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

Chemistry

PAPER 1
Foundation 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					

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 In an experiment, paper chromatography was used to separate the coloured dyes in four different inks, W, X, Y and Z.

(a) Look at Figure 1 for Question 1(a) in the Diagram Booklet. It shows the chromatogram at the end of the experiment.

(i) The chromatogram shows that only one of the inks contains a single dye.

Which ink contains a single dye?
(1 mark)

☐ **A** **W**

☐ **B** **X**

☐ **C** **Y**

☐ **D** **Z**

1(a) continued.

(ii) Which ink contains the greatest number of dyes?
(1 mark)

☐ A W

☐ B X

☐ C Y

☐ D Z

(continued on the next page)

1(a) continued.

(iii) The R_f value of a dye can be calculated using the equation

$$R_f = \frac{\text{distance moved by the dye}}{\text{distance moved by solvent front}}$$

At the end of the chromatography one dye had moved 3·60 cm and the solvent front had moved 9·20 cm.

Calculate the R_f value for this dye.

Give your answer to 2 decimal places.
(2 marks)

R_f = _____

(continued on the next page)

1 continued.

(b) The substance used as the solvent in the chromatography was heated for 8 minutes.

Look at Figure 2 for Question 1(b) in the Diagram Booklet. It shows how the temperature of the substance changed with time.

From **A** to **B** the substance was a liquid.

From **C** to **D** the substance was a gas.

(i) Give the name of the change when a liquid becomes a gas.
(1 mark)

_____

_____

(ii) Use Figure 2 to give the temperature of the substance at 4 minutes.
(1 mark)

_____ °C

(continued on the next page)

1(b) continued.

(iii) Use Figure 2 to give the time when the substance has completely changed into a gas.
(1 mark)

_____ **minutes**

(iv) The temperature of the substance at A was 25 °C.

Calculate the temperature rise of the substance from A to D.
(1 mark)

_____ **°C**

(Total for Question 1 = 8 marks)

2 (a) Most of the gold used in jewellery is not pure gold but alloys of gold.

The purity of gold is measured in carats.

Look at Figure 3 for Question 2(a) in the Diagram Booklet. It shows how the percentage of gold is related to the purity of gold measured in carats.

State the relationship between the percentage of gold and the number of carats.
(1 mark)

_____

_____

_____

(continued on the next page)

2 continued.

(b) Look at Figure 4 for Question 2(b) in the Diagram Booklet. It shows the arrangement of atoms in pure gold and in an alloy of gold.

Using Figure 4, explain why alloys of gold are stronger than pure gold.
(3 marks)

(continued on the next page)

2 continued.

(c) Explain ONE property of alloys of gold, other than their strength, that makes them suitable for use in jewellery.
(2 marks)

(Total for Question 2 = 6 marks)

3 This question is about electrolysis.

(a) Which statement describes what happens during electrolysis?
(1 mark)

☐ **A** atoms are decomposed

☐ **B** ionic compounds are decomposed

☐ **C** mixtures are separated

☐ **D** molecules are separated

(b) Look at Figure 5 for Question 3(b)(i) in the Diagram Booklet. It shows the electrolysis of copper chloride solution.

(i) Use the words from the list in the Diagram Booklet to complete the labelling of the diagram in Figure 5.
(2 marks)

(continued on the next page)

3(b) continued.

(ii) Look at the diagram for Question 3(b)(ii) in the Diagram Booklet. The products of the electrolysis shown in Figure 5 are solid **X** and gas **Y**.

Draw ONE straight line from each product to its name.
(2 marks)

(continued on the next page)

3(b) continued.

(iii) The experiment is repeated using powdered solid copper chloride instead of copper chloride solution.

Nothing happens and no products are formed.

Explain why nothing happens and no products are formed.
(2 marks)

(Total for Question 3 = 7 marks)

4 Steel is an alloy containing iron.

When exposed to damp air, some steels will corrode to form rust.

(a) (i) Which gas in the air is needed for corrosion to occur?
(1 mark)

- ☐ **A argon**
- ☐ **B carbon dioxide**
- ☐ **C nitrogen**
- ☐ **D oxygen**

(ii) What type of reaction happens when the iron in steel corrodes?
(1 mark)

- ☐ **A the iron has been displaced**
- ☐ **B the iron has been neutralised**
- ☐ **C the iron has been oxidised**
- ☐ **D the iron has been reduced**

(continued on the next page)

4 continued.

(b) Rust can be removed from steel by treating it with dilute hydrochloric acid.

One product formed in this reaction is iron chloride, $FeCl_3$

Calculate the relative formula mass of this iron chloride.
(2 marks)

(relative atomic masses: Fe = 56·0, Cl = 35·5)

_____

_____

_____

_____

_____

relative formula mass = _____

(continued on the next page)

4 continued.

(c) Look at Figure 6 for Question 4(c) in the Diagram Booklet. It shows the composition of one type of steel that has a low resistance to corrosion and another type of steel that has a high resistance to corrosion.

(i) Using Figure 6, state which non-metal is in both types of steel.
(1 mark)

_____

_____

(ii) Using Figure 6, state which metal is added to steel to increase its resistance to corrosion.
(1 mark)

_____

_____

(continued on the next page)

4(c) continued.

(iii) Explain ONE other way that corrosion of steel can be prevented.
(2 marks)

(continued on the next page)

4 continued.

(d) A student is given TWO nails of the same size but made of different types of steel.

They are also given two boiling tubes and some distilled water.

Devise an experiment to show which nail corrodes more quickly.
(3 marks)

Answer space continues on the next page.

4(d) continued.

(Total for Question 4 = 11 marks)

5 (a) When lead nitrate solution and potassium chloride solution are mixed, potassium nitrate and a precipitate of lead chloride are formed.

(i) Complete the word equation for this reaction. (1 mark)

lead nitrate + _____ ⟶

_____ + lead chloride

(ii) Lead nitrate is toxic.

Which hazard symbol should be on a container of lead nitrate? (1 mark)

☐ **A**

☐ **B**

☐ **C**

☐ **D**

5 continued.

(b) A student put 5 cm^3 of potassium carbonate solution into a test tube and added 2 cm^3 of calcium nitrate solution.

Look at Figure 7 for Question 5(b)(i) in the Diagram Booklet. A precipitate formed and was allowed to settle as shown in Figure 7.

The height of the precipitate was measured.

(i) Give the name of the piece of apparatus the student should use to find the volume of the potassium carbonate solution.
(1 mark)

_____

_____

(continued on the next page)

5(b) continued.

(ii) The student repeated the experiment.

The results are shown in Figure 8.

FIGURE 8

experiment	height of precipitate in cm
1	2·4
2	2·7
3	2·4

Use the data in Figure 8 to calculate the mean height of the precipitate.
(2 marks)

mean height of precipitate = _____ cm

(continued on the next page)

5(b) continued.

(iii) Describe how a pure, dry sample of the precipitate could be obtained from the mixture in the test tube.
(3 marks)

(continued on the next page)

5(b) continued.

(iv) The student investigated whether increasing the volume of calcium nitrate solution increased the height of the precipitate formed.

They repeated the experiment using different volumes of calcium nitrate.

State ONE variable that should be controlled in this investigation.
(1 mark)

_____

_____

(Total for Question 5 = 9 marks)

6 (a) Magnesium is a metal.

(i) State ONE physical property of magnesium.
(1 mark)

_____

_____

(ii) Which element is in the same group of the periodic table as magnesium?
Use the periodic table to help you answer this question.
(1 mark)

☐ A carbon

☐ B chromium

☐ C sodium

☐ D strontium

(b) (i) Magnesium atoms have 12 electrons.

Complete the electronic configuration of a magnesium atom.
(1 mark)

2.8._____

6(b) continued.

(ii) The electronic configuration of a chlorine atom is 2.8.7

Explain how the electronic configuration of chlorine is linked to its period in the periodic table.
(2 marks)

(continued on the next page)

6 continued.

(c) 1·20 g of magnesium reacts completely with 3·55 g of chlorine to form magnesium chloride.

Calculate the empirical formula of the magnesium chloride.

(relative atomic masses: Mg = 24·0, Cl = 35·5)

You must show your working.
(3 marks)

Answer space continues on the next page.

6(c) continued.

_____

_____

_____

empirical formula = _____

(continued on the next page)

6 continued.

(d) Sodium reacts with chlorine to form sodium chloride, which contains ionic bonds.

Hydrogen reacts with chlorine to form hydrogen chloride, which contains covalent bonds.

Look at Figure 9 for Question 6(d) in the Diagram Booklet. It shows dot and cross diagrams of these compounds.

Describe the differences between an ionic bond and a covalent bond.
(4 marks)

Answer space continues on the next page.

6(d) continued.

(Total for Question 6 = 12 marks)

7 (a) Figure 10 shows some information on a container of plant fertiliser.

FIGURE 10

contains	percentage by mass
ammonium nitrate (NH_4NO_3)	46 %
phosphorus oxide (P_2O_5)	0 %
potassium nitrate (KNO_3)	54 %

(i) State which element, often present in fertilisers, is NOT present in this fertiliser. (1 mark)

_____

_____

(continued on the next page)

7(a) continued.

(ii) Ammonium nitrate, NH_4NO_3, is prepared for use in fertilisers by neutralising ammonia with an acid.

Which acid reacts with ammonia to produce ammonium nitrate?
(1 mark)

☐ A ethanoic acid

☐ B hydrochloric acid

☐ C nitric acid

☐ D sulfuric acid

(iii) State why farmers spread fertilisers on their fields.
(1 mark)

_____

_____

_____

(continued on the next page)

7 continued.

(b) Ammonium sulfate is a fertiliser and is produced on a large scale in industry.

In this process, ammonia reacts with sulfuric acid.

(i) Write the word equation for the reaction between ammonia and sulfuric acid.
(2 marks)

_____

_____

_____

(continued on the next page)

7(b) continued.

(ii) Ammonium sulfate can also be made in the laboratory by titrating ammonia solution with dilute sulfuric acid.

Give ONE DISADVANTAGE of using this laboratory method to produce ammonium sulfate as a fertiliser compared with an industrial method.
(1 mark)

_____

_____

_____

(continued on the next page)

7 continued.

*(c) In the laboratory, ammonium sulfate crystals can be made using ammonia solution and dilute sulfuric acid.

The volume of ammonia solution required to neutralise 25 cm^3 of dilute sulfuric acid is found by titration using an indicator.

The results of the titration can be used to prepare a solution of ammonium sulfate.

Pure, dry ammonium sulfate crystals can be made from this solution.

Look at Figure 11 for Question 7(c) in the Diagram Booklet. It shows some of the equipment that may be used in the experiment.

Write a detailed method to make ammonium sulfate crystals starting with ammonia solution and dilute sulfuric acid.
(6 marks)

Answer space continues on the next 4 pages.

7(c) continued.

7(c) continued.

7(c) continued.

7(c) continued.

(Total for Question 7 = 12 marks)

8 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)

8 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)

8 continued.

(d) Look at Figure 12 for Question 8(d) in the Diagram Booklet. The results of the experiment are shown in Figure 12.

(i) Using Figure 12, give the pH of the acid at the start of the experiment.
(1 mark)

pH = _____

(ii) Using Figure 12, give the mass of calcium hydroxide required to make a neutral mixture.
(1 mark)

mass of calcium hydroxide =

_____g

(continued on the next page)

8(d) continued.

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

(continued on the next page)

8 continued.

(e) State what should be used to measure the pH of the mixture in this experiment.
(1 mark)

(f) The calcium hydroxide used is corrosive to the eyes and an irritant to skin.

Using this information, state ONE safety precaution that should be taken during the experiment when using any corrosive substance.
(1 mark)

(Total for Question 8 = 11 marks)

9 Look at Figure 13 for Question 9(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 14 for Question 9(b) in the Diagram Booklet. The student's observations for zinc and copper are recorded.

(continued on the next page)

9(b) continued.

(i) Use the information in Figure 13 and in Figure 14 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)

9(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)

9(b) continued.

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

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

$Mg + \_\_\_\_\_ HCl \longrightarrow$

$MgCl_2 + \_\_\_\_\_$

(continued on the next page)

9 continued.

*(c) There are THREE common methods of obtaining metals from the Earth's crust:

- mine the pure metal
- mine the metal ore and heat it with carbon
- mine the metal ore and electrolyse the molten compound.

The method used to obtain a metal is linked to its position in the reactivity series of metals.

Aluminium, gold, iron, and silver are some commonly used metals.

Use the reactivity series in Figure 13 to state and explain the method chosen to obtain each of these four metals.
(6 marks)

Answer space continues on the next 4 pages.

9(c) continued.

9(c) continued.

9(c) continued.

9(c) continued.

(Total for Question 9 = 13 marks)

10 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.

10(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)

10 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)

10(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)

10(c) continued.

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

1 _____

_____

_____

2 _____

_____

_____

(Total for Question 10 = 11 marks)

TOTAL FOR PAPER = 100 MARKS
END OF PAPER