Ch 6, Q 4

(a) $\vec{f}_n$ points up
(b) $\vec{N}$, perpendicular to the wall, and out from it.
(c) $f_s$ remains the same, just so as to equilibrate the weight $mg$
(d) $N$ increases, to equilibrate $F$
(e) $f_{s,\text{max}} = \mu_s N$ increases

Ch 6, Q 5

(a) $F_x$ decreases ($f_s = F_x$)
(b) $f_s$ decreases ($N = mg + F_y$)
(c) $N$ increases ($N = mg + F_y$)
(d) $f_{s,\text{max}} (= \mu_s N)$ increases
(e) $F_x$ increases
\( \mu_s = 0.40 \)
\( \mu_k = 0.25 \)

\[ F_{\mu, \text{max}} = \mu N \]

\[ \sum F_y = N + P - mg = 0 \]
\[ N = mg - P \]

\[ F_{\mu, \text{max}} = \mu_s (mg - P) \]

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

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

(a) \( F_{\mu, \text{max}} = (0.40)(24.5 - 8)N = 6.6 \text{ N} > 6 \text{ N} \) \( \Rightarrow \) to the left

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

\( F_{\mu, k} = \mu_k N = 0.25 (mg - P) = 3.6 \text{ N} \)

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

\( F_{\mu, k} = \mu_k N = 0.25 (mg - P) = 3.1 \text{ N} \) to the left.
(a) So that $F$ is minimum, we want the friction force $f_k$ pointing up the incline, and we want it to be $f_{k, \text{max}}$

$\Sigma F_x = f_{k, \text{max}} + F - mg \sin 20^\circ = 0$

$F = 80 \text{ N} \sin 20^\circ - f_{k, \text{max}}$

$F = 80 \text{ N} \sin 20^\circ - \mu_s |\overrightarrow{N}|$

$F = 80 \text{ N} \sin 20^\circ - (0.25)(80 \text{ N} \cos 20^\circ)$

$F = 8.6 \text{ N}$

(b) $f_k$ will now point opposite to the motion

$\Sigma F_x = F - f_{k, \text{max}} - mg \sin 20^\circ = 0$  \hspace{1cm} \text{we are right before motion begins.}$

$f_{k, \text{max}} = \mu_s N = mg \cos 20^\circ \mu_s$

$F = mg (\mu_s \cos 20^\circ + \sin 20^\circ)$

$F = 46 \text{ N}$

(c) Once it's moving, the friction is kinetic, pointing down the incline, so we can use \( \mu_k \) with $\mu_s$ replaced by $\mu_k$

$F = mg (\mu_k \cos 20^\circ + \sin 20^\circ) = 39 \text{ N}$
(a) Assume there is a friction force pointing downhill which forbids motion (a=0)

\[ \sum F_x = T - f - m_2 g \sin \theta \]
\[ m_2 g - f - m_2 g \sin \theta = 0 \]
\[ f = m_2 g - m_2 g \sin \theta \]
\[ f = -3.4 \text{ N} \]

Now, the maximum possible f is \( f_{\text{max}} = (m_2 g \cos 40^\circ)(0.56) = 4.4 \text{ N} \)

Because the \( |f| < f_{\text{max}} \), it remains at rest.

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

\[ \sum F_x = T - f - m_1 g = m_1 a \]
\[ T - m_1 g = \frac{m_1 a}{\sin \theta} \]
\[ T - m_1 g \cos \theta - m_1 g = m_1 a \]
\[ T = m_2 g - m_2 a \]

\[ \sum F_y = m_2 g - T = m_2 a \Rightarrow T = m_2 g - m_2 a \]
\[ m_2 g - m_2 a - m_2 m_1 g \cos \theta - m_1 g = m_1 a \]
\[
\frac{1}{m_1 + m_2} \left( m_2 g - m_1 \nu \cos \theta - m_1 g \right) = a
\]

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

\[
a = -3.9 \text{ m/s}^2
\]

The only change here is going to be the sign of \( f \) in equation (3). This will only change the sign of the term with \( \cos 40^\circ \) in (3).

So the block \( m_1 \) is moving faster and faster as it moves downhill.

\[
a = -1.0 \text{ m/s}^2
\]
\[ F - F_N - f_i = m_1 a \]

\[ F_N - f_c = m_2 a \]

\[ F = 12 \text{ N} \]
\[ f_i = 2 \text{ N} \]
\[ f_c = 4 \text{ N} \]
\[ F_F = ? \]
\[ m_1 = 1 \text{ kg} \]
\[ m_2 = 3 \text{ kg} \]

\[ a = 1.5 \text{ m/s}^2 \]

plug \( a \) into (2):

\[ F_N = m_2 a + f_c = (3 \times 3) \left(1.5 \frac{m}{s^2}\right) + 4N \]

\[ F_N = 8.5 \text{ N} \]

\[ (1) \text{ was never used} \]
block

\[ \text{FN}_b = \text{normal force on block} \]
\[ \text{FN}_s = \text{slab} \]
\[ m_s = \text{mass of slab} = 40 \text{ kg} \]
\[ m_b = \text{block} = 10 \text{ kg} \]
\[ f = \text{friction force} \]

\[ \Sigma F_x = 100N - f = m_b a_b \]
\[ 100N = m_s a_s \]
\[ a = \frac{100N}{m_s + m_b} = 2 \text{ m/s}^2 \]
\[ f = m_s a_s = (40 \text{ kg}) \times 2 \text{ m/s}^2 \]
\[ f = 80 \text{ N} \]

the \[ f_{\text{max}} = \text{FN}_b m_s = 100 \text{ m/s}^2 m_s \]
\[ f_{\text{max}} = 500 \text{ N} < f = 80 \text{ N} \Rightarrow \text{It's impossible to avoid sliding} \]

\[ \nabla \text{accelerators are different and we have kinetic friction.} \]
\[ f = m_b a_b \]

\[ f = M_k F_{n,b} = M_k m_b g \]

\[ \frac{1}{m_b} (100N - M_k m_b g) = m_b a_b \]

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

\[ a_b = 6.1 \text{ m/s}^2 \]

\[ a_s = \frac{f}{m_s} = \frac{M_k m_b g}{m_s} = \]

\[ a_s = 0.98 \text{ m/s}^2 \]
Ch 14, Q 3

All of the forces except for the one due to $3M$ cancel:

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

to the left.

Ch 14, P 4

$$F_{sum} = \frac{G \frac{M_5 M_6}{V_{im}^2}}{\frac{m_5 m_6}{V_{em}^2}} = \frac{M_5}{M_6} \left( \frac{V_{em}}{V_{im}} \right)^2$$

$$= \frac{1.99 \times 10^{20}}{5.98 \times 10^{24}} \left( \frac{3.82 \times 10^8}{1.5 \times 10^{11}} \right)^2$$

$$F_{sum} = 2.16$$

Ch 14, P 9

Forces due to the 500 kg masses cancel.

$$F = G \left[ \frac{300 \text{ m}}{d^2} - \frac{100 \text{ kg} \text{ m}^5}{d^2} \right] = \frac{6 \text{ m}^5}{d^2} (200 \text{ kg})$$

$$= (6.67 \times 10^{-11} \text{ N m}^2/\text{kg}^2) \left( \frac{250 \text{ kg}}{2 \times 10^{-4} \text{ m}} \right) (200 \text{ kg})$$

$$F = 0.017 \text{ N} \quad \text{at} \ 45^\circ \text{ from the positive x-axis}$$

[i.e., toward the 200 kg mass]