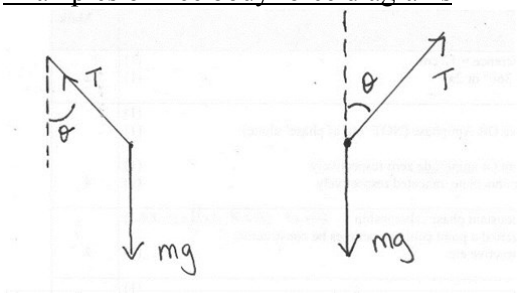
Question Number	Answer		Mark
1(a)(i)	Use of $v = \frac{2\pi r}{T}$ **Or** $v = rw$ v = 2.1 m s^{-1} Example of calculation $v = \frac{2\pi \times 0.4 \text{ m}}{1.2 \text{ s}}$ = 2.09 m s^{-1}	**(1)** **(1)**	**2**
1(a)(ii)	Radius/circumference decreased Measured speed greater than actual speed (dependent on first mark)	**(1)** **(1)**	**2**
1(a)(iii)	Use of $F = Bqv$ $F = 5.9 \times 10^{-24}$ N Example of calculation $F = 0.05 \text{ T} \times 1.6 \times 10^{-19}\text{C} \times 7.4 \times 10^{-4} \text{ m s}^{-1} = 5.9 \times 10^{-24}$ N	**(1)** **(1)**	**2**
1(b)	Use of $R\cos\theta = mg$ **and** $R\sin\theta = F$ **Or** $\tan\theta = F/mg$ Use of $F = \frac{mv^2}{r}$ (do not award if mg used as the force) r = 20 m (g =10 m s^{-2} leads to r = 20.04 m scores MP1 & 2 only) Example of calculation $r = \frac{mv^2}{mg\tan\theta} = \frac{v^2}{g\tan\theta}$ $r = \frac{(9 \text{ m s}^{-1})^2}{9.81 \text{ m s}^{-2} \times \tan 22^\circ} = 20.4$ m	**(1)** **(1)** **(1)**	**3**
	Total for question 16		**9**

Question Number	Answer	Mark
2(a)	Evidence of frictional force = (0.35 × mg) **(1)** Use of $F = mr\omega^2$ **Or** $F = mv^2/r$ **(1)** Use of $\omega = 2\pi/T$ **Or** $v = 2\pi r/T$ **(1)** t = 3.0 s **(1)** Example of calculation frictional force = 0.35 × 20 kg × 9.81 m s^{-2} = 68.7 N $F = mr\omega^2$ $\omega = \sqrt{}$ (68.7 N / (20 kg × 0.80 m) ω =2.1 rad s^{-1} $t = 2\pi/2.1$ rad s^{-1} t = 3.0 s	**4**
2(b)	There would be no difference **(1)** Both expressions for force depend on mass **Or** algebraic equation for ω or T derived (could be in the working for (a)) showing ω or T independent of m **Or** statement that masses cancel if supported by evidence in (a) **(1)**	**2**
	Total for question 13	**6**

Question Number	Answer	Mark
3	Free body force diagram showing 2 forces only Weight/W/mg **(1)** Tension / T **(1)** (Each additional forces e.g. horizontal component or resultant force, 1 mark penalty) **If θ is angle to the vertical then**: (Resolving vertically): $T\cos\theta = mg$ **(1)** (Resolving horizontally): $T\sin\theta = mv^2/r$ **Or** $T\sin\theta = mr\omega^2$ **(1)** Derives $\tan\theta = v^2/rg$ **and** links to observations **Or** Derives $\tan\theta = r\omega^2/g$ **and** links to observations **(1)** If angle to horizontal is used candidates can score MP3 and 4.[then sin and cos swop over and tan of angle will be reciprocal of above] <u>Examples of free body force diagrams</u>  (full credit for the last 3 marks can be given to candidates who draw a vector triangle and derive $\tan\theta = T_{horzt}/mg$ and then $\tan\theta = r\omega^2/g$ **and** observation)	**5**
	Total for question 12	**5**

Question Number	Answer	Mark
4(a)	Conversion from per minute to per second Conversion from revolutions to radians <u>Example of calculation</u> 20 revolutions = 20 x 2π /60 (= 2.1 rads s^{-1})	**(1)** **(1)**
4(b)	Use of $r\omega^2$ Answer in range 6 – 13 ms^{-2}	**(1)** **(1)** **(1)**
	Total for question 13	**5**

Question Number	Answer	Mark
5(a)	Use of $F=mv/t$ or $F = ma$ **(1)** Answer = 2.0 x 10^5 N **(1)** Eg F = 12000 x 57 / 3.5	**2**
5(b)	Arrow down labelled mg / W **(1)** Arrow up labelled eg R /reaction / force from seat **(1)** Equal length vertical arrows from a clear single point / centre of mass and "bottom" **(1)**	**3**
5(c)	4*m*g – *mg* OR 3*mg* **(1)** $(m)v^2/r$ seen **(1)** Answer = 110 (m) **(1)**	**3**

	Eg $3mg = mv^2 / r$ $r = (57)^2 / 3g$	
5(d)	Use of KE / PE conservation **(1)** Answer = 23 (m s^{-1}) **(1)** Eg $\frac{1}{2} m(57)^2 = \frac{1}{2} mv^2 + mg139$ $v^2 = \frac{1}{2} (57)^2 - 9.81x139$	**2**
5(e)	Using $(m)g$ only **(1)** Answer r = 54 m [allow ecf] **(1)** **Eg** $mg = mv^2 / r$ $r = (23)^2 / 9.81$	**2**
	Total for question	**12**