

B: (20 pts) Circular Pendulum

0.2 deg

0.75 m

A pendulum ball with mass $m = 200g$ swings in a horizontal circle on a string of length $L = 75cm$. As you swirl the ball around faster and faster, it rises: the speed v increases, the period t decreases, the angle θ increases and the tension T increases... But the string will break if the tension exceeds $15N$. What is the highest angle θ_{max} in degrees? What is the maximum speed v_{max} ? What is the shortest period t_{min} ?

• (5pts) $\theta_{max} [degrees] = \underline{82.5^\circ}$

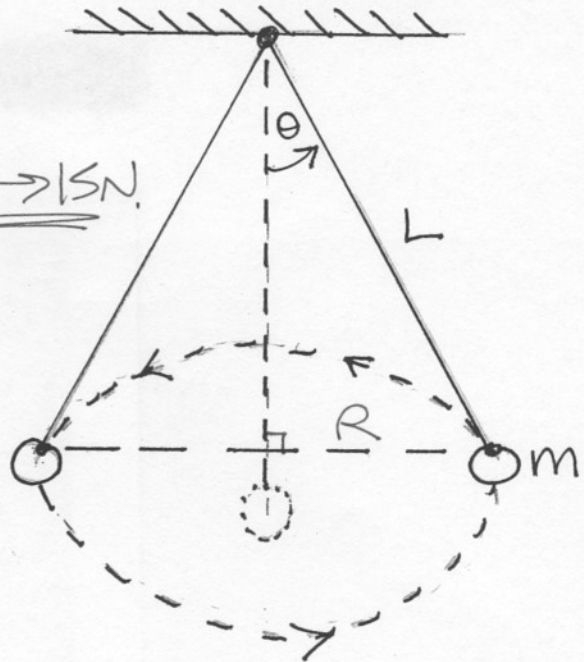
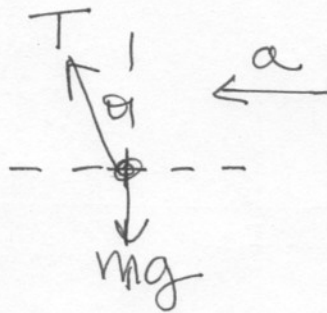
• (10pts) $v_{max} = \underline{7.44 m/s}$

• (5pts) $t_{min} = \underline{0.628 s}$

Let $T \rightarrow 15N$.



$R = L \sin \theta$



Newton:
$$\begin{cases} T \cos \theta = mg \\ T \sin \theta = \frac{mv^2}{R} \end{cases} \Rightarrow \cos \theta = \frac{mg}{T}$$

$$\theta = \underline{82.4919^\circ} \approx \underline{82.5^\circ}$$

$T \sin \theta = \frac{mv^2}{L \sin \theta}$

$v = \sqrt{\frac{LT}{m}} \sin \theta = \underline{7.43570 m/s} \approx \underline{7.44 m/s}$

$v = \frac{2\pi R}{t} \Rightarrow t = \frac{2\pi R}{v} = \frac{2\pi L \sin \theta}{v}$

$$= 2\pi \sqrt{\frac{mL}{T}} = .2\pi \approx \underline{0.628 s}$$