1. \( m = \rho_{\text{steel}} V = \left(19.3 \times 10^3 \text{ kg/m}^3\right) \left(4.50 \times 10^{-2} \text{ m}\right) \left(11.0 \times 10^{-2} \text{ m}\right) \left(26.0 \times 10^{-2} \text{ m}\right) = 24.8 \text{ kg}, \text{ and choice (a) is the correct response.}\)

2. On average, the support force each nail exerts on the body is

\[
\bar{F}_1 = \frac{mg}{1208} = \frac{(66.0 \text{ kg}) (9.80 \text{ m/s}^2)}{1208} = 0.535 \text{ N}
\]

so the average pressure exerted on the body by each nail is

\[
P_m = \frac{\bar{F}_1}{A_{\text{nail}}} = \frac{0.535 \text{ N}}{1.00 \times 10^{-4} \text{ m}^2} = 5.35 \times 10^5 \text{ Pa}
\]

and (d) is the correct choice.

3. From Pascal's principle, \( F_1/A_1 = F_2/A_2 \), so if the output force is to be \( F_2 = 1.2 \times 10^3 \text{ N} \), the required input force is

\[
F_1 = \left(\frac{A_1}{A_2}\right) F_2 = \left(\frac{0.050 \text{ m}^2}{0.70 \text{ m}^2}\right) (1.2 \times 10^3 \text{ N}) = 86 \text{ N}
\]

making (c) the correct answer.

5. The absolute pressure at depth \( h \) below the surface of a liquid with density \( \rho \), and with pressure \( P_0 \) at its surface, is \( P = P_0 + \rho gh \). Thus, at a depth of 754 ft in the waters of Loch Ness,

\[
P = 1.013 \times 10^5 \text{ Pa} + (1.00 \times 10^3 \text{ kg/m}^3)(9.80 \text{ m/s}^2) \left(\frac{1 \text{ m}}{3.281 \text{ ft}}\right) \left(754 \text{ ft}\right) = 2.35 \times 10^6 \text{ Pa}
\]

and (c) is the correct response.

9. The boat, even after it sinks, experiences a buoyant force, \( B \), equal to the weight of whatever water it is displacing. This force will support part of the weight, \( w \), of the boat. The normal force exerted on the boat by the bottom of the lake will be \( n = w - B \), \(<w\) will support the balance of the boat's weight. The correct response is (c).

10. The absolute pressure at depth \( h \) below the surface of a fluid having density \( \rho \) is \( P = P_0 + \rho gh \), where \( P_0 \) is the pressure at the upper surface of that fluid. The fluid in each of the three vessels has density \( \rho = \rho_{\text{water}} \), the top of each vessel is open to the atmosphere so that \( P_0 = P_{\text{atm}} \) in each case, and the bottom is at the same depth \( h \) below the upper surface for the three vessels. Thus, the pressure \( P \) at the bottom of each vessel is the same and (c) is the correct choice.

10. The water level on the side of the glass stays the same. The floating ice cube displaces its own weight of liquid water, and so does the liquid water into which it melts.
9.1 The elastic limit is the maximum stress, \( F/A \) where \( F \) is the tension in the wire, that the wire can withstand and still return to its original length when released. Thus, if the wire is to experience a tension equal to the weight of the performer without exceeding the elastic limit, the minimum cross-sectional area is

\[
A_{\text{min}} = \frac{\pi D_{\text{min}}^2}{4} = \frac{F}{\text{elastic limit}} = \frac{mg}{\text{elastic limit}}
\]

and the minimum acceptable diameter is

\[
D_{\text{min}} = \sqrt{\frac{4mg}{\pi \text{ (elastic limit)}}} = \sqrt{\frac{4(70 \text{ kg})(9.8 \text{ m/s}^2)}{\pi (5.0 \times 10^8 \text{ Pa})}} = 1.3 \times 10^{-3} \text{ m} = 1.3 \text{ mm}
\]

9.16 We shall assume that each chair leg supports one-fourth of the total weight so the normal force each leg exerts on the floor is \( n = mg/4 \). The pressure of each leg on the floor is then

\[
P_{\text{kg}} = \frac{n}{A_{\text{kg}}} = \frac{mg/4}{\pi r^2} = \frac{(95.0 \text{ kg})(9.80 \text{ m/s}^2)}{4\pi (0.500 \times 10^{-2} \text{ m})^2} = 2.96 \times 10^6 \text{ Pa}
\]

9.18 Let the weight of the car be \( W \). Then, each tire supports \( W/4 \), and the gauge pressure is

\[
P = \frac{F}{A} = \frac{W}{4A}
\]

Thus, \( W = 4AP = 4 \left(0.024 \text{ m}^2\right)(2.0 \times 10^5 \text{ Pa}) = 1.9 \times 10^4 \text{ N}. \]

9.21 (a) \( P = P_0 + \rho gh = 101.3 \times 10^3 \text{ Pa} + (1.00 \times 10^3 \text{ kg/m}^3)(9.80 \text{ m/s}^2)(27.5 \text{ m}) = 3.71 \times 10^5 \text{ Pa} \)

(b) The inward force the water will exert on the window is

\[
F = PA = P\pi r^2 = (3.71 \times 10^5 \text{ Pa})\pi \left(\frac{35.0 \times 10^{-2} \text{ m}}{2}\right)^2 = 3.57 \times 10^4 \text{ N}\]
9.29 When held underwater, the ball will have three forces acting on it: a downward gravitational force, \( mg \); an upward buoyant force, \( B = \rho_{\text{water}} V = \frac{4\pi\rho_{\text{water}} r^3}{3} \); and an applied force, \( F \). If the ball is to be in equilibrium, we have (taking upward as positive) \( \Sigma F_y = F + B - mg = 0 \), or

\[
F = mg - B = mg - \rho_{\text{water}} \left( \frac{4\pi r^3}{3} \right) g = \left[ m - \rho_{\text{water}} \left( \frac{4\pi r^3}{3} \right) \right] g
\]

giving

\[
F = \left[ 0.540 \text{ kg} - (1.00 \times 10^3 \text{ kg/m}^3) \left( \frac{0.250 \text{ m}}{2} \right)^3 \right] \left( 9.80 \text{ m/s}^2 \right) = -74.9 \text{ N}
\]

so the required applied force is \( \vec{F} = 74.9 \text{ N directed downward} \).

9.31 The boat sinks until the weight of the additional water displaced equals the weight of the truck. Thus,

\[
w_{\text{truck}} = [\rho_{\text{water}} (\Delta V)] g
\]

\[
= \left( 10^3 \frac{\text{kg}}{\text{m}^3} \right) [ (4.00 \text{ m})(6.00 \text{ m})(4.00 \times 10^{-2} \text{ m}) ] \left( 9.80 \frac{\text{m}}{\text{s}^2} \right)
\]

or

\[
w_{\text{truck}} = 9.41 \times 10^3 \text{ N} = \mathbf{9.41 \text{ kN}}
\]