Cambridge Technicals
Engineering

Unit 2: Science for engineering

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

Mark Scheme for January 2021

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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

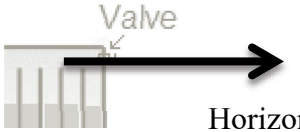
In all numerical calculation questions a correct response to 2 sf will gain all marks unless specified otherwise. You do not need to see all the workings if the answer is correct.

Question			Answer	Marks	Guidance
1	(a)	(i)	Balance	1	ALLOW scale(s)
		(ii)	Ammeter	1	ALLOW ameter, ammetre but NOT ampmeter. ALLOW galvanometer, multimeter
	(b)		The error of a measuring instrument (under reference conditions)	1	ALLOW a named measuring device eg scales or ammeter.
	(c)		ANY 3 of: Expose to known temperature(s) (eg place in ice water bath), Leave for time to reach equilibrium, Mark/compare scale value, Repeat at a second temperature, Divide scale accordingly between marked points, Calculate correction/adjustment needed,	3	
1			**TOTAL**	**9**	

Question			Answer	Marks	Guidance
2	(a)	(i)	distance ÷ time or 5 ÷ 20 (or any other coordinate values taken from graph) 0.25 (km min^{-1})	1 1	
		(ii)	× 1000 = 2500 m/min ÷ 60 = <u>4.2</u> (ms^{-1})	1 1	ALLOW ecf from candidate's value in part (i). Final value needed for both marks.
	(b)	(i)	ANY 2 of: Distance is a scalar / displacement is a vector. Displacement is measured from original starting position / distance is how far in total. Scalar/distance does not take account of direction and/or vector/displacement includes direction.	2	ALLOW cyclist goes in one direction and same distance in the opposite direction for third marking point.
		(ii)	10 km = 10000 m Work done = Force × distance = 800 × 10000 = 8,000,000 Unit = J (or Nm)	1 1 1	Conversion to SI units. Evidence of substituting values correctly into equation. ALLOW ecf of incorrect or no conversion. Unit must be consistent with value (eg 8 MJ is correct). [If 5km used instead of 10 km, then final value of 4,000,000 J will score MAX 2 marks out of 3.]
	(c)		F = 300 × cos50 (any subject) = 190 (N) [to 2sf]	1 1	i Ignore sign of answer.
2			**TOTAL**	**11**	

Question			Answer	Marks	Guidance
3	(a)		Charge (stored) per unit potential difference / volt	1	ALLOW charge ÷ potential difference or Q/V
	(b)		$0.8\ \mu F = 8 \times 10^{-7}\ F$ $V = Q \div C = 2\times10^{-5} \div 8\times10^{-7}$ $V = 25\ (V)$	1 1 1	Conversion to SI units. Evidence of correct substitution into equation. ALLOW ecf of incorrect or no conversion.
	(c)		$E = V/d = 20 / 5\times10^{-4}$ $40{,}000\ (Vm^{-1})$	1 1	Evidence of correct substitution into equation
	(d)		$5\tau \approx 1$ second. $\tau = CR$ so $R = \tau / 8\times10^{-7}$ $R = 0.25 \times 10^{6}\ (\Omega)$	1 1 1	 Rearrangement and substitution into correct equation. Answer of $R = 1.25 \times 10^{6}\ \Omega$ gains 2 marks if used $\tau \approx 1$ second].
3			**TOTAL**	**9**	

Question			Answer	Marks	Guidance
4	(a)		Strong Compressive	1 1	Correct answers circled or indicated clearly.
	(b)	(i)	No of bricks above window = ½× 8 × 8 = 32 bricks (area of triangle) OR Count bricks [accept value between 30 and 36 for this mark point] Mass of bricks = no of bricks × 3.5 Weight of bricks = mass × *g* = a value which rounds to 1100 to 2sf.	1 1 1	If 36 I used final value does not round to 1100, so 2 marks max No marks can be awarded for a value given appx. 1100 without supporting workings.
		(ii)	Beam 2 because it's the lowest value/small amount above the load requirement. OR Beam 3 Maximum load allows for a safety margin (wtte)	1 1	 NOT just beam 3 has the highest value.
		(iii)	ANY 3 of: (Planes of) atoms slip / slide Bonds between atoms break <u>and reform</u> (with other atoms) Dislocations move through structure / crystals permanent(ly) / irreversible / no return to original / equilibrium separation / starting <u>position/place</u>	3	 ALLOW layers of atoms move for slip NOT just bonds break NOT original shape Only one mark maximum for macroscopic explanation (fourth marking point)
		(iv)	ANY 1 from: Testing (few) beams to destruction assumes all other beams have similar properties. Destructive testing to measure load/stress at elastic limit/failure (or RA for NDT) Cost argument e.g. NDT expensive or beams inexpensive/plentiful Safety argument e.g. can test to plastic deformation safely	1	ALLOW accessibility of skills argument
4			**TOTAL**	**11**	

Question			Answer	Marks	Guidance
5	(a)	(i)	Gauge pressure is the pressure measured/seen on meter/gauge. Absolute pressure is the sum of gauge and atmospheric pressure.	1 1	ALLOW absolute pressure includes atmospheric pressure, but not 'accounts for'.
		(ii)	250 (kPa)	1	
	(b)	(i)	15°C = 288K and / or 55°C = 328K Evidence of use of P÷T = constant. P = 220 × 328/288 = 250 (kPa) [to 2sf]	1 1 1	Conversion of either temperatures to Kelvin. If <u>both</u> temperatures remain in °C final value = 807 kPa. 2 marks maximum.
		(ii)	 Horizontal arrow to the right	1	
		(iii)	ANY 2 of: Pressure difference causes a net force (on the air) Air flows down a pressure gradient Pressure inside > pressure outside Results in equal pressure / equilibrium	2	ALLOW balance.
		(iv)	Decrease Less air/water in same space.	1 1	
	(c)		11000 W or Watt	1 1	NOT Js^{-1}.
5			**TOTAL**	**13**	

Question			Answer	Marks	Guidance
6	(a)		Kinetic energy of particles(, plus) Potential energy of particles	1 1	ALLOW movement REJECT stored for potential: ALLOW energy due to their position.
	(b)	(i)	Straight line (with a ruler) drawn through points [not too thick or hairy] with a balance of plots either side of line and no rotation.	1	Steepest: (0, 16.8) to (9000, 27.2) Shallowest: (0, 17.1) to (9000, 26.9)
		(ii)	EITHER: c = 1 ÷ (gradient of line × m). Calculation of gradient (or reciprocal) taken from 2 points on line = 1 ÷ (0.0011 × 1.1) = 830 J kg^{-1} K^{-1} [790 ≥ c ≥ 870] OR: Rearrangement c = E ÷ m Δθ (could be with values taken from graph) Substitution of suitable values taken from points on the line [eg c = 9000 ÷ (1.1 × (27-17)] c = 820 (J kg^{-1} K^{-1}) [790 ≥ c ≥ 870]	1 1 1	Read offs to within a ½ small square. Gradient value should be between 1.09×10^{-3} and 1.16×10^{-3}, but ecf plot points taken from candidate's line. Must be a **temperature range**, not a single temperature
		(iii)	Temperature (E = 1000J) is 18 °C Relative error = 0.5 ÷ 18.0 = 0.03 or 3% [answer can be given to 1SF]	1 1	Ignore incorrect rounding beyond 1SF. If given as percentage, the % needs to be seen. ALLOW fraction in its simplest form (1/36).
		(iv)	ANY 2 of: No change of state. Temperatures involved are far from melting point/freezing point aluminium block remains solid. There is a change in sensible heat.	2	
6			**TOTAL**	**10**	

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