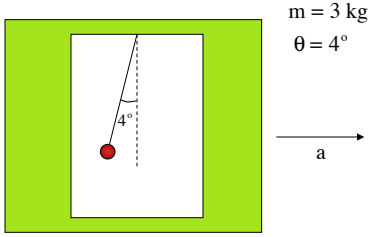
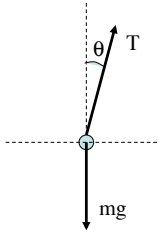
Problem 4.68

A 3 kg object hangs at 4° from the vertical of a railroad car when the car accelerates to the right. What is the car's acceleration?

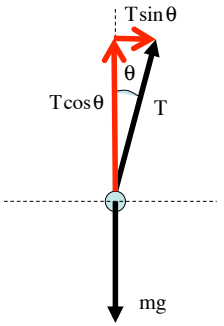


1.) Draw a f.b.d!



2.) Identify line of acceleration and put axes along that line and perpendicular to that line.

3.) Break off-axis forces into components along axes.



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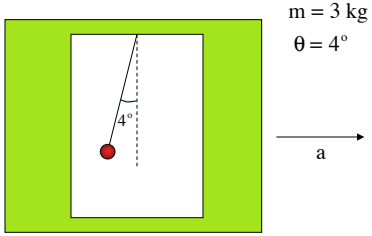


The Process:

0.) Huh? So start the process!

1.) Draw a f.b.d!

2.) Identify line of acceleration and put axes along that line and perpendicular to that line.

3.) Break off-axis forces into components along axes.

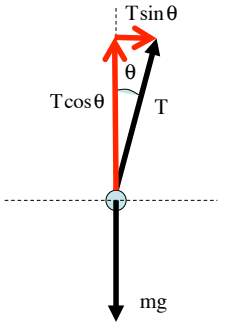
4.) Sum the forces along one axis and put equal to "ma."

a.) If you can solve with that equation, do so. If not, do the same with either the other direction or another object in system, depending upon what is available.

4.) Sum the forces along one axis and put equal to "ma." (Note: In the case of the "y" direction, the acceleration is zero.)

$$\sum F_y: \qquad T\cos\theta - mg = \overbrace{ma_y}^{0}$$

$$\Rightarrow \quad T = \frac{mg}{\cos\theta}$$



5.) If you need another equation, try another body in the system (in this case, there are none) or the other direction. We'll try the x-direction.

$$\sum F_x:$$

$$T\sin\theta = ma$$

$$\Rightarrow \quad \left(\frac{mg}{\cos\theta}\right)\sin\theta = ma$$

$$\Rightarrow \quad a = g\tan\theta$$

$$\Rightarrow \quad a = \left(9.8\ \text{m/s}^2\right)\tan 4^\circ$$

$$\Rightarrow \quad a = .685\ \text{m/s}^2$$

Using the equations:

$$T = \frac{mg}{\cos\theta} \qquad \text{and} \qquad T\sin\theta = ma$$

solve simultaneously:

$$T \quad \sin\theta = ma$$

$$\left(\frac{mg}{\cos\theta}\right)\sin\theta = ma$$

$$\Rightarrow \quad a = g\tan\theta$$

$$\Rightarrow \quad a = \left(9.8\ \text{m/s}^2\right)\tan 4^\circ$$

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