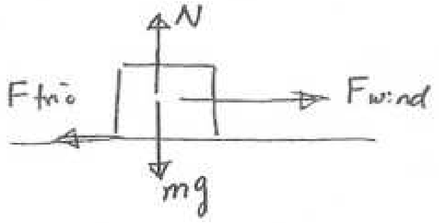
ch. 6 # 4, 7, 8, 20, 21, 26, 35, 49, 52, 53

#4



$m = 20\,kg$

$\mu_k = 0.8$

$\underline{x}$

$F_{wind} - F_{tric} = m\cancel{a}^{0}$ — ①

$F_{wind} - N\mu_k = 0$

$\underline{y}$

$N - mg = 0$

$\therefore N = mg$ — ②

① ← ②

$F_{wind} - mg\,\mu_k = 0$

$F_{wind} = mg\,\mu_k = 20\,kg \cdot 9.81\,m/sec^2 \cdot 0.8$

$= \underline{\underline{156.96\,N}}$

#35

(a) Eqn. 6-14 $D = \frac{1}{2}C\rho A V^2$ where $C = 0.8$; $\rho = 1.21\,kg/m^3$ and $A = 0.040\,m^2$ in this case.

So this drag force (156.96 N from #4) has to come from the force of wind — moving air particles.

Solve Eqn. 6-14 for V.

$$D = \frac{1}{2}C\rho A V^2$$

$$\therefore V = \sqrt{\frac{2D}{C\rho A}} = \sqrt{\frac{2 \cdot 156.96\,N}{0.8 \cdot 1.21 \cdot 0.04}} = 90.041\,m/sec$$

$$= \underline{324.15\,km/hr}$$

(b) $324.15\,km/hr \times 2 = \underline{\underline{648.30\,km/hr}}$ (402.67 mi/hr)

It is impossible w/ this given condition.

the error occured in #4 & #32 is μ_k of the day.

Clay is very slick when wet. It should've been 0.15 for μ_k.

If this was the case, the ans. for (a) is 99.25 km/hr ... little less than

[illegible]

53

(a)

F needed for a rock $156.96\,N$ (from #4)

F needed for 100 rocks $156.96\,N \times 100 = 15696\,N$

F needed for the ice sheet (Eqn. is the same as #4)

$$F = \overset{\mu_k}{0.1}\,\overset{m}{(400_m \times 500_m \times 20\times10^{-3}_m \times 917\,kg/m^3)} \cdot \overset{g}{9.81}$$

$$= 791661.6\,N$$

Total Force Needed $15696\,N + 791661.6\,N = \underline{735357.6\,N}$

Since $D = 4\,C_{ice}\,\rho\,A_{ice}\,V^2$

$$V = \sqrt{\frac{D}{4\,C_{ice}\,\rho\,A_{ice}}}$$

$$= \sqrt{\frac{735357.6}{4 \cdot 2\times10^{-3} \cdot 1.21 \cdot 400\times500}}$$

$$= 19.48931684\ m/sec = \underline{\underline{70.16\ km/hr}}$$

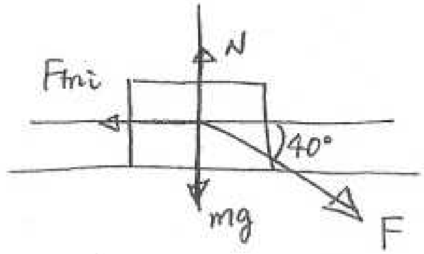
(b)

$70.16\ km/hr \times 2 = \underline{\underline{140.32}}\ km/hr$

(c)

This is possible and reasonable.

\# 7



$m = 3.5\,kg$

$F = 15\,N$

$\theta = 40°$

$\mu_k = 0.25$

Don't forget the y-comp of F.

x

$F\cos 40° - F_{fric} = ma$.

$\therefore F\cos 40° - N\mu_k = ma$ — ①

y

$N - mg - \underbrace{F\sin 40°}_{\downarrow} = 0$

$\therefore N = mg + F\sin 40°$ — ②

(a) Since $F_{fric} = N\mu_k \leftarrow$ ②

$= (mg + F\sin 40°)\,0.25$

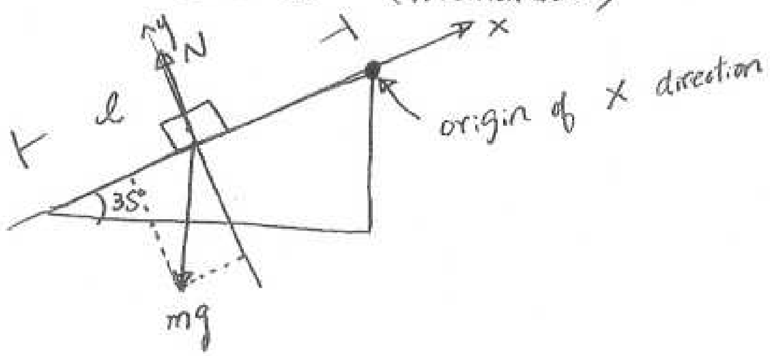
$= \underline{\underline{10.994\,N}}$ — ②′

(b) ① ← ②′

$F\cos 40° - 10.994\,N = ma$

$\therefore a = \dfrac{F\cos 40° - 10.994\,N}{m} = \underline{\underline{0.1418\ m/sec^2}}$

\# 8 case I (frictionless)



x

$F_x = m a_x = -mg\sin\theta$

$\therefore a_x = -g\sin\theta$ — ①

$V_x = -gt\sin\theta$ — ②

$X = -\frac{1}{2}gt^2\sin\theta$ — ③

y

$F_y = -mg\cos\theta + N$

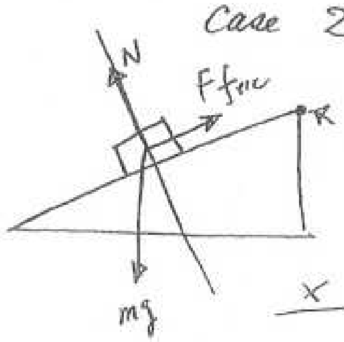
$\therefore a_y = -g\cos\theta + \frac{N}{m} = 0$ — ④

Eqn. ③ $X = -l$ (start at the top. Hence the dist. is negative)
Solve for t

$$-\ell = -\frac{1}{2} g t^2 \sin\Theta$$

$$t = \sqrt{\frac{2\ell}{g\sin\Theta}} \quad \text{——} \quad ③'$$

Case 2 (w/ friction)



once again, this is the origin

x

$$F_x = -mg\sin\Theta + F_{fric}$$

$$\downarrow$$

$$ma_x = -mg\sin\Theta + N\mu_k \quad — ⑤$$

y

$$F_y = -mg\cos\Theta + N = 0$$

$$\therefore N = mg\cos\Theta \quad — ⑥$$

$$⑤ \leftarrow ⑥$$

$$ma_x = -mg\sin\Theta + \mu_k mg\cos\Theta$$

$$a_x = -g\sin\Theta + \mu_k g\cos\Theta = g(-\sin\Theta + \mu_k\cos\Theta) \quad — ⑤'$$

$$V_x = \int a_x \cdot dt' = gt'(-\sin\Theta + \mu_k\cos\Theta) \quad \text{——} \quad ⑦$$

$$x = \int v_x \cdot dt = \frac{1}{2} g t^2 (-\sin\Theta + \mu_k\cos\Theta) \quad \text{——} \quad ⑧$$

Eqn. ⑧. $x = -\ell$

$$-\ell = \frac{1}{2} g t'^2 (-\sin\Theta + \mu_k\cos\Theta) \quad \text{——} \quad ⑧'$$

since $t' = 2t$ (frictionless takes a half time)

$$⑧' \leftarrow ③'$$

$$-\ell = \frac{1}{2} g \left(2\sqrt{\frac{2\ell}{g\sin\Theta}}\right)^2 (-\sin\Theta + \mu_k\cos\Theta)$$

$$-\cancel{\ell} = \frac{1}{\cancel{2}} \cancel{g} \left(4 \frac{\cancel{2}\cancel{\ell}}{\cancel{g}\sin\Theta}\right)(-\sin\Theta + \mu_k\cos\Theta)$$

$$-1 = \frac{4}{\sin\Theta}(-\sin\Theta + \mu_k\cos\Theta)$$

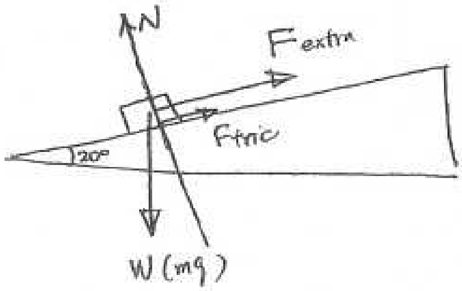
$$-\frac{\sin\Theta}{4} + \sin\Theta = \mu_k\cos\Theta$$

$$\mu_k = \frac{\frac{3}{4}\sin\Theta}{\cos\Theta}$$

$$= \underline{\underline{0.525}}$$

(0.52615563)

#20



$W = mg = 80\,N$

$\mu_s = 0.25$

$\mu_k = 0.15$

6-5

(a)

$\underline{x}$

$F_{extra} + F_{fric} - mg\sin\theta = 0$

$F_{extra} + N\mu_s - mg\sin\theta = 0$ —— ①

$\underline{y}$

$N - mg\cos\theta = 0$

$\therefore N = mg\cos\theta$ —— ②

① ⟵ ②

$F_{extra} + (mg\cos\theta)\mu_s - mg\sin\theta = 0$

$\therefore F_{extra} = mg\sin\theta - mg\,\mu_s\cos\theta$

$= mg(\sin\theta - \mu_s\cos\theta) = \underline{\underline{8.57\,N}}\ (8.56775905)$

(b) In order for the sled to move upward, the force has to break the friction (downward). So the eqns. become

$\underline{F_x}$

$-mg\sin\theta - F_{fric} + F = 0$

$\therefore -mg\sin\theta - N\mu_s + F = 0$ —— ①

$\underline{F_y}$

$N - mg\cos\theta = 0$

$N = mg\cos\theta$ —— ②

① ⟵ ②

$-mg\sin\theta - \mu_s mg\cos\theta + F = 0$

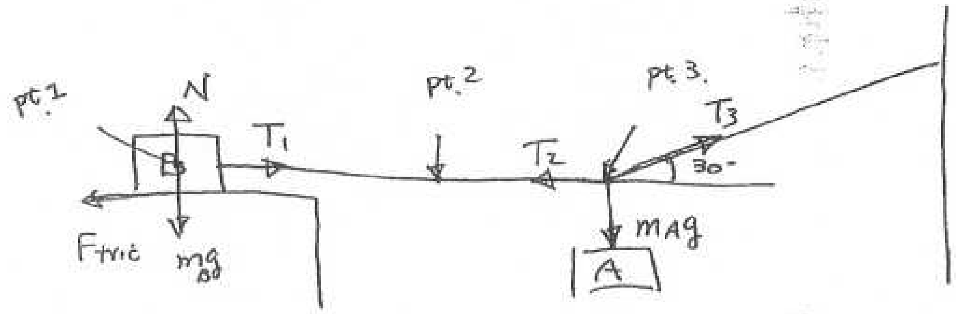
$F = mg\sin\theta + \mu_s mg\cos\theta$

$= mg(\sin\theta + \mu_s\cos\theta) = \underline{\underline{46.16\,N}}\ (46.15546388\,N)$

(c) Once the sled starts moving, the coeff. is μ_k. Eqns. are all the same in (b) except for μ_k

$\therefore F = mg(\sin\theta + \mu_k\cos\theta) = \underline{\underline{38.64\,N}}\ (38.63792292)$

#21



pt 1

x

$-F_{fric} + T_1 = 0$

$\therefore -N\mu_s + T_1 = 0$ — ①

y

$N - m_B g = 0$

$\therefore N = m_B g$ — ②

① ← ②

$-m_B g \mu_s + T_1 = 0$

$\therefore T_1 = m_B g \mu_s$ — ①'

pt 2

$T_1 - T_2 = 0$

$\therefore T_1 = T_2$

pt. 3

x

$-T_2 + T_3 \cos 30° = 0$ — ③

y

$T_3 \sin 30° - m_A g = 0$ — ④

③ ← ①'

$-m_B g \mu_s + T_3 \cos 30° = 0$

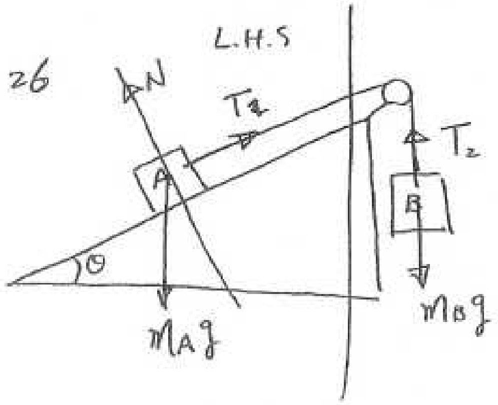
$\therefore T_3 = \dfrac{m_B g \mu_s}{\cos 30°}$ — ③'

④ ← ③'

$\dfrac{m_B g \mu_s}{\cos 30°} - m_A g = 0$

$\therefore m_A = \dfrac{m_B g \mu_s}{g \cos 30°} = \underline{\underline{102.624 N}}$

26



$m_A = 10\,kg$

$\theta = 30°$

$\mu_k = 0.2$

L.H.S.

X comp

$-m_A g \sin\theta + T_1 + F_{fric} = m\cancel{a}^{0}$

$\therefore -m_A g \sin\theta + T_1 + N\mu_k = 0$ — ①

y comp

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

$\therefore N = m_A g \cos\theta$ — ②

$T_1 = T_2$ — ③

R.H.S

X comp

None

y

$-m_B g + T_2 = 0$

$T_2 = m_B g$ — ④

① ← ②, ③ & ④

$-m_A g \sin\theta + m_B g + m_A g \cos\theta \cdot \mu_k = 0$

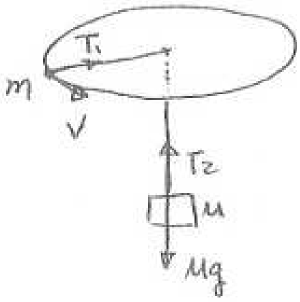
Solve for m_B

$m_B g = m_A g \sin\theta - m_A g \mu_k \cos\theta$

$= m_A g(\sin\theta - \mu_k \cos\theta)$

$\therefore m_B = 10(\sin\theta - \mu_k \cos\theta) = \underline{\underline{3.27\,kg}}$ (3.267949192...)

49



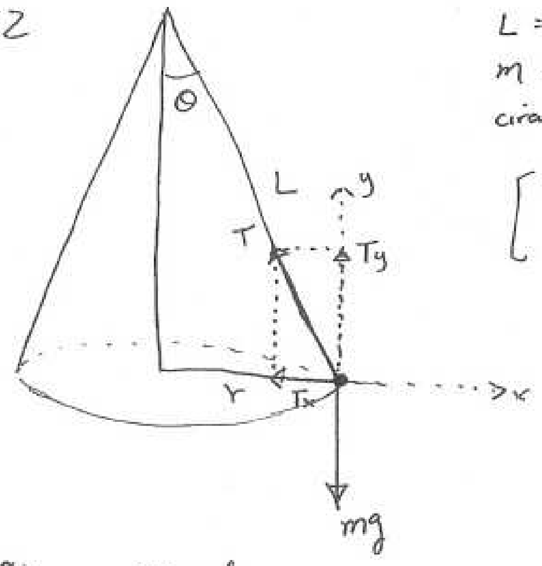
$F_{centri} = T_1 = m\frac{v^2}{r}$

This force comes from the weight of M via tension of a cord. Hence $T_1 = T_2$

$m\frac{v^2}{r} = Mg$

$$\therefore v = \sqrt{\frac{Mgr}{m}}$$

#52



$L = 0.90\ m$

$m = 0.040\ kg$

circumference $= 0.94\ m = 2\pi r$

Note:

[T_y cancels mg & T_x is the centripetal force]

X comp

$$-T\sin\theta = F_{centr} = -\frac{mv^2}{r} \quad \text{——— ①}$$

y comp

$$T\cos\theta - mg = 0 \quad \text{——— ②}$$

(a) Circumference $= 0.94\ m = 2\pi r$

$$\therefore r = \frac{0.94\ m}{2\pi} \quad \text{——— ③}$$

Also $$\theta = \sin^{-1}\frac{r}{L} = \sin^{-1}\frac{\frac{0.94\ m}{2\pi}}{0.9\ m} = 9.568607737^\circ \quad \text{——— ④}$$

② ← ④, solve for T

$$T = \frac{mg}{\cos\theta} = \frac{0.040\ kg \cdot 9.81\ m/sec^2}{\cos(9.5686^\circ\cdots)} = \underline{\underline{0.397936384\ N}}$$

(b) student way: ① ← ③′ solve for v

$$V = \sqrt{\frac{T\sin\theta\, r}{m}} = 0.497397456\ m/sec \quad \text{——— ①′}$$

$$P = \frac{2\pi r}{V} = \frac{2\pi r}{0.49\cdots} = \underline{\underline{1.889836765\ sec}}$$

(Seems easy enough. However, there are so many numbers you must calculate and write them down. If you mistype on a calculator, you have to retype — waste of time!)

Takashi way: $V = \sqrt{\frac{T\sin\theta\, r}{m}}$ & $P = \frac{2\pi r}{V}$

$$\therefore P = \frac{2\pi r}{\sqrt{\frac{T\sin\theta\, r}{m}}} = 2\pi\sqrt{\frac{r^{\cancel{2}}\cdot m}{T\sin\theta\, \cancel{r}}} = 2\pi\sqrt{\frac{r\cdot m}{\frac{mg}{\cos\theta}\sin\theta}} \qquad \left(T = \frac{mg}{\cos\theta}\right)$$

$$= 2\pi\sqrt{\frac{r}{g\tan\theta}} = 2\pi\sqrt{\frac{r}{g\cdot\frac{r}{L}}} = 2\pi\sqrt{\frac{L}{g}}$$

The last eqn. does not contain any # calculated in part (a). All givens. The point is "try to reduce as much as possible before you plug in #'s.

Also, just for fun check the eqn. 15-28 in ch. 15, P. 396. We derived the eqn. without knowing it!