Homework 7 Solutions

Q5.6 With friction, it takes longer to come down than to go up. On the way up, the frictional force and the component of the weight down the plane are in the same direction, giving a large acceleration. On the way down, the forces are in opposite directions, giving a relatively smaller acceleration. If the incline is frictionless, it takes the same amount of time to go up as it does to come down.

Q5.12 Blood pressure cannot supply the force necessary both to balance the gravitational force and to provide the centripetal acceleration, to keep blood flowing up to the pilot's brain.

P5.2 $\sum F_y = ma_y$: $+n - mg = 0$

$$f_s \le \mu_s n = \mu_s mg$$

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

P5.10 $T - f_k = 5.00a$ (for 5.00 kg mass)

$9.00g - T = 9.00a$ (for 9.00 kg mass)

Adding these two equations gives:

$$9.00(9.80) - 0.200(5.00)(9.80) = 14.0a$$
$$a = 5.60 \text{ m/s}^2$$
$$\therefore T = 5.00(5.60) + 0.200(5.00)(9.80)$$
$$= \boxed{37.8 \text{ N}}$$

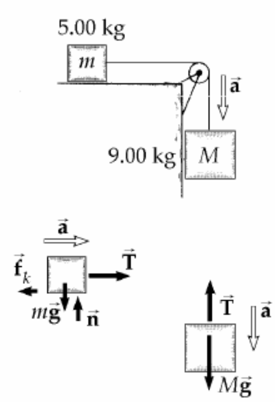

FIG. P5.10

P5.13 (Case 1, impending upward motion)
Setting

$$\sum F_x = 0: \quad P\cos 50.0° - n = 0$$
$$f_{s,\,\max} = \mu_s n: \quad f_{s,\,\max} = \mu_s P\cos 50.0°$$
$$= 0.250(0.643)P = 0.161P$$

Setting

$$\sum F_y = 0: \quad P\sin 50.0° - 0.161P - 3.00(9.80) = 0$$
$$P_{\max} = \boxed{48.6 \text{ N}}$$

(Case 2, impending downward motion)
As in Case 1,

$$f_{s,\,\max} = 0.161P$$

Setting

$$\sum F_y = 0: \quad P\sin 50.0° + 0.161P - 3.00(9.80) = 0$$
$$P_{\min} = \boxed{31.7 \text{ N}}$$

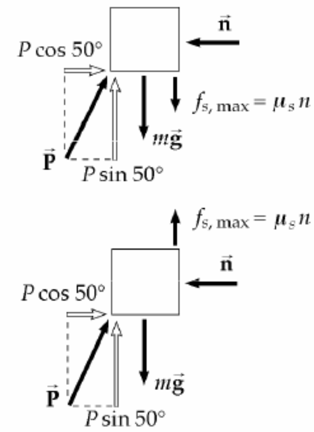

FIG. P5.13

P5.17 $n = mg$ since $a_y = 0$

The force causing the centripetal acceleration is the frictional force f.

From Newton's second law $f = ma_c = \frac{mv^2}{r}$.

But the friction condition is $f \le \mu_s n$

i.e., $\frac{mv^2}{r} \le \mu_s mg$

$$v \le \sqrt{\mu_s rg} = \sqrt{0.600(35.0 \text{ m})(9.80 \text{ m/s}^2)} \qquad v \le \boxed{14.3 \text{ m/s}}$$

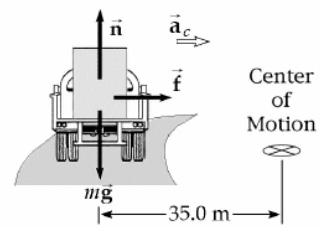

FIG. P5.17

P5.19 $T\cos 5.00° = mg = (80.0 \text{ kg})(9.80 \text{ m/s}^2)$

(a) $T = 787 \text{ N}: \vec{\mathbf{T}} = \boxed{(68.6 \text{ N})\hat{\mathbf{i}} + (784 \text{ N})\hat{\mathbf{j}}}$

(b) $T\sin 5.00° = ma_c: \boxed{a_c = 0.857 \text{ m/s}^2}$ toward the center of the circle.

The length of the wire is unnecessary information. We could, on the other hand, use it to find the radius of the circle, the speed of the bob, and the period of the motion.

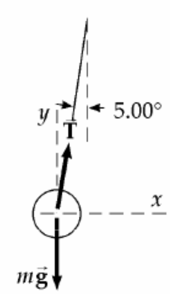

FIG. P5.19

P5.19 $T\cos 5.00° = mg = (80.0 \text{ kg})(9.80 \text{ m/s}^2)$

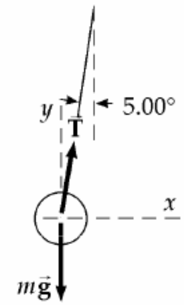

FIG. P5.19

(a) $T = 787 \text{ N}: \vec{\mathbf{T}} = \boxed{(68.6 \text{ N})\hat{\mathbf{i}} + (784 \text{ N})\hat{\mathbf{j}}}$

(b) $T\sin 5.00° = ma_c: \boxed{a_c = 0.857 \text{ m/s}^2}$ toward the center of the circle.

The length of the wire is unnecessary information. We could, on the other hand, use it to find the radius of the circle, the speed of the bob, and the period of the motion.

P5.23 $\sum F_y = \frac{mv^2}{r} = mg + n$

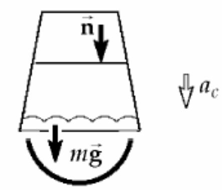

FIG. P5.23

But $n = 0$ at this minimum speed condition, so

$$\frac{mv^2}{r} = mg \Rightarrow v = \sqrt{gr} = \sqrt{(9.80 \text{ m/s}^2)(1.00 \text{ m})} = \boxed{3.13 \text{ m/s}}.$$

P5.33 $a = \frac{MG}{(4R_E)^2} = \frac{9.8 \text{ m/s}^2}{16} = \boxed{0.613 \text{ m/s}^2}$ toward the earth