

1)

<b>a</b>	work (done) = force × distance <u>moved</u> in the direction of force	B1	<b>Allow:</b> work = force × 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 = $5400$ ( $\text{J s}^{-1}$ )	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>	

2)

<b>(a)</b>	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>(b)</b>	Any suitable example of something strained (eg: <u>stretched</u> elastic band)	B1	
<b>(c)</b>	<b>(i)</b> $E_p = mgh$ and $E_k = \frac{1}{2}mv^2$ (Allow $\Delta h$ for $h$ )	B1	<b>Not:</b> $E_k = mgh$
	<b>(ii)</b> $mgh = \frac{1}{2}mv^2$ $v^2 = 2gh$ or $v = \sqrt{2gh}$	B1  B1	
<b>(d)</b>	<b>(i)</b> $m = \rho V$ $m = 1.0 \times 10^3 \times (1.2 \times 10^{-2} \times 2.0 \times 10^7)$ mass of water = $2.4 \times 10^8$ (kg)	C1 C1 A0	<b>Allow</b> any subject for the density equation
	<b>(ii)</b> 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
	<b>(iii)</b> 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>	

3)

a	kinetic energy = $\frac{1}{2} \times \text{mass} \times \text{speed}^2$	B1	<b>Allow</b> KE = $\frac{1}{2} mv^2$ , where $m$ = mass and $v$ = speed <b>Allow</b> velocity instead of speed <b>Not:</b> KE = $\frac{1}{2} mv^2$ on its own
b(i)	initial KE = $\frac{1}{2} \times 3.0 \times 10^{-2} \times 200^2$ (= 600 J) final KE = $\frac{1}{2} \times 3.0 \times 10^{-2} \times 50^2$ (= 37.5 J) Loss in KE = 600 – 37.5  Loss in KE = 562.5 (J) $\approx$ 560 (J)	C1 C1  A1	<b>Special case:</b> 1 mark for 'KE = $\frac{1}{2} mv^2$ ... loss in KE = ( $\frac{1}{2} \times 3.0 \times 10^{-2} \times 200 - \frac{1}{2} \times 3.0 \times 10^{-2} \times 50$ ) = 2.25 (J)' <b>Note:</b> No marks for 337.5 (J) when $\Delta v$ used in the KE equation ( $\frac{1}{2} \times 3.0 \times 10^{-2} \times 150^2 = 337.5$ J)
b(ii)	work done = (loss in ) KE / $a = (v^2 - u^2) / 2s$  $F \times 1.5 \times 10^{-2} = 562.5$ / $a = (-) 1.25 \times 10^6$  force = $3.75 \times 10^4$ (N)	C1  A1	Possible ecf from (b)(i)  <b>Allow:</b> A 2 sf answer of either $3.8 \times 10^4$ (N) or $3.7 \times 10^4$ (N)
<b>Total</b>		<b>6</b>	

4)

(a)	<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	B1	<b>Not:</b> 'Energy cannot be created / destroyed / lost'
(b)	work done = force $\times$ distance <u>moved</u> in the direction of the force Unit: N m or J	M1 A1 B1	<b>Allow:</b> 'force $\times$ displacement' for the M1 mark <b>Note:</b> The unit mark is an independent mark
(c) (i)	<u>kinetic</u> energy $\rightarrow$ heat	B1	<b>Not:</b> friction / deformation / sound / KE of dust / KE of Earth
(ii)	$(E = \frac{1}{2} mv^2)$ $8.4 \times 10^{16} = \frac{1}{2} \times 3.0 \times 10^8 \times v^2$  $v^2 = \frac{2 \times 8.4 \times 10^{16}}{3.0 \times 10^8}$ or $v = \sqrt{\frac{2 \times 8.4 \times 10^{16}}{3.0 \times 10^8}}$  ( $v = 2.37 \times 10^4$ m s <sup>-1</sup> )	C1  C1  A0	<b>Note:</b> This mark is for correct substitution  <b>Allow:</b> 2 marks for $v^2 = 5.6 \times 10^8$  <b>Allow:</b> 1 mark for a bald answer of $2.4 \times 10^4$
(iii)	$8.4 \times 10^{16} = F \times 200$  $F = \frac{8.4 \times 10^{16}}{200}$  force = $4.2 \times 10^{14}$ (N)	C1  C1  A1	Possible ecf <b>Allow:</b> $a = (-) \frac{u^2}{2s}$  $a = (-) \frac{(2.37 \times 10^4)^2}{2 \times 200}$ or $a = (-) \frac{(2 \times 10^4)^2}{2 \times 200}$ C1  $a = 1.4 \times 10^6$ (m s <sup>-2</sup> ) or $a = 1.0 \times 10^6$ (m s <sup>-2</sup> ) C1 $F = 3.0 \times 10^8 \times 1.4 \times 10^6$ or $F = 3.0 \times 10^8 \times 1.0 \times 10^6$ force = $4.2 \times 10^{14}$ (N) or force = $3.0 \times 10^{14}$ (N) A1
<b>Total</b>		<b>10</b>	

5)

<b>a</b>	...incorrect	M1	<b>In question 5, use tick or cross on Scoris to show if the mark is awarded</b> <b>Note:</b> mass <i>changes</i>
	Mass (of the particle) increases (as it approaches speed of light)	A1	
<b>b</b>	....correct	M1	<b>Note:</b> This mark is for stating the transfer of energy between kinetic and (gravitational) potential
	KE is changed into (G)PE or (G)PE is changed into KE or change in KE = change in (G)PE (AW)	A1	
<b>c</b>	...incorrect	M1	Allow <b>alternative</b> response: ..... incorrect M1 Acceleration and weight are not the same quantities (AW) A1
	Weight is equal to drag / air resistance / friction (and not acceleration of free fall)	A1	
<b>d</b>	...incorrect	M1	<b>Note</b> 1 mark if 'trilateration' is misspelled but candidate has mentioned that the statement is incorrect
	The technique is trilateration  ✍ <b>The term <i>trilateration</i> to be included and spelled correctly to gain the A1 mark</b>	A1	
<b>Total</b>		<b>8</b>	

6)

<b>(a)</b>		work done = force × distance <u>moved</u> in the direction of force	B1	<b>Allow:</b> work done = force × displacement in direction of force
<b>(b)</b>	<b>(i)</b>	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
		<b>(ii)</b> 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>	

7)

<b>a</b>	$\text{work done} = \text{force} \times \text{distance moved / travelled (in direction of force)}$  <b>The term <i>distance / displacement</i> to be included and spelled correctly to gain mark</b>	B1	<b>Note:</b> Must have reference to 'distance moved / travelled' <b>Allow:</b> 'work done = force $\times$ displacement'  <b>Must use tick or cross on Scoris to show if the mark is awarded</b>
<b>b(i)</b>	<u>gravitational</u> potential  $\text{kinetic}$  <b>The term <i>kinetic</i> to be included and spelled correctly to gain the second B1 mark</b>	B1  B1	<b>Not:</b> 'potential' on its own  <b>Note:</b> Ignore any reference to sound  <b>Must use ticks on Scoris to show where the marks are awarded</b>
<b>b(ii)</b>	(GPE $\Rightarrow$ ) $4000 \times 9.81 \times 110$ / (GPE $\Rightarrow$ ) $4.32 \times 10^6$ or (KE $\Rightarrow$ ) $\frac{1}{2} \times 4000 \times 20^2$ / (KE $\Rightarrow$ ) $8.0 \times 10^5$  $\text{Work done} = (4000 \times 9.81 \times 110) - \left(\frac{1}{2} \times 4000 \times 20^2\right)$  $\text{force} = \frac{3.516 \times 10^6}{510}$ force = $6.9 \times 10^3$ (N)	C1  C1  A1	<b>Allow:</b> 2 marks if second line is written or $3.5(16) \times 10^6$ (J) is quoted  <b>Allow:</b> 3 marks for a bald answer of $6.9 \times 10^3$ (N)
<b>Total</b>		<b>6</b>	

8)

<b>a</b>	<b>i</b>	work (done) / (elastic potential) energy	B1	<b>Not:</b> heat / gravitational potential energy / kinetic energy
	<b>ii</b>	displacement / distance	B1	
<b>b</b>		Any <u>two</u> from: <ul style="list-style-type: none"> <li>• Torque (of a couple)</li> <li>• Moment (of a force)</li> <li>• Work (done) / energy</li> </ul>	B1 $\times$ 2	<b>Not:</b> 'Couple' for 'torque'  <b>Allow:</b> PE / KE
<b>Total</b>			<b>4</b>	

9)

a	Energy can neither be created nor destroyed (but it can be transformed from one form to another) or Total energy of a closed system remains constant	B1	
b i	loss in PE = $0.10 \times 9.81 \times 0.60$ = 0.59 (J) or 0.589 ( J)	B1	
ii	$v^2 = 2as$ / $v^2 = 2 \times 2.8 \times 0.60$ / $v^2 = 3.36$ $v = \sqrt{2 \times 2.8 \times 0.60}$ or $v = 1.833$ or $v = 1.83$ $v = 1.8 \text{ (m s}^{-1}\text{)}$	M1 M1 A0	
iii	(KE =) $\frac{1}{2}mv^2$ / (KE =) $\frac{1}{2} \times 0.25 \times 1.8^2$ kinetic energy = 0.405 (J) or 0.41 (J)	C1 A1	Possible ecf from (b)(ii) <b>Note:</b> The answer is 0.42 (J) when 1.83 m s <sup>-1</sup> is used <b>Allow:</b> 1 mark for 0.162 (J) if 0.10 kg mass is used or for 0.567 (J) if 0.35 kg is used
iv	<u>KE</u> of 0.10 kg mass is not taken into account (AW)	B1	<b>Not:</b> 'There is friction'
<b>Total</b>		<b>7</b>	

10)

(a)	power = work done/ time or energy/time or 'rate of work done'	B1	
(b)	power = KE/time Using $\frac{1}{2}mv^2$ (power =) $\frac{1}{2} \times 9.7 \times 10^5 \text{ (kg s}^{-1}\text{)} \times 3.0^2$ (power =) $4.365 \times 10^6 \text{ (W)}$	C1 C1 A0	<b>Allow:</b> 1 mark for a bald answer of $4.37 \times 10^6$ since this is a 'show' question
(c)	efficiency = $\frac{1.2}{4.4} \times 100$ efficiency = 27 %	B1	<b>Note:</b> Answer to 3 sf is 27.3% if $4.4 \times 10^6$ is used <b>Note:</b> Answer is 27.5% if $4.365 \times 10^6$ is used <b>Not:</b> 0.27
(d)	(volume per second =) $9.7 \times 10^5 / 1030$ or 941.7 mass per second = density $\times$ volume per second $9.7 \times 10^5 = 1030 \times (3.0 \times \pi \times r^2)$ $r^2 = \frac{9.7 \times 10^5}{1030 \times 3\pi}$ radius = 10 (m)	C1 C1 A1	<b>Allow</b> any subject <b>Allow:</b> 2 marks for 100 (m); answer not square rooted
(e) (i)	water has greater density or water has greater mass / KE for the <u>same volume</u>	B1	
(ii)	Any <u>one</u> from: <ul style="list-style-type: none"> <li>Not an eyesore / cannot be seen</li> <li>Not noisy</li> <li>Predictable energy (with in and out tides)</li> <li>Do not occupy space on the land</li> </ul>	B1	<b>Allow</b> other sensible suggestions
<b>Total</b>		<b>9</b>	

11)

(a)	work done = force $\times$ distance <u>moved</u> in the direction of the force	M1 A1	<b>Allow:</b> 'displacement' instead of 'distance' <b>Allow:</b> 1 mark for 'force $\times$ distance in the direction of the force' <b>Not:</b> work done = energy transfer
(b)	power = work (done)/time or power = energy/time or power = rate of work done	B1	<b>Not:</b> Mixture of quantities and units, e.g: 'energy per second'
(c)	This is because of heat/thermal energy/friction	B1	<b>Not:</b> sound/vibrations
(d) (i)	$E_k = \frac{1}{2}mv^2$ / $E_k = \frac{1}{2} \times 810 \times 30^2$  $E_k = 3.645 \times 10^5$ (J) or $3.65 \times 10^5$ (J)	C1  A1	<b>Note:</b> Bald answer $3.645 \times 10^5$ (J) or $3.6 \times 10^5$ (J) scores 2/2 marks <b>Allow:</b> 1 mark for wrongly rounded answer of $3.7 \times 10^5$ (J)
(ii)	power = $\frac{3.65 \times 10^5}{12}$ power = $3.04 \times 10^4$ (W) $\approx 3.0 \times 10^4$ (W)	B1	Possible ecf
(iii) 1.	work done = $500 \times 30$ work done = $15000$ (J s <sup>-1</sup> )	B1	
2.	'output energy' = $18 \times 46 \times 10^6 \times 0.25$ (= $2.07 \times 10^8$ J)  total drive time = $\frac{18 \times 46 \times 10^6 \times 0.25}{15000}$ (= $1.38 \times 10^4$ s) total drive distance = $1.38 \times 10^4 \times 30$ = $4.1 \times 10^5$ (m)	C1  C1  A1	<b>Allow:</b> 'input energy' = $18 \times 46 \times 10^6$ (= $8.28 \times 10^8$ J)  This C1 mark can also be scored using: 'distance = $2.07 \times 10^8 / 500$ ' Possible ecf from iii 1.  <b>Allow:</b> Bald $4.1 \times 10^5$ (m) scores 3/3 2/3 for $1.66 \times 10^6$ m if 25% efficiency is not used 2/3 if 30 kW from ii is used; answer 2.0 or $2.1 \times 10^5$ (m)
<b>Total</b>		<b>11</b>	

12)

(a)	time = $6.9 \times 3.16 \times 10^7$ (= $2.18 \times 10^8$ s) average speed = $\frac{5.0 \times 10^{12}}{6.9 \times 3.16 \times 10^7}$ average speed = $2.29 \times 10^4$ or $2.3 \times 10^4$ (m s <sup>-1</sup> )	C1  A1	<b>Allow:</b> 1 mark for $5.0 \times 10^{12} / 6.9 = 7.2(46) \times 10^{11}$ (m y <sup>-1</sup> ) <b>Allow:</b> 1 mark for $\frac{5.0 \times 10^{12}}{3.16 \times 10^7} = 1.58 \times 10^5$ (m s <sup>-1</sup> )
(b)	distance = $0.70 \times 200$ (= 140 mm) or KE = $\frac{1}{2} \times 4.0 \times 10^{-6} \times 6100^2$ (= 74.4 J)  work done = change in KE  $F \times (0.70 \times 10^{-3} \times 200) = \frac{1}{2} \times 4.0 \times 10^{-6} \times 6100^2$  $F = 530$ (N)  ----- or ----- $F = ma$  $a = \frac{6100^2}{2 \times (0.70 \times 10^{-3} \times 200)}$ (= $1.33 \times 10^8$ )  $F = 4.0 \times 10^{-6} \times 1.33 \times 10^8$  $F = 530$ (N)	C1  C1  A1  C1  C1  A1	<b>Note:</b> Bald answer scores 3/3 marks  <b>Note:</b> 0.53 (N) scores 2/3 because of $10^0$ error in distance 1.06 $\times 10^5$ (N) scores 2/3 because '200' not taken into account 106 (N) scores 1/3 because '200' missed out and $10^0$ error
<b>Total</b>		<b>5</b>	

13)

(a)		(1 watt is equal to) 1 joule (of energy transferred) <u>per</u> second	B1	<b>Allow:</b> (1) $\text{J s}^{-1}$ <b>Not:</b> '1 J (of energy transferred) <u>in</u> 1 s' because the <u>per</u> or <u>rate</u> idea is not clear <b>Note:</b> Do not allow mixture of quantity and unit. Eg: '1 J per unit time' or 'energy per second'
(b)	(i)	$E_p = 700 \times 9.81 \times 8.5$ $E_p = 5.8(4) \times 10^4 \text{ (J)}$	B1	
	(ii)	output power = $\frac{5.84 \times 10^4}{45}$ output power = $1.3 \times 10^3 \text{ (W)}$	B1	Possible ecf from (i)
	(iii)	input power = $1.3 \times 10^3 / 0.3$ input power = $4.3 \times 10^3 \text{ (W)}$	B1	Possible ecf from (ii)
<b>Total</b>			<b>4</b>	

14)

(a)	(i)	(work done =) $Fx$ and $F = ma$ (Allow any subject)	B1	<b>Allow:</b> $d$ or $s$ instead of $x$
	(ii)	$(E_k =) max$ or (work done =) $max$ (Allow any subject) $v^2 = 2ax$ Use of $v^2 = 2ax$ and $E_k = max$ to show $KE = \frac{1}{2} mv^2$	B1 B1 B1	<b>Note:</b> This mark is for substituting ' $ma$ ' into the equation ' $Fx$ '  <b>Note:</b> This B1 mark is for manipulation of equations leading to $KE = \frac{1}{2} mv^2$  <b>Allow</b> full credit for alternative approaches
(b)		The (braking) distance is more (than 50m) $KE = Fx$ Correct reasoning for longer braking distance, eg: (KE increases and) $x \propto KE$  Or The (braking) distance is more (than 50m)  The van has smaller deceleration (for the same force)  Correct reasoning for longer braking distance in terms of $v^2 = u^2 + 2as$	B1 B1 B1  B1 B1 B1	Alternative: $Fx = \frac{1}{2} mv^2$ B1 Correct reasoning for longer braking distance, eg: $x \propto m$ B1  <b>Allow:</b> smaller acceleration  <b>Allow:</b> Correct reasoning for longer distance in terms of equations of motion
<b>Total</b>			<b>7</b>	

15)

(a)		velocity = rate of <u>change</u> of displacement	B1	<p><b>Allow</b> <math>v = \frac{\Delta s}{\Delta t}</math> where <math>\Delta s =</math> <u>change</u> in displacement <math>\Delta t =</math> time (taken)</p> <p><b>Allow</b> displacement travelled/time</p> <p><b>Allow</b> 'velocity = displacement/time' when followed by 'velocity = rate of change of displacement'</p> <p><b>Not</b> 'velocity = displacement/time' or 'distance/time'</p> <p><b>Not</b> mixture of quantity and unit, e.g. change of displacement per second</p> <p><b>Not</b> 'speed in a specific direction'</p>
(b)	(i)	<p>speed = 70000/3600</p> $KE = \frac{1}{2} \times 130 \times \left( \frac{70000}{3600} \right)^2$ <p>kinetic energy = <math>2.5 \times 10^4</math> (J)</p>	C1 C1 A1	<p><b>Note:</b> speed = 19.4... ( m s<sup>-1</sup>) will score this C1 mark</p> <p><b>Note:</b> Using 19.4 (m s<sup>-1</sup>) gives 2.446... <math>\times 10^4</math> (J); hence an answer of <math>2.4 \times 10^4</math> (J) will score full marks</p> <p><b>Allow</b> maximum of 2 marks if 19 (m s<sup>-1</sup>) is used – answer is 2.34... <math>\times 10^4</math> (J)</p> <p><b>Allow</b> 1 mark for <math>\frac{1}{2} \times 130 \times (70000/60)^2 = 8.84(7) \times 10^7</math> (J)</p> <p><b>Note:</b> No credit for <math>\frac{1}{2} \times 130 \times v^2</math> with any other incorrect value for <math>v</math>, including <math>v = 70</math> and 70000</p> <p><b>Note:</b> Bald answer of <math>2.5 \times 10^4</math> (J) scores full marks</p> <p><b>Note:</b> If the correct equation for KE is written and then the squaring of the speed is omitted, allow ecf as shown below: <math>E = \frac{1}{2} m v^2 = \frac{1}{2} \times 130 \times 19.4 = 1.3 \times 10^3</math> (J) ✓ × ✓ 2 marks</p>
(b)	(ii)	<p>Mass of Mononykus is 1/8 (of the mass of an ostrich) or mass of Mononykus is 16 (kg).</p> <p>Correct reasoning: <u>Volume</u> decreases by (a factor of) 8 <b>and</b> <u>density</u> assumed to be the same.</p>	B1 B1	<p><b>Allow</b> use of <math>V</math> for volume and <math>\rho</math> for density</p>
<b>Total</b>			<b>6</b>	

16)

(a)		force $\times$ distance <u>moved</u> / <u>travelled</u> in the direction of the force	B1	<b>Allow</b> force $\times$ displacement in direction of force
(b)		(Work done against friction generates) heat / thermal energy / internal energy	B1	<b>The term <i>heat / thermal / internal</i> to be included and spelled correctly to gain the B1 mark.</b>
(c)		1 J (of work done) <u>per</u> second	B1	<p><b>Allow</b> (1 W = 1) J s<sup>-1</sup> or J/s</p> <p><b>Allow</b> (1) joules per second</p> <p><b>Not</b> <math>W = 1 \text{ J in } 1 \text{ s}</math></p> <p><b>Allow</b> full credit as long as the definition for the 'watt' is not confused with the definition for 'power'</p> <p>(Examples:</p> <ul style="list-style-type: none"> <li>• power = rate of work done; <math>W = 1 \text{ J s}^{-1}</math> ✓</li> <li>• The rate of work done. It is J per s ×</li> <li>• watt = rate of work done, <math>W = 1 \text{ J s}^{-1}</math> × )</li> </ul>
(d)	(i)	<p>vertical distance = <math>(75^2 - 45^2)^{1/2}</math> or vertical distance = 60 (m)</p> <p>work done = <math>5200 \times 9.81 \times 60</math> or work done = <math>3.06 \times 10^6</math> (J)</p> <p>power = <math>3.06 \times 10^6/90</math></p> <p>power = <math>3.4 \times 10^4</math> (J s<sup>-1</sup>)</p>	C1 C1 A1	<p><b>Allow</b> 2 marks for an answer of <math>2.04 \times 10^6</math> (J s<sup>-1</sup>); 1.5 used instead of 90 s</p> <p>No credit for <math>[5200 \times g \times 75]/90</math> or <math>[5200 \times g \times 45]/90</math></p>
	(ii)	<p>efficiency = <math>\frac{34}{170} \times 100</math></p> <p>efficiency = 20 %</p>	B1	Possible ecf from (i)
<b>Total</b>			<b>7</b>	

17)

<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</b> / <b>(stop)watch</b> / <b>timer</b> /<b>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>	

18)

<b>(a)</b>	$E_p = 190 \times 9.81 \times 25$ $E_p = 4.7 \times 10^4$ (J)	B1	<b>Note:</b> Answer is $4.66 \times 10^4$ to 3sf
<b>(b)</b>	$E_k = \frac{1}{2} \times 190 \times 30^2$ $E_k = 8.6 \times 10^4$ (J)	B1	<b>Note:</b> Answer is $8.55 \times 10^4$ to 3sf
<b>(c)</b>	Work done by the motorbike / energy from the engine (AW)	B1	<b>Note:</b> There must be reference to work or energy <b>Allow:</b> chemical energy to kinetic energy / $E_k$