Q1.

1	(a)	(i)	angle (subtended) at centre of circle	B1	
			by an arc equal in length to the radius (of the circle)	B1	[2]
		(ii)	angle swept out per unit time / rate of change of angle	M1	
			by the string	A1	[2]
	(b)		friction provides / equals the centripetal force	B1	
			$0.72\,W = md\omega^2$	C1	
			$0.72\,mg = m \times 0.35\omega^2$		
			$\omega = 4.49$ (rad s^{-1})	C1	
			$n = (\omega/2\pi) \times 60$	B1	
			$= 43$ min^{-1} (allow 42)	A1	[5]
	(c)		*either* <u>centripetal</u> force increases as *r* increases		
			or <u>centripetal</u> force larger at edge	M1	
			so flies off at edge first	A1	[2]
			($F = mr\omega^2$ so edge first – treat as special case and allow one mark)		

Q2.

4	(a)	(i)	(θ =) ωt *(allow any subject if all terms given)*	B1	[1]
		(ii)	(SQ =) $r\sin\omega t$ *(allow any subject if all terms given)*	B1	[1]
	(b)		this is the solution of the equation $a = -\omega^2 x$	M1	
			$a = -\omega^2 x$ is the (defining) equation of s.h.m.	A1	[2]
	(c)	(i)	$f = \omega / 2\pi$	C1	
			$= 4.7 / 2\pi$		
			$= 0.75$ Hz	A1	[2]
		(ii)	$v = r\omega$ (*r* must be identified)	C1	
			$= 4.7 \times 12$		
			$= 56$ cm s^{-1}	A1	[2]

Q3.

1	(a)		angle (subtended) <u>at centre</u> of circle	B1	
			(by) arc equal in length to radius	B1	[2]
	(b)	(i)	point S shown below C	B1	[1]
		(ii)	(max) force / tension = weight + centripetal force	C1	
			centripetal force = $mr\omega^2$	C1	
			$15 = 3.0/9.8 \times 0.85 \times \omega^2$	C1	
			$\omega = 7.6$ rad s^{-1}	A1	[4]

Q4.

1	(a)	θ (rad) $= 2\pi \times (10.3/360)$		1	
		$= 0.180$ rad	(n.b. 3 sig. fig.)	1	**[2]**
	(b) (i)	$\tan\theta = 0.182$	(n.b. 3 sig. fig.)	1	
	(ii)	percentage error $= (0.002/0.180) \times 100$		1	
		$= 1.1$ (%)		1	**[3]**
		(allow 0.002/0.182 and allow 1→ 4 sig. fig.)			

Q5.

1	(a)	(i)	angle subtended at centre of circle	B1	
			arc equal in length to the radius	B1	[2]
		(ii)	arc = $r\theta$ and for one revolution, arc = $2\pi r$	M1	
			so, $\theta = 2\pi r/r = 2\pi$	A0	[1]
	(b)	(i)	*either* weight provides/equals the centripetal force		
			or acceleration of free fall is centripetal acceleration	B1	
			$9.8 = 0.13 \times \omega^2$	M1	
			$\omega = 8.7$ rad s^{-1}	A0	[2]
		(ii)	force in cord = weight + centripetal force (*can be an equation*)	C1	
			force in cord = $(L - 13) \times 5/1.8$ *or* force constant = 5.0/1.8	C1	
			$(L - 13) \times 5/1.8 = 5.0 + 5/9.8 \times L \times 10^{-2} \times 8.7^2$	C1	
			$L = 17.2$ cm	A1	[4]
			(*constant centripetal force of 5.0 N gives L = 16.6 cm allow 2/4*)		

Q6.

7	(a)		angle subtended at the centre of a circle	B1	
			by an arc equal in length to the radius	B1	[2]
	(b)	(i)	arc = distance × angle	C1	
			diameter $= 3.8 \times 10^5 \times 9.7 \times 10^{-6}$		
			$= 3.7$ km	A1	[2]
		(ii)	Mars is (much) further from Earth / away (*answer must be comparative)*	B1	
			angle (at telescope is much) smaller	B1	[2]

Q7.

2	**(a)**	**(i)**	$F = R\cos\theta$	M1	
			$W = R\sin\theta$	M1	
			dividing, $W = F\tan\theta$	A0	[2]
			(max. 1 if derivation to final line not shown)		
		(ii)	provides the centripetal force	B1	[1]
	(b)		*either* $F = mv^2/r$ and $W = mg$		
			or $v^2 = rg/\tan\theta$	C1	
			$v^2 = (14 \times 10^{-2} \times 9.8)/\tan 28°$	C1	
			$= 2.58$		
			$v = 1.6\,\text{m s}^{-1}$	A1	[3]