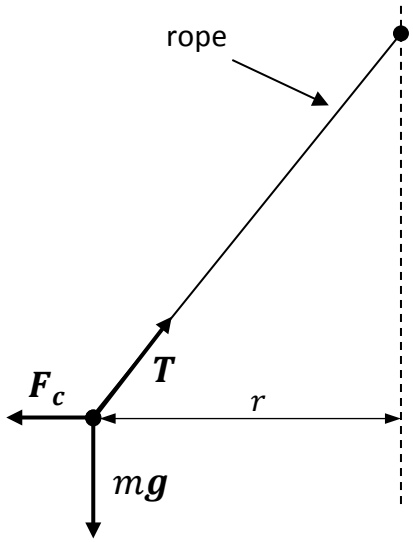
Answer on Question#53146 - Physics - Mechanics - Kinematics - Dynamics

Which physics formulas do I need to focus on to determine whether or not an amusement park swing ride rotating at its max speed can hold a $m = 50$ lb. child safely if, while stationary, the swing can hold up a $M = 200$ lb. man? Is the centripetal force what I am supposed to be finding, and then I compare it to the stationary hanging tension when the 200 lb. weight is on it?

Solution:

Actually, you should consider the (vector) sum of centrifugal force $\boldsymbol{F_c}$ and the force due to gravity $m\boldsymbol{g}$. This sum should be balanced by the tension $\boldsymbol{T}$ of the rope or chain of the swing. The magnitude of this tension force should be equal to the weight of the 200 lb. man.



The magnitude of the centrifugal force is given by

$$F_c = m\omega^2 r,$$

where ω – is the angular frequency of the swing's rotation. Therefore the magnitude of the tension force is given by

$$T = \sqrt{(mg)^2 + F_c^2} = m\sqrt{g^2 + \omega^4 r^2}$$

If the length of the rope is l then due to similarity we obtain

$$\frac{T}{F_c} = \frac{l}{r}$$

$$\frac{\sqrt{g^2 + \omega^4 r^2}}{\omega^2 r} = \frac{l}{r}$$

$$r = \sqrt{l^2 - \frac{g^2}{\omega^4}}$$

Therefore the tension force is

$$T = m\sqrt{g^2 + \omega^4\left(l^2 - \frac{g^2}{\omega^4}\right)} = m\omega^2 l$$

To determine whether or not the swing rotating at its max speed can hold a child you should substitute angular frequency into the previous expression and compare it with the weight of the man Mg. If it's greater than the man's weight the swing may not hold the child, if not then the swing will hold the child.