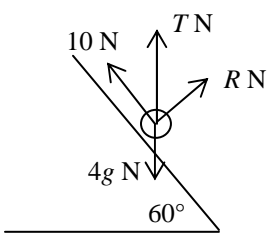


Q 1		mark		Sub
(i)	Acceleration is 8 m s^{-2} speed is $0 + 0.5 \times 4 \times 8 = 16 \text{ m s}^{-1}$	B1 B1		2
(ii)	$a = 2t$	B1		1
(iii)	$t = 7$ $a > 0$ for $t < 7$ and $a < 0$ for $t > 7$	B1 E1	Full reason required	2
(iv)	Area under graph $0.5 \times 2 \times 8 - 0.5 \times 1 \times 4 = 6$ so 6 m s^{-1} Increase	M1 B1 E1	Both areas under graph attempted. Accept both positive areas. If 2×3 seen accept ONLY IF reference to average accn has been made. Award for $v = -2t^2 + 28t + c$ seen or 24 and 30 seen. Award if 6 seen. Accept '24 to 30'. This must be clear. Mark dept. on award of M1	3
	total	8		

Q 2		mark		Sub
(i)	$a = 24 - 12t$	M1 A1	Differentiate cao	2
(ii)	Need $24t - 6t^2 = 0$ $t = 0, 4$	M1 A1	Equate $v = 0$ and attempt to factorise (or solve). Award for one root found. Both. cao.	2
(iii)	$s = \int_0^4 (24t - 6t^2) dt$ $= [12t^2 - 2t^3]_0^4$ $(12 \times 16 - 2 \times 64) - 0$ $= 64 \text{ m}$	M1 A1 M1 A1	Attempt to integrate. No limits required. Either term correct. No limits required Sub $t = 4$ in integral. Accept no bottom limit substituted or arb const assumed 0. Accept reversed limits. FT their limits. cao. Award if seen. [If trapezium rule used. M1 At least 4 strips: M1 enough strips for 3 s. f. A1 (dep on 2 nd M1) One strip area correct: A1 cao]	4
	total	8		

Q 3	mark	Sub	
(i)	$\mathbf{R} + \begin{pmatrix} -3 \\ 4 \end{pmatrix} + \begin{pmatrix} 21 \\ -7 \end{pmatrix} = \begin{pmatrix} 0 \\ 0 \end{pmatrix}$ $\mathbf{R} = \begin{pmatrix} -18 \\ 3 \end{pmatrix}$	M1 Sum to zero A1 Award if seen here or in (ii) or used in (ii). [SC1 for $\begin{pmatrix} 18 \\ -3 \end{pmatrix}$]	2
(ii)	$ \mathbf{R} = \sqrt{18^2 + 3^2}$ $= 18.248\dots \text{ so } 18.2 \text{ N (3 s. f.)}$ $\text{angle is } 180 - \arctan\left(\frac{3}{18}\right) = 170.53\dots^\circ$ $\text{so } 171^\circ \text{ (3 s. f.)}$	M1 Use of Pythagoras A1 Any reasonable accuracy. FT \mathbf{R} (with 2 non-zero cpts) M1 Allow $\arctan\left(\frac{\pm 3}{\pm 18}\right)$ or $\arctan\left(\frac{\pm 18}{\pm 3}\right)$ A1 Any reasonable accuracy. FT \mathbf{R} provided their angle is obtuse but not 180°	4
total	6		

Q 4	mark	Sub	
(i)		B1 All forces present. No extras. Accept mg , w etc. All labelled with arrows. Accept resolved parts only if clearly additional. Accept no angles	1
(ii)	Resolve parallel to the plane $10 + T \cos 30 = 4g \cos 30$ $T = 27.65299\dots \text{ so } 27.7 \text{ N (3 s. f.)}$	M1 All terms present. Must be resolution in at least 1 term. Accept $\sin \leftrightarrow \cos$. If resolution in another direction there must be an equation only in T with no forces omitted. No extra forces. A1 All correct A1 Any reasonable accuracy	3
(iii)	Resolve perpendicular to the plane $R + 0.5 T = 2g$ $R = 5.7735\dots \text{ so } 5.77 \text{ N (3 s. f.)}$	M1 At least one resolution correct. Accept resolution horiz or vert if at least 1 resolution correct. All forces present. No extra forces. A1 Correct. FT T if evaluated. A1 Any reasonable accuracy. cao.	3
total	7		

Q 5	mark	Sub	
(i) $x = 2 \Rightarrow t = 4$ $t = 4 \Rightarrow y = 16 - 1 = 15$	B1 F1	cao FT their t and y . Accept 15 j	2
(ii) $x = \frac{1}{2}t$ and $y = t^2 - 1$ Eliminating t gives $y = ((2x)^2 - 1) = 4x^2 - 1$	M1 E1	Attempt at elimination of expressions for x and y in terms of t Accept seeing $(2x)^2 - 1 = 4x^2 - 1$	2
(iii) either We require $\frac{dy}{dx} = 1$ so $8x = 1$ $x = \frac{1}{8}$ and the point is $\left(\frac{1}{8}, -\frac{15}{16}\right)$ or Differentiate to find v equate i and j cpts so $t = \frac{1}{4}$ and the point is $\left(\frac{1}{8}, -\frac{15}{16}\right)$	M1 B1 A1 M1 M1 A1	This may be implied Differentiating correctly to obtain $8x$ Equating the i and j cpts of their v	3
total	7		

Q 6		mark		Sub
(i)	$2000 = 1000a$ so $a = 2$ so 2 m s^{-2} $12.5 = 5 + 2t$ so $t = 3.75$ so 3.75 s	B1 M1 A1	Use of appropriate <i>uvast</i> for t cao	3
(ii)	$2000 - R = 1000 \times 1.4$ $R = 600$ so 600 N (AG)	M1 E1	N2L. Accept $F = mga$. Accept sign errors. Both forces present. Must use $a = 1.4$	2
(iii)	$2000 - 600 - S = 1800 \times 0.7$ $S = 140$ so 140 N (AG)	M1 A1 E1	N2L overall or 2 paired equations. $F = ma$ and use 0.7. Mass must be correct. Allow sign errors and 600 omitted. All correct Clearly shown	3
(iv)	$T - 140 = 800 \times 0.7$ $T = 700$ so 700 N	M1 B1 A1	N2L on trailer (or car). $F = 800a$ (or $1000a$). Condone missing resistance otherwise all forces present. Condone sign errors. Use of 140 (or $2000 - 600$) and 0.7	3
(v)	N2L in direction of motion car and trailer $-600 - 140 - 610 = 1800a$ $a = -0.75$ For trailer $T - 140 = -0.75 \times 800$ so $T = -460$ so 460 thrust	M1 A1 A1 M1 A1 F1	Use of $F = 1800a$ to find new accn. Condone 2000 included but not T . Allow missing forces. All forces present; no extra ones Allow sign errors. Accept \pm . cao. N2L with their $a (\neq 0.7)$ on trailer or car. Must have correct mass and forces. Accept sign errors cao. Accept ± 460 Dep on M1. Take tension as +ve unless clear other convention	6
	total	17		

Q7	mark	Sub	
(i) $u = \sqrt{10^2 + 12^2} = 15.62..$ $\theta = \arctan\left(\frac{12}{10}\right) = 50.1944... \text{ so } 50.2 \text{ (3s.f.)}$	B1 M1 A1	Accept any accuracy 2 s. f. or better Accept $\arctan\left(\frac{10}{12}\right)$ (Or their $15.62\cos\theta = 10$ or their $15.62\sin\theta = 12$) [FT their 15.62 if used] [If θ found first M1 A1 for θ F1 for u] [If B0 M0 SC1 for both $u\cos\theta = 10$ and $u\sin\theta = 12$ seen]	3
(ii) vert $12t - 0.5 \times 10t^2 + 9$ $= 12t - 5t^2 + 9 \text{ (AG)}$ horiz $10t$	M1 A1 E1 B1	Use of $s = ut + 0.5at^2$, $a = \pm 9.8$ or ± 10 and $u = 12$ or $15.62..$. Condone $-9 = 12t - 0.5 \times 10t^2$, condone $y = 9 + 12t - 0.5 \times 10t^2$. Condone g . All correct with origin of $u = 12$ clear; accept 9 omitted Reason for 9 given. Must be clear unless $y = s_0 + ...$ used.	4
(iii) $0 = 12^2 - 20s$ $s = 7.2 \text{ so } 7.2 \text{ m}$	M1 A1	Use of $v^2 = u^2 + 2as$ or equiv with $u = 12, v = 0$. Condone $u \leftrightarrow v$ From CWO. Accept 16.2.	2
(iv) We require $0 = 12t - 5t^2 + 9$ Solve for t the + ve root is 3 range is 30 m	M1 M1 A1 F1	Use of y equated to 0 Attempt to solve a 3 term quadratic Accept no reference to other root. cao. FT root and their x . [If range split up M1 all parts considered; M1 valid method for each part; A1 final phase correct; A1]	4
(v) Horiz displacement of B: $20 \cos 60t = 10t$ Comparison with Horiz displacement of A	B1 E1	Condone unsimplified expression. Award for $20\cos 60 = 10$ Comparison clear, must show $10t$ for each or explain.	2
(vi) vertical height is $20 \sin 60t - 0.5 \times 10t^2 = 10\sqrt{3}t - 5t^2 \text{ (AG)}$	A1	Clearly shown. Accept decimal equivalence for $10\sqrt{3}$ (at least 3 s. f.). Accept $-5t^2$ and $20\sin 60 = 10\sqrt{3}$ not explained.	1
(vii) Need $10\sqrt{3}t - 5t^2 = 12t - 5t^2 + 9$ $\Rightarrow t = \frac{9}{10\sqrt{3} - 12}$ $t = 1.6915... \text{ so } 1.7 \text{ s (2 s. f.) (AG)}$	M1 A1 E1	Equating the given expressions Expression for t obtained in any form Clearly shown. Accept 3 s. f. or better as evidence. Award M1 A1 E0 for 1.7 sub in each ht	3
total	19		