

Chemistry
UNIT: 4CH1
Science (Double Award) 4SD0
PAPER: 1C

Total Marks

Time: 2 hours

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

Surname					
Other names					
Centre Number					
Candidate Number					

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.

Show all the steps in any calculations and state the units.

Turn over

INFORMATION

The total mark for this paper is 110.

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

There may be spare copies of some diagrams.

ADVICE

Read each question carefully before you start to answer it.

Write your answers neatly and in good English.

Try to answer every question.

Check your answers if you have time at the end.

Answer ALL questions.

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 the diagram for Question 1 in the Diagram Booklet. It shows the electronic configuration of an atom of an element.

**(a) Name the part of the atom that contains the protons and neutrons.
(1 mark)**

**(b) Give the number of protons in this atom.
(1 mark)**

**(c) Give the number of the group that contains this element.
(1 mark)**

(continued on the next page)

Turn over

1 continued.

**(d) Give the number of the period that contains this element.
(1 mark)**

**(e) Give the charge on the ion formed from this atom.
(1 mark)**

(Total for Question 1 = 5 marks)

2 (a) The list below shows some changes of state.

boiling

condensation

evaporation

freezing

melting

sublimation

Look at the table for Question 2(a) in the Diagram Booklet. It lists some physical changes.

**Complete the table using words from the list to show the change of state for each physical change.
(4 marks)**

(continued on the next page)

Turn over

2 continued.

(b) A student plans to obtain salt crystals from a mixture of salt and sand.

The student adds pure water to the mixture to dissolve the salt.

**(i) State two things the student could do to make the salt dissolve quickly.
(2 marks)**

1 _____

2 _____

(continued on the next page)

Turn over

2 continued.

- (ii) State what the student should do next to separate the sand from the salt solution.
(1 mark)**

(continued on the next page)

2 continued.

**(iii) Describe how the student can obtain pure dry crystals of salt from the salt solution.
(4 marks)**

(continued on the next page)

Turn over

2 continued.

(Total for Question 2 = 11 marks)

3 Crude oil is an important source of organic compounds.

(a) Look at the diagram for Question 3(a) in the Diagram Booklet. It shows how crude oil can be separated into fractions by fractional distillation.

**(i) State what happens to the crude oil when it is in X.
(1 mark)**

**(ii) Give the name of fraction E.
(1 mark)**

(continued on the next page)

Turn over

3 continued.

**(iii) Give a use for fraction A.
(1 mark)**

(continued on the next page)

3 continued.

(b) One of the compounds in fraction D is tridecane ($C_{13}H_{28}$) which can be cracked to form shorter-chain hydrocarbons.

**(i) State the catalyst and temperature used in this cracking reaction.
(2 marks)**

catalyst

temperature

(continued on the next page)

Turn over

3 continued.

(ii) The equation shows an example of a catalytic cracking reaction.



**Give two reasons why this reaction is important.
(2 marks)**

1 _____

2 _____

(continued on the next page)

Turn over

3 continued.

(continued on the next page)

3 continued.

**(c) Sulfur is an impurity in crude oil.
Explain why this is a problem for
the environment.
(3 marks)**

(continued on the next page)

Turn over

3 continued.

(Total for Question 3 = 10 marks)

- 4 A student uses the reaction between iron and oxygen to find the percentage of oxygen in air.**

Look at the diagram for Question 4(a) in the Diagram Booklet. It shows the apparatus the student uses.

- (a) (i) State why the iron powder needs to be wet.
(1 mark)**

(continued on the next page)

4 continued.

**(ii) State the colour of the compound formed in the reaction between iron and oxygen.
(1 mark)**

**(iii) Give the formula of the compound formed.
(1 mark)**

(continued on the next page)

Turn over

4 continued.

- (iv) Explain the advantage of using iron powder rather than pieces of iron.
(2 marks)**

(continued on the next page)

Turn over

4 continued.

(b) Look at the diagram for Question 4(b) in the Diagram Booklet. It shows a close up of the scale on the gas syringe shown in the diagram for 4(a). The syringe in the diagram shows the reading at the end of the experiment.

Look at TABLE 1 for Question 4(b) in the Diagram Booklet. Complete table 1 to show the readings on the syringe.

**Give both values to the nearest 1 cm^3 .
(2 marks)**

(continued on the next page)

4 continued.

(c) The student repeats the experiment and obtains a different set of results.

Look at TABLE 2 for Question 4(c) in the Diagram Booklet. It shows these results.

**Use the results from table 2 to calculate the percentage by volume of oxygen in the air.
(3 marks)**

(continue your answer on the next page)

Turn over

4 continued.

**percentage by
volume of oxygen in air = _____ %**

(Total for Question 4 = 10 marks)

Turn over

5 This question is about alkanes and alkenes.

(a) The alkane C_5H_{12} has three isomers.

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

(continued on the next page)

5 continued.

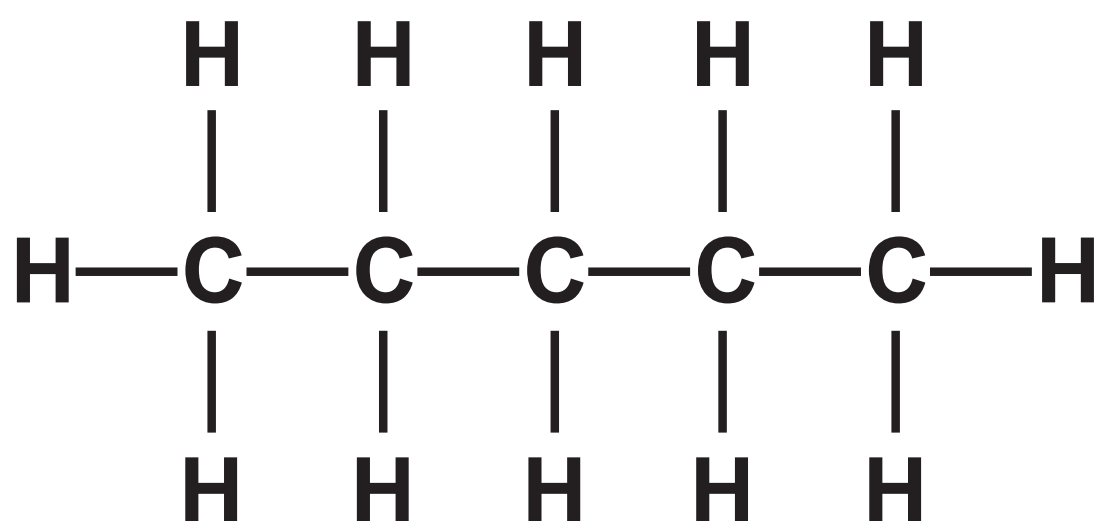
**(ii) Calculate the relative formula mass
(M_r) of C_5H_{12}
(1 mark)**

M_r of C_5H_{12} = _____

(continued on the next page)

5 continued.

(iii) This is the displayed formula of one of the isomers.



**Give the name of this isomer.
(1 mark)**

**(iv) Look at the diagram for Question 5(a)(iv) in the Diagram Booklet. Draw the displayed formulae of the other two isomers.
(2 marks)**

(continued on the next page)

Turn over

5 continued.

(b) Ethane (C_2H_6) and ethene (C_2H_4) both react with bromine.

Describe the differences in the reactions of ethane and ethene with bromine.

**Refer to the conditions, the products and the types of reaction involved.
(5 marks)**

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5 continued.

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5 continued.

(Total for Question 5 = 11 marks)

- 6 Look at the diagram for Question 6 in the Diagram Booklet. A student uses this apparatus to investigate the reaction between magnesium and dilute hydrochloric acid.**

(a) The word equation for the reaction is

**magnesium + hydrochloric acid →
magnesium chloride + hydrogen**

- (i) Complete the chemical equation for this reaction.
(1 mark)**



_____ + _____

(continued on the next page)

6 continued.

**(ii) Give the test for hydrogen.
(1 mark)**

(continued on the next page)

6 continued.

- (iii) The student uses
0.090 g of magnesium and
0.025 mol of hydrochloric acid.**

**Show by calculation that the
hydrochloric acid is in excess.
(2 marks)**

6 continued.

(b) The student measures the volume of hydrogen collected at regular intervals until the reaction stops.

The table shows the student's results.

Time in s	0	15	30	45	60	75
Volume of hydrogen in cm³	0	40	68	80	88	88

For the following questions, look at the grid for Question 6(b) and 6(c) in the Diagram Booklet.

(i) Plot the student's results.

(1 mark)

(ii) Draw a curve of best fit.

(1 mark)

(continued on the next page)

Turn over

6 continued.

(iii) Determine the volume of hydrogen collected in the first 10 seconds.

**Show on the graph how you obtained your answer.
(2 marks)**

volume of hydrogen = _____ cm³

(continued on the next page)

6 continued.

- (iv) Explain why the rate of reaction is greatest at the start of the reaction.
(2 marks)**

(continued on the next page)

Turn over

6 continued.

(c) The student repeats the experiment at a temperature 5°C higher than the original temperature.

All other conditions are kept the same.

**(i) Look again at the grid for Question 6(b) and 6(c) in the Diagram Booklet. On the grid, draw the curve you would expect the student to obtain.
(2 marks)**

(continued on the next page)

6 continued.

- (ii) Explain, in terms of particle collision theory, how increasing the temperature affects the rate of reaction.
(3 marks)**

(continued on the next page)

Turn over

6 continued.

(Total for Question 6 = 15 marks)

7 This question is about copper and copper compounds.

(a) A sample of copper contains two isotopes.

- **Cu-63 with relative abundance 69.5%**
- **Cu-65 with relative abundance 30.5%**

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

(continued on the next page)

Turn over

7 continued.

- (ii) Calculate the relative atomic mass (A_r) of this sample of copper.**

**Give your answer to three significant figures.
(3 marks)**

A_r of copper = _____

(continued on the next page)

Turn over

7 continued.

(b) When copper(II) carbonate is heated, copper(II) oxide and carbon dioxide are formed.

**(i) What is the name of this type of reaction?
(1 mark)**

☐ **A decomposition**

☐ **B neutralisation**

☐ **C oxidation**

☐ **D reduction**

(continued on the next page)

Turn over

7 continued.

**(ii) Which colour change occurs during this reaction?
(1 mark)**

- ☐ **A blue to black**
- ☐ **B blue to white**
- ☐ **C green to black**
- ☐ **D green to orange**

(continued on the next page)

7 continued.

(c) Look at the diagram for Question 7(c) in the Diagram Booklet. A student uses this apparatus to find the value of x in the formula $\text{CuSO}_4 \cdot x\text{H}_2\text{O}$

This is the student's method.

- **find the mass of an empty boiling tube**
- **add hydrated copper(II) sulfate to the tube and record the new mass**
- **heat the hydrated copper(II) sulfate until it changes colour**
- **allow the tube to cool and record the mass again**

Look at the table for Question 7(c) in the Diagram Booklet. It shows the student's results.

(continued on the next page)

7 continued.

- (i) Calculate the mass of CuSO_4 formed.
(1 mark)**

mass of CuSO_4 = _____ g

- (ii) Calculate the mass of water formed.
(1 mark)**

mass of water = _____ g

(continued on the next page)

Turn over

7 continued.

(iii) Show that the value of x is approximately 4 (3 marks)

**[M_r of $\text{CuSO}_4 = 159.5$
 M_r of $\text{H}_2\text{O} = 18$]**

7 continued.

(iv) The actual value of x is 5

**Give a reason why the calculated
value of x is lower than the
actual value.
(1 mark)**

(Total for Question 7 = 13 marks)

Turn over

8 Diamond and graphite are giant covalent structures made of carbon atoms.

Look at the diagram for Question 8(a) in the Diagram Booklet. It shows their structures.

(a) Discuss the differences between diamond and graphite.

**Refer to structure and bonding, electrical conductivity and hardness in your answer.
(6 marks)**

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Turn over

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Turn over

8 continued.

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8 continued.

(b) C₆₀ fullerene is a simple molecular substance made of 60 carbon atoms.

Look at the diagram for Question 8(b) in the Diagram Booklet. It shows its structure.

Look at the table for Question 8(b) in the Diagram Booklet. It shows the approximate melting points of diamond, graphite and C₆₀ fullerene.

**Explain why C₆₀ fullerene has a much lower melting point than diamond and graphite.
(4 marks)**

8 continued.

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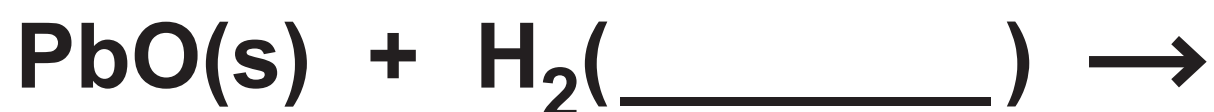
(Total for Question 8 = 10 marks)

Turn over

9 This question is about the oxides of lead.

(a) Yellow lead oxide (PbO) can be reacted with hydrogen to produce lead.

**(i) Complete the equation for the reaction by adding the missing state symbols.
(1 mark)**



(continued on the next page)

9 continued.

**(ii) What is the charge on the lead ion in PbO?
(1 mark)**

☐ **A 1–**

☐ **B 1+**

☐ **C 2–**

☐ **D 2+**

(continued on the next page)

Turn over

9 continued.

**(iii) Explain why the reaction of yellow lead oxide with hydrogen is a redox reaction.
(2 marks)**

(continued on the next page)

9 continued.

**(iv) Describe a physical test to show that the water produced in this reaction is pure.
(2 marks)**

(continued on the next page)

Turn over

9 continued.

(b) When red lead oxide (Pb_3O_4) is heated, yellow lead oxide forms.

The equation for the reaction is



A scientist heats a known mass of red lead oxide in a crucible in a fume cupboard.

The scientist leaves the crucible to cool, then records the total mass of the crucible and its contents.

(i) Describe what the scientist should do next to make sure that all the red lead oxide has reacted. (2 marks)

9 continued.

(continued on the next page)

9 continued.

(ii) The red lead oxide used in the reaction has a mass of 5.48 g.

**Calculate the maximum mass of yellow lead oxide that could form.
(3 marks)**

**[M_r of $\text{Pb}_3\text{O}_4 = 685$
 M_r of $\text{PbO} = 223$]**

(continue your answer on the next page)

Turn over

9 continued.

maximum mass of PbO = _____ g

(Total for Question 9 = 11 marks)

Turn over

10 This question is about ammonia and ammonium compounds.

(a) Ammonia (NH_3) is a simple covalent molecule.

On page 62 draw a dot-and-cross diagram to show the bonding in a molecule of ammonia.

(2 marks)

(continued on the next page)

10 continued.

(continued on the next page)

Turn over

10 continued.

(b) Look at the table for Question 10(b) in the Diagram Booklet. It shows the names and formulae of some ammonium compounds.

(i) Complete the table by giving the missing information.

(2 marks)

(ii) When ammonia reacts with sulfuric acid, ammonium sulfate is formed.

Write a chemical equation for this reaction.

(1 mark)

(continued on the next page)

Turn over

10 continued.

**(iii) Describe a test for ammonium ions.
(3 marks)**

(continued on the next page)

Turn over

10 continued.

(c) Look at the table for Question 10(c) in the Diagram Booklet. It gives some information about ammonia and ammonium compounds.

**(i) Calculate the percentage of nitrogen in ammonium nitrate.
(2 marks)**

[M_r of $\text{NH}_4\text{NO}_3 = 80$]

(continue your answer on the next page)

Turn over

10 continued.

percentage of nitrogen = _____ %

(continued on the next page)

Turn over

10 continued.

- (ii) Fertilisers add nitrogen to the soil to help plants grow.**

Ammonia and ammonium sulfate can both be used as fertilisers.

Discuss the advantages and disadvantages of using each of these compounds as fertilisers.

**Use information from the table in your answer.
(4 marks)**

**[pH of rainwater is
approximately 5-6]**

(continued on the next page)

Turn over

10 continued.

[illegible]

(continued on the next page)

Turn over

10 continued.

(Total for Question 10 = 14 marks)

TOTAL FOR PAPER = 110 MARKS
END OF PAPER