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

Total Marks

Chemistry
PAPER 1
Foundation 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					

Y74421A

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 ☒.

1 **Look at Figure 1 for Question 1 in the Diagram Booklet. It shows a test tube being heated in a beaker of water.**

The test tube contains solid wax.

As the test tube was heated, the solid wax changed to liquid wax.

After heating, the wax was allowed to cool to room temperature.

(continued on the next page)

1 continued.

(a) Look at Figure 2 for Question 1(a) in the Diagram Booklet. It shows the arrangement of particles in liquid wax.

Look at Figure 3 for Question 1(a) in the Diagram Booklet. Draw the arrangement of particles in solid wax in the box.
(1 mark)

(continued on the next page)

1 continued.

(b) When the wax cools, it changes from a liquid back to a solid.
This change is a PHYSICAL CHANGE.

(i) What name is given to the change of a liquid to a solid?
(1 mark)

☐ A condensing

☐ B evaporating

☐ C freezing

☐ D melting

(continued on the next page)

1(b) continued.

(ii) Explain why the change from a liquid to a solid is a physical change rather than a chemical change.
(2 marks)

(continued on the next page)

1 continued.

(c) Another physical change is when a liquid changes into a gas.

(i) Which row shows the movement and arrangement of the particles in a gas?
(1 mark)

	movement of particles	arrangement of particles
☐ A	slow	regular
☐ B	slow	random
☐ C	fast	regular
☐ D	fast	random

(continued on the next page)

1(c) continued.

(ii) Suggest why the wax did NOT change into a gas when the test tube was heated in the beaker of water.
(1 mark)

_____

_____

_____

(Total for Question 1 = 6 marks)

2 (a) Nitrogen reacts with hydrogen to form ammonia.

The reaction is reversible.

(i) Complete the word equation for the reaction by adding the SYMBOL to show that the reaction is reversible.
(1 mark)

nitrogen + hydrogen

_____ ammonia

(ii) Look at Figure 4 for Question 2(a)(ii) in the Diagram Booklet. It shows the electronic configuration of an atom of hydrogen.

Complete the dot and cross diagram for a molecule of hydrogen, H_2
(1 mark)

(continued on the next page)

2 continued.

(b) Ammonia reacts with sulfuric acid to form ammonium sulfate.

(i) Look at the diagram for Question 2(b)(i) in the Diagram Booklet. Write the word equation for this reaction.
(2 marks)

(ii) Ammonium sulfate contains ammonium ions, NH_4^+, and sulfate ions, SO_4^{2-}

What is the formula of ammonium sulfate?
(1 mark)

☐ A NHSO

☐ B NH_4SO_4

☐ C $(NH_4)_2SO_4$

☐ D $NH_4(SO_4)_2$

(continued on the next page)

2(b) continued.

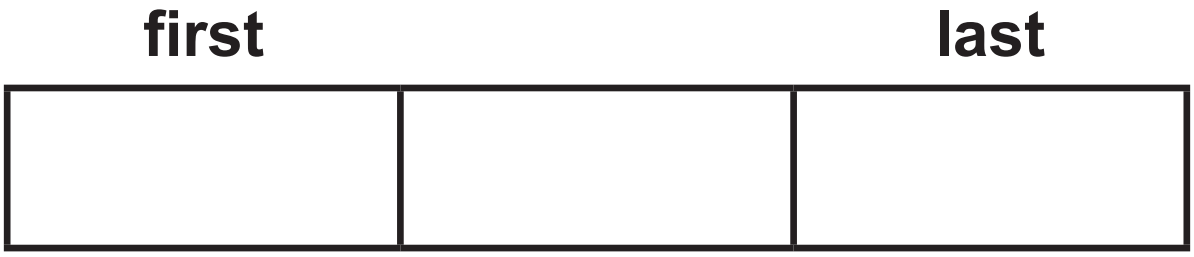
(iii) Explain why some farmers spread ammonium sulfate on their fields. (2 marks)

(Total for Question 2 = 7 marks)

3 Water treatment is needed to make most sources of water suitable for drinking.

(a) Water treatment includes the processes of CHLORINATION, FILTRATION and SEDIMENTATION.

Place these processes in the order that they take place during water treatment.
(2 marks)



(continued on the next page)

3 continued.

(b) Some tap water contains chloride ions.

(i) Explain, in terms of electrons, how a chlorine atom, Cl, forms a chloride ion, Cl^-
(2 marks)

(continued on the next page)

3(b) continued.

(ii) Why is chlorine added to water during water treatment?
(1 mark)

☐ A to clean the water

☐ B to dissolve insoluble substances in the water

☐ C to increase the pH of the water to 11

☐ D to kill any bacteria in the water

(iii) State why tap water is not suitable for use in chemical analysis.
(1 mark)

_____

_____

_____

(continued on the next page)

3 continued.

(c) A student was asked to distil a sample of tap water. Look at Figure 5 for Question 3(c) in the Diagram Booklet. It shows the apparatus the student used.

(i) The student made an error when setting up the apparatus in Figure 5.

This error meant that pure water could NOT be collected in the test tube.

Explain what the student needs to change so that pure water can be collected in the test tube.
(2 marks)

Answer space continues on the next page.

3(c)(i) continued.

(ii) State what the student should use to heat the water.
(1 mark)

(Total for Question 3 = 9 marks)

4 A student was asked to find the volume of lithium hydroxide solution that would react exactly with $25{\cdot}0\,cm^3$ of dilute hydrochloric acid.

Look at Figure 6 for Question 4 in the Diagram Booklet. The student used the equipment in Figure 6 to carry out a rough titration and then a further three accurate titrations.

(a) (i) Which is the name of the piece of equipment labelled **X** in Figure 6? (1 mark)

- ☐ A boiling tube
- ☐ B burette
- ☐ C funnel
- ☐ D measuring cylinder

(continued on the next page)

4(a) continued.

(ii) Describe how the student should measure the $25{\cdot}0\,cm^3$ of dilute hydrochloric acid accurately into the conical flask. (2 marks)

(continued on the next page)

4 continued.

(b) Look at Figure 7 for Question 4(b) in the Diagram Booklet. It shows the results of the student's titrations.

(i) Calculate the volume of lithium hydroxide solution added in the ROUGH titration.
(1 mark)

volume of lithium hydroxide solution

= _____ cm^3

(continued on the next page)

4(b) continued.

(ii) Calculate the mean volume of lithium hydroxide solution used in the ACCURATE titrations. (2 marks)

mean volume of lithium hydroxide solution

= _____ cm^3

(continued on the next page)

4 continued.

(c) Methyl orange indicator was added to dilute hydrochloric acid in the conical flask in the titration.

What colour change would be seen in the conical flask at the end point of the titration?
(1 mark)

☐ A blue to green

☐ B colourless to black

☐ C red to orange

☐ D white to pink

(continued on the next page)

4 continued.

(d) During the titration, lithium hydroxide solution, **LiOH**, reacts with dilute hydrochloric acid, **HCl**, to form lithium chloride, **LiCl**, and water.

(i) Look at the diagram for Question 4(d)(i) in the Diagram Booklet. Write the balanced equation for the reaction.
(2 marks)

(ii) State the name of this type of reaction.
(1 mark)

(Total for Question 4 = 10 marks)

5 (a) Look at Figure 8 for Question 5(a) in the Diagram Booklet. It shows some information about an atom of chlorine.

State the number of protons, neutrons and electrons in this atom. (3 marks)

number of protons =

_____

number of neutrons =

_____

number of electrons =

_____

(continued on the next page)

5 continued.

(b) Chlorine reacts with silicon to form silicon chloride.

A sample of silicon chloride contains 1·4 g of silicon atoms and 7·1 g of chlorine atoms.

Calculate the empirical formula of this sample of silicon chloride.

(relative atomic masses: Si = 28, Cl = 35·5)
(3 marks)

Answer space continues on the next page.

5(b) continued.

empirical formula = _____

(c) The modern periodic table is organised into groups and periods.

State in which group and in which period of the periodic table silicon is found.

You should use the periodic table to help you answer this question.
(2 marks)

group = _____

period = _____

(continued on the next page)

5 continued.

(d) Describe TWO differences between Mendeleev's periodic table and the modern periodic table.
(2 marks)

1 _____

_____

_____

2 _____

_____

_____

(Total for Question 5 = 10 marks)

6 (a) A $250\,cm^3$ solution of copper sulfate contains $6{\cdot}52\,g$ of dissolved solid.

Calculate the concentration of this copper sulfate solution in $g\,dm^{-3}$

$$\text{concentration } (g\,dm^{-3}) = \frac{\text{mass of solid } (g)}{\text{volume of solution } (dm^3)}$$

(2 marks)

concentration = _____ $g\,dm^{-3}$

(continued on the next page)

6 continued.

(b) Sodium hydroxide solution and copper sulfate solution were reacted together completely.

The result was a mixture of a precipitate of copper hydroxide in a solution of sodium sulfate.

Describe how to obtain

- a pure sample of solid copper hydroxide from the mixture

- a pure sample of solid sodium sulfate from the mixture.
(4 marks)

Answer space continues on the next page.

6(b) continued.

(continued on the next page)

6 continued.

(c) Look at Figure 9 for Question 6(c) in the Diagram Booklet. It shows the equipment used to electrolyse a sample of sodium sulfate solution.

Graphite electrodes are used in the electrolysis.

(i) Give two reasons why graphite is a suitable material for the electrodes.
(2 marks)

1 _____

_____

2 _____

_____

(continued on the next page)

6(c) continued.

(ii) Sodium sulfate solution contains ions.

Which ions are attracted to the positive electrode during the electrolysis?
(1 mark)

☐ A H^+ ions only

☐ B OH^- ions only

☐ C H^+ and Na^+ ions

☐ D SO_4^{2-} and OH^- ions

(continued on the next page)

6(c) continued.

(iii) Look at the diagram for Question 6(c)(iii) in the Diagram Booklet. Draw ONE straight line from each electrode to the product formed at that electrode during the electrolysis of sodium sulfate solution.
(2 marks)

(Total for Question 6 = 11 marks)

7 (a) A student investigated the rusting of iron rods using the following method.

STEP 1 find the mass of two identical iron rods

STEP 2 wrap magnesium ribbon around one of the iron rods

STEP 3 place each rod in separate boiling tubes containing $10\,cm^3$ of water

STEP 4 leave the iron rods for one week

STEP 5 find the new mass of the iron rods.

Look at Figure 10 for Question 7(a) in the Diagram Booklet. It shows the apparatus used.

(continued on the next page)

7(a) continued.

Look at Figure 11 for Question 7(a) in the Diagram Booklet. It shows the results of the investigation.

(i) Use the results in Figure 11 to calculate the percentage increase in the mass of the iron rod in boiling tube **B**.

$$\% \text{ increase} = \frac{\text{change in mass}}{\text{initial mass}} \times 100$$

(3 marks)

percentage increase in mass of iron rod = _____

(continued on the next page)

7(a) continued.

(ii) Which gas from the air has reacted with the iron rod in boiling tube **B**?
(1 mark)

☐ A argon

☐ B carbon dioxide

☐ C nitrogen

☐ D oxygen

(continued on the next page)

7(a) continued.

(iii) The iron rod did not rust in boiling tube **A**.

Explain why.
(2 marks)

(continued on the next page)

7 continued.

*(b) Look at Figure 12 for Question 7(b) in the Diagram Booklet. It shows some uses of copper metal.

Describe how the properties of copper metal make it a suitable material for the uses shown.

Your answer should include

- uses of copper metal shown in the photographs
- properties of copper metal including:
  - chemical reactivity
  - electrical conductivity
  - malleability
  - thermal conductivity

(6 marks)

Answer space continues on the next 5 pages.

7(b) continued.

7(b) continued.

7(b) continued.

7(b) continued.

7(b) continued.

(Total for Question 7 = 12 marks)

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

(a) (i) Complete the balanced equation for the reaction by adding a NUMBER in front of $HCl(aq)$. (1 mark)

$$Ba(OH)_2(s) + \_\_\_\_\_HCl(aq) \rightarrow BaCl_2(aq) + 2H_2O(l)$$

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

(continued on the next page)

8 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)

8(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.

(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)

8(b) continued.

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

(continued on the next page)

8(b) continued.

(iii) Figure 13 shows the student's results.

FIGURE 13

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)

8(b)(iii) continued.

Look at the graph for Question 8(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 = _____

(continued on the next page)

8 continued.

(c) Look at Figure 14 for Question 8(c) in the Diagram Booklet. It shows a hazard symbol on the container of barium hydroxide.

What is the meaning of the hazard symbol in Figure 14?
(1 mark)

☐ A corrosive

☐ B health hazard

☐ C oxidising

☐ D toxic

(continued on the next page)

8 continued.

(d) The barium hydroxide was measured in spatulas.

State one way that the measuring of the barium hydroxide could be improved.
(1 mark)

(Total for Question 8 = 11 marks)

9 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)

9(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)

9 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)

percentage by mass of sodium = _____

(continued on the next page)

9 continued.

*(c) A student has three solids, **A**, **B** and **C**.

The solids are sodium carbonate, powdered zinc and copper oxide, but the student does not know which solid is which.

The student reacted each solid with dilute sulfuric acid.

Look at Figure 15 for Question 9(c) in the Diagram Booklet. It shows the student's observations and the results of tests on any gases produced.

Use the observations and results in Figure 15 to identify which solid is which.

(continued on the next page)

9(c) continued.

Your answer should include

- how each test result helps you to identify the solid
- word equations to support your answer.

(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 (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 16 for Question 10(a)(i) in the Diagram Booklet. The results are shown.

Use the information in Figure 16 to calculate the percentage yield of titanium in this process.

(continued on the next page)

10(a)(i) continued.

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

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

percentage yield = _____

(continued on the next page)

10(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)

10(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.

10(a)(iii) continued.

atom economy = _____%

(continued on the next page)

10 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)

10(b) continued.

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

(continued on the next page)

10(b) continued.

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

(Total for Question 10 = 11 marks)

TOTAL FOR PAPER = 100 MARKS
END OF PAPER