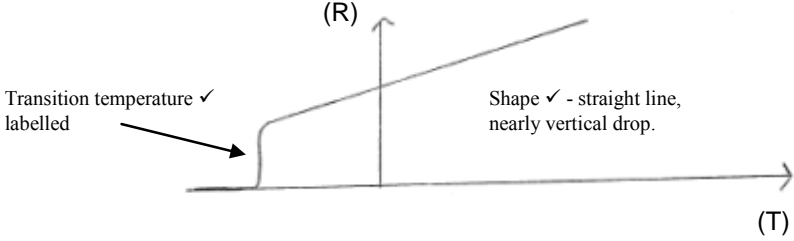


**PH1**

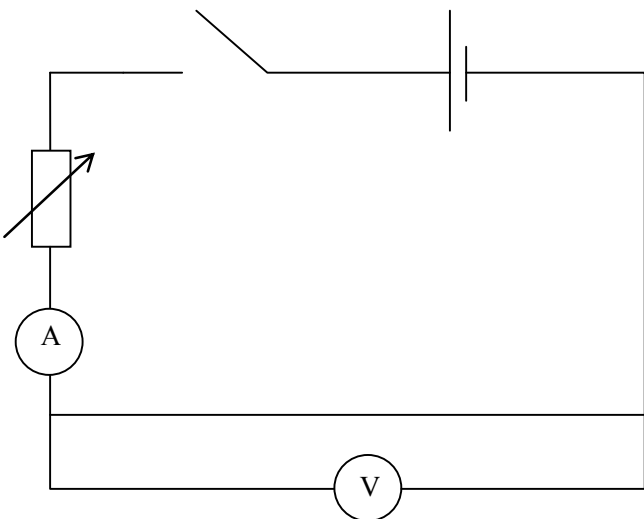
Question		Marking details	Marks Available																					
1	(a)	(i) $I \propto V(1)$ Providing the temperature / physical conditions remain constant (1)	2																					
		(ii) $V A^{-1}$ circled	1																					
	(b)	(i)	<table border="1" style="margin-left: auto; margin-right: auto;"> <thead> <tr> <th>Switch combination</th> <th>P</th> <th>Q</th> <th>S</th> </tr> </thead> <tbody> <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> </tbody> </table> (1) (1) (1)	Switch combination	P	Q	S	X open, Y open	On	On	Off	X closed, Y open	Off	On	Off	X open, Y closed	On	On	On	X closed, Y closed	Off	On	On	3
		Switch combination	P	Q	S																			
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	(ii)	<b>Either</b> $R = \frac{9}{0.18}$ (1) (= 50 $\Omega$ ) $\rightarrow R_P + R_Q = 50$ (1) $R_{\text{each buzzer}} = 25[\Omega]$ (1) ecf between 2 <sup>nd</sup> and 3 <sup>rd</sup> marks <b>Or</b> $R = \frac{4.5(1)}{0.18}$ (1) = 25[ $\Omega$ ] (1)	3																					
	(iii)	$R_{\text{Total}} = 16 \frac{2}{3} [\Omega]$ (1) $I = \frac{9}{16 \frac{2}{3}} = 0.54 [A]$ (1) ecf from (b)(ii) / no ecf for $R_{\text{Total}}$	2																					
(iv)	<b>Either</b> 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) $P_Q = 0.81 [W]$ <b>Or</b> $P_S = \frac{9^2}{25}$ (1) = 3.24 [W] $P_Q = \frac{4.5^2}{25}$ (1) = 0.81 [W] <b>Or</b> $P_S = \frac{2}{3} \times 0.54 \times 9$ (1) = 3.24 [W] $P_Q = \frac{1}{3} \times 0.54 \times 4.5$ (1) = 0.81 [W] $\rightarrow \frac{3.24}{0.81} = 4$ (1) or any correct algebraic solution = 3 marks	3																						
<b>Question 1 total</b>			<b>[14]</b>																					

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

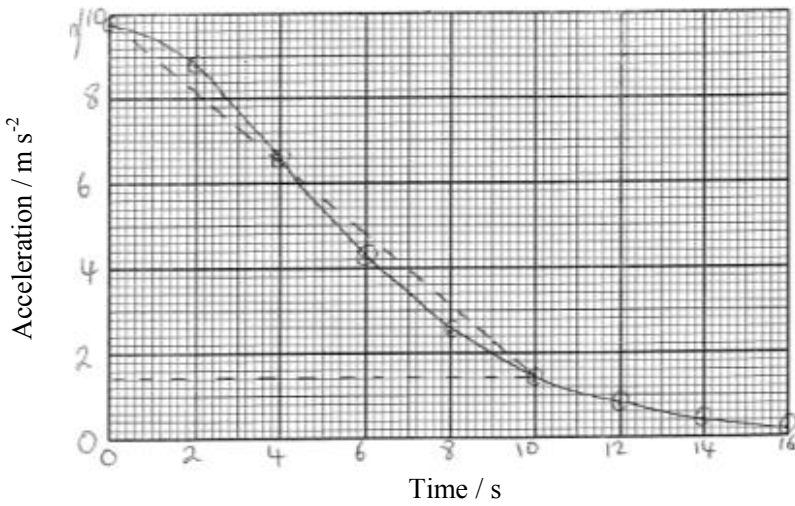
Question		Marking details	Marks Available
3	(a)	(i) <u>12</u> Joules per coulomb (1)	2
		Supplied from cell / source / battery / chemical to electrical (1)	
	(b)	(ii) Energy lost in the resistance of cell	1
		$\left\{ \frac{3.6(1)}{120} \right\} = 0.03 \text{ } [\Omega] \text{ (1)}$	2
	(c)	$I = \frac{12}{0.03}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

Question		Marking details	Marks Available
4	(a)	<p><b><u>All 4 positions considered, 2 relevant statements per position</u></b></p> <p><u>At start (A)</u> <math>E_{Grav} - \text{max}</math>  <math>E_k - \text{zero}</math> (1)  <math>E_{Elastic} - \text{zero}</math></p> <p><u>Free fall, Cord slack(B)</u> <math>E_{Grav} - \text{decreasing}</math>  <math>E_k - \text{increasing}</math> (1)  <math>E_{Elastic} - \text{zero}</math></p> <p><u>Cord stretching (C)</u> <math>E_{Grav} - \text{decreasing}</math>  <math>E_k - \text{increasing or decreasing}</math> (1)  <math>E_{Elastic} - \text{increasing}</math></p> <p><u>At lowest point (D)</u> <math>E_{Grav} - \text{minimum (accept zero if explained)}</math>  <math>E_k - \text{zero}</math> (1)  <math>E_{Elastic} - \text{maximum}</math></p> <p>5<sup>th</sup> 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.</p>	5
	(b)	<p>(i) <math>E_{p\text{ loss}} = 70 \times 9.8[1] \times 130</math> (1) substitution (not <math>g = 10 \text{ m s}^{-2}</math>)  <math>= 89\,271 \text{ [J]}</math> (1) (accept 89 300 or 89 000)</p> <p>(ii) <math>89271 = \frac{1}{2} k (50)^2</math> (2) [1 mark for <math>E_{p\text{ loss}} = \frac{1}{2} kx^2</math>; 1 mark for 50 [m]]  <math>k = 71.4 \text{ [N m}^{-1}\text{]}</math> (1) ecf from (b)(i)</p> <p>(iii) <math>mg = kx</math> (1) <math>= \frac{70 \times 9.81}{71.4} = 9.6 \text{ [m]}</math> (1) ecf on <math>k</math> from (b)(ii)                      N.B. Only penalise once for use of <math>g = 10 \text{ m s}^{-2}</math></p> <p><b>Question 4 total</b></p>	2 3 2
<b>Question 4 total</b>			<b>[12]</b>

Question		Marking details	Marks Available
5	(a)	(i) $v_H = 16 \cos 40^\circ$ (1) = 12.3 [m s <sup>-1</sup> ] $v_V = 16 \sin 40^\circ$ (1) = 10.3 [m s <sup>-1</sup> ]	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 <sup>-2</sup> $t = 6.4$ [s] (1) $t_{\text{flight}} = 12.8$ [s] (1) ecf between 2 <sup>nd</sup> and 3 <sup>rd</sup> marks <b>Or</b> any other alternative method used to gain correct answer = 3 marks	3
		(ii) $D_H = 12.3 \times 12.8 = 157$ [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
	<b>Question 5 Total</b>		

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

Question		Marking details	Marks Available
7	(a)	$F \rightarrow \text{kg m s}^{-2}$ (1) $\rho \rightarrow \text{kg m}^{-3}$ (1), $v^2 \rightarrow \text{m}^2 \text{s}^{-2}$ (1) Correct manipulation / cancelling seen $\rightarrow \text{m}^2$ (1)	4
	(b)	(i) Correct statement of Newton's 3 <sup>rd</sup> Law	1
		(ii) <ul style="list-style-type: none"> <li>• <u>May</u> not have same magnitude</li> <li>• Forces act on same object</li> <li>• Forces not of same type (e.g. not two 'g' forces or contact forces)</li> </ul> Don't accept : They are not equal unless qualified Only one statement required.	1
	(c)	(i) $60 \times 9.8 = 588 \text{ N}$ <b>unit mark</b>	1
(ii) $F_{\text{res}} = W - F_{\text{drag}}$ implied in any correct form (1) $F_{\text{drag}} = 588 - [(60 \times 1.4) (1)]$ ecf from (c)(i) $F_{\text{drag}} = 504 \text{ [N]}$ (1)		3	

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