Horizontal Circular Motion MS (From OCR 4729)

Q1, (Jun 2005, Q3)

(i)	$T\cos\theta = 0.01 \times 9.8$	M1		resolving vertically	
	$8/10T = 0.01 \times 9.8$	A1		with $\cos\theta = 8/10$	
	$T = 0.1225$ N	A1	3	AG	
(ii)	$T + T\sin\theta = ma$	M1		resolving horizontally	
	use of $mr\omega^2$	M1			
	$\omega = 5.72$ rads^{-1}	A1	3		
(iii)	K.E.$=½ \times 0.01 \times (r\omega)^2$	M1		$½mv^2$ with $v=rw$	
	K.E.$= 0.0588$	A1√	2	√0.0018 x their ω^2	**8**

Q2, (Jun 2008, Q6)

(i)	$T\cos60° = S\cos60° + 4.9$	M1 A1		Resolving vertically nb for M1: (must be components – all 4 cases)	
	$T\sin60° + S\sin60° = 0.5 \times 3^2/0.4$	M1 A1		Res. Horiz. $mr\omega^2$ ok if $\omega \neq 3$ If equal tensions $2T=45/4$ M1 only	
	$(S + 9.8)\sin60° + S\sin60° = 45/4$	M1			
	$S = 1.60$ N	A1			
	$T = 11.4$ N	A1	**7**		
(ii)	$T\cos60° = 4.9$ $T = 9.8$	M1 A1		Resolving vertically (component)	
	$T\sin60° = 0.5 \times 0.4\omega^2$	M1 A1		Resolving horiz. (component)	
	$\omega = 6.51$ rad s^{-1}	A1	**5**	or 6.5	**12**

Q3, (Jan 2006, Q8)

(i)	$R\cos30° = 0.1 \times 9.8$	M1		resolving vertically	
		A1			
	$R = 1.13$ N	A1	3		
(ii)	$r = 0.8\cos30° = 0.693$ or $2\sqrt{3}/5$	B1		may be implied	
	$R\cos60° = 0.1 \times 0.693\ \omega^2$	M1		or $0.1v^2/r$ & $\omega = v/r$	
		A1			
	$\omega = 2.86$	A1	4		
(iii)	$T = 1.96$ N	B1	1		
(iv)	$R\cos30° = T\cos60° + 0.1 \times 9.8$	M1			
		A1			
	$R = 2.26$ N	A1			
	$R\cos60° + T\cos30° = 0.1 \times v^2/r$	M1		or $mr\omega^2$ & use of $v = r\omega$	
		A1		with R=1.13 can get M1 only	
	4.43 ms^{-1}	A1	6		**14**
(iv)	LHS (or RHS)	M1*		method without finding R	
	$T + 0.1 \times 9.8\cos60°$	A1		i.e. resolving along PA	
	RHS (or LHS)	M1*			
	$0.1 \times v^2/r \times \cos30°$	A1		r to be 0.8 cos30° for A1	
	solve to find v	M1*		depends on 2* Ms above	
	4.43 ms^{-1}	A1	(6)		

Q4, (Jun 2012, Q5)

(i)	$\sin\theta = 0.8$ or $\cos\theta = 0.6$ or $\tan\theta = 4/3$ or $\theta = 53.1$	B1	θ is angle AP makes with horizontal
		*M1	Attempt to resolve horizontally and use N2L with a version of acceleration, not just a. Allow $T_A = T_B$ for M1 only.
	$T_A\cos\theta + T_B\cos\theta = 2 \times 1.2 \times 4^2$	A1	Use their θ
		*M1	Attempt to resolve vertically
	$T_A\sin\theta = T_B\sin\theta + 2g$	A1	Use their θ
	Solve simultaneously to get at least T_A or T_B	Dep*M1	
	$T_A = 44.25$ and $T_B = 19.75$	A1	For both. Allow 44.2, 44.3, 19.7, 19.8
		[7]	
(ii)	$T_B = 0$	B1	May be implied
		*M1	Attempt to resolve horizontally and use N2L with a version of acceleration, not just a
	$T_A\cos\theta = 2v^2/1.2$	A1	Use their θ
	$T_A\sin\theta = 2g$	B1	Use their θ
	Solve for v or ω	Dep*M1	
	$v = 2.97$	A1	
		[6]	

Q5, (Jun 2006, Q6)

(i)	T = 4.9 N	B1		B0 for 0.5g	
	$T = 0.3 \times 0.2 \times \omega^2$	M1		or $0.3v^2/0.2$ and $\omega = v/0.2$	
		A1			
	$\omega = 9.04$ rads^{-1}	A1	4		
(ii)	$\cos\theta = \sqrt{0.6/0.8}$ (0.968)	B1		(θ=14.5°) angle to vert. or equiv.	
	$T\cos\theta = 0.5 \times 9.8$	M1		angle consistent with diagram	
		A1		can be their angle	
	T = 5.06 N	A1	4		
(iii)	$T\sin\theta = 0.5 \times v^2/0.2$	M1		must be a component of T	
		A1		($\sin\theta$ = ¼) can be their angle	
	$v = 0.711$ ms^{-1}	A1	3		11

Q6, (Jun 2010, Q5)

(i)	$T\cos45° + R\sin45° = mg$	*M1	3 terms
		A1	
	$T\sin45° - R\cos45° = ml\sin45°\omega^2$	*M1	3 terms; $a = r\,\omega^2$
		A1	
	$2T = \sqrt{2}mg + ml\omega^2$	Dep*M1	Method to eliminate R
	$T = m/2(\sqrt{2}g + l\omega^2)$	A1 **6**	**AG** www
(ii)	$R = 0$	B1	may be implied
	$2R = \sqrt{2}mg - ml\omega^2$ or $T\cos45° = mg$ or $T = ml\omega^2$	B1	
	Solve to find ω	M1	
	$\omega = 4.16$ rad s^{-1}	A1 **4**	**10**

Q7, (Jun 2016, Q4)

(i)	$T\cos 30 + R\sin 60 = mg$	M1*	Resolving vertically (3 terms)
		A1	
	$T\sin 30 - R\cos 60 = m(a\sin 30)\omega^2$	M1*	Resolving horizontally (3 terms); an r used where r is not just a
		A1	
		M1 dep*	Eliminating T and solve for R in terms of m, g, a and ω
	$R = \frac{1}{6}m\left(2\sqrt{3}g - 3a\omega^2\right)$	A1	**AG** Correctly shown
		[6]	
(ii)	For using $R = 0$ to attempt to find either v or T	M1	Or attempt to find ω
	$T = \frac{mg}{\cos 30} = 39.6$	A1	39.606228…
	$\omega^2 = \frac{T}{ma}$, $v = 1.19\ \mathrm{m\,s^{-1}}$	A1	1.1893309…
		[3]	

Q8, (Jun 2014, Q7)

(i)	$T\cos30 + T\cos45 = 0.4g$ $T = 2.49$ N	M1 A1 A1 **[3]**	Resolve vertically (3 terms); may be different T's at this stage $T = 2.4918\ldots$
(ii)	cv(T)sin30 + cv(T)sin45 = $0.4v^2/0.5$ $v = 1.94$ m s^{-1}	M1 A1 A1 **[3]**	Resolve horizontally (3 terms); may be different T's at this stage Or use acceleration = $0.5\omega^2$ $v = 1.93904\ldots$
(iii)	$(2AP =)\dfrac{0.5}{\sin 45} + \dfrac{0.5}{\sin 30}$ $AP = 0.854$ m	M1 A1 **[2]**	Reasonable attempt to use trigonometry to find total length of string **AG** ($AP = 0.85355\ldots$m)
(iv)	$2T\sin\theta = 0.4(0.854\sin\theta)(3.46^2)$ $T = 2.04$ N $2T\cos\theta = 0.4g$ $\theta = 16.5°$ or $16.6°$	M1 A1 M1 A1 **[4]**	θ angle with vertical. Resolve horizontally. Allow with T only. r = component of 0.854 $T = 2.04474\ldots$ N using AP = 0.854 m, $T = 2.04367\ldots$ N using exact AP θ angle with vertical. Resolve vertically. Allow with T only $\theta = 16.55377\ldots°$ using AP = 0.854 m, $\theta = 16.4526\ldots°$ using exact AP **SC** M1A0M1A1 for use of T instead of 2T throughout

Q9, (Jan 2010, Q7)

(i)	$\cos\theta = 3/5$ or $\sin\theta = 4/5$ or $\tan\theta = 4/3$ or $\theta = 53.1°$ $R\cos\theta = 0.2\times9.8$ $R = 3.27$ N or 49/15	B1 M1 A1	 **[3]**	θ = angle to vertical
(ii)	$r = 4$ $R\sin\theta = 0.2\times4\times\omega^2$ $\omega = 1.81$ rad s^{-1}	B1 M1 A1 A1	 **[4]**	
(iii)	$\varphi = 26.6°$ or $\sin\varphi = \dfrac{1}{\sqrt{5}}$ or $\cos\varphi = \dfrac{2}{\sqrt{5}}$ or $\tan\varphi = 0.5$ $T = 0.98$ or $0.1g$ $N\cos\theta = T\sin\varphi + 0.2\times9.8$ $N\times3/5 = 0.438 + 1.96$ $N = 4.00$ $N\sin\theta + T\cos\varphi = 0.2\times4\times\omega^2$ $4\times4/5 + 0.98\cos 26.6° = 0.8\omega^2$ $\omega = 2.26$ rad s^{-1}	B1 B1 M1 A1 A1 M1 A1 A1	 **[8]**	φ = angle to horizontal Vertically, 3 terms may be implied Horizontally, 3 terms **15**