Paper Reference(s) 1CH0/1H
Pearson Edexcel Level 1/Level 2 GCSE (9–1)

Total Marks

Chemistry
PAPER 1
Higher Tier

Friday 17 May 2024 – Morning

Time: 1 hour 45 minutes

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

Surname					
Other names					
Centre Number					
Candidate Number					

Y74423A

Pearson

YOU MUST HAVE

Calculator, ruler, Periodic Table (enclosed)

YOU WILL BE GIVEN

Diagram Booklet

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.

Calculators may be used.

Any diagrams may NOT be accurately drawn, unless otherwise indicated.

You must show all your working out with your answer clearly identified at the end of your solution.

INFORMATION

The total mark for this paper is 100.

The marks for EACH question are shown in brackets – use this as a guide as to how much time to spend on each question.

In questions marked with an ASTERISK (*), marks will be awarded for your ability to structure your answer logically, showing how the points that you make are related or follow on from each other where appropriate.

A Periodic Table is provided as a separate insert.

There may be spare copies of some diagrams.

ADVICE

Read each question carefully before you start to answer it.

Try to answer every question.

Check your answers if you have time at the end.

Answer ALL questions. Write your answers in the spaces provided.

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 ☒.

(continued on the next page)

1 (a) Chemical cells produce a voltage.

Look at Figure 1 for Question 1(a) in the Diagram Booklet. It shows a chemical cell can be made by placing the metals copper and iron in a beaker of sodium chloride solution.

Describe what will happen to the reading on the voltmeter over a long period of time.
(2 marks)

(continued on the next page)

1 continued.

(b) Iron is a transition metal.

Which of the following is most likely to be a property of iron?
(1 mark)

☐ A iron forms a colourless oxide

☐ B iron is a poor conductor of heat

☐ C iron has a low boiling point

☐ D iron has a high density

(continued on the next page)

1 continued.

(c) An iron atom has a diameter of $2{\cdot}52 \times 10^{-10}$ m

What is the size of this iron atom in nanometres?
(1 mark)

☐ A 2·52

☐ B 0·252

☐ C 0·0252

☐ D 0·00252

(continued on the next page)

1 continued.

(d) Look at Figure 2 for Question 1(d) in the Diagram Booklet. It shows the arrangement of atoms in three different alloys of copper and zinc, **A**, **B** and **C**.

Explain which of the three alloys, **A**, **B** and **C**, is the strongest.
(2 marks)

Answer space continues on the next page.

1(d) continued.

(Total for Question 1 = 6 marks)

2 Barium hydroxide reacts with dilute hydrochloric acid to form barium chloride solution and water.

(a) (i) Look at the equation for Question 2(a)(i) in the Diagram Booklet. Complete the balanced equation for the reaction by adding a NUMBER in front of **HCl(aq)**
(1 mark)

(ii) State what you would SEE during the reaction.
(1 mark)

(continued on the next page)

2 continued.

(b) A student investigated how the pH of the mixture changed as barium hydroxide was added to dilute hydrochloric acid.

The student used this method.

STEP 1 measure out $50\,cm^3$ of dilute hydrochloric acid into a beaker using a measuring cylinder

STEP 2 use a glass rod to place a drop of the acid onto a piece of universal indicator paper and record the pH

STEP 3 add one spatula measure of barium hydroxide to the acid in the beaker and stir

(continued on the next page)

2(b) continued.

STEP 4 use the glass rod to place a drop of the mixture onto a new piece of universal indicator paper and record the pH again

STEP 5 repeat steps 3 and 4 until there is no further change in the pH

(continued on the next page)

2(b) continued.

(i) Name a piece of equipment that could be used to measure the pH of a substance more accurately than universal indicator paper. (1 mark)

(continued on the next page)

2(b) continued.

(ii) Explain why, in step 3, the mixture was stirred after adding the barium hydroxide.
(2 marks)

(continued on the next page)

2(b) continued.

(iii) Figure 3 shows the student's results.

FIGURE 3

number of spatula measures of barium hydroxide	pH of mixture
0	1
1	1
2	1
3	1
4	3
5	8
6	12
7	13
8	13

(continued on the next page)

2(b)(iii) continued.

Look at the graph for Question 2(b)(iii) in the Diagram Booklet. Plot a graph of the pH of the mixture against the number of spatula measures of barium hydroxide.
(3 marks)

(iv) Use the graph to find the pH of the mixture when 4·5 spatula measures of barium hydroxide are added.
(1 mark)

pH of the mixture = _____

(Total for Question 2 = 9 marks)

3 Sodium carbonate has the formula Na_2CO_3

(a) Sodium carbonate contains Na^+ ions and CO_3^{2-} ions.

(i) The atomic number of sodium is 11

What is the electronic configuration of the Na^+ ion? (1 mark)

☐ A 1

☐ B 2.8

☐ C 2.8.1

☐ D 2.8.2

(continued on the next page)

3(a) continued.

(ii) Explain why solid sodium carbonate CANNOT conduct electricity but a solution of sodium carbonate CAN conduct electricity.
(3 marks)

(continued on the next page)

3 continued.

(b) Calculate the percentage by mass of sodium in sodium carbonate, Na_2CO_3

percentage by mass of element =

$$\frac{\text{total relative atomic mass of element}}{\text{relative formula mass of compound}} \times 100$$

(relative atomic masses: C = 12, O = 16, Na = 23)

(3 marks)

Answer space continues on the next page.

3(b) continued.

percentage by
mass of sodium = _____

(Total for Question 3 = 7 marks)

4 (a) Titanium can be extracted from titanium oxide, TiO_2, by reaction with magnesium.

(i) **100 tonnes** of titanium oxide was heated with magnesium. The titanium formed in the reaction was separated and purified. The mass of titanium was then determined.

Look at Figure 4 for Question 4(a) in the Diagram Booklet. The results are shown.

(continued on the next page)

4(a)(i) continued.

Use the information in Figure 4 to calculate the percentage yield of titanium in this process.

$$\text{percentage yield} = \frac{\text{actual yield}}{\text{theoretical yield}} \times 100$$

Give your answer to 1 decimal place.
(3 marks)

percentage yield = _____

(continued on the next page)

4(a) continued.

(ii) Give TWO reasons why the percentage yield for THIS PROCESS is less than 100% (2 marks)

1 _____

_____

_____

2 _____

_____

_____

(continued on the next page)

4(a) continued.

(iii) The balanced equation for this process is

$$TiO_2 + 2Mg \rightarrow Ti + 2MgO$$

Calculate the atom economy of this process to produce titanium.

atom economy (%) =

$$\frac{\text{total formula mass of desired product}}{\text{total formula mass of all reactants or products}} \times 100$$

Give your answer to 2 significant figures.

(relative atomic masses: O = 16, Mg = 24, Ti = 48)

(3 marks)

Answer space continues on the next page.

4(a)(iii) continued.

_____

_____

_____

atom economy = _____%

(continued on the next page)

4 continued.

(b) Ethanol, C_2H_5OH, can be produced by two different methods.

- by the hydration of ethene, C_2H_4

$$C_2H_4 + H_2O \rightarrow C_2H_5OH$$

atom economy = 100%

- and by the fermentation of a carbohydrate,
e.g. sucrose, $C_{12}H_{22}O_{11}$

$$C_{12}H_{22}O_{11} + H_2O \rightarrow 4C_2H_5OH + 4CO_2$$

atom economy = 51·1%

(continued on the next page)

4(b) continued.

(i) State why the hydration of ethene has an atom economy of 100% (1 mark)

(continued on the next page)

4(b) continued.

(ii) Explain how the atom economy of the fermentation reaction can be improved.
(2 marks)

(Total for Question 4 = 11 marks)

5 This question is about the extraction of metals.

(a) Give TWO advantages of obtaining metals by recycling rather than by extracting them from their metal ores. (2 marks)

1 _____

_____

_____

2 _____

_____

_____

(continued on the next page)

5 continued.

(b) (i) Small amounts of some metals are extracted using displacement reactions.

In one process, zinc dust is used to precipitate cadmium metal from a solution containing cadmium ions.

$$\underset{\text{cadmium ions}}{Cd^{2+}(aq)} + Zn(s) \rightarrow \underset{\text{cadmium}}{Cd(s)} + Zn^{2+}(aq)$$

Explain why this displacement reaction can be described as a REDOX REACTION.
(3 marks)

Answer space continues on the next page.

5(b)(i) continued.

(continued on the next page)

5(b) continued.

(ii) The formula of the cadmium ion is Cd^{2+}

The formula of the phosphate ion is PO_4^{3-}

Which is the formula of cadmium phosphate?
(1 mark)

☐ A $Cd_2(PO_4)_3$

☐ B Cd_3PO_{12}

☐ C $Cd_3(PO_4)_2$

☐ D $Cd_3P_2O_8$

(continued on the next page)

5 continued.

(c) One of the alternative biological methods of extracting metals from very low-grade ores is bioleaching using bacteria.

Give one DISADVANTAGE of this method of extracting metals from low-grade ores.
(1 mark)

(continued on the next page)

5 continued.

(d) Lead is low in the reactivity series.

Describe how to obtain a sample of lead from some lead oxide in the laboratory.
(2 marks)

Answer space continues on the next page.

5(d) continued.

(Total for Question 5 = 9 marks)

6 Titration can be used to find the volume of dilute hydrochloric acid needed to neutralise $25{\cdot}0\,cm^3$ of barium hydroxide solution.

(a) Before the titration is carried out, the pipette and conical flask are rinsed out with pure water.

Explain the effect, if any, that traces of water in the pipette and conical flask after rinsing could have on the titration result.
(4 marks)

Answer space continues on the next page.

pipette

6(a) continued.

conical flask

(continued on the next page)

6 continued.

(b) In the titration, a few drops of phenolphthalein indicator are added to the barium hydroxide solution.

(i) State the change in colour of phenolphthalein at the end point, when the barium hydroxide solution has just been neutralised. (1 mark)

from _____

to _____

(ii) Write the ionic equation for the neutralisation reaction that occurs when hydrochloric acid is added to barium hydroxide solution. (2 marks)

_____

_____

(continued on the next page)

6 continued.

(c) When barium hydroxide solution is neutralised by dilute sulfuric acid, a white precipitate of barium sulfate is formed in the conical flask.

Describe an experiment to obtain a sample of pure, dry barium sulfate from the contents of the conical flask. (3 marks)

Answer space continues on the next page.

6(c) continued.

(Total for Question 6 = 10 marks)

7 (a) Water, acidified with dilute sulfuric acid, was electrolysed for **10 minutes** using inert electrodes.

Look at Figure 5 for Question 7(a) in the Diagram Booklet. It shows the apparatus used.

(i) In this electrolysis, the acidified water is an electrolyte.

Explain why acidified water is an electrolyte.
(2 marks)

(continued on the next page)

7(a) continued.

(ii) Hydrogen collects at the negative electrode and oxygen collects at the positive electrode.

Look at the diagrams for Question 7(a)(ii) in the Diagram Booklet. Which of these shows the results after **10 minutes** of this electrolysis?
(1 mark)

☐ A diagram **A**

☐ B diagram **B**

☐ C diagram **C**

☐ D diagram **D**

(continued on the next page)

7(a) continued.

(iii) Complete and balance the half equation for the formation of oxygen at the positive electrode in this electrolysis.
(2 marks)

$4OH^- \rightarrow$

(continued on the next page)

7 continued.

(b) Copper sulfate solution was electrolysed for **10 minutes** using copper electrodes.

Look at Figure 6 for Question 7(b) in the Diagram Booklet. It shows the mass of the cathode and the appearance of the copper sulfate solution before electrolysis and after electrolysis.

(continued on the next page)

7(b) continued.

(i) Describe what should be done to the copper cathode, after it has been removed from the copper sulfate solution, before its final mass is determined.
(2 marks)

(continued on the next page)

7(b) continued.

(ii) Explain, in terms of ions, the change in mass of the cathode shown in Figure 6.
(2 marks)

(continued on the next page)

7(b) continued.

(iii) Explain why the appearance of the copper sulfate solution did not change during the electrolysis.
(2 marks)

(Total for Question 7 = 11 marks)

8 This question is about the properties of different substances.

(a) Silicon tetrachloride is a simple molecular covalent compound.

(i) A molecule of silicon tetrachloride is composed of a silicon atom and four chlorine atoms.

- a silicon atom has
  4 outer electrons
- a chlorine atom has
  7 outer electrons

Draw a dot and cross diagram of a molecule of silicon tetrachloride, $SiCl_4$

Show outer electrons only.
(2 marks)

Answer space continues on the next page.

8(a)(i) continued.

(continued on the next page)

8(a) continued.

(ii) Explain why simple molecular covalent compounds such as silicon tetrachloride have low melting and boiling points.
(2 marks)

(continued on the next page)

8 continued.

(b) Look at Figure 7 for Question 8(b) in the Diagram Booklet. Part of the structure of rubidium bromide is shown.

Which row shows the most likely melting point and boiling point of rubidium bromide?
(1 mark)

	melting point in °C	boiling point in °C
☐ A	6·93	134·0
☐ B	69·3	134·0
☐ C	69·3	1340
☐ D	693	1340

(continued on the next page)

8 continued.

*(c) Diamond and graphite are two forms of carbon.

Look at Figure 8 for Question 8(c) in the Diagram Booklet. It shows how the carbon atoms are arranged in a part of the structure of each of these forms of carbon.

- diamond is one of the hardest known substances on Earth and is used in cutting tools.
- graphite is soft and flaky.
- diamond is a poor electrical conductor, but graphite is a good electrical conductor.

Explain, in terms of structure and bonding, these properties of diamond and graphite.
(6 marks)

Answer space continues on the next 5 pages.

8(c) continued.

8(c) continued.

8(c) continued.

8(c) continued.

8(c) continued.

(Total for Question 8 = 11 marks)

9 (a) An investigation was carried out on the reactivity of four metals, **D**, **E**, **F** and **G**.

Equal sized pieces of these metals were placed in excess dilute hydrochloric acid and left for three minutes.

Look at Figure 9 for Question 9(a) in the Diagram Booklet. It shows the observations of the reactions for metals **D**, **E** and **F**.

Look at Figure 10 for Question 9(a) in the Diagram Booklet. It shows the order of reactivity for these metals.

(continued on the next page)

9(a) continued.

(i) Use the information in Figure 9 and Figure 10 to suggest the observations that would be made for metal **G**.
(2 marks)

(continued on the next page)

9(a) continued.

(ii) The dilute hydrochloric acid used in this reaction is a strong acid.

Explain the meaning of the terms DILUTE and STRONG ACID.
(4 marks)

Answer space continues on the next page.

dilute

9(a)(ii) continued.

strong acid

(continued on the next page)

9 continued.

(b) The formula of lead ethanoate is $Pb(CH_3COO)_2$

Calculate the number of ATOMS that combine together to form $16{\cdot}25\,g$ of lead ethanoate.

(relative atomic masses: $H = 1{\cdot}00$, $C = 12{\cdot}0$, $O = 16{\cdot}0$, $Pb = 207$

Avogadro number = $6{\cdot}02 \times 10^{23}$)
(4 marks)

Answer space continues on the next page.

9(b) continued.

number of atoms = _____

(continued on the next page)

9 continued.

(c) Iron is more reactive than copper.

Iron will displace copper from copper nitrate solution.
Two possible balanced equations for the reaction are

Equation 1

$$Fe + Cu(NO_3)_2 \rightarrow Fe(NO_3)_2 + Cu$$

Equation 2

$$2Fe + 3Cu(NO_3)_2 \rightarrow 2Fe(NO_3)_3 + 3Cu$$

It was found that 2·24 g of iron reacted with excess copper nitrate solution to form 3·81 g of copper.

(continued on the next page)

9(c) continued.

Carry out a calculation, using the information above, to show which equation represents the reaction taking place.

(relative atomic masses: Fe = 56·0, Cu = 63·5)

(3 marks)

Answer space continues on the next page.

9(c) continued.

(Total for Question 9 = 13 marks)

10 Hydrogen can be produced by the reaction of methane with steam.

(a) Methane reacts with steam in the presence of a nickel catalyst to produce hydrogen and a dynamic equilibrium is reached.

The equation for this equilibrium reaction is

$$CH_4(g) + 2H_2O(g) \rightleftharpoons 4H_2(g) + CO_2(g)$$

methane

The forward reaction takes in heat energy and is endothermic.

(continued on the next page)

10(a) continued.

(i) Describe the effect of the catalyst on the rate of attainment of equilibrium and on the equilibrium yield of products. (2 marks)

(continued on the next page)

10(a) continued.

*(ii) A manufacturer produces hydrogen by the reaction of methane with steam in the presence of a nickel catalyst using the conditions

temperature 600 °C

pressure 20 atmospheres

Explain what effect there would be on the rate of attainment of equilibrium and the equilibrium yield of hydrogen if the manufacturer were to use a higher temperature of 1000 °C at a lower pressure of 10 atmospheres without changing the catalyst.
(6 marks)

Answer space continues on the next 5 pages.

10(a)(ii) continued.

10(a)(ii) continued.

10(a)(ii) continued.

10(a)(ii) continued.

10(a)(ii) continued.

(b) Using the equation for the reaction

$$CH_4(g) + 2H_2O(g) \rightleftharpoons 4H_2(g) + CO_2(g)$$

calculate the maximum volume of products, in dm^3, that could be formed by the complete reaction of $650\,dm^3$ of methane.

(assume all volumes of gases are measured under the same conditions of temperature and pressure)
(2 marks)

Answer space continues on the next page.

10(b) continued.

maximum volume of products = _____ dm^3

(continued on the next page)

10 continued.

(c) Using the same equation for the reaction

$$CH_4(g) + 2H_2O(g) \rightleftharpoons 4H_2(g) + CO_2(g)$$

calculate the maximum mass, in g, of carbon dioxide for every $1800\,dm^3$ of hydrogen, measured at room temperature and pressure, produced in this reaction.

(relative formula mass: $CO_2 = 44$; 1 mol of any gas at room temperature and pressure occupies $24\,dm^3$)
(3 marks)

Answer space continues on the next page.

10(c) continued.

mass of
carbon dioxide = _____ g

(Total for Question 10 = 13 marks)

TOTAL FOR PAPER = 100 MARKS
END OF PAPER