

PH1

Question		Marking details	Marks Available
1	(a)	(i) <u>Energy cannot be created or destroyed; it can only change from one form to another.</u> Don't accept can only be conserved.	[1]
		(ii) $E_p \rightarrow E_k$ (1) can be implied Some energy lost as heat or due to air resistance or due to friction with air - general statement (1) Air molecules gain E_k and/or molecules of object gain E_k - specific statement (1)	[3]
	(b)	(i) mgh calculated correctly = 376.7 [J] (1) accept g as 9.8 or 9.81 but not 10 $\frac{1}{2}mv^2$ calculated correctly = 288 [J] (1) $E_p - E_k = 88.7$ [J] [ecf from calculated values of E_p and/or E_k] (1)	[3]
		(ii) <u>Correct substitution</u> into $W = Fd$ i.e. 88.7 (ecf) = $F \times 4.0$ (1) $F = 22[.2N]$ (1) If either E_p or E_k substituted in for W then award 1 mark only Alternative Solution: Force down slope = $16 \times 9.81 \times \frac{2.4}{4}$ [$F = mgsin\theta$] = 94.2 [N] Resultant Force $\Sigma F = 16 \times \left(\frac{6^2}{8}\right) = 72$ [N] Mean Frictional Force = $94.2 - 72 = 22[.2N]$ Award 1 mark for either force values correct (or both) Award 2 marks for correct solution Question 1 total	[2] [9]
2	(a)	(i) Force a extension [provided elastic limit is not exceeded] Accept $F \propto x$ but x must be defined	[1]
		(ii) 4.0 [cm]	[1]
	(b)	F (from graph) = 0.6 [N] (1) Correct application of $a = \frac{\Sigma F}{m}$ i.e. $\frac{0.6}{0.4} = 1.5 \text{ ms}^{-2}$ (1) UNIT mark (ecf on F)	[2]
		(c)	(i) substitution into $\frac{1}{2}Fx$ (or area under graph or $\frac{1}{2}kx^2$) (1) ecf on F $E_{\text{spring}} = 3.6 \times 10^{-2}$ [J] (1)
	(d)	(ii) $E_{\text{spring}} = 0$ [J] (1) $\Sigma F = 0$ or acceleration = 0 <u>so extension = 0</u> (1)	[2]
		New extension = $\frac{1}{2} \times$ original (1) Force in each spring = $\frac{1}{2} \times$ original or spring constant of system = $2 \times$ original or energy in each spring = $\frac{1}{4} \times$ original (1) Total energy (in both springs) = $\frac{1}{2} \times$ original (1) Accept algebraic equivalents	[3]
		Question 2 total	[11]

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3	(a)	(i)	J s^{-1}	[3×1]
		(ii)	V A^{-1}	
		(iii)	A s	
	(b)	(i)	$t = 2 \times 3\,600$ or $7\,200 \text{ s}$ (1) $Q = 0.15 \times 7\,200 = 1\,080 \text{ [C]}$ (1)	[2]
		(ii)	$\frac{6480}{1080} = 6 \text{ [V]}$ (ecf on Q)	[1]
		(iii)	$\frac{5832}{1080} = 5.4 \text{ [V]}$ (ecf on Q)	[1]
		(iv)	$6 - 5.4 = 0.6 \text{ [V]}$ (1) (ecf from (b)(ii) & (iii)) $\frac{0.6}{0.15} = 4 \text{ [}\Omega\text{]}$ (1) (ecf on 0.6 [V])	[2]
		Or Correct substitution into $V = E - Ir$ (i.e. $5.4 = 6.0 - 0.15r$) (1) $r = 4 \text{ [}\Omega\text{]}$ (1) (ecf from (b)(ii) & (iii))		
		Alternative Solution: $\frac{(6480 - 5832)}{7200} = 0.09 \text{ J s}^{-1}$ (Lost energy in cell per second) (1) $I^2 r = 0.09$ and $r = 4 \text{ [}\Omega\text{]}$ (1)		
		Question 3 Total		
			[9]	

Question		Marking details	Marks Available		
4	(a)	<p><u>Electrical energy (or work done) transferred [to other forms passing] between two points (1) per coulomb of charge (1)</u> Definition of 1 V award 1 mark only</p>	[2]		
	(b)	(i)	$V_{\text{supply}} = V_1 + V_2 + V_3$	[1]	
		(ii)	Energy	[1]	
	(c)	(i)	$R_1 + 12 = \frac{9}{0.5}$ (1)	[2]	
			Clear manipulation seen to show $R_1 = 6 [\Omega]$ (1)		
		(ii)	(I)	$\frac{1}{R} = \frac{1}{R_1} + \frac{1}{R_2}$ to show effective parallel combination = 6Ω (1) this can be implied V across upper 6Ω resistor shown = 4.5 [V] (ecf on parallel combination) (1)	[2]
			(II)	Total resistance = 12Ω (1) $I = \frac{9.0}{12} = 0.75 \text{ [A]}$ (1) (accept $\frac{4.5}{6} = 0.75 \text{ [A]}$)	[2]
			(III)	$1.2 = \frac{9}{(6 + R_{\text{parallel}})}$ (1) $R_{\text{parallel}} = 1.5 \text{ [\Omega]}$ (1) $n \times \left(\frac{1}{12}\right) = \frac{1}{1.5}$ (1) ecf on 1.5 [\Omega] $n = 8$ (1) Full marks for correct answer based on trial and error Alternative solution: $\frac{9}{1.2} = 7.5 \text{ [\Omega]}$ (1) $7.5 - 6 = 1.5 \text{ [\Omega]}$ (1) $\frac{12}{n} = 1.5 \text{ [\Omega]}$ (1) $n = 8$ (1)	[4]
				Question 4 Total	

Question			Marking details	Marks Available
5	(a)	(i)	Ruler and wire shown and labelled (1) Moving pointer or jockey or crocodile clip indicated (1) Either: Correctly positioned ohmmeter with no power supply; or correctly positioned voltmeter and ammeter with power supply (1) [No labelling required for either method].	[3]
		(ii)	Diagonal line through origin	[1]
		(iii)	CSA from <u>diameter of wire</u> (1) Gradient from graph = (R/l) or (ρ/A) Or stated take a pair of R and l values from the graph (1) $\rho = \text{gradient} \times \text{CSA}$ or use of $\rho = RA/l$ (1)	[3]
	(b)	(i)	$R = \frac{144}{32} = 4.5 [\Omega]$ (1) Correct substitution into $R = \rho l/A$ (1) $l = 0.375 [\text{m}]$ (1) (ecf on R)	[3]
		(ii)	$I = 2.7 [\text{A}]$ (from V/R or P/V etc) (1) (ecf on I) Correct substitution into $I = nAve$ (1) $v = 1.24 \times 10^{-2} [\text{m s}^{-1}]$ (1) accept 0.01 m s^{-1}	[3]
		Question 5 Total		[13]

Question			Marking details	Marks Available	
6	(a)	(i)	Acceleration defined as rate of change of <u>velocity</u> [or equivalent] or $a = \frac{(v-u)}{t} \text{ (1)}$ <u>Clear manipulation</u> to show that $v=u+at$ (1)	[2]	
		(ii)	$v=u+at$ substituted into $x = (u+v)t/2$ (1) <u>Clear manipulation</u> shown (1)	[2]	
	(b)	(i)	A (1) Horizontal velocity (= 65 m s^{-1}) constant or same speed as plane or sack lands directly underneath plane (1) Vertical velocity increases or there is a vertical acceleration (1)	[3]	
		(ii)	(I)	Substitution into $v^2=u^2+2ax$ and $u = 0$ shown (1) x calculated = 45.9 [m] (1)	[2]
			(II)	Correct substitution into $v = at$ or $x=1/2at^2$ or $x = \frac{(u+v)t}{2}$ (1) $t=3.1 \text{ [s]}$ (1)	[2]
		(iii)	$v_R^2 = (65^2 + 30^2)$ (correct substitution into Pythagoras) (1) $v_R = 71.6 \text{ [m s}^{-1}\text{]}$ (1) Valid angle calculated <u>and shown</u> or described e.g. $\theta = 24.8^\circ$ below horizontal (1)	[3]	
Question 6 Total			[14]		
7	(a)	Replace <i>mass</i> with <i>force</i> (1) Don't accept weight Introduce <u>perpendicular distance to pivot</u> (1)	[2]		
	(b)	$(2 \times 700) - 1\,200$ (1) Weight of beam = 200 [N] (1) Alternative solution: Moment about A or B e.g. $(700 \times 5) = (1\,200 + W) \times 2.5$	[2]		
	(c)	(i)		[2]	
			Upward forces as shown and indicated (1) Downward forces as shown and indicated (1) N.B. $1\,200 \text{ [N]}$ force can be indicated anywhere between W and F_B		
			(ii)	Taking moments about A: $F_B \times 5.0$ (1) $(1\,200 \times 3.5) + (200 \times 2.5)$ (1) (ecf on 200) $F_B = 940 \text{ [N]}$ (1)	[3]
(iii)	$1\,400 - 940 = 460 \text{ [N]}$ (ecf from (b) and/or (c)(ii)) Accept answer based on moments calculated about B.	[1]			
Question 7 Total			[10]		