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 June 2017

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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.

OCR will not enter into any discussion or correspondence in connection with this mark scheme.

Subject specific marking instructions

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

- In numerical calculation questions a correct response will gain all marks unless specified otherwise. You do not need to see all the workings if the answer is correct unless it is a 'show that' question.
- Numerical answers should be given to a minimum of 2 significant figures unless specified otherwise. There is usually no penalty for using more than 2 significant figures, but the answer given should equal the stated value when rounded to 2 significant figures.
- Numerical answers given as fractions will not be credited unless specified otherwise.
- Power of ten (POT) errors will lose a max of one mark per calculation.
- In calculation questions where one of the marks is awarded for substitution into the equation, POT errors can be ignored. There will be a penalty in subsequent marks for POT errors.
- Where there is a mark awarded for using a correct equation it can be seen or implied.

Question			Solution	Marks	Guidance
1	(a)	(i)	kg m^{-1} s^{-2}	1	Pressure = force/area ; Pascal = kg m s^{-2}/m^2
1	(a)	(ii)	kg m^2 s^{-3}	1	Power = energy/time = force x distance/time Watt = kg m s^{-2} m/s
1	(b)	(i)	Error- Difference between the true value of a quantity and the value obtained by a measurement (wtte).	1	
1	(b)	(ii)	Uncertainty- Range of values either side of a measurement in which the true value is expected to lie (wtte)	1	Allow range of values either side of a true value.
1	(c)		Pressure	1	
1	(d)	(i)	(Total current) = (10.0 + (10.2 x 2) + (10.4 x 4) + (10.6 x 3)) = 103.8 Mean current = 103.8/10 = 10.38 (A)	1 1	First mark for totalling correctly 3 sf minimum so accept 10.4. No ecf. (10+10.2+10.4+10.6)/4 is XP and scores zero.
1	(d)	(ii)	Sum of squares = $0.38^2 + 2(0.18^2) + 4(0.02^2) + 3(0.22^2)$ = 0.356 [Or: Sum of squares = $\Sigma x^2 - n(\text{mean})^2 = ((10^2 + 2(10.2^2) + 4(10.4^2) + 3(10.6^2)) - 10(10.38^2) = 1077.8 - 1077.444 = 0.356$] Standard deviation =$\sqrt{(0.356/n)} = \sqrt{(0.356/10)} = 0.189$:	1 1	Allow ecf from incorrect value of M in part (i) Allow divide by 9 instead of 10. (SD = 0.199) 3sf minimum
1	(e)		Standard error of the mean = standard deviation/$\sqrt{n}$ = 7.5/$\sqrt{10}$ = 2.37	1	3sf minimum

Question			Solution	Mark	Guidance
2	(a)	(i)	Convert 72 km/h to SI units $v = 72 \times 10^3/3600$ / = 20 m $s^{-1.}$ Use of: $E_k = \frac{mv^2}{2}$ $E_k = \frac{1500*20^2}{2} = 3 \times 10^5$ (J)	 1 1	First mark for conversion. Accept 1 sf here. Ignore unit. If no conversion $E_k = 3.9 \times 10^6$ XP so no marks.
2	(a)	(ii)	P= F v = 500 * 20 P= 500 x 20 = 1 x 10^4 W = 10 kW	1 1	First mark for substituting into equation. Allow ecf from part (i). If v = 72 used, P = 3.6 x 10^4. Accept 1 sf here. **Unit required**.
2	(a)	(iii)	Either: Use of W = Fs so F = W/s and W = 3 x 10^5 J F + 500 (= 3 x 10^5/30 =) 1 x 10^4, so F = 9500 N [accept F = 3 x 10^5 /30 = 1 x 10^4 N = 10 kN] Or: using suvat eqn -a = u^2/2s to give a = -6.7 ms^{-2} F + 500 = ma, so F = (1500 x 6.7) – 500 = 9500 N	 1 1 (1) (1)	 First mark for choosing equation and realising that work done is equal to kinetic energy of the car – accept ecf from part (i). **Unit required**.
2	(b)	(i)	W = mg = m x 9.8 Weight = (30 x 10^{-3}) (9.8) = 0.29 N	1 1	One mark for using the equation, ignoring POT of m. Correct value to 2 sf with **unit** scores both marks.
2	(b)	(ii)	W = F_{CB} cos45° + F_{DB} cos45° (F_{CB} = F_{DB} for symmetry) W = 2 x F_{CB} cos45° F_{CB} = F_{DB} = W/(2 x cos45°)n = 0.29 / (2 x 0.707) F_{CB} = F_{DB} = 0.21 (N)	1 1	Resolve forces vertically (Accept use of sin 45°) Allow ecf of W from part i. Ignore unit If no division by 2 and F = 0.42 N award one mark only.

Question			Solution	Mark	Guidance
3	(a)	(i)	$\frac{1}{Rs} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} = \frac{1}{20} + \frac{1}{40} + \frac{1}{50} / \frac{1}{Rs} = 0.095$ Re = 10.5 (Ω)	1 1	No mark for quoting equation First mark awarded for correct substitution into equation Second mark for final value – no ecf. Accept 2sf so 11Ω is okay. If R = 0.095 this is XP so no marks awarded.
3	(a)	(ii)	I = V/R I = 50 / 10.5 I = 4.8 <u>A</u>	 1 1	No mark for quoting equation First mark for substitution. Second mark tor correct value and **unit.** If correct unit in part (iii) ignore unit here. Allow ecf from incorrect answer in part (i).
3	(a)	(iii)	I = V/R I_2 = 50 / 40 I_2 = 1.25 <u>A</u>	 1 1	No mark for quoting equation First mark for substitution of 50V and a value of resistance of an individual resistor. Second mark tor correct value and **unit**. If correct unit in part (ii) ignore unit here. Only penalise incorrect unit once in parts (ii) and (iii).
3	(a)	(iv)	P = I^2 R or P = I V or V^2/R P = 1.25^2 x 40 or P = 1.25 x 50 or P = 50^2/40 P = 63 W	 1 1	No mark for quoting equation First mark for substitution. Allow ecf of value for I or R used in part (iii). Ignore unit**.**
3	(b)		ρ = RA/l rearranged to give R = ρl/A = 1.68 x 10^{-8} x 10 /3.15 x 10^{-6} R= 0.053 <u>Ω</u>	 1 1	 First mark for substitution into equation (ignore incorrect POT). Correct POT and consistent **unit required** for second mark. Final value of 5.3 x 10^{-8} Ω or 5.3 x 10^{-5} Ω would score 1 mark for POT error.

Question			Solution	Mark	Guidance
4	(a)	(i)	$\varepsilon = \frac{\Delta l}{l}$ Extension = 100 x 10^{-6} (m) 100 x 10^{-6} / 1 = 100 x 10^{-6} = 1 x 10^{-4}	 1 1	No mark for quoting formula Award mark converting extension and original length to the same POT. Award second mark for correct method for calculating strain. One mark in total if incorrect POT error. Ignore any unit given.
4	(a)	(ii)	σ = F/A Correct substitution of Force and area into equation, ignoring POT. (A = (10 x 10^{-3})^2 = 1 x 10^{-4} m^2) 70000 / (1 x 10^{-4}) = 7 x 10^8 Pa or Nm^{-2} or (700 MPa or Nmm^{-2})	 1 1	No mark for quoting formula Correct POT and consistent **unit required**.
4	(a)	(iii)	E = σ/ε E = 7 x 10^8 / 100 x 10^{-6} E = 7 x 10^{12} (Pa)	 1 1	No mark for quoting formula. Award mark for correct use of formula Allow ecf for incorrect values for stress and strain calculated in parts (i) and (ii). Ignore unit.
4	(b)	(i)	A	1	
4	(b)	(ii)	B	1	
4	(b)	(iii)	C	1	
4	(b)	(iv)	A	1	

Question			Solution	Mark	Guidance
5	(a)		The pressure at the bottom of all three containers is identical	1	Bottom box contains tick.
5	(b)		Gauge pressure is the pressure measured/seen on meter/gauge. Absolute pressure is the sum of gauge and atmospheric pressure.	1 1	 "Absolute pressure = gauge pressure + atmospheric pressure" in any form will score one mark max.
5	(c)	(i)	Upthrust force = 50 – 20 = 30 (N)	1	Ignore unit.
		(ii)	Upthrust = volume of cube x g x density of water Volume = Upthrust/ (ρ g) V = 30/(1000 *9.8) V = 0.0031 $\underline{m^3}$ (or 3100 $\underline{cm^3}$)	1 1 1	Use of correct equation. Correct substitution into equation **Unit required**
5	(c)	(iii)	Density of cube = mass/volume Mass of cube = weight / g = 50/9.8 = 5.1 kg Density = 5.1/0.0031 = 1700 $\underline{kg\ m^{-3}}$	 1 1	 Mark for calculating mass of cube. If 30N or 20N used for weight this is XP and scores zero in this section. **Unit required.** If 50 used as mass then award one mark here.
5	(c)	(iv)	Hydrostatic pressure acts towards the surface(s) of submerged body.	1	Can be shown on diagram.

Question			Solution	Mark	Guidance
6	(a)	(i)	Latent heat is energy released or absorbed by the substance at constant temperature resulting in a phase/state change.	1	Need both parts for mark to be awarded.
6	(a)	(ii)	2	1	
6	(b)	(i)	Power output = efficiency x power input Power output = 0.85 x 2000 Power output = 1700 (W)	 1 1	 One mark for correct substitution Ignore unit.
6	(b)	(ii)	Heat required to increase the temperature by 10°C: $Q_o = m\ c\ \Delta T$ $Q_o = 10 \times 718 \times 10$ $Q_o = 71800$ (J)	 1 1	 One mark for correct substitution into equation. If T in Kelvin is used (283) this is XP and scores zero.
6	(b)	(iii)	Energy delivered per second taking into account heat loss: $\Delta Q/\Delta t$ = Power output of heater – energy lost per second = $\dot{Q}_{in} - \dot{Q}_{out}$ $\Delta Q/\Delta t = 1700 - 600 = 1100\ Js^{-1}$ Time required to heat the substance by 10°C: $t = Q_o / (\Delta Q/\Delta t)$ $t = 71800 / 1100 = 65$ s	 1 1 1 1	 Award mark for evidence of correct method. **Unit required.** Allow ecf for incorrect value of Q calculated in part (ii). Award up to two marks for using Power output from part (i) as $\Delta Q/\Delta t$ gives 42 s]

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