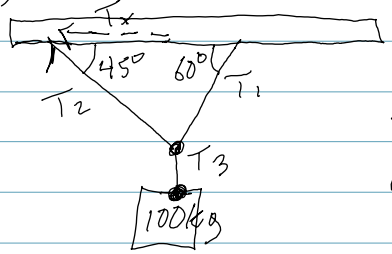
Unit 2 - Common Problems

1) Find the tension in each string



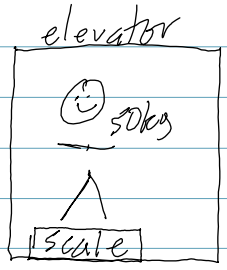
$\Sigma F_y = 0 = W + T_3$
$0 = -1000 + T_3$
$T_3 = 1000N$

$\Sigma F_x = 0 = T_{2x} + T_{1x}$
$0 = -T_2 \cos 45° + T_1 \cos 60°$
$T_2 = \frac{T_1 \cos 60°}{\cos 45°} = .7071\, T_1$

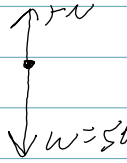
$\Sigma F_{y2} = 0 = T_3 + T_{2y} + T_{1y}$
$0 = -1000 + T_2 \sin 45° + T_1 \sin 60°$
$1000 = .7071 \sin 45° (T_1) + T_1 \sin 60°$
$1000 = .5 T_1 + .8660 T_1$
$1000 = 1.366 T_1$
$T_1 = 732.05N$

$T_2 = .7071 T_1$
$T_2 = .7071 (732.05)$
$T_2 = 517.63N$

2)



A) What does the scale read if the elevator is moving up at 3 m/s and slowing down at an acc. of $1 m/s^2$?



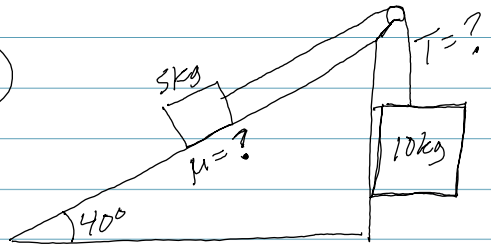
$\Sigma F = F_N + w$
$\Sigma F = ma$
$\Sigma F = 50(-1) = -50N$

$\Sigma F = -50 = F_N - 500$
$F_N = 450N$

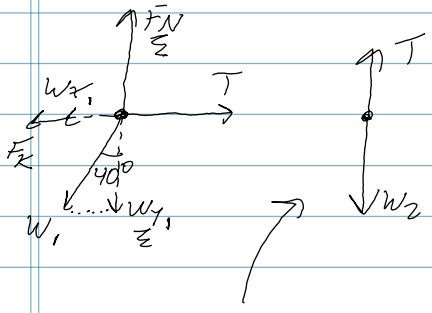
B) What does the scale read if the elevator is moving down at 5 m/s & increasing speed at an acc. of $0.5 m/s^2$?

$\Sigma F = F_N + w = ma$
$F_N - 500 = 50(-.5)$
$F_N = 475N$

3)



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.



(a) $\Sigma F = W_2 + W_{x_1} + F_k$ →

$\Sigma F = (m_1 + m_2)a$

$-100 + 50\sin 40° + F_k = (5+10)(-3)$

$-67.8606 + F_k = -45$

$F_k = 22.8606\ N$

$F_k = \mu F_N$

$22.8606 = \mu(50\cos 40°)$

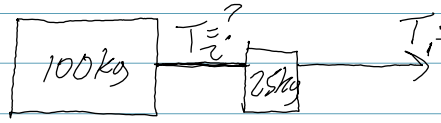
$\boxed{\mu = 0.597}$

(b) $\Sigma F_y = W_2 + T = m_2 a$

$T - 100 = 10(-3)$

$\boxed{T = 70N}$

4)



(A) What is the acceleration of the boxes?

$\Sigma F = T_1 = (m_1 + m_2)a$

$50 = (100+25)a$ $\quad \boxed{a = .4 m/s^2}$

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

$\Sigma F_{100} = T_2 = m_{100} a$

$T_2 = 100(.4)$

$\boxed{T_2 = 40N}$

OR

$\Sigma F_{25} = T_1 + T_2 = m_{25} a$

$50 + T_2 = 25(.4)$

$\boxed{T_2 = -40N}$

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

$\Sigma F_x = 0 = F_{s_{100}} + F_{s_{25}} + T = 0$

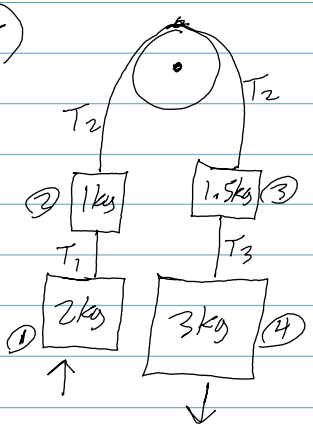
$0 = -\mu F_{N_1} + -\mu F_N + T = 0$ →

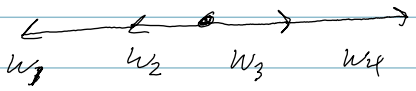
$\mu(1000) + \mu(250) = 50$

$1250\mu = 50$

$\boxed{\mu = 0.04}$

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





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

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

$\Sigma F = m a$

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

$15 = 7.5a$

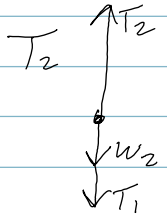
$a = +2 m/s^2$

T_1

$\Sigma F = w_1 + T_1 = m_1 a$

$-20 + T_1 = 2(2)$

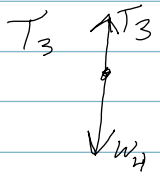
$T_1 = 24N$



$\Sigma F = T_2 + w_2 + T_1 = m_2 a$

$T_2 + (-10) + (-24) = 1(2)$

$T_2 = 36N$



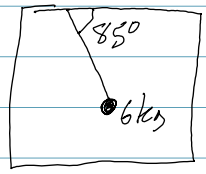
$\Sigma F = T_3 + w_4 = m_4 a$

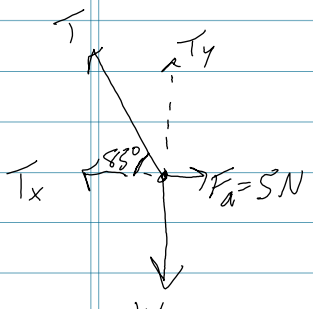
$T_3 - 30 = 3(-2)$

$T_3 = 24N$

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.





① $\Sigma F_y = 0 = w + T_y$

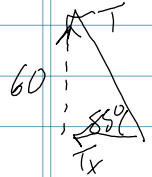
$0 = -60 + T_y$

$T_y = 60N$

$w = T_y$

② $\tan 85° = \frac{60}{T_x}$

$T_x = \frac{60}{\tan 85°} = 5.2493N$



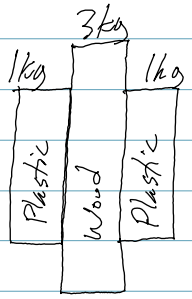
③ $\Sigma F_x = T_x + F_a$

$\Sigma F_x = ma$

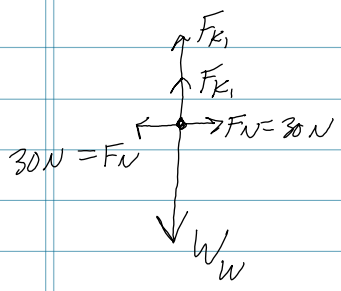
$-5.2493 + 5 = 6a$

$-.2493 = 6a$

$a = -0.0416 m/s^2$

7) 

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?



$\Sigma F_W = m_W a_W$

$\Sigma F_W = F_{K_1} + F_{K_2} + W$

$F_K = \mu F_N$

$F_N = F_{comp.}$

$2F_K + W_W = m_W a_W$

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

$2(.25)F_N - 30 = 3(-5)$

$.5F_N = 15$

$\boxed{F_N = 30N}$