Chapter 9

Problems & Exercises

1.

a) 46.8 $\text{N} \cdot \text{m}$

b) It does not matter at what height you push. The torque depends on only the magnitude of the force applied and the perpendicular distance of the force's application from the hinges. (Children don't have a tougher time opening a door because they push lower than adults, they have a tougher time because they don't push far enough from the hinges.)

3.

23.3 N

5.

Given:

$$\begin{aligned} m_1 &= 26.0\text{ kg}, m_2 = 32.0\text{ kg}, m_\text{s} = 12.0\text{ kg}, \\ r_1 &= 1.60\text{ m}, r_\text{s} = 0.160\text{ m, find (a) } r_2\text{, (b) } F_\text{p} \end{aligned}$$

a) Since children are balancing:

$$\text{net } \tau_\text{cw} = -\text{net } \tau_\text{ccw}$$
$$\Rightarrow w_1 r_1 + m_\text{s}\, g r_\text{s} = w_2 r_2$$

So, solving for r_2 gives:

$$\begin{aligned} r_2 &= \frac{w_1 r_1 + m_\text{s}\, g r_\text{s}}{w_2} = \frac{m_1\, g r_1 + m_\text{s}\, g r_\text{s}}{m_2 g} = \frac{m_1 r_1 + m_\text{s} r_\text{s}}{m_2} \\ &= \frac{(26.0\text{ kg})(1.60\text{ m}) + (12.0\text{ kg})(0.160\text{ m})}{32.0\text{ kg}} \\ &= 1.36\text{ m} \end{aligned}$$

b) Since the children are not moving:

$$\text{net } F = 0 = F_\text{p} - w_1 - w_2 - w_\text{s}$$
$$\Rightarrow F_\text{p} = w_1 + w_2 + w_\text{s}$$

So that

$$\begin{aligned} F_\text{p} &= (26.0\text{ kg} + 32.0\text{ kg} + 12.0\text{ kg})(9.80\text{ m/s}^2) \\ &= 686\text{ N} \end{aligned}$$

6.

$F_\text{wall} = 1.43 \times 10^3$ N

8.

a) 2.55×10^3 N, 16.3º to the left of vertical (i.e., toward the wall)

b) 0.292

10.

$F_{\mathrm{B}} = 2.12 \times 10^4$ N

12.

a) 0.167, or about one-sixth of the weight is supported by the opposite shore.

b) $F = 2.0 \times 10^4$ N, straight up.

14.

a) 21.6 N

b) 21.6 N

16.

350 N directly upwards

19.

25

50 N

21.

a) MA = 18.5

b) $F_{\mathrm{i}} = 29.1$ N

c) 510 N downward

23.

1.3×10^3 N

25.

a) $T = 299$ N

b) 897 N upward

26.

$$
\begin{aligned}
F_{\mathrm{B}} &= 470\text{ N}; r_1 = 4.00\text{ cm}; w_{\mathrm{a}} = 2.50\text{ kg}; r_2 = 16.0\text{ cm}; w_{\mathrm{b}} = 4.00\text{ kg}; r_3 = 38.0\text{ cm} \\
F_{\mathrm{E}} &= w_{\mathrm{a}}\left(\frac{r_2}{r_1} - 1\right) + w_{\mathrm{b}}\left(\frac{r_3}{r_1} - 1\right) \\
&= (2.50\text{ kg})(9.80\text{ m/s}^2)\left(\frac{16.0\text{ cm}}{4.0\text{ cm}} - 1\right) \\
&\quad +(4.00\text{ kg})(9.80\text{ m/s}^2)\left(\frac{38.0\text{ cm}}{4.00\text{ cm}} - 1\right) \\
&= 407\text{ N}
\end{aligned}
$$

28.

$$1.1 \times 10^3\text{ N}$$

$\theta = 190^{\text{º}}$ ccw from positive x axis

30.

$F_{\mathrm{V}} = 97$ N, $\theta = 59^{\text{º}}$

32.

(a) 25 N downward

(b) 75 N upward

33.

(a) $F_{\mathrm{A}} = 2.21 \times 10^3$ N upward

(b) $F_{\mathrm{B}} = 2.94 \times 10^3$ N downward

35.

(a) $F_{\text{teeth on bullet}} = 1.2 \times 10^2$ N upward

(b) $F_{\mathrm{J}} = 84$ N downward

37.

(a) 147 N downward

(b) 1680 N, 3.4 times her weight

(c) 118 J

(d) 49.0 W

39.

a) $\bar{x}_2 = 2.33$ m

b) The seesaw is 3.0 m long, and hence, there is only 1.50 m of board on the other side of the pivot. The second child is off the board.

c) The position of the first child must be shortened, i.e. brought closer to the pivot.