2. **REASONING AND SOLUTION**
   a. We will treat the neutron star as spherical in shape, so that its volume is given by the familiar formula, \( V = \frac{4}{3} \pi r^3 \). Then, according to Equation 11.1, the density of the neutron star described in the problem statement is
   \[
   \rho = \frac{m}{V} = \frac{m}{\frac{4}{3} \pi r^3} = \frac{3m}{4 \pi (1.2 \times 10^3 \text{ m})^3} = \frac{3(2.7 \times 10^{28} \text{ kg})}{4 \pi (1.2 \times 10^3 \text{ m})^3} = 3.7 \times 10^{18} \text{ kg/m}^3
   \]
   b. If a dime of volume \( 2.0 \times 10^{-7} \text{ m}^3 \) were made of this material, it would weigh
   \[
   W = mg = \rho V g = (3.7 \times 10^{18} \text{ kg/m}^3)(2.0 \times 10^{-7} \text{ m}^3)(9.80 \text{ m/s}^2) = 7.3 \times 10^{12} \text{ N}
   \]
   This weight corresponds to
   \[
   7.3 \times 10^{12} \text{ N} \left( \frac{1 \text{ lb}}{4.448 \text{ N}} \right) = 1.6 \times 10^{12} \text{ lb}.
   \]

12. **REASONING** Pressure is the magnitude of the force applied perpendicularly to a surface divided by the area of the surface, according to Equation 11.3. The force magnitude, therefore, is equal to the pressure times the area.

   **SOLUTION** According to Equation 11.3, we have
   \[
   F = PA = (8.0 \times 10^4 \text{ lb/in}^2)\left( (6.1 \text{ in.})(2.6 \text{ in.)} \right) = 1.3 \times 10^6 \text{ lb}
   \]

21. **REASONING** The magnitude of the force that would be exerted on the window is given by Equation 11.3, \( F = PA \), where the pressure can be found from Equation 11.4: \( P_2 = P_1 + \rho gh \). Since \( P_1 \) represents the pressure at the surface of the water, it is equal to atmospheric pressure, \( P_{\text{atm}} \). Therefore, the magnitude of the force is given by
   \[
   F = (P_{\text{atm}} + \rho gh)A
   \]
   where, if we assume that the window is circular with radius \( r \), its area \( A \) is given by \( A = \pi r^2 \).

   **SOLUTION**
   a. Thus, the magnitude of the force is
   \[
   F = [1.013 \times 10^5 \text{ Pa} + (1025 \text{ kg/m}^3)(9.80 \text{ m/s}^2)(11000 \text{ m})] \pi (0.10 \text{ m})^2 = 3.5 \times 10^6 \text{ N}
   \]
   b. The weight of a jetliner whose mass is \( 1.2 \times 10^5 \text{ kg} \) is
   \[
   W = mg = (1.2 \times 10^5 \text{ kg})(9.80 \text{ m/s}^2) = 1.2 \times 10^6 \text{ N}
   \]
   Therefore, the force exerted on the window at a depth of 11000 m is about three times greater than the weight of a jetliner!
24. **REASONING AND SOLUTION** The pump must generate an upward force to counteract the weight of the column of water above it. Therefore, \( F = mg = (\rho A)g \). The required pressure is then

\[
P = \frac{F}{A} = \rho gh = (1.00 \times 10^3 \text{ kg/m}^3)(9.80 \text{ m/s}^2)(71 \text{ m}) = 7.0 \times 10^5 \text{ Pa}
\]

32. **REASONING** Pressure is the magnitude of the force applied perpendicularly to a surface divided by the area of the surface, according to Equation 11.3.

**SOLUTION** According to Equation 11.3, the pressure is

\[
P = \frac{F}{A} = \frac{F}{\pi r^2} = \frac{21600 \text{ N}}{\pi (0.090 \text{ m})^2} = 8.5 \times 10^5 \text{ Pa}
\]

This is about eight times atmospheric pressure.

43. **REASONING AND SOLUTION** Under water, the weight of the person with empty lungs is \( W_{\text{empty}} = W - \rho_{\text{water}} g V_{\text{empty}} \), where \( W \) is the weight of the person in air and \( V_{\text{empty}} \) is the volume of the empty lungs. Similarly, when the person's lungs are partially full under water, the weight of the person is \( W_{\text{full}} = W - \rho_{\text{water}} g V_{\text{full}} \). Subtracting the second equation from the first equation and rearranging gives

\[
V_{\text{full}} - V_{\text{empty}} = \frac{W_{\text{empty}} - W_{\text{full}}}{\rho_{\text{water}} g} = \frac{40.0 \text{ N} - 20.0 \text{ N}}{\left(1.00 \times 10^3 \text{ kg/m}^3\right)(9.80 \text{ m/s}^2)} = 2.04 \times 10^{-3} \text{ m}^3
\]
44. **REASONING AND SOLUTION**  

The buoyant force exerted by the water must at least equal the weight of the logs plus the weight of the people,

\[ F_B = W_L + W_P \]

\[ \rho_w g V = \rho_L g V + W_P \]

Now the volume of logs needed is

\[ V = \frac{M_P}{\rho_w - \rho_L} = \frac{320 \text{ kg}}{1.00 \times 10^3 \text{ kg/m}^3 - 725 \text{ kg/m}^3} = 1.16 \text{ m}^3 \]

The volume of one log is

\[ V_L = \pi (8.00 \times 10^{-2} \text{ m})^2 (3.00 \text{ m}) = 6.03 \times 10^{-2} \text{ m}^3 \]

The number of logs needed is

\[ N = \frac{V}{V_L} = \frac{1.16}{(6.03 \times 10^{-2})} = 19.2 \]

Therefore, at least 20 logs are needed.

53. **REASONING AND SOLUTION**

a. The volume flow rate is given by

\[ Q = A v = (2.0 \times 10^{-4} \text{ m}^2) (0.35 \text{ m/s}) = 7.0 \times 10^{-5} \text{ m}^3/\text{s} \]

b. We know that \( A_1 v_1 = A_2 v_2 \) so that

\[ v_2 = v_1 \left( \frac{A_1}{A_2} \right) = (0.35 \text{ m/s}) \left( \frac{2.0 \times 10^{-4} \text{ m}^2}{0.28 \text{ m}^2} \right) = 2.5 \times 10^{-4} \text{ m/s} \]

57. **SSM** **REASONING AND SOLUTION**

a. Using Equation 11.12, the form of Bernoulli's equation with \( y_1 = y_2 \), we have

\[ P_1 - P_2 = \frac{1}{2} \rho \left( v_2^2 - v_1^2 \right) = \frac{1.29 \text{ kg/m}^3}{2} \left[ (15 \text{ m/s})^2 - 0 \right] = 150 \text{ Pa} \]

b. The pressure inside the roof is greater than the pressure on the outside. Therefore, there is a net outward force on the roof. If the wind speed is sufficiently high, some roofs are "blown outward."