Cambridge Technicals Engineering

Unit 3: Principles of mechanical engineering

Level 3 Cambridge Technical Certificate/Diploma in Engineering
05822 - 05825 & 05873

Mark Scheme for January 2024

OCR (Oxford Cambridge and RSA) is a leading UK awarding body, providing a wide range of qualifications to meet the needs of candidates of all ages and abilities. OCR qualifications include AS/A Levels, Diplomas, GCSEs, Cambridge Nationals, Cambridge Technicals, Functional Skills, Key Skills, Entry Level qualifications, NVQs and vocational qualifications in areas such as IT, business, languages, teaching/training, administration and secretarial skills.

It is also responsible for developing new specifications to meet national requirements and the needs of students and teachers. OCR is a not-for-profit organisation; any surplus made is invested back into the establishment to help towards the development of qualifications and support, which keep pace with the changing needs of today's society.

This mark scheme is published as an aid to teachers and students, to indicate the requirements of the examination. It shows the basis on which marks were awarded by examiners. It does not indicate the details of the discussions which took place at an examiners' meeting before marking commenced.

All examiners are instructed that alternative correct answers and unexpected approaches in candidates' scripts must be given marks that fairly reflect the relevant knowledge and skills demonstrated.

Mark schemes should be read in conjunction with the published question papers and the report on the examination.

© OCR 2024

MARKING INSTRUCTIONS

PREPARATION FOR MARKING

RM ASSESSOR

1. Make sure that you have accessed and completed the relevant training packages for on-screen marking: *RM Assessor Online Training*; *OCR Essential Guide to Marking*.

2. Make sure that you have read and understood the mark scheme and the question paper for this unit. These are posted on the RM Cambridge Assessment Support Portal http://www.rm.com/support/ca

3. Log-in to RM Assessor and mark the **required number** of practice responses ("scripts") and the **number of required** standardisation responses.

YOU MUST MARK 5 PRACTICE AND 10 STANDARDISATION RESPONSES BEFORE YOU CAN BE APPROVED TO MARK LIVE SCRIPTS.

MARKING

1. Mark strictly to the mark scheme.

2. Marks awarded must relate directly to the marking criteria.

3. The schedule of dates is very important. It is essential that you meet the 40% Batch 1 and 100% Batch 2 deadlines. If you experience problems, you must contact your Team Leader (Supervisor) without delay.

4. If you are in any doubt about applying the mark scheme, consult your Team Leader by RM message, telephone or by email.

5. **Crossed Out Responses**
   Where a candidate has crossed out a response and provided a clear alternative then the crossed out response is not marked. Where no alternative response has been provided, examiners may give candidates the benefit of the doubt and mark the crossed out response where legible.

Rubric Error Responses – Optional Questions
Where candidates have a choice of questions across a whole paper or a whole section and have provided more answers than required, then all responses are marked and the highest mark allowable within the rubric is given. (The underlying assumption is that the candidate has penalised themselves by attempting more questions than necessary in the time allowed.)

Multiple Choice Question Responses
When a multiple choice question has only a single, correct response and a candidate provides two responses (even if one of these responses is correct), then no mark should be awarded (as it is not possible to determine which was the first response selected by the candidate). When a question requires candidates to select more than one option/multiple options, then local marking arrangements need to ensure consistency of approach.

Contradictory Responses
When a candidate provides contradictory responses, then no mark should be awarded, even if one of the answers is correct.
Short Answer Questions (requiring only a list by way of a response, usually worth only **one mark per response**)
Where candidates are required to provide a set number of short answer responses then only the set number of responses should be marked. The response space should be marked from left to right on each line and then line by line until the required number of responses have been considered. The remaining responses should not then be marked. Examiners will have to apply judgement as to whether a 'second response' on a line is a development of the 'first response', rather than a separate, discrete response. (The underlying assumption is that the candidate is attempting to hedge their bets and therefore getting undue benefit rather than engaging with the question and giving the most relevant/correct responses.)

Short Answer Questions (requiring a more developed response, worth **two or more marks**)
If the candidates are required to provide a description of, say, three items or factors and four items or factors are provided, then mark on a similar basis – that is downwards (as it is unlikely in this situation that a candidate will provide more than one response in each section of the response space.)

Longer Answer Questions (requiring a developed response)
Where candidates have provided two (or more) responses to a medium or high tariff question which only required a single (developed) response and not crossed out the first response, then only the first response should be marked. Examiners will need to apply professional judgement as to whether the second (or a subsequent) response is a 'new start' or simply a poorly expressed continuation of the first response.

6.   Always check the pages (and additional lined pages if present) at the end of the response in case any answers have been continued there. If the candidate has continued an answer there then add an annotation to confirm that the work has been seen.

7. There is a NR (No Response) option. Award NR (No Response)
    -   if there is nothing written at all in the answer space
    -   OR if there is a comment which does not in anyway relate to the question (e.g. 'can't do', 'don't know')
    -   OR if there is a mark (e.g. a dash, a question mark) which isn't an attempt at the question
    Note: Award 0 marks - for an attempt that earns no credit (including copying out the question)

8. The RM Assessor **comments box** is used by your team leader to explain the marking of the practice responses.
    Please refer to these comments when checking your practice responses. **Do not use the comments box for any other reason.**
    If you have any questions or comments for your team leader, use the phone, the RM Assessor messaging system, or e-mail.

9. Assistant Examiners will email a brief report on the performance of candidates to your Team Leader (Supervisor) by the end of the marking period. Your report should contain notes on particular strength displayed as well as common errors or weaknesses. Constructive criticism of the question paper/mark scheme is also appreciated.

10. **Annotations**

Annotation	Meaning
✔	Correct response worthy of a mark. Number of ticks = number of marks awarded.
✘	Incorrect response
∧	Incomplete response
ECF	Error carried forward
BOD	Benefit of doubt
NBOD	No benefit of doubt
POT	Power of ten error
RE	Rounding error
SF	Significant figure error

If the data given in a question is to 2 sf, then allow to 2 or <u>more</u> significant figures. If an answer is given to fewer than 2 sf, then penalise once only in the <u>entire</u> paper.
Penalise a rounding error in the <u>second significant figure</u> once only in the paper.

11. **Subject-specific marking instructions**

    B marks: These are awarded as <u>independent</u> marks, which do not depend on other marks. For a **B**-mark to be scored, the point to which it refers must be seen specifically in the candidate's answers.
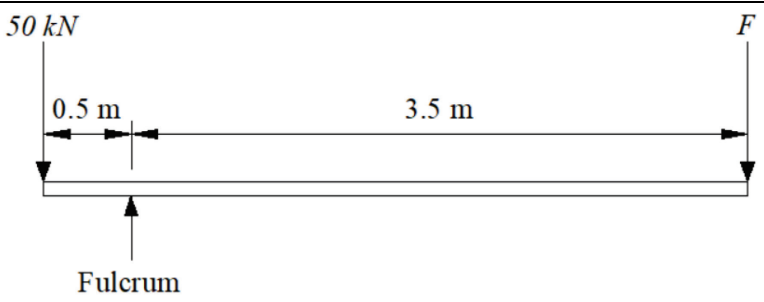
    M marks: These are <u>method</u> marks upon which **A**-marks (accuracy/answer marks) later depend. For an **M**-mark to be scored, the point to which it refers must be seen in the candidate's answers. If a candidate fails to score a particular **M**-mark, then none of the dependent **A**-marks can be scored.
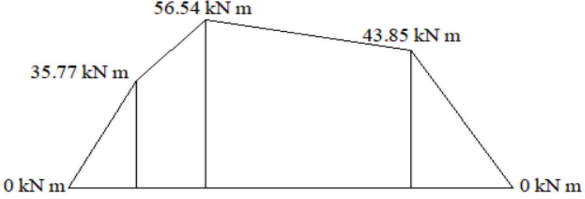
    C marks: These are <u>compensatory</u> method marks which can be scored even if the points to which they refer are not written down by the candidate, providing subsequent working gives evidence that they must have known it. For example, if an equation carries a **C**-mark and the candidate does not write down the actual equation but does correct working which shows the candidate knew the equation, then the **C**-mark is given.

    A marks: These are accuracy or <u>answer</u> marks, which either depend on an **M**-mark, or allow a **C**-mark to be scored.

Question			Answer	Marks	Guidance
1	(a)	(i)	$(60 \times 90)-(48 \times 84) = 1368$	C1	Area calculation
			$1368 \times 2500 = 3400000$ (3420000) (mm^3) or 0.0034 $(0.00342\ m^3$ or in part iii)	A1	Correct volume ACCEPT answer in m^3 or mm^3 (or any correct unit of volume) Assume units of $kg\ m^{-3}$ or $kg\ mm^{-3}$ to be m^3 or mm^3
				[2]	
1	(a)	(ii)			Allow ecf from 1ai throughout.
			$9.268 / 3420000 =$	C1	Synoptic mark from Unit 2 LO 2.2 Or
			$2.7099 \times 10^{-6}\ (kg\ mm^{-3})\ 2709.9kg\ m^{-3}$	A1	the equivalent in $kg\ m^{-3}$
				[2]	
1	(a)	(iii)			Allow ecf from 1ai throughout.
			$3420000\ mm^3 = 0.00342\ m^3$	C1	Convert mm^3 to m^3 (could be shown in part ai) Allow ecf for their volume from (i)
			$7860 \times 0.00342 = 26.881\ kg$	C1	Mass calculation(s)
			$26.881-9.268 = 17.6kg$	A1	
				[3]	

Question			Answer	Marks	Guidance
1	**(b)**		$(90\text{x}20)+\dfrac{(45\text{x}30)}{2}+\dfrac{(30\text{x}30)}{2} = 2925\text{mm}^2$	C1	Calculation of area
			$\bar{y} = \dfrac{\sum A_i y_i}{\sum A_i}$		
			$\bar{x} = \dfrac{(1800\text{x}45)+(675\text{x}15)+(450\text{x}80)}{2925}$	C1	Appropriate calculation of $\bar{x}$. If 3 areas used, multiply two defined areas by the correct centroids. If 5 areas used, multiply four defined areas by the correct centroids
			$= 43.46\text{mm}$	A1	Synoptic mark from Unit 1 LO 6.3
			$\bar{y} = \dfrac{(1800\text{x}10)+(675\text{x}30)+(450\text{x}30)}{2925}$	C1	Appropriate calculation of $\bar{y}$. If 3 areas used, multiply two defined areas by the correct centroids. If 5 areas used, multiply four defined areas by the correct centroids
			$= 17.69\text{mm}$	A1	
				[5]	

Question			Answer	Marks	Guidance
2	(a)	(i)	A: Flat	B1	
			B: V	B1	
			C: Toothed	B1	Allow tooth
				[3]	
2	(a)	(ii)	(100/200) x (100/D) = 0.2	C1	Substitution
			100/D = 0.2/0.5	C1	Re-arrangement
			D = 250mm	A1	Award 1 mark in total for (100/D = 0.2) D=500mm
				[3]	
2	(b)	(i)		B1	1 mark for 50 (kN) (or load) and 0.5 m.
				B1	1 mark for F and 3.5 m
					The diagram can be the other way round. **Directions must be correct.**
					Fulcrum need not be labelled and can be represented by a triangle as shown in the formula book
					Diagram does not need to be to scale.
				[2]	
2	(b)	(ii)	3.5xF = 0.5x50	C1	Substitution. Allow the use of incorrect distance if shown on diagram.
			F= 7.143 (kN) or 7143 (N)	A1	
				[2]	

	Question		Answer	Marks	Guidance
3	(a)		3x3 (= 9kN)	B1	
			(9kN) located at 2.5 m (from support)	B1	
				[2]	
3	(b)	(i)	50sin30	C1	Vertical component of 50 kN
			= 25(kN)	A1	Synoptic mark from Unit 1 LO4.3
				[2]	
3	(b)	(ii)			Allow ecf from 3bi throughout.
			$6.5R_B = (1 \times 15)+(2 \times 25)+(5 \times 25)$	C1	Correct substitution into RHS of equation
			$6.5R_B = 190$	C1	Re-arrangement
			$R_B = 29.23$ kN	A1	Accept 29.2 kN
			$R_A = 65-29.23 = 35.77$ kN	A1	Accept 35.8 kN
				[4]	
3	(b)	(iii)	BM @ 15 kN = 1x35.77 – 35.77kN m	C1	Allow ecf from 3bii throughout
			BM @ 50 kN = (2x35.77)-(15x1) = 56.54 kN m	C1	
			BM @ 25 kN = (5x35.77)-(4x15)-(3x25) = 43.85 kN m	C1	
				A1 A1	Award one mark for correctly labelled values, not including 0 kN m Award one mark for correctly labelled units (Synoptic assessment knowledge applied from Unit 2 LO1.1)
				[5]	

Question			Answer	Marks	Guidance
4		(i)	Allowable working stress = 400/2.5	C1	
			=160 (MPa) or 160000000 (Pa)	A1	
				[2]	
4		(ii)	400 MPa = 400000 kN m^{-2} or 400MPa = 400000000 N m^{-2}	C1	Evidence of conversion of stress and force to the same units
			400000 = 12000/area or 400000000 = 12000000/area	C1	Penalise POT errors only once in this question.
			Area = 0.03 or 30000	A1	Synoptic mark from Unit 2 LO 1.1
			m^2 or mm^2	A1	Unit mark – award for unit consistent with answer.
				[4]	

	Question		Answer	Marks	Guidance
5	(a)	(i)	$s = ut + \frac{1}{2}at^2$		
			$15 = \frac{1}{2}\,9.8t^2$	C1	Use of s = (ut + at^2)/2
			$t^2 = (15\times2)/9.8$	C1	Rearrangement
			$t = 1.7496$ secs (2dp)	A1	Accept 1.75
			$s = \frac{1}{2}\,(u+v)t = \frac{1}{2} \times (200+200) \times 1.7496$	C1	Use of $s = \frac{1}{2}\,(u+v)t$ with $u = v = 200$ OR s = vt allow with their t
			$s = 349.92$ m	A1	Accept 350m
				[5]	
5	(a)	(ii)	$(5.4 \times 200) = (100v)$	C1	Equate momentum
			Speed of cannon (v) = 1080/100 = 10.8 m s^{-1} (2dp)	A1	
				[2]	
5	(b)		Loss of PE = (4.5 – 2)g × 0.5 (12.25J)	C1	Loss in PE
			Gain in KE = (4.5+2)v^2/2 (3.25 v^2)	C1	Gain in KE
			(4.5 – 2)g × 0.5 = 4.5+2)v^2/2	C1	Equate energy
			$v^2 = (4.5 – 2)g / (4.5 +2) = 2.5g/6.5$	C1	Make v^2 subject Synoptic mark from Unit 1 LO 1.4
			$v^2 = 3.769.. v = 1.94$ m s^{-1}	A1	Calculate with g = 9.8
				[5]	

Question			Answer	Marks	Guidance
6		(i)	Magnitude in x direction = 25-22sin35 = 12.38 N	C1	
			Magnitude in y direction = -15-22cos35 = -33.02 N	C1	
					Synoptic mark from Unit 1 LO 4.3
			Resultant = $\sqrt{(12.38^2+33.02^2)}$ = 35 (35.3) N	A1	
			tan-1(33.02/12.38) or tan−1(*their x/ their y*)	C1	Award C1 if trig expression is inverted
			(or alternative correct trig expression)		
			= 69.45° clockwise from the horizontal	A1	
			(or 159.45° clockwise from the vertical)		
				[5]	
6		(ii)	BM @A = (0.085x15)+(0.040x22sin35)	C1	
			= 1.78 (N m) Clockwise (3dp)	A1	Accept 1780 (N mm) but requires direction
				[2]	

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

Twitter/ocrexams

/ocrexams

/company/ocr

/ocrexams