



Surname \_\_\_\_\_

Forename(s) \_\_\_\_\_

Centre Number \_\_\_\_\_

Candidate Number \_\_\_\_\_

Candidate Signature \_\_\_\_\_

I declare this is my own work.

**GCSE**

**COMBINED SCIENCE: TRILOGY**

**H**

Higher Tier

Chemistry Paper 2H

**8464/C/2H**

**Tuesday 13 June 2023**

**Morning**

**Time allowed: 1 hour 15 minutes**

**At the top of the page, write your surname and forename(s), your centre number, your candidate number and add your signature.**

**[Turn over]**



**MATERIALS**

**For this paper you must have:**

- **a ruler**
- **a scientific calculator**
- **the periodic table (enclosed).**

**INSTRUCTIONS**

- **Use black ink or black ball-point pen.**
- **Pencil should only be used for drawing.**
- **Answer ALL questions in the spaces provided.**
- **If you need extra space for your answer(s), use the lined pages at the end of this book. Write the question number against your answer(s).**
- **Do all rough work in this book. Cross through any work you do not want to be marked.**
- **In all calculations, show clearly how you work out your answer.**



## **INFORMATION**

- **The maximum mark for this paper is 70.**
- **The marks for questions are shown in brackets.**
- **You are expected to use a calculator where appropriate.**
- **You are reminded of the need for good English and clear presentation in your answers.**

**DO NOT TURN OVER UNTIL TOLD TO DO SO**



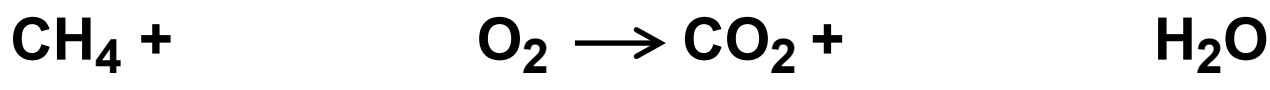
0	1
---	---

The combustion of fuels is a source of atmospheric pollutants.

0	1	.	1
---	---	---	---

Methane is a fuel.

Balance the equation for the combustion of methane.  
[1 mark]



0	1	.	2
---	---	---	---

Many fuels are mixtures.

Petrol and diesel are mixtures of hydrocarbons.

TABLE 1, on the opposite page, shows properties of petrol and of diesel.



**TABLE 1**

	<b>PETROL</b>	<b>DIESEL</b>
<b>Range of number of carbon atoms in a hydrocarbon molecule</b>	<b>4 to 12</b>	<b>12 to 20</b>
<b>Range of boiling points in °C</b>	<b>40 to 205</b>	<b>250 to 350</b>

**Compare the properties of petrol and diesel.**

**Use TABLE 1. [2 marks]**

---

---

---

---

---

---

**[Turn over]**



**01.3**

The gases released when a fuel is burned in car engines may include:

- oxides of nitrogen
- carbon monoxide
- water vapour.

Which chemical element do all these gases contain?  
[1 mark]

Tick (✓) ONE box.

☐

Carbon

☐

Hydrogen

☐

Nitrogen

☐

Oxygen



**01.4**

**When diesel burns in car engines, oxides of nitrogen are produced.**

**Where does the nitrogen come from? [1 mark]**

---

---

---

**01.5**

**When diesel burns, particulates may be produced.**

**What environmental effect do particulates from burning diesel cause? [1 mark]**

---

---

---

**[Turn over]**



**01.6**

**Carbon monoxide may be produced when diesel burns.**

**Give ONE reason why carbon monoxide is difficult to detect. [1 mark]**

---

---

---

**01.7**

**Explain why water vapour and NOT liquid water is produced when diesel burns. [2 marks]**

---

---

---

---

---

---



0	1	.	8
---	---	---	---

**Sulfur is a common impurity in diesel.**

**Explain why this causes an environmental problem.  
[3 marks]**

---

---

---

---

---

---

---

---

---

---

**[Turn over]**

<hr/>
12



0	2
---	---

**Chromatography is used to separate mixtures.**

**Chromatography involves a mobile phase and one other phase.**

0	2	.	1
---	---	---	---

**What is the other phase in chromatography? [1 mark]**

**Tick (✓) ONE box.**

☐

**Moving phase**

☐

**Recycled phase**

☐

**Stationary phase**

☐

**Viscous phase**



0	2	.	2
---	---	---	---

**Why do the substances in the mixture separate in the mobile phase? [1 mark]**

---

---

---

0	2	.	3
---	---	---	---

**How many spots will be produced on the chromatogram of a pure compound? [1 mark]**

**Number of spots =** \_\_\_\_\_

**[Turn over]**



0	2	.	4
---	---	---	---

In a chromatography experiment, a blue colour moved 4.77 cm.

The solvent moved 5.30 cm.

Calculate the  $R_f$  value for the blue colour. [2 marks]

---

---

---

---

---

$R_f$  value =

---



0	2	.	5
---	---	---	---

**Black ink is a mixture of several colours.**

**Plan an experiment using paper chromatography to:**

- **separate the colours in black ink**
- **identify the colours from their  $R_f$  values. [6 marks]**

---

---

---

---

---

---

---

---

---

---

**[Turn over]**



This image shows a blank sheet of white paper with horizontal ruling lines. The lines are evenly spaced and run across the width of the page. There are no margins, text, or other markings on the paper.

0	3
---	---

Crude oil is a mixture of many different compounds.

0	3	.	1
---	---	---	---

Give TWO reasons why crude oil is NOT a formulation.  
[2 marks]

1

---

2

---

[Turn over]



0	3	.	2
---	---	---	---

**Describe how crude oil is separated into fractions.  
[4 marks]**

[illegible]

0	3	.	3
---	---	---	---

The fractions from crude oil contain alkanes.

Explain why alkanes are cracked. [2 marks]

---

---

---

---

---

---

[Turn over]



Cracking produces a mixture of products.

03.4

An equation for cracking decane ( $C_{10}H_{22}$ ) is:



Describe a test to identify the gas produced in the reaction. [2 marks]

Test

---

---

---

Result

---

---

---



0	3	.	5
---	---	---	---

Alkenes are produced in cracking.

The general formula for the homologous series of alkenes is  $C_nH_{2n}$

Which formula represents an alkene? [1 mark]

Tick (✓) ONE box.

☐

$C_2H_2$

☐

$C_2H_4$

☐

$C_2H_6$

☐

$C_3H_8$

[Turn over]

11



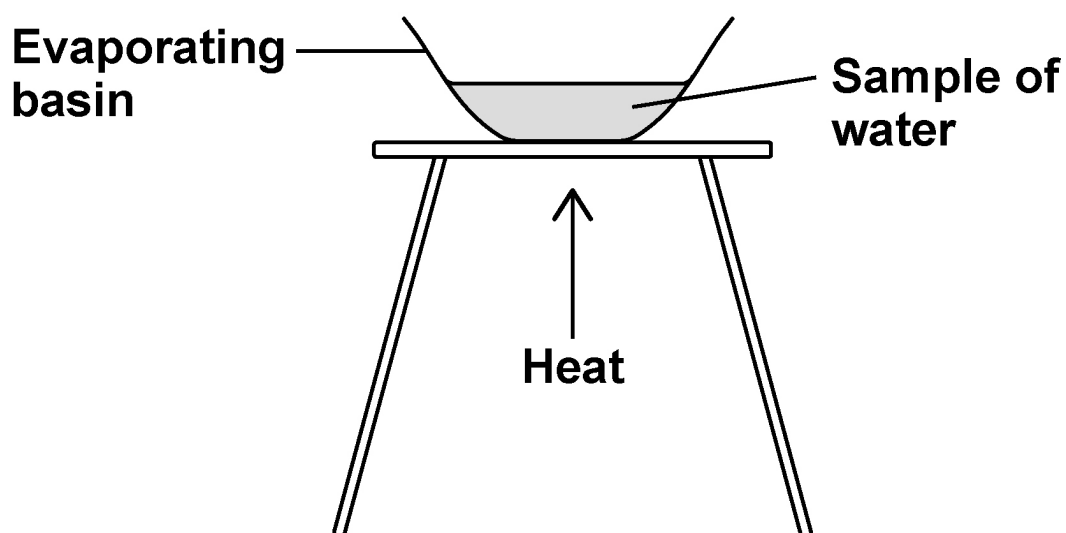
0	4
---	---

Some types of water contain dissolved substances.

A student investigated the mass of dissolved solids in distilled water and in sea water.

FIGURE 1 shows the apparatus.

FIGURE 1



**This is the method used.**

- 1. Weigh an evaporating basin.**
- 2. Add 20 cm<sup>3</sup> of distilled water to the evaporating basin.**
- 3. Weigh the evaporating basin and the water sample.**
- 4. Heat the water sample for 2 minutes.**
- 5. Weigh the evaporating basin and contents.**
- 6. Repeat steps 1 to 5 two more times.**
- 7. Repeat steps 1 to 6 with sea water.**

**0 4 . 1**

**The method used by the student did NOT give valid results.**

**Describe ONE improvement the student could make to obtain valid results. [1 mark]**

---

---

---

**[Turn over]**



A different student used a method which gave valid results.

04.2

TABLE 2 shows the results.

TABLE 2

	Mass of dissolved solids in grams			
Type of water	TEST 1	TEST 2	TEST 3	MEAN
Distilled water	0.00	0.00	0.00	0.00
Sea water	0.30	X	0.26	0.29

Calculate the value X for the mass of dissolved solids in sea water in Test 2. [2 marks]

---



---



---



---

Mass X = \_\_\_\_\_ g



0	4	.	3
---	---	---	---

The student concludes that distilled water is pure.

Describe a test to confirm that distilled water is pure.  
[2 marks]

Test \_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

Result \_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

[Turn over]



Tap water is potable.

A stage in the production of potable water is sterilising.

A gas is used to sterilise water.

The equation for the reaction is:



04.4

What is meant by the symbol  $\rightleftharpoons$ ? [1 mark]

---

---

---



0	4	.	5
---	---	---	---

The reaction is at equilibrium.

The reaction is exothermic.

**What happens to the equilibrium position when the temperature is increased? [1 mark]**

**Tick (✓) ONE box.**

☐

**Shifts towards the left-hand side**

☐

**Stays in the same place**

☐

**Shifts towards the right-hand side**

**[Turn over]**



0	4	.	6
---	---	---	---

**Describe a test to identify the gas used to sterilise water. [2 marks]**

**Test** \_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

**Result** \_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_



0	4	.	7
---	---	---	---

Another stage in the production of potable water is filtering.

Explain why potable water contains dissolved solids after filtering. [2 marks]

---

---

---

---

---

---

[Turn over]

11
----



0	5
---	---

**An increase of greenhouse gases in the Earth's atmosphere is causing global warming.**

**Global warming is causing global climate change.**

0	5	.	1
---	---	---	---

**Give ONE effect of global climate change. [1 mark]**

---

---

---



**05.2**

**Explain how greenhouse gases cause global warming.  
[4 marks]**

[illegible]

**[Turn over]**



0	5	.	3
---	---	---	---

**Explain how planting trees reduces global warming.  
[3 marks]**

---

---

---

---

---

---

---

---

---

---

—
8



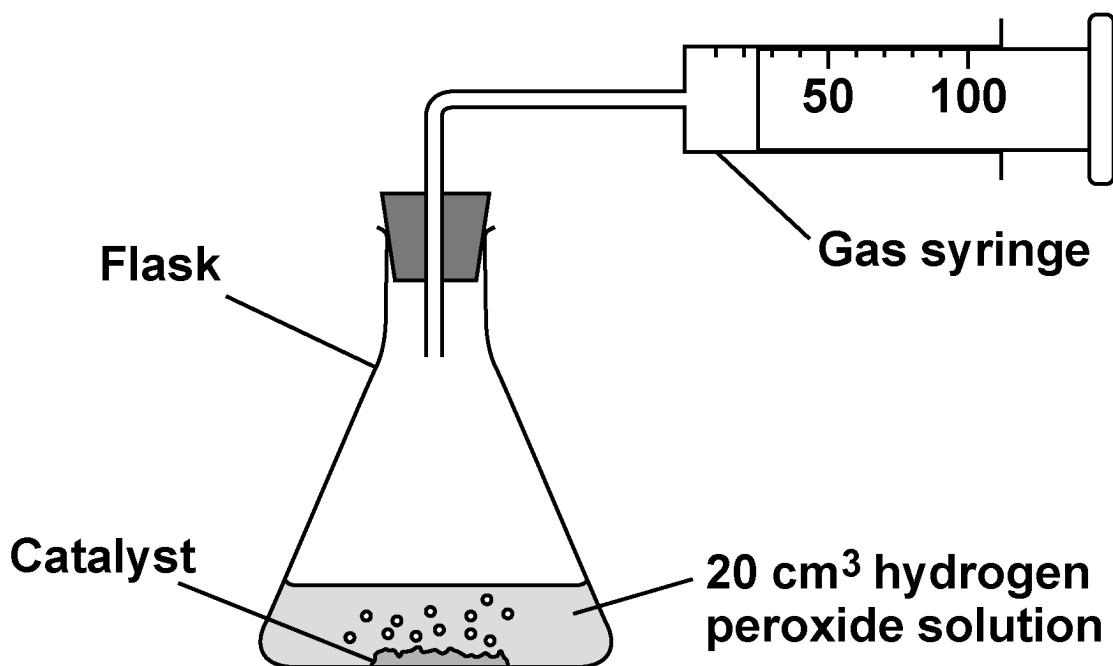
06

A student investigated the rate of decomposition of hydrogen peroxide using three different catalysts:

- manganese dioxide
- copper oxide
- zinc oxide.

FIGURE 2 shows the apparatus.

FIGURE 2



[Turn over]



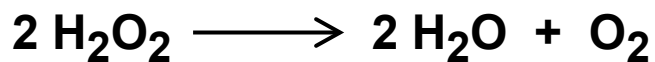
**This is the method used.**

- 1. Measure 20 cm<sup>3</sup> of hydrogen peroxide solution into a flask.**
- 2. Add 0.5 g of manganese dioxide catalyst to the flask.**
- 3. Attach a gas syringe to the flask.**
- 4. Measure the volume of oxygen produced every 30 seconds for 180 seconds.**
- 5. Repeat steps 1 to 4 two more times.**
- 6. Repeat steps 1 to 5 using copper oxide catalyst.**
- 7. Repeat steps 1 to 5 using zinc oxide catalyst.**



0	6	.	1
---	---	---	---

The equation for the decomposition of hydrogen peroxide is:



Describe a test to identify the gas produced in the reaction. [2 marks]

Test

---

---

---

Result

---

---

---

[Turn over]



0	6	.	2
---	---	---	---

Using 10 cm<sup>3</sup> of hydrogen peroxide solution gives less accurate results than using 20 cm<sup>3</sup> of hydrogen peroxide solution of the same concentration.

Explain why. [2 marks]

---

---

---

---

---

---



0	6	.	3
---	---	---	---

**Suggest ONE possible source of systematic error in the investigation. [1 mark]**

---

---

**[Turn over]**



**TABLE 3** shows the results for manganese dioxide catalyst.

**TABLE 3**

<b>Time in seconds</b>	<b>0</b>	<b>30</b>	<b>60</b>	<b>90</b>	<b>120</b>	<b>150</b>	<b>180</b>
<b>Volume of gas in cm<sup>3</sup></b>	<b>0</b>	<b>22</b>	<b>38</b>	<b>41</b>	<b>54</b>	<b>58</b>	<b>60</b>

**FIGURE 3**, on the opposite page, shows a graph of the results with copper oxide catalyst and with zinc oxide catalyst.

**06.4**

**Complete FIGURE 3, on the opposite page.**

**You should:**

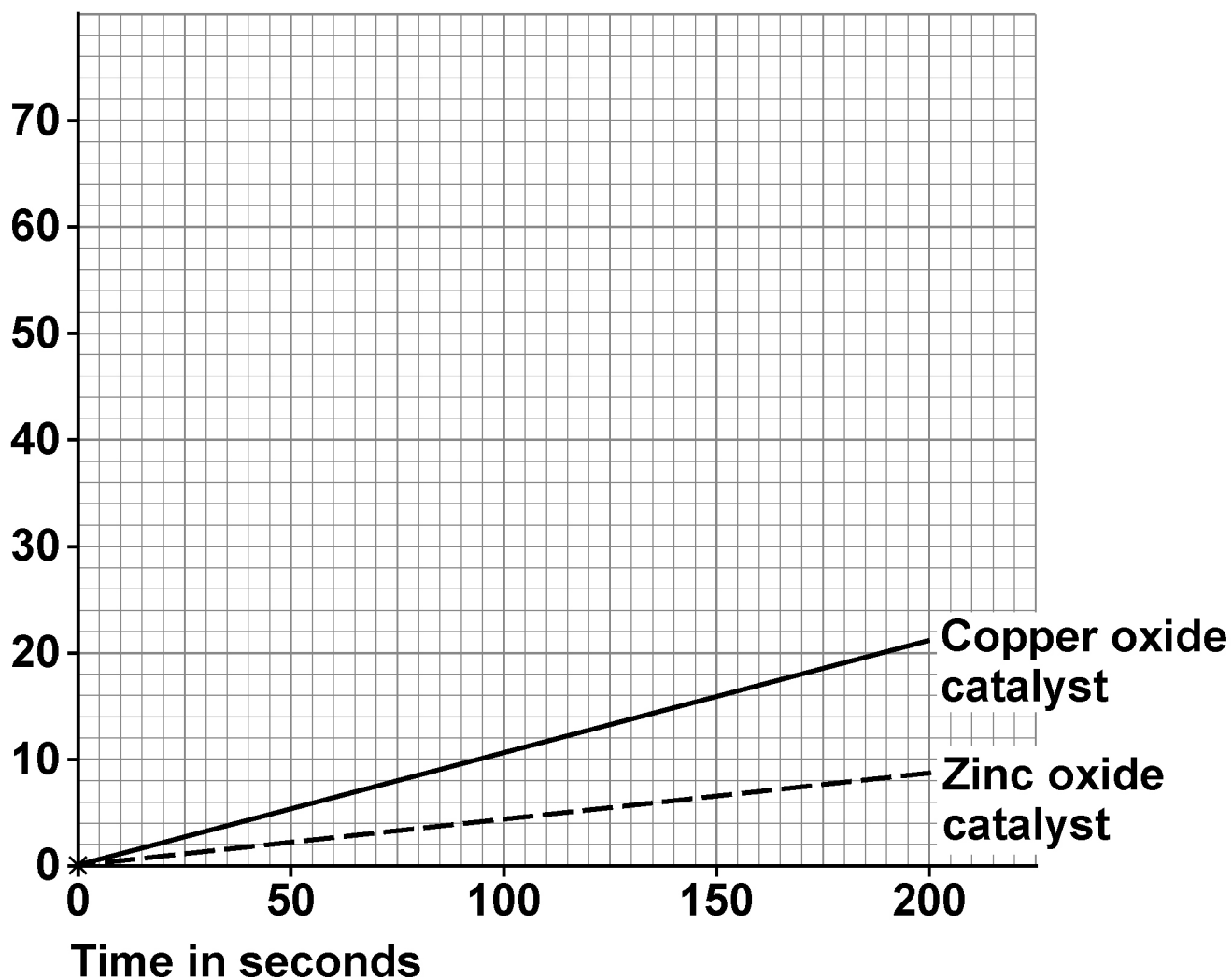
- plot the data from **TABLE 3**
- draw a line of best fit.

**The first point has been plotted for you. [3 marks]**



FIGURE 3

Volume of gas  
in  $\text{cm}^3$



[Turn over]



**BLANK PAGE**



0	6	.	5
---	---	---	---

Which catalyst gives the fastest RATE of reaction?

Give ONE reason for your answer.

Use the completed FIGURE 3, on page 37. [2 marks]

Catalyst \_\_\_\_\_

\_\_\_\_\_

Reason \_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

[Turn over]



0	6	.	6
---	---	---	---

The rate of reaction is NOT dependent on the volume of hydrogen peroxide solution.

Explain why. [2 marks]

---

---

---

---

---

---



**BLANK PAGE**

**[Turn over]**

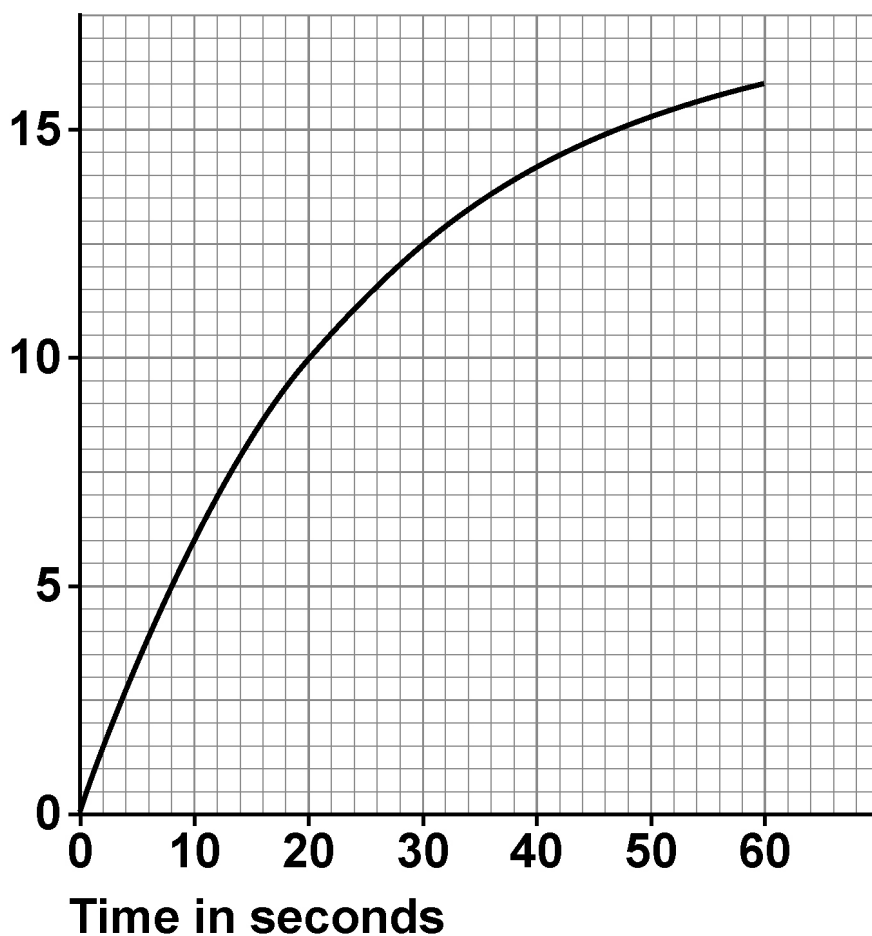


06.7

FIGURE 4 shows the results from a different investigation.

FIGURE 4

Volume of gas  
in  $\text{cm}^3$



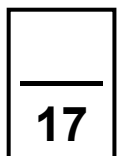
Determine the rate of reaction at 20 seconds.

Show your working on FIGURE 4.

Give your answer to 3 significant figures. [5 marks]



**END OF QUESTIONS**



**Additional page, if required.**

**Write the question numbers in the left-hand margin.**

[illegible]

**Additional page, if required.**

**Write the question numbers in the left-hand margin.**

[illegible]

**BLANK PAGE**

For Examiner's Use	
Question	Mark
1	
2	
3	
4	
5	
6	
<b>TOTAL</b>	

**Copyright information**

For confidentiality purposes, all acknowledgements of third-party copyright material are published in a separate booklet. This booklet is published after each live examination series and is available for free download from [www.aqa.org.uk](http://www.aqa.org.uk).

Permission to reproduce all copyright material has been applied for. In some cases, efforts to contact copyright-holders may have been unsuccessful and AQA will be happy to rectify any omissions of acknowledgements. If you have any queries please contact the Copyright Team.

Copyright © 2023 AQA and its licensors. All rights reserved.

**WP/M/MG/Jun23/8464/C/2H/E5**

