PH1

Question			Marking details	Marks Available
1	(a)	(i)	[For a metallic conductor] the potential difference and current are [directly] proportional/ I α V (1), provided the temperature remains constant / all physical factors remain constant (1) V = IR only no marks	2
		(ii)	It is constant / stays the same /increases as the temperature increases	1
	(b)	(i)	$A = 1.5(3) \times 10^{-8}$ [m^2](1) $R = \frac{\rho l}{A} = \frac{95 \times 10^{-8} \times 3.2}{1.5(3) \times 10^{-8}}$ (1) = 199 [Ω] (1)	3
		(ii)	$\frac{230^2}{200}$ = 265 [W] allow e.c.f. from (b)(i)	1
		(iii)	$\frac{1}{66.7(1)} = \frac{1}{200} + \frac{1}{R_2}$ (1) R_2 = 100 [Ω] (1)	3
		(iv)	R_2 (1) **either** reference to $\frac{V^2}{R}$ so lower *R* / same V across lower R **or** reference to I^2R so greater *I* **or** reference to *IV* so *I* increased [for constant *V*] **or** correct calculation of R_2 (1)	2
		(v)	$\frac{230}{66.7}$ = 3.5 [A] allow e.c.f. from (b)(iii)	1
			Question 1 total	**[13]**
2	(a)	(i)	Diagram to include • Correct electric circuit with ohmmeter **or** power supply with ammeter + voltmeter with correct symbols and positioning (1) • Method of heating shown (1) • Method of recording temperature shown (1)	3
		(ii)	Linear [or approximately linear] graph with positive gradient (1) and positive intercept on *R* axis (1).	2
	(b)	(i)	Conducting / delocalised / free electrons (1) collide (1) with metal lattice / atoms / ions (1) [not with other free electrons]	3
		(ii)	The greater the temperature the greater the vibrational energy of the lattice / metal ions (1) producing a greater chance [or rate] of collisions/ collisions more often / greater frequency of collisions (1) [not harder] .	2
			Question 2 total	**[10]**

Question			Marking details	Marks Available
3	(a)	(i)	Rate of change of velocity or $\frac{v-u}{t}$ or change in velocity / time taken	1
		(ii)	(u = 0) (1) [or by impl.] Acceleration = $\frac{6.0}{0.8}$ = 7.5 m s^{-2} (1) UNIT mark	2
	(b)		After release there are no [horizontal] forces acting [on the trolley] (1) so it travels with constant speed [to the left] (1). When Nigel catches it there is a force on the trolley to the right / towards Nigel (1) which causes the trolley to decelerate/ slow down/ stop moving [to rest] (1)	4
			Question 3 total	**[7]**
4	(a)		E_P = (7.0 × 10^6 × 1000)(1) × 9.81 × 600 (1) [= 4.1 × 10^{13}] 1st mark – use of density equation to get 7.0 x 10^9 kg 2nd mark – use of *mgh*	2
	(b)		Energy available per second = 0.9 × 4.1 × 10^{13} [= 3.6 × 10^{13}] J (1) allow e.c.f. from (a) Time = $\frac{3.6\times10^{13}}{6\times300\times10^{6}(1)}$ [= 2 × 10^4 [s] / 5.6 [hour]] (1)	3
	(c)	(i)	$\frac{7.0\times10^{9}}{2\times10^{4}\text{e.c.f.}}$ = 3.5 × 10^5 [kg s^{-1}] allow e.c.f from (a) and (b)	1
		(ii)	E_k per second [= ½ × 3.5 × 10^5 × 20^2] = 7 × 10^7 [J s^{-1}] allow e.c.f from (c)(i)	1
		(iii)	Energy wasted per second = $\frac{10\%\times4\times10^{13}\text{ J}}{2\times10^{4}\text{ s}}$ (1) allow e.c.f. from (a) and (b) [or equiv, or by impl.] = 2 × 10^8 [W] (1)	2
		(iv)	% lost in E_k = $\frac{7\times10^{7}}{2\times10^{8}}$ [e.c.f. on (ii) and (iii)] = 35%	1
		(v)	Any sensible answer, e.g. [k.e. in] water turbulence, [work against] friction in turbines, drag/friction between water and pipes not just heat or sound or refilling the high level reservoir.	1
			Question 4 Total	**[11]**

Question			Marking details	Marks Available
5	(a)	(i)	Electron	1
		(ii)	Negative charges repelled [by rod] (1) and move from A to B/ to the right (1) leaving A with a net positive charge (1)	3
		(iii)	Diagram with A shown as positive and B as negative (1) and the charges shown on the sides of the sphere which are nearly touching.(1)	2
	(b)	(i)	[$1.6 \times 10^{-19} \times 300 \times 10^{9}$ =] 4.8×10^{-8} C UNIT mark	1
		(ii)	$I = \frac{4.8\times10^{-8}}{20\times10^{-12}}$ (1) = 2.4×10^{3} [A] (1) allow e.c.f from (b)(i)	2
			Question 5 Total	**[9]**
6	(a)	(i)	$\frac{\text{[Total] distance}}{\text{time}}$ not rate of change of distance	1
		(ii)	$\frac{\text{displacement}}{\text{time}}$ not rate of change of displacement	1
	(b)	(i)	$\frac{6.0}{25}$ = 0.24[m s^{-1}]	1
		(ii)	$\frac{\sqrt{3.5^2+2.5^2}\,(1)}{25}$ = 0.17 [m s^{-1}](1)	2
	(c)	(i)	$E = IVt$ <u>used</u> [i.e. relevant numbers substituted] (1) Energy stored = 2.5 × (60 × 60) or 1.25 x 2 x (60 x 60) (1) × 15.0 i.e. conversion to seconds $E = 1.35 \times 10^{5}$ [J] or 37.5 Watt hours (1) Watt hours unit needed	3
		(ii)	$\frac{1.35\times10^{5}}{30}$ (1) = 4.5×10^{3} s [= 1¼ hour] (1) allow e.c.f. from (c)(i)	2
	(d)	(i)	Power = $\frac{\text{Work [or energy]}}{\text{time}} = \frac{F\times d}{t}$ Identification of work as $F \times d$ in context of power equation (1) Identification of velocity as d/t (1)	2
		(ii)	9 = F × 0.24 (1) [or by impl. – use of 0.24 m s^{-1}, i.e. identification of relevant v] allow e.c.f. from (b)(i) F = 37.5 [N] (1)	2
			Question 6 Total	**[14]**

Question			Marking details	Marks Available
7	(a)		Relevant pairs of values chosen (1) [e.g. 10 m $s^{-1} \rightarrow$ 8 m and 20 m $s^{-1} \rightarrow$ 32 m] Method / strategy, e.g compare $\frac{\text{distance}}{\text{speed}^2}$ for the pairs of values. (1) Conclusion clearly linked to calculation (1) Allow e.c.f for values of pairs if marking points 2 and 3 completed correctly.	3
	(b)	(i)	Identification of relevant equation: e.g. $v^2 = u^2 + 2ax$ (1) Identification of x = 18 m (1) deceleration = 6.3 [m s^{-2}] or a = -6.3 [m s^{-2}] (1)	3
		(ii)	$F = 800 \times 6.3 = 5000$ [N] allow e.c.f. from (b)(i)	1
	(c)		Reaction time is independent of speed / doesn't change (1) Then $v \propto d$ [from $d = vt$] (1)	2
	(d)	(i)	21 + 72 = 93 [m]	1
		(ii)	No change to thinking distance (1) [Reduced acc/deceleration would] increase braking distance (1)	2
	(e)		Time required = $\frac{\text{total distance}}{\text{speed}} = \frac{10}{50}$ [= 0.2 hour] (1) Time for first 6.0 km = $\frac{6.0}{80}$ [= 0.075 hour] (1) remaining time = 0.2 – 0.075 = 0.125 hour (1) Speed for remaining 4 km = $\frac{4}{0.125}$ = 32 [km / h] or 8.9 [m s^{-1}] (1)	4
			Question 7 Total	**[16]**