PH1 Mark Scheme – January 2010

Question			Marking details	Marks Available
1.	*(a)*		Flow of charge [accept ….charge/ions] **or** $\frac{[\Delta]Q}{[\Delta]t}$, if the symbols defined	1
	(b)	(i)	Sum of areas of triangle and rectangle areas attempted [or reasonable attempt at area of trapezium] (1) Q = 3.0 C ((**unit**))(1)	2
		(ii)	No. of electrons = $\frac{3.0(\text{e.c.f.})}{1.6\times10^{-19}(1)}$ = 1.9 × 10^{-19} (1) [1st mark div by e]	2
		(iii)	I = 1.2(0) A (from graph) (1); $v = \frac{I}{nAe}$ [manipulation shown – could be in following substitution – or by impl.](e.c.f. on I)(1) = 3.75 × 10^{-5} m s^{-1} [accept 3.8 × 10^{-5} m s^{-1}] (e.c.f. on I) (1)	3
				[8]
2.	*(a)*		Free [or equiv, e.g. conducting / moving / delocalised] electrons (1) collide / interact / hindered [by] (1) with atoms / ions of metal conductor / lattice ["particles" b.o.d.](1)	3
	(b)	(i)	I. [0 – 2 V]: Resistance constant / changes by v. small amount II. [2 – 8 V]: Resistance increases	1 1
		(ii)	**Either** $R_{\text{bulb}} = \frac{6.0}{0.8(1)}$ = 7.5 Ω (1) Total resistance = 5 Ω (1) [ecf] [Correct use of $\frac{1}{R}=\frac{1}{R_1}+\frac{1}{R_2}$] I = 1.2 A (1) [ecf on R] **Or** I through 15Ω = $\frac{6.0}{15}$ (1)= 0.4 A (1) I through bulb = 0.8 A (1) ∴ Total current = 1.2 A (1)	4
		(iii)	Subst in $P = I^2R$ [ecf on R and I] **or** in $P=\frac{V^2}{R}$ [ecf on R only] **or** $P=IV$ [ecf on I only] (1) P = 7.2 W (1)	2
				[11]

Question			Marking details	Marks Available
3.	*(a)*		The electrical (potential) energy transferred [or work done] *per coulomb / unit charge* passing through the cell [Underlined (1); *italic* (1)]	2
	(b)		Voltmeter shown in parallel with cell [outside the dotted line – accept inside the line if outside the cell/i.r combination] [Accept equivalent, e.g. connected in parallel with resistor]	1
	(c)		All points correctly plotted (2) [−1 per mistake, min 0] Line correctly drawn [with extrapolation just to V axis] (1)	3
	(d)	(i)	[e.m.f. =] 1.6 V	1
		(ii)	gradient attempted [or by impl.](1); r = 0.33 Ω / 0.3 Ω / $^1/_3$Ω (1)	2
				[10]
4.	*(a)*	(i)	$\frac{\text{Total distance}}{\text{[Total] time}}$ [or equiv.] [**Not** rate of change of distance]	1
		(ii)	Time for the whole journey = 3 h + 4 h = 7 h (1) [or 25 200 s] Mean speed $= \frac{480(1)}{7}\left[\frac{480000}{25200}\right]$ =68.6 km h^{-1} (1)[accept 69 – not 70]	3
	(b)	(i)	Forward force labelled Driving / engine force **and** reverse force labelled Friction / drag / air resistance]	1
		(ii)	Maximum at t = 0 (s) [accept: starts high at t = 0](1) Decreases (1) to zero [after 8 s] (1)	3
		(iii)	$a = \frac{\Delta v\text{(from tangent)}}{\Delta t\text{ (from tangent)}}$ (= 2.75 [accept 2.6 – 2.9] m s^{-1}) (1) $\sum F = ma$ / $\sum F$ = 350 × 2.75(ecf) (1)= 962.5 [accept 910 – 1015] N (1)	3
	(c)	(i)	Force × distance (moved) (1) in the direction of the force (1) [or equivalent, e.g. component of force in the direction of motion × distance moved, $Fd\cos\theta$ if symbols defined]	2
		(ii)	Power $P = \frac{\text{work done}}{\text{time}}$ or $P = \frac{Fd}{t}$ (1) d/t identified with v (1) [by impl. if $F{\times}d$ / t used to define power]	2
		(iii)	$F = \frac{40\times10^3}{18}$ [=2200 N]	1
	(d)	(i)	Energy cannot be created or destroyed only changed from one form to another.	1
		(ii)	Brake pads and wheel discs heat up (1) [accept k.e. → heat energy] Reference to particles' gaining energy (1)	2
				[20]

Question			Marking details	Marks Available
5.	*(a)*	(i)	Wire with rule positioned (1) and labelled moving pointer / jockey / croc clip (1) **Either c**orrectly positioned ohm-meter with no power supply **or** correctly position ammeter and voltmeter with power supply (1)	3
		(ii)	[Different] length[s] of wire (1) **Either** measure V and I **or** measure / read R (1)	2
		(iii)	Diameter of wire [not radius or csa by accept "thickness"] with micrometer / vernier calliper	1
		(iv)	cross-sectional area fro πr^2 or $\pi(d/2)^2$ (1) graph of R against l [**or** mean value of R/l] (1) ρ = gradient × [cs]a [**or** mean value of R/l × csa] (1) [NB $R = V/I$ given here can be used to credit 2nd mark of (ii)] [NB Finding R for a measured length and [cs] area and then ρ calculated → 1 only]	3
	(b)	(i)	$R \propto l$ (1) $\therefore$ R increases as strain gauge gets longer (1) $R \propto {}^1/A$ (1) $\therefore$ R increases as the strain gauge gets thinner (1) [**or** $R = \frac{\rho l}{A}$ or $\rho = \frac{RA}{l}$ (1), A increases & l decreases (1) ρ doesn't change /constant (1) so resistance increases (1)]	4
		(ii)	[csa =] $0.2 \times 10^{-3} \times 0.0012 \times 10^{-3}$ [or equiv.] (1) $\rho = 4.9 \times 10^{-7}$ Ω m ((**unit**)) (1) [ecf from csa calculation] [ecf on powers of 10 in both A and l]	2
		(iii)	**Either** $1.6 = \frac{650}{650 + R} \times 6$ (1) Manipulation (1); R = 1788 Ω (1) **Or** $I = \frac{1.6}{650}$ (=2.46 × 10^{-3} A) (1) $R = \frac{(6-1.6)(1)}{2.46 \times 10^{-3}}$ = 1788 Ω (1)	3 **[18]**

Question			Marking details	Marks Available
6.	*(a)*	(i)	Horizontal arrow [by eye] to right, close to **A**, labelled **D**. (1)	
		(ii)	Vertically downwards arrow at **A** labelled **F**. (1)[NB if other force(s) labelled, s.i.f. →0]	2
	(b)	(i)	$U_H = \frac{4.50}{1.50}\left(=3.0\,\text{m s}^{-1}\right)$	1
		(ii)	Use of relevant equation, e.g. $v = u + at$ or $v^2 = u^2 + 2ax$ (1) [or by impl.] Correct subst e.g. $0 = u - 9.81\times 0.75$ or $0 = u^2 - 2\times 9.81\times 2.75$ (1) [or by impl.] Answer U = 7.3 / 7.35 / 7.4 m s^{-1} (1)	3
		(iii)	$U = \sqrt{3.0^2 + 7.4^2}$ [or $U^2 = 3^2 + 7.4^2$] (1) [e.c.f. on both velocities] = 7.9 – 8.0 m s^{-1} (1)	2
	(c)	(i)	$E_{total} = mgh + \frac{1}{2}mv_H^2$ [or by impl.] [Accept E_{total} = P.E. + K.E.] (1) $= 6.0\times 9.81\times 2.75 + \frac{1}{2}\times 6.0\times 3.0^2$ [e.c.f. on v_H] (1) [subst] = 189 J (1) [NB If only PE considered then 0]	3
		(ii)	Extreme points of trajectory **both** marked with a **K**.	1
		(iii)	$\frac{1}{2}mU^2 = 189$ (1) [e.c.f.] [accept KE = 189 J ecf] U = 7.9 m s^{-1} (1)	2
				[14]