CAMBRIDGE TECHNICALS

Oxford Cambridge and RSA

CAMBRIDGE TECHNICALS LEVEL 3 (2016)

Examiners' report

ENGINEERING

05822–05825, 05873

Unit 1 January 2024 series

Version 1

ocr.org.uk/cambridgetechnicals

Contents

Introduction

Our examiners' reports are produced to offer constructive feedback on candidates' performance in the examinations. They provide useful guidance for future candidates.

The reports will include a general commentary on candidates' performance, identify technical aspects examined in the questions and highlight good performance and where performance could be improved. The reports will also explain aspects which caused difficulty and why the difficulties arose, whether through a lack of knowledge, poor examination technique, or any other identifiable and explainable reason.

Where overall performance on a question/question part was considered good, with no particular areas to highlight, these questions have not been included in the report.

A full copy of the question paper and the mark scheme can be downloaded from Teach Cambridge.

Would you prefer a Word version?

Did you know that you can save this PDF as a Word file using Acrobat Professional?

Simply click on **File > Export to** and select **Microsoft Word**

(If you have opened this PDF in your browser you will need to save it first. Simply right click anywhere on the page and select **Save as . . .** to save the PDF. Then open the PDF in Acrobat Professional.)

If you do not have access to Acrobat Professional there are a number of **free** applications available that will also convert PDF to Word (search for PDF to Word converter).

Unit 1 series overview

Engineers need a good grounding in Mathematics and the topics in this unit have been selected as they underpin all engineering learning. There was evidence, as in previous series, that LO3 (exponentials and logarithms) and LO5 (calculus) were not covered well. Responses to the algebraic question were mixed, with simultaneous equations (Question 2(a)) being well done, while the solution of quadratic equations (Questions 2(a) and 6(a)) were not done well.

Candidates are encouraged to use their calculators wisely and efficiently. There is usually no need to work a question by extensive methods when a calculator will do the work for you (e.g. the finding of the standard deviation of a set of data using the feature found on most calculators).

Candidates who did well on this paper generally:	Candidates who did less well on this paper generally:
• demonstrated a confidence in all topics • were careful to read and understand the question fully (e.g. giving answers to the required number of decimal places or significant figures) • laid out their work well so that it would be easy for the candidate to check the work done.	• were not fully conversant with all topics, thus limiting the questions that could be answered • demonstrated a lack of understanding of the order of priority of arithmetic operations in arithmetic and algebra.

Question 1 (a), (b) and (c)

1

(a) Multiply out the brackets and simplify $2(2x+7)-3(x+2)$.

....

....

.... **[2]**

(b) Factorise $4x+10y$.

.... **[1]**

(c) Solve the equation $2x-1=5$.

....

....

.... **[2]**

These first three parts were answered correctly by most candidates.

Question 1 (d)

(d) Solve the equation $x^2 + x - 6 = 0$.

[3]

This quadratic equation was solvable by factorisation. Many who attempted the question by this method left their answer as a pair of brackets. Others used the formula but quoted it incorrectly even though it is given in the formula booklet. There was evidence that many candidates had no idea how to solve a quadratic equation.

Assessment for learning

All three methods to solve quadratic equations are listed in the specification. Usually candidates are allowed to use whichever method (factorise, use formula or complete the square) they find the easiest. Occasionally candidates will be told which method to use.

Question 1 (e)

(e) Divide $x^3 + 2x^2 - 4x + 3$ by $x - 2$.

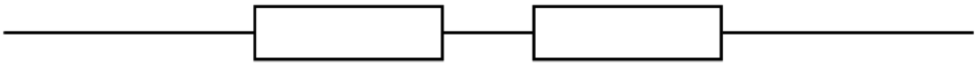
[3]

The method of performing an algebraic division was not understood by many candidates.

Question 2 (a)

2

(a) When resistors are connected in series the total resistance is the sum of the separate resistances.



An engineer has two types of resistors which have resistances, A and B.
If they connect 5 of type A and 3 of type B in series the total resistance is 670 Ω.
If they connect 4 of type A and 5 of type B in series the total resistance is 640 Ω.

Form two equations in A and B and solve simultaneously to find the value of each resistance.

....

....

....

....

....

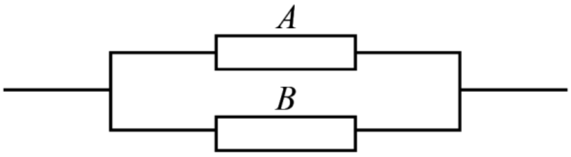
.... **[5]**

This simultaneous equation question was done well with most candidates achieving full marks.

Question 2 (b)

(b) When two resistances are connected in parallel the total resistance, R, is given by the following formula.

$$\frac{1}{R} = \frac{1}{A} + \frac{1}{B}$$



Rewrite the formula so that R is the subject.

....

....

....

.... **[2]**

This, in contrast, was not done at all well and most had little understanding of how to deal with the fractions. Many candidates achieved some success but left their answer as a fraction with a fractional denominator.

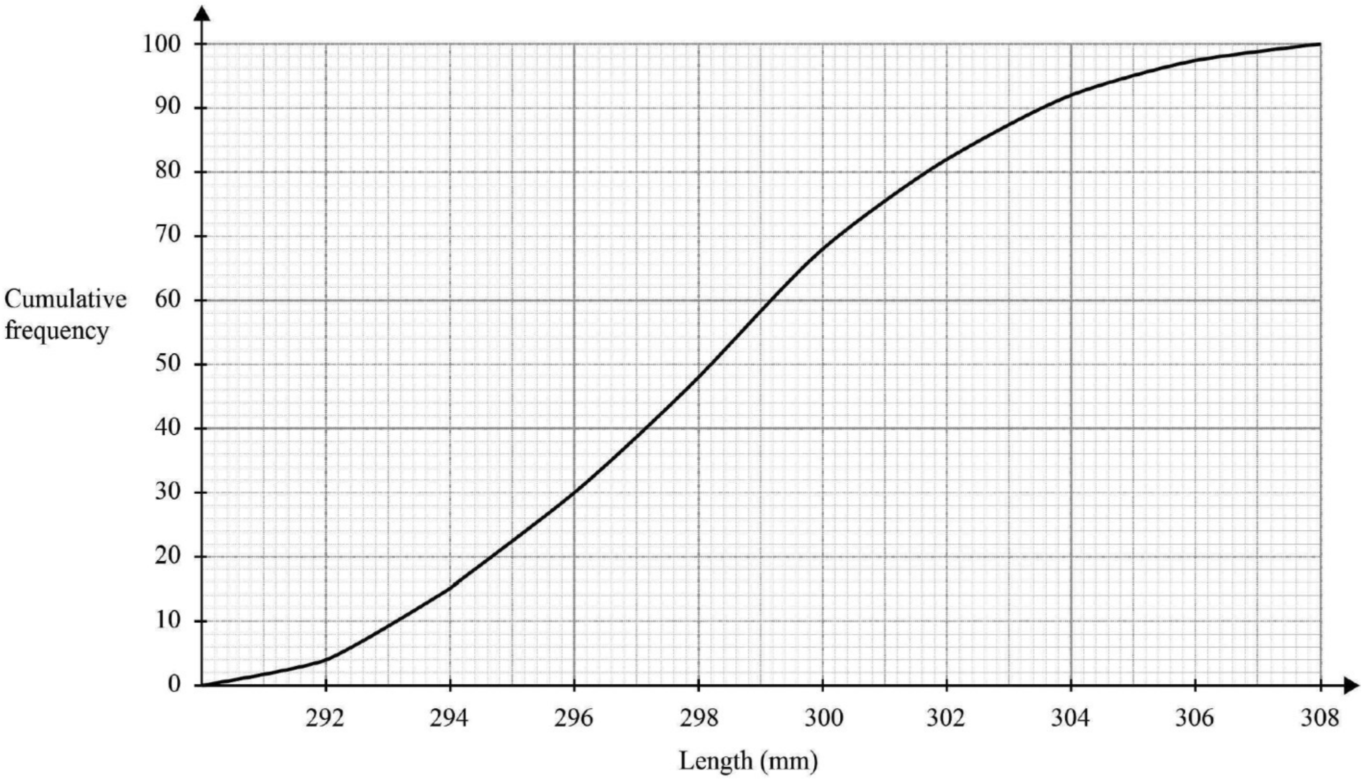
Question 3 (a)

3

(a) Steel bars are made to a nominal length of 300 mm. They cannot be used if they have a length over 305 mm.

An engineer chooses a sample of 100 bars each day and measures their length.

The cumulative frequency diagram below has been constructed from the data for one particular day.



How many bars in the sample cannot be used?

....

.... **[2]**

Most candidates scored both marks for this question, although a small minority used the point (300, 68) incorrectly.

Question 3 (b)

(b) On another occasion, the engineer chooses 10 bars at random. Their lengths are

292 296 297 300 301 302 303 304 307 308.

You are given that the mean length of this sample is 301.

Calculate the standard deviation of this sample.

....

....

....

....

.... **[3]**

Candidates should be performing these sorts of operation by calculator and it was pleasing to see that many candidates did so correctly, implied by the answer with no working. Those trying to do this long hand struggled.

Question 3 (c) (i)

(c) A machine has two components, A and B. It is found that the probability of component A failing within 24 hours is $\frac{1}{4}$ and the probability of component B failing within 24 hours is $\frac{1}{5}$.

The machine can only work if both components are functioning.

The probability that components fail is independent of the other.

One Monday morning the two components are replaced.

Find the probability that

(i) the machine is still working at the end of 24 hours,

....

....

....

....

....

....

.... **[3]**

Many candidates were confused by not reading the question carefully and so used probabilities to do with the machine still working "if A was still working but B was not". The simple answer was made rather more complicated as a result.

Question 3 (c) (ii)

(ii) the machine breaks down before the end of 24 hours.

....

.... **[1]**

The response expected was the answer to part (c)(i) subtracted from 1, and so many candidates were given the mark for doing so even if part (c)(i) was incorrect.

Question 4 (a) (i)

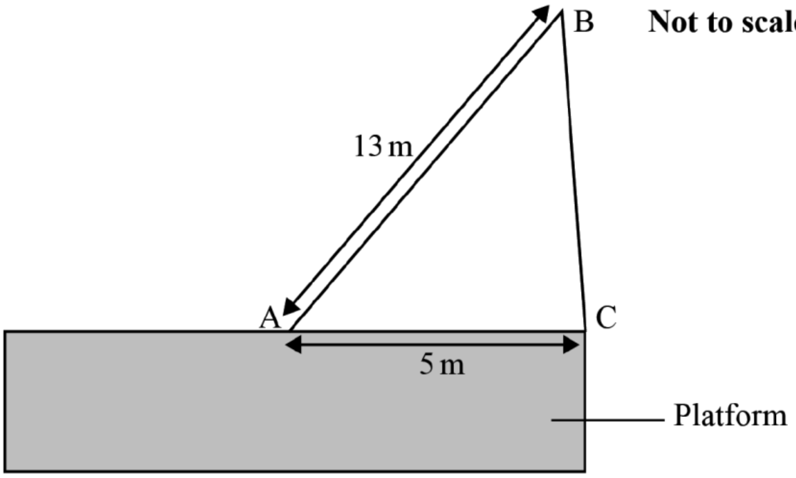
4

(a) A crane arm, AB, and a support arm, CB, are mounted so that AC is horizontal and at the edge of a platform as shown in **Fig. 1**.

The crane arm, AB, can be rotated in a vertical plane. BC has variable length.

AB = 13 metres and AC = 5 metres.

Fig. 1



(i) Find the angle BAC when B is vertically above C.

....

....

.... **[2]**

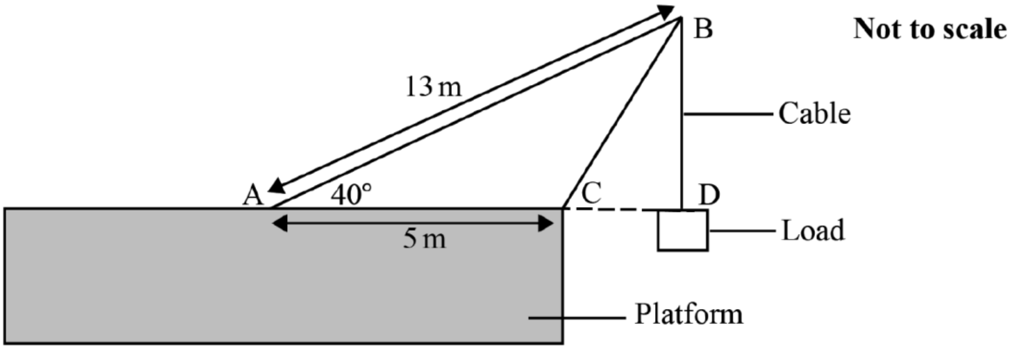
A majority of candidates earned full marks for this part. However, not many used the sine ratio for a right angled triangle. A number of candidates either used the sine rule (with the second angle 90^0) or used Pythagoras to find the third side (12 m) followed by use of the cosine ratio.

Question 4 (a) (ii)

AB is now rotated so that angle BAC = 40° as shown in **Fig. 2**.

The top of the crane arm, B, now extends over the edge of the platform. A load hung from the end of the cable BD can now be lowered below the surface of the platform.

Fig. 2



(ii) Calculate the length of the cable BD when D is level with the top surface of the platform (so that ACD is a straight line).

....

....

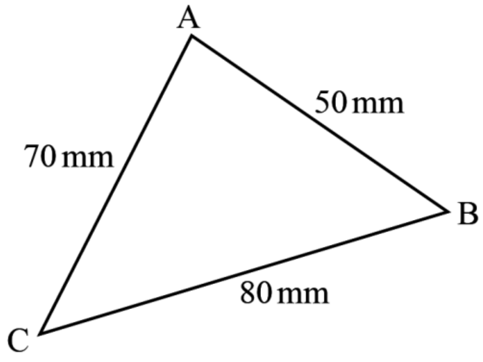
....

.... **[3]**

A number of candidates realised that the triangle BAD was right angled and used the sine ratio again to obtain the vertical side. Others found the angle at C by the sine rule (getting into a muddle over which angle was obtuse and which acute), then the side BC by the cosine rule followed by the sine ratio in triangle BCD. This was a lot of work for 3 marks.

Question 4 (b)

(b) A triangular piece of metal ABC has sides AC = 70 mm, CB = 80 mm and BA = 50 mm.



Not to scale

Find the angle ABC.

....

....

....

....

....

.... **[4]**

This was a straightforward application of the cosine rule where CosB had to be made the subject of the formula. It was this part of the question that caused the most problems. By far the most common error was to calculate $a^2 + c^2 - 2ac\cos B$ as $\left(a^2 + c^2 - 2ac\right)\cos B$.

Question 5 (a)

5

(a) Solve the equation $2^x = 3$. Give your answer correct to 3 decimal places.

....

....

....

....

....

.... **[4]**

Candidates who understood logarithms and were able to use their calculators to any base had no problem; using base 2 was the most efficient way to solve this equation. Others took logs to base 10 and had some algebraic work to do, not always correctly. A few tried a trial and improvement method and this was rewarded providing they were able to get to the answer correct to 3 decimal places.

Question 5 (b)

(b) Write as a single logarithm $3\log a + \log b$.

....

....

.... **[2]**

Use of the two log laws in the right order was necessary here and a majority were successful. Others, for instance, proceeded as if $3\log a + \log b$ was $3(\log a + \log b)$

Question 5 (c)

(c) Find the equation of the line that passes through the points (3, 4) and (7, 6).

....

....

.... **[2]**

There were a number of equations that could be used to find the equation of this particular line. Most candidates used the form $y = mx + c$, finding the gradient as an extra step. It was this extra step that was incorrect on many cases, obtaining a gradient of 2 rather than $\frac{1}{2}$.

Question 5 (d)

(d) Find the equation of the line that passes through the point (4, 2) and is perpendicular to the line $2x + 5y = 7$.

....

....

....

....

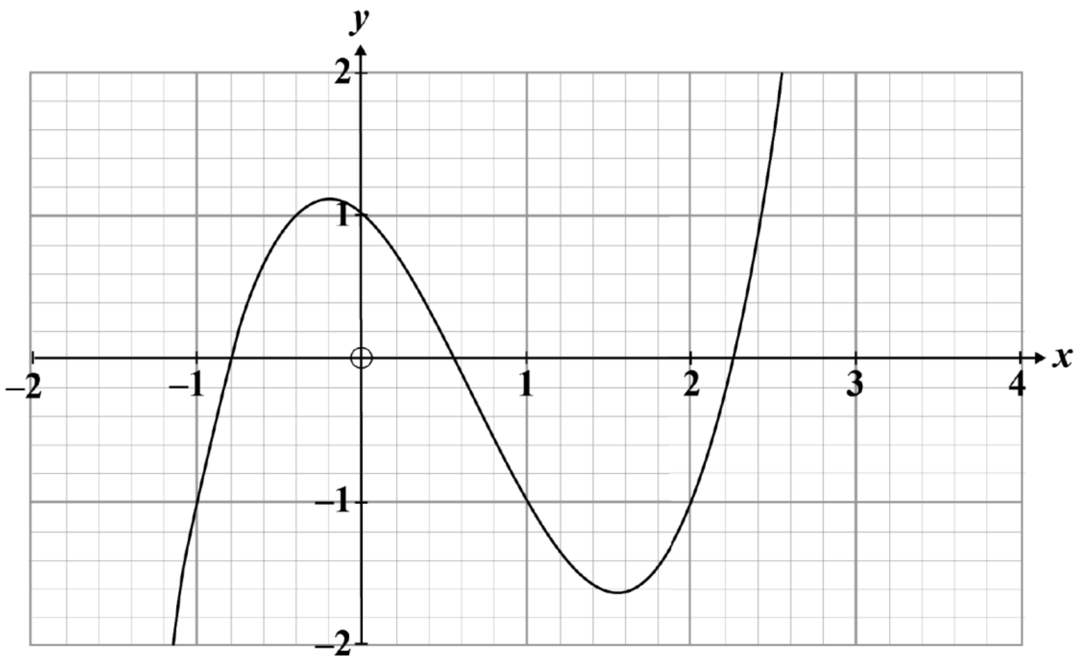
....

.... **[4]**

Writing the equation in the form $5x - 2y = c$ and substituting the coordinates of the given point was the most efficient way to find the equation of the perpendicular line. This was, however, rarely seen, so candidates found the gradient of the given line and used the property $m_1 m_2 = -1$ to find the gradient of the required line. This needed two extra steps which resulted in errors for many.

Question 5 (e) (i)

(e) The curve $y = x^3 - 2x^2 - x + c$ for $-2 \leqslant x \leqslant 3$ is shown on the graph below.



(i) Given that c is an integer, write down the value of c.

.... **[1]**

This part was to assess the connection between properties of a cubic equation and its roots graphically. c is the intercept on the y-axis which could be seen to be (0, 1).

Question 5 (e) (ii)

(ii) Write down the three values of x for which $x^3 - 2x^2 - x + 1 = 0$ correct to 1 decimal place.

....

....

.... **[2]**

The three values of x for which $y = 0$ are the roots of the equation and the intercept on the x-axis. So this was simply reading from the graph which many did correctly. Some did not read the question and tried to give their roots to 2 decimal places when only 1 was required.

Question 6 (a)

6 An engineer is modelling a flood bank between a road and a river.

(a) Show that $\frac{dy}{dx} = 0$ when $x = 2$ and $x = 5$.

....

....

....

....

....

.... **[5]**

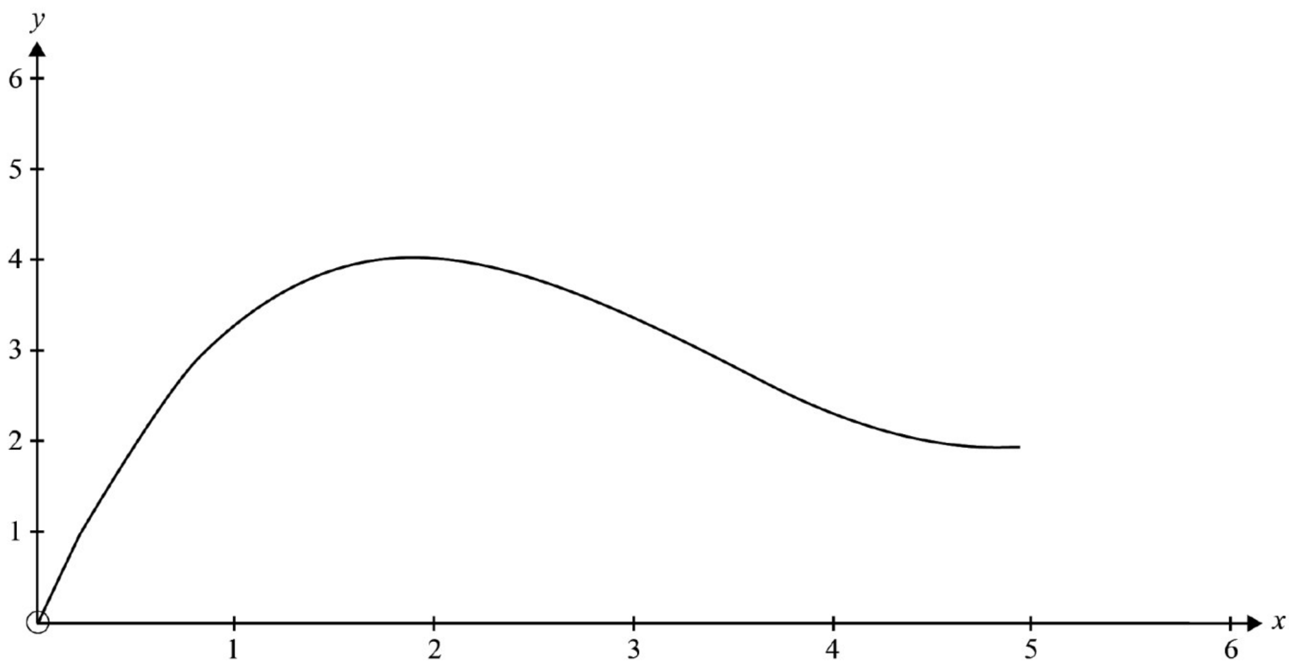
On a coordinate system the equation of the surface of the proposed flood bank is

$$y = \frac{1}{13}(2x^3 - 21x^2 + 60x)$$

for $0 \leqslant x \leqslant 5$, as shown in **Fig. 4**.

The edge of the river when at its lowest level is at (0, 0) and the edge of the road is where $x = 5$.

Fig. 4



It seemed as though a number of candidates were unable to access this question due to not covering the calculus section of the specification. Those that were able to answer the question did so well. A requirement was to determine the gradient function, $\frac{dy}{dx}$ and a number of candidates did not gain this mark.

Question 6 (b) (i) and (ii)

(b) The river level rises at certain times of the year and at present frequently floods the road.

(i) Calculate the height of the road above the river when the river is at its lowest level.

....

....

.... **[2]**

(ii) After the flood bank is built, calculate the height the river must rise before it will flood the road. Show your working.

....

....

.... **[2]**

In both parts (i) and (ii) the question required candidates to calculate the answer and many did not do so, reading values off the graph instead.

Key point

The command verb "calculate" means that some calculation has to be done. In both parts the answer calculated is exact. In part (i) this could not be done from reading from the graph. In part (ii) the exact answer could not be found from reading the graph, although a number guessed correctly. Answers with no working earned no marks. The only exception to this is where calculators can produce an answer that would normally be a complicated process to work, such as finding the mean and standard deviation of a set of data.

Supporting you

Teach Cambridge

Make sure you visit our secure website **Teach Cambridge** to find the full range of resources and support for the subjects you teach. This includes secure materials such as set assignments and exemplars, online and on-demand training.

Don't have access? If your school or college teaches any OCR qualifications, please contact your exams officer. You can forward them this link to help get you started.

Reviews of marking

If any of your students' results are not as expected, you may wish to consider one of our post-results services. For full information about the options available visit the OCR website.

Keep up-to-date

We send a monthly bulletin to tell you about important updates. You can also sign up for your subject specific updates. If you haven't already, sign up here.

OCR Professional Development

Attend one of our popular CPD courses to hear directly from a senior assessor or drop in to a Q&A session. Most of our courses are delivered live via an online platform, so you can attend from any location.

Please find details for all our courses for your subject on **Teach Cambridge**. You'll also find links to our online courses on NEA marking and support.

Signed up for ExamBuilder?

ExamBuilder is the question builder platform for a range of our GCSE, A Level, Cambridge Nationals and Cambridge Technicals qualifications. Find out more.

ExamBuilder is **free for all OCR centres** with an Interchange account and gives you unlimited users per centre. We need an Interchange username to validate the identity of your centre's first user account for ExamBuilder.

If you do not have an Interchange account please contact your centre administrator (usually the Exams Officer) to request a username, or nominate an existing Interchange user in your department.

Need to get in touch?

If you ever have any questions about OCR qualifications or services (including administration, logistics and teaching) please feel free to get in touch with our customer support centre.

Call us on
01223 553998

Alternatively, you can email us on
support@ocr.org.uk

For more information visit
- **ocr.org.uk/qualifications/resource-finder**
- **ocr.org.uk**
- **facebook.com/ocrexams**
- **twitter.com/ocrexams**
- **instagram.com/ocrexaminations**
- **linkedin.com/company/ocr**
- **youtube.com/ocrexams**

We really value your feedback

Click to send us an autogenerated email about this resource. Add comments if you want to. Let us know how we can improve this resource or what else you need. Your email address will not be used or shared for any marketing purposes.

I like this **I dislike this**

Please note – web links are correct at date of publication but other websites may change over time. If you have any problems with a link you may want to navigate to that organisation's website for a direct search.

CAMBRIDGE
UNIVERSITY PRESS & ASSESSMENT