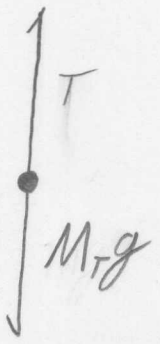
Force Problems

You've been asked to to review the design of an elevator in a hotel that is a popular spring break destination. The engineers have selected a cable that can withstand a maximum tension of 19,500 N before it snaps. The elevator has a mass of 490kg when empty. It goes from full speed, V_0=10m/s, to rest in a distance of d=3m.

If ten celebrating college students, each weighing 65kg, attempt to haul 10 kegs of root beer, each weighing 20 kg, from the top floor to the basement will they plummet to their doom when the elevator decelerates?

Write an expression for the tension in the elevator cable. It should be in terms of g, V_0, d, and M_T. Plug in the numbers and predict their fate



Given

$T_{max} = 19{,}500\ N$

$m_E = 490\ kg$

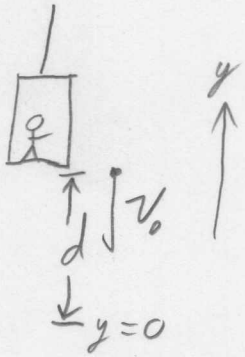
$v_0 = 10\ m/s$

$d = 3\ m$

$M_T = m_E + 10 \cdot 65\,kg + 10 \cdot 20\,kg = 1340\,kg$

$T - M_T g = M_T a \Rightarrow T = M_T(g+a)$

We need a. Have to use kinematics



$x_f = x_0 + v_0 t + \frac{1}{2} a t^2 \qquad v_f = v_0 + at$

$0 = d - v_0 t + \frac{1}{2} a t^2 \qquad 0 = -v_0 + at$

$\Rightarrow t = +\frac{v_0}{a}$

$0 = d - \frac{v_0^2}{a} + \frac{1}{2}\frac{v_0^2}{a} \Rightarrow a = \frac{1}{2}\frac{v_0^2}{d}$

$$\boxed{T = M_T\left(g + \frac{1}{2}\frac{v_0^2}{d}\right)}$$

$T = (1340)\left(9.8 + \frac{1}{2}\frac{10^2}{3}\right) = \boxed{35{,}000\ N}$

They're doomed!