CAMBRIDGE TECHNICALS

OCR
Oxford Cambridge and RSA

Examiners' report

CAMBRIDGE TECHNICALS LEVEL 3 (2016)

ENGINEERING

OCR Level 3 Cambridge Technical in Engineering Principles

Certificate: 05822

OCR Level 3 Cambridge Technical in Engineering

Extended Certificate: 05823

Foundation Diploma: 05824

Diploma: 05825

Extended Diploma: 05873

Unit 3 Summer 2025 series

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 3 series overview

This Level 3 paper examined the principles of mechanical engineering. It followed a similar format to previous papers.

To do well on this paper, candidates needed to:

- be familiar with all the parts of the specification examined
- be familiar with, and make use of, engineering language and terms
- attempt all questions
- be familiar with, and make appropriate use of, the contents of the formula booklet provided
- be able to convert areas and volumes from mm^2 or mm^3 to m^2 or m^3
- show clear and legible workings especially for 3, 4, 5 and 6-mark questions.

The paper appeared to be accessible with most questions being attempted by candidates from many centres.

It was pleasing to see that more candidates demonstrated the ability to use the conservation of energy principle following on from the January exam and report.

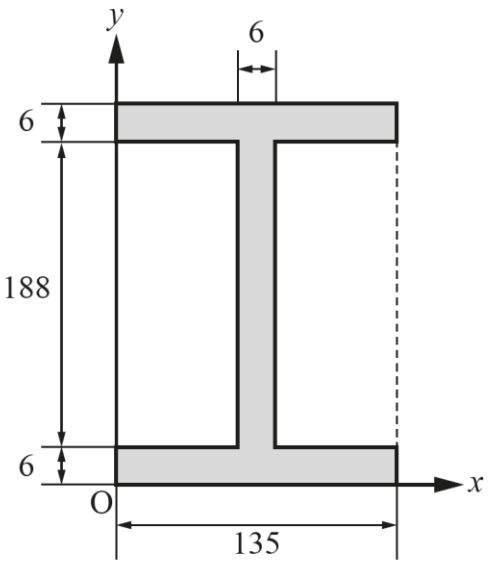
However, many candidates still demonstrated limited knowledge of how to calculate bending moments for a cantilevered beam and then use these to draw a bending moment diagram.

Candidates who did well on this paper generally:	Candidates who did less well on this paper generally:
• made good use of the formula booklet • read the question carefully • used engineering terms correctly • set out their calculations clearly • converted prefixes correctly • gave answers to a consistent number of significant figures • included correct units in their answers.	• didn't show any calculations with their answers • didn't attempt every question • didn't include directions with forces or moments • didn't label the axes for the bending moment diagram correctly.

Question 1 (a) (i)

1 The cross-section of a symmetrical rigid steel joist (RSJ) is shown below aligned within a Cartesian coordinate system (x, y) with the origin at point O as indicated.

The units of all dimensions are millimetres.



(a)

(i) Write down the coordinates of the centroid of this cross-section.

.....

.....

..... **[2]**

This was done well by most candidates, although some forgot to add 12mm to the 188mm height so got an incorrect answer for the y value.

Question 1 (a) (ii)

(ii) A steel joist with this cross-section has a length of 2000 mm.

Calculate the volume of the joist in mm^3.

.....

.....

.....

.....

.....

..... **[3]**

This was answered well by most candidates. The most common error was an incorrect calculation of the cross-sectional area.

Question 1 (a) (iii)

(iii) The joist has a mass of 43.14 kg.

Calculate the density of the steel in the joist. Give your answer in $kg\,m^{-3}$.

.....

.....

..... **[2]**

The main error here was an incorrect conversion from the volume in mm^3 to m^3.

Key point: Conversion of units

Candidates need to be aware that if they are converting a volume from mm^3 to m^3 they need to divide by 1000^3, not just 1000.

Question 1 (a) (iv)

(iv) The steel in the joist has a Young's modulus of 210 GPa.

Calculate the axial, compressive force required on the cross-sectional area of the joist that will cause its length to be reduced by 0.05 mm.

.....

.....

.....

.....

..... **[3]**

This was done well by many candidates. The two most common errors were using the incorrect power of ten for the prefix Giga and the incorrect conversion of the area from mm^2 to m^2.

Key point: Conversion of units

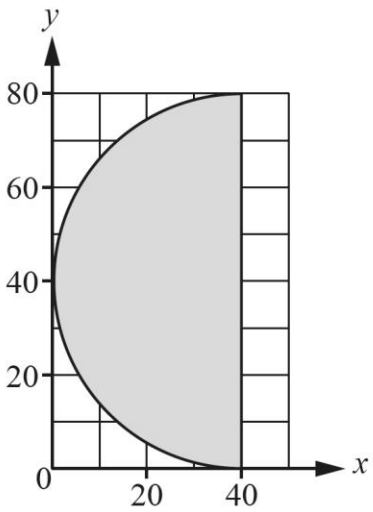
Candidates need to be aware that if they are converting an area from mm^2 to m^2 they need to divide by 1000^2, not just 1000.

Assessment for learning

Ensure that candidates are proficient at using the correct prefixes in calculations.

Question 1 (b)

(b) A semicircular plate with a radius of 40 mm aligned with a Cartesian axis system (x, y) is shown below.



Calculate the coordinates of the centroid of the plate.

.....

.....

..... **[2]**

Most candidates correct calculated $\frac{4r}{3\pi}$ correctly but then did not subtract it from 40.

Question 2 (a) (i)

2

(a) A class one lever with a mechanical advantage of 1.84 is used to lift a load of 290 N.

(i) Calculate the minimum effort required to lift the load.

.....

..... **[2]**

This was done well by most candidates.

Question 2 (a) (ii)

(ii) The distance between the fulcrum and the load is 1.4 m.

Calculate the distance between the position of the load and the position of the effort.

.....

.....

.....

..... **[2]**

Many candidates correctly calculated the distance from the fulcrum to the effort. However, they then did not add that to the distance from the fulcrum to the load to give the distance between the load and the effort as asked in the question.

Key point: Read the question carefully

Encourage candidates to read the question carefully so that they are aware of what exactly is required.

Question 2 (a) (iii)

(iii) Draw a labelled diagram of the lever showing the load, effort and fulcrum.

..... **[3]**

This was done well by most candidates, although some did not label the fulcrum.

Question 2 (b)

(b) Three gear systems are listed in the table below.

Put a tick (✓) in the boxes to indicate the correct properties of the listed systems.

Systems can have one of the properties, more than one of the properties or none of the properties.

	Properties		
	Axis of rotation changes 90°	**Converts rotational movement to linear movement**	**Direction of transmission can be reversed**
Bevel gear			
Rack and pinion			
Wormgear and wormwheel			

[3]

This was not a high scoring question for the majority of candidates. Many assumed that each gear could only have one property.

Question 2 (c)

(c) Give **one** reason for placing an idler gear between two adjacent gears in a gear train.

.....

.....

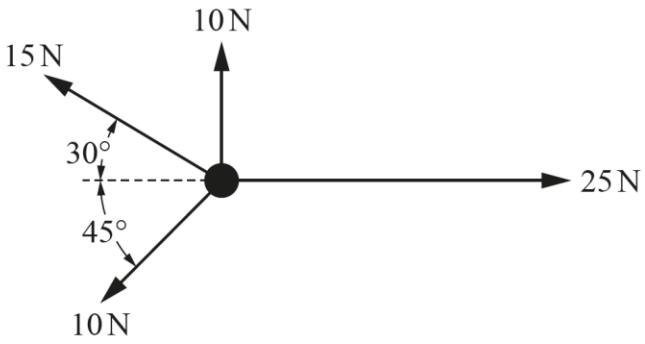
.....

..... **[1]**

This was done well but some candidates needed to use the word rotate rather than move.

Question 3 (a)

3 A particle lies on a smooth horizontal surface and is acted on by four coplanar forces as shown in the diagram.



(a) Calculate the magnitude of the resultant force.

.....

.....

.....

.....

.....

..... **[4]**

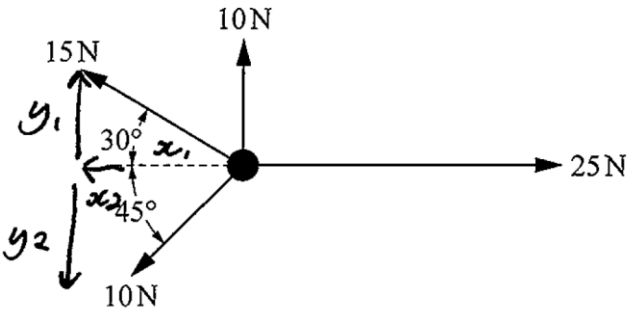
Most candidates recognised the need to use Pythagoras to calculate the resultant force from their overall horizontal and vertical forces, so most scored at least 1 mark. However, it was not always apparent how the horizontal or vertical forces had been calculated.

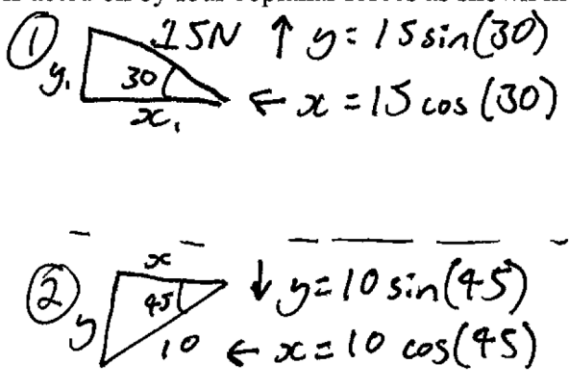
Key point: Answers requiring more than one calculation

In answers where more than one calculation is required, it is good practice to show these separately rather than just writing all the numbers down in one line. The exemplar shows a good response of how this can be done.

Exemplar 1

3 A particle lies on a smooth horizontal surface and is acted on by four coplanar forces as shown in the diagram.





(a) Calculate the magnitude of the resultant force.

(→ +ve) $x_T = 25 - 10\cos(45) - 15\cos(30) = 4.938551131$

(↑ +ve) $y_T = 10 + 15\sin(30) - 10\sin(45) = 10.42893219$

$R = \sqrt{10.4^2 + 4.9^2} = 11.54\text{N}$.

This is a good response of how the calculations are shown clearly at each stage and that the final response has been quoted with correct units.

Question 3 (b)

(b) The particle has a mass of 2.5 kg. Calculate the magnitude of the acceleration of the particle when acted upon by the four forces.

..... **[2]**

This was done well by most candidates using their force calculated in part a.

Question 3 (c)

(c) The particle accelerates from rest at the rate calculated in part **(b)**. Calculate the magnitude of the velocity of the particle after it has travelled a distance of 6 m.

.....

.....

..... **[3]**

This was done well by most candidates using their acceleration calculated in part b.

Question 4 (a)

4

(a) The instantaneous power of a car travelling at $16\,m\,s^{-1}$ is 50 kW. Calculate the force exerted by the car at this time.

.....

.....

..... **[2]**

The main error here by candidates was failing to convert kW to W, so many scored 1 mark out of the 2 available.

Question 4 (b)

(b) A toy rocket is launched vertically from ground level with an initial speed of $30\,m\,s^{-1}$. Assuming that the motion of the rocket is only affected by gravity after it is launched, calculate the maximum height that it reaches.

.....

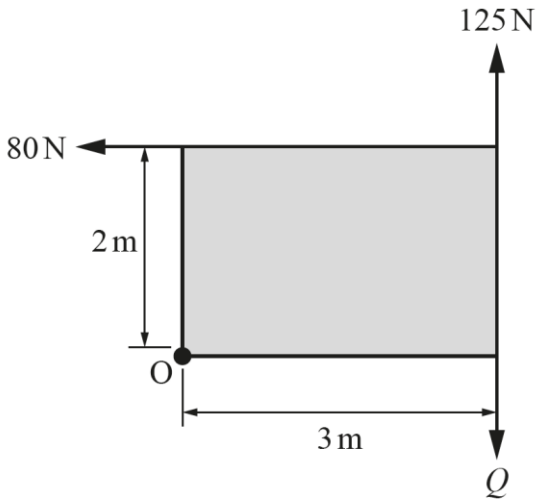
.....

..... **[3]**

Most candidates recognised that a suvat equation could be used to solve this, but a large minority did not appreciate that the value for acceleration, a, was $9.8 ms^{-2}$ due to gravity.

Question 4 (c)

(c)



Three forces are applied to a uniform plate resting on a smooth, horizontal surface, as shown above. Calculate the magnitude of force Q so that there will be no turning moment about corner O.

.....

.....

..... **[2]**

Most candidates found this challenging and didn't show their calculations clearly. Many were confused by which distance should be multiplied by which force.

Exemplar 2

$(80 \times 2) + (125 \times 3) = 3Q$

$160 + 375 = 3Q$

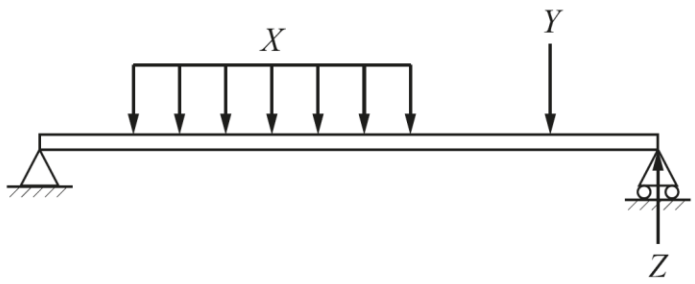
$Q = \frac{535}{3} = 178.3\,N.$ **[2]**

This is another good response of how the calculations are shown clearly at each stage and that the final response has been quoted with correct units.

Question 5 (a) (i)

5

(a) A horizontal, simply supported beam is shown below.



(i) Name the types of load indicated on the diagram.

load *X* .....

load *Y* .....

[2]

A large minority of candidates weren't able to answer this correctly.

Question 5 (a) (ii)

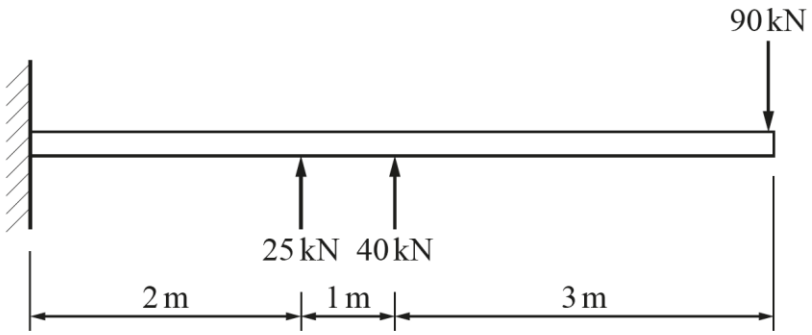
(ii) Name the type of force indicated by arrow *Z* on the diagram.

force *Z* ..... **[1]**

The majority of candidates didn't get this correct.

Question 5 (b) (i)

(b) A loaded, horizontal cantilever beam attached to a wall is shown below.



(i) Calculate the vertical reaction at the wall. The self weight of the beam can be ignored.

.....

..... **[2]**

There were a sizeable number of candidates who calculated the magnitude of the force correctly, but then did not state which direction the force acted in. A large minority also calculated the bending moment instead of the force.

Key point: Read the question carefully

Encourage candidates to read the question carefully so that they are aware of what exactly is required.

Question 5 (b) (ii)

(ii) Calculate the bending moment at the wall.

.....

.....

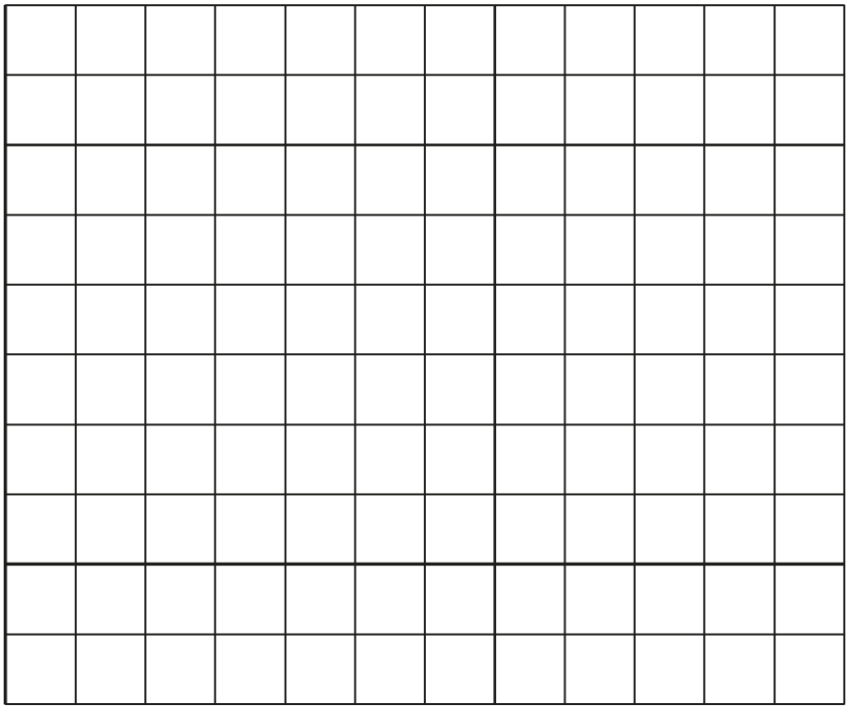
.....

..... **[3]**

Most candidates were able to calculate the three bending moments correctly, but many didn't take the different directions into account when calculating their final answer.

Question 5 (b) (iii)

(iii) Draw a labelled bending moment diagram for the beam on the grid below.



.....

.....

.....

.....

.....

..... **[4]**

Very few candidates scored marks for this question, despite 1 mark being available for labelling the axes with a reasonable scale. Many incorrectly label the y axis with force/moment in kN instead of bending moment in kNm.

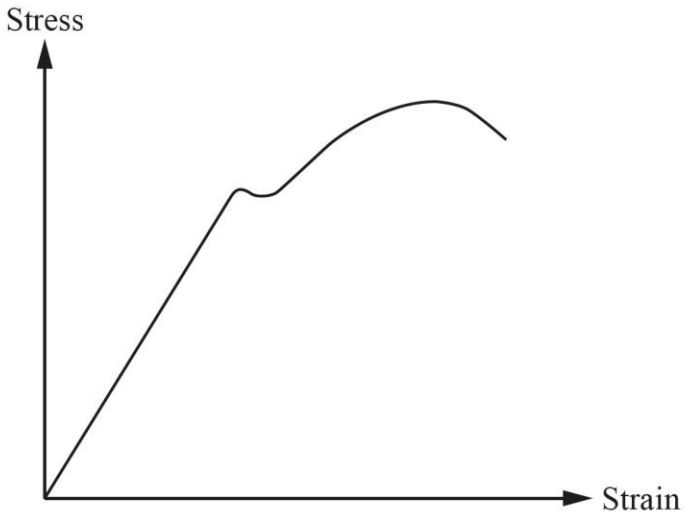
Misconception

The units of a bending moment are (k)Nm, not just (k)N.

Question 6 (a) (i)

6

(a) A stress–strain graph of a metallic material is shown below.



(i) Indicate with an arrow on the graph the location of the elastic limit of the material. **[1]**

Most candidates did this well.

Key point: Annotating diagrams

Please encourage candidates to draw the arrow so that it touches the graph rather than stopping in mid-air.

Question 6 (a) (ii)

(ii) State what happens when the operational stress levels of the material exceed the elastic limit.

.....

.....

.....

..... **[1]**

This was done very well by most candidates.

Question 6 (a) (iii)

(iii) The aluminium in a bar has an ultimate stress of $550\,N\,mm^{-2}$. The bar is used in a structure that has a safety factor of 1.75.

Calculate the allowable working stress of the structure.

.....

.....

.....

..... **[2]**

Most candidates scored full marks for this question.

Question 6 (b) (i)

(b) The mass of a rollercoaster car is 8700 kg. The car is stationary on the top of a downward-sloping track at a height of 24 m above the ground.

(i) Calculate the gravitational potential energy of the car relative to ground level.

.....

.....

.....

..... **[2]**

A large minority of candidates didn't score the second mark as they didn't include the correct units with their answer.

Key point: Include units with answers

Please encourage candidates to include units with their answers.

Question 6 (b) (ii)

(ii) The car then rolls down the slope until it reaches ground level. Neglecting frictional forces and assuming the conservation of energy, calculate the speed of the car when it reaches ground level.

.....

.....

.....

.....

.....

..... **[3]**

More candidates than in January used the principle of conservation of energy which was pleasing to see. However, there was still a larger majority that ignored that instruction and used suvat instead.

Key point: Read the question carefully

Encourage candidates to read the question carefully so that they are aware of what exactly is required.

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 exam paper builder platform for a range of our qualifications. Find out more.

Free for all OCR centres with an Interchange account, it allows unlimited users per centre. We require an Interchange username to verify your centre's users for ExamBuilder.

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

Once you have an Interchange username, use the form on this page to sign up for ExamBuilder, or ask an existing user at your centre to create an ExamBuilder account for you.

Online courses

Enhance your skills and confidence in internal assessment

What are our online courses?

Our online courses are self-paced eLearning courses designed to help you deliver, mark and administer internal assessment for our qualifications. They are suitable for both new and experienced teachers who want to refresh their knowledge and practice.

Why should you use our online courses?

With these online courses you will:

- learn about the key principles and processes of internal assessment and standardisation
- gain a deeper understanding of the marking criteria and how to apply them consistently and accurately
- see examples of student work with commentary and feedback from OCR moderators
- have the opportunity to practise marking and compare your judgements with those of OCR moderators
- receive instant feedback and guidance on your marking and standardisation skills
- be able to track your progress and achievements through the courses.

How can you access our online courses?

Access courses from Teach Cambridge. Teach Cambridge is our secure teacher website, where you'll find all teacher support for your subject.

If you already have a Teach Cambridge account, you'll find the link to the **Online courses** under the **Assessment** or **Training** tab – hover over **Assessment** or **Training** on the horizontal menu and select **Online courses** from the dropdown.

If you don't have a Teach Cambridge account yet, ask your exams officer to set you up – just send them this link and ask them to add you as a Teacher.

Access the courses **anytime, anywhere and at your own pace**. You can also revisit the courses as many times as you need.

Which courses are available?

We recommend all teachers complete the module on Online courses – NEA for their subject. These courses provide subject-specific information about course content; how to prepare for planning, marking and submitting; and support with understanding the marking criteria.

The subject-specific courses are tailored for each qualification that has non-exam assessment (NEA) units, except for AS Level and Entry Level. They cover the following topics:

- the structure and content of the NEA units
- the assessment objectives and marking criteria for the NEA units
- examples of student work with commentary and feedback for the NEA units
- interactive marking practice and feedback for the NEA units.

We are also developing courses for some of the examined units, which will be available soon.

How can you get support and feedback?

If you have any queries, please contact our Customer Support Centre on 01223 553998 or email support@ocr.org.uk.

We welcome your feedback and suggestions on how to improve the online courses and make them more useful and relevant for you. You can share your views by completing the evaluation form at the end of each course.

Tell us what you think

Your feedback plays an important role in how we develop, market, support and resource qualifications now and into the future. We want you and your students to enjoy and get the best out of our qualifications and resources, but to do that we need your honest opinions to tell us whether we're on the right track or not.

You can email your thoughts to resources.feedback@ocr.org.uk or visit our feedback page to learn more about how you can help us improve our resources.

Designing and testing in collaboration with you and your students

Helping young people develop an ethical view of the world

Equality, diversity, inclusion and belonging (EDIB) are part of everything we do

---

Contact the team at:

01223 553998

ocr.org.uk

To stay up to date with all the relevant news about our qualifications, register for email updates at ocr.org.uk/updates

Visit our Online Support Centre at support.ocr.org.uk

CAMBRIDGE
UNIVERSITY PRESS & ASSESSMENT