

Combined Science
PAPER 5
Higher Tier

Total Marks

Time: 1 hour 10 minutes plus your additional time allowance

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 – 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.

A periodic table is provided.

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 \boxtimes . If you change your mind about an answer, put a line through the box \boxtimes and then mark your new answer with a cross \boxtimes .

- 1 (a) The concentration of a solution can be calculated using the equation**

$$\text{concentration of solution} = \frac{\text{mass of solid}}{\text{volume of solution}}$$

A student dissolved 9.25 g of ammonium chloride in water and made up the solution to a volume of 200 cm³.

Use the equation to calculate the concentration of this solution in g dm⁻³.

(2 marks)

concentration = _____ g dm⁻³

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Turn over

1 continued.

(b) Dissolving ammonium chloride in water is an endothermic process.

Look at Figure 1 for Question 1(b) in the Diagram Booklet. It shows part of the reaction profile for this process.

**(i) Explain how Figure 1 shows that dissolving ammonium chloride in water is an endothermic process.
(2 marks)**

**(ii) Complete the reaction profile in Figure 1 and label the activation energy.
(2 marks)**

(continued on the next page)

Turn over

1 continued.

- (c) Look at Figure 2 for Question 1(c) in the Diagram Booklet. A student used the equipment in Figure 2 to investigate whether electricity can pass through solid ammonium chloride and through ammonium chloride solution.**

If an electrical current flows in the circuit, the lamp will light up.

Look at Figure 3 for Question 1(c) in the Diagram Booklet. It shows the results of the investigation.

**Explain the results of the investigation.
(3 marks)**

(continued on the next page)

Turn over

1 continued.

(Total for Question 1 = 9 marks)

2 Diesel oil is a mixture of hydrocarbons that can be obtained from crude oil.

(a) State the name of the process used to separate diesel oil from crude oil.

(1 mark)

(b) Diesel oil contains alkanes.

These alkanes are part of an homologous series.

Which statement about compounds in this homologous series is true?

(1 mark)

☐ **A they have the same chemical formula**

☐ **B they have the same empirical formula**

☐ **C they have the same general formula**

☐ **D they have the same molecular formula**

(continued on the next page)

2 continued.

- (c) When fuels such as diesel oil are burned, the high temperatures produced can cause nitrogen and oxygen in the air to form the pollutant nitrogen dioxide.**

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



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2 continued.

- (d) Explain how the greenhouse effect is caused by the gases produced by the complete combustion of diesel oil.
(3 marks)**

(Total for Question 2 = 7 marks)

3 This question is about potassium and zinc.

(a) Which of the following temperatures is most likely to be the melting point of potassium?

(1 mark)

☐ **A -63°C**

☐ **B 6.3°C**

☐ **C 63°C**

☐ **D 630°C**

(b) Explain how the electronic configuration of an atom of potassium is related to its position in the periodic table.

(2 marks)

(continued on the next page)

Turn over

3 continued.

(c) Potassium reacts with oxygen to form potassium oxide.

**(i) Describe the test to show that a gas is oxygen.
(2 marks)**

(ii) Potassium oxide is ionic.

**Write the electronic configurations for the ions in potassium oxide, K_2O .
(2 marks)**

potassium ion: _____

oxide ion: _____

(continued on the next page)

Turn over

3 continued.

- (d) Look at Figure 4 for Question 3(d) in the Diagram Booklet. It shows two gas syringes connected by a glass tube.**

Inside the glass tube there are some pieces of zinc.

Zinc reacts with oxygen at a temperature of over 225°C.

Not all the oxygen reacts at once, the oxygen reacts only when in contact with the zinc.

Devise a plan to find the volume of oxygen contained in a known volume of air, using the apparatus shown in Figure 4.

(4 marks)

(continued on the next page)

Turn over

3 continued.

(Total for Question 3 = 11 marks)

- 4 This question is about the rate of reaction between calcium carbonate and dilute hydrochloric acid.

The word equation for this reaction is

calcium carbonate + hydrochloric acid
→ calcium chloride + water + carbon dioxide

- (a) Which of the following is the formula for calcium carbonate?
(1 mark)

- ☐ A CaCO_2
- ☐ B CaCO_3
- ☐ C $\text{Ca}(\text{CO})_3$
- ☐ D $\text{Ca}(\text{CO}_3)_2$

- (b) Some pieces of calcium carbonate were added to dilute hydrochloric acid in a conical flask and the volume of carbon dioxide produced was measured.

Look at Figure 5 for Question 4(b) in the Diagram Booklet. Complete the diagram in Figure 5 to show the apparatus to collect the gas produced and measure its volume.

(2 marks)

(continued on the next page)

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4 continued.

(c) The reaction between calcium carbonate and dilute hydrochloric acid was investigated at different temperatures.

(i) State what could be used to keep the temperature of the conical flask and its contents at a temperature of 45°C throughout the reaction.

(1 mark)

(continued on the next page)

4 continued.

- (ii) Look at Figure 6 for Question 4(c)(ii) in the Diagram Booklet. It shows a graph of volume of gas collected in this investigation.**

Draw a tangent at 100 seconds on Figure 6.

Use this tangent to calculate the rate of reaction at this time.

(2 marks)

rate of reaction = _____ $\text{cm}^3 \text{s}^{-1}$

- (iii) The temperature of the acid was kept at 45°C .**

State ONE other variable that needs to be controlled during this investigation.

(1 mark)

(continued on the next page)

Turn over

4 continued.

- (iv) Explain, in terms of particles, how decreasing the temperature affects the rate of this reaction.
(3 marks)**

(Total for Question 4 = 10 marks)

- 5** This question is about some of the elements in group 7 of the periodic table.

(a) Which row in the table correctly shows the colours and physical states of the elements at room temperature?

(1 mark)

<input type="checkbox"/> A	iodine: purple gas	bromine: yellow liquid
<input type="checkbox"/> B	chlorine: pale green gas	iodine: brown solid
<input type="checkbox"/> C	bromine: red-brown liquid	chlorine: yellow liquid
<input type="checkbox"/> D	iodine: dark grey solid	bromine: red-brown liquid

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5 continued.

(b) The compound phosphorus oxychloride has the formula POCl_3 .

Calculate the percentage by mass of chlorine in phosphorus oxychloride.

(2 marks)

(relative atomic masses:

O = 16.0, P = 31.0, Cl = 35.5)

percentage by mass of chlorine =

(continued on the next page)

Turn over

5 continued.

(c) When iron reacts with chlorine, iron chloride is formed.

Two possible equations for this reaction are



In an experiment, 8.40 g iron reacts with chlorine to form 19.05 g iron chloride.

Show, using a calculation, which reaction, A or B, is taking place.

**You must show your working.
(3 marks)**

(relative atomic masses: Cl = 35.5, Fe = 56.0)

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Turn over

5 continued.

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5 continued.

***(d) Group 1 metals react with the elements from group 7 to form salts.**

Look at Figure 7 for Question *5(d) in the Diagram Booklet. It shows some examples of these reactions.

You will find the position of these elements in their groups on the periodic table.

Explain, in terms of their electronic configurations and the relative reactivity of these elements, which of the reactions shown in Figure 7 would be the most violent.

(6 marks)

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5 continued.

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5 continued.

[illegible]

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5 continued.

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(Total for Question 5 = 12 marks)

6 Pentadecane, $C_{15}H_{32}$, is a hydrocarbon and is used as a fuel.

(a) The incomplete combustion of pentadecane produces carbon monoxide. Carbon monoxide is a toxic gas.

**(i) Explain why the incomplete combustion of pentadecane can produce carbon monoxide as one of the products.
(2 marks)**

(continued on the next page)

6 continued.

- (ii) Explain how carbon monoxide behaves as a toxic gas.
(2 marks)

- (b) 1 mole of pentadecane can be cracked to form 1 mole of octane, C_8H_{18} , and 1 mole of propene, C_3H_6 , and 2 moles of another product.

Complete the balanced equation for this reaction by adding the formula of the missing product.
(1 mark)



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6 continued.

(c) Look at Figures 8 and 9 for Question 6(c) in the Diagram Booklet. Figure 8 shows the reaction of propene, C_3H_6 , with water.

Figure 9 shows some bond energies.

Use the bond energies in Figure 9 to calculate the energy change of the reaction in Figure 8.

(4 marks)

energy change of reaction =

_____ kJ mol^{-1}

(continued on the next page)

Turn over

6 continued.

- (d) Look at Figure 10 for Question 6(d) in the Diagram Booklet. Methane gas, CH_4 , was burned using the apparatus shown in Figure 10.**

Explain why water droplets form on the bottom of the beaker of cold water.

(2 marks)

(Total for Question 6 = 11 marks)

TOTAL FOR PAPER IS 60 MARKS
END OF PAPER