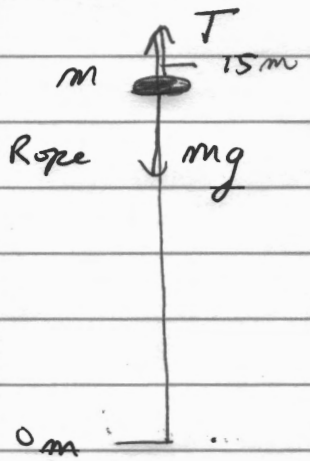
46. A student has to escape from his girlfriend's dormitory through a window that is 15.0 m above the ground. He has a heavy 20-m-long rope, but it will break when the tension exceeds 360 N and he weighs 600 N. The student will be injured if he hits the ground with a speed greater than 10 m/s. (*a*) Show that he cannot safely slide down the rope. (*b*) Find a strategy using the rope that will permit the student to reach the ground safely. (OMIT)

#46 Rope – window

(a)



$mg = 600\ N \Rightarrow m = \frac{600N}{9.8\ m/s^2} = 61.2\ kg$

Max $T = 360\ N$

Try sliding down the rope with $T = 360\ N$; $a \neq 0$.

$\Sigma F = ma$

$T - mg = ma$

$a = T/m - g = -3.92\ m/s^2$

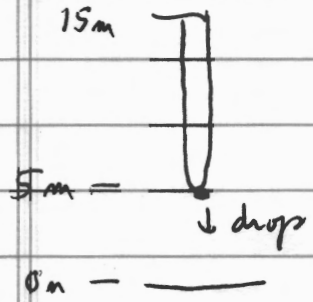
Speed when hitting ground?

$v_f^2 = v_0^2 + 2a(\Delta y)$

$v_f^2 = 0 + 2(-3.92\ m/s^2)(0 - 15\ m)$

$\boxed{v_f = 10.85\ m/s \rightarrow \text{TOO FAST!}}$

(b) Try doubling up the 20m rope. Then it can take $2 \cdot 360N = 720N$ and student can slide down at $a \approx 0$ and drop off bottom of rope.



Free fall from $y_0 = 5m$

$v_f^2 = v_0^2 + 2a\Delta y$

$v_f^2 = 0 + 2(-9.8\ m/s^2)(0 - 5m)$

$\boxed{v_f \cong 9.90\ m/s \Rightarrow \text{Barely OK}}$