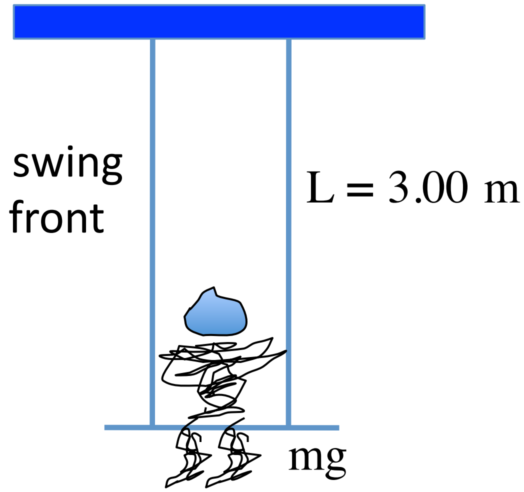
Problem 6.12

The kid on swing is shown to the right from two perspectives.

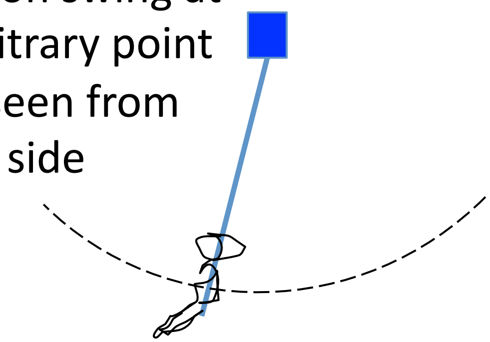
a.) If the tension at the lowest point is 350 N per chain, what's the velocity at the bottom?

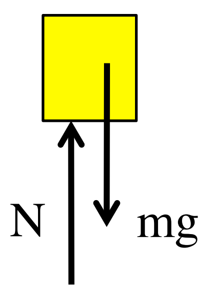
The forces acting on the kid when at the bottom of the arc at shown on the f.b.d. below. Notice that in this case, all the forces can be seen from looking from the side (versus from looking straight on). You just have to use your head with f.b.d. perspective . . . Assuming the kid isn't holding onto the rope but is being supported only by the swing's seat:

kid on swing from front

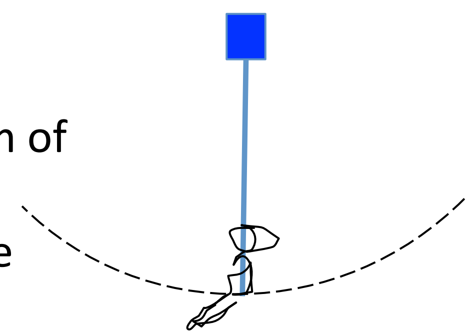


kid on swing at arbitrary point as seen from the side





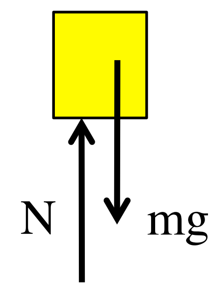
kid at bottom of arc as seen from the side



The trickiness here? The SWING has three forces acting on it: a normal force acting downward due to the kid's bottom and two tension forces acting upward due to the two ropes. A f.b.d. and N.S.L. on the swing should yield: $2T - N_{kid} = m_{swing}\frac{v^2}{R}$

The trickiness here? Because the SWING is massless, the right side is zero and the normal due to the kid must equal 2T = 700 N.

So summing the forces on the kid:



$\underline{\sum F_c :}$

$$N_{max} - mg = ma_c$$

$$\Rightarrow \quad N_{max} - mg = m\left(\frac{v_{max}^2}{R}\right)$$

$$\Rightarrow \quad v_{max} = \left(\frac{(N_{max} - mg)R}{m}\right)^{1/2}$$

$$= \left(\frac{\left((700.\ \text{N}) - (40.0\ \text{kg})(9.80\ \text{m/s}^2)\right)(3.00\ \text{m})}{(40.0\ \text{kg})}\right)^{1/2}$$

$$= 4.81\ \text{m/s}$$

b.) As was explained in Part a, the maximum normal force is equal to the maximum net tension force in the system, or 700 newtons.