

# **Cambridge Technicals**

## **Engineering**

### **Unit 1: Mathematics for engineering**

Level 3 Cambridge Technical in Engineering

**05822 - 05825 & 05873**

### **Mark Scheme for January 2025**

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.

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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.

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

***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 RM Assessor 50% and 100% (traditional 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 telephone, email or via the RM Assessor messaging system.

## 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 question 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. Enter a mark for each question answered into RM Assessor, which will select the highest mark from those awarded. *(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 objects 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 the annotation 'SEEN' to confirm that the work has been seen and mark any responses using the annotations in section 11.
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 any way 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 is not 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.**
9. *Assistant Examiners will send a brief report on the performance of candidates to their Team Leader (Supervisor) via email by the end of the marking period. The report should contain notes on particular strengths displayed as well as common errors or weaknesses. Constructive criticism of the question paper/mark scheme is also appreciated.*

10. For answers marked by levels of response: Not applicable in F501

**To determine the level** – start at the highest level and work down until you reach the level that matches the answer

**To determine the mark within the level**, consider the following

<b>Descriptor</b>	<b>Award mark</b>
On the borderline of this level and the one below	At bottom of level
Just enough achievement on balance for this level	Above bottom and either below middle or at middle of level (depending on number of marks available)
Meets the criteria but with some slight inconsistency	Above middle and either below top of level or at middle of level (depending on number of marks available)
Consistently meets the criteria for this level	At top of level

## 11. Annotations

Annotation	Meaning
	Correct response
	Incorrect response
	Missing something
	Follow through
	Benefit of doubt
	Ignore subsequent working
	Method mark awarded 0
	Method mark awarded 1
	Accuracy mark awarded 0
	Accuracy mark awarded 1
	Independent mark awarded 0
	Independent mark awarded 1
	Special Case
	Transcription error

## Mark scheme abbreviations

Other abbreviations in mark scheme	Meaning
oe	Or equivalent
Soi	Seen or implied
www	Without wrong working
ft	Follow through after an error which has been penalised already

## 12. Subject-specific marking instructions

Annotations should be used whenever appropriate during your marking.

**The A, M and B annotations must be used on your standardisation scripts for responses that are not awarded either 0 or full marks.** It is vital that you annotate standardisation scripts fully to show how the marks have been awarded. These annotations must be as close as possible to the working for which credit is being given.

An element of professional judgement is required in the marking of any written paper. Remember that the mark scheme is designed to assist in marking incorrect solutions. Correct *solutions* leading to correct answers are awarded full marks where indicated, but work must not be judged on the answer alone, and answers that are given in the question, especially, must be validly obtained; key steps in the working must always be looked at and anything unfamiliar must be investigated thoroughly.

Correct but unfamiliar or unexpected methods are often signalled by a correct result following an *apparently* incorrect method. Such work must be carefully assessed. When a candidate adopts a method which does not correspond to the mark scheme, award marks according to the spirit of the basic scheme; if you are in any doubt whatsoever (especially if several marks or candidates are involved) you should contact the PE.

The following types of marks are available.

### **M**

A suitable method has been selected and *applied* in a manner which shows that the method is essentially understood. Method marks are not usually lost for numerical errors, algebraic slips or errors in units. However, it is not usually sufficient for a candidate just to indicate an intention of using some method or just to quote a formula; the formula or idea must be applied to the specific problem in hand, e.g. by substituting the relevant quantities into the formula. In some cases, the nature of the errors allowed for the award of an M mark may be specified.

### **DM**

A method mark which is dependent on a previous method mark.

### **A**

Accuracy mark, awarded for a correct answer or intermediate step correctly obtained. Accuracy marks cannot be given unless the associated Method mark is earned (or implied). Therefore M0 A1 cannot ever be awarded.

### **B**

Mark for a correct result or statement independent of Method marks.

Unless otherwise indicated, marks once gained cannot subsequently be lost, eg wrong working following a correct form of answer is ignored. Sometimes this is reinforced in the mark scheme by the abbreviation isw. However, this would not apply to a case where a candidate passes through the correct answer as part of a wrong argument.

When a part of a question has two or more 'method' steps, the M marks are in principle independent unless the scheme specifically says otherwise; and similarly where there are several B marks allocated. Of course, in practice it may happen that when a candidate has once gone wrong in a part of a question, the work from there on is worthless so that no more marks can sensibly be given. On the other hand, when two or more steps are successfully run together by the candidate, the earlier marks are implied and full credit must be given.

The abbreviation ft implies that the A or B mark indicated is allowed for work correctly following on from previously incorrect results. Otherwise, A and B marks are given for correct work only — differences in notation are of course permitted. A (accuracy) marks are not given for answers obtained from incorrect working. When A or B marks are awarded for work at an intermediate stage of a solution, there may be various alternatives that are equally acceptable. In such cases, exactly what is acceptable will be detailed in the mark scheme rationale. If this is not the case please consult your Team Leader.

Sometimes the answer to one part of a question is used in a later part of the same question. In this case, A marks will often be 'follow through'. In such cases you must ensure that you refer back to the answer of the previous part question even if this is not shown within the image zone. You may find it easier to mark follow through questions candidate-by-candidate rather than question-by-question.

Wrong or missing units in an answer should not lead to the loss of a mark unless the scheme specifically indicates otherwise. Candidates are expected to give numerical answers to an appropriate degree of accuracy, with 3 significant figures often being the norm. Small variations in the degree of accuracy to which an answer is given (e.g. 2 or 4 significant figures where 3 is expected) should not normally be penalised, while answers which are grossly over- or under-specified should normally result in the loss of a mark. The situation regarding any particular cases where the accuracy of the answer may be a marking issue should be detailed in the mark scheme rationale. If in doubt, contact your Team Leader.

### **Rules for replaced work**

If a candidate attempts a question more than once and indicates which attempt he/she wishes to be marked, then examiners should do as the candidate requests.

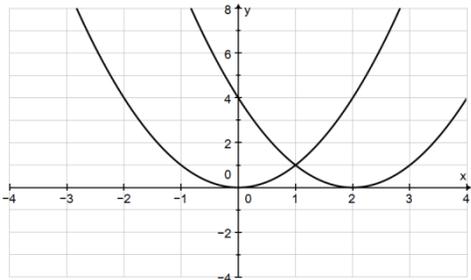
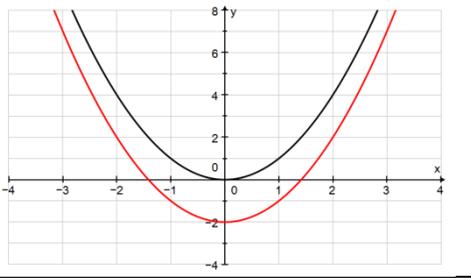
If there are two or more attempts at a question which have not been crossed out, examiners should mark what appears to be the last (complete) attempt and ignore the others.

For a *genuine* misreading (of numbers or symbols) which is such that the object and the difficulty of the question remain unaltered, mark according to the scheme but following through from the candidate's data. A penalty is then applied; 1 mark is generally appropriate. This is achieved by withholding one A mark in the question.

Note that a miscopy of the candidate's own working is not a misread but an accuracy error.

Question		Answer	Marks	Guidance				
1	(a)	$10x - 8y$	<b>B1</b>					
			[1]					
	(b)	$x^3 + 3x^2(2y) + 3x(2y)^2 + (2y)^3$ $= x^3 + 6x^2y + 12xy^2 + 8y^3$ <p><b>Alternative Method</b> Multiplying out</p> <table style="border-collapse: collapse; margin-left: 20px;"> <tr> <td style="border-right: 1px solid black; padding: 5px; text-align: center;"><math>x</math></td> <td style="padding: 5px;"><math>x^2 + 4xy + 4y^2</math></td> </tr> <tr> <td style="border-right: 1px solid black; padding: 5px; text-align: center;"><math>2y</math></td> <td style="padding: 5px;"><math>2x^2y + 8xy^2 + 8y^3</math></td> </tr> </table> $\Rightarrow x^3 + (2+4)x^2y + (8+4)xy^2 + 8y^3$ $= x^3 + 6x^2y + 12xy^2 + 8y^3$	$x$	$x^2 + 4xy + 4y^2$	$2y$	$2x^2y + 8xy^2 + 8y^3$	<b>B1</b> <b>M1</b> <b>A1</b>  <b>B1</b>  <b>M1</b>  <b>A1</b>	Coefficients soi 4 terms and correct powers of $x$ and $y$ Fully correct  Correct (possibly unsimplified) quadratic  Multiply <i>their</i> quadratic by $x + 2y$  Fully correct
$x$	$x^2 + 4xy + 4y^2$							
$2y$	$2x^2y + 8xy^2 + 8y^3$							
	(c)	$(x \pm 3)$ and $(x \pm 5)$ $(x - 3)(x - 5)$	<b>B1</b> <b>B1</b>	2 factors seen (which do not need to be multiplied) isw (i.e. solving equation)				
	(d)	$2(x - 2) - 3 = 5$ $\Rightarrow 2x - 7 = 5$ $\Rightarrow 2x = 12$ $\Rightarrow x = 6$	<b>M1</b> <b>M1</b>  <b>A1</b>	Dealing with bracket Dealing with numbers				
	(e)	$f(2) = 2^3 + 2 \times 2^2 - 5 \times 2 + 4$ $= 10$	<b>M1</b> <b>A1</b>	Use of factor theorem i.e. substitute $x = 2$ Does not need to be labelled "Remainder"				

		<p><b>Alternative Method 1 by long division</b></p> $\begin{array}{r} x^2 + 4x + 3 \\ (x-2) \overline{) x^3 + 2x^2 - 5x + 4} \\ \underline{x^3 - 2x^2} \phantom{+ 4} \\ 4x^2 - 5x \phantom{+ 4} \\ \underline{4x^2 - 8x} \phantom{+ 4} \\ 3x + 4 \phantom{+ 4} \\ \underline{3x - 6} \\ 10 \end{array}$ <p><b>Alternative Method 2 By reverse multiplication</b></p> $(x-2)(x^2) = x^3 - 2x^2$ $(x-2)(x^2 + 4x) = x^3 + 2x^2 - 8x$ $(x-2)(x^2 + 4x + 3) = x^3 + 2x^2 - 5x - 6$ $(x-2)(x^2 + 4x + 3) + 10 = x^3 + 2x^2 - 5x + 4$	<p><b>M1</b></p> <p>Sight of <math>x^3 - 2x^2</math> in first line of working and <math>x^2</math> in quotient</p> <p><b>A1</b></p> <p>10 seen www Accept <math>\frac{10}{(x-2)}</math></p> <p><b>M1</b></p> <p>Sight of build-up i.e. sight of <math>4x</math></p> <p><b>A1</b></p> <p>10 seen www. Accept <math>\frac{10}{(x-2)}</math></p>	
				<b>[2]</b>

Question	Answer	Marks	Guidance
2 (a)	$3x + 2y = 8.6$ $2x + 3y = 9.9$ e.g. $6x + 4y = 17.2$ $6x + 9y = 29.7$ $\Rightarrow 5y = 12.5 \Rightarrow y = 2.5$ $\Rightarrow 3x + 5 = 8.6$ $\Rightarrow 3x = 3.6 \Rightarrow x = 1.2$ (Cost of) screwdriver is £1.20 (Cost of) paintbrush is £2.50	<b>B1</b>  <b>M1</b>  <b>A1</b>  <b>A1</b>  <b>A1</b>	Both equations correct using 8.6, 86 or 860 etc. Use of other variables accepted. Any method to solve <i>their</i> equations  Both coefficients of $x$ or $y$ the same, or correct eqn in one variable by substitution  Both $x$ and $y$ (can be in pence)  Final answer seen w/w referring to cost of each Accept £1.2 and £2.5 and 1.20£ and 2.50£ and 1.2£ and 2.5£ And 120p, 250p
		[5]	
(b) (i)		<b>B1</b>  <b>B1</b>	Parabola translated horizontally or vertically  2 units to right of given curve Seen by passing through at least 3 points from (0, 4), (1, 1), (2, 0), (3, 1), (4, 4)
		[2]	
(ii)		<b>B1</b> <b>B1</b>	Parabola translated vertically 2 units below given curve. Seen by passing through at least 3 points from (-2, 2), (-1, -1), (0, -2), (1, -1), (2, 2)
		[2]	

Question			Answer	Marks	Guidance
3	(a)	(i)	0.5 oe	B1	
				[1]	
		(ii)	$\frac{\sqrt{3}}{2}$ oe	B1	isw
				[1]	
	(b)		63(.4) <sup>o</sup> 243(.4) <sup>o</sup>	B1 B1	ft their first answer SC B1 for answer in radians 1.11° and 4.25° Ignore extra values
				[2]	
	(c)		$\sin x = \sqrt{1 - \cos^2 x}$ $= \sqrt{1 - 0.49}$ $= \sqrt{0.51}$ oe	M1 A1 A1	Use of Pythagoras 0.49 or 0.51 or 49 or 51 soi Isw
				[3]	
	(d)		$\frac{6}{\sin 80} = \frac{BC}{\sin 35}$ $\Rightarrow BC = \frac{6}{\sin 80} \times \sin 35 = 3.49\dots$	M1 A1 A1	Use of sine rule Correct rearrangement Accept awrt 3.49 or 3.5
				[3]	

Question		Answer	Marks	Guidance
4	(a)	(0, 7)	<b>B1</b>	Accept without brackets
			<b>[1]</b>	
	(b)	$y = x^2 - 4x + 7$ $\Rightarrow \frac{dy}{dx} = 2x - 4$ $= 0 \quad 2x = 4 \Rightarrow x = 2$ $\Rightarrow y = 3$ i.e. (2,3) with or without brackets	<b>M1</b>  <b>A1</b> <b>M1</b> <b>A1</b>  <b>A1</b>	Diffn – at least two powers reduced by 1 and coefficients seen  Set <i>their</i> gradient fn = 0 <i>x</i> value  <i>y</i> value If M0 M0 then SC B2 for (2,3) with or without brackets
			<b>[5]</b>	
	(c)	$y = mx(+c)$ $\Rightarrow y = \frac{3}{2}x(+0)$ or $2y = 3x$ or $y = 1.5x$	<b>M1</b>  <b>A1</b>	Eqn for a straight line used  <b>ft</b> their coordinates from part (b)
			<b>[2]</b>	
	(d)	Area under curve $= \int_0^2 (x^2 - 4x + 7) dx$ $= \left[ \frac{x^3}{3} - 2x^2 + 7x \right]_0^2$ $= \left( \frac{8}{3} - 8 + 14 \right) - 0 = \frac{26}{3}$ Subtract area of triangle $= \frac{26}{3} - 3 = \frac{17}{3}$	<b>M1</b>  <b>A1</b>  <b>M1</b> <b>A1</b>  <b>M1</b> <b>A1</b>	Integrate curve. Ignore limits. At least two powers increased by 1 and at least one coefficient changed.  Correct integrated function  Substitute <i>their</i> upper limit i.e. <i>their x</i> value from part (b). Ignore lack of lower limit value. Accept correct answer www (and accept 8.7 or better)  Attempt to find area of triangle and subtract Accept 5.7 or better Accept correct answer www

		<p><b>Alternative method:</b>  Subtract functions</p> $\Rightarrow \text{Area} = \int_0^2 \left( (x^2 - 4x + 7) - \frac{3}{2}x \right) dx$ $= \int_0^2 \left( x^2 - \frac{11}{2}x + 7 \right) dx$ $= \left[ \frac{x^3}{3} - \frac{11x^2}{4} + 7x \right]_0^2$ $= \left( \frac{8}{3} - 11 + 14 \right) = \frac{17}{3}$	<p><b>M1</b> Subtract functions – the curve – <i>their</i> line eqn</p> <p><b>A1</b> Integrand</p> <p><b>M1</b> Integrate, ignore limits  <b>A1</b></p> <p><b>M1</b> Substitute <i>their</i> upper limit – ignore lower limit  <b>A1</b> Accept 5.7 or better  Accept answer www</p>
			<b>[6]</b>

Question			Answer	Marks	Guidance
5	(a)	(i)	Above 110 = 6 Below 100 = 5 Total 11 so not stopped	M1 A1 A1	Evidence of taking readings implied by values or lines on graph Accept [6,7] implied by [93, 94] and Accept [4,5] soi by total Total in range [10,12] and conclusion
				[3]	
		(ii)	No Because the error is above the median and there are no more values	B1	
				[1]	
	(b)	(i)	0.4	B1	Accept percentages
				[1]	
		(ii)	$= 1 - 0.4^3$ $= 0.936$	B1 M1 A1	$0.4^3 (=0.064)$ seen $1 - P(\text{product of 3 probs})$
			<b>Alternative method:</b>  e.g. stop once = 0.096 (or 0.288) stop twice = 0.144 (or 0.432) Stop three times = 0.216 $= 0.216 + 0.288 + 0.432$ $= 0.936$	B1     M1 A1	At least one correct, possibly unsimplified and possibly multiplied by 3     Adding 7 probabilities (possibly combining)
				[3]	



		<p><b>Alternative method 2</b>  <math>t = 5 \Rightarrow N = 92.6</math>  <math>t = 6 \Rightarrow N = 95.5</math>  <math>t = 7 \Rightarrow N = 97.2</math>            i.e. after 6 years</p>	<p><b>M1</b>  <b>A1</b>    <b>A1</b></p>	<p>Evidence of trial ;At least one value tried            At least <math>t = 5</math> and <math>t = 6</math> seen</p>
		<p><b>Alternative method 3</b>  <math>t = 5 \Rightarrow N = 92.6 \Rightarrow 92</math>  <math>t = 6 \Rightarrow N = 95.5 \Rightarrow 95</math>  <math>t = 7 \Rightarrow N = 97.2 \Rightarrow 97</math></p>	<p><b>M1</b>    <b>A1</b>  <b>A1</b></p>	<p>Evidence of trial with successive terms rounded down to an integer.            At least one value tried            At least <math>t = 6</math> and <math>t = 7</math> seen  <math>t = 7</math></p>
			<b>[3]</b>	

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