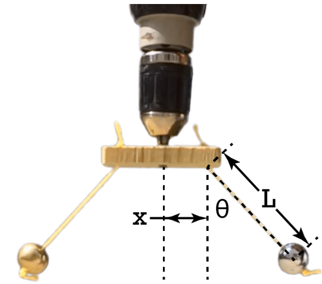
Flipping Physics Lecture Notes:

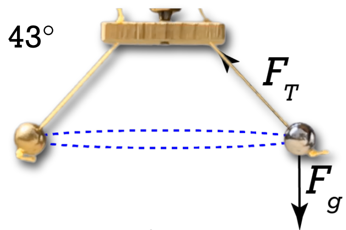
Conical Pendulum Demonstration and Problem

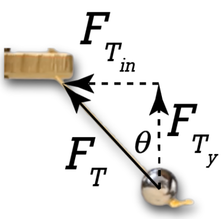


Example: Two spheres attached to a horizontal support are rotating with a constant angular velocity. Determine the angular velocity.
As shown in the figure: L = 9.7 cm, x = 3.4 cm and θ = 43°.

Knowns:

$$\omega = ?;\ x = 3.4cm\left(\frac{1m}{100cm}\right) = 0.034m;\ L = 9.7cm\left(\frac{1m}{100cm}\right) = 0.097m;\ \theta = 43^\circ$$

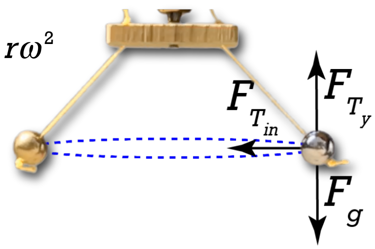




$$\sin\theta = \frac{O}{H} = \frac{F_{T_{in}}}{F_T} \Rightarrow F_{T_{in}} = F_T \sin\theta \ \&\ \cos\theta = \frac{A}{H} = \frac{F_{T_y}}{F_T} \Rightarrow F_{T_y} = F_T\cos\theta$$

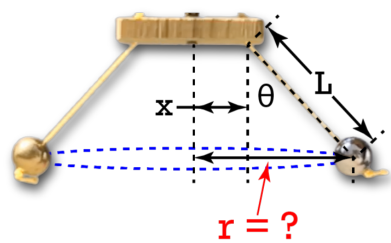
$$\sum F_y = F_{T_y} - F_g = ma_y \Rightarrow F_T\cos\theta - mg = m(0) = 0 \Rightarrow F_T\cos\theta = mg \Rightarrow F_T = \frac{mg}{\cos\theta}$$

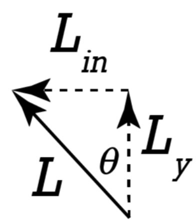
$$\sum F_{in} = F_{T_{in}} = ma_c \Rightarrow F_T\sin\theta = mr\omega^2 \Rightarrow \frac{mg}{\cos\theta}\sin\theta = mr\omega^2 \Rightarrow g\tan\theta = r\omega^2$$



$$\Rightarrow \omega^2 = \frac{g\tan\theta}{r} \Rightarrow \omega = \sqrt{\frac{g\tan\theta}{r}}$$

Need r: $r = L_{in} + x$ therefore we need L_{in}





$$\sin\theta = \frac{O}{H} = \frac{L_{in}}{L} \Rightarrow L_{in} = L\sin\theta \ \&\ \ r = L_{in} + x = L\sin\theta + x$$

$$\Rightarrow \omega = \sqrt{\frac{g\tan\theta}{L\sin\theta + x}} = \sqrt{\frac{(9.81)\tan(43)}{(0.097)\sin(43) + 0.034}} = \pm 9.55716 \approx \boxed{-9.6\frac{rad}{s}}$$

According to the right hand rule, the direction of the angular velocity and angular displacement of the spheres is down, which is negative.

$$\omega_{measured} = \frac{\Delta\theta}{\Delta t} = \frac{-2\pi rad}{0.66s} = -3\pi\frac{rad}{s} = -9.51998\frac{rad}{s}$$

Use the measured value as our observed value and the predicted value as our accepted value:

$$E_r = \frac{O - A}{A}\times 100 = \frac{-9.55716 - (-9.51998)}{-9.51998}\times 100 = -0.39052 \approx \boxed{-0.39\%}$$