Oxford Cambridge and RSA

Cambridge Technicals
Engineering

Unit 2: Science for engineering

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

Mark Scheme for January 2022

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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.

Annotations

Annotation	Meaning
tick	correct response worthy of a mark. **number of ticks = no of marks awarded**
cross	incorrect
omission (carat)	missing something
ecf	error carried forward
bod	benefit of doubt
nbod	not benefit of doubt
pot	power of ten error
con	contradiction
re	rounding error
sf	significant figure error
up	unit penalty

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)**	**(i)**	ampere OR amp ✓	1	ALLOW minor spelling error NOT just A
		(ii)	candela ✓	1	ALLOW minor spelling error NOT just cd
	(b)	**(i)**	**EITHER:** Difference i.e. 9.95 – 9.81 (= 0.14) ✓ Proportion i.e. 0.14 / 9.81 = 0.014(3) or 1.4% ✓ **OR:** Proportion 9.95/9.81 (= 1.0143) ✓ Difference 1.014 – 1 = 0.014(3) or 1.4% ✓	2	**ALLOW** 0.14/9.95 = 0.014 **ALLOW**: Proportion: 9.81/9.95 = 0.986 ✓ Difference: 1 – 0.986 = 0.014(1) or 1.4% ✓
		(ii)	Third column: – 0.2 ✓ Last column: (+)0.0225 and (+)0.04 ✓	2	Must see negative sign ALLOW +0.023 DO NOT ALLOW either of these square numbers to be negative.
		(iii)	$0.158 \div \sqrt{5}$ ✓ 0.071 ✓	2	
1			**TOTAL**	**8**	

Question			Answer	Marks	Guidance
2	**(a)**	**(i)**	Mass (second box) ticked ✓	1	
		(ii)	Weight is a <u>force</u> (acting on a mass) ✓ AND any one of: in a gravitational field or due to gravitational effect (or gravity) ✓ weight is mass x (acceleration of) gravity ✓ weight is a vector quantity/mass is a scalar ✓ weight has direction and magnitude whereas mass only has magnitude ✓ mass is a constant / amount of substance ✓	2	ALLOW mass is not a <u>force.</u>
	(b)	**(i)**	ms^{-2} ✓	1	
		(ii)	(find) gradient or slope ✓ draw a triangle and find height÷base / rise÷run / change in velocity÷time / $\frac{\Delta y}{\Delta x}$ (owtte) ✓ (draw a) tangent (at the point of interest) ✓	3	ALLOW explanation in terms of co-ordinates of TWO points on the line for MP2
	(c)		Calculation of an area (e.g. evidence on graph or working) or use of $s = \left(\frac{u+v}{2}\right)t$ ✓ EITHER: Splits area into geometric shape<u>s</u> (or converts to bar graph) ✓ Area of 2 or 3 shapes calculated (eg triangles, rectangles, trapeziums) ✓ More than 3 geometric shapes used (eg trapezium or rectangle per 50 s) ✓ OR: Count squares ✓ number of large squares multiplied by area of large square (50 s × 50 ms^{-1} = 2500 m) ✓ number of small squares multiplied by area of small squares (10 s × 10 ms^{-1} = 100 m) ✓ Total distance calculated to be in the range of 32000 m to 38000 m (32 km to 38 km) ✓	5	Finding average speed (100ms^{-1}) and multiplying by time (300 s) is equivalent to calculating one area (of one rectangle) so only gets the first mark.
2			**TOTAL**	**12**	

Question			**Answer**	**Marks**	**Guidance**
3	**(a)**		rate of flow ✓ of charged particles/electrons/charge ✓ OR amount of charge / number of electrons ✓ passing/moving per unit time ✓	2	ALLOW current = charge ÷ time for both marks (but not in symbol form unless symbols defined). ALLOW charge flow per second.
	(b)	**(i)**	$240^2 \div 128$ (evidence of use of $P = V^2/R$) ✓ 450 (W) ✓	2	
		(ii)	$1.5\text{mm}^2 = 1.5\times10^{-6}\,\text{m}^2$ ✓ Substitution into equation $\rho = \frac{RA}{l}$ $[4.8 \times 10^{-6} = \frac{(128 \times 1.5\times10^{-6})}{l}]$ ✓ Rearrangement and calculation of $l = 40$ (m) ✓	3	If conversion to SI units is omitted or incorrect allow max 2 marks. ALLOW max 1 mark if candidate calculates area as $2.25\times10^{-6}\text{m}^2$ to give length = 60m. ALLOW answer given to 1sf.
		(iii)	Wire heats up / temperature of wire increases (when current flows) (or reverse argument). ✓ <u>Resistivity</u> increases OR a microscopic explanation of why electrons find it more difficult to pass through wire ✓	2	ALLOW positive temperature coefficient (of resistance) for 2 marks NOT resistance increases as this is in the question stem
	(c)		$\Delta T = 20 - 15 = 5$ ✓ $Q = 15 \times 1150 \times 5$ (= 86250 J) ✓ t (= Q/P) = 86250 ÷ 200 ✓ t = 430 (s) (to 2 sf) ✓	4	Finding temperature difference If Q is calculated with 15 or 20 as ΔT instead of 5, allow ecf for t = Q/P (1300s or 1700s) – [2] max.
3			**TOTAL**	**13**	

Question			Answer	Marks	Guidance
4	(a)		7 (nN) ✓ Left. ✓	2	Could be indicated by an arrow. IGNORE west.
	(b)	(i)	0.1 (nm) ✓	1	
		(ii)	(Average) distance between atoms ✓ When (resultant) force (on atom) is zero OR when attractive force is equal to repulsive force OR forces are in equilibrium✓	2	Ignore 'separation' on its own but allow 'separation between atoms'. ALLOW position relative to other atoms for distance.
	(c)		Second box ticked ✓	1	
	(d)		5.5 kN = 5500 N ✓ Substitution into Stress = $5500 \div 2.4\times10^{-6}$ (= 2.3×10^{9} Pa) ✓ Substitution into E = stress / strain (2.3×10^{9} / 0.015) ✓ $E = 1.5 \times 10^{11}$ (Pa) ✓	4	Allow ecf for no or incorrect conversion to N. **[3]** max. Allow use of candidate's value of stress as evidence for use of correct method to find E for third marking point.
4			**TOTAL**	**10**	

Question			Answer	Marks	Guidance
5	(a)		The same as ✓ Cannot be compressed ✓	2	
	(b)		$P = 450 \div 2.0 \times 10^{-4}$ ✓ 2.3×10^{6} (Pa) ✓	2	Accept 2.3 MPa if unit given
	(c)	(i)	5 000 000 OR 5×10^{6} (Pa) ✓	1	
		(ii)	$F = 5.0 \times 10^{6} \times 0.0018$ ✓ 9000 (N) ✓	2	ALLOW ecf of incorrect answer to part (i).
	(d)	(i)	low resistance to shear forces. ✓	1	ALLOW flows easily when subjected to shear forces
		(ii)	$0.25 \div 1050$ ✓ 2.4×10^{-4} ✓ m^2s^{-1} ✓	3	
5			**TOTAL**	**11**	

Question			Answer	Marks	Guidance
6	**(a)**		623 (K) ✓	1	ALLOW answer to be given to 2sf (620) unless there is evidence that an incorrect addition (ie not =273) has been made.
	(b)		Evidence of use of Charles' Law - eg. correctly substituted $\frac{V}{T}$ or $\frac{T}{V}$ combination✓ 1.2 ÷ 623 = V ÷ 2073 (= 0.00193) ✓ V = 4.0 (m^3) ✓	3	ALLOW T to be in K or ºC for this mark point only. [V = 6.2 m^3] ALLOW ecf of incorrect temp in K from part (a). ALLOW consistent incorrect conversion of 1800ºC as well. ALLOW 4 m^3 (1sf)
	(c)		η = 32 ÷ 160 ✓ 0.20 OR 20% ✓	2	ALLOW 0.2
6			**TOTAL**	**6**	

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