Cambridge Technicals

Engineering

Unit 1: Mathematics for engineering

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

Mark Scheme for June 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.

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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.

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 telephone, *RM Assessor* messaging or by email.

5. Always check the initial pages (the additional answer pages which are at the back of the QP but posted in the zone for Q1(a)). If the candidate has continued an answer there then link it to the question to which it refers add an annotation to confirm that the work has been seen.

6. 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)

7. Please would all Assistant Examiners will email a brief report on the performance of candidates to the PE by the end of the marking period or earlier if requested.. 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.

8. **Annotations**

Annotation	Meaning
	Correct response
	Incorrect response
	Missing something
BOD	Benefit of doubt
FT	Follow through
ISW	Ignore subsequent working
M0	Method mark awarded 0
M1	Method mark awarded 1
A0	Accuracy mark awarded 0
A1	Accuracy mark awarded 1
B0	Independent mark awarded 0
B1	Independent mark awarded 1
SC	Special case

Mark scheme abbreviations

Other abbreviations in mark scheme	Meaning
Oe	Or equivalent
Soi	Seen or implied
www	Without wrong working
ft	Follow through
Awrt	Answer which rounds to
isw	Ignore subsequent working

9. **Subject-specific marking instructions**

Annotations should be used whenever appropriate during your marking.

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 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.

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.

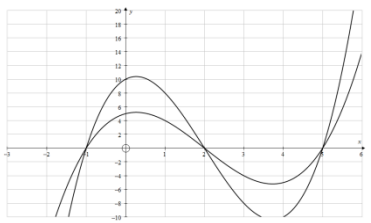
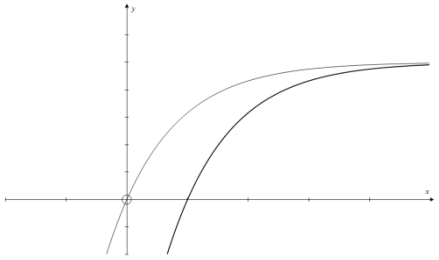
If there are two or more attempts at a question which have not been crossed out, examiners should mark what appears to be the last (complete) attempt and ignore the others.

NB Follow these maths-specific instructions rather than those in the assessor handbook.

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)		$2x-3=5$ $\Rightarrow 2x=8$ $\Rightarrow x=4$	M1 A1	Collect terms soi or divide all terms by 2 N.B $2x= 2$ is M1 A0 N.B. Must have $x=$
				[2]	
	(b)		$2x^2+4x$ $2x(x+2)$	B1 B1	Sight of either 2 or x or (x + 2) as factors Fully correct
				[2]	
	(c)		$\frac{x+1}{3}+\frac{x-1}{2}$ $=\frac{2(x+1)}{6}+\frac{3(x-1)}{6}$ $=\frac{5x-1}{6}$	M1 A1 A1	LCM of 6 soi by cross multiplication $5x$ or -1 www seen in numerator of a fraction Fully correct
				[3]	
	(d)		$(x-3)^2=x^2-6x.....$ $=x^2-6x+9$ $\Rightarrow a=-6,\ b=9$	M1 A1 A1	Sight of quadratic expansion to give $x^2+px+q,\ p,q\neq 0$ (not necessarily simplified) Both
				[3]	
	(e)		$x^2+4x-7=0$ $\Rightarrow x=\frac{-4\pm\sqrt{16+28}}{2}=\frac{-4\pm\sqrt{44}}{2}$ $\Rightarrow x=1.32,\ -5.32$	M1 A1 A1	Correct use of correct formula $\sqrt{44}$ or 6.83 soi by correct answer Both to 3sf SC both roots www correct to 3sf B3 SC both roots www correct to 2sf or more than 3 sf B2
				[3]	

Question			Answer	Marks	Guidance
2	(a)		Factor of $x - 1$	**B1**	Factor seen anywhere
			$f(x) = (x-1)(x^2 + x - 12)$	**M1**	Attempt to obtain quadratic factor
				A1	Correct quadratic soi
			$= (x-1)(x-3)(x+4)$	**A1**	Fully correct isw
					SC fully correct www B4
			Alternative method: Factor of (x – 1) seen Repeated use of factor theorem f(3) = 0 or f(-4)=0 $\Rightarrow (x-1)(x-3)(x+4)$	 B1 M1 A1 A1	 Fully correct
				[4]	
	(b)			**B1** **B1**	Same shape going through *x*-axis at same points i.e. looking like a positive cubic through the same points on *x*-axis. Height approx × 2. Accept errors from a first B0 Ignore $x > 5$ and $x < -1$
				[2]	
	(c)			**B1** **B1**	Same shape (with no turning point) and same orientation Through (1,0) and converging. Accept touching but not crossing
				[2]	

Question			Answer	Marks	Guidance
3	(a)	(i)	$x^2 + y^2 - 12x - 14y + 60 = 0$ $\Rightarrow (x-6)^2 + (y-7)^2 + 60 = 36 + 49$ $\Rightarrow (x-6)^2 + (y-7)^2 = 36 + 49 - 60 = 25$ Centre (6, 7) Radius 5	**M1** **A1** **A1**	Attempt to obtain $(x-6)^2$ or $(y-7)^2$ by rearranging soi If M0 then SC B1 for radius
				[3]	
		(ii)	(10,10) substituted gives $4^2 + 3^2 = 25$ (9, 3) substituted gives $3^2 + 4^2 = 25$	**B1**	Both – the substitutions can be seen in either the rearranged formula or the original.
			Alternative method Use of Pythagoras to prove that both points are 5 from C		
				[1]	
		(iii)	$= \sqrt{(9-10)^2 + (3-10)^2}$ $= \sqrt{1+49} = \sqrt{50} \quad \left(= 5\sqrt{2}\right)$	**M1** **A1**	Use of Pythagoras using coordinates of A and B.soi by correct answer Allow awrt 7.1
				[2]	
		(iv)	$\text{Cos ACB} = \dfrac{25+25-50}{50} = 0$ $\Rightarrow \text{Angle ACB} = 90^0$	**M1** **A1** **A1**	Use the correct cosine rule with *their* AB from 3(a)(iii) and *r* from 3(a)(i)to find any angle Ft Awrt 90^0 Answer with no working M0
			Alternative methods: 1 Dropping a perpendicular from C to AB to give half the angle then double 2.Use Pythagoras in triangle ACB to demonstrate that angle C = 90	 M1 A1 A1 M1 A1 A1	

				[3]	
		(v)	$=10\pi\times\frac{90}{360}=7.85$ Or $=5\pi\times\frac{90}{180}=\frac{5\pi}{2}=7.85$	**M1** **A1ft**	Use of correct formula and *their r* with *angle* 90^0 or *their* 3(a)(iv) Awrt 7.9 or **ft** Accept exact answer
				[2]	
	(b)		2 rads per sec = $\frac{2}{2\pi}=\frac{1}{\pi}$ revs per sec = $\frac{60}{\pi}$ revs per min=19.1 revs per min	**M1** **A1**	Conversion either of seconds to minutes or radians to revolutions. Awrt 19
				[2]	

Question			**Answer**	**Marks**	**Guidance**
4	**(a)**		Dev	**B1**	B0 if more than one tick. Any clear indication of selection.
				[1]	
	(b)	**(i)**	25	**M1** **A1**	Attempt to add height of bars soi
				[2]	
		(ii)	2	**M1** **A1**	Attempt to find middle number soi (or stating that the median is the value of *their* middle number – i.e.13^{th} **Ft** from *their* number of boxes
				[2]	
		(iii)	$\frac{8}{25}$ or 0.32	**M1** **A1**	Add height of bars for 4 and greater or less than 4 and take probability from 1 **Ft** from *their* number of boxes
				[2]	

Question			Answer	Marks	Guidance
5		(a)	12	B1	
				[1]	
		(b)	$RC = 1.2 \Rightarrow C = \dfrac{1.2}{600}$ $= 0.002\,(\text{farads})$ **oe**	M1 A1	Substitute into formula and rearranging isw Units are not required. Accept equivalents with powers of 10 if the appropriate conversion is stated.
				[2]	
		(c)	$V = 12e^{\frac{-3}{1.2}} = 12e^{-2.5} = 0.985$	M1 A1	Substituting into correct formula soi by correct answer Awrt 0.99
				[2]	
		(d)	$1.2 = 12e^{\frac{-t}{1.2}} \Rightarrow e^{\frac{-t}{1.2}} = 0.1$ $\Rightarrow \dfrac{-t}{1.2} = \ln 0.1 = -2.303$ $\Rightarrow t = 1.2 \times 2.303 = 2.76(\text{secs})$	M1 A1 M1 A1	Substitute into correct formula soi by correct answer Exponential term correctly isolated Take logs (taking logs may be seen as the first step) SC Answer with no working B4 SC Answer www 2.8 or >3sf which rounds to 2.76 B3
			Alternative method by trial and improvement e,g $2 < t < 3$ e.g $2.2 < t < 2.8$ $\Rightarrow t = 2.76$	M1 A1 M1 A1	By trial and improvement Any two values showing that they encompass 2.76 Successive reduction of upper limit and increase in lower limit justified by values
				[4]	

Question			Answer	Marks	Guidance
6	(a)		**AG** $y = \frac{x^3}{8} - \frac{3x^2}{4} + 5$ $\Rightarrow \frac{dy}{dx} = \frac{3x^2}{8} - \frac{6x}{4}$ $= 0$ when $\frac{3x^2}{8} = \frac{6x}{4} \Rightarrow x^2 = 4x$ $\Rightarrow x = 0,\ 4$ $y = 5,\ 1$	**M1** **A1** **M1** **A1**	Diffn First two powers reduced by 1 and coefficients adjusted Set grad fn = 0 and attempt to solve or substitute both and evaluate grad fn All working must be seen as AG.
				[4]	
	(b)		$A_1 = \int_0^4 \left(\frac{x^3}{8} - \frac{3x^2}{4} + 5 \right) dx$ $= \left[\frac{x^4}{32} - \frac{x^3}{4} + 5x \right]_0^4$ $= (8 - 16 + 20) - (0)$ $= 12$ $A_2 = 2 \times 1 = 2$ $\Rightarrow$ Total $= 14$ m^2	**M1** **A1** **M1** **A1** **M1** **A1**	Integration. At least two powers increased by 1 and coefficients adjusted. Ignore limits and extra bit Use correct limits in correct order to find area under curve 12 soi Calculate extra bit and add it to *their* answer above. Units must be given SC Answer correct www B4 or B6
			Alternative method for first 4 marks Numerical method: Calculation of bits of area At least two parts correct =12	 M1 M1 A1 A1	Values in table below
				[6]	

Values for numerical integration in Q6(b)

		Trapezium rule, $h = 4$	Trapezium rule, $h = 2$	Trapezium rule, $h = 1$	Midinterval, $h = 1$	Midintervsl, $h = 2$	Midintervsl, $h = 4$
x	y						
0	5	5	5	5			
0.5	4.828125				4.828125		
1	4.375			4.375×2		4.375×2	
1.5	3.734375				3.734375		
2	3		3×2	3×2			3×4
2.5	2.265625				2.265625		
3	1.625			1.625 × 2		1.625×2	
3.5	1.171875				1.171875		
4	1	1	1	1			
	Area	$(5+1)\times 4\times\frac{1}{2}$ $=12$	$(5+6+1)\times 2\times\frac{1}{2}$ $=12$	$(5+8.75+6+3.25+1)\times 1\times\frac{1}{2}$ $=12$	12	12	12

Alternative numerical method.	**M1**
Split first part into one rectangle and one triangle is as above ($h = 4$)	**M1**
The rectangle may be extended to include the 2nd bit.	**M1**
i.e. Rectangle = 6 × 1 = 6	**A1**
Triangle = $\frac{4\times 4}{2}=8$	**A1**
Sum = 14	**A1**

Alternative method adding squares M1	**M1**
Adding squares	**M1**
Include extra bit	**M1**
At least one square seen counted if more than a half	**A1**
12	**A1**
Sum = 14	**A1**

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