

PH1

Question		Marking details	Marks Available
1	(a)	Use of $\cos 40^\circ$ [or $\sin 50^\circ$] (1) [or by impl.] $\left(\frac{200}{\cos 40}\right)(1) = 260 \text{ N}$ [subst or ans]	2
	(b)	(i) Work done = Force \times distance (1) in direction of force (1) There is no movement in the vertical direction [or equiv.] (1) (ii) I. Work done = $200(1) \times 2000 = 4.0 \times 10^5 \text{ J}$ ((unit)) [or 400 kJ] (1) II. $P = \frac{4 \times 10^5(\text{ecf})}{30 \times 60(1)}(1)$ [NB or use of $P = Fv$]	3 2 2
	(c)	Attempt at resultant force calculation (1) $\Sigma F = 261(\text{ecf}) - 200(1) [=61 \text{ N}]$ [correct sign needed] $a = \frac{61}{40} [=1.53 \text{ m s}^{-2}]$ [no ecf on use of 261 N] (1)	3
[12]			
2	(a)	Ammeter shown in series with bulb [or in series with bulb/voltmeter parallel combination] (1) Voltmeter shown in parallel with bulb [or across bulb/ammeter series combination] (1)	2
	(b)	(i) 2.0 A (ii) 6.0 Ω	1 1
	(c)	Either: $\frac{1}{18} + \frac{1}{6(\text{ecf})} = \frac{1}{R_{\parallel}}(1); R_{\text{par}} = 4.5 \Omega(1)$ Subst into pot div equations: $12 = \frac{4.5}{4.5 + R} \times 16(1)$ $R = 1.5 \Omega(1)$ Or: $I_{18\Omega} = \frac{12}{18} [=0.67 \text{ A}](1); \text{ So } I_{\text{total}} = 2.67 \text{ A}$ [ecf from (a)](1) $R = \frac{4(1)}{2.67(\text{ecf})} = 1.5 \Omega(1)$	4
	(d)	Graph shown with positive gradient and linear through the origin for low values (1) and smoothly reducing gradient for higher values [NB – not negative gradients at end](1)	2
[10]			

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3	(a)	Moment [or torque / couple]	1
	(b)	(i) $4.0 \times 0.40 = \Delta \times 0.20$ (1) [or by impl.] Wt of $\Delta = 8.0$ N (1)	2
		(ii) 12.0 N (1)[ecf = 4.0 + (b)(i)]	1
	(c)	(i) $12(\text{ecf})x$ (1) = $9.0(0.8 - x)$ (1) $x = 0.34$ m (1)	3
(ii) x needs to stay the same (1) because force/weight [and hence the moment] at C are unchanged (1) N.B. Ecf from (b)(ii)		2 [9]	
4	(a)	(i) [gradient =] $\frac{v-u}{t}$ (1); represents acceleration [accept: a] (1)	2
		(ii) [Area =] $ut + \frac{1}{2}t(v-u)$ or $\frac{1}{2}(u+v)t$ (1) Represents displacement [accept: distance [travelled in a given direction]] (1)	2
		(iii) Either: $v = u + at$ (1) $x = ut + \frac{1}{2}t(ut)$ shown (1) [or other convincing working]	Or: $v = u + at$ (1) $x = \frac{1}{2}(u + u + at)t(1)$ [or other convincing working]
	(b)	(i) $x = ut + \frac{1}{2}at^2$ used with $u = 0$ (1) $x = 36$ m (1)	2
		(ii) $v = u + at$ used with $u = 0$ (1) [or $v^2 = u^2 + 2ax$ used with $u = 0$] $v = 6$ m s ⁻¹ (1)	2
	(c)	(i) $x = \frac{1}{2}(u+v)t$ used (1) $t = 40$ s (1) [Use of $u = 0$ seen \rightarrow 1 mark penalty]	2
		(ii) Use of $a = \frac{v-u}{t}$ (1) [Use of $u = 0$ seen \rightarrow 1 mark penalty] $a = [-] 0.15$ m s ⁻² (1)	2
	(d)	Axes [inc + and - acceleration; time; labelling] (1) Horizontal line from 0 s at 0.5 m s ⁻² (1) Horizontal line from at -0.15 m s ⁻² [ecf from (c)(ii)] (1) Change of a at 12 s and cease at 52 s (1)	4
	(e)	(i) 157 N	1
		(ii) $\left(\frac{157(\text{ecf})}{4(1)} + 8 \right)$ [= 47 N] (1) [or equivalent working.] NB Use of factor of 2 \rightarrow 0 marks	2 [21]

Question		Marking details	Marks Available
5	(a)	Rearrangement of $R = \frac{\rho l}{A}$ seen [or implied by 2 nd mark]. (1)	
		$\frac{\Omega \text{ m}^2}{\text{m}}$ seen (1) Accept equivalent working in terms of showing homogeneity: 1 st mark insertion of units in equation; 2 nd mark explicit conclusion	2
	(b)	(i) Convincing demonstration, e.g. $\pi \left(\frac{1.3 \times 10^{-3}}{2} \right)^2$ seen	1
		[Ans = $1.327 \times 10^{-9} \text{ m}^2$]	
		(ii) $R = \frac{1.7 \times 10^{-8} \times 20}{1.3(\text{or } 1.33) \times 10^{-6}}$ [=0.26 Ω]	1
		(iii) $\frac{0.26(\text{ecf})}{14}$ [or correct use of parallel formula] (1) = 0.019 Ω (1) If resistivity formula used, 1 st mark for $A \times 14$.	2
		(iv) Use of $P = I^2 R$ [or equiv, e.g. $P = IV$ and $V = IR$] (1) $\left(\frac{9 \times 0.26}{9 \times 0.19} \right)$ [NB 9 not 3] or $\left(\frac{I^2 R}{I^2 R / 14} \right)$ (1)	
		Answer in range 13 – 14.5 : 1 (1)	3
		(v) I. Less power loss in whole / larger cable [for a given current] / or smaller resistance [accept: if 1 strand breaks there will still be continuity.]	1
		II. More flexible [or less prone to snap with repeat bending] /if 1 strand breaks there will still be continuity [accept only once]	1
	(c)	(i) $7.52 - 7.7 \times 10^{28} \text{ m}^{-3}$	1
		(ii) Substitution in or re-arrangement of $I = nAve$ to give v : $v = \frac{I}{nAe}$ or $3.0 = \frac{7.7 \times 10^{28}(\text{ecf}) \times 1.3 \times 10^{-6} \times 1.6 \times 10^{-19}}{v}$ (1) [NB No ecf on n if 2.0×10^{24} used] $v = 1.9 \times 10^{-4} \text{ m s}^{-1}$ (1)	2
(iii) I , n and e do not change (1) A increased by $\times 14$ (1) v reduced by same ration $\rightarrow 1.36$ [1.4] $\times 10^{-5} \text{ m s}^{-1}$.(1)		3	
		[17]	

Question		Marking details	Marks Available
6	(a)	(i) V is the terminal p.d. – or clear explanation in energy terms: energy per coulomb delivered to external circuit / [NB “per coulomb” / “per unit charge” required on one of (i) and (ii) if energy explanation given]	1
		(ii) P.D. across the internal resistance [accept lost volts – “bod”] / energy per coulomb lost / dissipated in the internal resistance / cell	1
	(b)	(i) 2.4 V	1
		(ii) 0.4 Ω [allow e.c.f. from (b)(i)]	1
		(iii) e.g. “Drains” the cell <u>quickly</u> , Cell gets hot	1
	(c)	Correct use of $I = \frac{E}{R_{\text{Tot}}}$ $I = 1.0 \text{ A}$	2
	(d)	Trial and error acceptable: Use of $1 \times, 2 \times, 3 \times \dots$ (1); corresponding total resistance (1); use of $\frac{V}{R}$ (1) leading to 5 cells (1)	
		Nice answer: Subst in $I = \frac{E}{R+r} : 3.0 = \frac{2.4n}{2.0+0.4n}$ [ecf on $n \times 2$](1) Re-arrangement: $6.0 + 1.2n = 2.4n \rightarrow n = 5$	
		Marking points with analytical answer: $n \times 2.4$ (1) Use of total resistance = $2.0 + 0.4 n$ (1)	
		Application of $I = \frac{V}{R}$ (1); $n = 5$ (1)	4
			[11]