Circular Motion 2 MS

Q1.

7 (i)	$T = \dfrac{15\left(\dfrac{0.4}{\cos\theta}\right)}{2}$	M1	Uses $T = \dfrac{\lambda \text{ext}}{2}$
	$T = \dfrac{3}{\cos\theta}$ AG	A1	
	$T\cos\theta = mg$	M1	Resolves vertically for P
	$m = 0.3$	A1 [4]	
(ii)	$r = 0.4\tan\theta$	B1	
	$\dfrac{0.3v^2}{r} = T\sin\theta$ *OR* $0.3\omega^2 r = T\sin\theta$	M1	Newton's 2nd law with correct expression for radial accn, ft cv(m(i))
	$0.3\omega^2(0.4\tan\theta) = \dfrac{3}{\cos\theta} \times \sin\theta$	A1√	
	$\omega = 5$	A1 [4]	
	SC Candidates who choose at least two specific values of θ:		
	Calculation of r twice	B1	
	Both calculations give $\omega = 5$	B1	
(iii)	$\text{EPE} = \dfrac{15\left(\dfrac{0.4}{\cos\theta}\right)^2}{2\times 2}$	B1	
	$\text{KE} = \dfrac{0.3\left(5\times 0.4\tan\theta\right)^2}{2}$	B1√	ft candidate's value of ω Award if × 2 is with wrong term
	$\dfrac{15\left(\dfrac{0.4}{\cos\theta}\right)^2}{2\times 2} = \left(\dfrac{0.3(2\tan\theta)^2}{2}\right)\times 2$	M1	
	$\cos^2\theta\tan^2\theta = 0.5$ *OR* $\sin^2\theta = 0.5$		
	$\theta = 45$	A1 [4]	www

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Q2.

6 (i)	$\frac{0.2\times1.5^2}{0.5}=\text{Fr}$	M1		Newton's 2nd law, acc $=\frac{v^2}{r}$
	$\mu\left(=\frac{\text{Fr}}{0.2g}\right)=0.45$	A1	[2]	$\text{Fr}=0.9\,\text{N}$
(ii)	$R=0.2g-\frac{0.2g}{2}\sin 30$	M1		1.5
	$\text{Fr}=0.45\times1.5$	A1		0.675
	$\frac{0.2g}{2}\cos 30\pm0.675=0.2\omega^2 0.5$	M1		Either
	$\omega=3.93$ (greatest)	A1		
	$\omega=1.38$ (least)	A1	[5]	
(iii)	$\frac{0.2g}{2}\cos 30=0.2\omega^2 0.5$	M1		
	$\omega=2.94$	A1	[2]	

Q3.

3 (i)	$T\sin\theta=m\omega^2 r$	M1		Newton's 2nd law, acceleration = $5^2 r$ and component of T
	$3\omega\sin\theta=\left(\frac{\omega}{g}\right)5^2\ (L\sin\theta)$	A1		$3mg\sin\theta=m\,5^2\,(L\sin\theta)$
	$L=1.2\,\text{m}$ AG	A1	[3]	
(ii)	$3\omega\cos\theta=\omega$	M1		Resolves vertically for P
	$\theta=70.53°$	A1		OR $\theta=\cos^{-1}\left(\frac{1}{3}\right)$, $\theta=\sin^{-1}\sqrt{\frac{8}{9}}$ etc.
	$v=5\times1.2\sin\theta$	M1		$v=\omega r$
	$v=5.66\ \text{ms}^{-1}$	A1	[4]	

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Q4.

4	(i)	$r = 0.3\,\text{m}$	B1		Can be implied
		$0.4T/0.5 - 2(0.4/0.5) = 6$	M1		Resolving vertically for the particle
		$T = 9.5\,\text{N}$	A1		
		$9.5(0.3/0.5)+2(0.3/0.5)=6v^2/(0.3g)$	M1		Newton's Second Law radially for P
		$v = 1.86\,\text{ms}^{-1}$	A1	5	

Q5.

6	(i)	(a)	$2\cos45 + 2 \times 3/5 = 0.4\,\omega^2 \times 0.3$	**M1** **A1**		Uses N2L with 2 components of T and accn = $0.3\,\omega^2$
			$\omega = 4.67\ \text{rad}\,s^{-1}$	**A1**	3	
	(i)	(b)	$R + 2\sin45 + 2 \times 4/5 = 0.4\,\text{g}$	**M1**		
			$R = 0.986\,\text{N}$	**A1**	2	
	(ii)		$T\sin45 + T(4/5) = 0.4\,\text{g}$	**M1**		
			$T = 2.65$	**A1**		2.654
			$T\cos45 + T(3/5) = 0.4\,v^2/0.3$	**M1**		
			$v = 1.61\,\text{m}\,s^{-1}$	**A1**	4	

Q6.

7	(i)	$R\cos30 = 0.5\text{g}$		**M1**		
		$R = 5.77(35...)$	AG	**A1**		
		$R\sin30 = 0.5\omega^2$ x 0.4		**M1**		
		$\omega = 3.8(0)\ \text{rad s}^{-1}$		**A1**	[4]	

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(ii)	$T = 36(0.5 - 0.45)/0.45$	**M1**		4 N
	Vert cmpt = 4 x 0.3/0.5 = 2.4	**A1**		
	Horiz cmpt = 4 x 0.4/0.5 = 3.2	**A1**		
	$R\cos 30 + 2.4 = 0.5g$	**M1**		
	$R = 3(.00\ldots)$ N $0.5v^2/0.4 = 3.2 + R\sin 30$	**M1**		
	$v = 1.94$ m s^{-1}	**A1**	[6]	

Q7.

6(i)	$T = 12 \times 0.1 / 0.4$ (= 3 N)	**B1**	Uses $T = \lambda x / L$
	$3\sin\theta = 0.15\omega^2(0.5\sin\theta)$	**M1**	Uses Newton's Second Law horizontally
	$\omega = 6.32$ rad s^{-1}	**A1**	
	$T\cos\theta = 0.15g$ ($\cos\theta = 0.5$)	**M1**	Resolves vertically
	$\theta = 60$	**A1**	
	Total:	**5**	
6(ii)	$v = 6.32 \times 0.5\sin 60$	**B1 FT**	Uses $v = r\omega$ and r = 0.5sin60
	KE = $0.15(6.32 \times 0.5\sin 60)^2 / 2$ (=0.5625J)	**B1**	
	Difference = $0.5625 - 12 \times 0.1^2 / (2 \times 0.4)$	**M1**	Uses EE = $\lambda x^2 / (2L)$
	Difference = 0.4125 J	**A1**	
	Total:	**4**	

Q8.

1(i)	$(4 = 5r)\ r = 0.8$ m	**B1**	Uses $v = r\omega$
	Total:	**1**	
1(ii)	$T = 0.2 \times 5^2 \times 0.8$	**M1**	Uses Newton's Second Law horizontally
	$T = 4$ N	**A1 FT**	FT with their radius from part (i)
	$4 = \lambda(0.8 - 0.6)/0.6$	**M1**	Uses $T = \lambda x / L$
	$\lambda = 12$	**A1**	
	Total:	**4**	

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Q9.

1	$R = 0.4 \times 6^2 \times 0.5$ (= 7.2 N)	**B1**	Uses Newton's Second Law horizontally and $a = r\omega^2$.
	$F = 0.4\,g$	**B1**	Resolve vertically.
	$\mu = 4/7.2$	**M1**	Use $F = \mu R$.
	$\mu = 0.556$ or 5/9	**A1**	Accept $\mu = 0.56$.
		4	