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Oxford Cambridge and RSA

Cambridge **TECHNICALS LEVEL 3**

ENGINEERING

Cambridge TECHNICALS 2016

Feedback on the January 2018 exam paper (including selected exemplar candidate answers and commentary)

Unit 3 – Principles of mechanical engineering

Version 1

ocr.org.uk/engineering

CONTENTS

INTRODUCTION

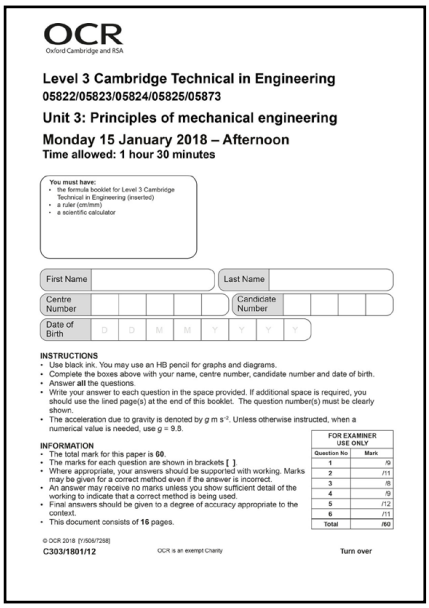
This resource brings together the questions from the January 2018 examined unit (Unit 3), the marking guidance, the examiners comments and the exemplar answers into one place for easy reference.

We have also included exemplar candidate answers with commentary for questions 2(a)(i), 2(a)(ii), 3(i). 3(ii), 3(iii), 4(a)(i) and 4(a)(i).

The marking guidance and the examiner's comments are taken from the Report to Centre for this question paper.

The Question Paper, Mark Scheme and the Report to Centre are available from:

https://interchange.ocr.org.uk/Modules/PastPapers/Pages/PastPapers.aspx?menuindex=97&menuid=250



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Level 3 Cambridge Technical in Engineering
05822/05823/05824/05825/05873
Unit 3: Principles of mechanical engineering
Monday 15 January 2018 – Afternoon
Time allowed: 1 hour 30 minutes

You must have:
- the formula booklet for Level 3 Cambridge Technical in Engineering (inserted)
- a ruler (cm/mm)
- a scientific calculator

First Name | Last Name
Centre Number | Candidate Number
Date of Birth D D M M Y Y Y Y

INSTRUCTIONS
- Use black ink. You may use an HB pencil for graphs and diagrams.
- Complete the boxes above with your name, centre number, candidate number and date of birth.
- Answer **all** the questions.
- Write your answer to each question in the space provided. If additional space is required, you should use the lined page(s) at the end of this booklet. The question number(s) must be clearly shown.
- The acceleration due to gravity is denoted by g m s^{-2}. Unless otherwise instructed, when a numerical value is needed, use g = 9.8.

INFORMATION
- The total mark for this paper is **60**.
- The marks for each question are shown in brackets **[ ]**.
- Where appropriate, your answers should be supported with working. Marks may be given for a correct method even if the answer is incorrect.
- An answer may receive no marks unless you show sufficient detail of the working to indicate that a correct method is being used.
- Final answers should be given to a degree of accuracy appropriate to the context.
- This document consists of **16** pages.

FOR EXAMINER USE ONLY	
Question No	Mark
1	/9
2	/11
3	/8
4	/9
5	/12
6	/11
Total	/60

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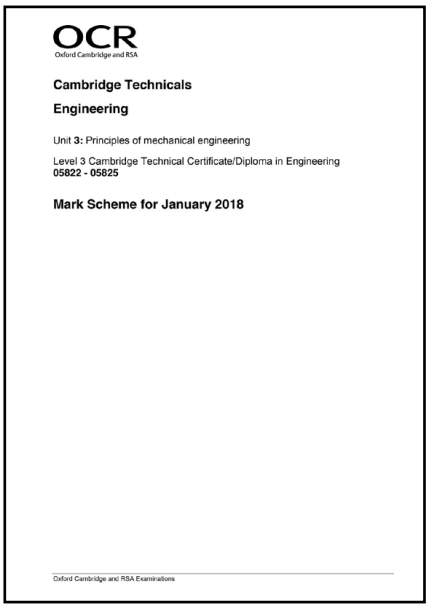

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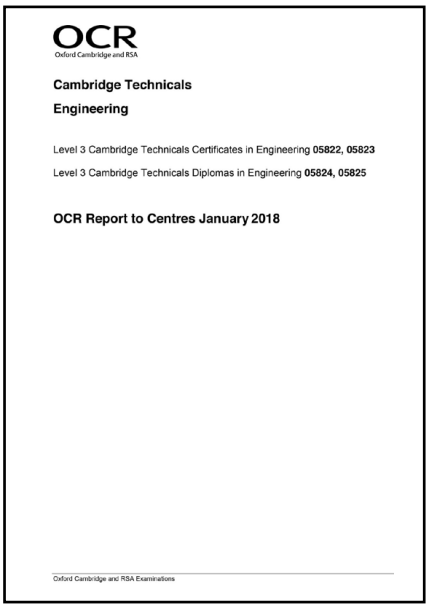
Cambridge Technicals
Engineering

Unit 3: Principles of mechanical engineering

Level 3 Cambridge Technical Certificate/Diploma in Engineering
05822 - 05825

Mark Scheme for January 2018

Oxford Cambridge and RSA Examinations



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Cambridge Technicals
Engineering

Level 3 Cambridge Technicals Certificates in Engineering **05822, 05823**

Level 3 Cambridge Technicals Diplomas in Engineering **05824, 05825**

OCR Report to Centres January 2018

Oxford Cambridge and RSA Examinations

GENERAL EXAMINER COMMENTS ON THE PAPER

As in previous series, most candidates show room for improvement in their presentation of answers to calculation questions. Such candidates would benefit from showing evidence of; the equation (or principle) used; rearranging; substituting; stating clearly their answer to an appropriate number of significant figures; including appropriate units. Many candidates are losing marks due to missing or incorrect units and powers of ten errors.

Some candidates' responses to questions 3, 4aii and 6a and 6b indicate they continue to struggle to apply the principle of moments successfully and that are unable to draw a bending moment diagram correctly. Most candidates were unable to apply the principle of conservation of momentum correctly.

Resources which might help address the examiner comments:

From the link below, you'll find 'The OCR guide to examinations' (along with many other skills guides)
http://www.ocr.org.uk/i-want-to/skills-guides/

Command verbs definitions
http://www.ocr.org.uk/Images/273311-command-verbs-definitions.pdf

Questions 1(i), (ii), (iii)

Answer **all** the questions.

1 A small box of mass 20 kg is being pulled along a rough horizontal surface by a rope inclined at an angle of 20° above the horizontal, as shown in Fig. 1. The tension in the rope is 150 N. The magnitude of the frictional force between the box and the surface is 30 N. The box is also subjected to a resistive force of 40 N opposing its motion.

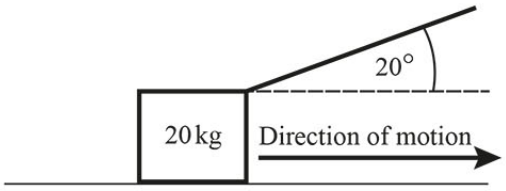
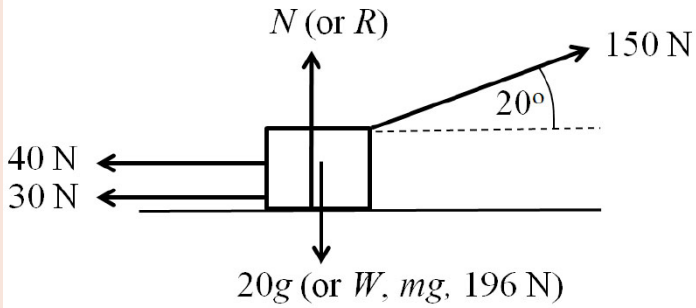


Fig. 1

(i) Show **all** forces acting on the box in the diagram below.



[2]

(ii) The tension force in the rope can be resolved into a horizontal component and a vertical component. Calculate the value of each of these components.

Horizontal: .....

Vertical: .....

Horizontal component = 150cos20 (= 140.95) (N)
Vertical component = 150sin20 (= 51.30) (N)

[2]

(iii) Calculate the magnitude of the normal reaction of the surface on the box.

.....

Vertical Equilibrium: N+51.303=20g
(N = 20×9.8-51.303 =) 144.69…(N)

[2]

Mark scheme guidance

Question 1(i):

Award 1 mark if 3/5 arrows correct.

Arrows must have arrowheads and connect to box Allow 30N and 40N put as one arrow with label of 70N.

Allow tension resolved into vertical and horizontal components (as in part ii)).

Allow any sensible labels used (e.g. normal reaction written instead of N, or friction instead of 30).

Question 1(ii):

Allow correct expressions shown in 1i.

If answers wrong way around award 1 mark.

Question 1(iii):

Award attempt at equilibrium e.g. N=20g

Accept answers rounding to 145N.

Allow ECF from part ii).

Examiner comments

Most candidates were able to show correctly some of the forces on a free body diagram and to find the horizontal and vertical components of a force. However, the majority were unable to add the forces in a particular direction correctly and this contributed to difficulties in applying Newton's 2nd Law. Many candidates failed to include correct units in their responses.

Question 1(iv)

(iv) Calculate the acceleration of the box.

Use of F = ma: 140.95-30-40 = 20a
a = 3.547..
ms^{-2}

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

Mark scheme guidance

Award this mark for attempt using incorrect force.

Accept answers in range 3.5-3.6.

Questions 2(a) and (b)

2 (a) Fig. 2 shows a diagram of a compound gear train consisting of four gears; A, B, C and D. Gears B and C rotate together on the same shaft.

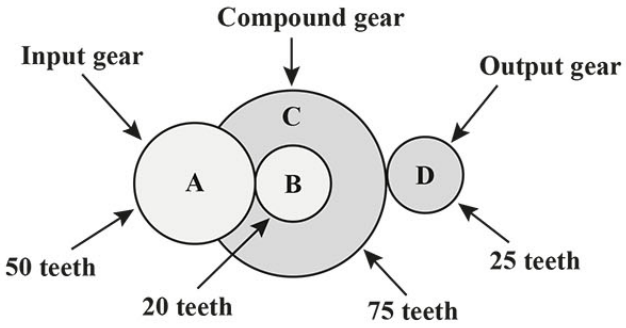


Fig. 2

(i) The input gear rotates at a speed of 120 rpm. Calculate the rotational speed of the output gear.

(Overall VR = $\frac{\text{product of drivers}}{\text{product of driven}}$) or VR = $\frac{50 \times 75}{20 \times 25}$ (= 7.5)

(Rotational speed of D =) 120 × 7.5

900 (rpm)

Or

For A to B: VR = 50/20 = 2.5 or Speed of B = 120 × 2.5 = 300

(Speed of C = 300rpm)

For C to D: VR = 75/25 = 3

Speed of D = 3 × 300 = 900 (rpm)

[3]

(ii) Gear A is now replaced with a new gear, E. Calculate the number of teeth required on gear E in order to achieve an overall Velocity Ratio (VR) of 9.

Use of Overall VR Formula $\frac{n \times 75}{20 \times 25} = 9$

N = 60

[2]

(b) Give one example of an application that uses a rack and pinion.

Any valid example e.g.:

- In a railway to allow trains to travel uphill
- In the steering mechanism of a car
- To open lock gates in canals
- In a stairlift (the rack runs up the stairs and the pinion is on the lift part).

[1]

Mark scheme guidance

Question 2(a)(i):

Correct method attempted.

Allow ECF for calculated VR.

For first velocity ratio.

For 2nd VR.

Question 2(a)(ii):

Allow alternative valid method.

Question 2(b):

Specific application must be clear do not allow one word answers such as car or train.

Examiner comments

Most candidates seemed to be familiar with simple gear calculations, but many struggled to deal with the compound gear in question 2a. Most candidates cited acceptable uses of "rack and pinion" in 2b.

Exemplar Candidate Work

Question 2(a)(i) – high level answer

2 (a) Fig. 2 shows a diagram of a compound gear train consisting of four gears; A, B, C and D. Gears B and C rotate together on the same shaft.

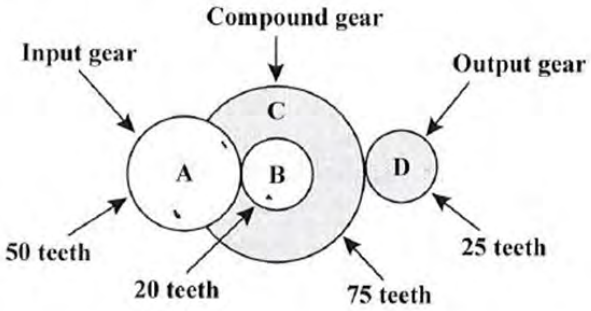


Fig. 2

(i) The input gear rotates at a speed of 120 rpm. Calculate the rotational speed of the output gear.

$\frac{50}{20} = 2.5 : 1 : 3$

$\frac{75}{25} = 3$

$1 : 0.4 : 1.2$

$120 \text{ RPM} \times 1.2 = 144 \text{ RPM}$. [3]

Commentary

This answer scores 1 compensation mark for correct calculation of the velocity ratio for gears A to B, and a second compensation mark for correct calculation of the velocity ratio for gears C to D.

To make this a full mark answer, the input speed (120 rpm) would need to be multiplied by the product of the two calculated velocity ratios (120 × 3 × 2.5) and the correct answer stated (900rpm).

Full credit is given in the mark scheme on this occasion if the unit is omitted but it is recommended that units are included.

Note also that although ratios are written down leading to correct values of velocity ratios, it is not entirely clear which velocity ratios are being calculated; "benefit of doubt" has been given by the examiner. It is recommended that wording such as "VR A to B" is used to avoid doubt.

Exemplar Candidate Work

Question 2(a)(ii) – high level answer

2 (a) Fig. 2 shows a diagram of a compound gear train consisting of four gears; A, B, C and D. Gears B and C rotate together on the same shaft.

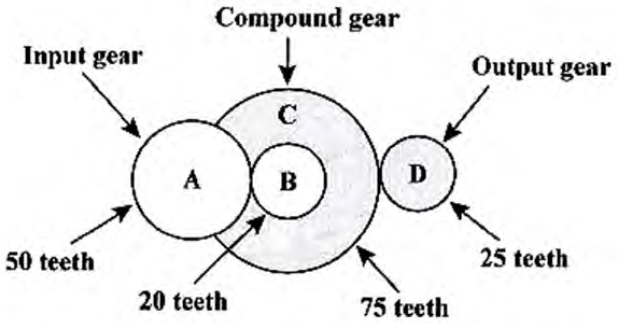


Fig. 2

(ii) Gear A is now replaced with a new gear, E. Calculate the number of teeth required on gear E in order to achieve an overall Velocity Ratio (VR) of 9.

$\frac{60 \times 75}{20 \times 25} = 9$

VR = 9

[2]

Commentary

The calculation given is correct and implies that the number of teeth required is 60. To make this a full mark answer, the number of teeth required should be stated clearly (e.g. N = 60 teeth).

Note that the answer presented could have been given "benefit of doubt" but candidates should be made aware that an accumulation of instances where there is some doubt is likely to result in some loss of marks. In this case the candidate has benefitted from "benefit of doubt" in part i. It is recommended that answers to questions are always clearly state with appropriate units (and not merely implied).

Questions 2(c), (d) and (e)

(c) Fig. 3 shows a diagram of a lever. The mass of the lever can be ignored.

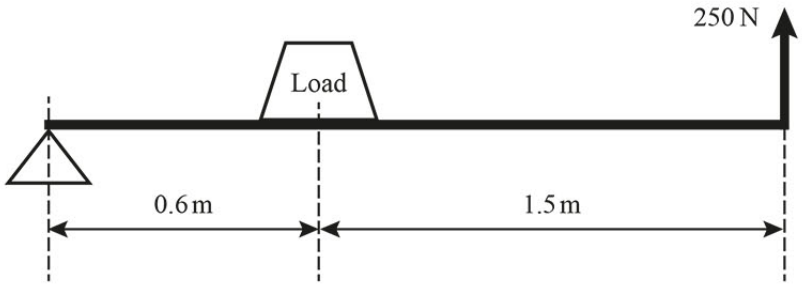


Fig. 3

(i) Name the class of lever shown in Fig. 3.

Class 2 .. **[1]**

(ii) An input force, F_I, of 250 N is applied to the lever. Calculate the maximum load that can be lifted using this force.

(250×2.1 = Load × 0.6)
= 875 (N) .. **[1]**

(iii) Calculate the Mechanical Advantage (MA).

(MA = F_o/F_i = 875/250 =) 3.5
Or (MA = a/b = 2.1/0.6 =) 3.5 .. **[1]**

(d) A belt and pulley system has a Velocity Ratio (VR) of 2.5. The diameter of the input pulley is 800 mm. Calculate the diameter of the output pulley.

800/2.5 = 320 (mm) .. **[1]**

(e) The input to another belt and pulley system is adjusted so that the Velocity Ratio doubles. State what effect this has on the Mechanical Advantage.

The MA halves. .. **[1]**

Mark scheme guidance

Question 2(c)(ii):

Accept 89kg (or 89.3kg).

Question 2(c)(iii):

Allow ECF from c)ii).

Question 2(d):

Accept answers of 0.32 (candidate converted units to m).

Examiner comments

Most candidates scored well on question 2c which demonstrated an ability to deal with the very simplest moment questions and ideas of velocity ratio and mechanical advantage, although a significant number of candidates thought that the class of lever shown was "class 3".

Question 3

3 Fig. 4 shows a uniform rectangular plate with length 10 m and width 5 m. The plate is subjected to three forces of 20 N, 90 N and 40 N.

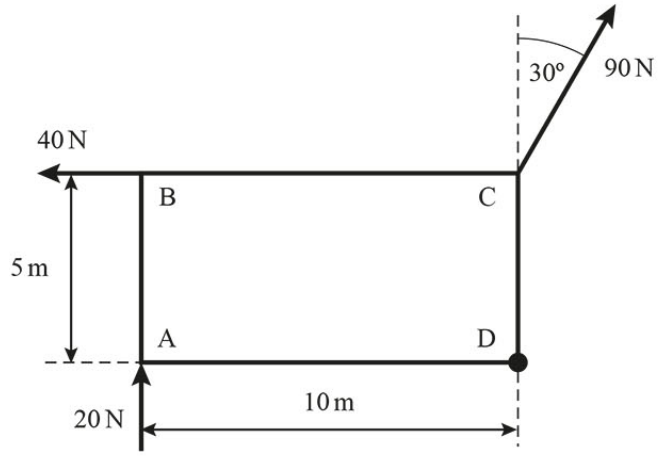


Fig. 4

(i) Calculate the moment exerted by the forces about corner D.

90sin30×5 + 20×10 – 40×5
= 225 (clockwise)
Nm

[3]

(ii) Calculate the magnitude of the resultant force acting on the plate.

Resultant vertical force = 90cos30 + 20 (= 97.942…(N))
Resultant horizontal force = 90sin30 – 40 (= 5 (N))

Magnitude = $\sqrt{97.942^2 + 5^2} = 98.1$ (N)

[3]

(iii) An additional horizontal force is now applied to corner C. Calculate the magnitude and direction of this force that will cause the total moment about corner D to become zero.

$F_C \times 5 = 225$ / $F_C = 45$ (N)
Horizontal force applied at corner C towards corner B

[2]

Mark scheme guidance

Question 3(i):

award C1 if 2 components correct.

Allow answers of -225Nm (this is given answer if anti-clockwise take as positive).

Question 3(ii):

Allow ECF from component Force values.

Question 3(iii):

Allow ECF from part i).

Accept "left". Accept arrow pointing left.

Examiner comments

Most candidates struggled with this question about a plate in equilibrium. Most were unable to "take moments" correctly about appropriate points when several forces were involved, although some credit was given for attempts with missing terms or incorrect directions.

Most candidates were able to calculate the resultant force by adding the vertical and horizontal components.

Exemplar Candidate Work

Question 3(i) – high level answer

3 Fig. 4 shows a uniform rectangular plate with length 10 m and width 5 m. The plate is subjected to three forces of 20 N, 90 N and 40 N.

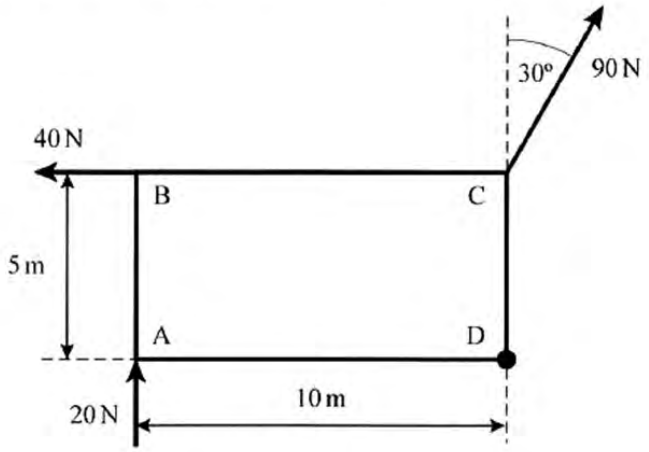


Fig. 4

(i) Calculate the moment exerted by the forces about corner D.

20 × 10 = 200

40 × 5√5 = 447.21

2.5 × 90 = 225 [3]

Commentary

A correct answer of 225 scores 2 marks. There is a separate mark for the correct unit and this is not scored by this response.

Note that it is not clear that the answer of "225" written by the candidate in this case is supported by correct working.

To be a full mark high level answer, the following presentation is recommended:

Moment about D = 90sin30 × 5 + 20 × 10 – 40 × 5 = 225Nm (clockwise).

Exemplar Candidate Work

Question 3(ii) – high level answer

3 Fig. 4 shows a uniform rectangular plate with length 10 m and width 5 m. The plate is subjected to three forces of 20 N, 90 N and 40 N.

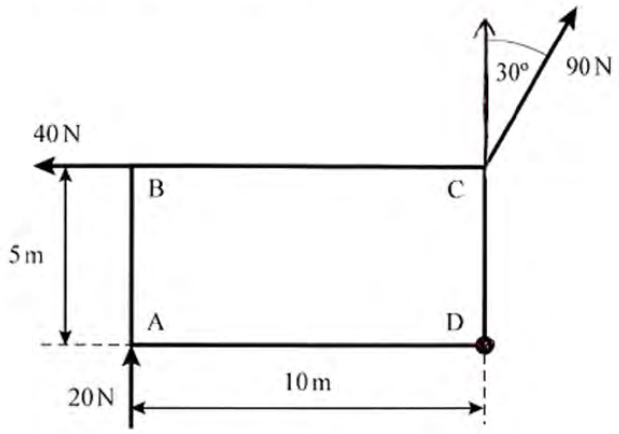
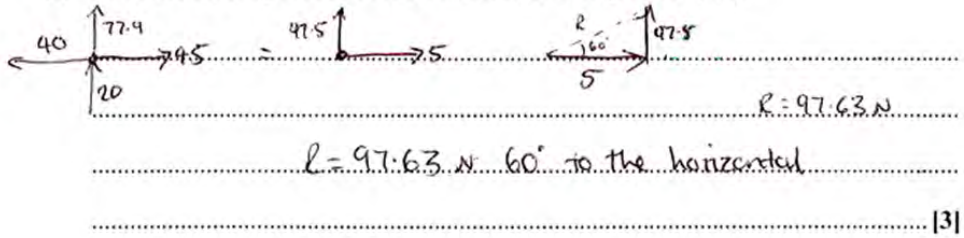


Fig. 4

(ii) Calculate the magnitude of the resultant force acting on the plate.



[3]

Commentary

This response uses the correct method to calculate the magnitude of the resultant of 2 perpendicular forces. The correct horizontal component is (5N) is used but the vertical component has not been calculated correctly. However, the 2 values calculated (5N and 97.63N) have been followed through correctly.

To make this a full mark high level answer, the vertical component would need to be calculated correctly (F_V = 90cos30+20 = 97.9(42) N) and used correctly with the horizontal component to calculate the magnitude of the resultant force.

Strictly, the calculated answer should be given to no more than 2 significant figures as the data given in the question is to 1sf or 2sf. Best practice is to show the answer with more significant figures in the working and then to state the final answer to the appropriate number of significant figures (suggest 1 more SF than the SF in the data used).

Exemplar Candidate Work

Question 3(iii) – high level answer

3 Fig. 4 shows a uniform rectangular plate with length 10 m and width 5 m. The plate is subjected to three forces of 20 N, 90 N and 40 N.

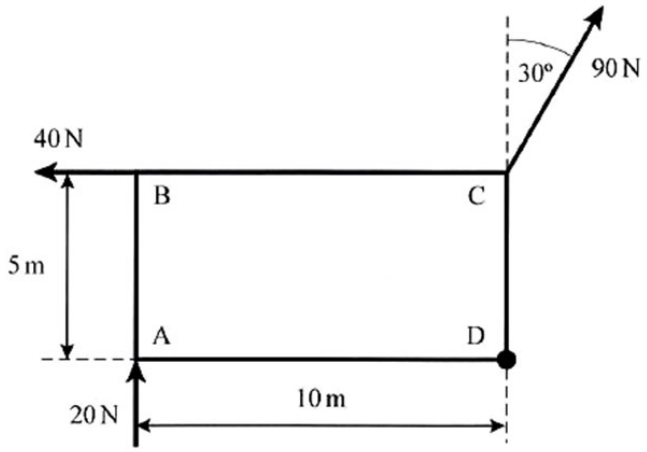


Fig. 4

(iii) An additional horizontal force is now applied to corner C. Calculate the magnitude and direction of this force that will cause the total moment about corner D to become zero.

$(20 \times 10) + (90 \sin(30) \times 5) = (40 \times 5) + (5 \times x)$

$x = 45$ N [2]

Commentary

The correct numerical answer of 45N is clearly stated and this is supported by appropriate working. However, the question asks for the "direction" as well as the "magnitude" so this response scores just one mark.

To make this a full mark high level answer, the direction of the force must be clearly stated – for example "Horizontal force at C towards B".

Note also that the supporting calculations can be simplified by using the answer to 3ai ($F_C \times 5 = 225$ so $F_C = 45$N)

Question 4(a)(i)

4 (a) Fig. 5 shows a plate of uniform density aligned within a Cartesian coordinate system, (x, y), with the origin at corner O. The plate has the shape of a rectangle, 120 mm wide and 180 mm long and contains a circular hole. The hole has a diameter of 40 mm with its centre at coordinates (90, 150).

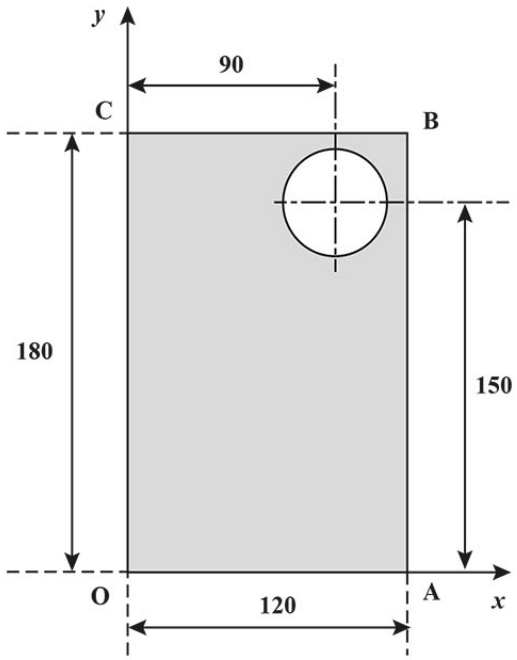


Fig. 5

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

Use of second moment of area method, may be seen in vector format, table format or other.

Shape	Area	x_i	y_i	$a_i x_i$	$a_i y_i$
1	21600	60	90	1296000	1944000
2	-400π	90	150	-113097	-188496
	20343.36			1182903	1755504

$\bar{x} = \dfrac{1182903}{20343.36} = 58.14...$ (mm)

$\bar{y} = \dfrac{1755504}{20343.36} = 86.29...$ (mm)

..... **[5]**

Mark scheme guidance

Area and co-ordinates of centroid found for first shape (numbers 21600, 60, 90). Award if 2/3 correct.

Area and co-ordinates of centroid found for second shape (numbers -400π, 90, 150). Award if 2/3 correct.

The sum of their $a_i x_i$ (or $a_i y_i$) found and divided by their total area.

(Using $\bar{x} = \dfrac{\Sigma a_i x_i}{\text{total area}}$ oe for $\bar{y}$)

Correct answers for $\bar{x}$ and $\bar{y}$ rounding to 58 and 86 respectively to 2 s.f.

Examiner comments

In 4a, most candidates demonstrated an ability to calculate the coordinates of the centroid of a plate. Many candidates and Centres use a tabular approach to show workings for the individual parts that the plate is broken down into and this is good practice. The best candidates also included summary equations before clearly stating the coordinates.

Exemplar Candidate Work

Question 4(a)(i) – high level answer

4 (a) Fig. 5 shows a plate of uniform density aligned within a Cartesian coordinate system, (x, y), with the origin at corner O. The plate has the shape of a rectangle, 120 mm wide and 180 mm long and contains a circular hole. The hole has a diameter of 40 mm with its centre at coordinates (90, 150).

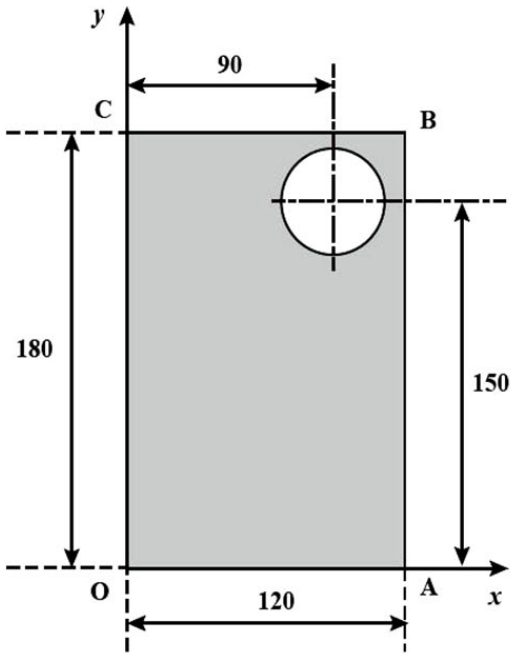


Fig. 5

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

Shape	Area	$\bar{x}_i$	$\bar{y}_i$	$A \times \bar{x}$	$A \times \bar{y}$
1	12566 mm²	90	180	1130976	1884960
2	20343.36	60	90	1220601.6	1830902.4
+	21600			+ 1333699.2	+ 2019398.4

$\bar{x}_i = \frac{1333699.2}{21600}$ $\bar{y}_i = \frac{2019398.4}{21600}$

$= 61.7$ $= 93.5$

[5]

Commentary

This answer scores the first two compensation marks for using the correct area and centroids for each of the 2 shapes. Note however that the minus sign for the area of the circle is omitted in this response which is incorrect.

Although the 3rd compensation mark has also been awarded with ECF, this is probably too generous; to score this mark, the sum of the $a_i x_i$ (or $a_i y_i$) should be attempted.

The answers given for $\bar{x}$ and $\bar{y}$ are incorrect so the 4th and 5th marks are not awarded.

To make this a full mark high level answer the following is required:

- Correct areas and coordinates of centroids found for each of the 2 shapes.
- The correct sums $a_i x_i$ and $a_i y_i$ found and divided by the correct total area (found by subtracting the area of the circle from the area of the rectangle).
- Correct answers for $\bar{x}$ and $\bar{y}$ clearly stated with units.

Question 4(a)(ii) and (b)

(ii) The plate has a weight of 80 N and is suspended from corner C. By considering moments about corner C calculate the vertical force required at corner A so that side OA remains horizontal.

Calculating moment of weight of plate about C
80×58.1= 4648 (Nmm)
Force = 4648/120 = 38.7 (N)

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

(b) A steel beam of length 1.8 m undergoes an axial strain of 0.2 %. Calculate the change in length of the beam.

Use of formula change in length = strain x original length
=0.002 × 1.8
Change in length = 0.0036 (m)

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

Mark scheme guidance

Question 4(a)(ii):

Allow ECF from part i).

Question 4(b):

Allow strain = 0.02

Examiner comments

4b provided further evidence of difficulties in applying principle of moments to a plate in equilibrium.

Most candidates were able to use the length and strain of a steel bar to find the change in length although there were very many 'power of ten' (POT) errors.

Exemplar Candidate Work

Question 4(a)(ii) – high level answer

4 (a) Fig. 5 shows a plate of uniform density aligned within a Cartesian coordinate system, (x, y), with the origin at corner O. The plate has the shape of a rectangle, 120 mm wide and 180 mm long and contains a circular hole. The hole has a diameter of 40 mm with its centre at coordinates (90, 150).

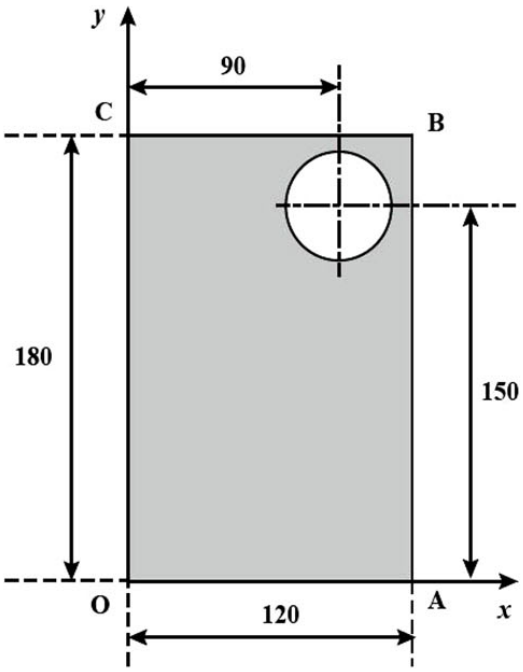


Fig. 5

(ii) The plate has a weight of 80 N and is suspended from corner C. By considering moments about corner C calculate the vertical force required at corner A so that side OA remains horizontal.

(86-3 x 80) = 86-3 x 80 = 6904

86·3 x 80 = 120A

6904 = 120A

A = 57·5N [2]

Commentary

1 mark has been awarded here for using the correct method but with an incorrect value of the horizontal distance of corner C from the centroid.

To make this a full mark high level answer, the correct value of the distance from C to the centroid (58.1mm) or the candidates calculated value (in this case 61.7mm) should be used.

The recommended presentation is:

Taking moments about point C, $80 \times 58.1 = F \times 120$, $F = 38.7N$

Questions 5(a) and (b)

5 (a) A steel pile is in the shape of a cylinder with a diameter of 0.14 m and a height of 0.8 m. The mass of the pile is 105 kg. Calculate the density of the steel.

Vol = $\pi r^2 h = \pi \times 0.07^2 \times 0.8$ (= 0.012315)
Density = mass/volume = 105/0.012315 = 8526 kg/m^3

..... [3]

(b) A different pile of mass 100 kg is dropped from rest and has a speed of 7.5 m s^{-1} when it makes contact with the ground.

(i) Calculate the distance fallen by the pile before it reaches the ground. (You may assume that the pile falls under the influence of gravity, with no other forces affecting its motion.)

Use of SUVAT with u = 0, a = 9.8, v = 7.5 and equation $v^2 = u^2 + 2as$
$7.5^2 = 0 + 2 \times 9.8s$
s = 2.869…(m)
or
use of result $v = \sqrt{2gh}$ and rearranging to get h=2.869…(m)

[2]

(ii) Calculate the kinetic energy of the pile when it reaches the ground.

(Kinetic Energy = $\frac{1}{2}mv^2 = \frac{1}{2} \times 100 \times 7.5^2$ =) 2812.5 (J)

[1]

(iii) After initially reaching the ground the pile sinks to a depth of 0.3 m before coming to a complete rest. Calculate the loss in gravitational potential energy between the time it initially reaches the ground to the time it comes to a complete rest.

(Potential Energy = $mgh = 100 \times 9.8 \times 0.3$ =) 294 (J)

..... [1]

(iv) Using an energy method, calculate the work done by the resistive force in bringing the pile to rest. Hence calculate the value of this resistive force.

Work done = (change in energy = 2812.5+294 =) 3106.5 (J)
(Force = work/distance = 3106.5/0.3 =) 10355 (N)

..... [2]

Mark scheme guidance

Question 5(a):

Allow ECF of their value of volume.

Question 5(b)(i):

Allow one error (e.g. a=-9.8).

Question 5(b)(iv):

Allow ECF of their value of work done.

Examiner comments

In 5a, most candidates were able to calculate correctly the density of the cylinder although once again there were many POT errors. There were also many instances where candidates did not include correct units.

In 5b most candidates were able to apply simple suvat equations and to calculate Kinetic energy, potential energy and work done. Many candidates failed to include correct units in their responses.

Question 5(c)

(c) Fig. 6 shows an aluminium plate in the shape of a rectangle aligned within a Cartesian coordinate system, (x, y), with the origin at the corner marked O. The plate is 30 mm long and 25 mm wide and near each corner is a hole with diameter 4 mm.

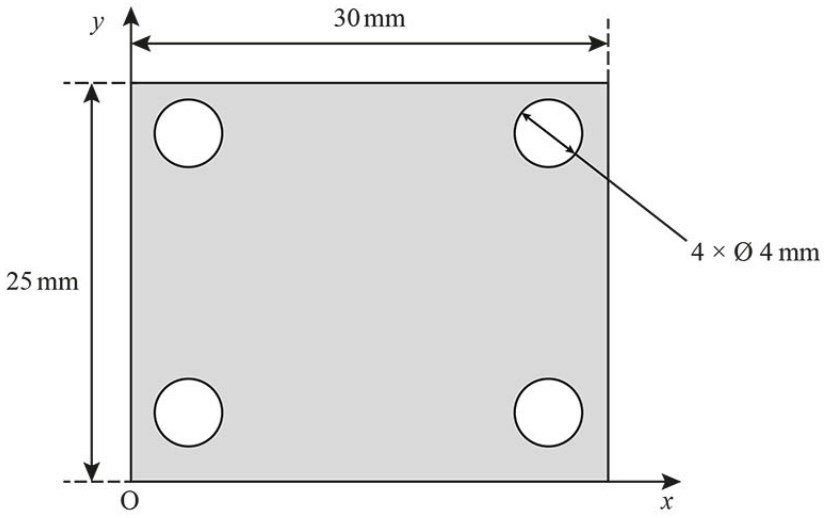


Fig. 6

(i) Calculate the area of the aluminium in the plate. You should give your final answer in units of mm^2.

Area = $30 \times 25 - 4\pi \times 2^2$
= 699.7… (mm^2)

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

(ii) A fifth hole, also of diameter 4 mm, is to be made in the plate. State the coordinates of the centre of this new hole so that the centroid of the plate remains unchanged.

(15, 12.5)

[1]

Mark scheme guidance

Question 5(c)(i):

Allow 1 error (e.g. using given diameter of 4 instead of radius or forgetting to multiply area of circle by 4).

Question 5(c)(ii):

Accept centroid of plate.

Examiner comments

Most candidates were able to calculate correctly the area of a plate although there were some careless errors – for example forgetting to multiply the area of 1 hole by the number of holes. Almost all candidates realised that adding a 5th hole at the centroid does not change the position of the centroid.

Questions 6(a) and (b)(i), (ii)

6 (a) Name the type of beam which has a fixed support at each end.

Encastre [1]

(b) Fig. 7 shows a cantilever beam of length 10 m fixed to a wall. The beam is subjected to point loads of 500 N, 600 N and 200 N. The mass of the beam can be ignored.

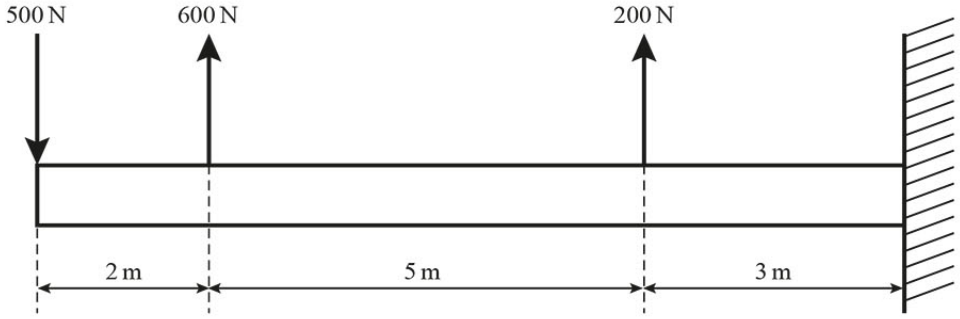


Fig. 7

(i) Calculate the vertical reaction force at the wall.

300 (N) (downwards) [1]

(ii) Calculate the value of the bending moment at the wall.

Attempt to calculate moment = 200×3 + 600×8 – 500×10
= 400 (Nm) [2]

Mark scheme guidance

Question 6(a):

Allow reasonable spelling errors.

Question 6(b)(ii):

Allow max 2 errors in sign or distance.

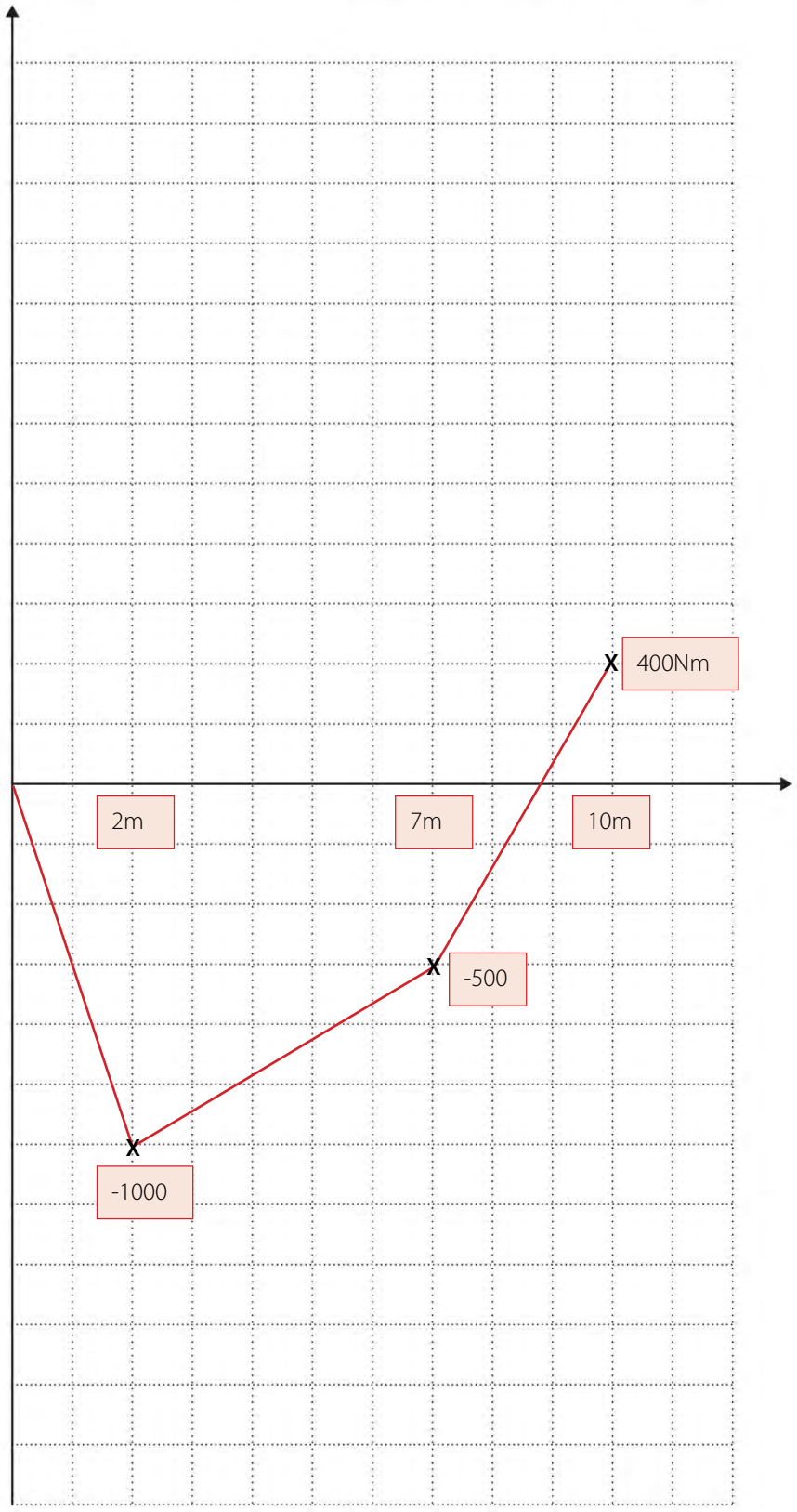
Allow -400

Examiner comments

Very few candidates were able to recall the correct name for the type of beam shown. A significant minority were unable to calculate either the vertical reaction force or the bending moment at the wall.

Question 6(b)(iii)

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



[4]

Mark scheme guidance

0 moment at free end (0m along beam from LHS) AND non-zero value at wall end AND no curves.

Calculation of moment at 2m (-500×2 = -1000) ignoring signs. This can be stated or shown on diagram.

Calculation of moment at 7m (-500×7 + 600×5 = -500) ignoring signs. This can be stated or shown on diagram.

Diagram as shown. Allow opposite sign convention so that diagram is reflected about x-axis.

Allow values marked on axes or at critical values.

Examiner comments

Most candidates struggled (as in previous sessions) to draw a labelled bending moment diagram correctly. This was compounded in a minority of cases by the absence of clear labelling of axes.

Question 6(c)

(c) Two particles of mass 3 kg and 5 kg are travelling towards each other and collide. Before the collision the speed of the 3 kg particle is 2.4 m s^{-1} and the speed of the 5 kg particle is 1.8 m s^{-1}. After the collision the 3 kg particle has a speed of 0.5 m s^{-1} in the **opposite** direction to its initial motion. Calculate the speed and direction of the 5 kg particle after the collision. (You may assume momentum is conserved during the collision.)

Attempt at conservation of momentum:
$3\times2.4 - 5\times1.8 = -3\times0.5 + 5v$
$(-1.8 = -1.5 + 5v)$
$v = 0.06$ (ms^{-1}) in same direction as initial velocity (may be shown as arrow).

..... [3]

Mark scheme guidance

Allow max 2 errors in sign or terms.

Award this mark for a single sign error followed through correctly.

No ECF.

Examiner comments

Most candidates were unable to apply the principle of conservation of momentum correctly.

The small print

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