35. (a) A water barometer should have **[(1) a higher height than]** the mercury barometer due to its low density.

(b) $p_a = \rho gh$, ☞ $h = \dfrac{1.01 \times 10^5 \text{ Pa}}{(1000 \text{ kg/m}^3)(9.80 \text{ m/s}^2)} = \boxed{10 \text{ m}}$.

[36]. (a) $p_w = \rho gh = (1000 \text{ kg/m}^3)(9.80 \text{ m/s}^2)(10 \text{ m}) = \boxed{9.8 \times 10^4 \text{ Pa}}$.

(b) $p = p_o + p_w = 1.01 \times 10^5 \text{ Pa} + 9.8 \times 10^4 \text{ Pa} = \boxed{2.0 \times 10^5 \text{ Pa}}$.

39. $p = \dfrac{F}{2A}$, where A is the contact area of each tire.

So $A = \dfrac{F}{p} = \dfrac{mg}{2p} = \dfrac{(90.0 \text{ kg})(9.80 \text{ m/s}^2)}{2(690 \times 10^3 \text{ Pa})} = \boxed{6.39 \times 10^{-4} \text{ m}^2}$.

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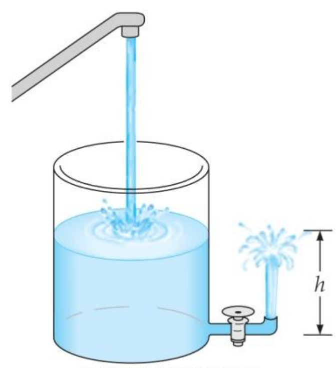
44. The pressure at the bottom is the standard atmospheric pressure. The pressure at the top needs to be lower by an amount that is equal to the pressure caused by a 15.0-cm column of water.

$p_{top} = p_o - \rho gh = 1.013 \times 10^5 \text{ Pa} - (1000 \text{ kg/m}^3)(9.80 \text{ m/s}^2)(0.150 \text{ m}) = \boxed{9.98 \times 10^4 \text{ Pa}}$.

[46]. (a) $w = mg = \rho Vg = (1000 \text{ kg/m}^3)(5.0 \times 10^{-5} \text{ m}^2)(12 \text{ m})(9.80 \text{ m/s}^2) = \boxed{5.9 \text{ N}}$.

(b) $p_w = \rho gh = (1000 \text{ kg/m}^3)(9.80 \text{ m/s}^2)(12 \text{ m}) = \boxed{1.2 \times 10^5 \text{ Pa}}$.

(c) $F = pA = (1.2 \times 10^5 \text{ Pa})(0.20 \text{ m}^2) = \boxed{2.4 \times 10^4 \text{ N}}$.



50. First calculate the velocity of the water when it comes out of the spout. Water falls a distance of h, so its velocity out of the sprout is (from energy conservation)

$v = \sqrt{2gh} = \sqrt{2(9.80 \text{ m/s}^2)(0.45 \text{ m})} = 2.97$ m/s, which is the initial velocity for the rise.

From kinematics, the maximum height is $\dfrac{v^2}{2g} = \dfrac{(2.97 \text{ m/s})^2}{2(9.80 \text{ m/s}^2)} = \boxed{0.45 \text{ m}}$.

53. (a) From Pascal's principle, $p_i = p_o$, ☞ $\dfrac{F_i}{A_i} = \dfrac{F_o}{A_o}$.

So $F_i = \dfrac{A_i}{A_o} F_o = \dfrac{4.00 \text{ cm}^2}{250 \text{ cm}^2} \times (3500 \text{ kg})(9.80 \text{ m/s}^2) = 548.8 \text{ N} = \boxed{549 \text{ N}}$.

(b) $p = \dfrac{F}{A} = \dfrac{548.8 \text{ N}}{4.00 \times 10^{-4} \text{ m}^2} = \boxed{1.37 \times 10^6 \text{ Pa}}$.

66. (a) He did it by $\boxed{\text{water displacement}}$.

(b) $\rho = \dfrac{m}{V} = \dfrac{0.750 \text{ kg}}{3.980 \times 10^{-5} \text{ m}^3} = 18.8 \times 10^3 \text{ kg/m}^3 < \rho_g = 19.3 \times 10^3 \text{ kg/m}^3$. $\boxed{\text{No}}$.

67. When floating, $w = F_b = \rho_f gV_f$.

$m = \dfrac{w}{g} = \rho_f V = (1000 \text{ kg/m}^3)(4.5 \text{ m})(2.0 \text{ m})(0.29 \text{ m}) = \boxed{2.6 \times 10^3 \text{ kg}}$.

69. First find the volume of the crown with buoyancy. $F_b = (0.80 \text{ kg})(9.80 \text{ m/s}^2) - 7.30 \text{ N} = 0.54 \text{ N}$.

Since $F_b = \rho_f gV_f$, $V = \dfrac{F_b}{\rho_f g} = \dfrac{0.54 \text{ N}}{(1000 \text{ kg/m}^3)(9.80 \text{ m/s}^2)} = 5.51 \times 10^{-5} \text{ m}^3$.

So the density is $\rho = \dfrac{m}{V} = \dfrac{0.80 \text{ kg}}{5.51 \times 10^{-5} \text{ m}^3} = 14.5 \times 10^3 \text{ kg/m}^3 < \rho_g = 19.3 \times 10^3 \text{ kg/m}^3$. $\boxed{\text{No}}$.

70. The tension in the scale (scale reading) is the difference between the weight and buoyant force.

$T = mg - F_b = \rho gV - \rho_f gV = (\rho - \rho_f)gV = (7800 \text{ kg/m}^3 - 1000 \text{ kg/m}^3)(9.80 \text{ m/s}^2)(0.30 \text{ m})^3 = \boxed{1.8 \times 10^3 \text{ N}}$.

73. $m = \rho V = (200 \text{ kg/m}^3)(0.100 \text{ m})^3 = 0.200 \text{ kg}$. $F_b = 7.84 \text{ N} + mg = 7.84 \text{ N} + (0.200 \text{ kg})(9.80 \text{ m/s}^2) = 9.80 \text{ N}$.

$F_b = \rho_f gV_f$, ☞ $\rho_f = \dfrac{F_b}{gV} = \dfrac{9.80 \text{ N}}{(9.80 \text{ m/s}^2)(0.100 \text{ m})^3} = \boxed{1.00 \times 10^3 \text{ kg/m}^3 \text{ (Probably } H_2O)}$.

76. (a) For the girl to float, $w = mg = F_b = \rho_f gV_f = \rho_f g(0.90V)$.

So $\rho_m = \dfrac{m}{V} = (0.97)\rho_f = (0.97)(1000 \text{ kg/m}^3) = \boxed{9.7 \times 10^2 \text{ kg/m}^3}$.

(b) $\rho_w = \dfrac{w}{V} = \rho_m g = (970 \text{ kg/m}^3)(9.80 \text{ m/s}^2) = \boxed{9.5 \times 10^3 \text{ N/m}^3}$.

87. $A_1 v_1 = A_2 v_2$, ☞ $v_2 = \dfrac{A_1}{A_2} v_1 = \dfrac{\pi (0.20 \text{ m})^2}{\pi (0.35 \text{ m})^2} \times (3.0 \text{ m/s}) = \boxed{0.98 \text{ m/s}}$.

$\boxed{90}$. $A_1 v_1 = A_2 v_2$, ☞ $v_2 = \dfrac{A_1}{A_2} v_1 = \dfrac{\pi (1.00 \text{ cm})^2}{\pi (0.800 \text{ cm})^2} \times (0.265 \text{ m/s}) = 0.414 \text{ m/s}$.

So the increase is $\Delta v = 0.414 \text{ m/s} - 0.265 \text{ m/s} = \boxed{0.149 \text{ m/s}}$.

91. From Bernoulli's principle, $p_1 + \frac{1}{2}\rho v_1^2 + = p_2 + \frac{1}{2}\rho v_2^2$,

$\Delta p = \frac{1}{2}\rho(v_2^2 - v_1^2) = \frac{1}{2}(1.06 \times 10^3 \text{ kg/m}^3)[(0.414 \text{ m/s})^2 - (0.265 \text{ m/s})^2] = \boxed{53.6 \text{ Pa}}$.

$\boxed{94}$. (a) Use Bernoulli's principle, $p_1 + \frac{1}{2}\rho v_1^2 + \rho g y_1 = p_2 + \frac{1}{2}\rho v_2^2 + \rho g y_2$.

Here $p_1 = p_2 = p_a$, and $v_1 \approx 0$ (at the top of the water surface), so $v_2 = \sqrt{2g\Delta y}$.

For the 40-cm high (upper) hole, $v_u = \sqrt{2(9.80 \text{ m/s}^2)(0.05 \text{ m})} = 0.990 \text{ m/s} = \boxed{0.99 \text{ m/s}}$;

for the 30-cm high (middle) hole, $v_m = \sqrt{2(9.80 \text{ m/s}^2)(0.15 \text{ m})} = 1.71 \text{ m/s} = \boxed{1.7 \text{ m/s}}$;

for the 20-cm high (bottom) hole, $v_b = \sqrt{2(9.80 \text{ m/s}^2)(0.25 \text{ m})} = 2.21 \text{ m/s} = \boxed{2.2 \text{ m/s}}$;

for the 10-cm high (bottom) hole, $v_b = \sqrt{2(9.80 \text{ m/s}^2)(0.35 \text{ m})} = 2.62 \text{ m/s} = \boxed{2.6 \text{ m/s}}$.

(b) They are all horizontal projectile motions. First find the time of flight from the vertical motion.

$y = \frac{1}{2}gt^2$, ☞ $t = \sqrt{\dfrac{2y}{g}}$. So the range is $x = v_x t = v_x \sqrt{\dfrac{2y}{g}}$. Therefore

$x_1 = (0.990 \text{ m/s})\sqrt{\dfrac{2(0.40 \text{ m})}{9.80 \text{ m/s}^2}} = 0.28 \text{ m}$; $x_2 = (1.71 \text{ m/s})\sqrt{\dfrac{2(0.30 \text{ m})}{9.80 \text{ m/s}^2}} = 0.42 \text{ m}$;

$x_3 = (2.21 \text{ m/s})\sqrt{\dfrac{2(0.20 \text{ m})}{9.80 \text{ m/s}^2}} = 0.45 \text{ m}$; $x_4 = (2.62 \text{ m/s})\sqrt{\dfrac{2(0.10 \text{ m})}{9.80 \text{ m/s}^2}} = 0.37 \text{ m}$.

So the greatest range $\boxed{0.45 \text{ m}}$ is $\boxed{\text{from } y = 20 \text{ cm}}$.

96. Use Bernoulli's principle, $p_1 + \frac{1}{2}\rho v_1^2 + \rho g y_1 = p_2 + \frac{1}{2}\rho v_2^2 + \rho g y_2$.

With $v_1 = 0$, it becomes $\frac{1}{2}\rho v_2^2 = p_1 - p_2 + \rho g(y_1 - y_2)$.

$$v_2 = \sqrt{\frac{2(p_1 - p_2)}{\rho} + 2g(y_1 - y_2)} = \sqrt{\frac{2(1.40 \times 10^5 \text{ Pa})}{1000 \text{ kg/m}^3} + 2(9.80 \text{ m/s}^2)(-10.0 \text{ m})} = 9.165 \text{ m/s}.$$

$Q = A_2 v_2 = \pi(0.0500 \text{ m})^2(9.165 \text{ m/s}) = 0.0719 \text{ m}^3\text{/s} = \boxed{71.9 \text{ L/s}}$.

107. $T = w = \rho_r g V_r = 2.94$ N, ☞ $V_r = \dfrac{T}{\rho_r g} = \dfrac{2.94 \text{ N}}{(2500 \text{ kg/m}^3)(9.80 \text{ m/s}^2)} = 1.20 \times 10^{-4} \text{ m}^3$.

The spring force is $F_s = k\,x = (200 \text{ N/m})(0.0100 \text{ m}) = 2.00$ N.

The buoyant force is $F_b = \rho g V = w - F_s = 2.94 \text{ N} - 2.00 \text{ N} = 0.94$ N.

So $\rho = \dfrac{F_b}{gV} = \dfrac{0.94 \text{ N}}{(9.80 \text{ m/s}^2)(1.20 \times 10^{-4} \text{ m}^3)} = \boxed{8.0 \times 10^2 \text{ kg/m}^3}$.