



Oxford Cambridge and RSA

# **Cambridge Technicals Engineering**

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

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

## **Mark Scheme for June 2022**

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.

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**MARKING INSTRUCTIONS****PREPARATION FOR MARKING****TRADITIONAL**

Before the Standardisation meeting you must mark at least 10 scripts from several centres. For this preliminary marking you should use **pencil** and follow the **mark scheme**. Bring these **marked scripts** to the meeting.

**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 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 or by email.
5. 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.
6. Assistant Examiners are asked to email a brief report on the performance of candidates to their Team Leader (Supervisor) by the end of the marking period. The 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.

## 7. Annotations

Annotation	Meaning
✓ and ✗	
BOD	Benefit of doubt
FT	Follow through
ISW	Ignore subsequent working
M0, M1	Method mark awarded 0, 1
DM1	Method mark dependent on previous M mark
A0, A1	Accuracy mark awarded 0, 1
B0, B1	Independent mark awarded 0, 1
SC	Special case
λ	Omission sign
<b>Other abbreviations in mark scheme</b>	
Oe	Or equivalent
Soi	Seen or implied
www	Without wrong working
Ecf	Error carried forward

## 8. 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 in the body of the work and **not** anywhere near the right hand margin of each page.

Mark in using a red pen.

Put the mark for each subquestion near to and to the right of the mark for the question. Total all marks for the question and put this total in a ring at the bottom right of each question.

*Because of the way the marks are checked by OCR it is crucial that all part marks are placed within the body of the work and not on the right hand side of the page.*

Transfer these marks to the box on the front page.

Total the marks for the paper. I suggest that all unringed marks are then totalled to make sure that the final mark is correct.

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 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 your Team Leader.

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.

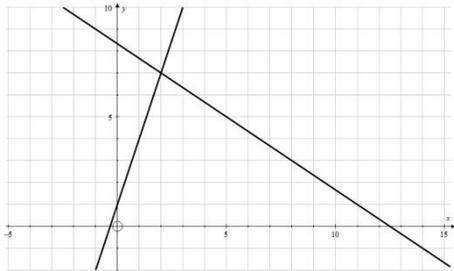
If a response has been crossed out but not replaced then examiners should attempt to mark it so far as it can be seen.

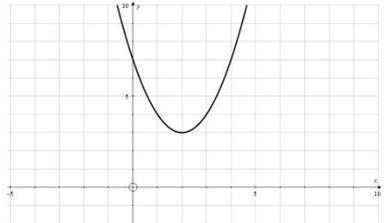
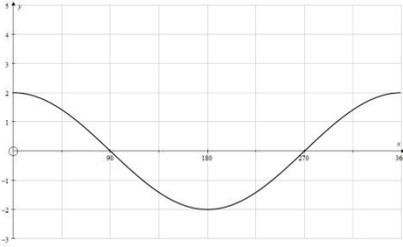
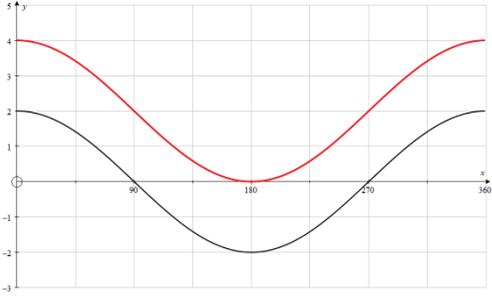
For a *genuine* misreading (of numbers or symbols) which is such that the object and the difficulty of the question remain unaltered, mark according to the scheme but following through from the candidate’s data. A penalty is then applied; 1 mark is generally appropriate, though this may differ for some units. 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)	$6x$ $-8y$	<b>B1</b> <b>B1</b>	
			[2]	
	(b)	$(x \pm 4)(x \pm 3)$ $(x - 4)(x - 3)$	<b>B1</b> <b>B1</b>	isw
			[2]	
	(c)	$= \frac{?}{12}$ $= \frac{3(x+2)+4(3-x)}{12}$ $= \frac{18-x}{12}$	<b>B1</b> <b>B1</b>  <b>B1</b>	Sight of a common denominator <b>soi</b> Sight of (unsimplified) numerator <b>soi</b>  Mark final answer
			[3]	
	(d)	$\frac{T^2}{4\pi^2} = \frac{m}{k}$ $\Rightarrow k = \frac{4\pi^2 m}{T^2}$ <b>oe</b>	<b>B1</b>  <b>B1</b>	Sight of $\frac{T^2}{4\pi^2}$ or $\frac{4\pi^2}{T^2}$ or $\left(\frac{T}{2\pi}\right)^2$ or $\left(\frac{2\pi}{T}\right)^2$ Allow in any correct format.
			[2]	

Question		Answer	Marks	Guidance
2	(i)	<b>AG</b> $f(2) = 2^3 - 6 \times 2^2 + 11 \times 2 - 6$ $= 8 - 24 + 22 - 6 = 0$	<b>M1</b> <b>A1</b>	Correctly substituting $x = 2$ into $f(x)$ Numbers must be seen <b>oe</b> (e.g. $30 - 30 = 0$ )
			<b>[2]</b>	
	(ii)	$x^3 - 6x^2 + 11x - 6$ $\Rightarrow (x - 2)(x^2 - 4x + 3)$ $\Rightarrow (x - 2)(x - 1)(x - 3)$	<b>M1</b>  <b>M1</b> <b>A1</b>	Long division or inspection to get a 3 term quadratic ie. $x^2 + \dots$ or use of factor theorem to find one root correctly  Factorise <i>their</i> quadratic or find all three roots by factor theorem
			<b>[3]</b>	
	(iii)	$x = 1, 2, 3$	<b>B1</b>	ft <i>their</i> three bracket factorised form in (ii)
			<b>[1]</b>	

Question		Answer	Marks	Guidance
3	(a)	(i)		<p><b>B1</b> Straight line with positive gradient Or straight line through (0, 1)</p> <p><b>B1</b> Correct line</p>
		(ii)	$x = 2, y = 7.$	<p><b>[2]</b></p> <p><b>B1</b> Allow (2, 7). Allow ft from their graph.</p>
	(b)	(i)	<p><b>AG</b></p> $300 = 2\pi r^2 + 24\pi r$ $\Rightarrow 6.28r^2 + 75.4r - 300 = 0$ $\Rightarrow 3.14r^2 + 37.7r - 150 = 0$	<p><b>M1</b> Sight of substitution for <math>h</math> and <math>\pi</math> and <math>A</math></p> <p><b>A1</b></p>
		(ii)	$3.14r^2 + 37.7r - 150 = 0$ $\Rightarrow r = \frac{-37.7 \pm \sqrt{37.7^2 + 4 \times 3.14 \times 150}}{2 \times 3.14}$ $= 3.15$	<p><b>[2]</b></p> <p><b>M1</b> Use of correct formula – allow sign errors</p> <p><b>A1</b> Correct substitution <b>soi</b></p> <p><b>A1</b> No extras. awrt 3.15 SC B3 for correct answer www SC B2 for both solutions www</p>
			<b>[3]</b>	

4	Question	Answer	Marks	Guidance
	(a)		<p><b>B1</b></p> <p><b>B1</b></p>	<p>Parabola the right way up with minimum in 1<sup>st</sup> quadrant (i.e. <math>x &gt; 0, y &gt; 0</math>)</p> <p>Minimum at (2, 3) The coordinates for the minimum must be clearly seen by a scale on axes or labelled.</p>
			[2]	
	(b) (i)		<p><b>B1</b></p> <p><b>B1</b></p>	<p>Correct shape, starting and ending at (0,2), (360,2) (Allow no labels on x-axis) “Correct shape” means evidence of “flattening off” at end points</p> <p>Correct range – i.e. <math>-2 \leq y \leq 2</math></p>
			[2]	
	(b) (ii)		<p><b>B1</b></p>	<p>Identical to (i) and consistently 2 up Allow ft here</p>
			[1]	
	(c) (i)	$-p$	<p><b>B1</b></p>	
			[1]	
	(ii)	$\sqrt{1-p^2}$	<p><b>M1</b></p> <p><b>A1</b></p>	<p>Evidence of Pythagoras (e.g. square root sign) All correct</p>
			[2]	

Question		Answer	Marks	Guidance
5	(a)	$\Rightarrow \left(\frac{dy}{dx} = 2x - 4\right)$ $= 0 \text{ when } 2x - 4 = 0 \Rightarrow x = 2$ $\Rightarrow y = 4 - 8 + 7 = 3$ i.e. (2,3)	<b>M1</b> <b>DM1</b> <b>A1</b> <b>A1</b>	Diffn Set = 0 $x = 2$ $y = 3$ <b>ft their x</b>
			[4]	
	(b)	(i)		
		$V = 12\left(1 - e^{-\frac{t}{4}}\right)$ $\text{when } t = 5, V = 12\left(1 - e^{-\frac{5}{4}}\right)$ $= 8.56$	<b>M1</b>  <b>A1</b>	Substitute $t = 5$  Allow 8.6
			[2]	
		(ii)		
		$7 = 12\left(1 - e^{-\frac{t}{4}}\right) \Rightarrow e^{-\frac{t}{4}} = \frac{5}{12}$ $\Rightarrow -\frac{t}{4} = \ln \frac{5}{12} = -0.875$ $\Rightarrow t = 3.50 \text{ (secs)}$	<b>B1</b>  <b>M1</b>  <b>A1</b>	Sight of $V = 7$ substituted <b>soi</b> Take logs  3.5 or better (3.5019) SC B3 for correct answer by trial and improvement
			[3]	
	(c)	$A = \int_0^{20} 20e^{-\frac{x}{20}} dx = \left[-400e^{-\frac{x}{20}}\right]_0^{20}$ $= -400\left((e^{-1}) - (e^0)\right) = 400\left(\frac{1}{e} - 1\right)$ $= 252.8 \text{ mm}^2$	<b>M1</b> <b>A1</b> <b>DM1</b>  <b>A1</b>	Integrate, ignore limits Substitute both limits  Includes units Allow 253 mm <sup>2</sup> SC B4 for correct answer from calculator (or B3 for no units)
			[4]	

Question	Answer	Marks	Guidance
6	(i) Angle AOB = $2 \sin^{-1} \frac{6}{10}$ $= 73.7^\circ$	M1 A1 A1	Doubling half the angle Correct ratio SC B2 obtaining 53.1
	<b>Alternative method:</b> $\cos AOB = \frac{10^2 + 10^2 - 12^2}{2 \times 10 \times 10} = 0.28$ $\Rightarrow AOB = 73.7^\circ$	M1 A1 A1	Must have correct substitutions SC B2 obtaining 53.1
		[3]	
	(ii) Area of segment = area sector – area triangle Area of sector = $10^2 \pi \times \frac{\text{their } AOB}{360}$ $= 64.3$ Area of triangle = $\frac{1}{2} \times 12 \times h$ where $h = \sqrt{10^2 - 6^2} = 8$ $\Rightarrow$ Area of triangle = $\frac{1}{2} \times 12 \times 8 = 48$ $\Rightarrow$ Area of segment = $64.3 - 48$ $= 16.3 \text{ cm}^2$	M1 M1 A1 M1 A1 A1	Sight of subtraction of areas of <i>their</i> sector and <i>their</i> triangle Sector – ft method Allow 64.4 Triangle – ft method Allow 16.4 must have units
	<b>Alternative method:</b> Area of triangle = $\frac{1}{2} ab \sin C$ $= \frac{1}{2} \times 10 \times 10 \times \sin \text{their } AOB = 48$	M1 A1	Use of area formula
		[6]	

Question		Answer	Marks	Guidance
7	(a)	Expectation = Prob $\times$ number = $0.2 \times 50$ = 10	<b>M1</b> <b>A1</b>	For final answer
			[2]	
	(b) (i)	P(red) = 0.5 P(2 <sup>nd</sup> red) = 0.5 P(both red) = 0.25	<b>M1</b> <b>A1</b>	Multiply 2 equal probs Or 25%
			[2]	
	(ii)	P(2 <sup>nd</sup> red) = $\frac{19}{39}$  $\Rightarrow$ P(both red) = $\frac{1}{2} \times \frac{19}{39} = \frac{19}{78}$ ( $\approx 0.244$ )	<b>B1</b> <b>M1</b> <b>A1</b>	Prob of 2 <sup>nd</sup> soi Multiply by 0.5 by a fraction with 19 in numerator or 39 in denominator Allow 0.24 or 24%
			[3]	

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