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 = 2π / 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 = $6.37 \times 10^6 \times \cos 52.2° = 3.90 \times 10^6$ 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 constant
	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.

$\frac{1}{f}$ against m	m against $\frac{1}{f}$
$K = \dfrac{r^2}{f_0 \times \text{gradient}}$	$K = \dfrac{r^2 \times \text{gradient}}{f_0}$

$\frac{1}{f}$ against m	m against $\frac{1}{f}$
$\beta = f_0 \times y\text{-intercept}$	$\beta = -\dfrac{f_0 \times y\text{-intercept}}{\text{gradient}}$ **or** $\beta = -\dfrac{r^2 \times y\text{-intercept}}{K}$

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 <u>if</u> a straight line is produced (with y-intercept = $\frac{\beta}{f_0}$) Do not accept line through the origin.