PH1

<table>
<tr><th colspan="3">Question</th><th>Marking details</th><th>Marks Available</th></tr>
<tr><td>1</td><td>(a)</td><td>(i)</td><td>$I \propto V$ (1)

Providing the temperature / physical conditions remain constant (1)</td><td>

2</td></tr>
<tr><td></td><td></td><td>(ii)</td><td>V A^{-1} circled</td><td>1</td></tr>
<tr><td></td><td>(b)</td><td>(i)</td><td>
<table>
<tr><th>Switch combination</th><th>P</th><th>Q</th><th>S</th></tr>
<tr><td>X open, Y open</td><td>On</td><td>On</td><td>Off</td></tr>
<tr><td>X closed, Y open</td><td>Off</td><td>On</td><td>Off</td></tr>
<tr><td>X open, Y closed</td><td>On</td><td>On</td><td>On</td></tr>
<tr><td>X closed, Y closed</td><td>Off</td><td>On</td><td>On</td></tr>
</table>
(1)
(1)
(1)</td><td>

3</td></tr>
<tr><td></td><td></td><td>(ii)</td><td>Either $R = \frac{9}{0.18}$ (1) (= 50 Ω) → $R_P + R_Q$ = 50 (1)

$R_{each\ buzzer}$ = 25[Ω] (1) ecf between 2nd and 3rd marks
Or $R = \frac{4.5\ (1)}{0.18}$ (1) = 25[Ω] (1)</td><td>

3</td></tr>
<tr><td></td><td></td><td>(iii)</td><td>$R_{Total} = 16\frac{2}{3}$ [Ω] (1) $I = \frac{9}{16\frac{2}{3}}$ = 0.54 [A] (1)
ecf from (b)(ii) / no ecf for R_{Total}</td><td>2</td></tr>
<tr><td></td><td></td><td>(iv)</td><td><u>Either</u> ecf from (b)(ii) or (b)(iii) or both

$P_S = \left(\frac{2}{3} \times 0.54\right)^2 \times 25$ (1) $P_S = 3.24$ [W]

$P_Q = \left(\frac{1}{3} \times 0.54\right)^2 \times 25$ (1) $P_Q = 0.81$ [W]

<u>Or</u>

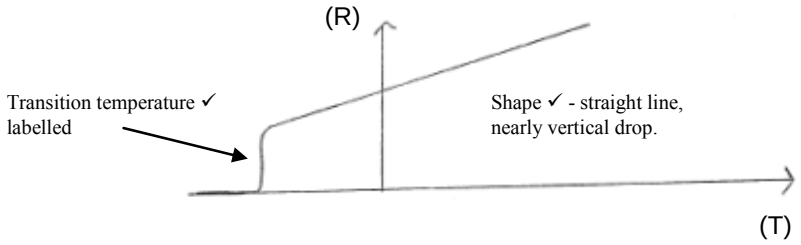
$P_S = \frac{9^2}{25}$ (1) = 3.24 [W] $P_Q = \frac{4.5^2}{25}$ (1) = 0.81 [W]

<u>Or</u>

$P_S = \frac{2}{3} \times 0.54 \times 9$ (1)= 3.24 [W] $P_Q = \frac{1}{3} \times 0.54 \times 4.5$ (1) = 0.81 [W]

→ $\frac{3.24}{0.81} = 4$ (1) or any correct algebraic solution = 3 marks</td><td>

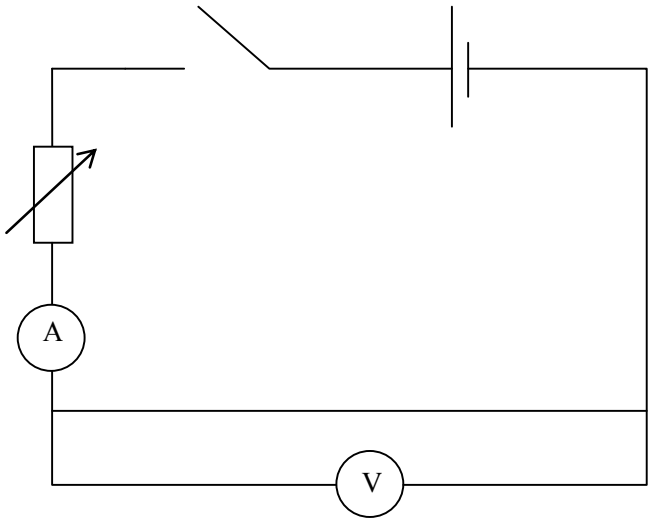
3</td></tr>
<tr><td></td><td></td><td></td><td>Question 1 total</td><td>[14]</td></tr>
</table>

Question			Marking details	Marks Available
2	*(a)*		A material with zero/negligible resistance	1
	(b)	(i)	Transition temperature (accept critical temperature)	1
		(ii)	 If axes labelled, must be correct.	2
		(iii)	0 / negligible / almost zero	1
	(c)		Collisions between free/delocalised/flowing/conducting electrons and ions/atoms in lattice/atoms/particles (1) increase vibrations of ions /atoms / particles **or** electrons transfer KE to ions (1)	2
			Question 2 Total	**[7]**

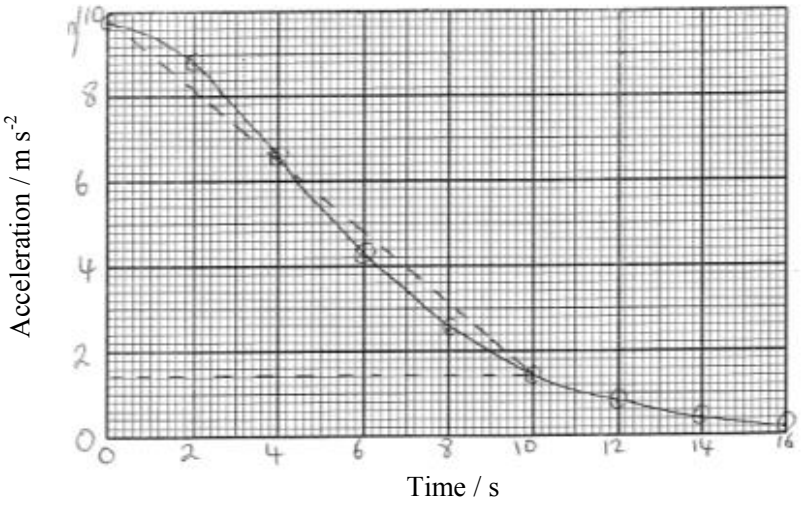
Question			Marking details	Marks Available
3	*(a)*	(i)	12 Joules per coulomb (1)	
			Supplied from cell / source / battery / chemical to electrical (1)	2
		(ii)	Energy lost in the resistance of cell	1
	(b)		$\left\{\frac{3.6(1)}{120}\right\}$ = 0.03 [Ω] (1)	2
	(c)		$I = \frac{12}{0.03}$ = 400 [A] ecf from (b)	1
	(d)	(i)	Q = 3 x [(16 x 60^2) or 57 600 (1)]	
			= 172800 [C] (1)	2
		(ii)	$t = \frac{172,800}{120}$ = 1440 seconds / 24 mins **UNIT mark**	1
			Allow ecf from (d) (i)	
			Question 3 Total	**[9]**

Question			Marking details	Marks Available
4	*(a)*		**<u>All 4 positions considered, 2 relevant statements per position</u>** <u>At start</u> (A) E_{Grav} – max E_k – zero $E_{Elastic}$ – zero (1) <u>Free fall, Cord slack(B)</u> E_{Grav} – decreasing E_k – increasing $E_{Elastic}$ – zero (1) <u>Cord stretching</u> (C) E_{Grav} – decreasing E_k – increasing or decreasing $E_{Elastic}$ – increasing (1) <u>At lowest point</u> (D) E_{Grav} – minimum (accept zero if explained) E_k – zero $E_{Elastic}$ – maximum (1) 5th mark available for other general comment e.g. Some of initial energy lost due to air resistance / rope gets hot (1) Don't accept statement of the conservation of energy on its own.	5
	(b)	(i)	$E_{p\ loss}$ = 70 x 9.8[1] x 130 (1) substitution (not g = 10 m s^{-2}) = 89 271 [J] (1) (accept 89 300 or 89 000)	2
		(ii)	89271 = ½ k (50)^2 (2) [1 mark for $E_{p\ loss} = \frac{1}{2}kx^2$; 1 mark for 50 [m]] k = 71.4 [N m^{-1}] (1) ecf from (b)(i)	3
		(iii)	$mg = kx$ (1) $= \frac{70 \times 9.81}{71.4}$ = 9.6 [m] (1) ecf on k from (b)(ii) N.B. Only penalise once for use of g = 10 m s^{-2}	2
			Question 4 total	**[12]**

Question			Marking details	Marks Available
5	*(a)*	(i)	$v_H = 16 \cos 40°$ (1) = 12.3 [m s^{-1}]	
			$v_V = 16 \sin 40°$ (1) = 10.3 [m s^{-1}]	2
		(ii)	Horizontal: constant velocity Vertical: acceleration / changing (both statements required)	1
	(b)	(i)	$0 = 10.3 - 1.6\,t$ (1) ecf from (a)(i) penalise only once for use of 9.8 m s^{-2}	
			t = 6.4 [s] (1)	
			t_{flight} = 12.8 [s] (1) ecf between 2nd and 3rd marks **Or** any other alternative method used to gain correct answer = 3 marks	3
		(ii)	D_H = 12.3 x 12.8 = 157 [m] ecf from (b)(i)	1
		(iii)	$0 = (10.3)^2 - 2 \times 1.6\ s$ (1) ecf from (a)(i)	
			S = 33.2[m] (1)	2
	(c)		Air resistance on Earth (1)	
			g on Earth different (accept greater) than on the Moon (1)	2
			Question 5 Total	**[11]**

Question			Marking details	Marks Available
6	*(a)*	(i)	 Circuit (without voltmeter and ammeter) (1) Voltmeter and Ammeter correctly positioned (1)	2
		(ii)	$R = \frac{10}{0.9}$ = 11.11 [Ω] (1) $A = 3.14\text{x}10^{-8}$ [m^2] (1) $\rho = \frac{11.11 \text{ x } 3.14\text{x}10^{-8}}{3.2}$ (1) substitution $\rho = 1.09\text{x}10^{-7}$ [Ω m] (1) ecf for R and A	4
		(iii)	Platinum and Tin	1
	(b)		$\rho = \frac{0.74\text{x}10^{-3}}{(3.14\text{x}10^{-8} \text{ x } 3.2)(1)} = 7365$ [kg m^{-3}] (1) ecf for A Tin (1) ecf from density value	3
			Question 6 Total	**[10]**

Question			Marking details	Marks Available
7	*(a)*		$F \rightarrow$ kg m s^{-2} (1)	
			$\rho \rightarrow$ kg m^{-3} (1), $v^2 \rightarrow m^2 s^{-2}$ (1)	
			Correct manipulation / cancelling seen $\rightarrow m^2$ (1)	4
	(b)	(i)	Correct statement of Newton's 3rd Law	1
		(ii)	• <u>May</u> not have same magnitude • Forces act on same object • Forces not of same type (e.g. not two '*g*' forces or contact forces) Don't accept : They are not equal unless qualified Only one statement required.	1
	(c)	(i)	60 x 9.8 = 588 N **unit mark**	1
		(ii)	$F_{res} = W - F_{drag}$ implied in any correct form (1)	
			F_{drag} = 588 –[(60 x 1.4) (1)] ecf from (c)(i)	
			F_{drag} = 504 [N] (1)	3

Question			Marking details	Marks Available
	(d)	(i)		
			Axes labelled with units (1); Points plotted correctly to within ±½ square division (1); Line (1)	3
		(ii)	Area attempted (1)	
			(1.4 x 10) + (½ x 10 x [9.8-14])	
			14 + 42 = 56 [m s^{-1}] (1) (accept range 52 – 60)	2
		(iii)	504 = $\frac{1.2 \times D \times 56^2}{2}$ substitution (1) allow ecf on F_{drag} and v	
			D = 0.27 [m^2] (1) (accept range 0.23 – 0.31)	2
			Question 7 total	**[17]**