4.33 We assume the train is still slowing down at the instant in question.

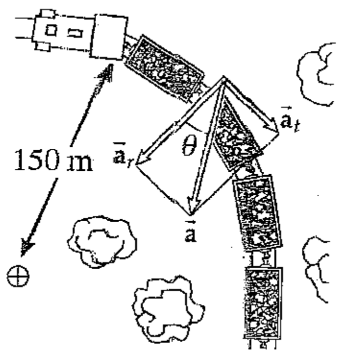


FIG. P3.29

$$a_c = \frac{v^2}{r} = 1.29 \text{ m/s}^2$$

$$a_t = \frac{\Delta v}{\Delta t} = \frac{(-40.0 \text{ km/h})(10^3 \text{ m/km})\left(\frac{1 \text{ h}}{3\,600 \text{ s}}\right)}{15.0 \text{ s}} = -0.741 \text{ m/s}^2$$

$$a = \sqrt{a_c^2 + a_t^2} = \sqrt{(1.29 \text{ m/s}^2)^2 + (-0.741 \text{ m/s}^2)^2}$$

at an angle of $\tan^{-1}\left(\frac{|a_t|}{a_c}\right) = \tan^{-1}\left(\frac{0.741}{1.29}\right)$

$$\vec{a} = \boxed{1.48 \text{ m/s}^2 \text{ inward and } 29.9° \text{ backward}}$$

5.33

First, we will compute the needed accelerations:

(1) Before it starts to move: $a_y = 0$

(2) During the first 0.800 s: $a_y = \frac{v_{yf} - v_{yi}}{t} = \frac{1.20 \text{ m/s} - 0}{0.800 \text{ s}} = 1.50 \text{ m/s}^2$

(3) While moving at constant velocity: $a_y = 0$

(4) During the last 1.50 s: $a_y = \frac{v_{yf} - v_{yi}}{t} = \frac{0 - 1.20 \text{ m/s}}{1.50 \text{ s}} = -0.800 \text{ m/s}^2$

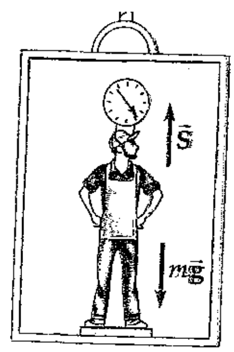


FIG. P4.37

Newton's second law is: $\sum F_y = ma_y$

$$+S - (72.0 \text{ kg})(9.80 \text{ m/s}^2) = (72.0 \text{ kg})a_y$$

$$S = 706 \text{ N} + (72.0 \text{ kg})a_y.$$

(a) When $a_y = 0$, $S = \boxed{706 \text{ N}}$.

(b) When $a_y = 1.50 \text{ m/s}^2$, $S = \boxed{814 \text{ N}}$.

(c) When $a_y = 0$, $S = \boxed{706 \text{ N}}$.

(d) When $a_y = -0.800 \text{ m/s}^2$, $S = \boxed{648 \text{ N}}$.

5.37

$$\sum F_y = ma_y: \quad +n - mg = 0$$
$$f_s \le \mu_s n = \mu_s mg$$

This maximum magnitude of static friction acts so long as the tires roll without skidding.

$$\sum F_x = ma_x: \quad -f_s = ma$$

The maximum acceleration is $a = -\mu_s g$. The initial and final conditions are: $x_i = 0$, $v_i = 50.0 \text{ mi/h} = 22.4 \text{ m/s}$, $v_f = 0$, $v_f^2 = v_i^2 + 2a(x_f - x_i)$: $-v_i^2 = -2\mu_s g x_f$

(a) $$x_f = \frac{v_i^2}{2\mu g}$$
$$x_f = \frac{(22.4 \text{ m/s})^2}{2(0.100)(9.80 \text{ m/s}^2)} = \boxed{256 \text{ m}}$$

(b) $$x_f = \frac{v_i^2}{2\mu g}$$
$$x_f = \frac{(22.4 \text{ m/s})^2}{2(0.600)(9.80 \text{ m/s}^2)} = \boxed{42.7 \text{ m}}$$

5.59

$m_{\text{suitcase}} = 20.0 \text{ kg}$, $F = 35.0 \text{ N}$

$$\sum F_x = ma_x: \quad -20.0 \text{ N} + F\cos\theta = 0$$
$$\sum F_y = ma_y: \quad +n + F\sin\theta - F_g = 0$$

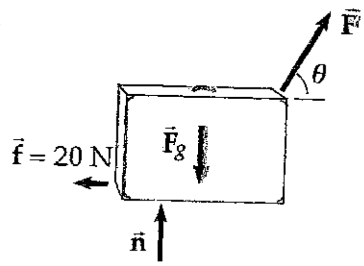


FIG. P5.8

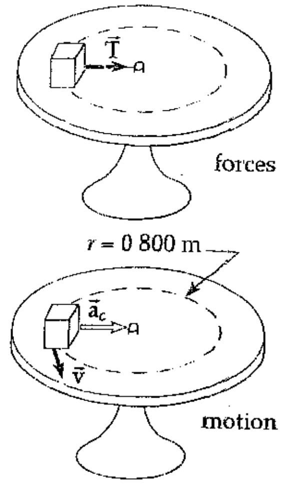
(a) $F\cos\theta = 20.0 \text{ N}$
$$\cos\theta = \frac{20.0 \text{ N}}{35.0 \text{ N}} = 0.571$$
$$\boxed{\theta = 55.2°}$$

(b) $n = F_g - F\sin\theta = [196 - 35.0(0.821)] \text{ N}$
$$\boxed{n = 167 \text{ N}}$$

6 i

$m = 3.00$ kg, $r = 0.800$ m. The string will break if the tension exceeds the weight corresponding to 25.0 kg, so

$$T_{max} = Mg = 25.0(9.80) = 245\text{ N}$$



When the 3.00 kg mass rotates in a horizontal circle, the tension causes the centripetal acceleration,

so $$T = \frac{mv^2}{r} = \frac{(3.00)v^2}{0.800}$$

Then $$v^2 = \frac{rT}{m} = \frac{(0.800)T}{3.00} \le \frac{(0.800)T_{max}}{3.00} = \frac{0.800(245)}{3.00} = 65.3\ \text{m}^2/\text{s}^2$$

and $$0 \le v \le \sqrt{65.3}$$

or $$\boxed{0 \le v \le 8.08\ \text{m/s}}$$

6. ii

$$F_g = mg = (4\text{ kg})(9.8\ \text{m/s}^2) = 39.2\text{ N}$$
$$\sin\theta = \frac{1.5\text{ m}}{2\text{ m}}$$
$$\theta = 48.6°$$
$$r = (2\text{ m})\cos 48.6° = 1.32\text{ m}$$

$$\sum F_x = ma_x = \frac{mv^2}{r}$$

$$T_a\cos 48.6° + T_b\cos 48.6° = \frac{(4\text{ kg})(6\text{ m/s})^2}{1.32\text{ m}}$$
$$T_a + T_b = \frac{109\text{ N}}{\cos 48.6°} = 165\text{ N}$$

$$\sum F_y = ma_y$$
$$+T_a\sin 48.6° - T_b\sin 48.6° - 39.2\text{ N} = 0$$
$$T_a - T_b = \frac{39.2\text{ N}}{\sin 48.6°} = 52.3\text{ N}$$

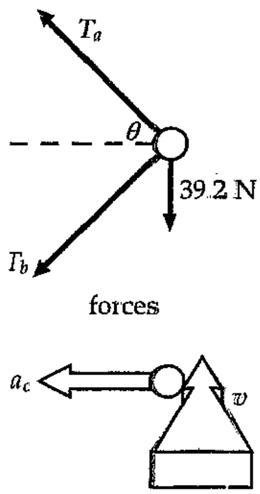


FIG. P5.20

(a) To solve simultaneously, we add the equations in T_a and T_b:

$$T_a + T_b + T_a - T_b = 165\text{ N} + 52.3\text{ N}$$

$$T_a = \frac{217\text{ N}}{2} = \boxed{108\text{ N}}$$

(b) $$T_b = 165\text{ N} - T_a = 165\text{ N} - 108\text{ N} = \boxed{56.2\text{ N}}$$

6 57

(a) Since the centripetal acceleration of a person is downward (toward the axis of the earth), it is equivalent to the effect of a falling elevator. Therefore,

$$F_g' = F_g - \frac{mv^2}{r} \text{ or } \boxed{F_g > F_g'}$$

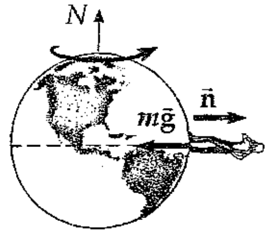


FIG. P5.49

(b) At the poles $v = 0$ and $F_g' = F_g = mg = 75.0(9.80) = \boxed{735\text{ N}}$ down.

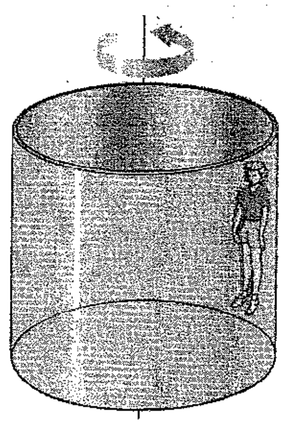
At the equator, $F_g' = F_g - ma_c = 735\text{ N} - 75.0(0.033\,7)\text{ N} = \boxed{732\text{ N}}$ down.

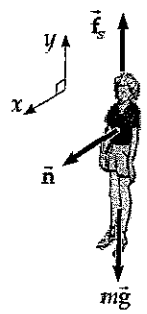
6 65

(a) $n = \dfrac{mv^2}{R}$ $\qquad f - mg = 0$

$f = \mu_s n$ $\qquad v = \dfrac{2\pi R}{T}$

$$T = \boxed{\sqrt{\frac{4\pi^2 R\mu_s}{g}}}$$





(b) $T = \boxed{2.54\text{ s}}$

$$\#\frac{\text{rev}}{\text{min}} = \frac{1\text{ rev}}{2.54\text{ s}}\left(\frac{60\text{ s}}{\text{min}}\right) = \boxed{23.6\ \frac{\text{rev}}{\text{min}}}$$