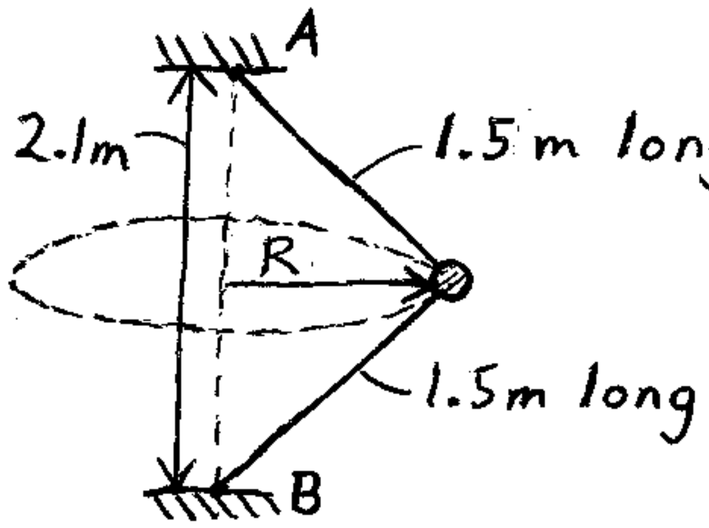
real-world-physics-problems.com
Oct. 6, 2020

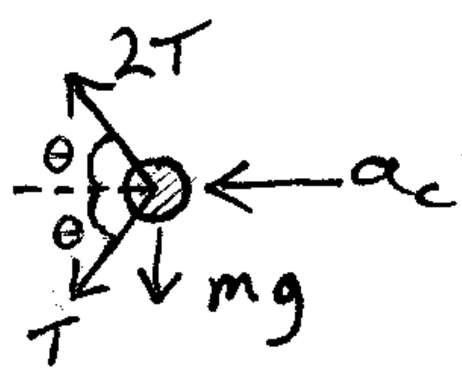
This is a force and motion problem involving uniform circular motion.

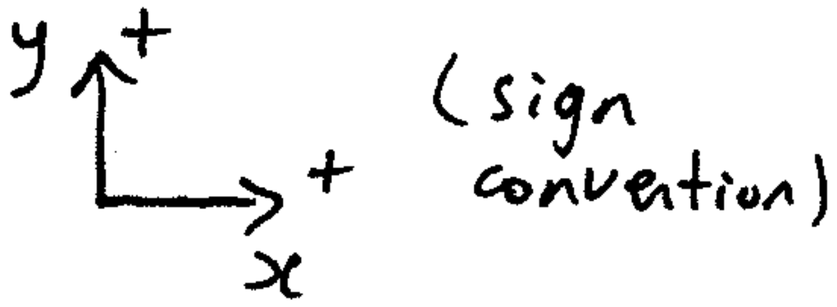


A 3 kg ball is going around in a horizontal circle of radius R. The ball is connected to two strings which are supported at A and B, as shown. If the tension in the upper string is twice the tension in the lower string, what is the speed of the ball?

Solution:

Free-body diagram





From trigonometry, $\sin\theta = \frac{2.1/2}{1.5}$, $R = \frac{1.5}{\cos\theta}$

$\theta = 44.427°$ $= 1.071$ m

Apply Newton's second law in x-direction:

$\Sigma F_x = ma_x$, $m = 3$ kg $\quad a_c = \frac{v^2}{R} = \frac{v^2}{1.071}$

$-2T\cos\theta - T\cos\theta = m(-a_c)$

$$\Rightarrow -3T\cos\theta = 3\left(-\frac{v^2}{1.071}\right) \quad (1)$$

Apply Newton's second law in y-direction:

$$\Sigma F_y = m a_y \;,\; a_y = 0$$

$$\Rightarrow 2T\sin\theta - T\sin\theta - mg = m(0)$$

$$\Rightarrow T\sin\theta = 3(9.8) \quad (2)$$

Divide equation (1) by equation (2):

$$3\frac{\cos\theta}{\sin\theta} = 0.09526\, v^2$$

$$v = 5.67 \text{ m/s} \quad \text{(answer)}$$