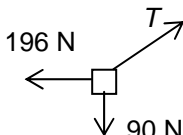


Q 1	mark	Sub
$0 = u - 9.8 \times 3$ $u = 29.4$ so 29.4 m s^{-1} $s = 0.5 \times 9.8 \times 9 = 44.1$ so 44.1 m	M1 <i>uvast</i> leading to u with $t = 3$ or $t = 6$ A1 Signs consistent M1 <i>uvast</i> leading to s with $t = 3$ or $t = 6$ or their u F1 FT their u if used with $t = 3$. Signs consistent. Award for 44.1, 132.3 or 176.4 seen. [Award maximum of 3 if one answer wrong]	4 4
Q 2	mark	Sub
(i)	$\sqrt{(-6)^2 + 13^2} = 14.31782\dots$ so 14.3 N (3 s. f.)	2
(ii)	Resultant is $\begin{pmatrix} -6 \\ 13 \end{pmatrix} - \begin{pmatrix} -3 \\ 5 \end{pmatrix} = \begin{pmatrix} -3 \\ 8 \end{pmatrix}$ Require $270 + \arctan \frac{8}{3}$ so $339.4439\dots^\circ$ so 339°	3
(iii)	$\begin{pmatrix} -3 \\ 5 \end{pmatrix} = 5\mathbf{a}$ so $(-0.6\mathbf{i} + \mathbf{j}) \text{ m s}^{-2}$ change in velocity is $(-6\mathbf{i} + 10\mathbf{j}) \text{ m s}^{-1}$	3 8

Q 3	mark	Sub
(i) $F = 14000 \times 0.25$ so 3500 N	M1 Use of N2L . Allow $F = mga$ and wrong mass. No extra forces. A1	2
(ii) $4000 - R = 3500$ so 500 N	B1 FT F from (i). Condone negative answer.	1
(iii) $1150 - R_T = 4000 \times 0.25$ so 150 N	M1 N2L applied to truck (or engine) using all forces required. No extras. Correct mass. Do not allow use of $F = mga$. Allow sign errors. A1 cao	2
(iv) either Component of weight down slope is Extra driving force is cpt of mg down slope $14000g \sin 3^\circ$ $= 14000 \times 9.8 \times 0.0523359... = 7180.49...$ so 7180 N (3 s. f.) or $D - 500 - 14000g \sin 3 = 14000 \times 0.25$ $D = 11180.49... so extra is 7180 N (3 s. f.)$	M1 Attempt to find cpt of <i>weight</i> (allow wrong mass). Accept $\sin \leftrightarrow \cos$. Accept use of $m \sin \theta$. M1 May be implied. Correct mass. No extra forces. Must have resolved weight component. Allow $\sin \leftrightarrow \cos$ A1 M1 Attempt to find cpt of <i>weight</i> (allow wrong mass). Accept $\sin \leftrightarrow \cos$. Accept use of $m \sin \theta$. M1 N2L with all terms present with correct signs and mass. No extras. FT 500 N. Accept their 500 + 150 for resistance. Must have resolved weight component. Allow $\sin \leftrightarrow \cos$. A1 Must be the extra force.	3 8

Q 4	mark	Sub
(i) either Need j cpt 0 so $18t^2 - 1 = 0$ $\Rightarrow t^2 = \frac{1}{18}$. Only one root as $t > 0$	M1 Need not solve E1 Must establish only one of the two roots is valid	
or Establish sign change in j cpt Establish only one root	B1 B1	2
(ii) $\mathbf{v} = 3 \mathbf{i} + 36t \mathbf{j}$ Need i cpt 0 and this never happens	M1 Differentiate. Allow i or j omitted A1 E1 Clear explanation. Accept 'i cpt always there' or equiv	3
(iii) $x = 3t$ and $y = 18t^2 - 1$ Eliminate t to give $y = 18\left(\frac{x}{3}\right)^2 - 1$ so $y = 2x^2 - 1$	B1 Award for these two expressions seen. M1 t properly eliminated. Accept any form and brackets missing A1 cao	3 8
Q 5	mark	Sub
(i) $0^2 = V^2 - 2 \times 9.8 \times 22.5$ $V = 21$ so 21 m s^{-1}	M1 Use of appropriate <i>uvast</i> . Give for correct expression E1 Clearly shown. Do not allow $v^2 = 0 + 2gs$ without explanation. Accept using $V = 21$ to show $s = 22.5$.	2
(ii) $28 \sin \theta = 21$ so $\theta = 48.59037\dots$	M1 Attempt to find angle of projection. Allow $\sin \leftrightarrow \cos$. A1	2
(iii) Time to highest point is $\frac{21}{9.8} = \frac{15}{7}$ Distance is $2 \times \frac{15}{7} \times 28 \times \cos(\text{their } \theta)$.. 79.3725... so 79.4 m (3 s. f.)	B1 Or equivalent (time of whole flight) M1 Valid method for horizontal distance. Accept $\frac{1}{2}$ time. Do not accept 28 used for horizontal speed or vertical speed when calculating time. B1 Horizontal speed correct A1 cao. Accept answers rounding to 79 or 80. [If angle with vertical found in (ii) allow up to full marks in (iii). If $\sin \leftrightarrow \cos$ allow up to B1 B1 M0 A1] [If $u^2 \sin 2\theta / g$ used then M1* Correct formula used. FT their angle. M1 Dep on *. Correct subst. FT their angle. A2 cao]	4 8

Q 6	mark	Sub
(i) $0.5 \times 2 \times 12 + 0.5 \times 4 \times 12$ so 36 m	M1 Attempt at sum of areas or equivalent. No extra areas. A1	2
(ii) $8 - \frac{36}{12} = 5$ seconds	B1 cao	1
(iii) -6 m s^{-2}	M1 Attempt at accn for $0 \leq t \leq 2$ B1 must be - ve or equivalent	2
(iv) $58.5 = 12 \times 6 + 0.5 \times a \times 36$ so $a = -0.75$	M1 Use of <i>uvast</i> with 12 and 58.5 A1	2
(v) $a = -10 + \frac{9}{2}t - \frac{3}{8}t^2$ $a(1) = -10 + \frac{9}{2} - \frac{3}{8} = -5.875$	M1 Differentiation A1 A1 cao	3
(vi) $s = \int \left(12 - 10t + \frac{9}{4}t^2 - \frac{1}{8}t^3 \right) dt$ $= 12t - 5t^2 + \frac{3}{4}t^3 - \frac{1}{32}t^4 + C$ $s = 0$ when $t = 0$ so $C = 0$ $s(8) = 32$	M1 Attempt to integrate A1 At least one term correct A1 All correct. Accept + <i>C</i> omitted A1* Clearly shown A1 cao (award even if A1* is not given)	5
(vii) either $s(2) = 9.5$ and $s(4) = 8$ Displacement is negative Car going backwards or Evaluate $v(t)$ where $2 < t < 4$ or appeal to shape of the graph Velocity is negative Car going backwards	B1 Both calculated correctly from their s . No further marks if their $s(2) \leq s(4)$ E1 E1 Do <i>not</i> need car going backwards <i>throughout</i> the interval. B1 e.g. $v(3) = -1.125$ No further marks if their $v \geq 0$ E1 E1 Do <i>not</i> need car going backwards <i>throughout</i> the interval [Award WW2 for 'car going backwards'; WW1 for velocity or displacement negative]	3

Q 7	mark	Sub
(i) $T_{AB} \sin \alpha = 147$ so $T_{AB} = \frac{147}{0.6}$ $= 245$ so 245 N	M1 Attempt at resolving. Accept $\sin \leftrightarrow \cos$. Must have T resolved and equated to 147. B1 Use of 0.6. Accept correct subst for angle in wrong expression. A1 Only accept answers agreeing to 3 s. f. [Lami: M1 pair of ratios attempted; B1 correct sub; A1]	3
(ii) $T_{BC} = 245 \cos \alpha$ $= 245 \times 0.8 = 196$	M1 Attempt to resolve 245 and equate to T , or equiv Accept $\sin \leftrightarrow \cos$ E1 Substitution of 0.8 clearly shown [SC1 $245 \times 0.8 = 196$] [Lami: M1 pair of ratios attempted; E1]	2
(iii) Geometry of A, B and C and weight of B the same and these determine the tension	E1 Mention of two of: same weight: same direction AB: same direction BC E1 Specific mention of same geometry & weight or recognition of same force diagram	2
(iv) 	No extra forces. B1 Correct orientation and arrows B1 'T' 196 and 90 labelled. Accept 'tension' written out.	
either Realise that 196 N and 90 N are horiz and vert forces where resultant has magnitude and line of action of the tension $\tan \beta = 90/196$ $\beta = 24.6638\dots$ so 24.7 (3 s. f.) $T = \sqrt{196^2 + 90^2}$ $T = 215.675\dots$ so 216 N (3 s. f.) or $\uparrow T \sin \beta - 90 = 0$ $\rightarrow T \cos \beta - 196 = 0$ Solving $\tan \beta = \frac{90}{196} = 0.45918\dots$ $\beta = 24.6638\dots$ so 24.7 (3 s. f.) $T = 215.675\dots$ so 216 N (3 s. f.)	M1 Allow for only β or T attempted B1 Use of $\arctan(196/90)$ or $\arctan(90/196)$ or equiv A1 M1 Use of Pythagoras E1 B1 Allow if $T = 216$ assumed B1 Allow if $T = 216$ assumed M1 Eliminating T , or... A1 [If $T = 216$ assumed, B1 for β ; B1 for check in 2 nd equation; E0]	7
(v) Tension on block is 215.675.. N (pulley is smooth and string is light) $M \times 9.8 \times \sin 40 = 215.675\dots + 20$ $M = 37.4128\dots$ so 37.4 (3 s. f.)	B1 May be implied. Reasons not required. M1 <i>Equating</i> their tension on the block unresolved ± 20 to weight component. If equation in any other direction, normal reaction must be present. A1 Correct A1 Accept answers rounding to 37 and 38	4