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) $R = \dfrac{\rho l}{A} = \dfrac{95 \times 10^{-8} \times 3.2}{1.5(3) \times 10^{-8}}$ (1) = 199 [Ω] (1)	3
		(ii)	$\dfrac{230^2}{200} = 265$ [W] allow e.c.f. from (b)(i)	1
		(iii)	$\dfrac{1}{66.7(1)} = \dfrac{1}{200} + \dfrac{1}{R_2}$ (1) $R_2 = 100$ [Ω] (1)	3
		(iv)	R_2 (1) **either** reference to $\dfrac{V^2}{R}$ 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)	$\dfrac{230}{66.7} = 3.5$ [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 $\dfrac{v-u}{t}$ or change in velocity / time taken	1
		(ii)	($u = 0$) (1) [or by impl.] Acceleration = $\dfrac{6.0}{0.8}$ = 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 = $(7.0 \times 10^6 \times 1000)$(1) $\times$ 9.81 $\times$ 600 (1) [= 4.1×10^{13}] 1st mark – use of density equation to get 7.0×10^9 kg 2nd mark – use of mgh	2
	(b)		Energy available per second = $0.9 \times 4.1 \times 10^{13}$ [= 3.6×10^{13}] J (1) allow e.c.f. from (a) Time = $\dfrac{3.6 \times 10^{13}}{6 \times 300 \times 10^6 (1)}$ [= 2×10^4 [s] / 5.6 [hour]] (1)	3
	(c)	(i)	$\dfrac{7.0 \times 10^9}{2 \times 10^4 \,\text{e.c.f.}}$ = 3.5×10^5 [kg s^{-1}] allow e.c.f from (a) and (b)	1
		(ii)	E_k per second [= ½ $\times$ $3.5 \times 10^5 \times 20^2$] = 7×10^7 [J s^{-1}] allow e.c.f from (c)(i)	1
		(iii)	Energy wasted per second = $\dfrac{10\% \times 4 \times 10^{13} \,\text{J}}{2 \times 10^4 \,\text{s}}$ (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 = $\dfrac{7 \times 10^7}{2 \times 10^8}$ [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)	$I = \dfrac{4.8 \times 10^{-8}}{20 \times 10^{-12}}$ (1) = 2.4×10^3 [A] (1) allow e.c.f from (b)(i)	2
			Question 5 Total	**[9]**
6	(a)	(i)	$\dfrac{\text{[Total] distance}}{\text{time}}$ not rate of change of distance	1
		(ii)	$\dfrac{\text{displacement}}{\text{time}}$ not rate of change of displacement	1
	(b)	(i)	$\dfrac{6.0}{25} = 0.24[\text{ m s}^{-1}]$	1
		(ii)	$\dfrac{\sqrt{3.5^2 + 2.5^2}\,(1)}{25} = 0.17 \text{ [m s}^{-1}](1)$	2
	(c)	(i)	$E = IVt$ <u>used</u> [i.e. relevant numbers substituted] (1) Energy stored = $2.5 \times (60 \times 60)$ or $1.25 \times 2 \times (60 \times 60)$ (1) $\times 15.0$ i.e. conversion to seconds $E = 1.35 \times 10^5$ [J] or 37.5 Watt hours (1) Watt hours unit needed	3
		(ii)	$\dfrac{1.35 \times 10^5}{30}$ (1) = 4.5×10^3 s [= 1¼ hour] (1) allow e.c.f. from (c)(i)	2
	(d)	(i)	Power = $\dfrac{\text{Work [or energy]}}{\text{time}} = \dfrac{F \times d}{t}$ Identification of work as $F \times d$ in context of power equation (1) Identification of velocity as d/t (1)	2
		(ii)	$9 = F \times 0.24$ (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} → 8 m and 20 m s^{-1} → 32 m] Method / strategy, e.g compare $\dfrac{distance}{speed^2}$ 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 = $\dfrac{total\ distance}{speed} = \dfrac{10}{50}$ [= 0.2 hour] (1) Time for first 6.0 km = $\dfrac{6.0}{80}$ [= 0.075 hour] (1) remaining time = 0.2 − 0.075 = 0.125 hour (1) Speed for remaining 4 km = $\dfrac{4}{0.125} = 32$ [km / h] or 8.9 [m s^{-1}] (1)	4
			Question 7 Total	**[16]**