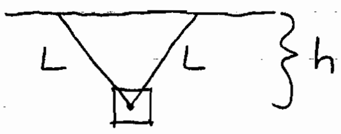
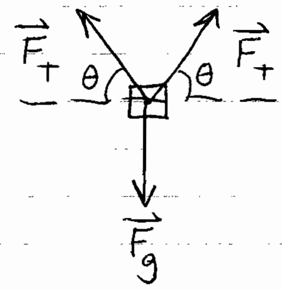
PH 211 - Chapter 06 Homework Solutions

3) $m = 20.0\,kg$ $\quad h = 2.00\,m$ $\quad L = 3.00\,m$ $\quad F_T = ?$ $\quad g = 9.80\,m/s^2$



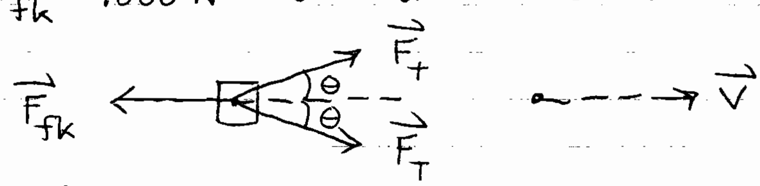


$$\Sigma \vec{F}_y = (+F_T \sin\theta) + (+F_T \sin\theta) + (-F_g) = 0 \qquad 2F_T \sin\theta = F_g$$

$$F_T = \frac{mg}{2\sin\theta} \qquad \sin\theta = \frac{opp}{hyp} = \frac{h}{L} \qquad F_T = \frac{mg}{2(h/L)} = \frac{mgL}{2h}$$

$$F_T = \frac{(20.0)(9.80)(3.00)}{2(2.00)} = 147\,N$$

4) $F_{fk} = 1000\,N$ $\quad 2\theta = 20.0^\circ$ $\quad \theta = 10.0^\circ$ $\quad F_T = ?$



$$\Sigma \vec{F}_x = (+F_T \cos\theta) + (+F_T \cos\theta) + (-F_{fk}) = 0 \qquad 2F_T \cos\theta = F_{fk}$$

$$F_T = \frac{F_{fk}}{2\cos\theta} = \frac{(1000)}{2\cos(10.0^\circ)} = 508\,N$$

6) $m = 2.00\,kg$

(a) $\Sigma \vec{F}_x = (5.00) + (-1.00) + (-3.00\sin 20.0^\circ) = 2.974\,N = m\vec{a}_x$

$\vec{a}_x = (2.974)/(2.00) = 1.49\,m/s^2$

$\Sigma \vec{F}_y = (2.82) + (-3.00\cos 20.0^\circ) \cong 0 \qquad \vec{a}_y = 0$

(b) $\Sigma \vec{F}_x = (-3.00) + (2.00)\cos 15.0^\circ + (2.00)\sin 15.0^\circ = -0.551\,N = m\vec{a}_x$

$\vec{a}_x = (-0.5505)/(2.00) = -0.275\ m/s^2$

$\Sigma \vec{F}_y = (1.414) + (2.00)\sin 15.0^\circ + (-2.00)\cos 15.0^\circ \cong 0$

$\vec{a}_y = 0$

8) $t = 1.00s$ $\quad \vec{a}_x = \frac{d\vec{v}_x}{dt} = \text{slope} = \frac{12-0}{3-0} = 4.00\ m/s^2$

$\vec{F}_{net} = \Sigma \vec{F} = m\vec{a} = (2.00)(4.00) = 8.00\,N$

$t = 4.00s$ $\quad a_x = \frac{d\vec{v}_x}{dt} = \text{slope} = 0$ $\quad \vec{F}_{net} = \Sigma \vec{F} = m\vec{a} = 0.$

$t = 7.00s$ $\quad \vec{a}_x = \frac{d\vec{v}_x}{dt} = \text{slope} = \frac{0-12}{8-6} = -6.00\ m/s^2$

$\vec{F}_{net} = \Sigma \vec{F} = m\vec{a} = (2.00)(-6.00) = -12.0\,N$

9) $0 \le t \le 3.00s$ $\quad \vec{x}_i = 0$ $\quad \vec{v}_{ix} = 0$ $\quad \vec{F}_{net} = \Sigma \vec{F} = \vec{F}_x = 4.00\,N$

$\vec{a}_x = \frac{\vec{F}_x}{m} = \frac{4.00}{2.00} = 2.00\ m/s^2$ $\quad \vec{v}_{fx} = \vec{v}_{ix} + \vec{a}_x \Delta t = 0 + (2.00)(3.00)$

$\vec{v}_{fx} = 6.00\ m/s$

$3.00s \le t \le 5.00s$ $\quad \vec{v}_{ix} = 6.00\,m/s$ $\quad \vec{F}_x = -2.00\,N$

$\vec{a}_x = \frac{\vec{F}_x}{m} = \frac{(-2.00)}{2.00} = -1.00\ m/s^2$ $\quad \vec{v}_{fx} = \vec{v}_{ix} + \vec{a}_x \Delta t = (6.00) + (-1.00)(2.00)$

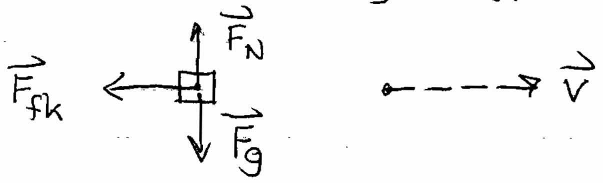
$\vec{v}_{fx} = 4.00\,m/s$

After $t = 5.00s$, the net force is zero so the object doesn't accelerate after $t = 5.00s$. Therefore, at $t = 6.00s$, the object's velocity is $4.00\,m/s$ and its acceleration is $0\ m/s^2$.

14) $m = 55.0\,kg$ $\quad$ (a) $\vec{F}_g = m\vec{g} = (55.0)(9.80) = 539\,N$

(b) Her mass is the same. Mass doesn't depend on the location of the object. $\vec{F}_g = m\vec{g} = (55.0)(1.62) = 89.1\,N$

23) $m = 50{,}000\ \text{kg}$ $\quad \vec{v}_{ix} = +10.0\ \text{m/s}$ $\quad \Delta x = ?$ $\quad \vec{v}_{fx} = 0$



$$\Sigma \vec{F}_x = (-F_{fk}) = m\vec{a}_x$$

$$\Sigma \vec{F}_y = (+F_N) + (-F_g) = 0 \qquad F_N = mg$$

$$F_{fR} = \mu_R F_N = \mu_R mg$$

$$-\mu_R mg = m\vec{a}_x = -ma \qquad a = \mu_R g$$

$v_{fx}^2 = v_{ix}^2 \pm 2a\Delta x$ (Use minus sign since locomotive is decelerating.)

$$0 = v_{ix}^2 - 2a\Delta x \qquad \Delta x = \frac{v_i^2}{2a} = \frac{}{2\mu_R g} \qquad \mu_R = 0.002$$

$$\Delta x = \frac{(10.0)^2}{2(0.002)(9.80)} = 2{,}550\ \text{m} = 2.55\ \text{km} = 2.55 \times 10^3\ \text{m}$$

27) $\vec{v}_{ix} = 0 \qquad 0 \le t \le 4.00\ \text{s} \qquad \vec{F}_x = \frac{10-0}{4-0}t + 0 = 2.5t$

$$\vec{a}_x = \frac{\vec{F}_x}{m} = \frac{2.5t}{5.0} = \frac{t}{2}$$

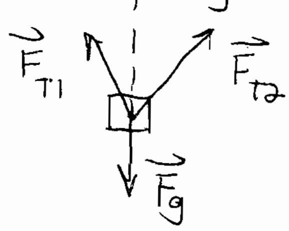
$$\vec{v}_x = \int \vec{a}_x\,dt = \int \frac{t}{2}\,dt = \frac{t^2}{4} + C = \frac{t^2}{4} + \vec{v}_{ix} = \frac{t^2}{4} + 0 = \frac{t^2}{4}$$

$$\vec{v}_x(t = 4.00\ \text{s}) = \frac{(4.00)^2}{4} = 4.00\ \text{m/s}$$

After $t = 4.00$ s, the net force is zero, the object no longer accelerates and its velocity remains constant.

$$\vec{v}_x(t = 6.00\ \text{s}) = \vec{v}_x(t = 4.00\ \text{s}) = 4.00\ \text{m/s}$$

29) $m = 1000\ \text{kg}$



$$\Sigma \vec{F}_x = (F_{T2}\sin 30^\circ) + (-F_{T1}\sin 20^\circ) = 0$$

$$\Sigma \vec{F}_y = (F_{T2}\cos 30^\circ) + (F_{T1}\cos 20^\circ) + (-F_g) = 0$$

$F_{T2} = F_{T1}\dfrac{\sin 20^\circ}{\sin 30^\circ}$ (substitute into y-equation)

$$F_{T1}\frac{\sin 20^\circ}{\sin 30^\circ}\cos 30^\circ + F_{T1}\cos 20^\circ = F_g = mg$$

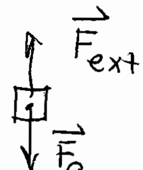
$$F_{T1}\left(\sin 20^\circ \frac{\cos 30^\circ}{\sin 30^\circ} + \cos 20^\circ\right) = mg \qquad F_{T1}\left(\sin 20^\circ \cot 30^\circ + \cos 20^\circ\right) = mg$$

$$F_{T1} = \frac{mg}{(\sin 20^\circ \cot 30^\circ + \cos 20^\circ)} = \frac{(1000)(9.80)}{(\sin 20^\circ \cot 30^\circ + \cos 20^\circ)} = 6400\text{ N}$$

$$F_{T2} = F_{T1}\frac{\sin 20^\circ}{\sin 30^\circ} = 4380\text{ N}$$

37) $m = 50.0\text{g} = 0.0500\text{ kg}$

Phase One : Acceleration



$$\Sigma \vec{F}_y = m\vec{a}_y$$

$$(+F_{ext}) + (-F_g) = +ma_y$$

$$a_y = \frac{F_{ext} - mg}{m} \qquad \Delta y_1 = 1.00\text{ m}$$

$v_{fy}^2 = v_{iy}^2 \pm 2a_y \Delta y_1$ (Use plus sign since ball is accelerating.)

$$v_{fy}^2 = 0 + 2a_y \Delta y_1 \qquad v_{fy} = \sqrt{2a_y \Delta y_1}$$

Phase Two : Deceleration $\quad v_{iy} = \sqrt{2a_y \Delta y_1} \quad v_{fy} = 0 \quad a = g \quad \Delta y = ?$

$v_{fy}^2 = v_{iy}^2 \pm 2a_y \Delta y$ (Use minus sign since ball is decelerating.)

$$0 = v_{iy}^2 - 2g\Delta y_2 \qquad \Delta y_2 = \frac{v_{iy}^2}{2g} = \frac{2a_y \Delta y_1}{2g} = \frac{a_y \Delta y_1}{g}$$

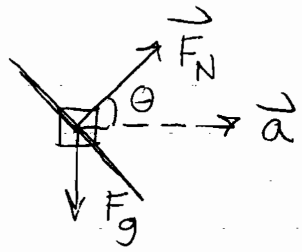
$$\Delta y_2 = \frac{(F_{ext} - mg)\Delta y_1}{mg} = \frac{((2.00) - (0.0500)(9.80))(1.00)}{(0.0500)(9.80)} = 3.08\text{ m}$$

60) $\vec{v}_{ix} = \vec{v}_{ox} \qquad \Sigma \vec{F}_x = \vec{F}_x = ct \qquad \vec{v}_{fx} = ? \qquad \vec{a}_x = \frac{\vec{F}_x}{m} = \frac{ct}{m}$

$$\vec{v}_x = \int \vec{a}_x dt = \int \frac{ct}{m} dt = \frac{ct^2}{2m} + C = \frac{ct^2}{2m} + \vec{v}_{ox}$$

$$\vec{v}_x = \vec{v}_{ox} + \frac{ct^2}{2m}$$

71) (a) $y = x^2$



slope $= \frac{dy}{dx} = 2\vec{x}$

The slope of the parabolic track is $2x$, where $x < 0$.
The slopes of two perpendicular lines multiplied together is negative one.

(Slope of Normal Force) $\times$ (Slope of Parabola) $= -1$
Slope of Normal Force $= \tan\theta$

$(\tan\theta)(2\vec{x}) = (-1)$ $\quad \tan\theta = \frac{-1}{2\vec{x}}$ $\quad$ or $\quad -2\vec{x} = \frac{1}{\tan\theta}$

$\Sigma \vec{F}_x = (+F_N \cos\theta) = m\vec{a}_x$

$\Sigma \vec{F}_y = (+F_N \sin\theta) + (-F_g) = 0$ $\quad F_N = \frac{F_g}{\sin\theta} = \frac{mg}{\sin\theta}$

$\frac{mg}{\sin\theta}\cos\theta = m\vec{a}_x$ $\quad \vec{a}_x = g\frac{\cos\theta}{\sin\theta} = \frac{g}{\tan\theta} = -2g\vec{x}$

(If the position is negative, then the acceleration is positive, and vice versa.)

(b) $x = 20.0\,\text{cm} = 0.200\,\text{m}$

$\vec{a}_x = -(2)(9.80)(0.200) = -3.92\ \text{m/s}^2$