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

Chemistry

PAPER 1

Higher Tier

Total Marks

Monday 22 May 2023 – 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						

Q72631A

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.

(continued on the next page)

INFORMATION continued.

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) Look at Figure 1 under Question 1(a) in the Diagram Booklet. It shows information about two isotopes of hydrogen, A and B.

Complete the table to show the number of subatomic particles in each isotope.
(2 marks)

(continued on the next page)

1 continued.

(b) Hydrogen gas and oxygen gas are used in a hydrogen–oxygen fuel cell.

Separate containers of hydrogen and oxygen are used to supply the gases.

A student tests the voltage supplied by the fuel cell every 15 minutes.

Look at Figure 2 for Question 1(b) in the Diagram Booklet. The results are shown in Figure 2.

Describe what Figure 2 shows about how the voltage of this fuel cell varies with time.
(2 marks)

(continued on the next page)

1 continued.

(c) A chemical cell is made by placing two electrodes into an aqueous electrolyte.

Look at Figure 3 for Question 1(c) in the Diagram Booklet. It shows a chemical cell.

State why sodium and sulfur electrodes are NOT suitable for this experiment.
(2 marks)

sodium

sulfur

(Total for Question 1 = 6 marks)

2 In an experiment, powdered calcium hydroxide was added to dilute hydrochloric acid and the pH was measured.

The method used was

STEP 1 measure 200 cm^3 dilute hydrochloric acid into a beaker

STEP 2 add 0·1 g of powdered calcium hydroxide to the beaker

STEP 3 find the pH of the mixture

STEP 4 repeat steps 2 and 3 until the pH stops changing.

(a) State what should be done after STEP 2 to make sure that any reaction is complete.
(1 mark)

(continued on the next page)

2 continued.

(b) Complete the word equation for the reaction.
(2 marks)

calcium hydroxide + hydrochloric acid

→ _____

(c) Which row of the table shows the state symbols for powdered calcium hydroxide and dilute hydrochloric acid in the balanced chemical equation?
(1 mark)

	calcium hydroxide	hydrochloric acid
☐ A	aq	l
☐ B	l	aq
☐ C	s	aq
☐ D	s	l

(continued on the next page)

2 continued.

(d) Look at Figure 4 for Question 2(d) in the Diagram Booklet. The results of the experiment are shown in Figure 4.

(i) Using Figure 4, give the pH of the acid at the start of the experiment.
(1 mark)

pH = _____

(ii) Using Figure 4, give the mass of calcium hydroxide required to make a neutral mixture.
(1 mark)

mass of calcium hydroxide =

_____ g

(continued on the next page)

2(d) continued.

(iii) Explain why the pH starts at a low value and ends at a higher value.
(3 marks)

(Total for Question 2 = 9 marks)

3 Look at Figure 5 for Question 3(a) in the Diagram Booklet. It shows part of the reactivity series of metals.

(a) Which metal reacts when added to cold water? (1 mark)

☐ A calcium

☐ B copper

☐ C gold

☐ D silver

(b) A student investigates the reactivity of four different metals.

The student adds an equal-sized piece of each metal to separate test tubes containing dilute hydrochloric acid.

Look at Figure 6 for Question 3(b) in the Diagram Booklet. The student's observations for zinc and copper are recorded.

(continued on the next page)

3(b) continued.

(i) Use the information in Figure 5 and in Figure 6 to predict the observations for the reactions of magnesium and of iron with dilute hydrochloric acid.
(2 marks)

magnesium

iron

(continued on the next page)

3(b) continued.

(ii) When metals react with acids, hydrogen gas is produced.

Describe the test to show that the gas is hydrogen.
(2 marks)

(continued on the next page)

3(b) continued.

(iii) When magnesium reacts with hydrochloric acid, magnesium chloride and hydrogen are formed.

Complete the balanced equation for the reaction.
(2 marks)

Mg + _____ HCl →

$MgCl_2$ + _____

(continued on the next page)

3 continued.

(c) An excess of magnesium is added to some dilute hydrochloric acid of pH 2.
The mass of hydrogen gas produced is measured.

The experiment is repeated with excess magnesium but with the same volume of dilute hydrochloric acid of pH 1.

(i) State how many times greater the concentration of hydrogen ions is in the acid of pH 1 than in the acid of pH 2.
(1 mark)

(continued on the next page)

3(c) continued.

(ii) With the acid of pH 2, the mass of hydrogen gas produced when the reaction is complete is 0·005 g.

Predict the mass of hydrogen gas produced in the reaction with acid of pH 1.
(1 mark)

mass = _____ g

(Total for Question 3 = 9 marks)

4 **There are several stages to the production of sulfuric acid in industry.**

(a) Sulfur dioxide is required for the production of sulfuric acid.

Sulfur dioxide can be obtained by heating copper sulfide, Cu_2S, in excess air.

$$Cu_2S + O_2 \longrightarrow 2Cu + SO_2$$

Calculate the atom economy for the production of sulfur dioxide, SO_2, in this reaction.

(relative atomic mass: Cu = 63·5
relative formula masses: O_2 = 32·0, Cu_2S = 159·0, SO_2 = 64·0)

Give your answer to two significant figures.
(4 marks)

Answer space continues on the next page.

4(a) continued.

_____

_____

atom economy = _____ %

(b) In one stage vanadium oxide, V_2O_5, is used.

Based on the position of vanadium in the periodic table, which row shows the most likely melting point of vanadium and colour of vanadium oxide? (1 mark)

	melting point of vanadium in °C	colour of vanadium oxide
☐ A	50	white
☐ B	1910	white
☐ C	50	orange
☐ D	1910	orange

(continued on the next page)

4 continued.

(c) The equation shows a reaction forming sulfuric acid.

$$SO_3 + H_2O \longrightarrow H_2SO_4$$

(i) Calculate the maximum mass of sulfuric acid that could be produced from 400 tonnes of sulfur trioxide, SO_3.

(relative formula masses: $SO_3 = 80$, $H_2SO_4 = 98$)
(2 marks)

maximum mass of sulfuric acid = _____ tonnes

(continued on the next page)

4(c) continued.

(ii) Using a different amount of sulfur trioxide, it was calculated that 700 tonnes of sulfuric acid could be made.

The actual mass produced was 672 tonnes.

Calculate the percentage yield of sulfuric acid.
(2 marks)

percentage yield = _____

(continued on the next page)

4(c) continued.

(iii) State TWO reasons why the percentage yield is less than 100 %.
(2 marks)

1 _____

_____

2 _____

_____

_____

(Total for Question 4 = 11 marks)

5 (a) Ammonia is manufactured in the Haber process by the reversible reaction between nitrogen and hydrogen.

(i) Write the balanced equation for the reversible reaction between nitrogen and hydrogen to make ammonia, NH_3
(3 marks)

(ii) Which row shows the typical conditions of temperature and pressure used in the Haber process?
(1 mark)

	temperature in °C	pressure in atmospheres
☐ A	250	100
☐ B	250	200
☐ C	450	500
☐ D	450	200

(continued on the next page)

5(a) continued.

(iii) In the Haber process, iron is added to the vessel where the nitrogen and hydrogen react.

State the purpose of the iron.
(1 mark)

(iv) The reaction between nitrogen and hydrogen to make ammonia can reach dynamic equilibrium.

The reaction gives out heat.

Explain how the position of equilibrium changes if the temperature is decreased.
(2 marks)

Answer space continues on the next page.

5(a)(iv) continued.

(b) Compound **A** is a dark brown gas.

Compound **B** is a colourless gas.

Two molecules of **A** combine to form one molecule of **B** in a reversible reaction.

You are given

- a sealed glass tube containing an equilibrium mixture of **A** and **B**
- a beaker
- a kettle
- some ice

(continued on the next page)

5(b) continued.

At room temperature, the equilibrium mixture is a pale brown colour.

Devise an experiment to show how the position of equilibrium of this reaction is affected by temperature.

The sealed tube must NOT be opened.

(3 marks)

Answer space continues on the next page.

5(b) continued.

(Total for Question 5 = 10 marks)

6 A student investigates the mass of copper produced when copper chloride solution in a beaker is electrolysed using inert electrodes.

(a) Where is copper formed during the electrolysis? (1 mark)

☐ A at the anode

☐ B at the bottom of the beaker

☐ C at the cathode

☐ D on the surface of the electrolyte

(b) Look at Figure 7 for Question 6(b) in the Diagram Booklet. The student investigated the change in the mass of copper formed when the current was altered.

(i) State and explain the trend shown in these results.
(3 marks)

Answer space continues on the next page.

6(b)(i) continued.

(ii) Describe how, after the power supply has been switched off, the mass of copper formed can be measured.
(2 marks)

(continued on the next page)

6 continued.

(c) In another experiment, 74 mg of copper is formed.

Calculate the number of copper atoms in 74 mg of copper.

(relative atomic mass Cu = 63·5;
Avogadro constant = $6{\cdot}02 \times 10^{23}$)

(3 marks)

number of atoms = _____

(Total for Question 6 = 9 marks)

7 Titration is used to carry out some neutralisation reactions.

(a) Ammonium nitrate can be made by neutralisation.

(i) State the name of the two reactants that are neutralised to make the salt ammonium nitrate.
(2 marks)

_____ and

_____

(ii) Ammonium nitrate is a fertiliser.
Another fertiliser is ammonium phosphate.

Which elements are combined in ammonium phosphate?
(1 mark)

☐ A nitrogen, oxygen and phosphorus only

☐ B hydrogen, oxygen and phosphorus only

☐ C hydrogen, nitrogen and phosphorus only

☐ D hydrogen, nitrogen, oxygen and phosphorus only

(continued on the next page)

7 continued.

(b) Titrations involve aqueous solutions and the use of burettes.

(i) Look at Figure 8 for Question 7(b)(i) in the Diagram Booklet. Figure 8 shows readings on part of a burette at the start and at the end of a titration.

Calculate the volume of solution added from this burette.

Give your answer to a suitable number of decimal places.
(2 marks)

volume = _____ cm^3

(continued on the next page)

7(b) continued.

(ii) A student carries out a titration four times.

The volumes from the student's results table are shown in Figure 9.

FIGURE 9

	rough	titration 1	titration 2	titration 3
volume in cm^3	25·90	24·90	24·60	25·00
used to calculate mean volume				

Tick the volumes that should be used to calculate the mean volume.
(1 mark)

(iii) Look at Figure 10 for Question 7(b)(iii) in the Diagram Booklet. It shows the burette and flask prepared for use by the student. The burette is supported vertically by a clamp that is not shown in the diagram.

(continued on the next page)

7(b)(iii) continued.

The student wrote a description of how they used the burette.

I took the burette from the cupboard. I closed the tap and filled the burette with the correct solution. I added the solution from the burette drop by drop to the flask until the indicator changed colour.

Give THREE improvements to the way that the student used the BURETTE.
(3 marks)

Answer space continues on the next page.

1 _____

_____

_____

2 _____

_____

_____

7(b)(iii) continued.

3 _____

_____

_____

(c) In a titration a student placed alkali in the flask.

By mistake a few drops of litmus AND a few drops of phenolphthalein were added to the flask.

The student added acid to the flask until the mixture was acidic.

Predict the colour change that would be seen. (1 mark)

from _____

to _____

(continued on the next page)

7 continued.

(d) In a titration a student rinsed out the flask with distilled water and did not dry it.

They used the flask for titration, adding the solution from the burette until the indicator changed colour.

State the effect, if any, on the titre volume of using the wet flask rather than a dry flask.
(1 mark)

(Total for Question 7 = 11 marks)

8 Crystals of copper sulfate are prepared by reacting copper oxide, a base, with dilute sulfuric acid.

(a) Name the other product of this reaction.
(1 mark)

(b) During the experiment, a spatula measure of copper oxide, a black powder, is added to warm, dilute sulfuric acid in a beaker.

When the mixture is stirred, the black powder disappears and the mixture turns pale blue.

The student then adds more copper oxide until the maximum amount of copper sulfate is formed without wasting copper oxide.

Explain how the student knows when to stop adding copper oxide.
(3 marks)

Answer space continues on the next page.

8(b) continued.

(continued on the next page)

8 continued.

(c) The reaction produces an aqueous solution of copper sulfate.

What is the best way to obtain crystals of copper sulfate from an aqueous solution?
(1 mark)

☐ A pour the solution through filter paper in a funnel

☐ B heat the solution with a Bunsen burner until dry

☐ C heat the solution using a water bath

☐ D leave the solution in a cold, damp place

(continued on the next page)

8 continued.

(d) When some water is removed from the aqueous solution of copper sulfate, crystals of copper sulfate are made.

Describe how the arrangement and movement of the particles change as crystals are formed from a solution.

(3 marks)

(continued on the next page)

8 continued.

(e) In this reaction, copper oxide, CuO, forms copper sulfate, $CuSO_4$.

Explain, in terms of electrons, whether the copper in copper oxide has been oxidised, has been reduced, or has not been oxidised or reduced.
(2 marks)

(continued on the next page)

8 continued.

(f) In another experiment, a copper sulfate solution with a concentration of $39{\cdot}875\,g\,dm^{-3}$ is used.

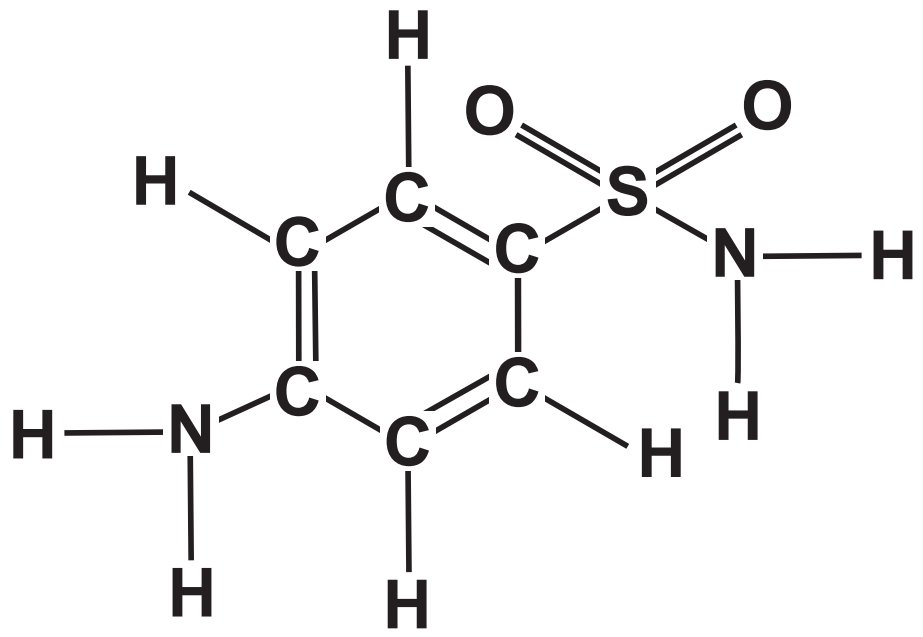
Calculate the mass of copper sulfate dissolved in $0{\cdot}300\,dm^3$ of this solution.
(1 mark)

mass = _____ g

(Total for Question 8 = 11 marks)

9 (a) Figure 11 shows the structure of a molecule of compound S.

FIGURE 11



(i) Use Figure 11 to deduce the empirical formula of compound S.
(1 mark)

(continued on the next page)

9(a) continued.

(ii) Look at Figure 12 for Question 9(a)(ii) in the Diagram Booklet. The melting points of three samples of S are shown in Figure 12.

State whether each of these samples, **A**, **B** and **C**, is pure or impure and justify your answers using the information in Figure 12.

(3 marks)

(continued on the next page)

9 continued.

(b) A scientist uses chromatography in an investigation of compound **S**.

In the conditions used, compound **S** has an R_f value of 0·22.

Calculate the distance the spot of compound **S** moves if the solvent front has moved by 2·4 cm. (2 marks)

distance = _____ cm

(continued on the next page)

9 continued.

*(c) A solution of sodium chloride in water needs to be separated to obtain a sample of pure, dry sodium chloride and a sample of pure water.

Figure 13 shows the boiling points of sodium chloride and water.

FIGURE 13

substance	boiling point in °C
sodium chloride	1465
water	100

Explain this difference in boiling points in terms of the structure and bonding of sodium chloride and water and how this difference is used to choose a method to separate sodium chloride solution into pure, dry sodium chloride and pure water.

(6 marks)

Answer space continues on the next 3 pages.

9(c) continued.

9(c) continued.

9(c) continued.

(Total for Question 9 = 12 marks)

10 (a) Buildings sometimes have water sprinklers to put out fires.

The pipes in some water sprinklers are filled with nitrogen gas to prevent corrosion when the system is not in use.

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

(continued on the next page)

10(a) continued.

(ii) Nitrogen can be made from sodium azide, NaN_3.

$$2NaN_3 \longrightarrow 2Na + 3N_2$$

Calculate the maximum volume, in cm^3, of nitrogen produced from 110 g of sodium azide.

(relative formula mass: $NaN_3 = 65$;

1 mol of gas occupies 24 dm^3 in the conditions used)
(4 marks)

Answer space continues on the next page.

10(a)(ii) continued.

volume = _____ cm^3

*(b) Compare and contrast the properties and uses of pure aluminium and pure copper with the alloys of aluminium and the alloys of copper.

Include in your answer an EXPLANATION of the similarities and the differences in the properties and the uses of a pure metal and its alloy.
(6 marks)

Answer space continues on the next 5 pages.

10(b) continued.

10(b) continued.

10(b) continued.

10(b) continued.

10(b) continued.

(Total for Question 10 = 12 marks)

TOTAL FOR PAPER = 100 MARKS

END OF PAPER

Turn over