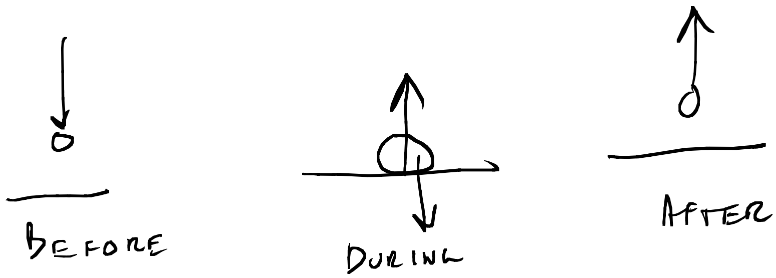
HOMEWORK 4 SOLUTIONS

Note Title 1/3/2006

C6.) THE REACTION FORCE EXERTED BY THE GROUND.



C7.) AS THE BUS BRAKES, THE OBJECTS IN IT WILL WISH TO CONTINUE MOVING IN THE DIRECTION THE BUS WAS GOING. THEREFORE, A LOOSE OBJECT WILL SLIDE FORWARD IN A BUS, NOT BACKWARD. THE JUDGE SHOULD RULE IN FAVOR OF THE BUS COMPANY.

C11.) THIS IS THE CORRECT VERSION OF THE PREVIOUS SITUATION. AS THE BUS MOVES FORWARD, OBJECTS AT REST WILL TRY TO REMAIN AT REST, THUS MOVING BACKWARD IN THE BUS.

4.3 $w = (2\text{ tons})\left(\dfrac{2000\text{ lbs}}{1\text{ ton}}\right)\left(\dfrac{4.448\text{ N}}{1\text{ lb}}\right) = \boxed{2\times10^4\text{ N}}.$

4.4 $w = (38\text{ lbs})\left(\dfrac{4.448\text{ N}}{1\text{ lb}}\right) = \boxed{1.7\times10^2\text{ N}}.$

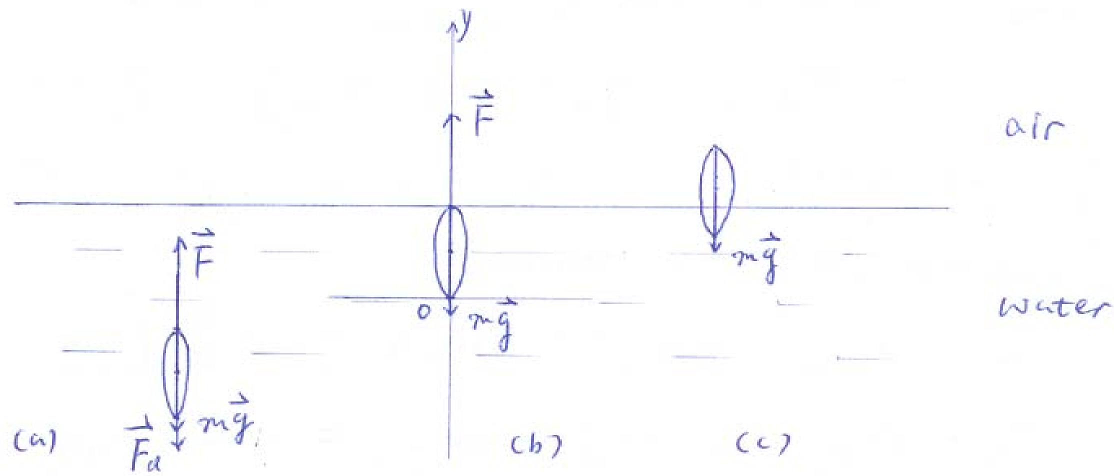
8 Since the force is assumed constant, the bullet traveling down the barrel of the rifle can be viewed as a motion of constant acceleration in one dimension. Thus, using the equation $2a \cdot \Delta x = v_f^2 - v_i^2$, where $\Delta x = 0.82\,m$, $v_i = 0$ and $v_f = 320\,m/s$. $\Rightarrow$

$$a = \frac{v_f^2 - v_i^2}{2\Delta x} = \frac{(320\,m/s)^2 - 0}{2 \times 0.82\,m} = 6.2 \times 10^4\,m/s^2$$

Based on the law of acceleration:

$$F = ma = 5.0g\,\frac{1kg}{1000g} \cdot 6.2 \times 10^4\,m/s^2 = \boxed{310\,N}$$

9



Choosing upward as positive, when the salmon is under the water as (a) shows, it has a constant $\vec{v} = +3.0\,m/s$. Thus, its original acceleration $\vec{a}_i = 0$. The Newton's second law gives

$$\sum_i \vec{F}_i = \vec{F} + \vec{F_d} + m\vec{g} = F - F_d - mg = 0$$

3

From the head of the fish breaks the surface (as (b) shows) to 2/3 of the fish's length has left the water (as (c) shows) , the fish experiences the distance

$\Delta y = 2/3\, l = 2/3 \times 1.5\,m = 1.0\,m$.

$\because\ 2a\Delta y = v_f^2 - v_i^2 \quad \therefore\ a = \dfrac{v_f^2 - v_i^2}{2\Delta y}$

where $v_f = 6.0\,m/s$, $v_i = 3.0\,m/s$

$\therefore\ a = \dfrac{(6.0\,m/s)^2 - (3.0\,m/s)^2}{2 \times 1.0\,m} = +13.5\,m/s^2$ upward

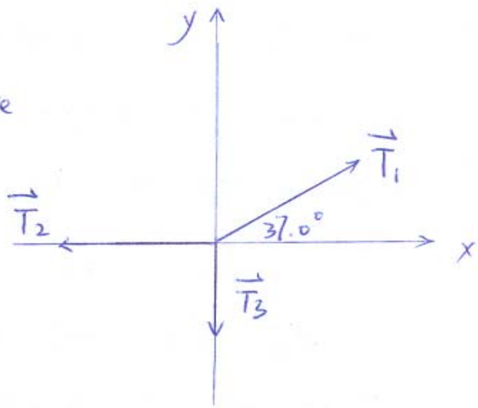
During this time :

$\sum_i \vec{F}_i = \vec{F} + m\vec{g} = F - mg = ma$

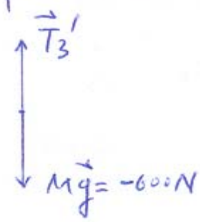
$\therefore\ F = m(a+g) = 61\,kg\,(13.5\,m/s^2 + 9.8\,m/s^2)$

$= \boxed{1.4 \times 10^3\,N}$

15 Choose right to be the positive x direction and upward the positive y direction as the Figure on the right shows.



First we anbysis the forces on the cat burglar:



There are two forces on him, both of which are along y direction.

$$\vec{T_3}' + M\vec{g} = 0 \Rightarrow \vec{T_3}' = -M\vec{g} = 600N \text{ of } +y \text{ direction}$$

Thus, we can get the value of $\vec{T_3}$:

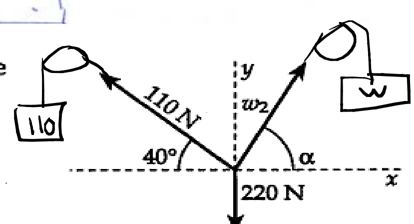
$$\vec{T_3} = -\vec{T_3}' = 600N \text{ of } -y \text{ direction}$$

Since $\sum_i \vec{T_i} = 0$, $\Rightarrow$

$$\left.\begin{aligned} T_{1x} + T_{2x} + T_{3x} &= -T_2 + T_1 \cdot \cos 37.0° = 0 \\ T_{1y} + T_{2y} + T_{3y} &= T_1 \sin 37.0° - T_3 = 0 \end{aligned}\right\} \Rightarrow$$

$$\boxed{\begin{aligned} T_1 &= 997N \text{ above } x\text{-direction } 37.0° \\ T_2 &= 796 N \text{ of } -x \text{ direction} \\ T_3 &= 600 N \text{ of } -y \text{ direction} \end{aligned}}$$

4.18 If the hip exerts no force on the leg, the system must be in equilibrium with the three forces shown in the free-body diagram.



Thus $\Sigma F_x = 0$ becomes

$$w_2 \cos\alpha = (110 \text{ N})\cos 40° \quad (1)$$

From $\Sigma F_y = 0$, we find

$$w_2 \sin\alpha = 220 \text{ N} - (110 \text{ N})\sin 40° \quad (2)$$

Dividing Equation (2) by Equation (1) yields

$$\alpha = \tan^{-1}\left(\frac{220 \text{ N} - (110 \text{ N})\sin 40°}{(110 \text{ N})\cos 40°}\right) = \boxed{61°}$$

Then, from either Equation (1) or (2), $w_2 = \boxed{1.7 \times 10^2 \text{ N}}$.

4.25 (a) The average acceleration is given by

$$\bar{a} = \frac{v_f - v_i}{\Delta t} = \frac{5.00 \text{ m/s} - 20.0 \text{ m/s}}{4.00 \text{ s}} = -3.75 \text{ m/s}^2 .$$

The average force is found from the second law as

$$\overline{(\Sigma F)} = m\bar{a} = (2000 \text{ kg})(-3.75 \text{ m/s}^2) = \boxed{-7.50 \times 10^3 \text{ N}}.$$

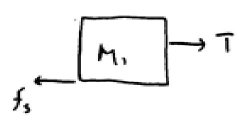
(b) The distance traveled is:

$$x = \bar{v}(\Delta t) = \left(\frac{5.00 \text{ m/s} + 20.0 \text{ m/s}}{2}\right)(4.00 \text{ s}) = \boxed{50.0 \text{ m}}.$$

36.) SEE p. 111.

$\boxed{36.)}$ (con't) $m_1 = 10$ kg , $m_2 = 4.0$ kg , $\mu_s = 0.5$, $\mu_k = 0.3$

(a)



$T = m_2 g = 39.2$ N

$f_s = \mu_s n_1$, $n_1 = m_1 g$

$f_s = \mu_s m_1 g = (0.5)(10 \text{ kg})(9.8 \text{ m/s}^2) = 49$ N

Then, since $f_s > T$, the system will not accelerate when released from rest.

$\boxed{\text{Thus, } a = 0}$ For the system to accelerate, T must overcome the force of static friction

(b) In this case, we assume that the system is already in motion.

$f_k = \mu_k n_1 = \mu_k m_1 g = (0.3)(10 \text{ kg})(9.8 \text{ m/s}^2) = 29.4$ N

We can see that $f_k < T$, so the system accelerate.
In particular

$\Sigma F = T - f_k = m_{total}\, a$ $\qquad m_{total} = m_1 + m_2$

$\Rightarrow a = \frac{T - f_k}{m_1 + m_2} = \frac{9.8 \text{ N}}{14 \text{ kg}} = 0.7 \text{ m/s}^2$

$\boxed{\text{The acceleration of the system is then } a = 0.7 \text{ m/s}^2}$

4.37 (a) Since the crate has constant velocity, $a_x = a_y = 0$.

Applying Newton's second law:

$$\Sigma F_x = F\cos 20.0° - f_k = ma_x = 0, \text{ or } f_k = (300 \text{ N})\cos 20.0° = 282 \text{ N}$$

and $\Sigma F_y = n - F\sin 20.0° - w = 0$, or

$$n = (300 \text{ N})\sin 20.0° + 1000 \text{ N} = 1.10\times 10^3 \text{ N}.$$

The coefficient of friction is then $\mu_k = \dfrac{f_k}{n} = \dfrac{282 \text{ N}}{1.10\times 10^3 \text{ N}} = \boxed{0.256}$.

(b) In this case, $\Sigma F_y = n + F\sin 20.0° - w = 0$,

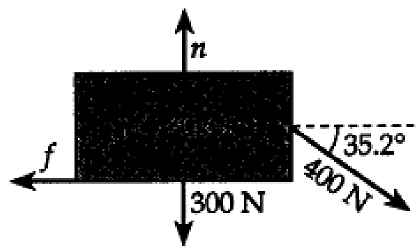
so $n = w - F\sin 20.0° = 897 \text{ N}$.

The friction force now becomes $f_k = \mu_k n = (0.256)(897 \text{ N}) = 230 \text{ N}$.

Therefore, $\Sigma F_x = F\cos 20.0° - f_k = ma_x = \left(\dfrac{w}{g}\right)a_x$ and the acceleration is

$$a = \frac{(F\cos 20.0° - f_k)g}{w} = \frac{[(300 \text{ N})\cos 20.0° - 230 \text{ N}](9.80 \text{ m/s}^2)}{1000 \text{ N}} = \boxed{0.509 \text{ m/s}^2}$$

4.42 In the vertical direction, we have



$$n - 300 \text{ N} - (400 \text{ N})\sin 35.2° = 0$$

from which, $n = 531$ N.

Therefore, $f = \mu_k n = (0.570)(531 \text{ N}) = 302 \text{ N}$.

From applying the second law to the horizontal motion, we have

$$(400 \text{ N})\cos 35.2° - 302 \text{ N} = (30.6 \text{ kg})a_x, \text{ yielding } a_x = 0.798 \text{ m/s}^2$$

Then, from $\Delta x = v_{ix}t + \frac{1}{2}a_x t^2$, we have $4.00 \text{ m} = 0 + \frac{1}{2}(0.798 \text{ m/s}^2)t^2$, which gives $t = \boxed{3.17 \text{ s}}$.

4.46 (a) The force of friction is found as $f = \mu_k n = \mu_k(mg)$.

Choose the positive direction of the x-axis in the direction of motion and apply the second law. We have $-f = ma_x$, or $a_x = \dfrac{-f}{m} = -\mu_k g$.

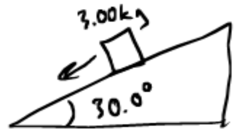
From $v^2 = v_i^2 + 2a(\Delta x)$, with $v = 0$, $v_i = 50.0 \text{ km/h} = 13.9 \text{ m/s}$, we find

$$0 = (13.9 \text{ m/s})^2 + 2(-\mu_k g)(\Delta x), \text{ or } \quad \Delta x = \frac{(13.9 \text{ m/s})^2}{2\mu_k g}. \qquad (1)$$

With $\mu_k = 0.100$, this gives $\Delta x = \boxed{98.6 \text{ m}}$.

(b) With $\mu_k = 0.600$, Equation (1) above gives $\Delta x = \boxed{16.4 \text{ m}}$.

(47)

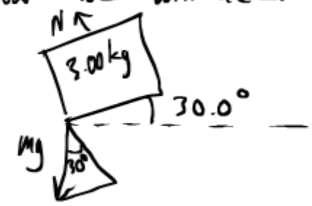


a) Since the block starts from rest, we have $V_0 = 0$

Then we have: $2.00\,m = \frac{1}{2} a (1.50s)^2$

$$\frac{4.00\,m}{(1.50s)^2} = \boxed{1.778 \frac{m}{s^2} \text{ down the ramp}}$$

b) Now we will need to diagram the forces on the block:



normal: $mg \cos 30° = 9.8 \frac{m}{s^2} \cdot (3.00kg) \cos 30° = 25.46N$

downward: $mg \sin 30° = (9.8 \frac{m}{s^2})(3.00kg) \sin(30°) = 14.7N$

We know the block is accelerating at $1.778 \frac{m}{s^2}$

From $F=ma$, $F = (3.00kg)(1.778 \frac{m}{s^2}) = 5.334N$ downward

We know gravity pulls downward at $14.7N$

This means friction must push up at $14.7N - 5.334N = 9.366N$

And the normal force is $25.46N$

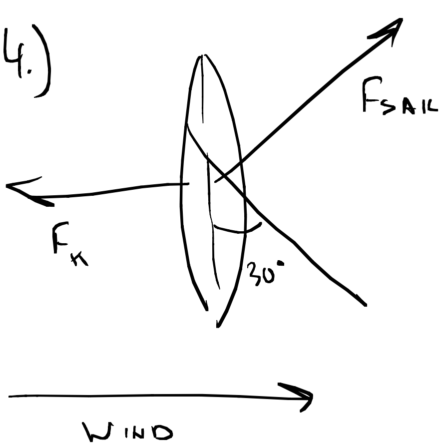
So that $25.46 \cdot \mu = 9.366N \Rightarrow \mu = .368$, $\boxed{\text{so the coefficient of friction is } 0.368}$

c) We already found that the friction force is $\boxed{9.37\,N}$

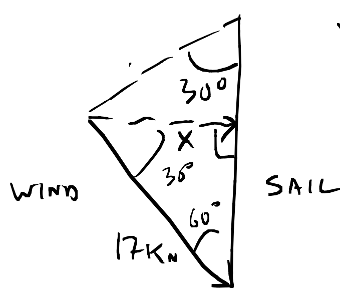
d) We know the block accelerates (from rest) at $1.778 \frac{m}{s^2}$ for a time of $1.50s$

$V = at = 1.778 \frac{m}{s^2} \cdot 1.50s = \boxed{2.67 \frac{m}{s}}$

54.)



WE NEED TO CALCULATE THE ⊥ COMPONENT OF THE WIND.



$X = \sin(60°) \cdot 17$ KNOTS.

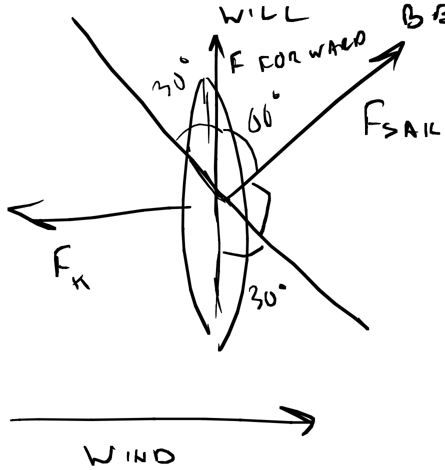
$= 14.7$ KNOTS

THE FORCE IS THEN

$$F_{SAIL} = 550 \frac{N}{m/s}(14.7\text{ KNOTS}) = \frac{550\ N}{m/s} \cdot 14.7\text{ KNOT} \cdot .514 \frac{m/s}{\text{KNOT}}$$

$$= 4155\ N$$

BECAUSE THE KEEL PREVENTS THE BOAT FROM MOVING SIDEWAYS, THE INITIAL ACCEL. WILL BE THE NORTHERN COMPONENT OF F_{SAIL}.



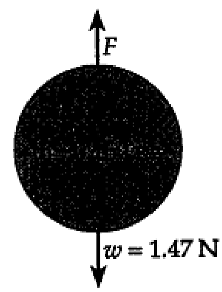
THE FORWARD FORCE IS THEN

$$F_{SAIL}(\cos 60°) = \frac{4155\ N}{2} = 2077.5\ N$$

$F = ma$, $m = 800$ Kg, SO

$$a = 2.6\ m/s^2 \text{ NORTH.}$$

4.56 The acceleration of the ball is found from



$$a = \frac{v^2 - v_i^2}{2(\Delta y)} = \frac{(20.0\ \text{m/s})^2 - 0}{2(1.50\ \text{m})} = 133\ \text{m/s}^2$$

From the second law, $\Sigma F_y = F - w = ma$, so

$$F = w + ma = 1.47\ \text{N} + (0.150\ \text{kg})(133\ \text{m/s}^2) = \boxed{21.5\ \text{N}}.$$

4.57 On the level surface, the normal force exerted on the sled by the ice equals the total weight, or $n = 600$ N. Thus, the friction force is

$$f = \mu_k n = (0.050)(600\ \text{N}) = 30\ \text{N}.$$

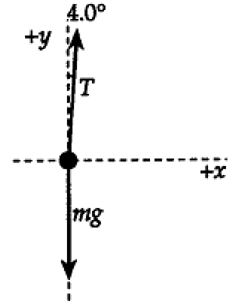
Hence, the second law yields $\Sigma F_x = -f = ma_x$, or

$$a_x = \frac{-f}{m} = \frac{-f}{w/g} = \frac{-(30\ \text{N})(9.80\ \text{m/s}^2)}{600\ \text{N}} = -0.49\ \text{m/s}^2.$$

The distance the sled travels on the level surface before coming to rest is

$$\Delta x = \frac{v^2 - v_i^2}{2a_x} = \frac{0 - (7.0\ \text{m/s})^2}{2(-0.49\ \text{m/s}^2)} = \boxed{50\ \text{m}}.$$

4.68 In the vertical direction, we have



$$\Sigma F_y = T\cos 4.0° - mg = 0\text{, or}\qquad T = \frac{mg}{\cos 4.0°}.$$

In the horizontal direction, the second law becomes:

$$\Sigma F_x = T\sin 4.0° = ma\text{, so}$$

$$a = \frac{T\sin 4.0°}{m} = g\tan 4.0° = \boxed{0.69\ \text{m/s}^2}.$$