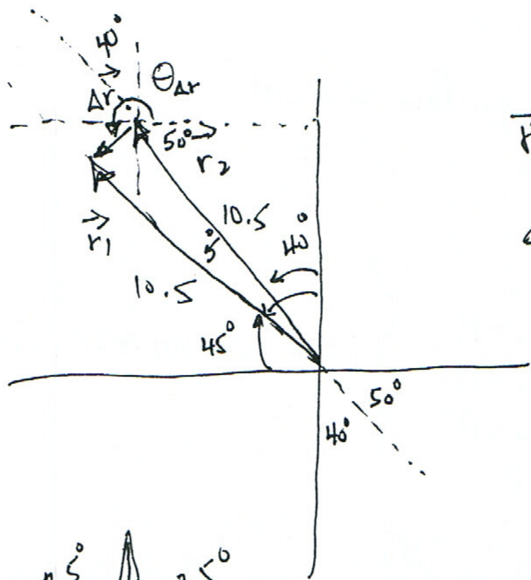
Assorted Problems

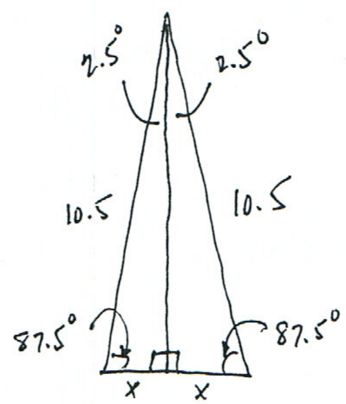
Vectors
&
Newton's 2nd Law

-53



$\vec{r}_1 = \vec{r}_2 + \Delta\vec{r}$

$\Delta\vec{r} = \vec{r}_1 - \vec{r}_2$



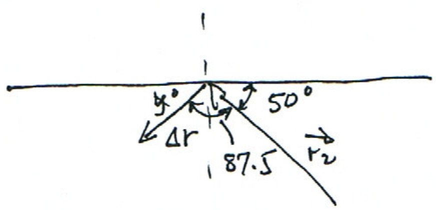
$$\begin{array}{r} 90 \\ -\ 2.5 \\ \hline 87.5 \end{array}$$

$x = 10.5 \cos 87.5^\circ$

$x = 0.458$

$|\Delta\vec{r}| = 2x = 2(0.458)$

$|\Delta\vec{r}| = 0.916$ m.



$y^\circ + 87.5 + 50 = 180$

$y^\circ + 137.5 = 180$

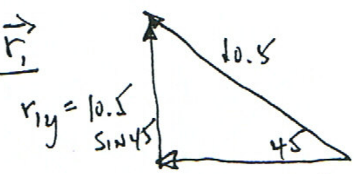
$y^\circ = 180 - 137.5 = 42.5^\circ$

$y^\circ = 42.5^\circ$

VECTORS ALL THE WAY

$\Delta\vec{r} = \vec{r}_1 - \vec{r}_2$

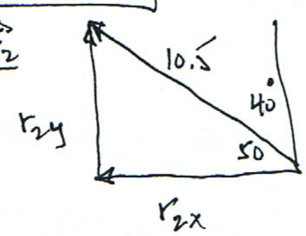
$\vec{r}_1$



$r_{1y} = \frac{10.5\sqrt{2}}{2} = 5.25(1.41) = 7.42$

$r_{1x} = \frac{-10.5\sqrt{2}}{2} = -5.25(1.41) = -7.42$

$\vec{r}_2$



$r_{2y} = 10.5 \sin 50 = 8.04$

$r_{2x} = -10.5 \cos 50 = -6.75$

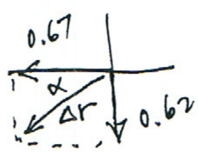
$\Delta\vec{r} = \vec{r}_1 - (\vec{r}_2)$

$= (-7.42\hat{i} + 7.42\hat{j}) - (-6.75\hat{i} + 8.04\hat{j})$

$= (-7.42 + 6.75)\hat{i} + (7.42 - 8.04)\hat{j}$

$\Delta\vec{r} = -0.67\hat{i} - 0.62\hat{j}$

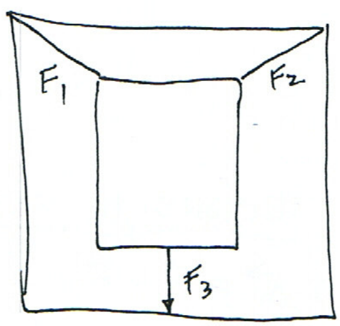
$|\Delta\vec{r}| = \sqrt{(.67)^2 + (0.62)^2} = \sqrt{0.833} = 0.913$



$\tan\alpha = \frac{0.62}{0.67} = 0.925$

$\alpha = \tan^{-1}(0.925)$

$\alpha = 42.8^\circ$



GIVEN:

Weight of picture = 100 N

$F_1 = 100$ N

QUES:

a.) $F_2 = ?$

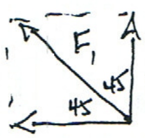
(1) $F_2 > F_1$

(2) $F_2 = F_1$

(3) $F_2 < F_1$

} BY SYMMETRY $F_1 = F_2$

b.) $F_3 = ?$

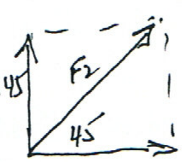


$F_1 = 100$ N

$F_{1y} = F_1 \sin 45 = 100 \cdot \frac{\sqrt{2}}{2}$

$F_{1y} = 50\sqrt{2}$

$F_{1x} = F_1 \cos 45 = 100\left(\frac{\sqrt{2}}{2}\right) = 50\sqrt{2}$



$F_{2y} = F_2 \sin 45$

$F_{2x} = F_2 \cos 45 = 100 \cdot \frac{\sqrt{2}}{2} = 50\sqrt{2}$

$F_{2y} = F_2 \sin 45 = 100 \cdot \frac{\sqrt{2}}{2} = 50\sqrt{2}$

X-DIRECTION

$\sum F_X = -F_{1x} + F_{2x} = 0 \qquad F_{1x} = F_{2x}$

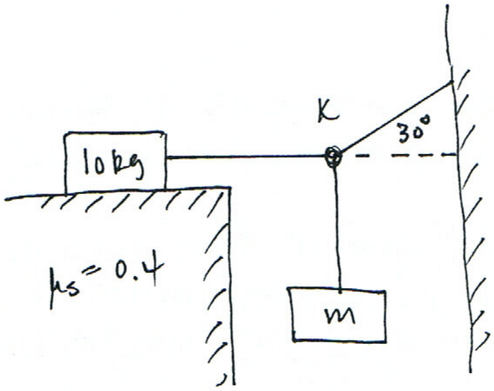
Y-DIRECTION

$\sum F_y = F_{1y} + F_{2y} - W - F_3 = 0$

$F_3 = W - F_{1y} - F_{2y} = 100 - 2(50\sqrt{2})$

$F_3 = 100 - 100\sqrt{2} = 100(1 - \sqrt{2})$

$\boxed{F_3 = 100(0.41) = 41N}$



QUES: WHAT IS THE MAXIMUM VALUE OF m BEFORE THE 10 kg BLOCK BEGINS TO MOVE TO THE RIGHT?

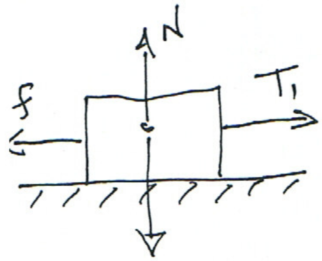
OBSERVATION:

ANGLE STAYS THE SAME UNTIL THE 10 kg BLOCK MOVES.

WE ARE INTERESTED IN RAISING THE VALUE OF m JUST UNTIL THE 10 kg BLOCK BEGINS TO MOVE

OUR ANALYSIS WILL APPLY ONLY UNTIL THE 10 kg BLOCK MOVES.

FORCE ON 10 kg BLOCK



$Mg = 10g$

$\Sigma F_x = T_1 - f = 0 \quad T_1 = f$

$\Sigma F_y = N - 10g = 0$

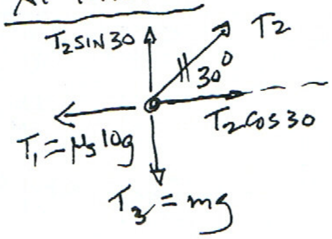
$T_1 = f = \mu_s N = \mu_s(10g)$

FORCES ON m

$\Sigma F_y = T_3 - mg = 0$

$T_3 = mg$

AT KNOT K



$\Sigma F_x = T_2 \cos 30 - T_1 = 0 \qquad T_2 = \dfrac{T_1}{\cos 30}$

$\Sigma F_y = T_2 \sin 30 - mg = 0$

$T_2 \sin 30 = mg$

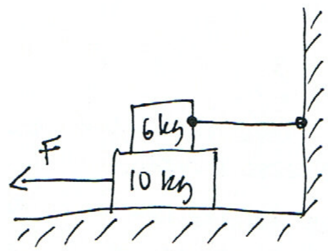
$\dfrac{T_1}{\cos 30} \cdot \sin 30 = T_1 \tan 30 = mg$

$\mu_s(10g) \cdot \tan 30 = mg$

$10 \mu_s \tan 30 = m$

$10(0.4)\dfrac{1}{\sqrt{3}} = m$

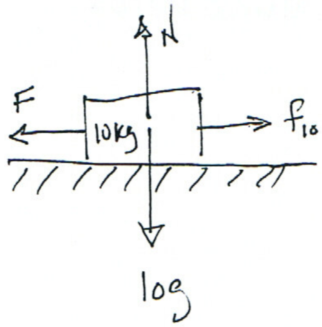
$\boxed{\dfrac{4}{\sqrt{3}} = 2.31\,\text{kg} \doteq m}$



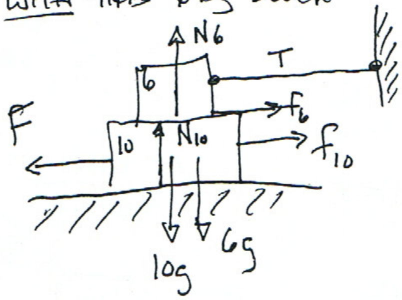
GIVEN: THE COEFFICIENTS OF FRICTION FOR BOTH SURFACES ARE $\mu_s = 0.6$, $\mu_k = 0.4$

FIND: WHAT VALUE OF $\vec{F}$ IS NEEDED TO KEEP THE BOTTOM BLOCK MOVING TO THE LEFT WITH A CONSTANT ACCELERATION OF $2 \frac{m}{s^2}$?

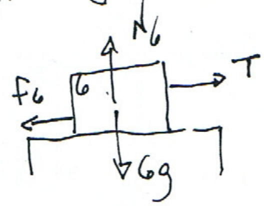
FORCES ON 10 kg BLOCK WITHOUT 6 kg BLOCK



FORCES ON 10kg BLOCK WITH THE 6kg BLOCK



FROM 6kg BLOCK POINT OF VIEW



$\Sigma F_x = T - f_6 = 0$

$T = f_6$

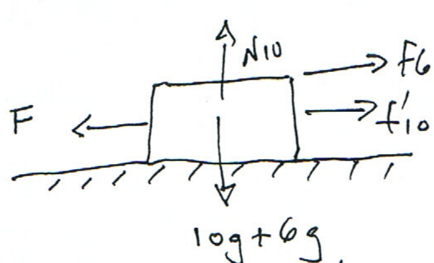
$\Sigma F_y = N_6 - 6g = 0$

$N_6 = 6g$

$T = f_6 = \mu_k N_6$

$f_6 = \mu_k 6g$

FROM 10kg BLOCK POINT OF VIEW



ADDED WEIGHT OF 6kg BLOCK ON 10kg BLOCK INCREASES THE FRICTION FORCE f_{10}

$\Sigma F_x = F - f_6 - f'_{10} = ma$

$\Sigma F_y = N_{10} - 10g - 6g = 0$

$N_{10} = 16g \quad \therefore f'_{10} = \mu_k N_{10} = \mu_k \cdot 16g$

CONTINUED

$\Sigma F_x = F - f_6 - f'_{10} = ma$

$F = ma + f_6 + f'_{10}$

$= ma + \mu_k 6g + \mu_k 16g$

$= ma + \mu_k 22g$

$F = 10(2) + 0.4(22)9.8$

$= 20 + 86.2$

$F = 106.2$ N