Problem Solving With Circular Motion

Q1, (OCR 4729, Jun 2013, Q5)

(i)	Vertical force = mg	*B1	
	Horizontal force = $m \times 0.4 \times 7^2$	*M1A1	
	Uses vertical force = $\mu \times$ horizontal force	dep*M1	Dependent on B1 and M1
	$\mu = 0.5$	A1	If a value for m used B0M1A0M1A0 max.
		[5]	
(ii)	$mg = T \times 0.3/0.5$	B1	
		*M1	Resolve T and equate to mass $\times$ ($r\omega^2$ or v^2/r)
	$m \times 0.4\,\omega^2 = T \times 0.4/0.5$	A1	
	Solve for ω or v	dep*M1	
	$\omega = 5.72$ rad s^{-1}	A1	allow $7\sqrt{6}/3$ If a value for m and/or T used B0M1A0M1A0 max.
		[5]	

Q2, (OCR 4729, Jun 2015, Q8)

(i)		$0.4v^2/0.6 = 6,\ v = 3$	M1 A1 **[2]**	Attempt at use of N2L with $a = v^2/r$ or $a = r\omega^2$; allow verification. **AG** If +/-3 then -3 must be rejected for A1.
(ii)			*M1	Attempt at use of conservation of linear momentum
		$3(0.4) = 0.4v_A + 0.5v_B$	A1	
			*M1	Attempt at use of restitution equation, must be correct way round
		$v_B - v_A = 3(0.35)$	A1	Must be consistent with the directions used for CoLM
			dep*M1	Solving simultaneous equations
		$v_A = 0.75$ m s^{-1} and $v_B = 1.8$ m s^{-1}	A1 **[6]**	Both values positive as final answer.
(iii)		$Y = 0.4g\ (= 3.92)$	B1	Resolve vertically
		$(4.9)^2 - (0.4g)^2\ (= 2.94^2)$	B1	Use of Pythagoras
		$0.4(0.6)\omega^2 = \text{cv}(2.94)$	M1	Resolve horizontally, cv(2.94) from a legitimate attempt at 2.94
		$\omega = 3.5$	A1 **[4]**	Exact
OR		$4.9\cos\theta = 0.4g$	B1	Resolve vertically, θ angle with vertical
		$\cos\theta = 0.8$ or $\theta = 36.9$	B1	
		$0.4(0.6)\omega^2 = 4.9\sin\theta$	M1	Resolve horizontally, θ substituted and from a legitimate attempt
		$\omega = 3.5$	A1 **[4]**	Exact
OR		$Y = 0.4g\ (= 3.92)$	B1	Resolve vertically
		$X = 0.4(0.6)\omega^2\ (= 0.24\omega^2)$	B1	Resolve horizontally
		$(0.4g)^2 + (0.4(0.6)\omega^2)^2 = 4.9^2$	M1	Attempt at use of Pythagoras, from a legitimate attempt at X
		$\omega = 3.5$	A1 **[4]**	Exact

Q3, (OCR 4729, Jan 2013, Q8)

(i)	**(a)**	$0.8F + 0.6R = 0.4g$ $4F + 3R = 19.6$ **[AG]**	M1 A1 **[2]**	Attempt to resolve vertically www	
(i)	**(b)**	$0.8R - 0.6F = 0.4 \times 4.5^2/3$ Solve for R or F $F = 1.516$ $R = 4.512$ Use $\mu = F/R$ to get $\mu = 0.336$ **[AG]**	M1 A1 M1 A1 A1 B1 **[6]**	Attempt with three terms. aef including cos, sin correct angle Use 2 relevant resolutions.	
(ii)		$0.6R - 0.8F = 0.4g$ $R = 11.8$ or $F = 3.98$ $0.8R + 0.6F = 0.4 \times 3 \times \omega^2$ $\omega = 3.14$ rad s^{-1}	M1 A1 A1 M1 A1 A1 **[6]**	Resolve vertically, three terms N2L, resolve horizontally, three terms	

Q4, (Jun 2006, Q7)

(i)	$\frac{1}{2}\ 0.3v^2 + \frac{1}{2}\ 0.4v^2$	B1		
	$\pm 0.3g(0.6\sin\theta)$	B1		
	$\pm 0.4g(0.6\theta)$	B1		
	$[0.35v^2 = 2.352\theta - 1.764\sin\theta]$	M1		For using the principle of conservation of energy.
	$v^2 = 6.72\theta - 5.04\sin\theta$	A1	5	AG
(ii)		M1		For applying Newton's 2nd Law radially to P and using $a = v^2/r$
	$0.3(v^2/0.6) = 0.3g\sin\theta - R$	A1		
	$[\frac{1}{2}(6.72\theta - 5.04\sin\theta) =$	M1		For substituting for v^2.
	$0.3g\sin\theta - R]$			
	Magnitude is $(5.46\sin\theta - 3.36\theta)$N	A1		AG
	$[5.46\cos\theta - 3.36 = 0]$	M1		For using $dR/d\theta = 0$
	Value of θ is 0.908	A1	6	
(iii)	$[T - 0.3g\cos\theta = 0.3a]$	M1		For applying Newton's 2nd Law tangentially to P
	$[0.4g - T = 0.4a]$	M1		For applying Newton's 2nd Law to Q [If $0.4g - 0.3g\cos\theta = 0.3a$ is seen, assume this derives from $T - 0.3g\cos\theta = 0.3a$ ……. M1 and $T = 0.4g$ ……. M0]
	Component is $5.6 - 4.2\cos\theta$	A1	3	
OR				
(iii)	$0.4g - 0.3g\cos\theta = (0.3 + 0.4)a$	B2		
	Component is $5.6 - 4.2\cos\theta$	B1	3	
OR				
(iii)	$[2v(dv/d\theta) = 6.72 - 5.04\cos\theta]$	M1		For differentiating v^2 (from (i)) w.r.t. θ
	$2\ (0.6a) = 6.72 - 5.04\cos\theta$	M1		For using $v(dv/d\theta) = ar$
	Component is $5.6 - 4.2\cos\theta$	A1	3	

Q5, (Jun 2011, Q7i,ii)

i		M1	For using the principle of conservation of energy. Allow sign error, sin/cos; need 3 terms.
	$\frac{1}{2}mv^2 = \frac{1}{2}m5.6^2 - mg0.8(1 - \cos\theta)$	A1	
	$v^2 = 15.68(1 + \cos\theta)$	A1	AG No slips
	$T - mg\cos\theta = mv^2/r$	M1	For using Newton's second law. Allow sign error and/or sin/cos and/or m omitted
		A1	
	$[T - 0.3g\cos\theta = 0.3x15.68(1 + \cos\theta)/0.8]$	M1	For substituting for v^2
	Tension is $2.94(3\cos\theta + 2)$ N oe	A1	
		[7]	
ii		M1	For putting $T = 0$ and attempting to solve accept $\theta = \cos^{-1}(-2/3)$
	θ is 131.8° (or 2.3 rads) Accept 132° (exact)	A1	
	v is 2.29	B1	$\sqrt{15.68/3}$ exact
		[3]	

Q6, (Jan 2007, Q7)

(i)(a)	Extension = $1.2\alpha - 0.6$	B1	
[$T = mg\sin\alpha$]		M1	For resolving forces tangentially
$0.5x9.8\sin\alpha = 6.86(1.2\alpha - 0.6)/0./6$		A1ft	
$\sin\alpha = 2.8\alpha - 1.4$		A1 4	AG
(i)(b)	[0.8, 0.756.., 0.745.., 0.742.., 0.741.., 0.741..,]	M1	For attempting to find α_2 and α_3
$\alpha = 0.74$		A1 2	
(ii)	$\Delta h = 1.2(\cos 0.5 - \cos 0.8)$ [0.217…]	B1	
[$0.5x9.8x0.217.. = 1.06355..$]		M1	For using $\Delta(PE) = mg\Delta h$
[$6.86(1.2x0.8 - 0.6)^2/(2x0.6) = 0.74088$]		M1	For using EE = $\lambda x^2/2L$
		M1	For using the principle of conservation of energy
$\frac{1}{2}0.5v^2 = 1.06355.. - 0.74088$		A1	Any correct equation for v^2
Speed is $1.14ms^{-1}$		A1	
Speed is decreasing		B1ft 7	