

A:(40 pts) Vertical Loop

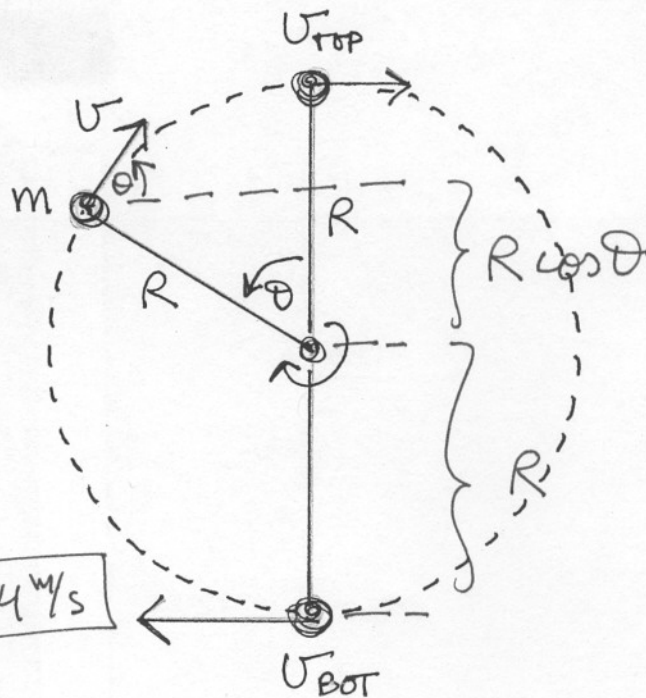
A ball is tied to a string and made to move in a vertical circle of radius $R=0.8m$. The ball has mass $m=1.2kg$. Assume mechanical energy is conserved. If the speed at the top of the circle is $v_{top}=4.9m/s$, what is the speed v_{bot} at the bottom of the circle? What is the tension T on the string at the bottom? Now consider the ball when it is rising at an angle $\theta=50^\circ$ from the top as shown. What is the speed v of the ball there? What is the power P exerted by gravity on the ball there?

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

•(10pts) $T = \underline{94.8 \text{ N}}$

•(10pts) $v = \underline{5.44 \text{ m/s}}$

•(10pts) $P = \underline{-49.0 \text{ W}}$

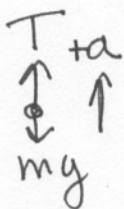


• Top \rightarrow Bottom:

$$\frac{m}{2} v_{top}^2 + mg(2R) = \frac{m}{2} v_{bot}^2$$

$$\Rightarrow v_{bot} = \sqrt{v_{top}^2 + 4gR}$$

$$= \underline{7.44110 \text{ m/s}} \approx \underline{7.44 \text{ m/s}}$$



$$T - mg = m v_{bot}^2 / R \Rightarrow$$

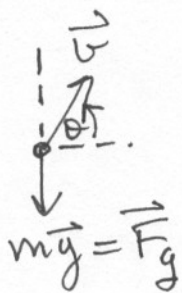
$$T = mg + \frac{m}{R} (v_{top}^2 + 4gR) = \underbrace{5mg}_{58.8} + \underbrace{m v_{top}^2 / R}_{36.015}$$

$$= \underline{94.815 \text{ N}} \approx \underline{94.8 \text{ N}}$$

• at $\theta = 50^\circ$: $\frac{m}{2} v^2 + mg(R + R \cos \theta) = \frac{m}{2} v_{bot}^2$

$$\Rightarrow v = \sqrt{v_{bot}^2 - 2gR(1 + \cos \theta)} = \sqrt{v_{top}^2 + 2gR(1 - \cos \theta)}$$

$$= \underline{5.44161 \text{ m/s}} \approx \underline{5.44 \text{ m/s}}$$



$$P_g = \vec{F}_g \cdot \vec{v} = -mgv \sin \theta = \underline{-49.0217 \text{ W}}$$

$$\approx \underline{-49.0 \text{ W}}$$