oxide.
(1 mark)

amount of M = _____ mol

(iii) Calculate the relative atomic mass of M.
(2 marks)

relative atomic mass of M = _____

(continued on the next page)

9(b) continued.

(iv) Use the Periodic Table to identify metal M.
(1 mark)

(Total for Question 9 = 12 marks)

10 This method is used in an experiment to produce hydrated zinc nitrate crystals.

- pour 50 cm^3 of dilute nitric acid into a beaker
- add a spatula of zinc powder to the acid
- add more zinc until it is in excess
- filter the mixture
- obtain crystals of zinc nitrate from the filtrate

(a) State why the mixture is filtered.
(1 mark)

(continued on the next page)

10 continued.

(b) Describe how a pure, dry sample of hydrated zinc nitrate crystals could be obtained from the filtrate. (4 marks)

Answer space continues on the next page.

10(b) continued.

(continued on the next page)

10 continued.

(c) This equation represents the formation of hydrated zinc nitrate in the experiment.

$$Zn(s) + 2HNO_3(aq) + 6H_2O(l) \longrightarrow Zn(NO_3)_2 \cdot 6H_2O(aq) + H_2(g)$$

(i) In another experiment, 9·75 g of zinc is completely reacted with nitric acid.

Show that the maximum possible mass of hydrated zinc nitrate crystals that could be formed is approximately 45 g.

[for $Zn(NO_3)_2 \cdot 6H_2O$, $M_r = 297$]

(2 marks)

(continued on the next page)

10(c) continued.

(ii) The actual yield of hydrated zinc nitrate crystals is 36·4 g.

Calculate the percentage yield of hydrated zinc nitrate crystals.
(2 marks)

percentage yield = _____ %

(Total for Question 10 = 9 marks)

TOTAL FOR PAPER = 110 MARKS

END OF PAPER