

1(a)	velocity and acceleration both have constant magnitude
	velocity is (always) perpendicular to acceleration
1(b)(i)	$v = R\omega$
1(b)(ii)	$a = R\omega^2$ or $a = v^2 / R$
	$a = v\omega$
1(c)(i)	$x = R \sin \theta$
1(c)(ii)	$\theta = \omega t$
1(c)(iii)	clear substitution of $\theta = \omega t$ into $x = R \sin \theta$ leading to $x = R \sin \omega t$
1(c)(iv)	equation is of the form $x = x_0 \sin \omega t$ (so simple harmonic motion)
1(d)(i)	amplitude = $0.46 / 2$
	= 0.23 m
1(d)(ii)	$\omega = 2\pi / T$
	period = $2\pi / 1.9$ = 3.3 s
1(d)(iii)	$a_0 = \omega^2 x_0$
	= $1.9^2 \times 0.23$ = 0.83 m s^{-2}
1(e)	shadow on screen, labelled A, above left-hand edge of the circular path

1(a)(i)	radius = $6.37 \times 10^6 \times \cos 52.2^\circ = 3.90 \times 10^6 \text{ m}$
1(a)(ii)	period = 24 hours
	$v = 2\pi r / T$ or $v = r\omega$ and $\omega = 2\pi / T$
	$v = (2\pi \times 3.90 \times 10^6) / (24 \times 60 \times 60)$ = 280 m s^{-1}
1(b)(i)	$F = mv^2 / r$
	= $(58.6 \times 280^2) / (3.90 \times 10^6)$ = 1.2 N
1(b)(ii)	arrow pointing horizontally to the left
1(b)(iii)	arrow from student pointing along the dotted line, labelled 'weight'
	upwards arrow from student pointing in a direction to the left of normal and above the tangent to the Earth, labelled 'contact force'

1	Defining the problem	
	vary m and measure f or m is the independent variable and f is the dependent variable	
	keep f_0 <u>constant</u>	
	Methods of data collection	
	labelled diagram of workable experiment including: - turntable base and motor on bench - two labels from turntable, motor, belt, C, putty, bench, release mechanism	
	workable circuit showing terminals of motor connected to (d.c.) supply	
	method to measure time to determine f and f_0 , e.g. use a stopwatch to measure $(n)t$ and method to measure m , e.g. use a (top-pan) balance	
	measure the time t for n revolutions and $T = t / n$ and $f = 1 / T$ or $f = n / t$	
	Method of Analysis	
	plots a graph of $\frac{1}{f}$ against m or equivalent Do not accept logarithms.	
1	$\frac{1}{f}$ against m $K = \frac{r^2}{f_0 \times \text{gradient}}$	m against $\frac{1}{f}$ $K = \frac{r^2 \times \text{gradient}}{f_0}$
	$\beta = f_0 \times y\text{-intercept}$	m against $\frac{1}{f}$ $\beta = -\frac{f_0 \times y\text{-intercept}}{\text{gradient}}$ or $\beta = -\frac{r^2 \times y\text{-intercept}}{K}$

1	Additional detail including safety considerations
	D1 precaution linked to <u>putty</u> leaving turntable, e.g. screens around apparatus / cushions to prevent putty from leaving bench
	D2 keep r <u>constant</u>
	D3 use rule(r) to measure r
	D4 stand and fixed point located above P (to ensure r is constant)
	D5 method to ensure putty is dropped at (constant) distance r , e.g. ; fixed location above the turntable to drop putty to keep r constant or draw a circle of radius r on the turntable
	D6 method to keep f_0 constant, e.g. adjust the rheostat to keep the current in the motor constant / check ammeter
	D7 clamp motor and/or turntable (base) <u>to bench</u>
	D8 lubricate the turntable to reduce friction
	D9 repeat experiment for the same value of m and determine the average f
	D10 relationship valid if a straight line is produced (with y -intercept = $\frac{\beta}{f_0}$) Do not accept line through the origin.