PH1

Question			Marking details	Marks Available
1	*(a)*		Use of cos 40° [or sin 50°] (1) [or by impl.] $\left(\frac{200}{\cos 40}\right)$(1)= 260 N [subst or ans]	2
	(b)	(i)	Work done = Force × distance (1) in direction of force (1) There is no movement in the vertical direction [or equiv.] (1)	3
		(ii)	I. Work done = 200 (1) × 2000 = 4.0 × 10^5 J ((**unit**)) [or 400 kJ] (1) II. $P = \frac{4\times10^5\text{(ecf)}}{30\times60\text{(1)}}$ (1) [NB or use of $P=Fv$]	2 2
	(c)		Attempt at resultant force calculation (1) ΣF = 261 (ecf) – 200 (1) [=61 N] [correct sign needed] $a = \frac{61}{40}$ [=1.53 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	1
		(ii)	6.0 Ω	1
	(c)		**Either:** $\frac{1}{18}+\frac{1}{6\text{(ecf)}}=\frac{1}{R_{\parallel}}$ (1); R_{par} = 4.5 Ω (1) Subst into pot div equations: $12 = \frac{4.5}{4.5+R}\times16$ (1) R = 1.5 Ω (1) **Or**: $I_{18\,\Omega} = \frac{12}{18}$ [=0.67 A] (1); So I_{total} = 2.67 A [ecf from *(a)*](1) $R = \frac{4\text{(1)}}{2.67\text{(ecf)}}$ = 1.5 Ω (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(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) $x = ut + ½t(ut)$ shown (1) [or other convincing working] Or: $v = u + at$ (1) $x = ½(u + u + at)t$(1) [or other convincing working]	2
	(b)	(i)	$x = ut + ½at^2$ 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 2nd mark]. (1) $\frac{\Omega\ \mathrm{m}^2}{\mathrm{m}}$ seen (1) Accept equivalent working in terms of showing homogeneity: 1st mark insertion of units in equation; 2nd mark explicit conclusion	2
	(b)	(i)	Convincing demonstration, e.g $\pi\left(\frac{1.3\times10^{-3}}{2}\right)^2$ seen [Ans = 1.327×10^{-9} m^2]	1
		(ii)	$R = \frac{1.7\times10^{-8}\times20}{1.3(\text{or }1.33)\times10^{-6}}$ [=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, 1st mark for A × 14.	2
		(iv)	Use of $P = I^2R$ [or equiv, e.g. $P = IV$ and $V = IR$] (1) $\left(\frac{9\times0.26}{9\times0.19}\right)$ [NB 9 not 3] **or** $\left(\frac{I^2R}{I^2 R/14}\right)$ (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 × 10^{28} m^{-3}	1
		(ii)	Substitution in or re-arrangement of $I = nAve$ to give v: $v = \frac{I}{nAe}$ or 3.0 = 7.7 × 10^{28}(ecf) × 1.3 × 10^{-6} × 1.6 × $10^{-19}v$(1) [NB No ecf on n if 2.0 × 10^{24} used] v = 1.9 × 10^{-4} m s^{-1} (1)	2
		(iii)	I, n and e do not change (1) A increased by × 14 (1) v reduced by same ration → 1.36 [1.4] × 10^{-5}m s^{-1}.(1)	3
				[17]

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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 quickly, Cell gets hot	1
	(c)		Correct use of $I = \frac{E}{R_{\text{Tot}}}$ $I = 1.0$ A	2
	(d)		Trial and error acceptable: Use of 1 ×, 2 ×, 3 × … (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 × 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]