Physics 160

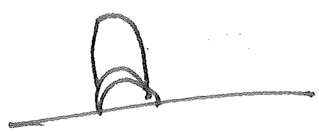
Extra Credit #13

5.11

But there's a "trick" I'll show Below

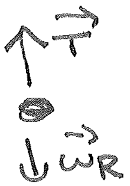
$$a_y = 4g = 4(9.8\,m/s^2) = 39.2\,m/s^2$$

↑ a = 4g



Forces on Rocket: Thrust $\vec{T}$ upward

weight, $\vec{w}_R$ down



$\sum F_y = m a_y$. Forces on Rocket ⇒

$$T - w_R = m_R a_y$$

$$\Rightarrow T = w_R + m_R a_y . \qquad w_R = m_R g$$

$$a_y = 4g$$

$$\Rightarrow T = m_R g + m_R(4g) = 5 m_R g = 5(2.25 \times 10^6\,kg)(9.8\,m/s^2)$$

$$= 1.1025 \times 10^8\,N$$

Writing Acceleration in terms of "g" Allows us to have A very compAct Answer.

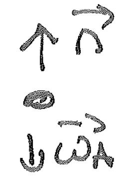
b) Inside spaceship is Astronaut → she's Also Accelerating at 4g

↑ $a_y = 4g$

Forces on Astronaut: Normal up from sideways Chair, $\vec{n}$

$\vec{n}$ = ? since spaceship exerting, (cont.)

Also $\vec{w}_A$ DOWN. w_A = Astronaut weight.



$$\sum F_y = ma_y \Rightarrow n - w_A = M_A a_y$$

(M_A ↑ Astronaut MASS)

$$\Rightarrow n = w_A + M_A a_y = M_A g + M_A(4g) = 5M_A g$$

$$\text{So } \frac{n}{w_A} = \frac{5M_A g}{M_A g} = 5 \Rightarrow n = 5w_A$$

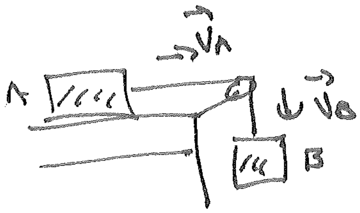
c) Shortest time to reach $V = 331\,m/s$

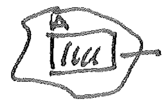
We use Acceleration of Rocket $\Rightarrow a_y = 4g = 39.2\,m/s^2$

$$V_y = \cancel{V_{0y}}^{\,0} + a_y t \Rightarrow t = \frac{V_y}{a_y} = \frac{331\,m/s}{39.2\,m/s^2} = 8.44\,s$$

(V_{0y}: Starts From Rest)

Kinetic Friction



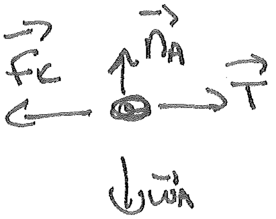


Forces on A: Tension, $\vec{T}$ to right

Kinetic Friction, $\vec{f}_K$ to left

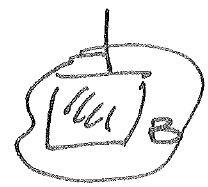
Normal $\vec{n}_A$ up, Weight $\vec{w}_A$ down

A's fbd



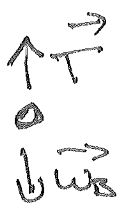
Forces on $\vec{B}$: Tension, $\vec{T}$ up ~~down~~

same magnitude as tension on A since massless rope and pulley.



Weight, $\vec{w}_B$ down

B's fbd



Constant speed ⇒ No Acceleration for either mass

So for B: $\Sigma F_y = 0 \Rightarrow T - w_B = 0$

$\Rightarrow T = w_B$

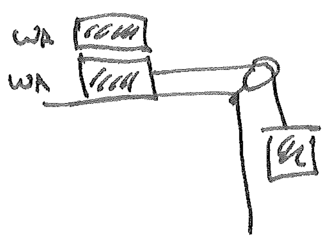
For A: $\Sigma F_x = 0 \Rightarrow T - f_K = 0 \Rightarrow T = f_K$

$\Sigma F_y = 0 \Rightarrow n_A - w_A = 0 \Rightarrow n_A = w_A$

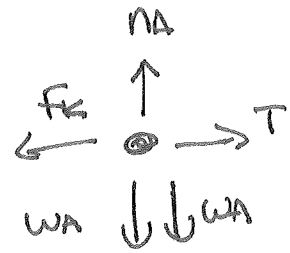
Putting it all together $T = w_B$ and $T = f_K \Rightarrow f_K = w_B$

$$\mu_K = \frac{f_K}{n_A} = \frac{w_B}{w_A}$$

b) Two masses with w_A



A's fbd:



Double the mass

$$\sum F_x = m a_x$$

$$\Rightarrow T - f_k = 2 m_A a_{Ax}$$

$\sum F_y = 0$ still since no Acc. in that direction

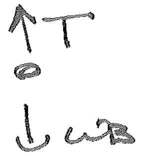
$$\Rightarrow n_A - w_A - w_A = 0 \Rightarrow n_A = 2w_A$$

$f_k = \mu_k n_A = \mu_k (2w_A)$ using $\mu_k = \frac{w_B}{w_A} \Rightarrow$

$$f_k = \frac{w_B}{w_A}(2w_A) = 2w_B$$

$$\Rightarrow T - 2w_B = 2 m_A a_{Ax}$$

B's Diagram is the same but vectors not the same length:



$$\sum F_y = m a_y \Rightarrow T - w_B = m_B a_{By}$$

A and B have same magnitude of acceleration but A accelerates to right while B accelerates down $\Rightarrow$ $a_{Ax} = a$, $a_{By} = -a$

$\therefore \quad T - 2w_B = M_A a_{Ax} \Rightarrow T - 2w_B = 2M_A a$

$T - w_B = M_B a_{By} \Rightarrow T - w_B = M_B(-a)$

So $T - 2w_B = 2M_A a$

$-(T - w_B = M_B(-a))$

$\Rightarrow T - 2w_B = 2M_A a$

$-T + w_B - M_B a$

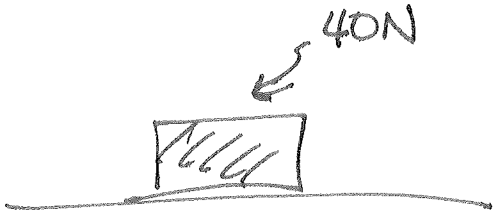
$\cancel{T} - \cancel{T} - 2w_B + w_B = (2M_A + M_B)a$

$\Rightarrow -w_B = (2M_A + M_B)a$

$\Rightarrow a = \dfrac{-w_B}{(2M_A + M_B)}$, $M_A = \dfrac{w_A}{g}$, $M_B = \dfrac{w_B}{g}$

$\Rightarrow a = \dfrac{-w_B}{\frac{2w_A}{g} + \frac{w_B}{g}} = -\left(\dfrac{w_B}{w_A + w_B}\right)g \qquad |a| = \left(\dfrac{w_B}{2w_A + w_B}\right)g$

5.28

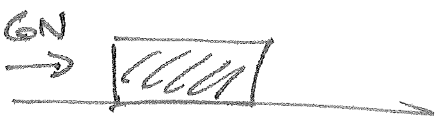


$\mu_s = 0.4$

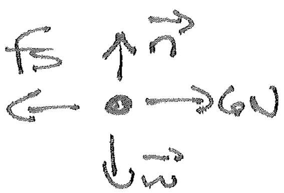
$\mu_k = 0.2$

iF No Horizontal Force then No Friction is Needed

b)



THE MAXIMUM static friction $f_{s,MAX} = \mu_s n$



$\sum F_y = 0$ SINCE $a_y = 0$

$\Rightarrow n - w = 0 \Rightarrow n = w = 40N$

So $f_{s,MAX} = 0.4(40N) = 16N$

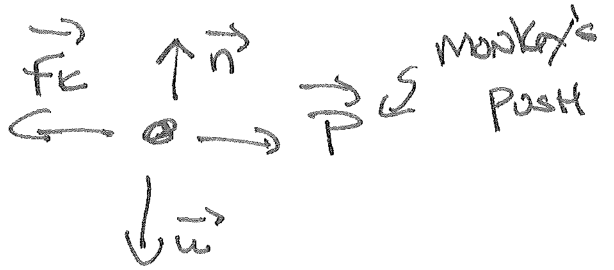
6N is less THAN 16N, so box will not move $\Rightarrow \sum F_x = 0$

$\Rightarrow 6N - f_s = 0 \Rightarrow f_s = 6N$

c) MiNiMUM FORCE is 16N SiNCE that's when $f_{s,MAX}$ is reached.

d) Once motion begins, static becomes kinetic

$f_K = \mu_K n = 0.2(40N) = 8N$



Constant speed $\Rightarrow a_x = 0$

$\Rightarrow \sum F_x = 0 \Rightarrow P - f_K = 0$

$\Rightarrow P = f_K = 8N$

e) $P = 18N$ Doesn't effect kinetic friction since its value is always $\mu_K n$

f) with $P = 18N$, $a_x = ?$ $\sum F_x = ma_x \Rightarrow P - f_K = ma_x$

$m = \frac{w}{g} = \frac{40N}{9.8 m/s^2} = 4.08 kg$

$\therefore 18N - 8N = 4.08kg\, a_x \Rightarrow a_x = \frac{10N}{4.08kg} = 2.45 m/s^2$