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

$$\rho = \frac{m}{V} = \frac{m}{\frac{4}{3}\pi r^3} = \frac{3m}{4\pi r^3} = \frac{3(2.7\times10^{28}\text{ kg})}{4\pi(1.2\times10^3\text{ m})^3} = \boxed{3.7\times10^{18}\text{ kg/m}^3}$$

b. If a dime of volume $2.0\times10^{-7}\text{ m}^3$ were made of this material, it would weigh

$$W = mg = \rho V g = (3.7\times10^{18}\text{ kg/m}^3)(2.0\times10^{-7}\text{ m}^3)(9.80\text{ m/s}^2) = 7.3\times10^{12}\text{ N}$$

This weight corresponds to

$$7.3\times10^{12}\text{ N}\left(\frac{1\text{ lb}}{4.448\text{ N}}\right) = \boxed{1.6\times10^{12}\text{ lb}}.$$

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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

$$F = PA = (8.0\times10^4\text{ lb/in.}^2)[(6.1\text{ in.})(2.6\text{ in.})] = \boxed{1.3\times10^6\text{ lb}}$$

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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: $P_2 = P_1 + \rho g h$. Since P_1 represents the pressure at the surface of the water, it is equal to atmospheric pressure, P_{atm}. Therefore, the magnitude of the force is given by

$$F = (P_{\text{atm}} + \rho g h)A$$

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

$$F = [1.013\times10^5\text{ Pa} + (1025\text{ kg/m}^3)(9.80\text{ m/s}^2)(11\,000\text{ m})]\pi(0.10\text{ m})^2 = \boxed{3.5\times10^6\text{ N}}$$

b. The weight of a jetliner whose mass is 1.2×10^5 kg is

$$W = mg = (1.2\times10^5\text{ kg})(9.80\text{ m/s}^2) = \boxed{1.2\times10^6\text{ N}}$$

Therefore, the force exerted on the window at a depth of 11 000 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 = (ρhA)g. The required pressure is then

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

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

$$P = \frac{F}{A} = \frac{F}{\pi r^2} = \frac{21\ 600\ \text{N}}{\pi (0.090\ \text{m})^2} = \boxed{8.5 \times 10^5\ \text{Pa}}$$

This is about eight times atmospheric pressure.

43. **SSM** **WWW** ***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_{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

$$V_{\text{full}} - V_{\text{empty}} = \frac{W_{\text{empty}} - W_{\text{full}}}{\rho_{\text{water}} g} = \frac{40.0\ \text{N} - 20.0\ \text{N}}{(1.00 \times 10^3\ \text{kg/m}^3)(9.80\ \text{m/s}^2)} = \boxed{2.04 \times 10^{-3}\ \text{m}^3}$$

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

$$N = V/V_L = (1.16)/(6.03 \times 10^{-2}) = 19.2$$

Therefore, $\boxed{\text{at least 20 logs are needed}}$.

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53. ***REASONING AND SOLUTION***

a. The volume flow rate is given by

$$Q = Av = (2.0 \times 10^{-4}\ \text{m}^2)(0.35\ \text{m/s}) = \boxed{7.0 \times 10^{-5}\ \text{m}^3/\text{s}}$$

b. We know that $A_1 v_1 = A_2 v_2$ so that

$$v_2 = v_1(A_1/A_2) = (0.35\ \text{m/s})(2.0 \times 10^{-4}\ \text{m}^2)/(0.28\ \text{m}^2) = \boxed{2.5 \times 10^{-4}\ \text{m/s}}$$

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

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

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

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."