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

Chemistry

PAPER 1
Higher Tier

Total Marks

Time: 1 hour 45 minutes

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

Surname					
Other names					
Centre Number					
Candidate Number					

X69485A

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.

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 ☒.

1 (a) Chemical cells produce a voltage.

A chemical cell can be made by placing the metals copper and zinc in a beaker of sodium chloride solution.

Look at Figure 1 for Question 1(a) in the Diagram Booklet. It shows a diagram of this chemical cell.

Describe what will happen to the brightness of the light bulb over a long period of time.
(2 marks)

(continued on the next page)

1 continued.

(b) Copper is a transition metal.

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

☐ A copper forms a white oxide

☐ B copper has a high melting point

☐ C copper has a low boiling point

☐ D copper has a low density

(c) A copper atom has a diameter of 0·256 nm.

What is the size of this copper atom in metres?
(1 mark)

☐ A $2{\cdot}56 \times 10^{-8}$

☐ B $2{\cdot}56 \times 10^{-9}$

☐ C $2{\cdot}56 \times 10^{-10}$

☐ D $2{\cdot}56 \times 10^{-11}$

(continued on the next page)

1 continued.

(d) Brass is an alloy of copper and zinc.
One type of brass contains 70% copper.

Zinc atoms are slightly larger than copper atoms.

Draw a labelled diagram in the space below to show the arrangement of copper and zinc atoms in this alloy.

Describe, or draw diagrams to show, how the arrangement of atoms in brass differs from the arrangement of atoms in pure copper.
(2 marks)

(Total for Question 1 = 6 marks)

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

(a) The equation for the reaction is

$$Ba(OH)_2(s) + 2HCl(aq) \longrightarrow BaCl_2(aq) + 2H_2O(l)$$

Which row of the table shows the correct state of each of the substances in the equation for the reaction?
(1 mark)

	barium hydroxide	hydrochloric acid	barium chloride	water
☐ A	solid	aqueous	aqueous	liquid
☐ B	solid	liquid	solid	aqueous
☐ C	aqueous	aqueous	solid	liquid
☐ D	aqueous	liquid	aqueous	aqueous

(continued on the next page)

2 continued.

(b) A student wanted to investigate how the pH of the mixture changes as barium hydroxide is added to dilute hydrochloric acid.

They followed this method.

STEP 1 measure out 50·0 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 0·2 g of barium hydroxide to the acid in the beaker and stir

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 3–4 until there is no further change in the pH.

(continued on the next page)

2 continued.

(i) Name a piece of equipment which could be used to measure out 50·0 cm^3 of dilute hydrochloric acid more accurately than the measuring cylinder.
(1 mark)

_____

_____

(ii) Describe how the pH of the mixture is determined when a drop of it is placed on the universal indicator paper.
(2 marks)

_____

_____

_____

_____

_____

_____

(continued on the next page)

2 continued.

(iii) In the method, universal indicator paper is used to determine the pH.

Explain why litmus paper would not be a suitable indicator to use in this experiment. (2 marks)

_____

_____

_____

_____

_____

_____

(continued on the next page)

2 continued.

(iv) Figure 2 shows the student's results.

FIGURE 2

mass of barium hydroxide in g	pH of mixture
0·0	1
0·2	1
0·4	1
0·6	1
0·8	2
1·0	7
1·2	12
1·4	13
1·6	13

Look at grid for Question 2(b)(iv) in the Diagram Booklet. On the grid:

- Add suitable scales to the vertical and horizontal axes.
- Plot a graph of the pH of the mixture against the mass of barium hydroxide.

(3 marks)

(Total for Question 2 = 9 marks)

3 Magnesium carbonate has the formula $MgCO_3$.

(a) Magnesium carbonate contains Mg^{2+} and CO_3^{2-} ions.

(i) The atomic number of magnesium is 12.

What is the electronic configuration of the Mg^{2+} ion?
(1 mark)

☐ A 2

☐ B 2.8

☐ C 2.8.2

☐ D 2.8.4

(continued on the next page)

3 continued.

(ii) Explain why solid magnesium carbonate cannot conduct electricity but solid magnesium can. (3 marks)

(continued on the next page)

3 continued.

(b) Calculate the percentage by mass of magnesium in magnesium carbonate, $MgCO_3$.
(3 marks)

(relative atomic masses: C = 12.0, O = 16.0, Mg = 24.0)

percentage by mass of magnesium = _____

(continued on the next page)

3 continued.

(c) Magnesium carbonate reacts with dilute hydrochloric acid.
Water and carbon dioxide are two of the products of the reaction.

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

$MgCO_3 + 2HCl \longrightarrow$ _____ $+ H_2O + CO_2$

(Total for Question 3 = 8 marks)

4 Sucrose is a carbohydrate.

When a solution of sucrose is fermented using yeast, ethanol is formed.

$$\text{sucrose} + \text{water} \longrightarrow \text{ethanol} + \text{carbon dioxide}$$

(a) In one experiment, 100·00 g of sucrose was dissolved in water.

Yeast was added and the mixture allowed to ferment until no more bubbles of carbon dioxide were seen to be formed.

The ethanol was obtained from the mixture and its mass determined.

Look at the table for Question 4(a) in the Diagram Booklet. The results are shown in Figure 3.

The percentage yield is calculated using

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

(continued on the next page)

4 continued.

(i) State the meanings of the terms ACTUAL YIELD and THEORETICAL YIELD. (2 marks)

actual yield

_____

_____

_____

theoretical yield

_____

_____

_____

(continued on the next page)

4 continued.

(ii) Use the information in Figure 3 to calculate the percentage yield of ethanol in this experiment.
(2 marks)

_____

_____

_____

_____

_____

_____

percentage yield = _____

(continued on the next page)

4 continued.

(iii) State TWO reasons why the actual yield of a reaction is usually less than the theoretical yield.
(2 marks)

1 _____

_____

_____

2 _____

_____

_____

(continued on the next page)

4 continued.

(b) The balanced equation for the fermentation of sucrose is

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

(i) Calculate the atom economy of this reaction to produce ethanol.
(3 marks)

Give your answer to two significant figures.

(relative formula masses: $C_{12}H_{22}O_{11}$ = 342, H_2O = 18, C_2H_5OH = 46, CO_2 = 44)

atom economy = _____%

(continued on the next page)

4 continued.

(ii) Explain the effect on the atom economy of this reaction if the carbon dioxide produced was used to make fizzy drinks.
(2 marks)

(Total for Question 4 = 11 marks)

5 When copper sulfate solution is electrolysed using copper electrodes, the mass of each electrode changes.

(a) Draw a labelled diagram to show the apparatus that can be used to electrolyse copper sulfate solution using copper electrodes.
(2 marks)

(continued on the next page)

5 continued.

(b) Before the electrolysis is carried out, the mass of each electrode is determined.

Explain what should be done to the copper electrodes before their masses are determined. (2 marks)

(continued on the next page)

5 continued.

(c) Look at Figure 4 for Question 5(c) in the Diagram Booklet. It shows the results obtained from an electrolysis experiment when copper sulfate solution was electrolysed for 10 minutes.

(i) Explain, in terms of ions, the changes in mass of the two electrodes shown in the results in Figure 4.
(3 marks)

(continued on the next page)

5 continued.

(ii) The electrolysis was repeated using another pair of copper electrodes of the same masses.

Explain a change that could be made to the electrolysis experiment to cause the mass of the cathode to increase by 2·34 g in 10 minutes.
(2 marks)

(Total for Question 5 = 9 marks)

6 The method used to extract a metal from its ore depends on the position of the metal in the reactivity series.

(a) Aluminium is extracted from its ore by electrolysis.

Explain why this method is used to extract aluminium from its ore.
(2 marks)

(continued on the next page)

6 continued.

(b) (i) One step in the extraction of titanium metal involves the displacement reaction between titanium chloride, $TiCl_4$, and magnesium.

$$TiCl_4 + 2Mg \longrightarrow Ti + 2MgCl_2$$

This equation can be simplified as

$$Ti^{4+} + 2Mg \longrightarrow Ti + 2Mg^{2+}$$

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

(continued on the next page)

6 continued.

_____

_____

(ii) The formula of the sulfate ion is SO_4^{2-}.

Which of the following is the formula of titanium sulfate containing the Ti^{4+} ion? (1 mark)

☐ A $TiSO_4$

☐ B Ti_2SO_4

☐ C $Ti(SO_4)_2$

☐ D $Ti_2S_2O_8$

(continued on the next page)

6 continued.

(c) Phytoextraction is an alternative biological method that can be used to extract metals from very low-grade ores.

Give ONE disadvantage of phytoextraction as a method of extraction of metals.
(1 mark)

_____

_____

_____

(continued on the next page)

6 continued.

(d) Copper is low down in the reactivity series and can be obtained from copper oxide.

Devise a simple method to obtain a sample of copper from copper oxide in the laboratory.
(2 marks)

(Total for Question 6 = 9 marks)

7 The volume of dilute sulfuric acid required to neutralise 25·0 cm^3 of ammonia solution can be found by titration.

In the titration, a few drops of methyl orange indicator were added to the ammonia solution in a conical flask before adding the dilute sulfuric acid.

(a) State the change in colour of the methyl orange at the end point when the ammonia solution has just been neutralised.
(2 marks)

from _____ to _____

(b) When the ammonia solution was neutralised by the dilute sulfuric acid, a solution of ammonium sulfate was formed.

Complete the balanced equation for the reaction between ammonia solution and sulfuric acid.
(2 marks)

_____NH_3 + H_2SO_4 ⟶ _____

(continued on the next page)

7 continued.

(c) The titration was repeated to obtain a mean volume of dilute sulfuric acid required to neutralise the 25·0 cm^3 of ammonia solution.
The volumes of the two solutions were measured accurately.

Explain TWO other practical steps that should be used in the titration to ensure that an accurate titre volume is obtained.
(4 marks)

1 _____

_____

_____

_____

_____

_____

_____

2 _____

_____

(continued on the next page)

7 continued.

(continued on the next page)

7 continued.

(d) The mean volume of dilute sulfuric acid required to neutralise the ammonia solution was determined from the results of the titration.

This volume of dilute sulfuric acid was added to 25·0 cm^3 of ammonia solution in a conical flask.

Devise a plan to produce a sample of dry ammonium sulfate from the contents of the conical flask.
(3 marks)

(continued on the next page)

7 continued.

(Total for Question 7 = 11 marks)

8 (a) Bromine is a liquid at room temperature and vaporises readily.
Bromine has a simple molecular structure.

Which row of the table shows the most likely melting and boiling points of bromine?
(1 mark)

	melting point in °C	boiling point in °C
☐ A	–70	–6·3
☐ B	–17	6·3
☐ C	–7	63
☐ D	17	630

(continued on the next page)

8 continued.

(b) Look at Figure 5 for Question 8(b) in the Diagram Booklet. Part of the structure of graphene is shown in Figure 5.

Explain why graphene will be a good conductor of an electric current.
(3 marks)

(continued on the next page)

8 continued.

(c) Look at Figure 6 for Question 8(c) in the Diagram Booklet. Part of the structure of potassium chloride is shown in Figure 6.

Potassium chloride has a melting point of 770 °C.

Explain why potassium chloride has a high melting point.
(2 marks)

(continued on the next page)

8 continued.

*(d) Look at Figure 7 for Question 8(d) in the Diagram Booklet. A molecule of methane can be represented in several different ways as shown in Figure 7.
These representations have been labelled **A–E** to assist you in your answer.

Describe what information can be obtained from each representation including the limitations of these representations of methane.
(6 marks)

(continued on the next page)

8 continued.

(continued on the next page)

8 continued.

(continued on the next page)

8 continued.

(continued on the next page)

8 continued.

(Total for Question 8 = 12 marks)

9 (a) A student carried out an investigation to determine the order of reactivity of four metals, **W**, **X**, **Y** and **Z**.
A piece of metal **W** was added to a test tube containing excess dilute hydrochloric acid.
This was repeated with the other three metals, **X**, **Y** and **Z**.
In each case, the size of each piece of metal was the same.
The student recorded observations on each reaction for three minutes.

(continued on the next page)

9 continued.

The observations obtained are shown in Figure 8.

FIGURE 8

metal	observations with dilute hydrochloric acid
W	Bubbles formed quickly with some metal remaining after three minutes.
X	A few bubbles were seen to form. The metal looked unchanged after three minutes.
Y	Bubbles formed quickly. After three minutes all the metal had reacted.
Z	Bubbles formed very quickly with no metal remaining after three minutes.

(i) Look at the diagram for Question 9(a)(i) in the Diagram Booklet. Use the information in Figure 8 to place the metals in order of reactivity from the least reactive to the most reactive.
(2 marks)

(continued on the next page)

9 continued.

(ii) The experiment was repeated using an excess of dilute sulfuric acid in place of the dilute hydrochloric acid.

metal + sulfuric acid ⟶ metal sulfate + hydrogen

When metal Y reacts with dilute sulfuric acid, bubbles form quickly at first and then the reaction stops.
Most of the solid metal remains.

Explain why the reaction between metal Y and excess dilute sulfuric acid stopped even though there was solid metal Y left.
(2 marks)

(continued on the next page)

9 continued.

(iii) The reactions between metals and dilute ethanoic acid are slower than reactions between metals and dilute hydrochloric acid. This is because ethanoic acid is a weak acid.

Explain the meaning of the term WEAK ACID. (2 marks)

(continued on the next page)

9 continued.

(b) The formula of aluminium sulfate is $Al_2(SO_4)_3$.

Calculate the total number of atoms that combine to form 5·13 g of aluminium sulfate.
(4 marks)

(relative atomic masses: O = 16.0, Al = 27.0, S = 32.0
Avogadro number = $6·02 \times 10^{23}$)

(continued on the next page)

9 continued.

_____

_____

_____

number of atoms = _____

(continued on the next page)

9 continued.

(c) Iron is more reactive than lead.
Iron reacts with lead nitrate solution to form solid lead.
Two possible balanced equations for the reaction are

Equation 1 $Fe + Pb(NO_3)_2 \longrightarrow Fe(NO_3)_2 + Pb$

Equation 2 $2Fe + 3Pb(NO_3)_2 \longrightarrow 2Fe(NO_3)_3 + 3Pb$

In one experiment, it was found that 4·48 g of iron reacted with excess lead nitrate solution to form 24·84 g of lead.

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

(relative atomic masses: Fe = 56.0, Pb = 207)

(continued on the next page)

9 continued.

(Total for Question 9 = 13 marks)

10 When hydrogen is removed from an alkane, an alkene is formed.

This is an example of a dehydrogenation reaction.

(a) Under certain conditions the dehydrogenation of propane forms propene and a dynamic equilibrium is reached.

(i) State what is meant by dynamic in this context.
(1 mark)

(continued on the next page)

10 continued.

*(ii) The equation for this equilibrium reaction is

$$\underset{\text{propane}}{C_3H_8(g)} \rightleftharpoons \underset{\text{propene}}{C_3H_6(g)} + H_2(g)$$

The forward reaction takes in heat energy and is endothermic.
A manufacturer produces large quantities of propene using this equilibrium reaction.

Suggest, with explanations, suitable conditions that the manufacturer could use to maximise the yield and rate of production of propene from propane.
(6 marks)

(continued on the next page)

10 continued.

(continued on the next page)

10 continued.

(continued on the next page)

10 continued.

(continued on the next page)

10 continued.

(b) $C_3H_8(g) \rightleftharpoons C_3H_6(g) + H_2(g)$
propane propene

State the maximum volume of propene, in dm^3, formed by the dehydrogenation of 300 dm^3 of propane.
(1 mark)

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

maximum volume of propene = _____ dm^3

(continued on the next page)

10 continued.

(c) 900 dm^3 of propane, measured at room temperature and pressure, were dehydrogenated to form propene.

$C_3H_8(g) \rightleftharpoons C_3H_6(g) + H_2(g)$
propane propene

Calculate the maximum mass, in kg, of hydrogen formed in this reaction.
(4 marks)

(relative atomic mass: H = 1.0;
1 mol of any gas at room temperature and pressure occupies 24 dm^3)

(continued on the next page)

10 continued.

mass of hydrogen = _____ kg

(Total for Question 10 = 12 marks)

TOTAL FOR PAPER = 100 MARKS
END OF PAPER