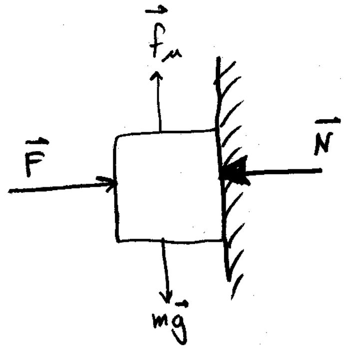


Ch 6, Q 4

(a) $\vec{f}_\mu$ points u

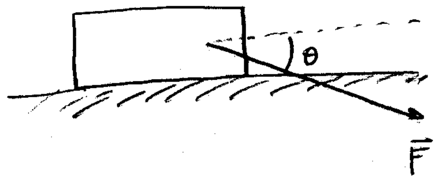
(b) $\vec{N}$, perpendicular to the wall, and out from it.

(c) f_s remains the same, just so as to equilibrate the weight $m\vec{g}$

(d) N increases, to equilibrate F

(e) $f_{s,max} = \mu_s N$ increases

Ch 6, Q 5



(a) F_x decreases

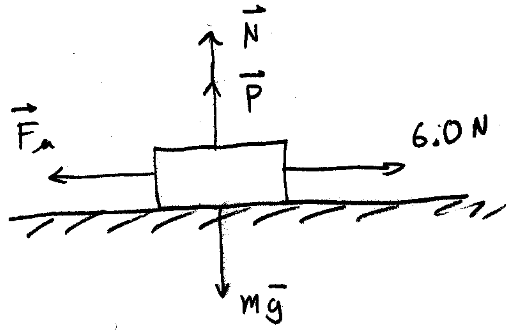
(b) f_s decreases ($f_s = F_x$)

(c) N increases ($N = mg + F_y$)

(d) $f_{s,max}$ $(= \mu_s N)$ increases

(e) f_k increases.

Ch 6 P10



$\mu_s = 0.40$

$\mu_k = 0.25$

$F_{\mu,max} = \mu N$

$\Sigma F_y = N + P - mg = 0$

$N = mg - P$

$F_{\mu,max} = \mu_s (mg - P)$

If $F_{\mu,max} > 6$ N block doesn't move. $F_\mu = 6.0$ N.

If $F_{\mu,max} < 6$ N block moves. Use $F_{\mu,k} = \mu_k N$

(a) $F_{\mu,max} = (0.40)(24.5 - 8)$ N $= 6.6$ N > 6 N doesn't move. $\Rightarrow \boxed{F_\mu = 6.0\text{N}}$ to the left

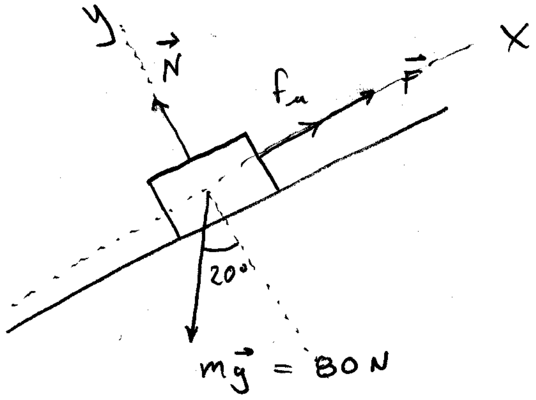
(b) $F_{\mu,max} = (0.40)(24.5 - 10)$ N $= 5.8$ N < 6 N moves

$F_{\mu,k} = \mu_k N = 0.25\,(mg - P) = \boxed{3.6\text{ N}}$ to the left

(c) From part (b) we know it moves

$F_{\mu,k} = \mu_k N = 0.25\,(mg - P) = \boxed{3.1\text{N}}$ to the left.

Ch 6, P18



$\mu_s = 0.25$

$\mu_k = 0.15$

(a) So that F is minimum, we want the friction force f_μ pointing up the incline, and we want it to be $f_{\mu,max}$.

$$\Sigma F_x = f_{\mu,max} + F - mg \sin 20° = 0$$

$$F = 80N \sin 20° - f_{\mu,max}$$

$$F = 80N \sin 20° - \mu_s |\vec{N}|$$

$$F = 80N \sin 20° - (0.25)\underbrace{(80N \cos 20°)}_{|\vec{N}|}$$

$$\boxed{F = 8.6\ N}$$

(b) f_μ will now point opposite to the motion

$$\Sigma F_x = F - f_{\mu,max} - mg \sin 20° = 0$$ we are right **before** motion begins.

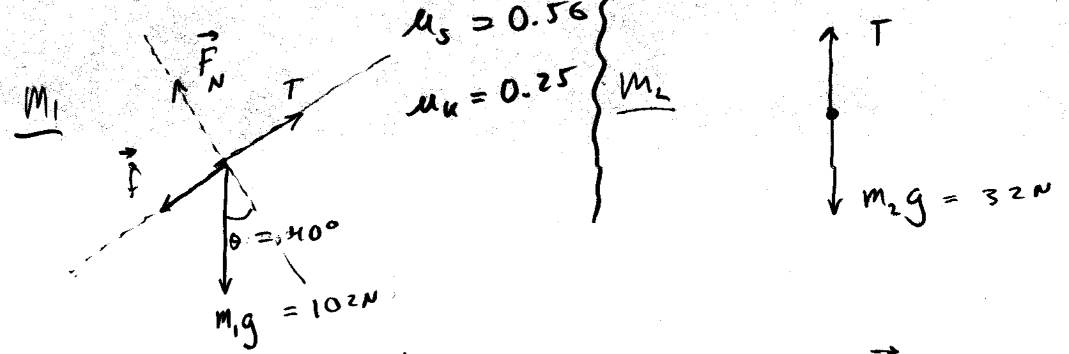
$$f_{\mu,max} = N\mu_s = mg \cos 20° \mu_s$$

$$F = mg(\mu_s \cos 20° + \sin 20°)$$ ✻

$$\boxed{F = 46\ N}$$

(c) Once it's moving, the friction is kinetic, pointing down the incline, so we can use ✻ with μ_s replaced by μ_k

$$F = mg(\mu_k \cos 20° + \sin 20°) = \boxed{39\ N}$$



(a) Assume there is a $\overbrace{\text{friction}}^{\text{static}}$ force $\vec{f}_s$ pointing downhill which forbids motion $(a=0)$

m_1 $\quad \sum F_x = T - f - m_1 g \sin\theta$

m_2 $\quad \sum F_y = m_2 g - T = 0$

$$m_2 g - f - m_1 g \sin\theta = 0$$

$$f = m_2 g - m_1 g \sin\theta$$

$$f = -34\,N$$ (the minus sign tells us $\vec{f}$ points uphill)

Now, the maximum possible f is $f_{max} = f_{s,max} = N \mu_s$

$$f_{max} = (m_1 g \cos 40°)(0.56) = 43 < |f|$$

Because the $|f| < f_{max}$, if the body starts at rest, it remains at rest. $\Rightarrow$ $\boxed{a = 0}$

(b) Because the block is moving up, friction points down. ...... ✡

m_1: $\quad \sum F_x = T - f - m_1 g \sin\theta = m_1 a$

$$T - \mu_k F_N - m_1 g \sin\theta = m_1 a \quad (1)$$

$$T - \mu_k m_1 g \cos\theta - m_1 g \sin\theta = m_1 a \quad (2).$$

m_2: $\quad \sum F_y = m_2 g - T = m_2 a \Rightarrow T = m_2 g - m_2 a$

(2) into (1) $\quad m_2 g - m_2 a - \mu_k m_1 g \cos\theta - m_1 g \sin\theta = m_1 a$

$$\frac{1}{m_1+m_2}\left(m_2 g - \mu_k m_1 g \cos\theta - m_1 g \overbrace{}^{\sin\theta}\right) = a$$

$$a = \frac{9.8\,m/s^2}{(134)\,N}\left[32 - (0.25)(102)\cos 40° - \overbrace{102}^{\sin 40°}\right] N \quad (3)$$

$$\boxed{a = -3.9\,m/s^2}$$

the $\underline{m_1}$ is slowing down as it moves uphill.

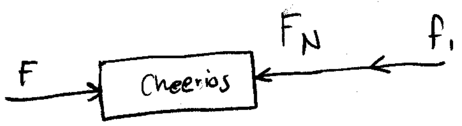
(c) The only change here it's going to be the sign of f in equation ✲. This will only change the sign of the term with cos 40° in (3).

$$a = \frac{9.8\,m/s^2}{134\,N}\left[32 + (0.25)(102)\cos 40° - 102\sin 40°\right] N$$

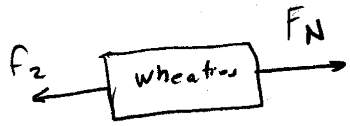
$$\boxed{a = -1.0\,m/s^2}$$

so the block $\underline{m_1}$ is moving faster and faster as it moves downhill.

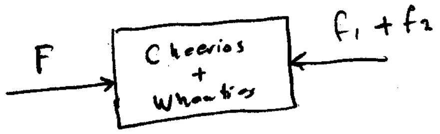
Ch 6, P 24



$F - F_N - f_1 = m_1 a$ ①



$F_N - f_2 = m_2 a$ ②



$F - f_1 - f_2 = (m_1 + m_2) a$ ③

$F = 12\ N$

$f_1 = 2\ N$

$f_2 = 4\ N$

$F_N = ?$

$m_1 = 1\ kg$

$m_2 = 3\ kg$

③ $\Rightarrow$ $a = \dfrac{F - f_1 - f_2}{m_1 + m_2} = \dfrac{(12 - 2 - 4)\ N}{1\ kg + 3\ kg}$

$a = 1.5\ m/s^2$

plug a into ②

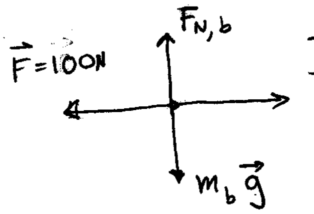
$F_N = m_2 a + f_2 = (3\ kg)(1.5 \frac{m}{s^2}) + 4\ N$

$\boxed{F_N = 8.5\ N}$

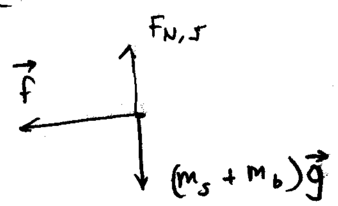
[① was never used]

Ch 6, P27

block



slab



$F_{N,b}$ = normal force on block

$F_{N,s}$ = " " " slab

m_s = mass of slab = 40 kg

m_b = " " block = 10 kg

$\vec{f}$ = friction force

$\mu_s = 0.60$

$\mu_k = 0.40$

assume there is no sliding, so that accelerations are the same $a \equiv a_b = a_s$.

block $\sum F_x = 100N - f = m_b a_b$ (1)

slab $\sum F_x = f = m_s a_s$ (2)

$100N - \cancel{m_s a} = m_b a + m_s a$

$a = \dfrac{100N}{m_s + m_b} = 2\ m/s^2$

$f = m_s a = (40kg)\ 2m/s^2$

$f = 80\ N$

the $f_{max} = F_{N,b}\,\mu_s = m_b\, g\, \mu_s$

$f_{max} = 59N < f = 80N \Rightarrow$ It's impossible to avoid sliding

$\Downarrow$

accelerations are different and we have kinetic friction.

(1) $\Rightarrow$ $100\,N - f = m_b a_b$ $\qquad f = \mu_k F_{N,b} = \mu_k m_b g$

$$\frac{1}{m_b}\left(100N - \mu_k m_b g\right) = \cancel{m_b} a_b$$

$$a_b = \frac{1}{10kg}\left[100\,N - (0.40)(10\,kg)(9.8\,\tfrac{m}{s^2})\right]$$

$$\boxed{a_b = 6.1\ m/s^2}$$

(2) $\Rightarrow$ $a_s = \dfrac{f}{m_s} = \dfrac{\mu_k m_b g}{m_s} =$

$$\boxed{a_s = 0.98\ m/s^2}$$

Ch 14. Q3

All of the forces on M $\underbrace{\text{cancel}}_{\text{the central}}$, except for the one due to $3M$.

$$F = G\frac{m_1 m_2}{r^2} = G\frac{(3M)(M)}{d^2} = \boxed{\frac{G\,3M^2}{d^2}}$$

to the left.

Ch 14, P4

$$\frac{F_{sun}}{F_{earth}} = \frac{\cancel{G}\frac{m_s \cancel{M_m}}{r_{sm}^2}}{\cancel{G}\frac{m_e \cancel{M_m}}{r_{em}^2}} = \frac{m_s}{m_e}\left(\frac{r_{em}}{r_{sm}}\right)^2$$

$$= \frac{1.99\times10^{30}}{5.98\times10^{24}}\left(\frac{3.82\times10^{8}}{1.5\times10^{11}}\right)^2$$

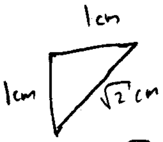
$$\boxed{\frac{F_{sun}}{F_{earth}} = 2.16}$$

Ch 14, P9

Forces due to the 500 kg masses cancel.

$$F = G\left[\frac{300\,m_s}{d^2} - \frac{100\text{ kg}\,m_s}{d^2}\right] = \frac{G\,m_s}{d^2}(200\text{ kg})$$

$$= \left(6.67\times10^{-11}\frac{N\,\cancel{m^2}}{\cancel{kg^2}}\right)\left(\frac{250\,\cancel{kg}}{2\times10^{-4}\,\cancel{m^2}}\right)(200\,\cancel{kg})$$



$d = \sqrt{2}$ cm

$1^2+1^2 = 2$

$d^2 = 2\text{ cm}^2$

$= 2\times10^{-4}\text{ m}^2$

$$\boxed{F = 0.017\text{ N}}$$

at $45°$ from the positive x axis. [i.e., toward the 300 kg mass]