Cambridge Technicals

Engineering

Unit 2: Science for engineering

Level 3 Cambridge Technical in Engineering
05822 - 05825 & 05873

Mark Scheme for January 2025

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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 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. A*ssistant 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

Descriptor	Award mark
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

8.   **Annotations**

Annotation	Meaning
✔	correct response worthy of a mark. **number of ticks = no of marks awarded**
✖	incorrect
∧	missing something
ECF	error carried forward
BOD	benefit of doubt
NBOD	benefit of doubt not given
POT	power of ten error
CON	contradiction
RE	rounding error
SF	significant figure error
TE	transcription error
SEEN	to indicate that a blank page or space has been seen
BP	blank page

Mark Scheme abbreviations

Coa: correct answer only
Wtte: words to that effect

11.   **Subject specific marking instructions**

In all numerical calculation questions a correct response to 2 sf will gain all marks unless specified otherwise. You do not need to see all the workings if the answer is correct.

	Question		Answer	Marks	Guidance
1	**(a)**		Pressure / stress ✓ Frequency ✓ (Magnetic) flux ✓	3	**ALLOW** Young modulus **NOT** frames, **NOT** pitch. **NOT** flux density
	(b)	**(i)**	At least one correct read off from ruler 40 OR 89 (correct to half a small graduation) ✓ (Length = 89 − 40) = 49 (mm)✓	2	If there is a consistent POT error in both readings eg giving final answer of 4.9 mm [1] mark.
		(ii)	Less than ✓ Absolute ✓ Less than ✓	3	IF candidate gets 'absolute' **ALLOW** ECF from first line. ie Greater than, absolute, greater than will get 2 marks.
		(iii)	Minus ✓ 2.5 mm ✓	2	**ALLOW** – (minus sign) or negative. Range should be between 2.2 and 2.8
	(c)		Ductile ✓ Strong ✓	2	Top box ticked. Bottom box ticked. **ALLOW** any clear indication of correct answers. If 3 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 but cannot be less than zero.
	(d)		All directions shown ✓	1	Middle box ticked. **ALLOW** any clear indication of correct answer.
1			**TOTAL**	**13**	

	Question		Answer	Marks	Guidance
2	**(a)**		Velocity is the gradient of displacement-time graph OR $v = \frac{displacement}{time}$ OR suitable substitution, e.g; $v = \frac{9-0}{7-0}$ ✓ $v = 1.3$ ✓ Unit = ms^{-1} OR m/s ✓	3	**ACCEPT** any value which rounds to 1.3 to 2SF for the first 2 marks. Independent unit mark.
	(b)	**(i)**	Distance (moved from a given origin) ✓ In a given (certain) direction ✓	2	**ALLOW** 'how far object has moved' for distance, and 'change of position'. **NOT** just vector quantity (this doesn't really define it)
		(ii)	Positive AND decreasing gradient from B ✓ To reach a maximum at C of 12 small squares AND approx zero gradient at C. ✓	2	**IGNORE** any line drawn to the right of C.
		(iii)	Velocity increases from (zero) at A to max at B ✓ rate of change of velocity decreases (sinusoidally) from A to B ✓ symmetrical curve about B (by eye) ✓	3	**ALLOW** rate of change of velocity increases (sinusoidally) from B to C if graph inverted. **IGNORE** any line to the right of C Additional guidance exemplars included in markscheme on next page.
2			**TOTAL**	**10**	

	EXEMPLARS for Question 2(b)(iii)	
A		• Not at maximum at B *X* • Rate of change of velocity decreases from A to B ✔ • Not symmetrical *X* **ONE** mark only.
B		• Velocity increases to max at B ✔ • Rate of change of velocity constant from A to B *X* • Symmetrical ✔ **TWO** marks awarded.
C		• Velocity decreases to min at B *X* • Rate of change of velocity decreases from A to B ✔ • Symmetrical about B ✔ **TWO** marks awarded.
D		• Velocity decreases to min at B *X* • Rate of change of velocity decreases from A to B ✔ • Not good enough for being symmetrical (3 squares too low at C) NBOD *X* **ONE** mark only
E		• Velocity increases to max at B ✔ • Rate of change of velocity looks slightly like it is increasing A to B *X* • Just about good enough for symmetrical BOD ✔ **TWO** marks awarded.

	Question		Answer	Marks	Guidance
3	**(a)**	**(i)**	Charge / electrons / charged particles ✓ Moving / flowing / passing / per unit time. ✓	2	This second mark can only be awarded if candidate gets the first mark point. [dependent mark].
		(ii)	1 min = 60 (s)✓ Substitution into $Q = It$ eg $Q = 1.3 \times 60$ ✓ = 78 (mC) ✓	3	Conversion of time to seconds. This could be implied in the working. **ALLOW** substitution mark for working showing $t = 1$
		(iii)	**ANY 1** of: ✓ Same as battery emf, Current is zero, No potential drop across the wires, No energy loss in the wires, Positive terminal is at the same potential as one plate of capacitor or same argument for negative terminal, There is no potential difference in between the terminals of the battery and the plates of the capacitor,	1	**ALLOW** same as battery pd. **ALLOW** supply emf is 6V
		(iv)	Substitution into $E = \frac{V}{d} = 6 \div 0.2$ ✓ = 30 (Vm^{-1}) ✓	2	**IGNORE** POT for substitution mark.
	(b)		pd decreases from (0, 6) (ie touching vertical axis at V = 6) ✓ Correct shape by eye (starts steep with gradient decreasing smoothly) ✓ After one time period (1s) pd has decreased to about 0.3 of the initial pd (between 2 and 2.5 V if initial pd is 6V) ✓	3	**ALLOW** ecf from initial voltage – at 1s.
3			**TOTAL**	**11**	

	Question		Answer	Marks	Guidance
4	(a)	(i)	Compressive ✓ Tensile ✓	2	
		(ii)	Deformation ✓	1	Top box ticked.
	(b)		Correct substitution into equation $E = \frac{\sigma}{\varepsilon}$ (any subject and any POT) [e.g. $210 = \frac{600}{\varepsilon}$] ✓ Correct (relative) POT for both E and σ (to give ε = 0.0028571) ✓ Convert to percentage by multiplying by 100; ε = 0.28571 (%) ✓ = 0.29 (%) 2sf ✓	4	**ALLOW** (for 4th mark point) candidate's calculated value rounded correctly to 2 SF.
	(c)		ANY of: Confirm mechanical property eg (ultimate tensile) strength / (yield) strength / fracture toughness / fatigue strength, elastic limit, yield point etc. Easier /cheaper to carry out than non-destructive testing Easier to interpret data / less specialist skills needed than non-destructive testing.	1	**NOT** to 'find what the beam can withstand'. **NOT** just 'find the limits of the material'. 'Find the max load before failure' is okay. Only allow comparatives if ndt is referred to.
4			**TOTAL**	8	

Question			Answer	Marks	Guidance
5	**(a)**	**(i)**	Shear stress (above the line) <u>AND</u> Velocity gradient (below the line) ✓✓	2	Both required for the marks. **ALLOW** 1 mark if fraction is inverted
		(ii)	Kinematic viscosity is the ratio of dynamic viscosity to density (or wtte)	1	**ALLOW** kinematic viscosity is dependent on the density of the fluid.
	(b)		Read off at 15 °C = 460 (allow any value between 440 and 480) <u>and</u> read off at 45 °C = 90 (allow any value between 80 and 100) $340 \leq$ difference ≤ 400 ✓	1	**IGNORE** sign of final answer.
	(c)		Substitution into $Q = mC\Delta\theta = 1.0 \times 2180 \times (40 - 10)$ ✓ Q = 65400 (J) ✓	2	
5			**TOTAL**	**6**	

	Question		Answer	Marks	Guidance
6	**(a)**	**(i)**	Conversion 50°C = 323 K ✓ Substitution into $pV = nRT$ [$p \times 0.002 = 0.1 \times 8.3 \times 323$] ✓ Rearrange to give $p = 1.34 \times 10^5$ (Pa) ✓	3	**ALLOW** substitution mark only for using temp in °C or an incorrectly calculated temperature in Kelvin (working needs to be seen). Using temp of 50 gives final answer 20750. 1 mark MAX.
		(ii)	Volume decreases ✓ Volume halves because PV constant / Boyle's law (at constant T) / P is inversely proportional to V. ✓	2	
	(b)	**(i)**	$Q = (U_2-U_1) + W$ <u>AND</u> $U_2-U_1 = 0$ (OR $U_2 = U_1$) ✓ So Q (= W) = 1.2 (kWh) OR 1200 (Wh) ✓ Conversion to MJ: $1.2 \times 1000 \times 60 \times 60 = 4.3(2)$ MJ ✓	3	No mark for copying down non-flow energy equation on its own. **NOT** $\underline{U_1} = 0$ and/or $U_2 = 0$. **NOT** $U_2-U_1 = n - n$, where n is any random number including 0, 1.2 without explanation. Final answer of 4.32 on the answer line gets 2 marks, bur need to see clear working for first mark point.

		(ii)	Kinetic energy of the particles ✓ Potential energy of the particles ✓	2	Second box ticked Fourth box ticked **ALLOW** any clear indication of correct answers. If 3 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 but cannot be less than zero.
		(iii)	Conversion 1.3 bar = 130 kPa ✓ Absolute pressure = gauge + atmospheric = 231 kPa ✓	2	Need to see value to 3SF.
6			**TOTAL**	**12**	

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