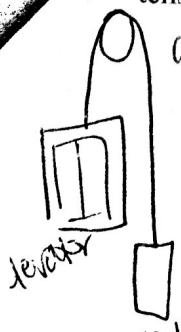
Elevators often make use of counterweights to reduce the force needed by the motor. If the elevator has a mass of 1550 kg and the counterweight has a mass of 1250 kg, find the acceleration of the elevator and the tension in the cable. Assume the pulley is frictionless and the mass of the cord is negligible.



$a_{elevator} = -a_{cw}$ $\quad |a_{sys}| = \frac{\Sigma F_{ext}}{m_{tot}} = \frac{(1550kg)(9.81m/s^2) - (1250kg)(9.81m/s^2)}{1550kg + 1250kg}$

$|a_{sys}| = \frac{1520.5N - 1226.25N}{2800kg}$

$\boxed{|a_{sys}| = 1.05m/s^2}$

$a_{elevator} = 1.05m/s^2$ (downward)

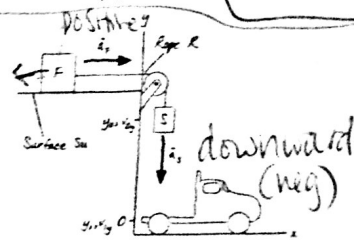
$\Sigma F_{y\,elevator} = F_T - F_G = ma_y$

$F_T = F_G + ma_y$

$F_T = (1550kg)(9.81m/s^2) + (1550kg)(-1.05m/s^2)$

$F_T = 15205.5 - 1627.5 = \boxed{13600N}$

9. Some bank robbers have pushed a 1000kg safe to a second-story window. They plan to break the window, then lower the safe 3.0 m to their truck. Not being too clever, they stack up 500 kg of furniture, tie a rope between the safe and the furniture, and place the rope over a pulley. Then they push the safe out the window. Assume pulley is frictionless and mass of the cord is negligible. Coefficient of kinetic friction between the ~~safe~~ furniture + the floor is 0.50



a. What is the safe's acceleration?

$a_{Fx} = -a_{Sy}$

$|a_{sys}| = \frac{\Sigma F_{ext}}{m_{tot}} = \frac{m_S g - \mu_K m_F g}{m_S + m_F} = \frac{(1000kg)(9.81m/s^2) - 0.5(500kg)(9.81m/s^2)}{1500kg}$

$= \frac{9810N - 2452.5N}{1500kg} = \boxed{4.90m/s^2 \text{ downward}}$

b. What is the tension in the rope? $F_{TS} = F_{TF}$ tension is same across rope

$\Sigma F_{Sy} = F_{TS} - F_{GS} = m_S a_{Sy}$

$F_T = F_{GS} + m_S a_{Sy}$

$F_T = (1000kg)(9.81m/s^2) + (1000kg)(-4.90m/s^2)$

$F_T = 9810N - 4900N$

$\boxed{F_T = 4910N}$

c. (Extra: what is the speed of the safe when it hits the truck?)

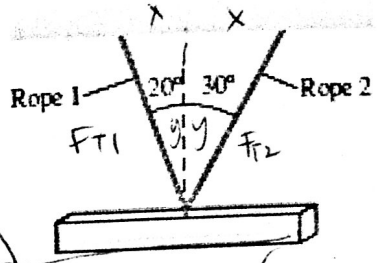
$v_{fy}^2 - v_{iy}^2 = 2a\Delta y$ ($v_{iy} = 0$)

$v_{fy}^2 = 2(-4.90m/s)(3m)$

$v_{fy} = 5.4 m/s$ which is about 12mph

unlikely a mick will survive a 1000kg safe hitting it @ 5.4m/s!

10. The 1000 kg steel beam to the right is supported by two ropes. What is the tension in each rope?



$\Sigma F_y = F_{T1y} + F_{T2y} - mg = 0$

$\Sigma F_x = F_{T1x} + F_{T2x} = 0$

x-components

$F_{T1x} = F_{T2x}$

$F_{T1}\sin 20 = F_{T2}\sin 30$

$F_{T1} = \frac{F_{T2}\sin 30}{\sin 20}$

$F_{T1y} + F_{T2y} = (1000\,kg)(9.81\,m/s^2) = 9800\,N$

$F_{T1}\cos 20 + F_{T2}\cos 30 = 9800\,N$

$\frac{F_{T2}\sin 30\cos 20}{\sin 20} + F_{T2}\cos 30 = 9800\,N$

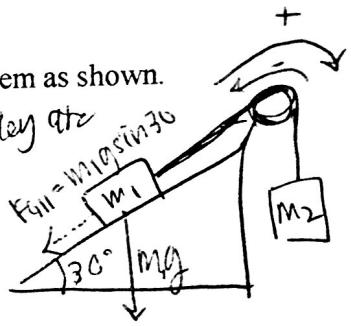
$F_{T2}\left(\frac{\sin 30\cos 20}{\sin 20} + \cos 30\right) = 9800\,N$

$F_{T2} = 4395\,N$

$F_{T1}\sin 20 = (4395\,N)\sin 30$

$F_{T1} = 6462\,N$

11. A mass $m_1 = 25.0$ kg and a mass $m_2 = 35.0$ kg are placed on an incline system as shown.



a. What is the acceleration for each block? Assume mass + friction of pulley are negligible

$|a_{sys}| = \frac{\Sigma F_{ext}}{m_{tot}} = \frac{m_2 g - m_1 g \sin\theta}{m_1 + m_2}$

$|a_{sys}| = \frac{(35\,kg)(9.81\,m/s^2) - (25\,kg)(9.81\,m/s^2)(\sin 30)}{60\,kg}$

$= \frac{343\,N - 123\,N}{60\,kg}$

$= 3.67\,m/s^2$ up the incline for m_1, downward for m_2

b. The surface of the incline is sandblasted to give it a rough texture. If $\mu_k = 0.80$ between m_1 and the incline, what is the new acceleration for each block?

$F_N = m_1 g\cos\theta$

$|a_{sys}| = \frac{m_2 g - m_1 g\sin\theta - \mu_k m_1 g\cos\theta}{m_1 + m_2}$

$= \frac{220\,N - (0.8)(25\,kg)(9.81\,m/s^2)(\cos 30)}{60\,kg}$

$= \frac{220\,N - 170\,N}{60\,kg}$

$|a_{sys}| = 0.83\,m/s^2$ up the incline for m_1, down the incline for m_2