Cambridge Technicals

Engineering

Unit 2: Science 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.

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 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 50% 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 Assessor* messaging or by email or by telephone,

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.

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. Award No Response (NR) if:
   - there is nothing written in the answer space

   Award Zero '0' if:
   - anything is written in the answer space and is not worthy of credit (this includes text and symbols).

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 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.

9. **Annotations**

Annotation	Meaning
	correct response worthy of a mark. **number of ticks = no of marks awarded**
	incorrect
	missing something
	error carried forward
	benefit of doubt
	not benefit of doubt
	power of ten error
	contradiction
	rounding error
	significant figure error
	seen
	blank page

Mark Scheme abbreviations

Wtte: words to that effect

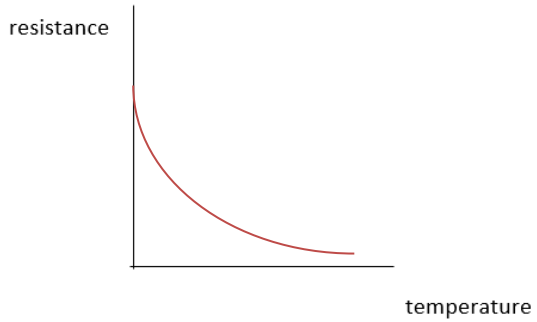
10. **Subject specific marking instructions**

In all numerical calculation questions a correct response to 2 sf will gain all marks unless specified otherwise. If gives an answer to more than 2 sf, if it rounds to the answer given in the mark scheme to 2 sf, the mark can be awarded.
If this is not the case for specific questions, this will be detailed in the mark scheme.
You do not need to see all the workings if the answer is correct.

Question			Answer	Marks	Guidance
1	(a)		ampere ✓ metre ✓ second ✓	3	**ALLOW** any clear indication of correct answers. If 4 or more ticks present, each incorrect tick will contradict a correct response, so the number of marks awarded will be no of correct ticks – no of incorrect ticks. For example, if a candidate has ticked Ampere, Coulomb, Metre and Second. they will get 3 correct −1 incorrect =2 marks.
	(b)	(i)	uncertainty ✓	1	**ALLOW** correct response to be circled / underlined / highlighted, **ONLY** if the answer line is blank.
		(ii)	290 and 310 ✓	1	Both required for the mark, but they can be in either order.
1			**TOTAL**	5	

<table>
<tr><th colspan="3">Question</th><th>Answer</th><th>Marks</th><th>Guidance</th></tr>
<tr><td>2</td><td>(a)</td><td></td><td>
<table>
<tr><th>Statement</th><th>Graph X</th><th>Graph Y</th><th>Both graphs</th><th>Neither graph</th></tr>
<tr><td>The car is travelling at constant speed</td><td>✓</td><td></td><td></td><td></td></tr>
<tr><td>20 s after the journey started, the speed is $10ms^{-1}$</td><td></td><td></td><td>✓</td><td></td></tr>
<tr><td>The car slows down during the journey</td><td></td><td></td><td></td><td>✓</td></tr>
<tr><td>40s after the journey started, the distance travelled is 400 m</td><td></td><td></td><td>✓</td><td></td></tr>
</table>
</td><td>4</td><td>One mark for each correct row of the table.

If there are 2 or more ticks in a row, then that row does not get a mark.</td></tr>
<tr><td></td><td>(b)</td><td>(i)</td><td>Any 2 from:
The (2) forces are equal (in magnitude) and opposite (in direction) ✓
The (2) forces are parallel ✓
The (2) forces do not act on the same point OR there is a distance between the two forces ✓</td><td>2</td><td>NOT 2 forces acting against one another for first marking point.
IGNORE balanced for first marking point.
IGNORE different direction, but allow one up and one down for opposite and allow one clockwise and one anticlockwise for opposite.
IGNORE reference to pivot.</td></tr>
<tr><td></td><td></td><td>(ii)</td><td>Substitution into equation $F = 50 \times 0.4$ ✓
Correct evaluation $F = 20$ (Nm) ✓</td><td>2</td><td>IGNORE POT of distance for substitution mark so a final answer of 2000 only gains one mark.
A raw answer of 2000 on the answer line gets one mark without any working.
NOT distance of 45 cm.
NOT F = 100 N</td></tr>
<tr><td>2</td><td></td><td></td><td>TOTAL</td><td>8</td><td></td></tr>
</table>

Question			Answer	Marks	Guidance
3	(a)		calibration OR calibrating ✓	1	
	(b)	(i)	(ntc) thermistor ✓	1	**ALLOW** temperature dependent resistor or thermal resistor. **NOT** variable resistor
		(ii)	Negative gradient (from positive non-zero value at or near y-axis) ✓ Magnitude of gradient decreases with temperature ✓  	2	No need to touch either axis but can cross either axis. **IGNORE** any values added to axes. For second mark point; • **ALLOW** a positive gradient decreasing with temperature. • **DO NOT ALLOW** an obvious turning point at either end of line (a little flick in the wrong direction). • **IGNORE** short horizontal line at the end of curve. • If logarithmic scale on y-axis is indicated then allow a straight line.
	(c)		Calculation of total resistance in circuit; $R = 40 + 10$ (= 50) ✓ Correct substitution into Ohm's Law equation (any subject); eg $I = (V \div R =) 6 \div 50$ ✓ Evaluation $I = 0.12$ (A) ✓	3	**ALLOW** one mark for final answer of 0.15 A. with or without working shown. [using R = 40 Ω]

	(d)	**(i)**	Substitution into correct equation; $\rho = \frac{RA}{L}$ (any subject) eg: $1.5 \times 10^{-6} = \frac{(10 \times A)}{0.4}$ ✓ Rearranging equation for A (either using algebra or numbers) $A = \rho l \div R$ OR $A = \frac{(1.5 \times 10^{-6}) \times 0.4}{10}$ ✓ evaluation; $A = 6.0 \times 10^{-8}$ (m^2) ✓	3	Rearranging and substitution can be done in any order. **DO NOT ALLOW** incorrect equation eg $\rho = \frac{RA}{I}$. Some candidates confuse *l* and *I*. **ALLOW** final value to 1SF ie 6×10^{-8}. A POT error with no working will gain no marks.
		(ii)	Explanation of what temperature coefficient of resistance means✓ For example; ONE of the following: • (low temperature coefficient means) a (small) change in R when T changes; • high temperature coefficient means a (large) change in R when T changes; • temperature coefficient is a measure of the amount the R changes when T changes. Description of effect from a change in R (when T changes) ✓ For example; ONE of the following: • affect the current flowing in the circuit • affect the calibration of the sensor/meter • make the temperature reading incorrect	2	For first marking point assume that answer refers to low temperature coefficient unless otherwise stated (because low temp coefficient is in question stem). **ALLOW** 'so the resistance (of the 10Ω resistor) stays constant' for first marking point. **NOT** so the temperature stays constant. **ALLOW** so it doesn't change the results, for second mark point.
3			**TOTAL**	**12**	

Question			Answer	Marks	Guidance
4	**(a)**	**(i)**	B ✓	1	
		(ii)	C ✓	1	
	(b)		strain ✓ ultimate tensile stress ✓	2	
	(c)	**(i)**	Pascal OR Pa ✓	1	**ALLOW** N m^{-2} OR N/m^2, **NOT** N cm^{-2}, etc. **ALLOW** MPa **ALLOW** Pascals. **NOT** Pas, PA, pA. nm^{-2} **IGNORE** correct equivalent base SI units (kg m^{-1} s^{-2}) but any incorrect equivalent base SI units <u>on the answer line</u> would be CON. Just ignore other working in the margins (not on answer line).
		(ii)	No unit ✓	1	**ALLOW** any clear indication of correct answers. If more than 2 boxes are ticked, then no mark is awarded.
	(d)	**(i)**	(Average) distance / length / space /gap between (atoms) ✓ when no (external) force / stress applied OR (net /resultant) force between atoms is zero ✓	2	**IGNORE** separation and equilibrium for first marking point. **ALLOW** how far apart the atoms are. **DO NOT ALLOW** equal or uniform distance between atoms. **ALLOW** 'when the force(s) on an atom are in equilibrium' (or wtte) for the second mark point.

		(ii)	Calculation of volume $V = 0.15^3$ (= 0.003375 m^3 (or 3375 cm^3)) ✓ Substitution into equation $p = (m \div V =)\ 9.1 \div 0.15^3$ ✓ Evaluation $p = 2700\ kgm^{-3}$ ✓	3	If there is evidence of a calculation of volume (not just length of side) which is incorrect (could be implied by writing the equation) **ALLOW** ECF of that value for volume into the equation (second mark point only). If no conversion of length to m or volume to $m^{3.}$, final answer will be 0.0027; this gains 2 marks without seeing any working. If there is an incorrect conversion of length to m or volume to $m^{3.}$ Up to 2 marks could be awarded for the working. Actual value = 2696. Allow final answers to more than 2SF.
4			**TOTAL**	**11**	

Question			Answer	Marks	Guidance
5	(a)	(i)	gas ✓	1	**ALLOW** plasma
		(ii)	liquid ✓	1	
	(b)		**FIRST LOOK ON ANSWER LINE** **If answer = 2.28 or 2280 award 3 marks. ✓✓✓** If not, then check for steps of a correct method: **EITHER** sum of squared differences 1 + 16 + 4 + 1 + 4 = 26 ✓ (variance = sum of squared differences ÷ n) = (26 ÷ 5) = 5.2 ✓ s.d = √5.2 = 2.28 (2.3 to 2SF) ✓ **OR** $\sum x^2$ = 10201+10816+9604+9801+9604 = 50026 ✓ $\frac{\sum x^2}{N} - \left(\frac{\sum x}{N}\right)^2 = = \frac{\sum x^2}{N} - (x_{mean})^2 =$ (50026 ÷ 5) – 100^2 = 5.2 ✓ s.d = √5.2 = 2.28 (2.3 to 2SF) ✓	3	**ALLOW** answers given to 2SF (2.3) and if more than 3 sf are given the candidate's answer should round to 2.28. Ignore unit and POT. If working is shown using 4 *(n* -1) as the divisor, and then goes on to square root, this only loses one mark. AWARD 2 marks for answer of 2.54 with working.
	(c)		At least one arrow pointing down at right angles to the top surface ✓ All down arrows must be perpendicular to surface, (at least 2) and approximately the same size ✓ Horizontal arrow(s) on both sides all pointing inwards to the block on the sides ✓ Horizontal arrows must all be perpendicular to surface and get longer as you go deeper and not be shorter (by eye) than any of the down arrows ✓	4	**IGNORE** any arrows at the bottom of the cube. **ALLOW** small gap between arrowhead and block. **IGNORE** arrows at an angle on the top corners for first marking point. Must be at least one horizontal arrow on each side for 3rd mark point. Must be at least 2 arrows on each side for 4th mark point.

	(d)		Evidence of calculating weight of block and using upthrust equation using numbers or algebra. ✓ eg, $F = mg = Vg\rho$ OR $86g = Vg\rho$ OR $843 = Vg\rho$ OR $86 = V\rho$ Using $V = area \times d$ and substituting for ρ in the equation. ✓ eg, $0.2d \times g \times 1000 = 86g$ OR $0.2d \times 9.8 \times 1000 = 843$ OR $0.2d \times 1000 = 86$ OR $0.2d \times g \times 1000 = Upthrust$ Rearrangement and evaluation: (d = 86 ÷ 200 OR d = 840 ÷ 1960 =) 0.43 (m) ✓	3	
5			**TOTAL**	**12**	

Question			Answer	Marks	Guidance
6	(a)	(i)	Add 273 ✓	1	**NOT** 0°C = 273K or 0K = -273°C
		(ii)	Minimum / least / lowest possible energy ✓ Internal energy ✓	2	**DO NOT ALLOW** no energy, zero energy owtte for first mark point. **ALLOW** sum of kinetic and potential energy instead of internal energy. NOT just energy on its own.
	(b)		Substitution into gas equation: $pV = mR_{He}T$ $3000 \times 110000 = m \times 2080 \times 320$ ✓ Rearranging for m: $m = 3000 \times 110000 \div (2080 \times 320)$ OR $m = \frac{PV}{RT}$ ✓ Evaluation: $m = 495.793\ldots$ ✓ Final answer correctly rounded to 3SF: $m = 496$ (kg) ✓	4	**IGNORE** POT of pressure for substitution and rearrangement mark. Substitution and rearranging can be done in either order. Use of 110 Pa as pressure gives answer 0.496; this will lose the evaluation mark [3 marks max] **ALLOW** candidate's value correctly rounded to 3SF for last marking point.
	(c)		Substitution of values into relationship: $\frac{\mathbf{110}}{320} = \frac{p_2}{\mathbf{280}}$ OR $\frac{\mathbf{280}}{320} = \frac{p_2}{\mathbf{110}}$ ✓ Rearrangement: $p_2 = (110 \div 320) \times 280$ ✓ Evaluation $p_2 = 96$ (kPa) ✓	3	**ALLOW** $p_2 = (p_1 \div 320) \times 280$ for 2nd marking point or use of candidate's value of p_1 if p_1 is clearly stated. Actual value is 96.25 kPa
	(d)		Elastic deformation: material returns to its original shape OR plastic deformation: material does not return to its original shape ✓ When the (applied) force OR load OR stress is removed ✓	2	**ALLOW** elastic deformation is reversible and/or plastic deformation is permanent. **ALLOW** correct description in microscopic terms for first marking point. eg Plastic deformation is when atoms slide over one another, OR elastic deformation is when atoms move apart and then return to equilibrium position, etc.
6			**TOTAL**	**12**	

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

CAMBRIDGE
UNIVERSITY PRESS & ASSESSMENT

OCR is part of Cambridge University Press & Assessment, a department of the University of Cambridge.

OCR operates academic and vocational qualifications regulated by Ofqual, Qualifications Wales and CCEA as listed in their qualifications registers including A Levels, GCSEs, Cambridge Technicals and Cambridge Nationals.

OCR provides resources to help you deliver our qualifications. These resources do not represent any particular teaching method we expect you to use. We update our resources regularly and aim to make sure content is accurate but please check the OCR website so that you have the most up-to-date version. OCR cannot be held responsible for any errors or omissions in these resources.

Though we make every effort to check our resources, there may be contradictions between published support and the specification, so it is important that you always use information in the latest specification. We indicate any specification changes within the document itself, change the version number and provide a summary of the changes. If you do notice a discrepancy between the specification and a resource, please contact us.

Whether you already offer OCR qualifications, are new to OCR or are thinking about switching, you can request more information using our Expression of Interest form.

Please get in touch if you want to discuss the accessibility of resources we offer to support you in delivering our qualifications.