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

SOLUTION Solving Equation 9.1 for F, we have

$$F = \frac{\tau}{\ell} = \frac{45\text{ N}\cdot\text{m}}{(0.28\text{ m})\sin 50.0°} = \boxed{2.1\times10^2\text{ N}}$$

7. ***REASONING AND SOLUTION*** The torque due to F_1 is

$$\tau_1 = -F_1L_1 = -(20.0\text{ N})(0.500\text{ m}) = -10.0\text{ N·m (CW)}$$

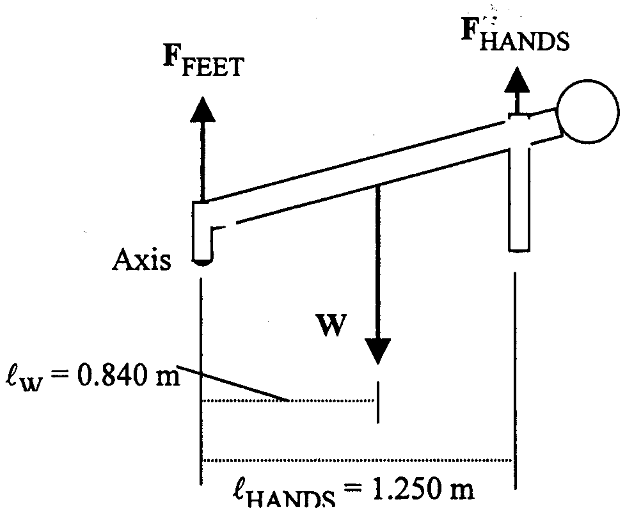
The torque due to F_2 is

$$\tau_2 = (F_2\cos 30.0°)L_2 = (35.0\text{ N})(1.10\text{ m})\cos 30.0° = 33.3\text{ N·m (CCW)}$$

The net torque is therefore,

$$\Sigma\tau = \tau_1 + \tau_2 = -10.0\text{ N·m} + 33.3\text{ N·m} = \boxed{23.3\text{ N}\cdot\text{m, counterclockwise}}$$

12. ***REASONING*** The drawing shows the forces acting on the person. It also shows the lever arms for a rotational axis perpendicular to the plane of the paper at the place where the person's toes touch the floor. Since the person is in equilibrium, the sum of the forces must be zero. Likewise, we know that the sum of the torques must be zero.



SOLUTION Taking upward to be the positive direction, we have

$$F_{\text{FEET}} + F_{\text{HANDS}} - W = 0$$

Remembering that counterclockwise torques are positive and using the axis and the lever arms shown in the drawing, we find

$$W\ell_{\text{W}} - F_{\text{HANDS}}\ell_{\text{HANDS}} = 0$$

$$F_{\text{HANDS}} = \frac{W\ell_{\text{W}}}{\ell_{\text{HANDS}}} = \frac{(584 \text{ N})(0.840 \text{ m})}{1.250 \text{ m}} = 392 \text{ N}$$

Substituting this value into the balance-of-forces equation, we find

$$F_{\text{FEET}} = W - F_{\text{HANDS}} = 584 \text{ N} - 392 \text{ N} = 192 \text{ N}$$

The force on each hand is half the value calculated above, or $\boxed{196 \text{ N}}$. Likewise, the force on each foot is half the value calculated above, or $\boxed{96 \text{ N}}$.

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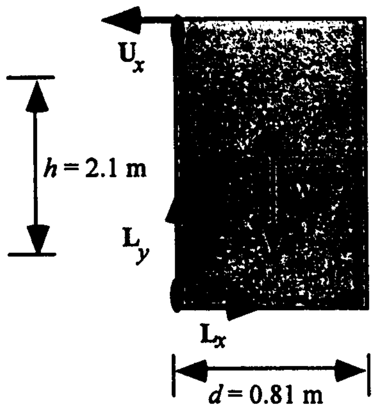
15. SSM ***REASONING*** The figure at the right shows the door and the forces that act upon it. Since the door is uniform, the center of gravity, and, thus, the location of the weight **W**, is at the geometric center of the door.



Let **U** represent the force applied to the door by the upper hinge, and **L** the force applied to the door by the lower hinge. Taking forces that point to the right and forces that point up as positive, we have

$$\Sigma F_x = L_x - U_x = 0 \quad \text{or} \quad L_x = U_x \qquad (1)$$

$$\Sigma F_y = L_y - W = 0 \quad \text{or} \quad L_y = W = 140 \text{ N} \qquad (2)$$

Taking torques about an axis perpendicular to the plane of the door and through the lower hinge, with counterclockwise torques being positive, gives

16. ***REASONING AND SOLUTION*** The net torque about an axis through the contact point between the tray and the thumb is

$$\Sigma\tau = F(0.0400\text{ m}) - (0.250\text{ kg})(9.80\text{ m/s}^2)(0.320\text{ m}) - (1.00\text{ kg})(9.80\text{ m/s}^2)(0.180\text{ m}) - (0.200\text{ kg})(9.80\text{ m/s}^2)(0.140\text{ m}) = 0$$

$$\boxed{F = 70.6\text{ N, up}}$$

Similarly, the net torque about an axis through the point of contact between the tray and the finger is

$$\Sigma\tau = T(0.0400\text{ m}) - (0.250\text{ kg})(9.80\text{ m/s}^2)(0.280\text{ m}) - (1.00\text{ kg})(9.80\text{ m/s}^2)(0.140\text{ m}) - (0.200\text{ kg})(9.80\text{ m/s}^2)(0.100\text{ m}) = 0$$

$$\boxed{T = 56.4\text{ N, down}}$$