OCR
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 2020

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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.

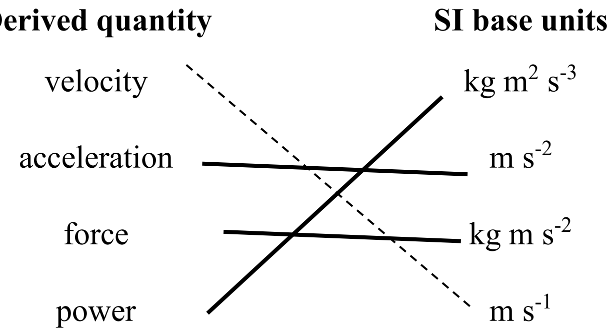
Mark schemes should be read in conjunction with the published question papers and the report on the examination.

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)			2	All three correct, 2 marks One (or two), 1 mark
	(b)		Second box ticked	1	One tick only, no marks if more than one box ticked.
	(c)	(i)	- (minus sign) 1 (kPa)	1 1	
		(ii)	ANY 2 of: Gauge pressure = absolute pressure – atmospheric pressure or wtte. Gauge pressure (of the atmosphere) would be zero / negligible / 1 Absolute pressure of the atmosphere is (equal to the) atmospheric pressure. Gauge pressure is a measure of pressure / force per unit area in an enclosed space or wtte.	2	ALLOW Gauge pressure does not include (excludes) atmospheric pressure
	(d)		finds difference i.e. $1.68 \times 10^{-8} - 1.61 \times 10^{-8} = 7 \times 10^{-10}$ Ωm divides <u>their</u> difference by true value i.e. 0.07÷1.68 = 0.042 or 4.2 (%) OR division 1.61 ÷ 1.68 = 0.958 [1] relative error = 1 – 0.958 = 0.042 or 4.2 (%) [1] division 1.68 ÷ 1.61 = 0.958 = 1.043 [1] relative error = 1.043 – 1 = 0.043 or 4.3 (%) [1]	1 1	ALLOW division by measured value for 2nd MP i.e. accept answer of 0.07÷1.61 = 4.3% [2] ALLOW final answer to be in percentage, decimal or fraction in its simplest form eg 1/24. IGNORE any units given on answer line. BUT 0.042% only gets one mark. IGNORE sign.
1			**TOTAL**	**9**	

Question			Answer	Marks	Guidance
2	**(a)**		Force EITHER giving a mass of 1 kg an acceleration (in the direction of the force) of 1 ms^{-2} OR giving a freely moving body a rate of change of momentum of 1 kg m s^{-2} (in the direction of the force).	1 1	 Units required for second mark. NOT a definition of force.
	(b)	**(i)**	(2cm x 60 kN/cm =) 120 kN	1	within range ± 10 kN
		(ii)	120 kN = 120000 N 120000 ÷ 9.8 =12000 (kg) (actual value 12245 (kg))	1 1	Converting kN to N. ALLOW ecf of value from (b)(i) Dividing by g. ALLOW use of g = 10 ms^{-2} as this also give same value to 2sf. This mark can be gained without the correct unit conversion.
		(iii)	Triangle or parallelogram of forces on diagram (arrows not required). ALLOW a right-angled triangle with Reaction force as the hypotenuse. Measures correct resultant as 4 cm 240kN Award second 2 marks if answer correct using calculation *e.g.* Resolve forces horizontally (280 sin 60° - 0 = 240) and/or vertically (280 cos 60° - 120 = 21) [1]; Resultant = √ ((vertical force)^2 + (horizontal force)^2) = 240 kN OR no/negligible vertical component so resultant = horizontal component [1]	1 1 1	First mark is for the diagram. If nothing relevant on diagram, then a maximum of 2 marks can be awarded. ACCEPT final value between 230kN and 250kN for [2] marks ALLOW reaction force between 270kN and 290kN for calculation method and ALLOW ecf of weight from b(i). ALLOW angle between 55° and 65°. ALLOW final answer in surd form (30√65) for both marks.
		(iv)	point/place/position where the weight/gravitational force (can be considered to) acts .	1 1	
2			**TOTAL**	**10**	

Question			Answer	Marks	Guidance
3	**(a)**		coulomb	1	NOT just ‘C’.
	(b)	**(i)**	Converting current to SI units 1.5×10^{-9} (A) Evidence of substituting correct values into equation I = nAve (any subject); Rearrangement of equation with numbers or symbols [$v = I \div nAe$ or $v = 1.5 \times 10^{-9} \div (2.5 \times 10^{-4} \times 1.5 \times 10^{16} \times 1.6 \times 10^{-19})$] Evaluation, v = 0.0025 (ms^{-1})	1 1 1 1	If unit conversion is incorrect or missing, the remaining 3 marks can be awarded. Award this mark if equation is stated and all values listed correctly. A correct raw answer eg, 2.5 mm s^{-1} will gain all 4 marks.
	(b)	**(ii)**	negative (circled)	1	ALLOW any clear indication.
	(c)	**(i)**	30 (kΩ)	1	ALLOW value between 28 and 32 kΩ
		(ii)	20 kΩ at 30°C 10 (kΩ) change	1 1	ALLOW value between 18 and 21 kΩ ALLOW ecf from (c)(i). IGNORE sign of final answer.
		(iii)	ANY 2 of: Gradient of graph levels off (at higher temperatures) (or wtte) Change of resistance (at higher temperatures) is small. Thermistor has low sensitivity. Temperature values won’t be precise/accurate.	2	ALLOW by example i.e. values in that range are quoted from graph ALLOW temperature difficult to read for 4th marking point. ALLOW no data above 80 °C or doubt about whether thermistor works above 80 °C, for 1 mark.
3			**TOTAL**	**11**	

Question			Answer	Marks	Guidance
4	(a)		Brittleness ☐ Ductility ✓ Hardness ☐ Malleability ☐ Toughness ✓	 1 1	One mark for each correct tick. If there are more than 2 ticks, an incorrect tick cancels out a correct tick.
	(b)	(i)	Read off extension from graph = 0.0025 (m) (Strain =) 0.0025 ÷ 17.5 = 0.00014	1 1	ALLOW value between 0.0022 and 0.0028. If read off is outside acceptable range above, but between 0.0020 and 0.0030, then the calculation mark can be awarded with ecf. IGNORE any units given.
	(b)	(ii)	extends linear section or indicates read-off at end of linear section or states in words that the line is no longer linear (or wtte) Any value between 40 and 48 (kN)	1 1	
	(b)	(iii)	Read off extension at 30 kN load (0.0034 > x > 0.0039) Recall equation E = ½ Fx (or E = ½ kx^2) or evidence of area under graph. ½ x 0.00375 x 30 = 0.05625 OR ½ x 0.00375 x 30000 = 56.25 (0.05625) **<u>kJ</u>** or (56.25) **<u>J</u>**	1 1 1 1	 Ignore POT of Force value in calculation. ALLOW Nm instead of J. Unit must be consistent with value of force used to gain the final mark. If no evidence of calculation unit mark can be awarded for kJ on its own.
4			**TOTAL**	**10**	

Question			Answer	Marks	Guidance
5	**(a)**		Liquid Gas	1 1	Accept plasma
	(b)		Upthrust or force on an immersed object, equals <u>weight</u> of fluid displaced.	1 1	ALLOW force due to buoyancy. DO NOT ALLOW mass of fluid, but mass of fluid × g is acceptable
	(c)		Weight of boat or mg = Upthrust or Vρg Substituting into volume = m ÷ ρ or 2500 ÷ 1020 or 24500 ÷ 1020g = 2.5 (m^3)	1 1 1	NOT upthrust = Vρg, as that is given in the formula booklet. Any subject. This mark is for substituting. Actual value = 2.45 m^3.
	(d)		Irregular paths / not following a streamline / random directions Random speed / velocity	1 1	ALLOW chaotic motion / eddies. ALLOW not all at the same speed/velocity.
	(e)		P = VI = 48 x 85 4080 W = 4.1 (kW)	1 1	 Actual value = 4.08 kW.
	(f)		Input power (= 3.1 ÷ 0.85) = 3.6 kW Substituting into E = Pt [30 = 3.6 × t] t = 8.2 (hours) OR Available power from battery = 0.85 x 30 kWh = 25.5 kWh Substituting into E = Pt [25.5 = 3.1× t] t = 8.2 (hours) OR Substituting into E = Pt [30 = 3.1 × t] time = 9.7 with 85% efficiency t = 0.85 x 9.7 = 8.2 (hours)	1 1 1 (1) (1) (1) (1) (1) (1)	 Any subject ALLOW answer given to 1sf. A final answer of 9.7 hours will get 2 marks. If input power = 3.1×0.85 = 2.6 kW, to give a final answer of 11 hours, 1 mark can be awarded.
5			**TOTAL**	**14**	

Question			Answer	Marks	Guidance
6	**(a)**		(have) minimum (internal) energy	1	DO NOT ALLOW zero energy ALLOW have particles with zero vibrational / kinetic energy. ALLOW have particles that don't move / vibrate.
	(b)		291 (K)	1	
	(c)		Converting volume to SI units: 5 litres = 0.005 m^3 Substituting values into pV = nRT (any subject) Correct rearrangement of equation; eg n = (105000 x 0.005) ÷ (8.314 x 291) 0.22 (moles)	1 1 1 1	 IGNORE POT for substitution mark. Award substitution mark if equation is stated and all correct values seen. ALLOW 18°C for sub mark. Using T = 18°C can gain a maximum of 3 marks; eg answer = 3.5. ALLOW ecf for T value given in part (b).
6			**TOTAL**	**6**	

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