

Question		Answer	Marks	Guidance
1	(a)	work done = force $\times$ distance <u>moved</u> in the direction of force	B1	<b>Allow:</b> work done = force $\times$ displacement in direction of force
	(b) (i)	mass = $700/9.81$ or mass = 71.4 (kg) kinetic energy = $\frac{1}{2} \times 71.4 \times 15^2$ kinetic energy = $8.0 \times 10^3$ (J)	C1 A1	<b>Note:</b> Answer to 3 sf is $8.03 \times 10^3$ (J) <b>Note:</b> ' $\frac{1}{2} \times 700 \times 15^2 = 7.9 \times 10^4$ ' scores zero <b>Allow:</b> 1 sf answer
	(ii)	GPE = $mgh$ $700 \times 32$ / $2.24 \times 10^4$ (J) work done = $2.24 \times 10^4 - 8.03 \times 10^3$ resistive force = $\frac{1.44 \times 10^4}{120}$ resistive force = 120 (N)	C1 C1 A1	Possible ecf  <b>Note:</b> Dividing the work done by 32 (m) gives 450 (N). This answer scores 2 marks.
<b>Total</b>			<b>6</b>	


Question		Answers	Marks	Guidance
2	(a)	<p><u>total</u> energy of a (closed) system remains constant or Energy cannot be created or destroyed (it can only be transferred into other forms) or <u>total</u> initial energy = <u>total</u> final energy</p>	B1	<b>Not:</b> 'Energy cannot be created / destroyed / lost'
	(b)	<p>work done = force × distance <u>moved</u> in the direction of the force Unit: N m or J</p>	M1 A1 B1	<p><b>Allow:</b> 'force × displacement' for the M1 mark <b>Note:</b> The unit mark is an independent mark</p>
	(c) (i)	<u>kinetic</u> energy → heat	B1	<b>Not:</b> friction / deformation / sound / KE of dust / KE of Earth
	(ii)	<p><math>(E = \frac{1}{2}mv^2)</math>  <math>8.4 \times 10^{16} = \frac{1}{2} \times 3.0 \times 10^8 \times v^2</math>  <math>v^2 = \frac{2 \times 8.4 \times 10^{16}}{3.0 \times 10^8}</math> or <math>v = \sqrt{\frac{2 \times 8.4 \times 10^{16}}{3.0 \times 10^8}}</math>  <math>(v = 2.37 \times 10^4 \text{ m s}^{-1})</math></p>	C1  C1 A0	<p><b>Note:</b> This mark is for correct substitution  <b>Allow:</b> 2 marks for <math>v^2 = 5.6 \times 10^8</math> <b>Allow:</b> 1 mark for a bald answer of <math>2.4 \times 10^4</math></p>
	(iii)	<p><math>8.4 \times 10^{16} = F \times 200</math>   <math>F = \frac{8.4 \times 10^{16}}{200}</math>   force = <math>4.2 \times 10^{14}</math> (N)</p>	C1  C1 A1	<p>Possible ecf <b>Allow:</b>  <math>a = (-)\frac{u^2}{2s}</math>  <math>a = (-)\frac{(2.37 \times 10^4)^2}{2 \times 200}</math> or <math>a = (-)\frac{(2 \times 10^4)^2}{2 \times 200}</math> C1  <math>a = 1.4 \times 10^6 \text{ (m s}^{-2}\text{)}</math> or <math>a = 1.0 \times 10^6 \text{ (m s}^{-2}\text{)}</math> C1  <math>F = 3.0 \times 10^8 \times 1.4 \times 10^6</math> or <math>F = 3.0 \times 10^8 \times 1.0 \times 10^6</math>  force = <math>4.2 \times 10^{14}</math> (N) or force = <math>3.0 \times 10^{14}</math> (N) A1</p>
		<b>Total</b>	<b>10</b>	

3	Expected Answers	Marks	Additional Guidance
<b>a</b>	work (done) = force $\times$ distance <u>moved</u> in the direction of force	B1	<b>Allow:</b> work = force $\times$ displacement in direction of force <b>Not:</b> work (done) = energy transfer
<b>b(i)</b>	(Net /total /resultant force is) zero  The <u>acceleration</u> is zero	B1  B1	<b>Not</b> 'a = 0'
<b>b(ii)</b>	$9.0 \times 10^3 \cos 83^\circ$ or $9.0 \times 10^3 \sin 7^\circ$  $1.1 \times 10^3$ (N)	C1  A1	<b>Not</b> ' $9.0 \times 10^3 \cos 7^\circ$ '
<b>b(iii)</b>	work done per second = $300 \times 18$  work done per second = $5400 \text{ (J s}^{-1}\text{)}$	B1	
<b>b(iv)</b>	(total force down slope =) $1100 + 300$ (N) (power =) $1400 \times 18$ (power =) $2.52 \times 10^4$ (W) or $2.5 \times 10^4$ (W)  or  rate of work done against weight = $1.1 \times 10^3 \times 18$ (= 19800 W) power = 19800+ 5400 power = $2.52 \times 10^4$ (W) or $2.5 \times 10^4$ (W)	C1 C1 A1   C1 C1 A1	<b>Allow:</b> 1400 (N)  Possible ecf from <b>(b)(ii)</b>   <b>Allow:</b> ' $F_x \cos \theta = 9.0 \times 10^3 \times 18 \times \cos 83^\circ$ '  Possible ecf from <b>(b)(ii)</b> and <b>(b)(iii)</b>
	<b>Total</b>	<b>9</b>	

Question		Expected Answers	Marks	Additional Guidance
4	(a)	Energy cannot be created or destroyed; it can only be transferred/transformed into other forms or The (total) energy of a system remains constant or (total) initial energy = (total) final energy (AW)	B1	<b>Allow:</b> 'Energy cannot be created / destroyed / lost'
	(b)	Any suitable example of something strained (eg: <u>stretched</u> elastic band)	B1	
	(c) (i)	$E_p = mgh$ <u>and</u> $E_k = \frac{1}{2}mv^2$ (Allow $\Delta h$ for $h$ )	B1	<b>Not:</b> $E_k = mgh$
	(ii)	$mgh = \frac{1}{2}mv^2$ $v^2 = 2gh$ or $v = \sqrt{2gh}$	B1 B1	
	(d) (i)	$m = \rho V$ $m = 1.0 \times 10^3 \times (1.2 \times 10^{-2} \times 2.0 \times 10^7)$ mass of water = $2.4 \times 10^8$ (kg)	C1 C1 A0	<b>Allow</b> any subject for the density equation
	(ii)	loss in potential energy = $2.4 \times 10^8 \times 9.81 \times 2.5 \times 10^3$  30% of GPE = $0.3 \times 5.89 \times 10^{12}$ ( $= 1.77 \times 10^{12}$ )  power = $\frac{1.77 \times 10^{12}}{900}$  power = $1.9(63) \times 10^9$ (W) ( $\approx 2$ GW)	C1 C1 C1 A0	<b>Allow</b> 1 mark for ' $5.89 \times 10^{12}$ (J)'  <b>Allow</b> 2 marks for ' $1.77 \times 10^{12}$ (J)'  <b>Note:</b> $\frac{5.89 \times 10^{12}}{900}$ ( $= 6.5$ GW) scores 2 marks
	(iii)	Any correct suitable suggestion; eg: the energy supply is not constant/ cannot capture all the rain water / large area (for collection)	B1	<b>Note:</b> Do not allow reference to 'inefficiency' / 'cost'
<b>Total</b>			<b>11</b>	

Question		Answer	Marks	Guidance	
5	a	pressure and stress or pressure and Young modulus or stress and Young modulus or moment (of a force) and torque (of a couple)	B1	<p><b>Allow</b> other correct combinations <b>Allow</b> the following:</p> <ul style="list-style-type: none"> <li>e.m.f. and p.d.</li> <li>Any two from frequency, activity, decay constant and Hubble constant because of the <math>s^{-1}</math></li> </ul> <p><b>Ignore</b> any units given (even if incorrect)</p> <p><b>Special case:</b> Allow quantities with no units, e.g. strain and efficiency. <b>Not</b> any combination of length, distance and extension</p>	
	b	i	x-component = 6.0 (N) and y-component = 2.0 (N)	B1	<p><b>Allow</b> 1 sf answers <b>Allow</b> tolerance <math>\pm 0.1</math> N <b>Not</b> x-component = 2.0 (N) and y-component = 6.0 (N)</p>
		ii	resultant components are 8.0 (N) and 5.0 (N)  $F^2 = 8.0^2 + 5.0^2$ force = 9.4 (N)	C1  C1 A1	<p><b>Allow:</b> 1 sf values for this C1 mark Possible ecf from <b>(b)(i)</b> with x-components = 2 + <b>b(i)</b> and y-component = 3 + <b>b(i)</b>.</p> <p><b>Note:</b> Answer is 9.43 to 3sf <b>Not</b> an answer left in square root form, e.g. <math>\sqrt{89}</math></p> <p><b>Allow</b> full credit for a scale drawing; marks awarded as below:</p> <ul style="list-style-type: none"> <li>A dot / cross / mark at 8.0,5.0 (<math>\pm 0.1</math>) C1</li> <li>Line drawn from 0,0 to 8.0,5.0 C1</li> <li>force = 9.4 <math>\pm 0.1</math> (N) A1</li> </ul>
	c	i	Down	B1	<b>Allow</b> a downward arrow on Fig. 2.2

Question		Answer	Marks	Guidance
	ii	Horizontal component of the velocity is constant  There is no <u>horizontal force</u>	B1  B1	<b>Allow:</b> There is no horizontal <u>acceleration</u>  <b>Allow:</b> Weight / $g$ has no horizontal component or Weight / $g$ is $90^\circ$ to the horizontal or Weight / $g$ is vertical or 'there is <u>only</u> a vertical force'  ( <b>Not</b> 'gravity' for 'weight'; allow 'force of gravity')
	iii	Any <u>two</u> from: <ul style="list-style-type: none"> <li>• It decreases from <b>X</b> to <b>Y</b></li> <li>• It is zero at <b>Y</b> / It has the same magnitude at <b>X</b> and <b>Z</b></li> <li>• It increases from <b>Y</b> to <b>Z</b></li> <li>• It is positive from <b>X</b> to <b>Y</b> and negative from <b>Y</b> to <b>Z</b> (or vice versa)</li> </ul>	B1 × 2	<b>Ignore</b> description in terms of acceleration or deceleration  <b>Allow</b> it changes sign / direction from <b>X</b> to <b>Z</b>
<b>Total</b>			<b>10</b>	

Question		Answer	Marks	Guidance
6		<p>Any <u>one</u> from:</p> <ul style="list-style-type: none"> <li>• Mass obtained using a balance / scales</li> <li>• Weight / load obtained using a newtonmeter / spring balance</li> <li>• Distance / height obtained using a ruler / metre stick / measuring tape</li> </ul> <p>Time obtained using a clock / (stop)watch / timer or light-gate <u>and</u> timer or light-gate <u>and</u> data-logger</p> <p>(output power =) 'mass <math>\times</math> <math>g</math> <math>\times</math> distance'/time or 'weight <math>\times</math> distance/time' or 'weight <math>\times</math> speed'</p> <p>input power = output power/0.15</p>	<p>B1</p> <p>B1</p> <p>B1</p> <p>B1</p>	<p> The term <b>clock / (stop)watch / timer /data-logger</b> must be spelled correctly to gain this mark</p> <p><b>Allow</b> symbols, e.g <math>mgh/t</math>, <math>Wh/t</math> and <math>Wv</math></p>
		<b>Total</b>	<b>4</b>	