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1	$-12\sin\theta = 12\sin\theta - 1.6g$ $\theta = 41.8^\circ$ OR $0 = 12\sin\theta \times 1.6 - \frac{1}{2} \times 10 \times 1.6^2$ $\theta = 41.8^\circ$ OR $0 = 12\sin\theta - 10 \times 0.8$ $\theta = 41.8^\circ$	M1 A1 M1 A1 M1 A1	2	$\sin\theta = (1.6g/2)12$ Uses $s = ut + \frac{1}{2}at^2$ Uses $v = u + at$ at the highest point
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2	(i) $10\cos30 \times 1.2\sin\theta - 10\sin30 \times 1.2\cos\theta$ $= 6 \times 0.8\sin\theta$ $5.5923 \dots \sin\theta = 6\cos\theta$ $\theta = 47(.0)$ OR $10 \times 1.2\sin(\theta - 30) = 6 \times 0.8\sin\theta$ or $10 \times 1.2\cos(120 - \theta) = 6 \times 0.8\sin\theta$ $5.5923 \dots \sin\theta = 6\cos\theta$ $\theta = 47(.0)$	M1 A1 M1 A1 M1 A1 M1 A1	4	Creating a 3 term solvable equation in $\sin\theta$ and $\cos\theta$ Creating a 3 term solvable equation in $\sin\theta$ and $\cos\theta$
	(ii) $\mu = (10\cos30 - 6)/(10\sin30)$ $\mu = 0.532$	M1 A1	2	For using $F = \mu R$ with a reasonable attempt to find F and R

3	(i) $0.4g = 16e/0.8$ $e = 0.2$ AG	M1 A1	2	Uses $mg = 16\text{ext}/0.8$
	(ii) EE at C = $16 \times 0.6^2 / (2 \times 0.8)$ $0.4u^2 / 2 + 16 \times 0.2^2 / (2 \times 0.8)$ $+ 0.4g(1.4 - 1.0) = 16 \times 0.6^2 / (2 \times 0.8)$ $u = 2.83 \text{ ms}^{-1}$	B1 M1 A1	3	KE/EE/PE balance attempted with 4 terms. $\sqrt{8}$ not allowed
	(iii) $16 \times 0.6^2 / (2 \times 0.8)$ $= 0.4v^2 / 2 + 0.4g(1.4 - 0.8)$ $v = 2.45 \text{ ms}^{-1}$	M1 A1	2	KE/EE/PE balance attempted with 3 terms.

4	(i) $18^2 - (20\cos40)^2 = 20^2 - (20\cos40)^2$ $-2gh$ $h = 3.8 \text{ m}$ OR $m \times 20^2 / 2 - m \times 18^2 = mgh$ $h = 3.8 \text{ m}$	M1 A1 M1 A1	2	Uses vertical motion with $v^2 = u^2 - 2gs$ Uses energy equation
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(ii)	$V^2 = 18^2 - (20\cos 40)^2$ $V = 9.4483$ $9.4483 = -9.4483 + gt$ $t = 1.89 \text{ s}$ $x = 1.89 \times 20\cos 40$ $x = 29(.0) \text{ m}$ OR $3.8 = (20\sin 40)T - gT^2 / 2$ $T = 2.23(0), 0.34(1)$ $t = 2.23(0) - 0.34(1)$ $t = 1.89$	M1 A1 M1 A1 M1 A1 M1 A1 M1 A1	6	V is the vertical component of the velocity of P when P's speed is 18 M1 for using their V M1 scored if their time is used Uses $s = ut + \frac{1}{2}at^2$
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5 (i)	$OG(\text{arc}) = 1.8\sin(\pi/2)/(\pi/2)$ $OX(1.8 \times 2 + \pi \times 1.8) = 1.1459 \times \pi \times 1.8$ $OX = 0.7(00) \text{ m}$	B1 M1 A1	3	1.1459.. or $3.6/\pi$ 0.70017..
(ii)	$OY = 1.8\tan 22$ $OG(\text{lamina}) = 2 \times 1.8\sin(\pi/2)/(3\pi/2)$ $1.8\tan 22 \times (W + 27.5) =$ $0.7W + 0.763943 \times 27.5$ $W = 37(.3)\text{N}$	B1 B1 M1 A1 A1	5	C of M solid = 0.727247..m from O C of M lamina = 0.763943.. or $2.4/\pi$ $27.5 \left[4 \times 1.8 / (3\pi) - 0.727247 \right] =$ $W(0.727247 - 0.70017)$ Accept to 2sf as sensitive to rounding error

6 (i)	$0.6dv / dt = 0.6g - 3v$ $\int 1/(10 - 5v)dv = \int dt$ $-\frac{1}{5}\ln(10 - 5v) = t(+c)$ Finds c or uses limits twice $t = 0.738 \text{ s}$	B1 M1 A1 M1 A1	5	Newton's Second Law $0.6 \int 1/(0.6g - 3v)dv = \int dt$ $\frac{0.6}{-3} \ln(0.6g - 3v) = t(+c)$
(ii)	$0.6vdv / dx = -3v$ $\int 0.2dv = -\int dx$ $x = 0.39 \text{ m}$	B1 M1 A1	3	Newton's Second Law Integration with use of limits or finding c

7 (i)	$T = 42m(0.5 - 0.4) / 0.4$ $10m = Y + T \times (0.3 / 0.5)$ $Y = 3.7m$	B1 M1 A1 AG	3	$T = 10.5m$
(ii)	$m\omega^2 \times 0.4 = T \times (0.4 / 0.5)$ $\omega = 4.58 \text{ rads}^{-1}$	M1 A1 ^{1/2}	2	ft cv of T

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(iii)	$mv^2 / 0.4 = T \times (0.4 / 0.5) \pm 2m$ $v = 2.04 \text{ ms}^{-1}$ or $v = 1.6 \text{ ms}^{-1}$	M1 A1 A1	3	Either case
(iv)	$Y = 10m$ $10m = mv^2 / 0.4$ $v = 2 \text{ ms}^{-1}$	B1 M1 A1	3	Fresh value of Y not Y(i) Reject or ignore –2