

Combined Science
Paper 5
Higher Tier

Total Marks

Time: 1 hour 10 minutes

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.

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 60.

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.

The 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. A student used the apparatus in Figure 1 to investigate the rate of the reaction between a metal and dilute hydrochloric acid.**

Pieces of the metal were placed in dilute hydrochloric acid in the flask, and the total volume of gas produced was measured every minute.

- (a) Look at Figure 2 for Question 1(a) in the Diagram Booklet. It shows a graph of the student's results.**

(continued on the next page)

1 continued.

- (i) Name a piece of apparatus that would be better to measure the volume of gas produced, instead of the 250 cm³ measuring cylinder.**

**Give a reason for your answer.
(2 marks)**

name of apparatus

reason

(continued on the next page)

1 continued.

- (ii) Calculate the mean rate of production of hydrogen over the first 90 seconds, in cm³ per second.
(3 marks)**

rate = _____ cm³ per second

(continued on the next page)

1 continued.

(iii) The student measured the volume of gas for 10 minutes.

State why the measurements could have been stopped at 9 minutes.

(1 mark)

(continued on the next page)

1 continued.

(b) The experiment was repeated, but with acid of a higher concentration.

The rate of reaction was faster.

**(i) Explain why the rate of reaction increases when the concentration of acid is increased.
(2 marks)**

(continued on the next page)

1 continued.

- (ii) Another student suggests four other ways of increasing the rate of this reaction.**

**Which one is correct?
(1 mark)**

- ☐ **A use the same acid but at a lower temperature**
- ☐ **B use a larger trough**
- ☐ **C use a smaller flask**
- ☐ **D use the same metal but in a powdered form**

(Total for Question 1 = 9 marks)

2 This question is about gases.

(a) When sodium is added to water, hydrogen gas is produced.

Which observation shows that a gas has been produced?

(1 mark)

- ☐ **A a white precipitate forms**
- ☐ **B effervescence is seen**
- ☐ **C the sodium sinks in the water**
- ☐ **D the water changes to a pink colour**

(continued on the next page)

2 continued.

(b) Some damp litmus paper is placed in a gas.

The litmus paper is bleached.

**Which gas bleaches damp litmus paper?
(1 mark)**

☐ **A carbon dioxide**

☐ **B chlorine**

☐ **C hydrogen**

☐ **D oxygen**

(continued on the next page)

2 continued.

(c) When calcium carbonate is heated it decomposes.



When 5.000 g of calcium carbonate is heated, the mass of solid remaining is 2.800 g.

Calculate the mass of carbon dioxide that has been released.

Give your answer to three significant figures.
(2 marks)

mass of carbon dioxide = _____ g

(continued on the next page)

2 continued.

(d) Look at Figure 3 for Question 2(d) in the Diagram Booklet. It shows a diagram of an atom of helium.

**(i) Explain, using Figure 3, why helium is inert.
(2 marks)**

(ii) Helium is used to fill balloons.

**State one property of helium, apart from it being inert, that makes it suitable for filling balloons.
(1 mark)**

(continued on the next page)

Turn over

2 continued.

(e) Oxygen gas has the formula O₂

**Calculate the number of oxygen ATOMS in
3.50 mol of oxygen gas.**

**(Avogadro constant = 6.02×10^{23})
(2 marks)**

number of oxygen atoms = _____

(Total for Question 2 = 9 marks)

- 3 (a) Look at Figure 4 for Question 3(a) in the Diagram Booklet. It shows some information about the composition of pollutant exhaust gases from the engines of two different vehicles.**
- (i) Give TWO ways in which the data in Figure 4 shows that the diesel engine is MORE damaging to the environment than the petrol engine.**
(2 marks)

(continued on the next page)

3 continued.

- (ii) Explain, using information from Figure 4, ONE way in which the diesel engine is LESS damaging to the environment than the petrol engine.
(2 marks)**

(continued on the next page)

3 continued.

(b) (i) Which statement about the members of the alkane homologous series is correct?
(1 mark)

- ☐ A they show a trend in chemical properties
- ☐ B their boiling point decreases as the molecules get larger
- ☐ C the molecular formula of neighbouring compounds differs by CH_3
- ☐ D their viscosity increases as the molecules get larger

(ii) Which one of the following hydrocarbons belongs to the same homologous series as octane, C_8H_{18} ?
(1 mark)

- ☐ A C_4H_6
- ☐ B C_4H_8
- ☐ C C_4H_{10}
- ☐ D C_4H_{12}

(continued on the next page)

Turn over

3 continued.

(iii) Write the balanced equation for the complete combustion of octane, C_8H_{18} (3 marks)

(Total for Question 3 = 9 marks)

4 The elements in group 7 of the periodic table are known as the halogens.

(a) Name the halogen that is in period 4 of the periodic table.

(1 mark)

(continued on the next page)

4 continued.

**(b) Explain why chlorine is more reactive than iodine.
(3 marks)**

(continued on the next page)

4 continued.

- (c) Look at Figure 5 for Question 4(c) in the Diagram Booklet. A piece of burning sodium is placed into a gas jar containing chlorine gas, as shown.**

At the end of the reaction, the inside of the gas jar is coated with white crystals.

**Identify the white crystals.
(1 mark)**

(continued on the next page)

4 continued.

(d) Sodium also reacts with bromine.

- (i) Write the balanced equation for the reaction between sodium and bromine.
(2 marks)**

- (ii) In another experiment, a student adds colourless sodium bromide solution to chlorine water.**

**State what you would SEE in this reaction.
(1 mark)**

(continued on the next page)

4 continued.

(iii) The ionic equation for the reaction between sodium bromide and chlorine is:



Explain which species has been oxidised in this reaction.

(2 marks)

(Total for Question 4 = 10 marks)

5 This question is about oxygen.

- (a) The percentage of oxygen in today's atmosphere is greater than the percentage of oxygen in the Earth's early atmosphere.**

**Explain what caused this change to happen.
(2 marks)**

(continued on the next page)

5 continued.

(b) Magnesium reacts with oxygen from the air to form magnesium oxide.

A student carries out an investigation to determine the mass of magnesium oxide formed when a known mass of magnesium reacts completely with oxygen.

This is the method the student used.

STEP 1 find the mass of a crucible and lid

STEP 2 put a known mass of magnesium into the crucible and put the lid on

STEP 3 heat for five minutes using a roaring Bunsen burner flame

STEP 4 let the crucible, lid and contents cool down

STEP 5 find the final mass of the crucible, lid and contents

(continued on the next page)

5 continued.

**Explain how the student could check that the magnesium had reacted completely with oxygen.
(2 marks)**

(continued on the next page)

5 continued.

- (c) In another experiment, it was found that 1.24 g of phosphorus reacted completely with 1.60 g of oxygen to form phosphorus oxide.**

The relative formula mass of this phosphorus oxide is 284.

Deduce the molecular formula of this phosphorus oxide.

You must show your working.

**(relative atomic masses: O = 16, P = 31)
(4 marks)**

(continued on the next page)

Turn over

5 continued.

molecular formula = _____

(continued on the next page)

5 continued.

- (d) Look at Figure 6 for Question 5(d) in the Diagram Booklet. A student uses the apparatus shown in Figure 6 to investigate the percentage of oxygen in the atmosphere.**

The apparatus was left for a few days.

- (i) Explain one change the student would see after a few days.
(2 marks)**

(continued on the next page)

5 continued.

- (ii) Explain one change that can be made to the apparatus in Figure 6 to allow the student to calculate the percentage of oxygen in the atmosphere.
(2 marks)**

(Total for Question 5 = 12 marks)

- 6 (a) In some chemical reactions, bonds are broken in the reactant molecules and new bonds are formed to make the product molecules.**
- (i) Look at the table for Question 6(a)(i) in the Diagram Booklet. Mark your answer with a cross in a box ☐.**

Which row is correct about the energy changes for these processes?
(1 mark)

(continued on the next page)

6 continued.

(ii) Hydrogen reacts with fluorine.



Look at Figure 7 for Question 6(a)(ii) in the Diagram Booklet. It shows the bond energies for the bonds in the three molecules in the equation.

**Calculate the energy change for this reaction.
(4 marks)**

(continued on the next page)

Turn over

6 continued.

energy change = _____ kJ mol⁻¹

(continued on the next page)

6 continued.

***(b) Look at Figure 8 for Question 6(b) in the Diagram Booklet. It shows the reaction profile for an uncatalysed exothermic reaction.**

Using some examples of catalysts you have met in chemistry, discuss what catalysts do and their effect on the activation energy of a reaction.

**You can use Figure 8 to illustrate your answer.
(6 marks)**

(continued on the next page)

Turn over

6 continued.

[illegible]

(continued on the next page)

Turn over

6 continued.

[illegible]

(continued on the next page)

Turn over

6 continued.

[illegible]

(continued on the next page)

Turn over

6 continued.

(Total for Question 6 = 11 marks)

TOTAL FOR PAPER = 60 MARKS
END OF PAPER