CAMBRIDGE TECHNICALS

OCR
Oxford Cambridge and RSA

CAMBRIDGE TECHNICALS LEVEL 3 (2016)

Examiners' report

ENGINEERING

05822–05825, 05873

Unit 3 Summer 2024 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. A selection of candidate answers is also provided. 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 OCR.

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, and make appropriate use of, the contents of the formula booklet provided
- be familiar with all the parts of the specification examined
- be familiar with, and make use of, engineering language and terms
- show clear and legible workings especially for 2, 3, 4 and 5 mark questions
- attempt all questions.

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

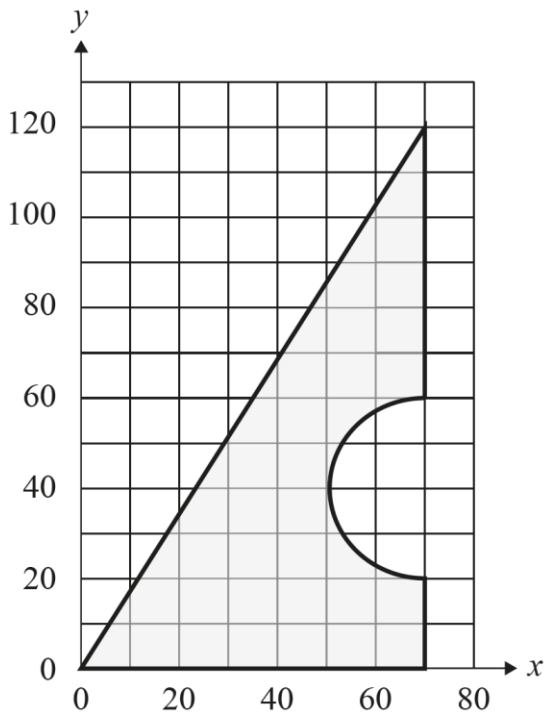
However, some candidates demonstrated limited knowledge of how to calculate mechanical advantage and then use it to calculate an output force from an input mass. A minority of candidates also demonstrated uncertainty in how to calculate moments acting in different directions.

Candidates who did well on this paper generally:	Candidates who did less well on this paper generally:
• set out their calculations clearly • included correct units in their answers • made good use of the formula booklet • converted prefixes correctly • gave answers to a consistent number of significant figures • used engineering terms correctly.	• didn't attempt all the questions • missed out parts of individual questions • didn't show any working out in calculations.

Question 1 (a) (i)

1

(a) The shaded area in the diagram below shows a triangular aluminium plate with a semi-circular cutaway section. The plate is aligned within a Cartesian coordinate system, (x, y). Both x and y are measured in units of millimetres.



(i) Calculate the area of the plate.

.....

.....

.....

.....

.....

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

Most candidates answered this correctly. Some did not calculate the area of the semi-circle correctly, leaving the area as that of the circle. A few also added the area of the semi-circle to that of the triangle, rather than subtracting it.

Question 1 (a) (ii)

(ii) Calculate the coordinates of the centroid of the plate.

.....

.....

.....

.....

.....

..... **[7]**

Many candidates incorrectly calculated the centroids starting from 0,0 rather than from 70,0.

Calculating individual centroids

It is important that candidates know which part of the triangle they calculate the centroids from.

Question 2 (a)

2

(a) Complete the paragraph below.

Choose words from the following list. The words can be used once, more than once or not at all.

flat-toothed **linear** **oscillating** **rotational** **spur** **worm**

A rack and pinion gear system consists of a ..... gear known as the pinion and a ..... component known as the rack. It is used to convert ..... motion to ..... motion.

[4]

This was done well by most candidates with virtually all correctly completing the last two points. A few incorrectly thought that the spur gear was a worm gear.

Question 2 (b)

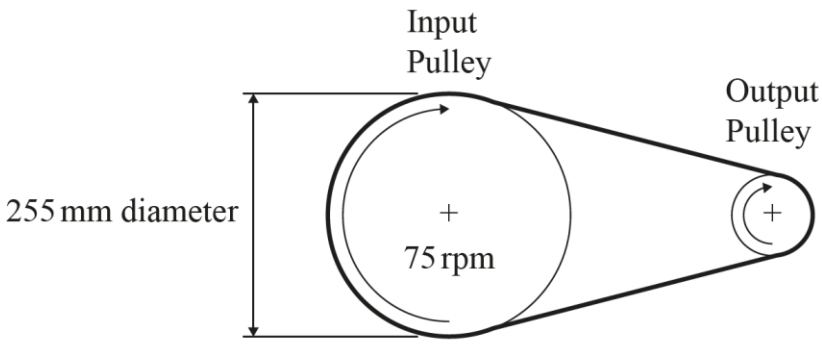
(b) State a suitable example of where a chained sprocket system could be used.

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

This was done very well, with most candidates stating 'bicycle' as a correct answer.

Question 2 (c)

(c) The diagram below shows a belt and pulley system in which the input pulley has a diameter of 255 mm and rotates at 75 rpm.



Calculate the diameter of the output pulley if it is to rotate at 225 rpm.

.....

.....

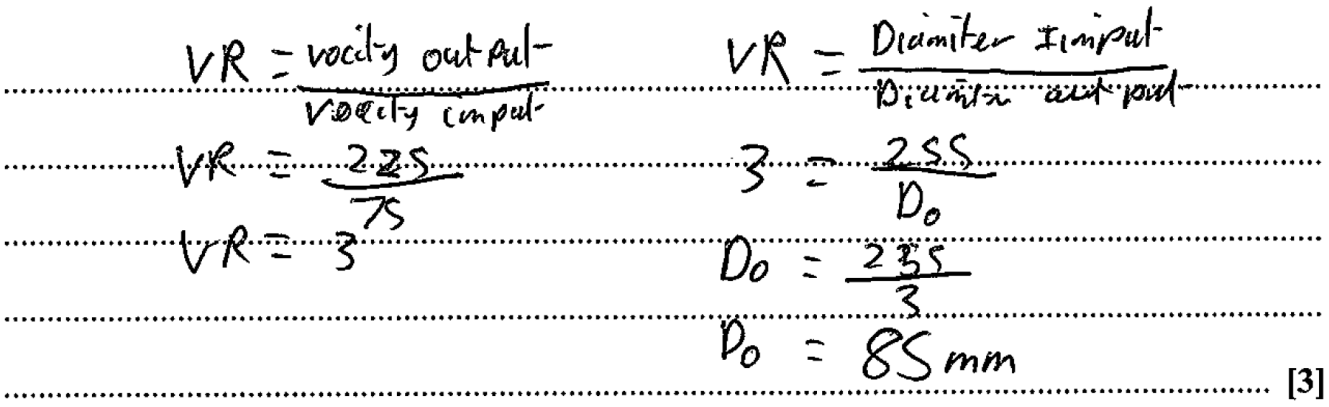
.....

.....

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

Candidates should be encouraged to write down the equations that they are using. A good example of this is shown in Exemplar 1. Many candidates just wrote down a series of incorrect calculations with no explanations and therefore were not able to access any of the marks available. A lot of candidates incorrectly used 225mm as the input diameter instead of 255 mm.

Exemplar 1



Exemplar 1 demonstrates a clear explanation of the candidate's calculations by showing the equations being used.

Question 2 (d)

(d) Give **two** advantages and **one** disadvantage of using a belt and pulley system in preference to a simple gear system.

Advantage 1: .....

.....

Advantage 2: .....

.....

Disadvantage: .....

.....

[3]

Many candidates mentioned cost which was ignored. A lot also correctly mentioned how the torque varied but didn't link this to the speed so didn't achieve a mark.

Question 3 (a)

3

(a) A piece of steel measuring 200 mm × 100 mm × 2 mm is to be cut into two pieces each measuring 100 mm × 100 mm × 2 mm using a guillotine. Assuming the steel has a shear stress of 250 N mm^{-2} calculate the force required to shear the steel plate.

.....

.....

.....

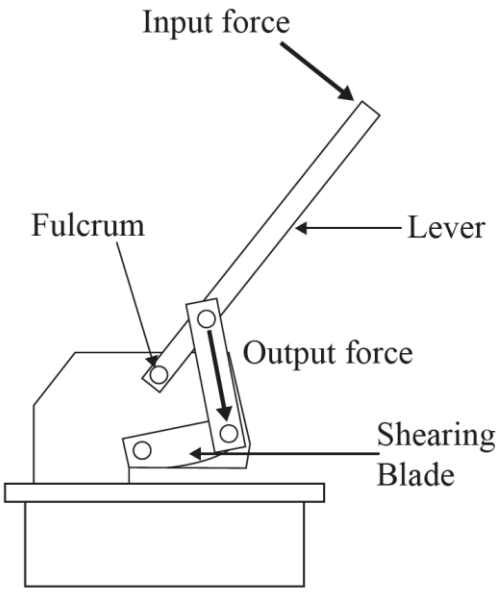
..... **[3]**

Not many candidates calculated the correct area. Many incorrectly used the volume in their calculation.

Question 3 (b)

(b) The diagram below shows a guillotine containing a lever.

State the class of this lever.

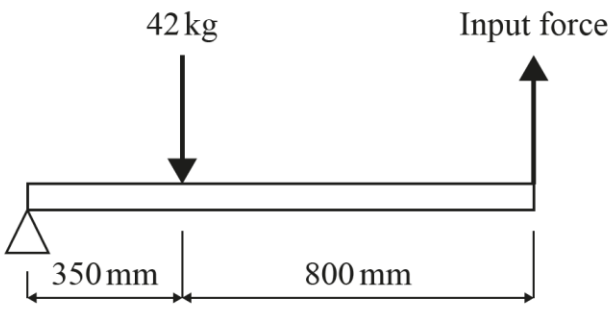


Class: ..... **[1]**

This was done well, with most candidates recognising this as a Class 2 lever.

Question 3 (c) (i)

(c) A wheelbarrow holding a mass of 42 kg is represented by the lever diagram shown below.



(i) Calculate the mechanical advantage of the lever.

.....

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

Many candidates didn't use the total distance (1150mm) from the pivot so did not gain the mark.

Question 3 (c) (ii)

(ii) Calculate the minimum input force required to lift the 42 kg mass.

.....

.....

.....

.....

.....

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

Many candidates did not covert kg to N.

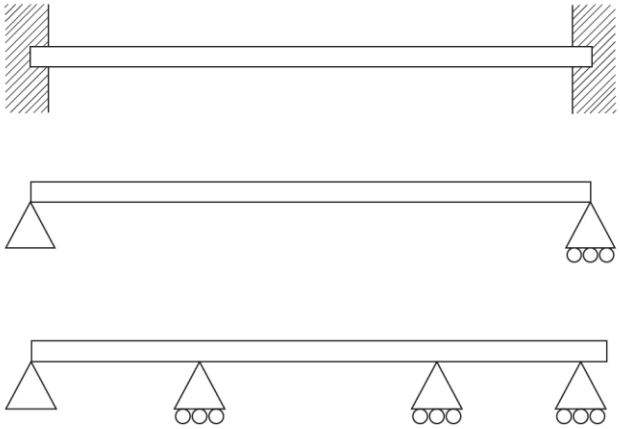
Assessment for learning

Not many candidates linked the MA calculated in the previous question to the input and output forces. The equation is given in the formula booklet at the bottom of page 11. Encourage candidates to use the formula booklet to help them.

Question 4 (a)

4

(a) State the type of beam shown in each of the following diagrams.



Beam type

.....

.....

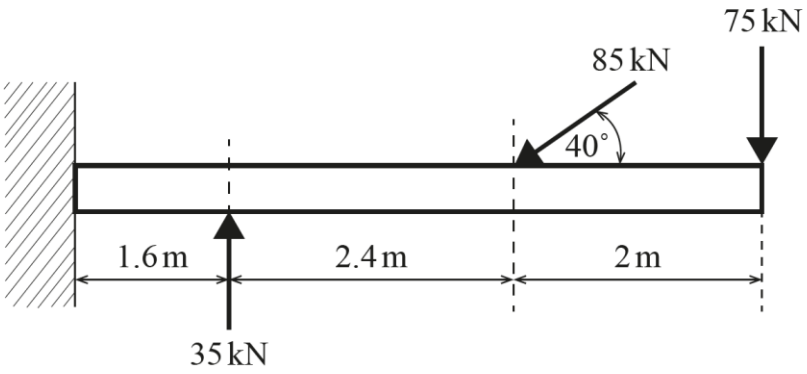
.....

[3]

There were quite a few candidates who thought that the third beam was a rolling beam rather than a continuously supported beam.

Question 4 (b) (i)

(b) A cantilever beam is subjected to three forces of 35 kN, 85 kN and 75 kN at positions and in directions as shown in the diagram below. For this question the self weight of the beam need not be considered.



(i) Calculate the vertical component of the 85 kN force.

.....

.....

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

Most candidates answered this question correctly.

Question 4 (b) (ii)

(ii) Calculate the magnitude of the vertical reaction force at the support.

.....

.....

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

A significant minority of candidates tried to calculate moments for this question.

Question 4 (b) (iii)

(iii) Calculate the moment at the support.

.....

.....

.....

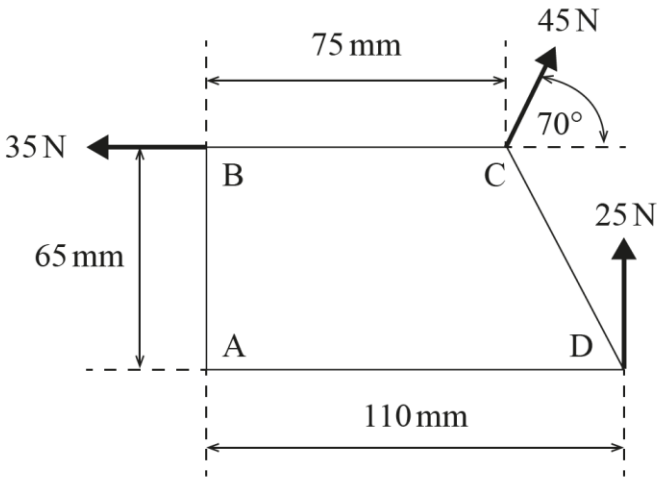
.....

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

This was done well by many candidates.

Question 5 (a)

5 A steel plate ABCD, aligned in a vertical plane, is subjected to three forces of 35 N, 45 N and 25 N which act at positions and in directions as shown in the diagram below.



(a) Calculate the magnitude and direction, relative to the horizontal, of the resultant of the three forces shown in the diagram. Illustrate your answer in a diagram immediately after your calculations.

.....

.....

.....

.....

.....

.....

[5]

A large majority of candidates scored at least 3 marks for this question. A significant minority did not calculate the angle to the horizontal or illustrate their answer with a diagram so did not gain the final 2 marks.

Question 5 (b)

(b) Calculate the moment about corner A. Give the units in your answer.

.....

.....

.....

.....

.....

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

A significant minority of candidates thought that the correct unit for a moment was N rather than Nm or Nmm.

Question 5 (c)

(c) An additional force of 85 N is added to the plate so that it acts vertically downwards on side AD.

Calculate the distance between this force and point A so that the total moment about point A becomes zero.

.....

.....

.....

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

Many candidates gained both marks for this question even though they had not scored full marks on the previous question.

Question 6 (a) (i)

6

(a) A car with a mass of 1600 kg is travelling at a speed of 90 kilometres per hour.

(i) Calculate the kinetic energy of the car. Give your answer in Joules.

.....

.....

.....

.....

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

The most common error here was incorrectly using 90 km/h as the velocity in the kinetic energy equation. However, there was a sizeable minority who quoted the kinetic energy equation correctly and then did not square their value of velocity.

Question 6 (a) (ii)

(ii) While travelling at this speed the driver disengages the engine and applies the brakes.

Calculate the total braking force, F, required to stop the car in a distance of 50 m on a horizontal road assuming a constant deceleration.

.....

.....

.....

.....

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

Less than half the candidates equated the kinetic energy to the work done, so more candidates made it more complex by using suvat equations to calculate the answer.

Question 6 (a) (iii)

(iii) As soon as the brakes are applied the wheels are locked and stop rotating. This causes the car to slide along the road.

Assuming that the total braking force is solely due to the friction between the tyres and the road surface, draw a diagram showing **all** the forces acting between the road surface and the tyres while the car is decelerating.

Indicate the car's direction of travel in your diagram.

You may represent the car and all of its wheels as a single point mass.

[2]

Most candidates answered this 2 mark question well, but some included unnecessarily detailed drawings of cars which gained no marks.

Assessment for learning

In questions like this, worth 2 marks, candidates should be discouraged from drawing detailed pictures in their responses, adding in extra forces that are not required, or showing values rather than the name of the forces.

Question 6 (a) (iv)

(iv) Using the braking force calculated in part **(ii)** calculate the coefficient of friction, μ, between the tyres of the car and the road surface.

.....

.....

.....

.....

.....

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

A small minority did not convert the mass to a force.

Question 6 (a) (v)

(v) Calculate the constant rate of deceleration from the moment the brakes are engaged until the car stops.

.....

.....

.....

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

A significant minority of candidates had calculated this correctly as part of their calculation in 6(a)(ii). Some then tried to do further calculations with this correct value, so were unable to gain full marks for this question.

Question 6 (b)

(b) A lorry with a mass of 3500 kg travelling at 15 m s^{-1} collides 'head-on' with a van of mass 1500 kg travelling in the opposite direction with a speed of 20 m s^{-1}.

Immediately after the collision the lorry continues to travel in the same direction with a speed of 3 m s^{-1} while the van is forced backwards.

Assuming that total momentum is conserved, calculate the speed of the van immediately after the collision.

.....

.....

.....

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

Most candidates did well on this question but some made calculation errors without showing their working, so no marks could be given.

Assessment for learning

Candidates should be encouraged to always show their working clearly so they may get some marks on a question.

Exemplar 2

Assuming that total momentum is conserved, calculate the speed of the van immediately after the collision. p before = p after

$(3500 \times 15) - (1500 \times 20) = (3500 \times 3) + 1500v$

$52500 - 30000 = 10500 + 1500v$

$22500 - 10500 = 1500v$

$v = 8.0\ ms^{-2}$ **[3]**

Exemplar 2 shows how the calculations are presented in a clear way.

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 a free test-building platform, providing unlimited users exclusively for staff at OCR centres with an Interchange account.

Choose from a large bank of questions to build personalised tests and custom mark schemes, with the option to add custom cover pages to simulate real examinations. You can also edit and download complete past papers.

Find out more.

You will need an Interchange account to access our digital products. 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.

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 available courses for your subject under Assessment - NEA/Coursework - Online courses. Click on the blue arrow to start the course.

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?

There are **two types** of online course: an **introductory module** and **subject-specific** courses.

The introductory module, Building your Confidence in Internal Assessment, is designed for all teachers who are involved in internal assessment for our qualifications. It covers the following topics:

- the purpose and benefits of internal assessment
- the roles and responsibilities of teachers, assessors, internal verifiers and moderators
- the principles and methods of standardisation
- the best practices for collecting, storing and submitting evidence
- the common issues and challenges in internal assessment and how to avoid them.

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.

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