

**Modified Enlarged 24 pt**

**OXFORD CAMBRIDGE AND RSA  
EXAMINATIONS**

**Monday 11 January 2021 – Afternoon**

**Level 3 Cambridge Technical in  
Engineering**

**05822/05823/05824/05825/05873**

**Unit 1: Mathematics for engineering**

**Time allowed: 1 hour 30 minutes plus your  
additional time allowance**

**You must have:**

**the Formula Booklet for Level 3**

**Cambridge Technical in Engineering  
(with this document)**

**a ruler (cm/mm)**

**a scientific calculator**

**Please write clearly in black ink.**

**Centre  
number**

--	--	--	--	--

**Candidate  
number**

--	--	--	--

**First name(s)** \_\_\_\_\_

**Last name** \_\_\_\_\_

**Date of  
birth**

D	D	M	M	Y	Y	Y	Y
---	---	---	---	---	---	---	---

## **READ INSTRUCTIONS BELOW INSTRUCTIONS**

**Use black ink. You can use an HB pencil, but only for graphs and diagrams.**

**Write your answer to each question in the space provided. If you need extra space use the lined pages at the end of this booklet. The question numbers must be clearly shown.**

**Answer ALL the questions.**

**Where appropriate, your answer should be supported with working. Marks might be given for using a correct method, even if your answer is wrong.**

**Give your final answers to a degree of accuracy that is appropriate to the context.**

## **INFORMATION**

**The total mark for this paper is 60.**

**The marks for each question are shown in brackets [ ].**

## **ADVICE**

**Read each question carefully before you start your answer.**

**Answer ALL the questions.**

**1 (a) Factorise  $4x + 2y$ .**

\_\_\_\_\_ **[1]**

**(b) Solve the equation**  
 **$2(x + 3) - 4 = 3(1 - x)$ .**

\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_ **[3]**

**(c) Find the remainder when**  
 **$x^3 + 2x^2 + 3x + 4$  is divided by**  
 **$(x + 1)$ .**

\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_ **[2]**

**(d) It is given that  $f(x) = x^2 + 4x - 6$ .**

- (i) Write  $f(x)$  in the form  $(x + a)^2 + b$  where  $a$  and  $b$  are integers to be determined.**

---

---

---

---

**[3]**

- (ii) Hence or otherwise find the values of  $x$  that satisfy the equation  $f(x) = 0$ , giving your answers exactly.**

---

---

---

---

**[2]**

**2 (a) It is given that  $f(x) = x^3 + 2x - 3$ .**

**(i) Show that  $f(1) = 0$ .**

---

---

**[1]**

**(ii) Factorise  $f(x)$ .**

---

---

---

---

---

**[2]**

**(iii) Show that the equation  
 $f(x) = 0$  has only one root.**

---

---

**[2]**

- (b) Rearrange  $v^2 = u^2 + 2as$  to make  $a$  the subject.**

---

---

---

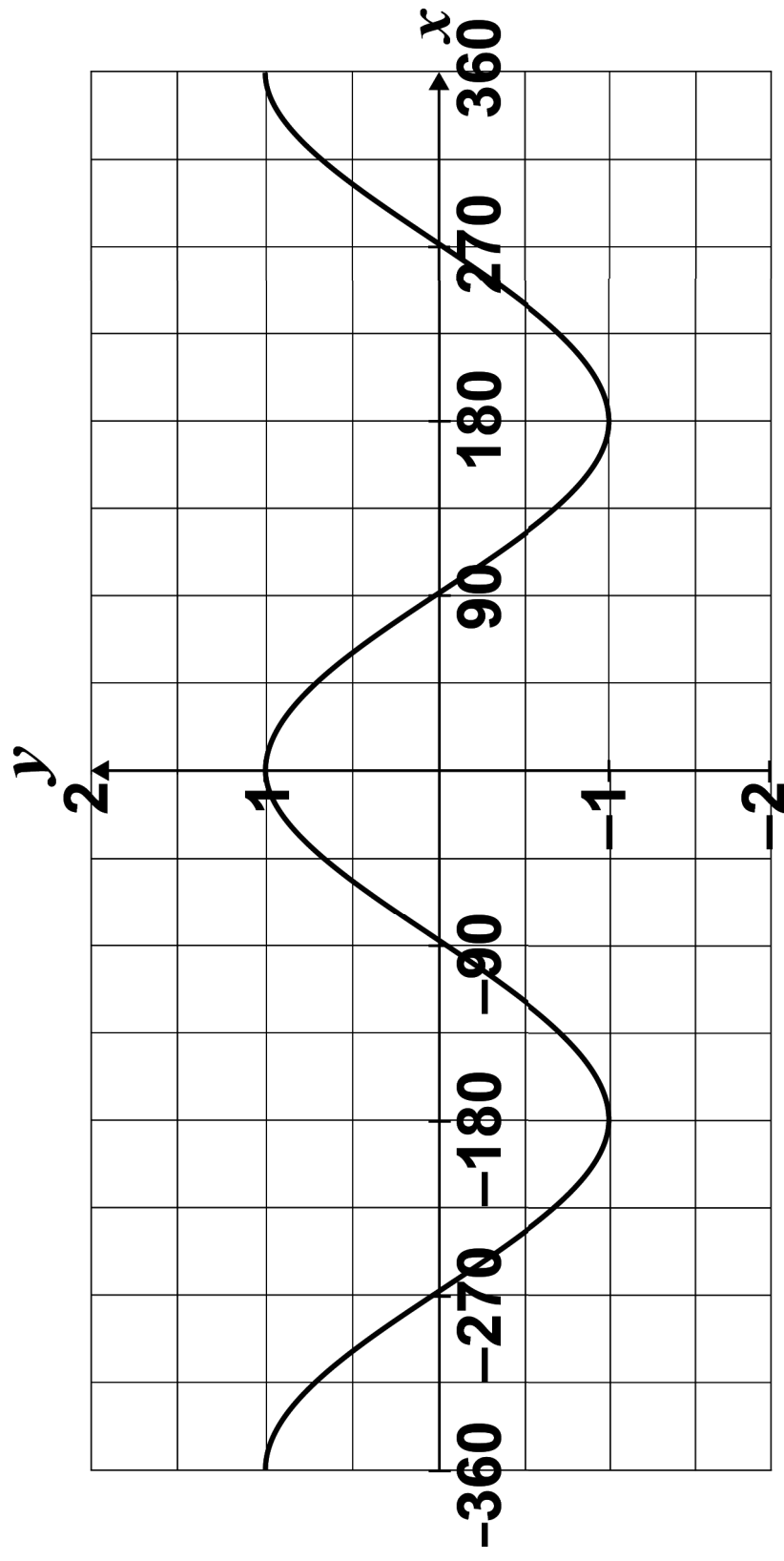
---

**[3]**

- 3 (a) Fig. 1 on the opposite page shows part of the curve  $y = \cos x$ .**

**On Fig. 1 opposite, sketch the graph of the curve  $y = \cos 2x$ . [2]**

Fig. 1

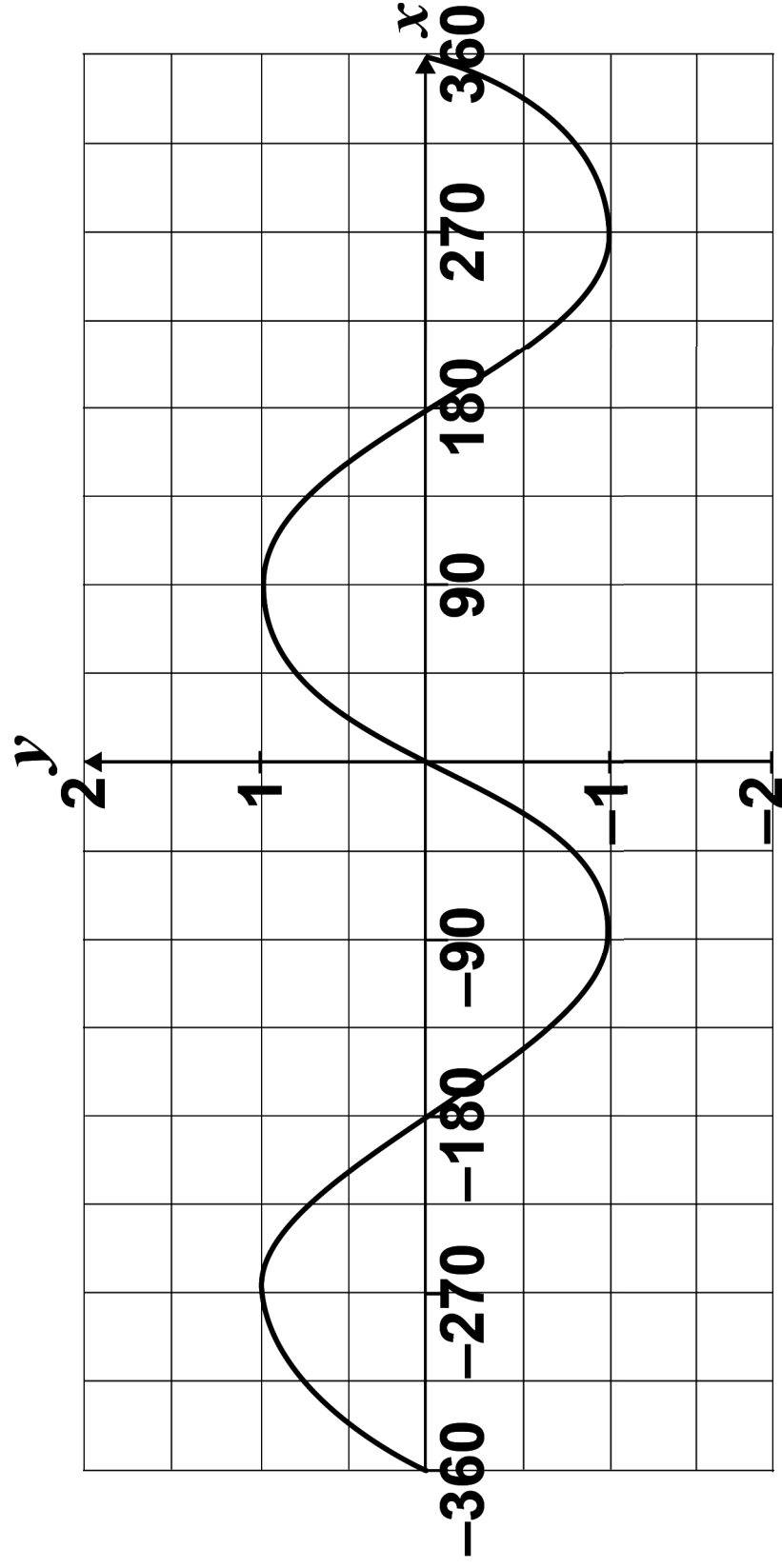


**(b) Fig. 2 on the opposite page shows part of the curve  $y = \sin x$ .**

**On Fig. 2 opposite, sketch the curve  $y = \sin x + 1$ . [2]**



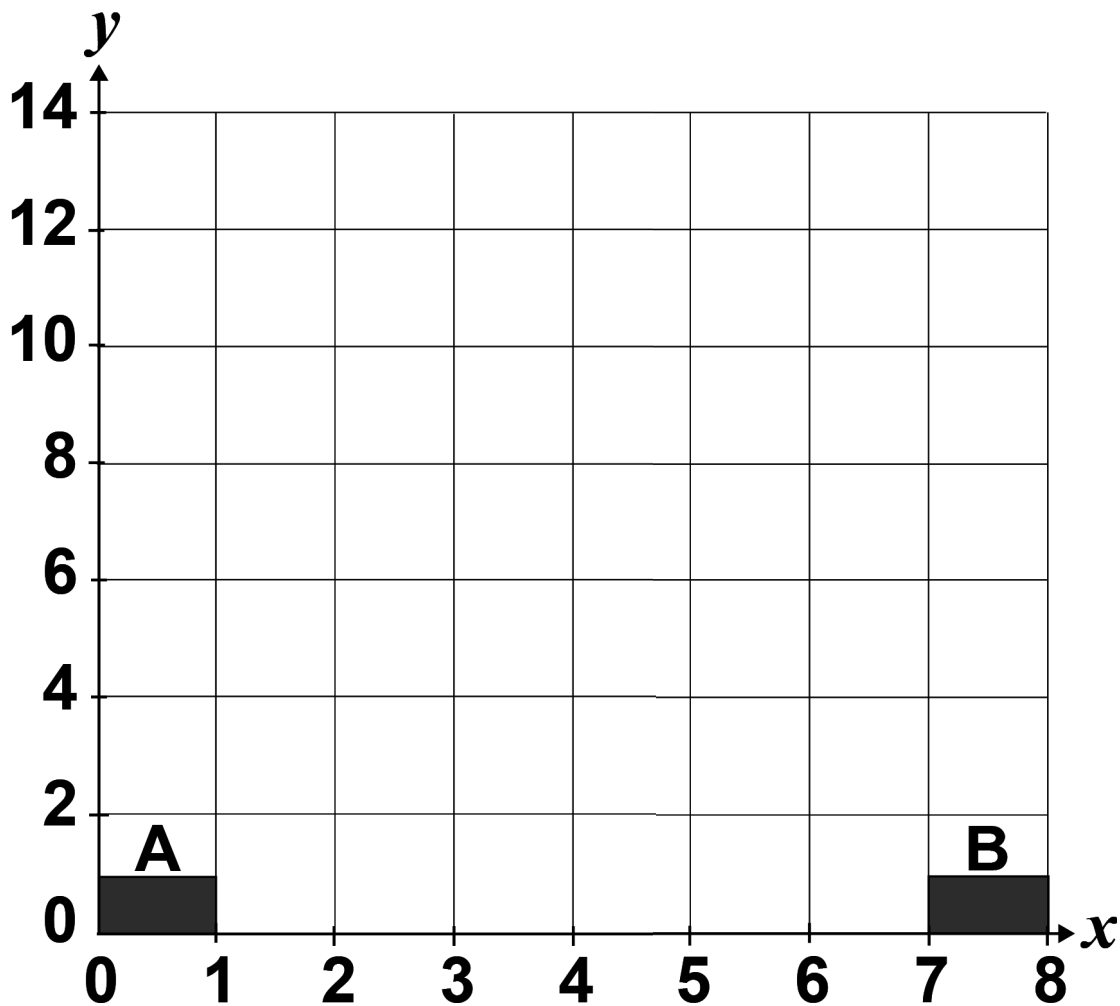
Fig. 2



- (c) A supporting arch for a bridge is given on a coordinate grid where units are in metres. The bridge is symmetric about the line  $x = 4$ .

The base of the bridge is on supports A and B with coordinates  $(1, 1)$  and  $(7, 1)$  respectively.

Fig. 3



The arch of the bridge has equation  $y = -6 + 8x - x^2$ .

(i) On Fig. 3, sketch the curve  $y = -6 + 8x - x^2$ . [3]

(ii) Give the coordinates of the highest point of the arch.

---

---

[1]

4 (a) Write  $\log a - 2 \log b$  as a single logarithm.

---

---

---

[2]

(b) The voltage decay in a capacitor can be modelled by the formula  $V = 12e^{\frac{-t}{4}}$  where  $V$  is the voltage remaining in the capacitor after  $t$  seconds.

(i) Calculate the voltage remaining after 5 seconds.

---

---

---

[2]

(ii) Calculate the time it takes for the initial voltage to be halved.

---

---

---

---

---

[3]

- 5 (a) Write down the exact value of  $\tan 60^\circ$ .

---

---

[1]

- (b) An alternating current can be represented by the formula  $V = 220\cos t$  where  $t$  is measured in degrees.

- (i) Find the value of  $V$  when  $t = 320$ .

---

---

[1]

- (ii) Find a value for  $t$  when  $V = 180$ .

---

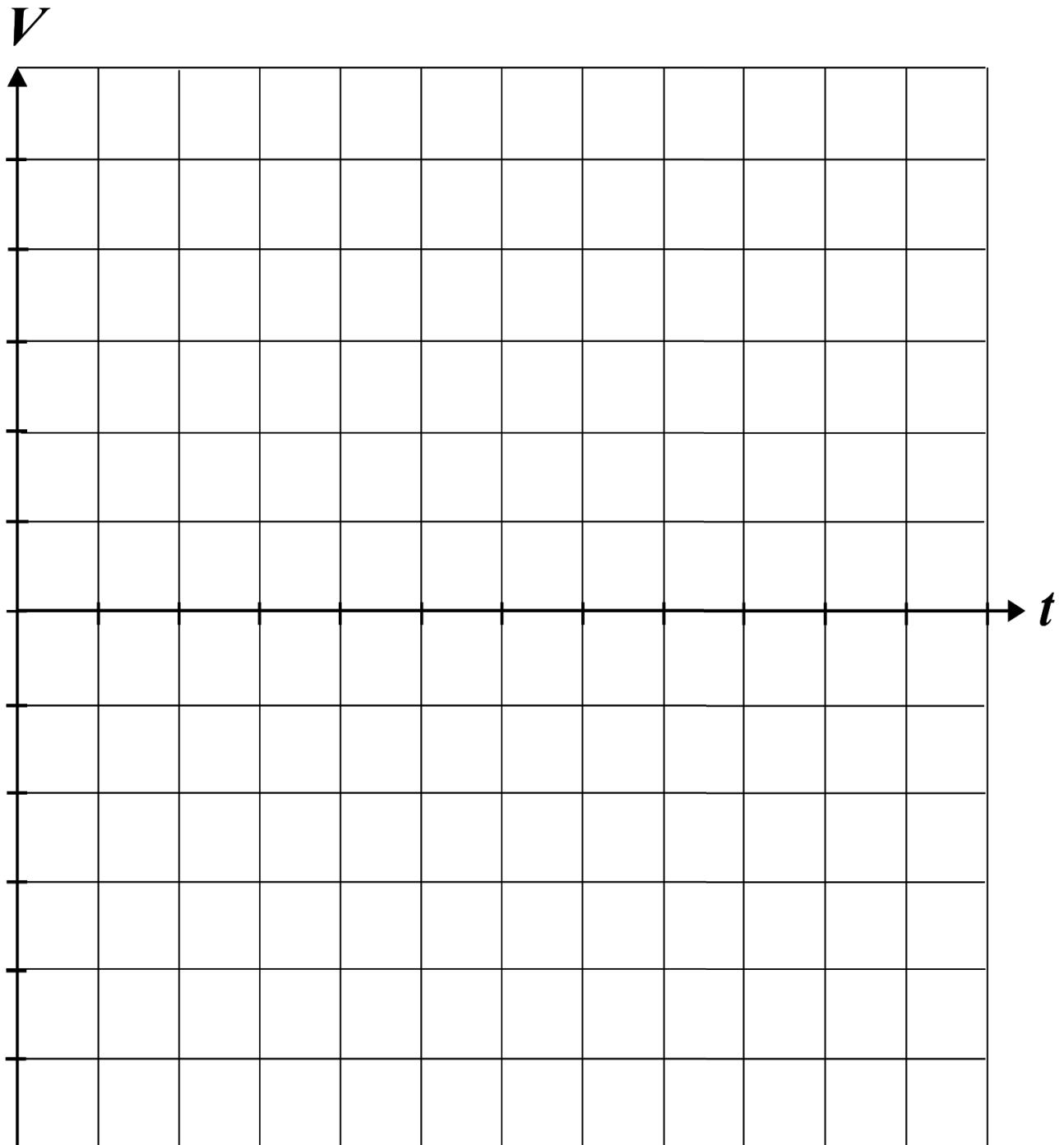
---

---

[2]

(iii) On the grid below, sketch the graph of

$$V = 220\cos t \text{ for } 0^\circ \leq t \leq 360^\circ. [2]$$



- (c) A triangular metal plate,  $ABC$ , is such that  $AB = 6\text{ cm}$ ,  $BC = 2\text{ cm}$  and  $AC = 5\text{ cm}$ .

Find the angle  $CAB$ .

---

---

---

---

---

[3]

**6 A curve has equation**

$$y = 2x^3 - 3x^2 - 12x + 4 .$$

- (i) By differentiation, find the coordinates of the turning points of the curve.**

---

---

---

---

---

---

---

---

---

---

**[5]**



- (ii) By differentiating again, determine the nature of the turning point for which  $x > 0$ .

---

---

---

---

---

---

[3]

- 7 (a) A factory uses 3 identical machines in a manufacturing process. It has been found that the probability of a machine failing during the course of a day is 0.2, independent of other machines.**

- (i) What is the probability that all the machines are working at the end of the day?**

---

---

---

**[2]**

- (ii) Find the probability that exactly one machine fails.**

---

---

---

**[3]**

- (b) The thickness of steel bars coming off a production line is measured with a micrometer. The values for 25 bars, given to 2 decimal places, are given in the table below.

Thickness (mm)	9.58	9.59	9.60	9.61	9.62
Frequency	2	4	13	4	2

- (i) Explain how you can tell that the mean value is 9.60 mm without doing any calculations.

---

---

[1]

- (ii) Calculate the standard deviation of the data.

---

---

---

---

[3]

**END OF QUESTION PAPER**

### ADDITIONAL ANSWER SPACE

**If additional answer space is required, you should use the following lined pages. The question numbers must be clearly shown – for example, 1(c) or 5(a).**

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.







Oxford Cambridge and RSA

**Copyright Information:**

OCR is committed to seeking permission to reproduce all third-party content that it uses in its assessment materials. OCR has attempted to identify and contact all copyright holders whose work is used in this paper. To avoid the issue of disclosure of answer-related information to candidates, all copyright acknowledgements are reproduced in the OCR Copyright Acknowledgements Booklet. This is produced for each series of examinations and is freely available to download from our public website ([www.ocr.org.uk](http://www.ocr.org.uk)) after the live examination series.

If OCR has unwittingly failed to correctly acknowledge or clear any third-party content in this assessment material OCR will be happy to correct its mistake at the earliest possible opportunity.

For queries or further information please contact the Copyright Team, OCR (Oxford Cambridge and RSA Examinations), The Triangle Building, Shaftesbury Road, Cambridge CB2 8EA.

OCR is part of the Cambridge Assessment Group. Cambridge Assessment is the brand name of University of Cambridge Local Examinations Syndicate (UCLES), which is itself a department of the University of Cambridge.