Motion in a Circle

Mark Scheme 2

Level	International A Level
Subject	Physics
Exam Board	CIE
Topic	Motion in a circle
Sub Topic	
Paper Type	Theory
Booklet	Mark Scheme 2

Time Allowed: **47 minutes**

Score: **/39**

Percentage: **/100**

A*	A	B	C	D	E	U
>85%	'77.5%	70%	62.5%	57.5%	45%	<45%

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})	C	
			$n = (\omega / 2\pi) \times 60$	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)		

2 **(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*)

3 **(a)** **(i)** angular speed = $2\pi/T$ **C1**
$= 2\pi/(3.2 \times 10^7)$
$= 1.96 \times 10^{-7}$ rad s^{-1} **A1** **[2]**

(ii) force = $mr\omega^2$ <u>or</u> force = mv^2/r and $v = r\omega$ **C1**
$= 6.0 \times 10^{24} \times 1.5 \times 10^{11} \times (1.96 \times 10^{-7})^2$
$= 3.46 \times 10^{22}$ N **A1** **[2]**

(b) **(** gravitation/gravity/gravitational field (strength) **B1** **[1]**

(ii) $F = GMm/x^2$ <u>or</u> $GM = r^3\omega^2$ **C1**
$3.46 \times 10^{22} = (6.67 \times 10^{-11} \times M \times 6.0 \times 10^{24})/(1.5 \times 10^{11})^2$ **C1**
$M = 1.95 \times 10^{30}$ kg **A1** [3]

4 (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) x 100 1

= 1.1 (%) 1 **[3]**

(allow 0.002/0.182 and allow 1→ 4 sig. fig.)

5	**(a)**	force on proton is normal to velocity and field	M1	
		provides centripetal force (for circular motion)	A1	[2]
	(b)	magnetic force = Bqv	B1	
		centripetal force = $mr\omega^2$ or mv^2/r	B1	
		$v = r\omega$	B1	
		$Bqv = Bqr\omega = mr\omega^2$		
		$\omega = Bq/m$	A1	[4]