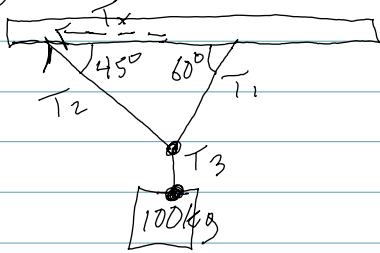


Unit 2 - Common Problems

1) Find the tension in each string



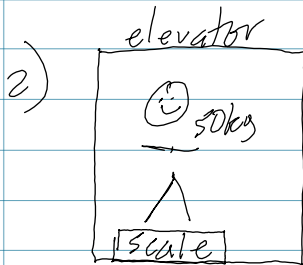
$$\begin{aligned} \sum F_y = 0 &= W + T_3 \\ 0 &= -1000 + T_3 \\ \boxed{T_3} &= 1000 \text{ N} \end{aligned}$$

$$\begin{aligned} \sum F_x = 0 &= T_{2x} + T_{1x} \\ 0 &= -T_2 \cos 45^\circ + T_1 \cos 60^\circ \\ T_2 &= \frac{T_1 \cos 60^\circ}{\cos 45^\circ} = \underline{.7071 T_1} \end{aligned}$$

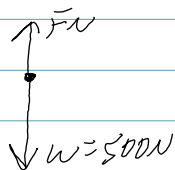
$$\begin{aligned} \sum F_{y2} = 0 &= T_3 + T_{2y} + T_{1y} \\ 0 &= -1000 + T_2 \sin 45^\circ + T_1 \sin 60^\circ \\ 1000 &= .7071 \sin 45^\circ (T_1) + T_1 \sin 60^\circ \\ 1000 &= .5 T_1 + .8660 T_1 \\ 1000 &= 1.366 T_1 \\ \boxed{T_1} &= 732.05 \text{ N} \end{aligned}$$

$$\begin{aligned} T_2 &= .7071 T_1 \\ T_2 &= .7071 (732.05) \end{aligned}$$

$$\boxed{T_2 = 517.63 \text{ N}}$$



A) What does the scale read if the elevator is moving up at 3 m/s and slowing down at an acc. of 1 m/s²?



$$\sum F = F_N + w$$

$$\sum F = ma$$

$$\sum F = 50(-1) = -50 \text{ N}$$

$$\sum F = -50 = F_N - 500$$

$$\boxed{F_N = 450 \text{ N}}$$

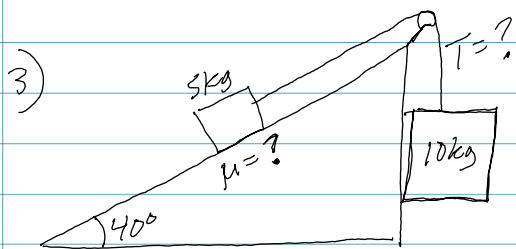
B) What does the scale read if the elevator is moving down at 5 m/s & increasing speed at an acc. of 0.5 m/s²?



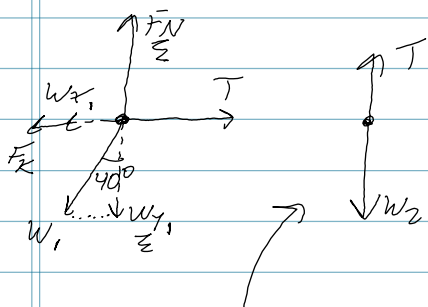
$$\sum F = F_N + w = ma$$

$$F_N - 500 = 50(-.5)$$

$$\boxed{F_N = 475 \text{ N}}$$



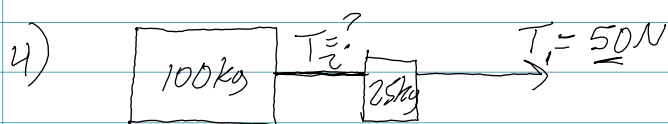
Find (a) the coefficient of friction between the 5kg object & the slope and (b) the tension in the string, if both objects are accelerating at 3 m/s^2 down & up the slope.



$$\begin{aligned} \text{(a)} \quad \sum F &= W_z + W_{x_1} + F_k \rightarrow \\ \sum F &= (m_1 + m_2) a \\ -100 + 50 \sin 40^\circ + F_k &= (5 + 10)(-3) \\ -67.8606 + F_k &= -45 \\ F_k &= 22.8606 \text{ N} \end{aligned}$$

$$\begin{aligned} \text{(b)} \quad \sum F_y &= W_2 + T = m_2 a \\ T - 100 &= 10(-3) \\ \boxed{T} &= \boxed{70 \text{ N}} \end{aligned}$$

$$\begin{aligned} F_k &= \mu F_n \\ 22.8606 &= \mu (50 \cos 40^\circ) \\ \boxed{\mu} &= \boxed{0.597} \end{aligned}$$



(A) What is the acceleration of the boxes?

$$\begin{aligned} \sum F &= T_1 = (m_1 + m_2) a \\ 50 &= (100 + 25) a \quad \boxed{a = 0.4 \text{ m/s}^2} \end{aligned}$$

(B) What is the tension in the string between the boxes?

$$\begin{aligned} \sum F_{100} &= T_2 = m_{100} a \\ T_2 &= 100(.4) \\ \boxed{T_2} &= \boxed{40 \text{ N}} \end{aligned}$$

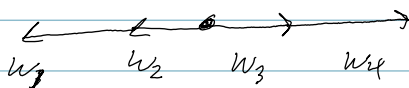
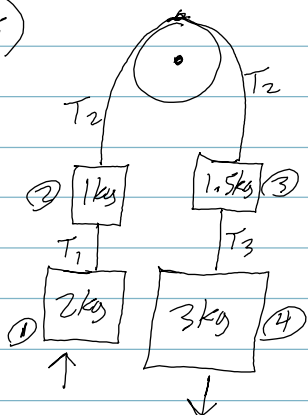
OR

$$\begin{aligned} \sum F_{25} &= T_1 + T_2 = m_{25} a \\ 50 + T_2 &= 25(.4) \\ \boxed{T_2} &= \boxed{-40 \text{ N}} \end{aligned}$$

C) If there was friction, what would the coefficient of friction need to be so that the boxes wouldn't move? $\sum F = 0$

$$\begin{aligned} \sum F_x = 0 &= F_{S_{100}} + F_{S_{25}} + T = 0 \\ 0 &= -\mu F_n + -\mu F_n + T = 0 \end{aligned} \quad \rightarrow \quad \begin{aligned} \mu(1000) + \mu(250) &= 50 \\ 1250\mu &= 50 \\ \boxed{\mu} &= \boxed{0.04} \end{aligned}$$

5) Find the acc. of each object & the tension in each string.



$$\sum F = w_1 + w_2 + w_3 + w_4$$

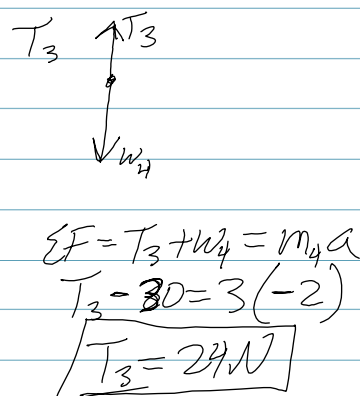
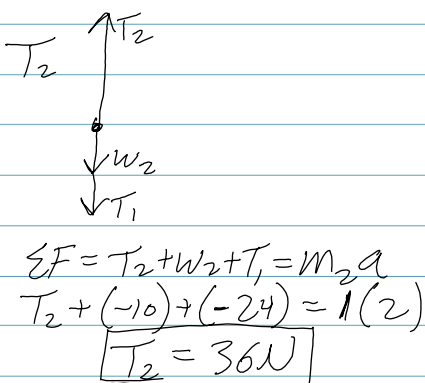
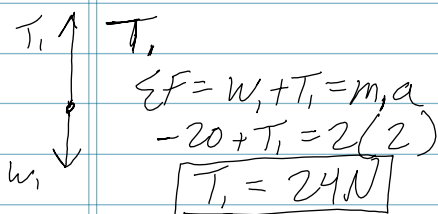
$$\sum F = (m_1 + m_2 + m_3 + m_4)a$$

$$\sum F = m a$$

$$-20 - 10 + 15 + 30 = (1 + 2 + 1.5 + 3)a$$

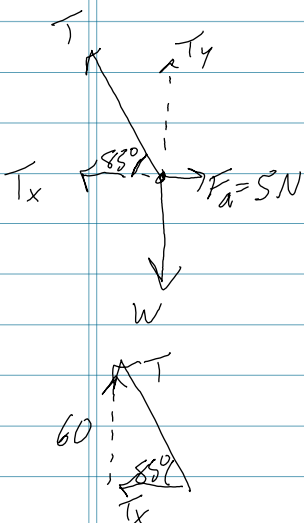
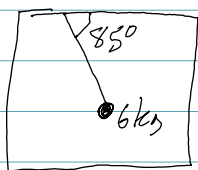
$$15 = 7.5a$$

$$a = +2 \text{ m/s}^2$$



← acc

6) A box is acc. to the left. Find the acc. of the 6 kg object that is hanging from a 0.5m long string & is experiencing a air resistance force of 5N.



$$\textcircled{1} \sum F_y = 0 = w + T_y$$

$$0 = -60 + T_y$$

$$T_y = 60 \text{ N}$$

$$w = T_y$$

$$\textcircled{2} \tan 85^\circ = \frac{60}{T_x}$$

$$T_x = \frac{60}{\tan 85^\circ} = 5.2493 \text{ N}$$

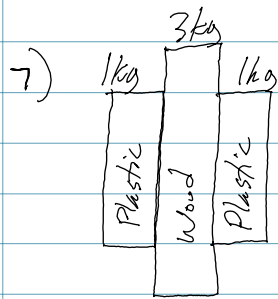
$$\textcircled{3} \sum F_x = T_x + F_a$$

$$\sum F_x = m a$$

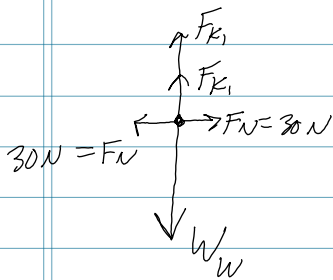
$$-5.2493 + 5 = 6a$$

$$-.2493 = 6a$$

$$a = -0.0416 \text{ m/s}^2$$



How hard must the plastic blocks be compressed if the wood block is acc. down at 5 m/s^2 & the coefficient of friction between the wood & plastic is 0.25 ?



$$\sum F_w = m_w a_w$$

$$\sum F_w = F_{k1} + F_{k2} + W$$

$$F_k = \mu F_N$$

$$F_N = F_{\text{comp}}$$

$$2F_k + W_w = m_w a_w$$

$$2(\mu)(F_N) - 30 = 3(-5)$$

$$2(0.25)F_N - 30 = 3(-5)$$

$$0.5F_N = 15$$

$$\boxed{F_N = 30 \text{ N}}$$