

Q1.

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

Q2.

- 4 (a) (i) $(\theta =) \omega t$ (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
 $= 4.7 / 2\pi$
 $= 0.75 \text{ Hz}$ A1 [2]
- (ii) $v = r\omega$ (r must be identified) C1
 $= 4.7 \times 12$
 $= 56 \text{ cm s}^{-1}$ A1 [2]

Q3.

- 1 (a) angle (subtended) at centre 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 = $m r \omega^2$ C1
 $15 = 3.0 / 9.8 \times 0.85 \times \omega^2$ C1
 $\omega = 7.6 \text{ rad s}^{-1}$ 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 \rightarrow 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 B1
 or acceleration of free fall is centripetal acceleration M1
 $9.8 = 0.13 \times \omega^2$ M1
 $\omega = 8.7 \text{ rad s}^{-1}$ 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
 $L = 17.2 \text{ cm}$ A1 [4]
 (constant centripetal force of 5.0 N gives $L = 16.6 \text{ cm}$ 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 \times angle C1
 diameter = $3.8 \times 10^5 \times 9.7 \times 10^{-6}$ A1 [2]
 = 3.7 km
- (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) $F = R \cos \theta$
 $W = R \sin \theta$
dividing, $W = F \tan \theta$
(max. 1 if derivation to final line not shown)
- (ii) provides the centripetal force
- (b) either $F = mv^2/r$ and $W = mg$
or $v^2 = rg/\tan \theta$
 $v^2 = (14 \times 10^{-2} \times 9.8)/\tan 28^\circ$
 $= 2.58$
 $v = 1.6 \text{ ms}^{-1}$
- M1
M1
A0 [2]
- B1 [1]
- C1
C1
A1 [3]