2. **REASONING** The torque is given by Equation 9.1, \( \tau = F \lambda \), where \( F \) is the magnitude of the applied force and \( \lambda \) is the lever arm. From the figure in the text, the lever arm is given by \( \lambda = (0.28 \text{ m}) \sin 50.0^\circ \). Since both \( \tau \) and \( \lambda \) are known, Equation 9.1 can be solved for \( F \).

**SOLUTION** Solving Equation 9.1 for \( F \), we have

\[
F = \frac{\tau}{\lambda} = \frac{45 \text{ N} \cdot \text{m}}{(0.28 \text{ m}) \sin 50.0^\circ} = 2.1 \times 10^2 \text{ N}
\]

14. **REASONING** When the board just begins to tip, three forces act on the board. They are the weight \( W \) of the board, the weight \( W_p \) of the person, and the force \( F \) exerted by the right support.

Since the board will rotate around the right support, the lever arm for this force is zero, and the torque exerted by the right support is zero. The lever arm for the weight of the board is equal to one-half the length of the board minus the overhang length: \( 2.5 \text{ m} - 1.1 \text{ m} = 1.4 \text{ m} \).

The lever arm for the weight of the person is \( x \). Therefore, taking counterclockwise torques as positive, we have

\[-W_p x + W(1.4 \text{ m}) = 0\]

This expression can be solved for \( x \).

**SOLUTION** Solving the expression above for \( x \), we obtain

\[x = \frac{W(1.4 \text{ m})}{W_p} = \frac{(225 \text{ N})(1.4 \text{ m})}{450 \text{ N}} = 0.70 \text{ m}\]
27. **REASONING AND SOLUTION** The weight \( W \) of the left side of the ladder, the normal force \( F_N \) of the floor on the left leg of the ladder, the tension \( T \) in the crossbar, and the reaction force \( R \) due to the right-hand side of the ladder, are shown in the figure below. In the vertical direction \(-W + F_N = 0\), so that

\[
F_N = W = mg = (10.0 \text{ kg})(9.80 \text{ m/s}^2) = 98.0 \text{ N}
\]

In the horizontal direction it is clear that \( R = T \). The net torque about the base of the ladder is

\[
\Sigma \tau = -T [(1.00 \text{ m}) \sin 75.0^\circ] - W [(2.00 \text{ m}) \cos 75.0^\circ] + R [(4.00 \text{ m}) \sin 75.0^\circ] = 0
\]

Substituting for \( W \) and using \( R = T \), we obtain

\[
T = \frac{(98.0 \text{ N})(2.00 \text{ m}) \cos 75.0^\circ}{(3.00 \text{ m}) \sin 75.0^\circ} = 17.5 \text{ N}
\]

51. **REASONING AND SOLUTION** The rotational kinetic energy of the shell is \( KE_r = (1/2) I \omega^2 \) and the translational kinetic energy is \( KE_t = (1/2) Mv^2 \). Now, \( v = R \omega \) since the sphere rolls without slipping, so

\[
KE_t = (1/2) MR^2 \omega^2
\]

The desired fraction is

\[
KE_r/KE = I/(I + MR^2) = \frac{2}{5}
\]