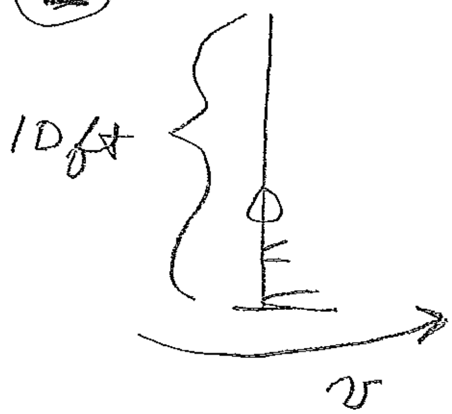
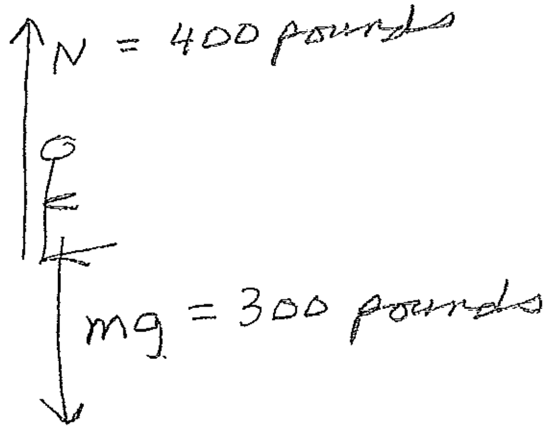
Solutions to HWK 4

1





Since the swing has 2 ropes, the total force that the seat can exert on Shaquille is $2(200) = 400$ pounds. (N in the figure)

So the maximum upward Net Force on Shaquille is $400 - 300 = 100$ pounds.

His acceleration is $\frac{v^2}{r}$, so

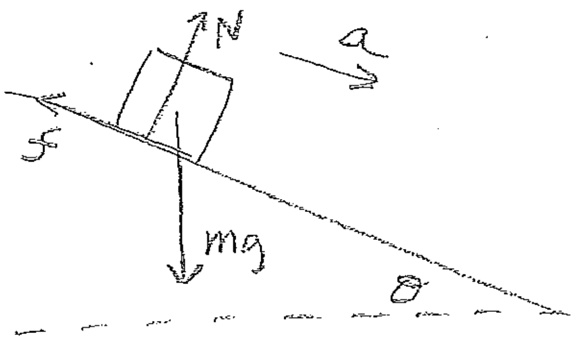
$$100 \text{ pounds} = \frac{mv^2}{r}$$

$$100 \text{ pounds} = \frac{mg\,v^2}{gr} = 300 \text{ pounds}\left(\frac{v^2}{gr}\right)$$

$$v^2 = \frac{gr}{3}$$

$$v_{max} = \sqrt{\frac{(32)(10)}{3}} = \boxed{10.3 \text{ ft/s}}$$

(2)



as shown in lecture:

$N = mg\cos\theta$

$f = \mu mg\cos\theta$

$$ma = mg\sin\theta - \mu mg\cos\theta$$

$$a = g(\sin\theta - \mu\cos\theta)$$

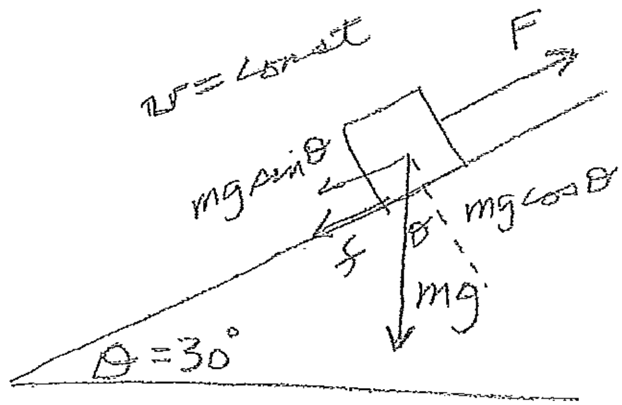
$$\frac{g}{3} = g(\sin 30^\circ - \mu\cos 30)$$

$$\mu = \frac{\sin 30 - \frac{1}{3}}{\cos 30} = \frac{\frac{1}{2} - \frac{1}{3}}{\sqrt{3}/2} = \boxed{\frac{1}{3\sqrt{3}}}$$

or $\boxed{\mu = .192}$

③ The first two figures allow us to determine the coefficient of friction

$$\mu = \frac{f}{N} = \frac{60}{100} = \boxed{.6}$$



Since v = constant, the net force on the block is zero,

$$F = mg\sin\theta + f$$

but $f = \mu N = \mu mg\cos\theta$

So

$$F = mg\sin\theta + \mu mg\cos\theta$$

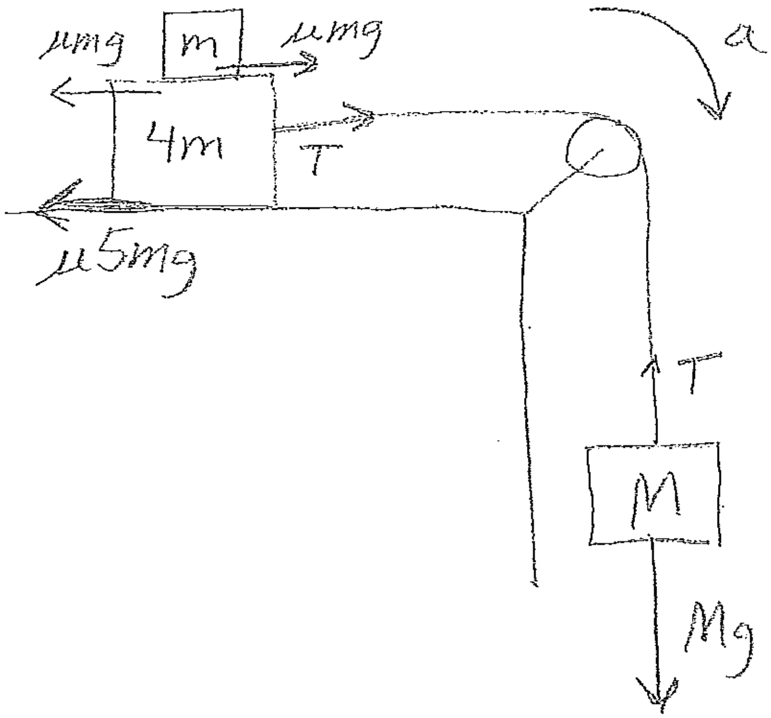
From experiment a), $\boxed{mg = 100}$

So

$$F = 100\sin 30 + .6(100)\cos 30$$

$$F = \boxed{50 + 30\sqrt{3}} \approx \boxed{102 \text{ units}}$$

(4)



Top block:

$$\boxed{\mu mg = m a_{max}}$$

4m block:

$$\boxed{T - \mu mg - \mu 5mg = 4m a_{max}}$$

Hanging Block:

$$\boxed{Mg - T = M a_{max}}$$

adding the equations gives

$$Mg - \mu 5mg = (5m + M) a_{max}$$

From Top block equation $a_{max} = \mu g$

So

$$Mg - \mu 5mg = (5m + M)\mu g$$

$$M - 5\mu m = 5\mu m + \mu M$$

$$M = \frac{10\mu m}{1-\mu} = \frac{10(.6)m}{1-.6} = \boxed{15m}$$

Solutions to Fourth Homework
PHY131

(5)

(a) $K.E. = \frac{80\,\text{Kg}}{2}\left(10\,\frac{m}{s}\right)^2 = \boxed{4000\,J}$

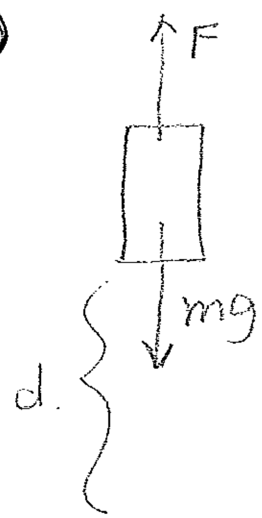
(b) $100\,\text{mph} = 100\,\text{mph}\left(\frac{.447\ m/s}{1\ \text{mph}}\right) = 44.7\ m/s$

$K.E. = \frac{(.255\,\text{Kg})}{2}\left(44.7\,m/s\right)^2 = \boxed{255\,J}$

(c) $70\,\text{mph} = 70\,\text{mph}\left(\frac{.447\ m/s}{1\ \text{mph}}\right) = 31.3\ m/s$

$K.E. = \frac{1500\,\text{Kg}}{2}\left(31.3\,m/s\right)^2 = \boxed{734{,}000\,J}$

(6)



$|\vec{a}| = g/5$

$\vec{a}\downarrow$

$\boxed{W_{grav} = mgd}$

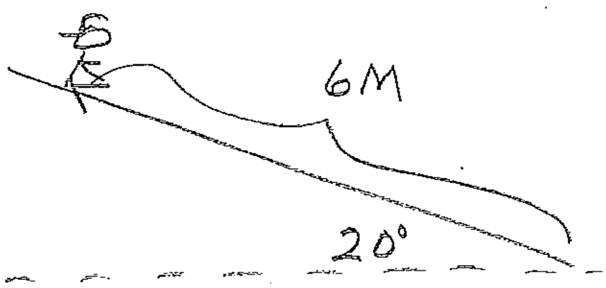
$mg - F = ma$

$mg - F = m\left(\frac{g}{5}\right)$

$F = \frac{4}{5}mg$

$W_{ROPE} = \left(\frac{4}{5}mg\right)d\cos 180^\circ = \boxed{-\frac{4}{5}mgd}$

7



a) Work done by gravity

$W = mg\,\Delta Y$

$W_{gravity} = 40(9.8)\,6 \sin 20°$

$$\boxed{W_{gravity} = 804\text{ J}}$$

(b) Net Work = change in K.E.

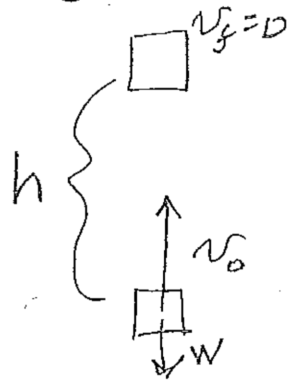
$804\text{ J} + W_{friction} = \frac{m}{2}v_f^2 - \frac{m}{2}v_i^2$

$804\text{ J} + W_{friction} = \frac{40}{2}(3)^2 = 180\text{ J}$

$$\boxed{W_{friction} = -624\text{ J}}$$

8

(a)



Net work = change in K.E.

$$W_{gravity} + W_{friction} = 0 - \frac{m}{2} v_0^2$$

$$-Wh - fh = -\frac{m}{2} v_0^2$$

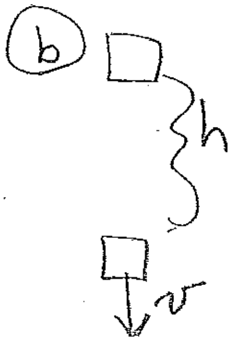
$$h(W + f) = \frac{m}{2} v_0^2$$

$$hw\left(1 + \frac{f}{W}\right) = \frac{m}{2} v_0^2$$

$$h \cancel{m} g\left(1 + \frac{f}{W}\right) = \frac{\cancel{m}}{2} v_0^2$$

$$\boxed{h = \frac{v_0^2}{2g\left(1 + \frac{f}{W}\right)}}$$

(b)



On the way down,

$$W_{gravity} + W_{friction} = \Delta(K.E.)$$

$$wh - fh = \frac{m}{2} v^2$$

$$v^2 = \frac{2h}{m}(w - f)$$

$$v^2 = \frac{2}{m} \frac{v_0^2}{2g\left(1 + \frac{f}{w}\right)}(w - f)$$

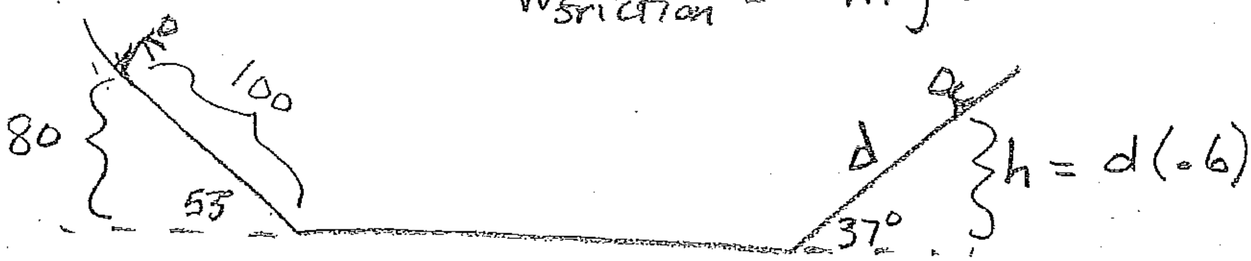
$$v^2 = v_0^2 \frac{(w - f)}{(w + f)}$$

$$\boxed{v = v_0 \sqrt{\frac{(w - f)}{(w + f}}}$$

(9)

(a) The work done by friction in crossing the parking lot once is: $-mg\mu(50\text{M})$

$$W_{friction} = -mg\,30$$



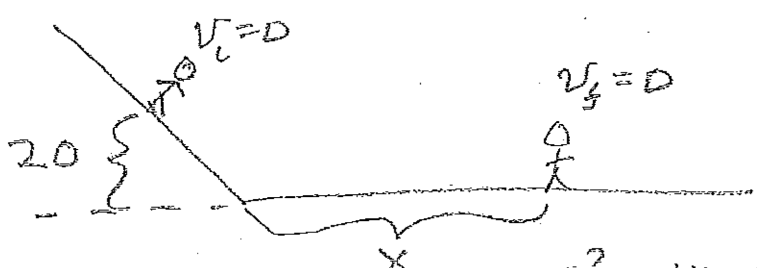
$$\text{Net Work} = \Delta(\text{K.E.})$$

$$W_{grav.} + W_{frict} = 0 - 0 = 0$$

$$mg(80-h) - mg\,30 = 0$$

$$\boxed{h = 50} \quad \text{so} \quad d = \frac{50}{.6} = \boxed{83.3 \text{ ft up the hill}}$$

(b) She loses 30mg of energy each time she crosses the parking lot. After going back and forth, she has $80mg - 2(30mg) = 20mg$



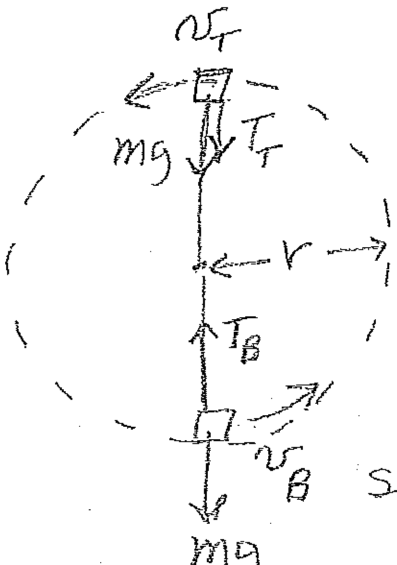
$$\text{NET WORK} = \frac{m}{2}v_f^2 - \frac{m}{2}v_i^2 = 0 - 0 = 0$$

$$W_{grav} + W_{frict} = 0$$

$$20mg - mg(.6)x = 0$$

$$x = \frac{20}{.6}\text{ m} = \boxed{33.3\text{ m}} \text{ from the left hill}$$

(10)



$$T_T + mg = \frac{m v_T^2}{r}$$

$$T_B - mg = \frac{m v_B^2}{r}$$

Subtracting the ~~equations~~ gives

$$T_B - T_T - 2mg = \frac{m}{r}\left(v_B^2 - v_T^2\right)$$

Since gravity is the only force doing work:

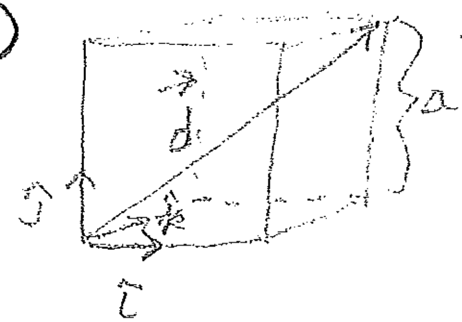
$$\frac{m}{2}v_B^2 - \frac{m}{2}v_T^2 = W_g = mg(2r)$$

$$\underbrace{m\left(v_B^2 - v_T^2\right)} = 4mgr$$

$$T_B - T_T = \frac{4mgr}{r} + 2mg$$

$$\boxed{T_B - T_T = 6mg}$$

(18)



the diagonal vector $\vec{d}$:

$\vec{d} = a\hat{i} + a\hat{j} + a\hat{k}$

$\vec{d} \cdot \hat{i} = |\vec{d}||\hat{i}| \cos\alpha$

$a = \sqrt{3}\, a \cos\alpha$

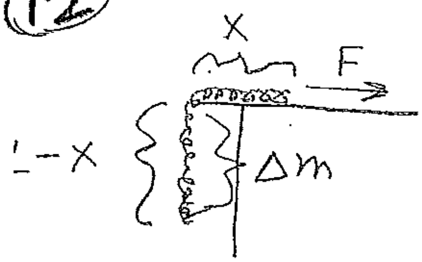
$|\vec{d}| = \sqrt{a^2+a^2+a^2}$

$= \sqrt{3}\, a$

So $\boxed{\cos\alpha = \frac{1}{\sqrt{3}}}$

$\boxed{\alpha = 54.7^\circ}$

(12)



$F = (\text{hanging mass})\, g$

$F = (\Delta m)\, g$

$\frac{\Delta m}{m} = \frac{L-x}{L}$

$\Delta m = m\left(\frac{L-x}{L}\right)$

$F = \frac{mg}{L}(L-x)$

$W = \int_{L/4}^{L} F\, dx$

$W = \int_{L/4}^{L} \frac{mg}{L}(L-x)\, dx$

$W = \frac{mg}{L}\left(Lx - \frac{x^2}{2}\right)\Big|_{L/4}^{L} = \frac{mg}{L}\left(L\left(\frac{3L}{4}\right) - \frac{\left(L^2 - L^2/16\right)}{2}\right)$

$$\boxed{W = mgL\,\frac{9}{32}}$$