9709_s12_ms_53

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1	$OX = (25\cos30) \times 2$	B1		43.3	
	$OY = (25\sin30) \times 2 - g \times 2^2/2$	B1		5	
	$OP^2 = 43.3^2 + 5^2$	M1			
	$OP = 43.6\,\text{m}$	A1	[4]		**[4]**
2	$OG = (0.7\sin1)/1$	B1		0.589	
		M1		Moments about A. Accept uncancelled form	
	$+/\!-3 \times (0.589 - 0.7\cos1) = F \times (0.7\sin1) \times 2$	A1√		√ candidate's value of 0.589	
	$F = 0.537\,\text{N}$	A1	[4]		**[4]**
3	**(i)** $0.2v\mathrm{d}v/\mathrm{d}x = -0.4x$	M1		Newton's Second Law, – sign essential	
	$v^2/2 = -2x^2/2\ (+ c)$	A1		Accept uncancelled form	
	$0 = -2 \times 2.5^2/2 + c \rightarrow c = 6.25$	M1			
	$KE = 0.2 \times 6.25 = 1.25\,\text{J}$	A1	[4]	$v = 3.54\,\text{ms}^{-1}$	
	(ii) $2^2/2 = -2x^2/2 + 6.25$	M1		$v = 2$ in accurate integral attempt at limits or finding arbitrary constant e.g. in (i)	
	$x = 2.06$	A1	[2]		**[6]**
4	**(i)** Vertical force $= 10m$	B1		May be implied	
	$10m = mv^2/0.4$	M1		Newton's Second Law radially	
	$v = 2\,\text{ms}^{-1}$	A1	[3]		
	(ii) $T = 13 \times (0.4 - 0.25)/0.25$	B1		$T = 7.8\,\text{N}$	
	$m \times 8^2 \times 0.4 = 7.8 + 10m$	M1		Newton's Second Law radially, 2 horizontal forces	
	$m = 0.5$	A1	[3]	$m(25.6 - 10) = 7.8$	
	(iii) $7.8 = m \times \omega^2 \times 0.4$	M1		Newton's Second Law radially, no horizontal reaction	
	$\omega = 6.24$	A1	[2]	$(\sqrt{39})$	**[8]**

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5	(i)		M1		Uses $T = 45ext/1.5$
		$45e/1.5 = 45(1 – e)/1.5 \pm 0.6g\sin30$	A1		Note either portion may be e
		$AP (= 0.55 + 1.5) = 2.05$ m	A1	[3]	
	(ii)		M1		KE/EE/PE energy conservation
		$45 \times 1^2/(2 \times 1.5) =$ $45 \times 0.55^2/(2 \times 1.5)$ $+ 45 \times 0.45^2/(2 \times 1.5)$	A1		3 correct EE terms
		$+ 0.6g \times 0.45\sin30 + 0.6v^2/2$	A1		Correct equation
		$v = 4.5 \text{ ms}^{-1}$	A1	[4]	
	(iii)		M1		EE/PE conservation
		$45 \times 1^2/(2 \times 1.5)$ $= 45(1.6 – 1.5)^2/(2 \times 1.5)$ $+ 45(4 – 1.6 – 1.5)^2/(2 \times 1.5)$			
		$+ 0.6 \times 10(2.5 – 1.6)\sin30$	A1	[2]	Total energy = 15 **[9]**
6	(i)		M1		Table of moments idea
		$(ah/2+0.5a)x$ $= (ah/2)(–h/3)+(0.5a)(0.5/2)$	A1		Correct sum of parts
		$0.5a(1 + h)x = 0.5a(0.25 – h^2/3)$	M1		Must include cancelling of a
		$x = (3 – 4h^2)/(12 + 12h)$ AG	A1	[4]	
	(ii)	$3 – 4h^2 = 0$	M1		Uses $x = 0$
		$h = 0.866$	A1	[2]	
	(iii)	$\tan\theta = x/(a/2) = (a/2)/h$	M1		Correct trigonometry
		$(2/18)/(a/2) = (a/2)/0.5$	DM1		Ratios accurately substituted
		$a = 0.471$	A1	[3]	**[9]**

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7	**(i)** $\theta = 31(.0)°$	B1		$\theta = \tan^{-1}0.6$	
	$0.017 = 10/[2(v\cos31)]^2$	M1			
	$v = 20$ AG	A1	[3]		
	(ii) $v^2 = (20\cos31)^2 + [(20\sin31)^2 - 2g \times 5.2]$	M1		Accept $v^2 = 20^2 - 2g \times 5.2$	
	$v = 17.2\,\text{ms}^{-1}$	A1			
	$0.017x^2 - 0.6x + 5.2 = 0$	M1		Solves 3 term quadratic equation	
	$x = 20$	A1		Ignore smaller root if shown	
	$dy/dx = 0.6 - 0.017(2x)$	M1			
	$\tan \alpha = 0.6 - 0.017(2 \times 20)$	A1			
	$\alpha = 4.6°$ below the horizontal	A1	[7]	$4.57°$	
OR					
7	**(i)** $\theta = 31(.0)°$	B1		$\theta = \tan^{-1}0.6$	
	$0.017 = 10/[2(v\cos31)]^2$	M1			
	$v = 20$ AG	A1	[3]		
	(ii) $5.2 = 20\sin31 - 10t^2/2$	M1		Sets up and solves a 3 term quadratic equation	
	$t = 1.17$ ($t = 1.166..$)	A1		Ignore smaller root if shown	
	$v_{vert} = (-)1.37(2)$	A1		From $v = 20\sin31 - 10t$	
	$v^2 = 17.1(5)^2 + 1.37(2)^2$	M1		Or uses method in (ii) above 17.1(5) is horizontal velocity component	
	$v = 17.2\,\text{ms}^{-1}$	A1			
	$\tan \alpha = 1.37(2)/17.1(5)$	M1			
	$\alpha = 4.6°$ below the horizontal	A1	[7]	$4.57°$	**[10]**