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 2023

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.

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 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 10 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 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. **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.

   Contradictory Responses
   When a candidate provides contradictory responses, then no mark should be awarded, even if one of the answers is correct.

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
	Incorrect response
	Missing something
FT	Follow through
BOD	Benefit of doubt
ISW	Ignore subsequent working
M0	Method mark awarded 0
M1	Method mark awarded 1
A0	Accaccuracy 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
ecf	Error carried forward

11. **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.

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.

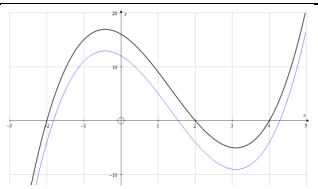
NB Follow these maths-specific instructions rather than those in the assessor handbook.

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. 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)		$3(x-4)+2=11$ $\Rightarrow 3x-10=11$ $\Rightarrow 3x=21$ $\Rightarrow x=7$	M1 M1 A1	Deal with brackets correctly Collect terms
				[3]	
	(b)		$\frac{x-1}{3}+\frac{x}{4}$ $=\frac{4(x-1)}{12}+\frac{3x}{12}$ $=\frac{7x-4}{12}$	M1 A1 A1	Attempt at LCM At least one fraction correct
				[3]	
	(c)		$2(x+3y)+3(2x-y)$ $=2x+6y+6x-3y$ $=8x+3y$	 B1 B1	 (+) $8x$ $+3y$
				[2]	

Question			Answer	Marks	Guidance
2	(a)		$x^2+5x-7=0$ $\Rightarrow x=\frac{-5\pm\sqrt{25+28}}{2}=\frac{-5\pm\sqrt{53}}{2}$ $\Rightarrow x=\frac{-5\pm 7.280}{2}=1.1 \text{ and } -6.1$	M1 A1 A1	Correct substitutions into correct formula Sight of 7.280..= root 53 **soi** by correct answers. Both needed to 2sf Correct roots www B3 Correct roots to 3 or more sf B2 SC one root correct to 2sf www B1
			Alternative by completion of square $x^2+5x=7$ $\Rightarrow \left(x^2+5x+6.25\right)=13.25$ $\Rightarrow \left(x+2.5\right)^2=13.25$ $\Rightarrow x+2.5=\pm\sqrt{13.25}$ $\Rightarrow x=-2.5\pm 3.64=1.1,-6.1$	M1 A1 A1	Sight of 6.25 **oe** Equation correct (square rooting correct)
				[3]	
	(b)	(i)	Long division	M1 A1	Sight of $x^2 - 5x....$ or correct multiplication with 6 terms All correct Could be done the other way round
				[2]	
		(ii)	$x^3-4x^2+x+6=0$ $\Rightarrow \left(x+1\right)\left(x^2-5x+6\right)=0$ $\Rightarrow \left(x+1\right)\left(x-3\right)\left(x-2\right)=0$ $\Rightarrow x=-1,2,3$	B1 M1 A1	x = -1 in answer Valid attempt to solve quadratic by formula, completion of square or factorisation ($\left(x\pm 3\right)\left(x\pm 2\right)$) x= 2, 3 SC B3 all 3 roots www SC If M0 then B1 for one of x = 2,3 www
				[3]	

Question			Answer	Marks	Guidance
3	(a)		$A = \left(\frac{8d}{9}\right)^2$ $\Rightarrow \frac{8d}{9} = \sqrt{A}$ $\Rightarrow d = \frac{9}{8}\sqrt{A}$ **oe**	**M1** **A1** **A1**	Deal with square root A correct equation involving d All correct Alternative: M1 deal with square A1 equation involving d^2
				[3]	
	(b)			**B1** **B1**	Similar curve **under** original, covering for at least [-2,5] 4 below seen by at least 3 of (-2,-4), (0,4), (2,-4), (4,-4), (5,6) BOD for accuracy
				[2]	
	(c)	**(i)**	e.g. The value of N when $t = 0$		e.g. starting point, initial value, starting population **oe**
				[1]	
		(ii)	$\log 10^6 = \log 1000 + t \log 1.5$ $\Rightarrow t = \frac{3}{\log 1.5} = 17.04$ $\Rightarrow t = 18$	**M1** **M1** **A1** **A1**	Attempt to use logs using correct rules Simplify to make t the subject SC B2 for 18, B1 for 17.04
			Alternative $1.5^t = 10^3$ $\Rightarrow t = \log_{1.5} 1000$ $= 17.04$ $\Rightarrow t = 18$	**M1** **M1** **A1** **A1**	Other bases possible Simplify powers Correct use of logs to make t the subject
				[4]	

Question			Answer	Marks	Guidance
4	(a)		$\left(\frac{3+9}{2}, \frac{5+3}{2}\right)$ $\Rightarrow (6,4)$	M1 A1	Mean of values **soi** or a vector method seen N.B. Answer with no working is 0
				[2]	
	(b)		$\sqrt{(9-3)^2+(3-5)^2} = \sqrt{6^2+2^2}$ $= \sqrt{40} \quad \left(= 2\sqrt{10}\right)$	M1 A1	Pythagoras Accept awrt 6.32
				[2]	
	(c)		$(x-6)^2+(y-4)^2 = 10$ **oe**	B1 B1	For equation of circle with (6,4) ft their part(a) For radius^2 (awrt 10) ft their part (b) Allow half their part (b) squared
				[2]	
	(d)		Grad AC $= \frac{5-3}{3-9} = -\frac{1}{3}$ $\Rightarrow$ Grad BD $= 3$ $\Rightarrow y-4 = 3(x-6)$ $\Rightarrow y = 3x-14$	M1 A1 M1 A1	Finding grad AC and using $m_1 m_2 = -1$ Using *their* midpoint or B or D from graph and *their* gradient (Use of $y = mx + c$ allowed) Must be three term equation SC Grad BD=3 www B2
				[4]	

Question			Answer	Marks	Guidance
5	(a)	(i)	$A = \frac{1}{2} \times 20 \times 20 \sin 60$	M1	Correct formula with angle 60^0 and $r = 20$ or $\frac{20}{3}$ Or semi-perimeter method
			$= 173.2$	A1	Accept 3sf
			Alternative $h = \sqrt{20^2 - 10^2} = 17.32$	M1	Pythagoras **and** area formula
			$\Rightarrow A = \frac{1}{2} \times 20 \times 17.32 = 173.2$	A1	
				[2]	
		(ii)	$A = \pi \times 20^2 \times \frac{60}{360}$	M1	Must be correct formula **with** 60^0 or $\frac{\pi}{3}$
			$= 209.4$	A1	Accept 3 sf
				[2]	
	(b)		Segment = 209.4 – 173.2 = 36.2	M1	Subtract *their* (i) from *their* (ii)
			$\Rightarrow$Total = *their* (a)(i) + 3 × *their* 36.2	M1	Correct calculation – i.e. correct two terms
			=281.8 (mm^2)	A1	Accept awrt 281 or 282.
				[3]	

Question			Answer	Marks	Guidance
6	(a)		<table><tr><td>59</td><td>5</td><td>295</td></tr><tr><td>60</td><td>10</td><td>600</td></tr><tr><td>61</td><td>30</td><td>1830</td></tr><tr><td>62</td><td>5</td><td>310</td></tr><tr><td></td><td></td><td>3035</td></tr></table> Mean = 3035/50 = 60.7	**M1** **M1*** **DM1** **A1**	Use of mid-interval multiply by frequency For $\frac{\sum x_i f_i}{\sum f_i}$ by correct answer. 4 marks for correct answer www
				[4]	
	(b)	**(i)**	Variance = 0.64 gives sd = 0.8	**B1**	
				[1]	
		(ii)	$60 \pm 3 \times 0.8$ $= [57.6, 62.4]$ So yes at lower end but not certain at upper end	**M1** **A1** **A1**	*Their* sd From part (b)(i) Both ends correct Not certain because they might not pass at upper end
				[3]	

Question			Answer	Marks	Guidance
7	(a)		$V = x^2h$	B1	Must have V =… Accept unsimplified? i.e. $V = x \times x \times h$ Accept Volume = ...
				[1]	
	(b)		**AG** Surface area = area of base + 4 side $\Rightarrow S = x^2 + 4xh$ with $V = x^2h \Rightarrow h = \frac{V}{x^2}$ $\Rightarrow S = x^2 + 4 \times \frac{4000}{x} = x^2 + \frac{16000}{x}$	M1 B1 A1	Accept including inside Isolate h
				[3]	
	(c)		$S = x^2 + 4 \times \frac{4000}{x}$ $\Rightarrow \frac{dS}{dx} = 2x - \frac{16000}{x^2}$ $= 0$ when $x^3 = 8000$ $\Rightarrow x = 20$	M1 A1 M1 A1 A1	Diffn (Either 2 or –ve sign seen) Set *their* derivative = 0 For equation **soi**
				[5]	

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