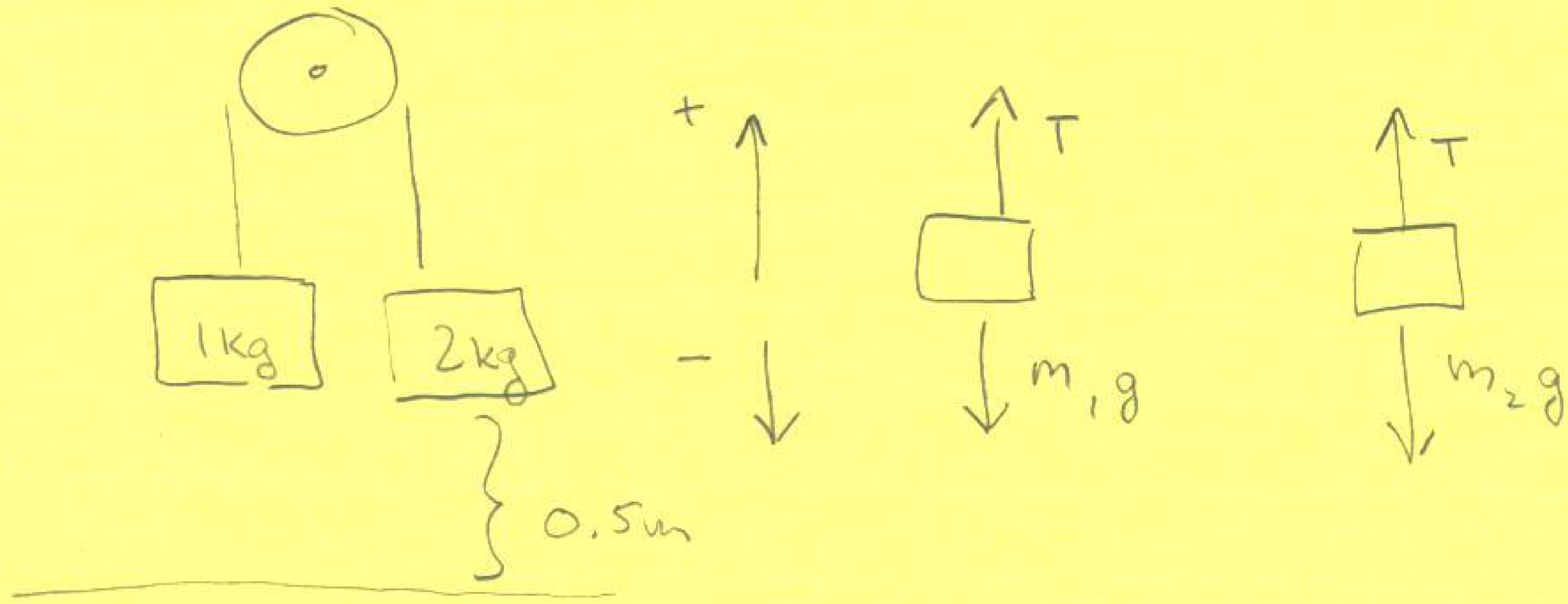
(1)

Problem Lab3



(1) $T - m_1 g = m_1 a_1 \qquad T - m_2 g = m_2 a_2$

(2) $a_2 = -a_1$ since they are connected by a rope

So the system of equations is

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So solving for a_1 :

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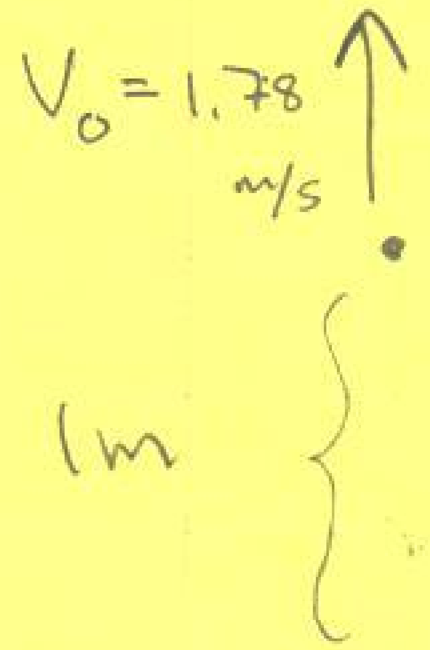
(2) becomes $T - m_2 g = -m_2\left(\frac{T}{m_1} - g\right)$

$$\left(1 + \frac{m_2}{m_1}\right)T = 2 m_2 g$$

2

d) 

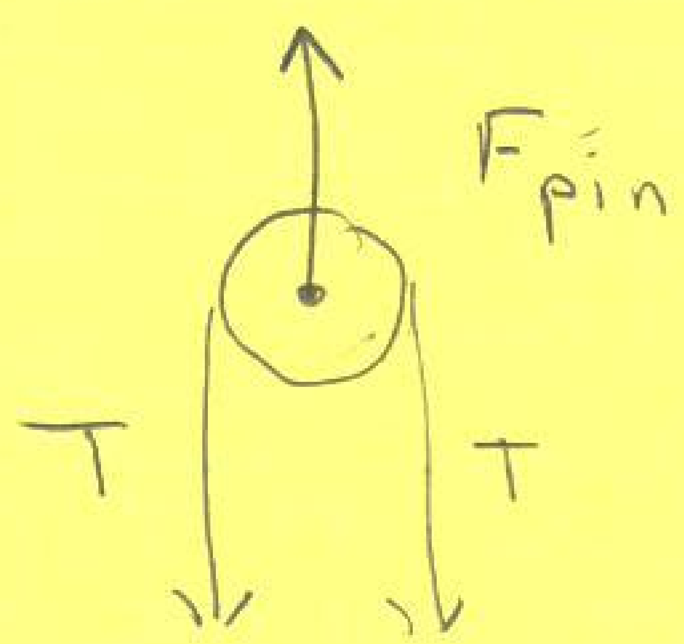
$$\overset{0}{\cancel{v_f^2}} = v_0^2 + 2a\,\Delta x$$

$$0 = (1.78\,m/s)^2 + 2(-9.8\,m/s^2)\,\Delta x$$

$$\Rightarrow \Delta x = 0.163\,m$$

So the total height is $h = 1.0m + 0.163m$
$h = 1.163m$

e) Then we have to find the force on the pulley



$$\sum F_{\substack{on\\pulley}} = \overset{0}{\cancel{m_{pulley}\,a_{pulley}}}$$

$$F_{pin} - 2T = 0 \Rightarrow F_{pin} = 2 \cdot T$$

$$\boxed{F_{pin} = 26N}$$

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So $\quad T = \dfrac{2m_2 g}{1 + \dfrac{m_2}{m_1}} = \dfrac{2m_2 m_1}{m_2 + m_1}\, g$

$$T = 2 \cdot \frac{(2kg) \cdot 1kg}{(2kg) + (1kg)}\, g$$

a) $\quad T = 2 \cdot \frac{2}{3}\, kg \;\; 9.8\, m/s^2 \;\approx 13\, N$

b) We find the acceleration and then find the velocity

$$\frac{T}{m_1} - g = a_1$$

$$13\, \frac{kg\, m/s^2}{1kg} - 9.8\, m/s^2 = a_1$$

$$a = 3.2\, m/s^2$$

Then

$$V_f^2 = \overset{0}{\cancel{V_0^2}} + 2a\,\Delta x$$

$$V_f^2 = 2\,(3.2\, m/s^2)\,(0.5m) \Rightarrow V_f = 1.788\, m/s$$

c) After the block hits the ground, then the rope goes slack, and

$$T = 0$$

Hockey Puck

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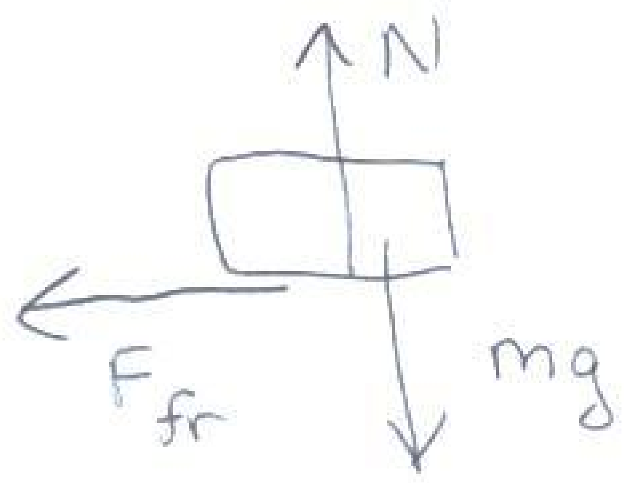
Sketch

A.



B.

$$\cancel{v_f^2}^{\,0} = v_0^2 + 2a\,\Delta x$$

$$\frac{-(10\,m/s)^2}{2\,(2\,m)} = a$$

$$-25\,m/s^2 = a^x$$

C.

$$\Sigma F^x = ma^x \qquad \Sigma F^y = m\cancel{a^y}^{\,0}$$

$$-|F_{fr}| = m\,(-|a|) \qquad N - mg = 0$$

$$N = mg$$

$$-\mu_k N = m\,(-|a|)$$

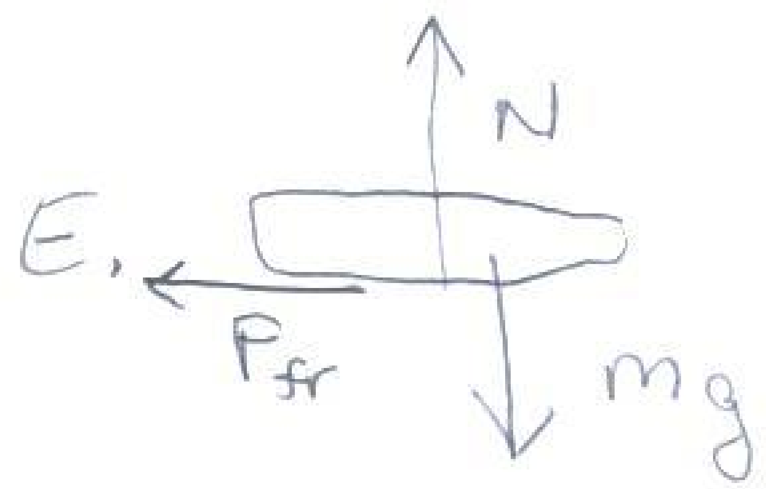
$$+\mu_k \cancel{m} g = \cancel{m}(+|a|)$$

$$\mu_k = \frac{|a|}{g} = \frac{25\,m/s^2}{9.8\,m/s^2} = 2.5$$

Then in an elevator

$$\sum F^y = ma^y$$

D. Let $a_o = -2\,m/s^2$, this is the acceleration



y] $N - mg = m a_o$

F. $N = m(g + a_o)$

x] $F_{fr} = \mu_k N$

$$F_{fr} = \mu_k m(g + a_o)$$

$$F_{fr} = (2.5)(0.05\,kg)(9.8\,m/s^2 - 2\,m/s^2)$$

$$F_{fr} = 0.975\,N$$

G. $\sum F^x = -F_{fr} = ma^x$

$$\mu_k \cancel{m}(g + a_o) = \cancel{m} a^x$$

$$\mu_k(g + a_o) = a^x$$

$$2.5(9.8\,m/s - 2\,m/s^2) = a$$

$$a = 19\,m/s^2$$

$$\cancel{V_f^2} = V_o^2 + 2a\Delta x$$

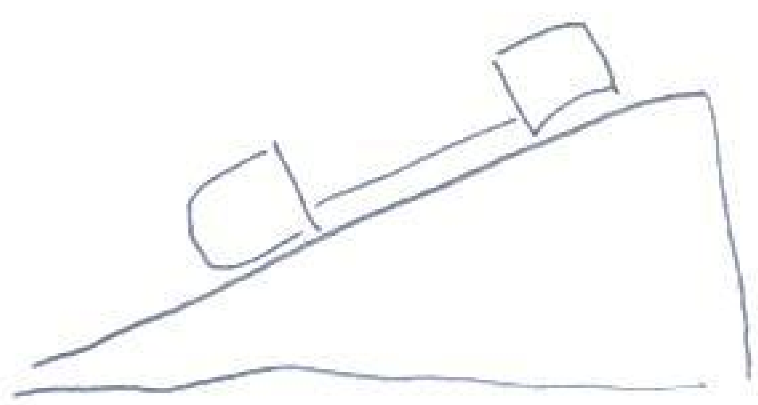
$$-V_o^2 = 2(-|a|)\Delta x$$

$$\frac{V_o^2}{2|a|} = \Delta x$$

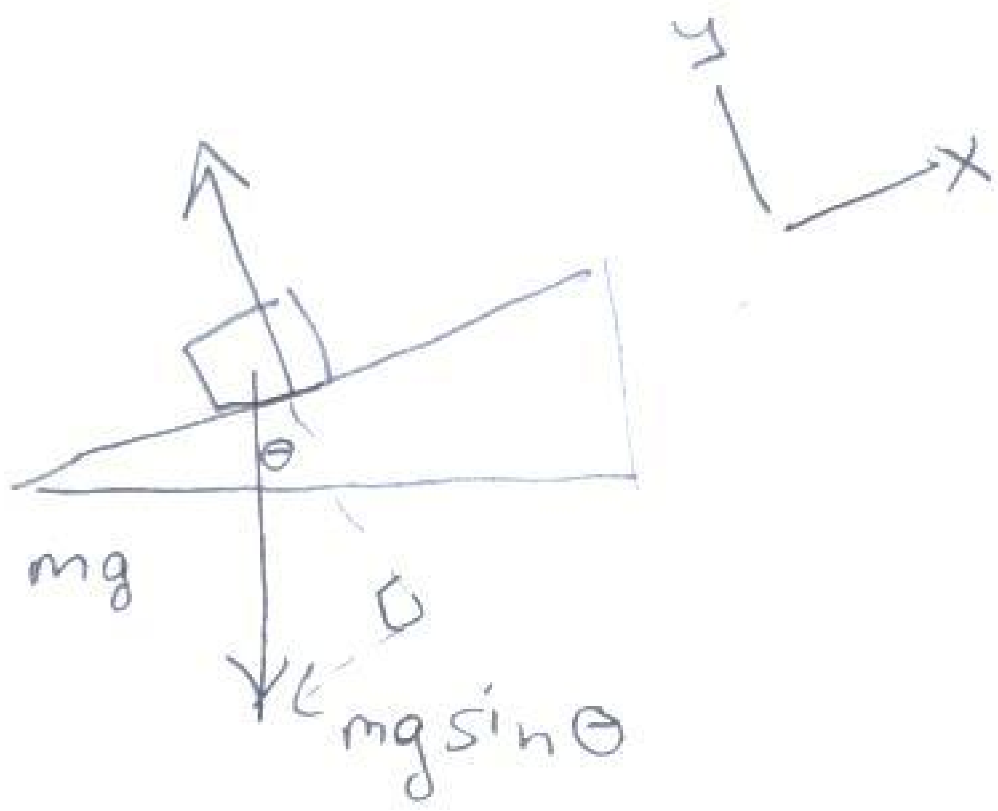
$$\frac{(10m/s)^2}{2(19m/s^2)} = \Delta X$$

$$2.63m = \Delta X$$

Ramp



A.



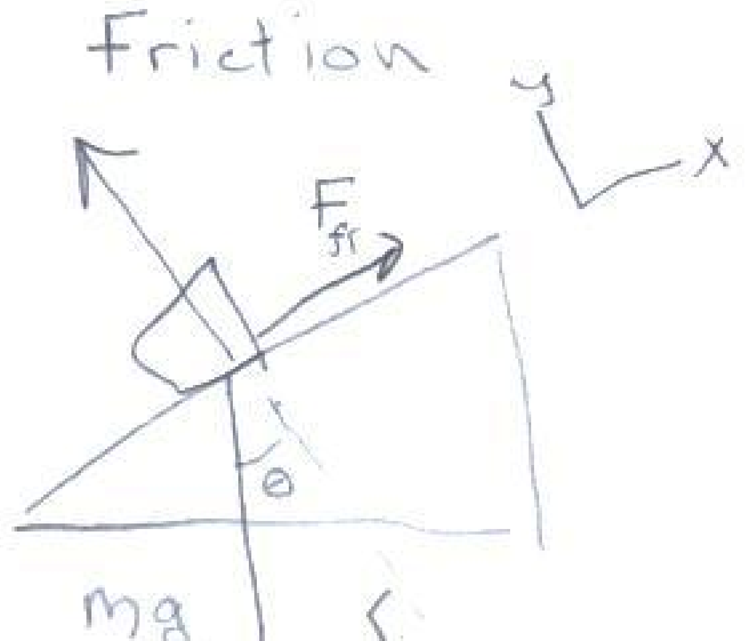
$$\Sigma F^x = ma^x$$

$$-\cancel{m}g\sin\theta = \cancel{m}a^x$$

$$-g\sin\theta = a^x$$

For block #2 it is the same

B. With Friction



$$\Sigma F^y = \cancel{m_1 a_1^y} \; 0$$

$$-m_1 g\cos\theta + N = 0$$

$$N = mg\cos\theta$$

$$\Sigma F^x = m_1 a_1^x$$

$$-mg\sin\theta + F_{fr} = ma_1^x$$

$\underline{x}$ direction

(1) $\sum F_1^x = m_1 a_1^x$ $\qquad$ $\sum F_2^x = m_2 a_2^x$ (2)

Before starting we note that:

$$F_{fr,1} = \mu_{k,1} N_1 = \mu_1 m_1 g \cos\theta = (0.1)(2kg)(9.8)\cos 30$$
$$= 1.69 N$$
$$F_{fr,2} = \underbrace{\mu_{k,2} N_2 = \mu_2}_{\text{I drop the "k" to ease notation}} m_2 g \cos\theta = (0.2)(1kg)(9.8)\cos 30$$
$$= 1.69N$$

$$T - m_1 g \sin\theta + F_{fr,1} = m_1 a \quad (Eq\ (1))$$

$$-T - m_2 g \sin\theta + F_{fr,2} = m_2 a \quad (Eq\ (2))$$

Adding these two equations

$$-(m_1+m_2) g \sin\theta + (F_{fr,1} + F_{fr,2}) = (m_1+m_2) a$$

$$-g\sin\theta + \frac{(F_{fr,1} + F_{fr,2})}{m_1+m_2} = a$$

$$-(9.8 m/s^2)\sin 30° + \frac{(1.69N + 1.69N)}{2kg + 1kg} = a$$

$$a = -3.76 m/s^2$$

Then

$$-\cancel{m}g\sin\theta + \mu_k \cancel{m}g\cos\theta = \cancel{m}a_1^x$$

$$g(\mu_k\cos\theta - \sin\theta) = a_1^x$$

For block I we have

$$a_1^x = (9.8\,m/s^2)(0.1\cos 30^\circ - \sin 30^\circ)$$

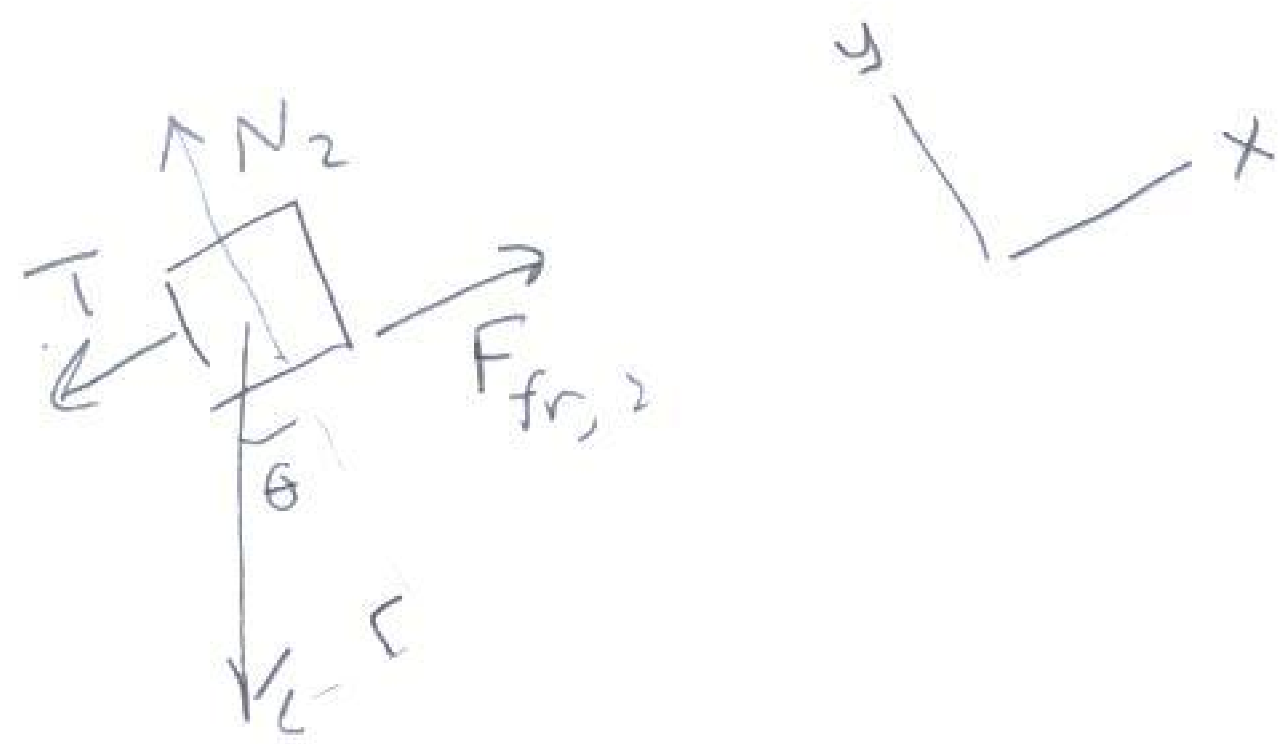
$$a_1^x = -4.05\,m/s^2$$

For black #2 we have

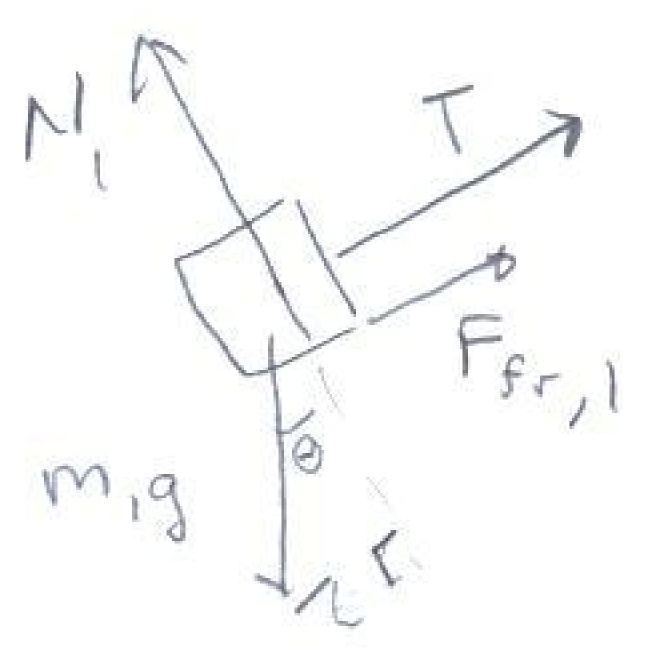
$$a_2 = g(\mu_{k,1}\cos\theta - \sin\theta)$$

$$a_2 = (9.8\,m/s^2)(0.2\cos 30^\circ - \sin 30^\circ)$$

$$= -3.2\,m/s^2$$



C.



In y direction

$$\sum F^y = m_1 \cancel{a_1^y}^{\,0} \qquad N_1 = m_1 g\cos\theta, \quad N_2 = m_2 g\cos\theta$$

D.

To find the tension we have:

$$T = m_1 g \sin\theta - F_{fr,1} + m_1 a$$

$$T = (2kg)(9.8)\sin 30^\circ - 1.69N + (2kg)(3.76\ m/s^2)$$

$$T = 15.63N$$

E. If the 2 blocks were reversed. Then the 2kg block would run down into the 1 kg block. The tension is necessarily zero

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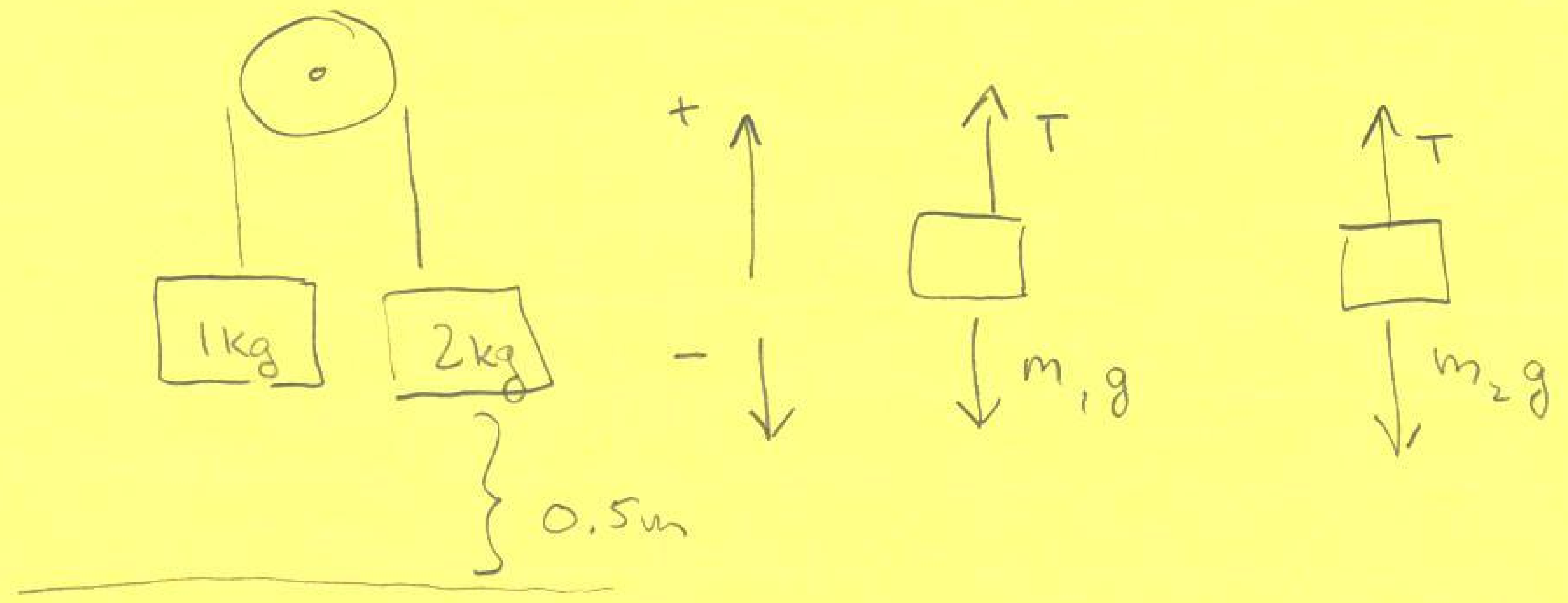
Problem Lab3



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