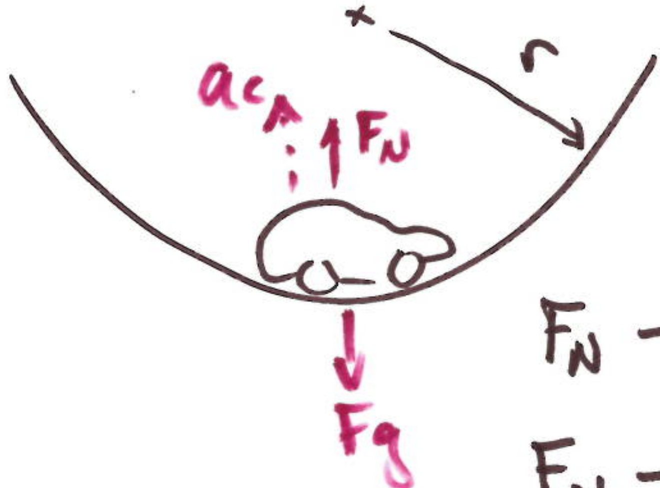
Physics 200 Exam 2 Review Noon

1.a. Car travels at bottom of rounded valley.



$$a_c = \frac{v^2}{r}$$

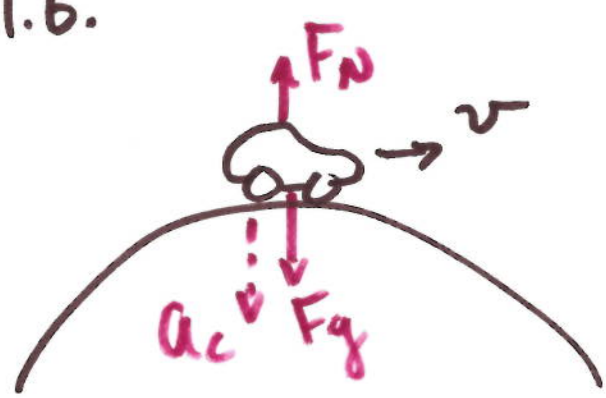
$$F_N - F_g = +ma_c$$

$$F_N - mg = m\frac{v^2}{r}$$

as $v\uparrow$, $F_N\uparrow$

No simple limit on v. maybe tire blows as $F_N\uparrow$.

1.b.



$$F_N - F_g = -ma_c$$

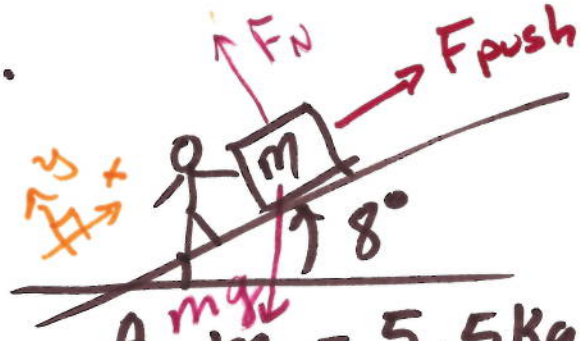
$$F_N - mg = -m\frac{v^2}{r}$$

as $v\uparrow$, $F_N\downarrow$

and $F_N \geq 0$. Thus v_{max} is when

$$0 - mg = -m\frac{v_{max}^2}{r}$$

2.

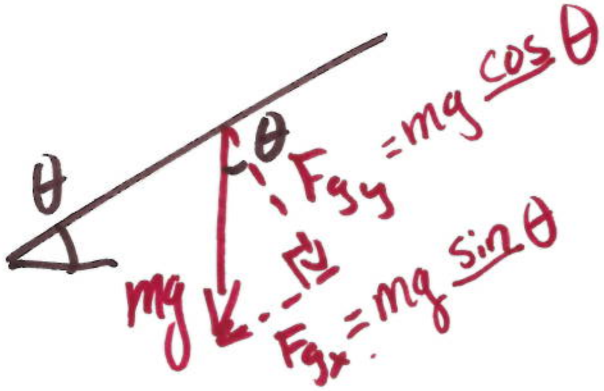


$m = 5.5\,\text{Kg}$

Assume F_{push} is directly up incline.

Neglect friction.

What is <u>min</u> force to move it up?



$$\Sigma F_x = ma_x$$

$$F_{push} - mg\sin\theta = ma_x$$

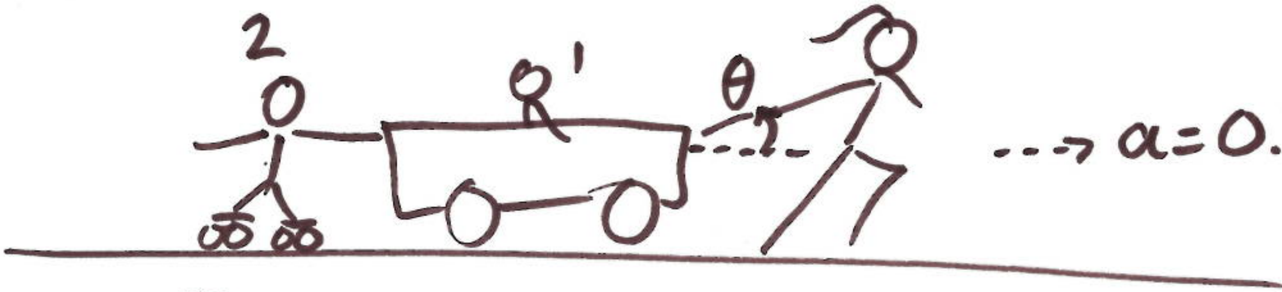
$$\Sigma F_y = ma_y$$

$$F_N - mg\cos\theta = ma_y$$

Set $a_x \to 0$ to find $F_{p\,(min)}$. Will need a <u>bit</u> more to move it.

$$F_{push\,(min)} - mg\sin\theta = 0$$

$$\boxed{F_{push\,(min)} = mg\sin\theta}$$

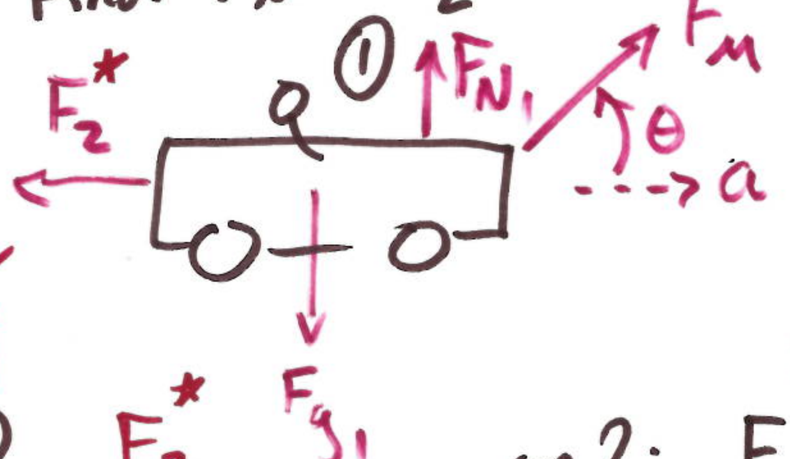


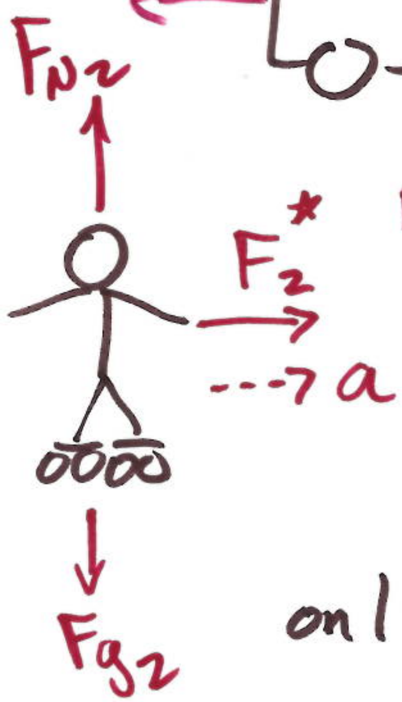
$a = 0.375\,\frac{m}{s^2}$

$m_2 = 35\,kg$ $\quad m_1 = 30\,kg$ $\quad \theta = 60°$

Neglect friction.

Find: F_M $\quad F_2$





$\Sigma F_x = m_2 a_x$

on 2: $F_2 = m_2 a$

$= 35\,kg\left(0.375\,\frac{m}{s^2}\right)$

$= 13.1\,N$

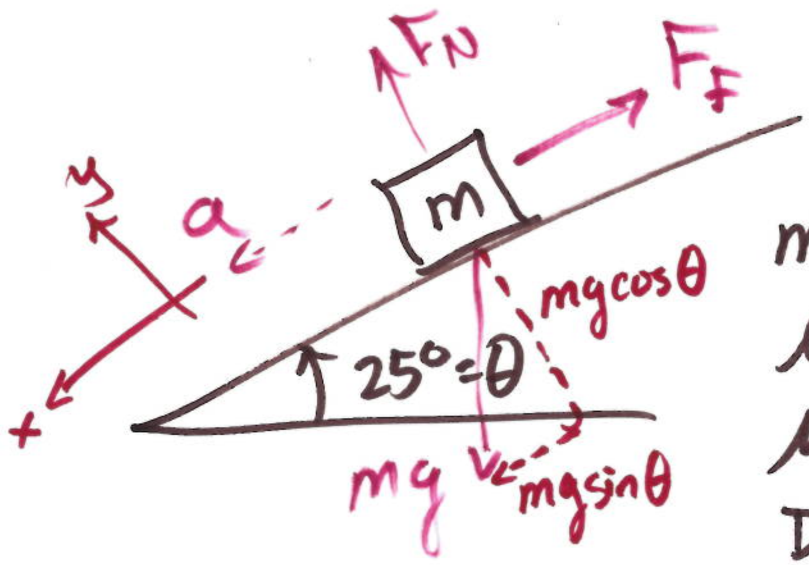
on 1: $\Sigma F_x = m_1 a_x$

$F_M \cos 60° - F_2 = m_1 a$

$F_M \cos 60° = F_2 + m_1 a$

$F_M = \dfrac{F_2 + m_1 a}{\cos 60°} = \dfrac{13.1\,N + 30\,kg\left(0.375\,\frac{m}{s^2}\right)}{\frac{1}{2}}$

$F_M = 49\,N$



$m = 0.522\,kg$

$\mu_s = 0.40$

$\mu_k = 0.20$

Does it move?
If so, find a.

$\sum F_x = m\overset{?}{a}$

$\boxed{mg\sin\theta - F_f = m\overset{?}{a}}$

$\sum F_y = 0$

$F_N - mg\cos\theta = 0$

$\boxed{F_N = mg\cos\theta}$

Try Static First

$$F_{f_s} \leq \mu_s F_N = 0.4 \times mg\cos\theta$$
$$= 0.4 \times 0.522\,kg\left(9.8\tfrac{m}{s^2}\right)\cos 25°$$
$$= 1.85\,N$$

$$mg\sin\theta = 0.522\,kg\left(9.8\tfrac{m}{s^2}\right)\sin 25° = 2.16\,N$$

It moves.

$$F_{f_K} = \mu_K F_N = 0.2 \times mg\cos\theta = 0.925\,N$$

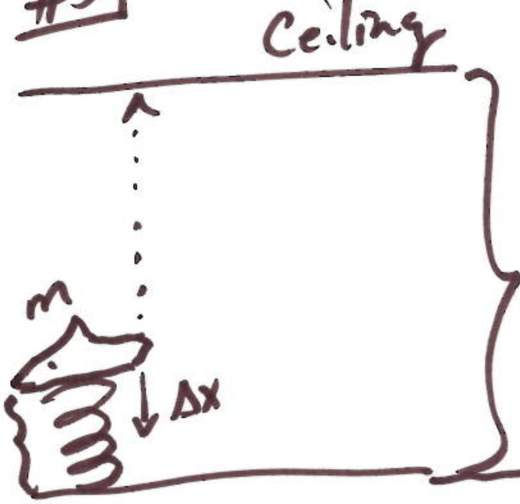
Compute F_{f_K}

$$mg\sin\theta - F_{f_K} = ma$$

$$2.16N - 0.925N = 0.522Kg\ a$$

$$\boxed{2.37\frac{m}{s^2} = a}$$

#5



h
6.3m

h=0

m=2.2Kg

find Δx.

$L = 0.32m$

$k = 543\frac{N}{m}$

$\vec{F}_e = -k\vec{\Delta x}$ x

$U_e = \frac{1}{2}k(\Delta x)^2$ ✓

$U_g = mgh$

$$\sum E_f - \sum E_0 = \sum W_{N.C.}$$

$$U_{g_f} - (U_e + U_{g_0}) = 0$$

$$mgh - \left(\frac{1}{2}k\Delta x^2 + mg(L-\Delta x)\right) = 0$$

$$\frac{-\frac{1}{2}k\Delta x^2 + mg\Delta x + mgh + mgL}{mg} = \frac{0}{mg}$$

$$-\frac{k}{2mg}\Delta x^2 + \Delta x + (h+L) = 0$$

$ax^2+bx+c=0$ find x

$$a = \frac{-543\frac{N}{m}}{2(2.2Kg)(9.8\frac{m}{s^2})}$$

$b = 1$

$c = h+L = 6.62m$

$$a = -12.6\frac{1}{m}$$

$$\Delta x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$$

$$\Delta x = \frac{-1 \pm \sqrt{1 - 4(-12.6 \tfrac{1}{\cancel{m}})(6.62 \cancel{m})}}{2(-12.6)\tfrac{1}{m}}$$

$$\Delta x = \frac{-1 \pm 18.3}{-25.2} m = \frac{-19.3}{-25.2} m = 0.766 m$$

oops.
$\Delta x > L$.
buy new spring.

6.

$\rightarrow \vec{d} = 3.3m$

$m = 9.4Kg$

Const. $\vec{v} = 2.1 m/s$ right $\rightarrow$

$\mu_K = 0.34$

Find W by <u>each</u> Force.

$$W = Fd\cos\theta$$

F	θ	$\cos\theta$
F_p	60°	$\cos 60° = 1/2$
F_N	90°	0
F_g	90°	0
F_{fK}	180°	-1

$$\Sigma F_x = ma_x$$

$$\star\ F_p \cos\theta - F_{fK} = 0$$

$$F_p \cos\theta = F_{fK} = \mu_K F_N$$

$$\left.\begin{aligned} &\Sigma F_y = 0 \\ &F_N - mg + F_p \sin\theta = 0 \\ &\overset{*}{F_N} = \underbrace{mg - \overset{*}{F_p}\sin\theta} \end{aligned}\right\} \hat{y}$$

$$\left. F_p \cos\theta = \mu_K F_N \right\} \hat{x}$$

$$\overset{*}{F_p}\cos\theta = \mu_K \left(mg - \overset{*}{F_p}\sin\theta\right)$$

$$F_p \cos\theta + \mu_K F_p \sin\theta = \mu_K mg$$

$$F_p \left(\cos\theta + \mu_K \sin\theta\right) = \mu_K mg$$

$$F_p = \frac{\mu_K mg}{\cos\theta + \mu_K \sin\theta} = \frac{0.34(9.4\,\text{kg})(9.8\,\tfrac{\text{m}}{\text{s}^2})}{\cos 60^\circ + 0.34\sin 60}$$

$$= \frac{31.3\,\text{N}}{0.794} = \boxed{39.4\,\text{N}}$$

$$F_p \cos\theta = F_{f_K} = \mu_K F_N$$

$$\overset{\shortparallel}{19.7\,\text{N}}$$

$$W_{F_p} = F_p\, d \cos 60^\circ = 39.4\,\text{N} \overbrace{\cos 60^\circ}^{1/2} (3.3\,\text{m})$$

$$= 65\,\text{J}$$

$$W_{F_{f_K}} = F_{f_K} \cdot d \cdot \cos 180^\circ = 19.7\,\text{N} \times 3.3\,\text{m}\ (-1)$$

$$= -65\,\text{J}$$

7.)

$k = 444\frac{N}{m}$

$m = 0.567\,kg$

$\theta = 5.1^\circ$

only gravity and elastic (spring) $\vec{F}$ do work.

$\Rightarrow$ Use Energy.

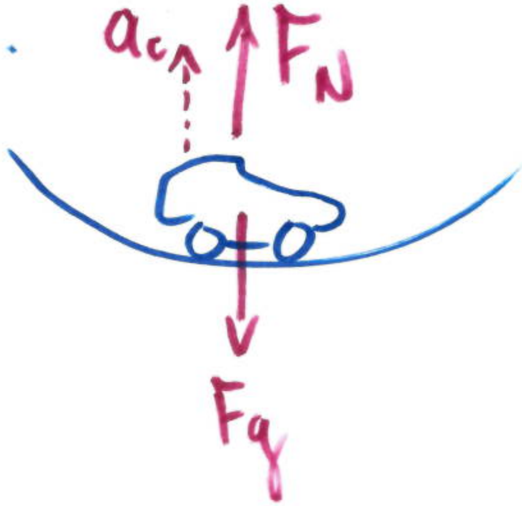
$h = 2.2m \times \sin\theta$
$= 0.196m$

$$\Sigma E_0 = \Sigma E_f$$
$$U_g = U_e$$
$$mgh = \frac{1}{2}k(\Delta x)^2$$

$$\frac{2mgh}{k} = (\Delta x)^2 = 4.9\times10^{-3}m^2$$

$$\Delta x = 0.070m$$
$$\simeq 7.0cm$$

1a.



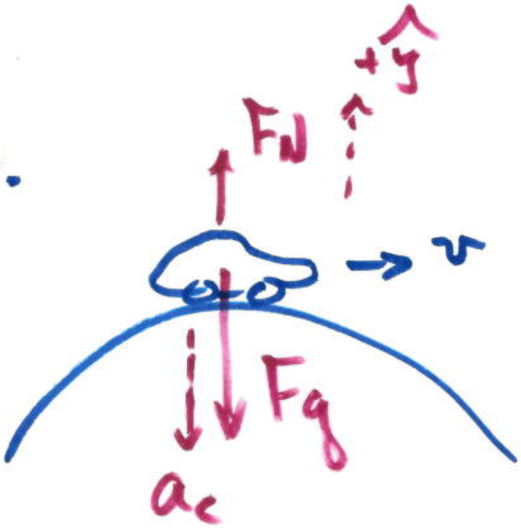
Is there a max? v
min?

$$a_c = \frac{v^2}{r}$$

$$\sum F = ma$$

$$F_N - F_g = m a_c = m\frac{v^2}{r}$$

1.b.



$$\sum F = ma$$

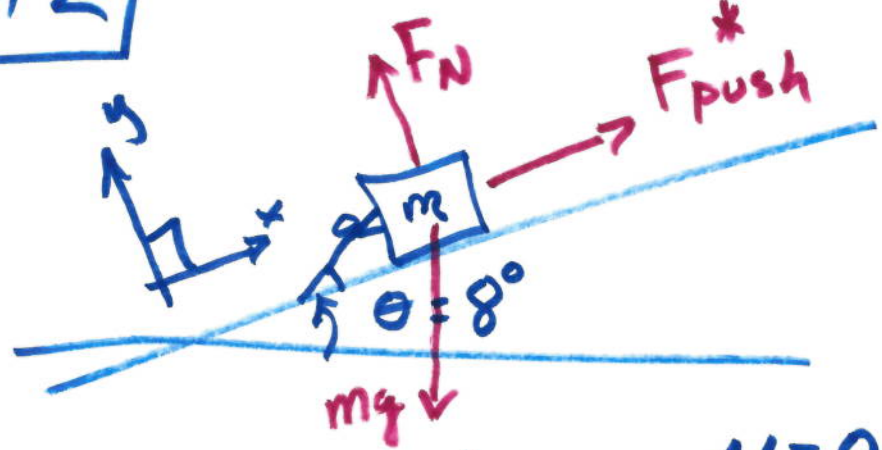
$$F_N - mg = -m\overbrace{\frac{v^2}{r}}^{a_c}$$

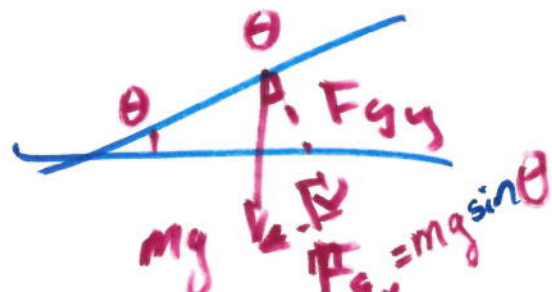
yes, there is a max. v.
because
$F_N \to 0$, tires
leave ground.

$$\cancelto{0}{F_N} - mg = -m\frac{v_{max}^2}{r}$$

#2

$$\Sigma \vec{F} = m\vec{a}$$





$m = 5.5\,kg$ $\mu = 0.$

Find min. F to get box up incline.

"minimum" F $\longrightarrow$ $a \to 0$.

$$\Sigma F_x = m\cancel{a_x}^{0}$$

$$^{*}F_{push} - F_{g_x} = 0$$

$$F_{push} = F_{g_x}$$

$$\boxed{F_{push} = mg\sin\theta}$$

$$= 5.5\,kg\ 9.8\,\frac{m}{s^2}\ \sin 8°$$

$$= \boxed{7.50\,N}$$

$$\cos\theta = \frac{adj}{hyp} = \frac{F_{gy}}{mg}$$

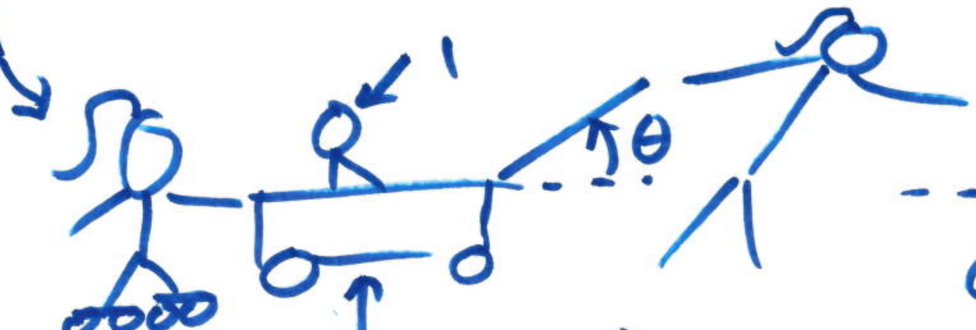
$$\sin\theta = \frac{opp}{hyp} = \frac{F_{gx}}{mg}$$

$$\Sigma F_y = 0$$

$$F_N - F_{gy} = 0$$

$$\boxed{F_N = mg\cos\theta}$$

#3 / 2



$a = 0.375\ m/s^2$

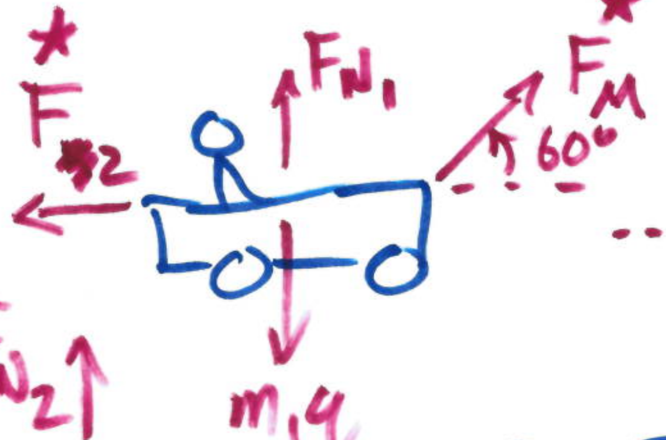
$m_1 = 30\,kg$

35kg

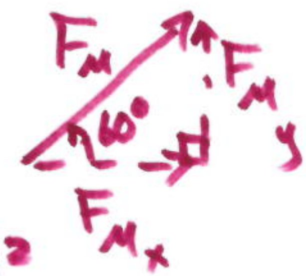
$\theta = 60°$

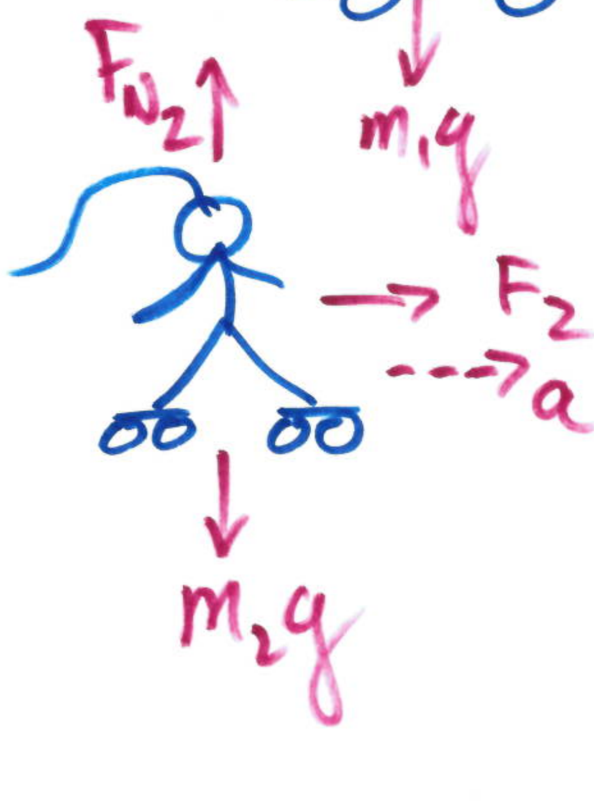
* F_{mom}

F_2 *



$a = 0.375\ m/s^2$





$$\Sigma F_x = m_2 a$$

$$\Sigma F_y = 0$$

$$F_{N_2} - m_2 g = 0$$

$$\boxed{F_2 = m_2 a}$$

#3 continued

$$\Sigma F_{1x} = m_1 a$$

$$F_M \cos 60^\circ - F_2 = m_1 a$$

$$F_M = \frac{m_1 a + F_2}{\cos 60^\circ} = \frac{m_1 a + m_2 a}{\cos 60^\circ}$$

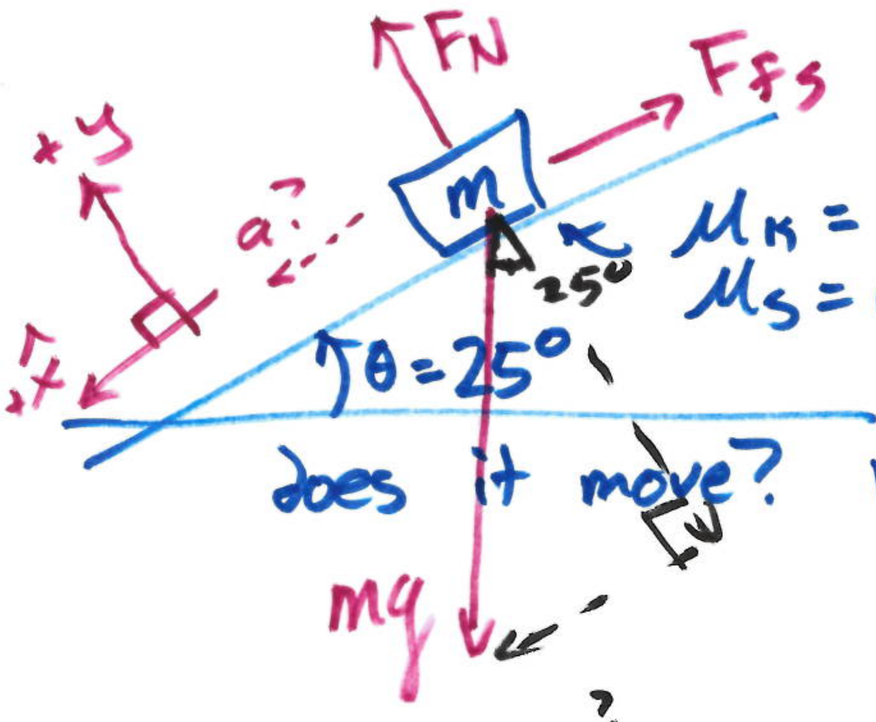
$$\Sigma F_{1y} = 0$$

$$F_{N_1} - m_1 g + F_M \sin 60^\circ = 0$$

$$F_M = \frac{(30\,kg + 35\,kg)(0.375\,m/s^2)}{\cos 60^\circ}$$

$$= \cancel{31.75\,N}\ 49\,N$$

$$F_2 = m_2 a = 11.25\,N$$



$\mu_K = 0.20$

$\mu_s = 0.40$

$m = 0.522\,kg$

does it move? If so find a.

$$\Sigma F_x = m\overset{?}{a}_x \qquad \Sigma F_y = 0$$

$$F_N - mg\underline{\cos}\,25° = 0$$

$$-F_{fs} + mg\,\underline{\sin}\,25° = m\overset{?}{a}$$

$$F_N = mg\cos 25°$$

$$F_{fs} \le \mu_s F_N$$

$$\le 0.40\,(0.522\,kg)\left(9.8\,\tfrac{m}{s^2}\right)\cos 25°$$

$$F_{fs} \le 1.85\,N$$

$$mg\sin 25° = 0.522\,kg\left(9.8\,\tfrac{m}{s^2}\right)\sin 25°$$

$$= 2.16\,N$$

$$F_{fK} = \mu_K F_N = 0.20\,(.522)(9.8)\cos 25°$$

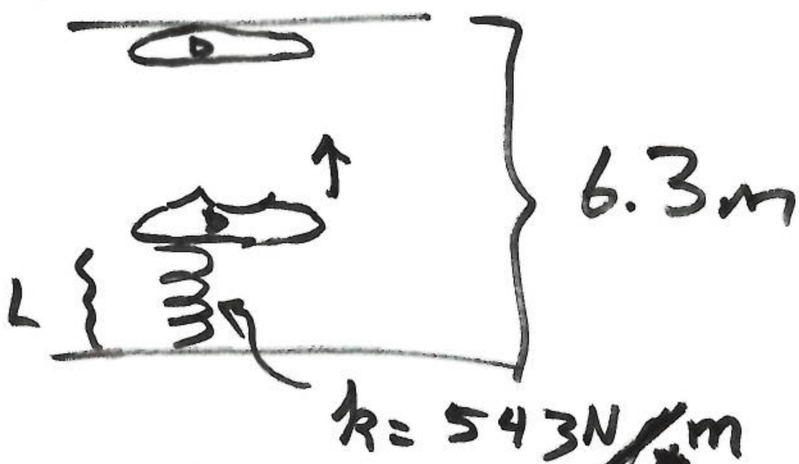
$$= 0.925\,N$$

$$-F_{fK} + mg\sin 25° = ma$$

$$-0.925\,N + 2.16\,N = (0.522\,kg)\,a^*$$

$$\boxed{2.37\,\tfrac{m}{s^2} = a}$$

5.



$$\underbrace{\Sigma E_f}\; - \Sigma E_0 = W_{N.C.}$$

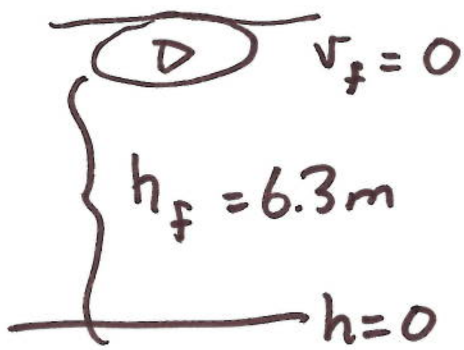
$$\Sigma E_{K_f} + \Sigma U_f - \Sigma E_{K_0} - \Sigma U_0 =$$

$L = 0.32\,m$

$m = 2.2\,kg$

init

final



U_{e_0} U_{g_0}

U_{g_f}

$h_0 = 0.32\,m - \Delta x$

$$\Sigma E_f - \Sigma E_0 = \cancel{W_{NC}}^{\,0}$$

$$mgh_f - mgh_0 - \frac{1}{2}k\,\Delta x^2 = 0$$

$$mgh_f - mg(L - \Delta x) - \frac{1}{2}k\Delta x^2 = 0$$

$$mgh_f - mgL + mg\Delta x - \frac{1}{2}k\Delta x^2 = 0$$

quadratic in Δx. Ouch.

$$\underbrace{h_f - L}_{c} + \underbrace{\Delta x}_{b=1} - \underbrace{\frac{k}{2mg}}_{a}\Delta x^2 = 0$$

$6.3m - 0.32m$

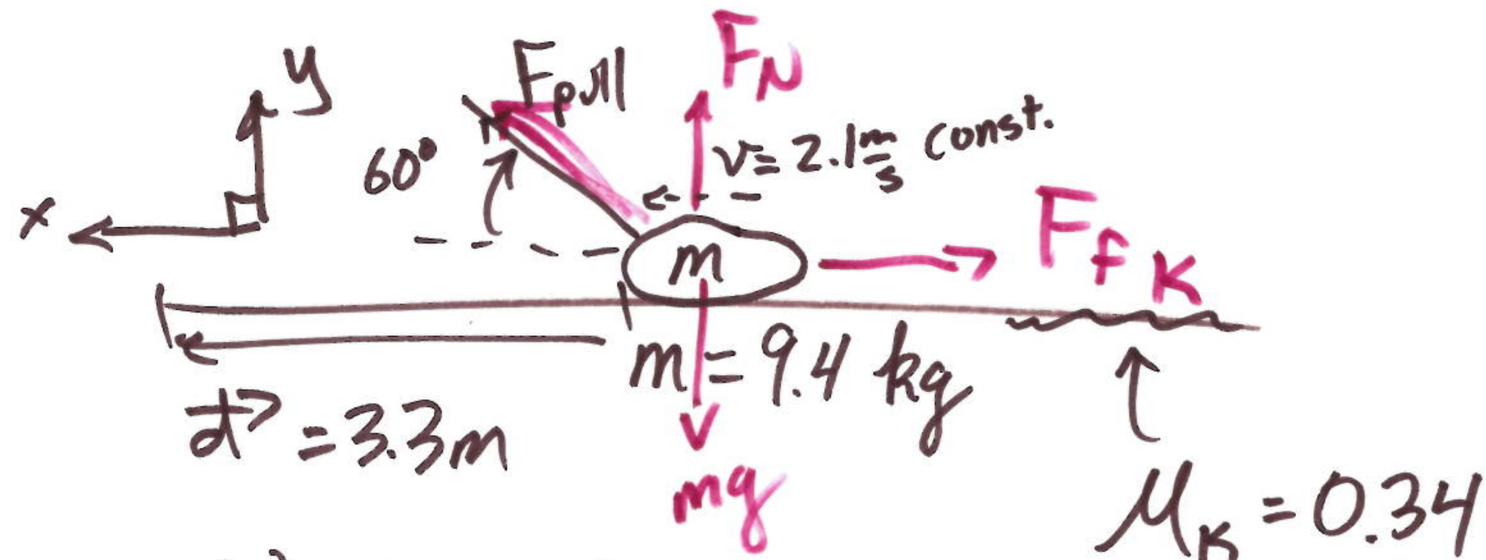
$5.98m = c \qquad b = 1 \qquad a = \dfrac{-543\frac{N}{m}}{2(2.2kg)(9.8\frac{m}{s^2})}$

$$= -12.6\frac{1}{m}$$

$$\Delta x = \frac{-1 \pm \sqrt{1 - 4(-12.6\frac{1}{m})(5.98m)}}{2(-12.6\frac{1}{m})}$$

$$= \frac{-1 \pm 17.4}{-25.2}m = \frac{1 \mp 17.4}{25.2}m = \boxed{0.73m}$$

#6



Find W by each F on backpack.

$W = Fd\cos\theta$

F	θ	$\cos\theta$
F_p	60°	$\frac{1}{2}$
F_N	90°	0
F_g	90°	0
F_{f_K}	180°	-1

$$W_{F_p} = \overset{?}{F_p}\,\overset{\checkmark}{d}\,\overset{\checkmark}{\cos 60°}$$

$W_{F_N} = 0$

$W_{F_g} = 0$

$\mu_K \cdot F_N$

$$W_{F_{f_K}} = F_{f_K}\,\overset{\checkmark}{d}\,\overset{\checkmark}{\cos 180°}$$

Since v = const, $\vec{a} = 0$.

$$\sum F_x = 0$$

$$\underset{?}{F_{pull_x}} - \underset{\underset{?}{\mu_K F_N}}{F_{fK}} = 0$$

$$\sum F_y = 0$$

$$\underset{?}{F_{pull_y}} + \underset{?}{F_N} - mg = 0$$

$$F_p \cos 60° = \mu_k F_N \qquad F_p \sin 60° + F_N = mg$$

$$F_p = \frac{\mu_k F_N}{\cos 60°}$$

$$\frac{\sin}{\cos} = \tan$$

$$\mu_k F_N \tan 60° + F_N = mg$$

$$F_N = \frac{mg}{\mu_k \tan 60° + 1} = \frac{9.4\,\text{kg}\ 9.8\frac{\text{m}}{\text{s}^2}}{0.34 \tan 60° + 1}$$

$$F_N = 58\,\text{N}$$

$$F_p = \frac{0.34\,(58\,\text{N})}{\cos 60°} \leftarrow \frac{\mu_k F_N}{\cos 60°}$$

$$= 39.4\,\text{N}$$

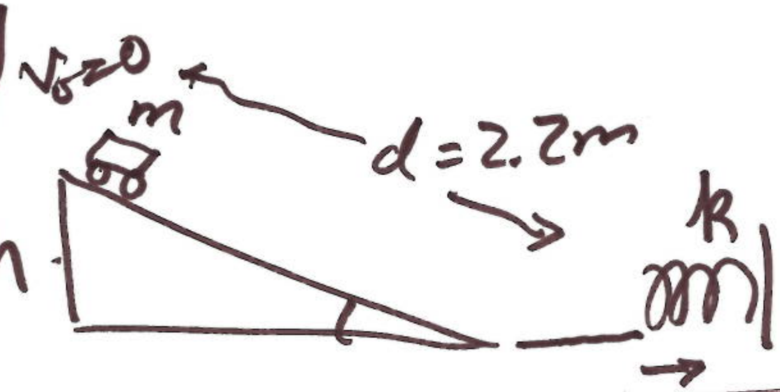
$$W_{F_p} = 39.4\,\text{N}\,(3.3\,\text{m}) \cos 60°$$

$$= 65\,\text{J}$$

$$W_{F_{f_k}} = \underset{F_N}{58\,\text{N}}\,(0.34)\,(3.3\,\text{m})\,\overbrace{(\cos 180°)}^{-1}$$

$$= -65\,\text{J}$$

#7



$\theta = 5.1^\circ$ $\boxed{\Delta x = ★ ?}$

$m = 0.567\,kg$ $k = 444 \frac{N}{m}$.

Neglect friction.

$$\Sigma E_f - \Sigma E_0 = W_{NC}$$

$$U_e - U_g = 0$$

$$\frac{1}{2}k(\Delta x)^2 - mgh = 0$$

$$h = d\sin\theta$$

$$\sin\theta = \frac{h}{d}$$

$$(\Delta x)^2 = \frac{mg\,d\sin\theta}{\frac{1}{2}k}$$

$$(\Delta x)^2 = \frac{0.567\,kg\left(9.8\frac{m}{s^2}\right)\overset{2.2m}{\downarrow}\sin 5.1^\circ}{222\,N/m \leftarrow \frac{k}{2}}$$

$$\Delta x = 0.0\overset{70}{\cancel{47}}\,m$$

$$= \underset{7.0}{\cancel{4.7}}\,cm \quad (OK)$$