PH1 Mark Scheme – January 2011

Question			Marking details	Marks Available
1	*(a)*	(i)	[Rate of] flow of charge / $I = \frac{Q}{t}$ or $\frac{dQ}{dt}$ with Q defined	1
		(ii)	C s^{-1}	1
	(b)	(i)	$x = y + z$	1
		(ii)	charge	1
	(c)	(i)	$\frac{1}{R} = \frac{1}{R_1} + \frac{1}{R_2}$ or $R = \frac{R_1 R_2}{R_1 + R_2}$ of by impl. (1) $R_{\parallel} = 30\ \Omega$ (1); $R_{\text{Total}} = 40\ \Omega$ (1) [no e.c.f.]	3
		(ii)	[Current x =] 0.15 A e.c.f. [Accept equiv., e.g. $^6/_{40}$, but not 0.2A without working]	1
		(iii)	$V_1 = 0.15 \times 10$ [= 1.5 V] (1) [e.c.f.] $V_2 = 6 - 1.5$ [= 4.5 V] [or $30 \times 0.15 = 4.5$ V] (1) [e.c.f.]	2
		(iv)	$y = \frac{4.5}{120}$ [= 0.038 A] (1) $z = 0.15 - 0.038$e.c.f. [= 0.11 A] $\left[\text{or } \frac{4.5}{40} \text{ [= 0.11 A]}\right]$ (1) [Accept solutions based upon ratios, e.g. $y = \frac{0.15}{4}$ …]	2 **[12]**
2.	*(a)*	(i)	$R = \frac{1.6}{15 \times 10^{-3}\,(1)}$ (reading from graph, accept 14×10^{-3}) R= 107 Ω [answers in range 107 – 114 Ω]	2
		(ii)	[Very] high [accept infinite]	1
	(b)	(i)	V not proportion to I / not a straight line [through the origin] ["Not through origin" insufficient on its own]	1
		(ii)	Bulb / thermistor [Not wire or superconductor, but accept superconducting device, e.g. superconducting electromagnet coil]	1
	(c)		$R = \frac{V}{I}$ (1) ; $R = \frac{10.4\,(1)}{15 \times 10^{-3}} = 693\ \Omega$ (1) **Alt 1**: $10.4 = \frac{R}{R + 107} \times 12$ [or equiv.] (1) manipulation e.g. $10.4R + 112.8 = 12(1)$; $R = 696\ \Omega$ (1) **Alt 2**: $R_T = \frac{V}{I}$ or $\frac{12}{1.5 \times 10^{-3}}$ (1) = 800 Ω (1); R 800 – 107 = 693 Ω (1)	3 **[8]**

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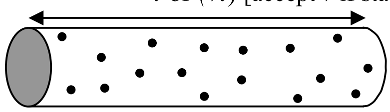
3	*(a)*		l or (vt) [accept v if stated dist travelled in 1 s] (1)  [NB free electrons not required to be labelled] Number of free electrons = $nAvt$ [**or** nAl] (1) Total change = $nAvte$ [**or** $nAle$] (1) $I = \frac{nAvte}{t}$ with cancelling shown [or $\frac{nAle}{t}$, where $\frac{l}{t} = v$ shown] (1)	4
	(b)		$2.0 = 1.0 \times 10^{29} \times 1.7 \times 10^{-6} v \times 1.6 \times 10^{-19}$ (1) [substitution] $v = 7.4 \times 10^{-5}$ m s^{-1} ((**unit**))(1)	2
	(c)		collisions [accept obstructions](1) between <u>free electrons and copper atoms / ions / lattice</u> (1) [accept: delocalised / moving / conducting electrons]	2
	(d)		$R = \frac{P}{I^2}$ [or $P = I^2R$] (1); $R = \frac{0.1}{4}$ [=0.025 Ω] (1) $\rho = \frac{0.025\text{[e.c.f.]} \times 1.7 \times 10^{-6}}{2.5}$ (1) [manipulation i.e $\rho = \frac{RA}{l}$ or with figures] $\rho = 1.7 \times 10^{-8}$ Ω m. (1)	4
	(e)		cross-sectional area — smaller (1) *n* — the same (1) resistivity — the same (1)	3 **[15]**
4.	*(a)*	(i)	To overcome the frictional / drag force or because the applied force is insufficient.	1
		(ii)	$\frac{1}{\text{gradient}}$ attempted (1); Correct substitution, e.g. $\frac{3.0 - 0.5}{3.0}$ (1) m = 0.8(3) kg ((**unit**)) (1)	3
	(b)	(i)	A = contact force of surface on body [accept <u>normal</u> reaction](1) B = gravitational force of Earth on body (1) [accept: weight / mg]	2
		(ii)	<u>Gravitation force of body (mass)</u> (1) on Earth (1)	2 **[8]**

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5.		(i)	$[\pi \times 22^2]$(1) [accept πr^2] × 14 (1) [=21 287 m^3 s^{-1}] [21 287 → 1 mark]	2
		(ii)	mass every second = 1.2 × 21000 [or as calculated in (i)] [= 25 200] kg s^{-1}	1
		(iii)	Initial E_{k1} = ½ × 25 200 × 14^2 (1) e.c.f. from (ii) Final E_{k2} = ½ × 25 200 × 14^2 (1) e.c.f. from (ii) ΔE_k = 945 × 10^3 J s^{-1} (1) e.c.f. from E_{k1} and E_{k2} NB. "Solutions" based upon ½ m × (14 – 11)^2 → 0	3
		(iv)	Useful power available = 614 250 J s^{-1} (1) e.c.f. from (iii) $N_{\text{turbines}} = \frac{1000 \times 10^6}{614250}$ [=1628] (1)	2 **[8]**
6	*(a)*		Velocity = $\frac{\text{Displacement}}{\text{time}}$ / displacement per unit time / rate of change of displacement [but **not** per unit time] / $\frac{ds}{dt}$ with s defined]	1
	(b)	(i)	v + 1 [or equiv]	1
		(ii)	$t = \frac{s}{v}$ used [or by impl.](1) → $t = \frac{12(1)}{15}$ [= 8 s]	2
		(iii)	$v + 1 = \frac{28}{8}$ (1) [allow e.c.f. from (i) only on v – 1 or 1 – v] manipulation (1) v = 2.5 m s^{-1} (1) **Alt 1**: Distance moved by Stacey in 8 s = 8 m ✓ Distance moved by walkway in 8 s = 28 – 8 = 20 m ✓ Speed of walkway = $\frac{20}{8}$ = 2.5 m s^{-1} ✓ **Alt 2**: Velocity of Stacey on walkway = $\frac{28}{8}$ = 3.5 m s^{-1} ✓ Velocity of walkway = 3.5 – 1.0 ✓= 2.5 m s^{-1} ✓	3
		(iv)	5.0 m s^{-1} e.c.f. from (iii), i.e. ans = 2.5 + (iii)	1 **[8]**

Question			Marking details	Marks Available
7.	*(a)*		Use of cos 70° (1) $2T \cos 70° = 800$ (1) [$\rightarrow T = 1170$ N] [Accept mysterious division by 2 (b.o.d.)]	2
	(b)	(i)	Area under graph attempted or ½ Fx or ½ kx^2 (1) 240 J (1)	2
		(ii)	Initial energy stored in bow converted entirely to E_k of arrow (1) 240 e.c.f. = ½ $50 \times 10^{-3}\ v^2$ (1) [subst] manipulation leading to $v = 98$ m s^{-1} shown. (1) [Final mark not available if incorrect E_k used]	3
	(c)	(i)	$x = ut + \frac{1}{2}at^2$ (1); $u = 0$ (1) $t = 0.55$ s [accept 0.6 s] (1)	2
		(ii)	$D = V_H t$ [or by imp.] (1) e.c.f. of t $D = 98$ [or 100] × 0.55 [or 0.6] [e.c.f.] $\therefore D = 54$ m (1)	3
		(iii)	$v_{vertical} = u + at$ **and** $u = 0$ (1) [or equiv or by impl.] $v_v = 5.4$ m s^{-1} (1) $v_{resultant} = \sqrt{5.4^2 + 98.0^2}$ (1) or $v^2 = 5.4^2 + 98.0^2$ $v_{resultant} = 98.1$ m s^{-1} (1) Angle to horizontal [clearly identified] = $\sin^{-1}\frac{5.4}{98.1} = 3°$ (1) [Or equivalent correct application of other trig function]	5
	(d)		Greater [initial] force [or equiv.] required to pull the Turkish bow string [through a given distance] (1) [or more work / energy needed] Greater area under the Turkish bow curve (1) [leading to] more [elastic] potential energy stored (1). Arrows will leave Turkish bow with a greater speed / velocity (1) [Accept converse arguments]. [Alt to 2nd marking point: linking to 1st marking point …. because gradient of graph greater for Turkish bow]	4
				[21]