Chapter 15

An open-tube mercury manometer (see figure) is connected to a gas tank. What is the absolute pressure of the gas if $h = 0.60$ m and a nearby mercury barometer reads 76 cm.Hg? (Density of mercury = 13.6*10^3 kg/m^3)

\[ P_o = P + \rho g h \]

\[ \Rightarrow P = P_o - \rho g h \]

\[ = 1.01 \times 10^{5} - 13.6 \times 10^{3} \times 0.6 \]

\[ = 2.1 \times 10^{4} \text{ Pa} \]

A block of wood floats in water with 2/3 of its volume submerged. In oil, it has 0.900 of its volume submerged. Find the density of oil.

\[ \frac{1}{3} = 1 - \frac{P}{P_o} \Rightarrow \rho = \rho_o \times \frac{2}{3} = 667 \text{ kg/m}^3 \]

\[ 0.1 = 1 - \frac{P}{P_o} \Rightarrow \rho_{o.e} = \frac{P}{0.9} = \frac{667}{0.9} = 741 \text{ kg/m}^3 \]

A block of wood floats in water with 0.67 of its volume submerged. The density of water is 1000 kg/(m**3). When the same block floats in oil, 0.90 of its volume is submerged. Find the density of the oil.

\[ 744 \text{ kg/(m}^3) \]

\[ 838 \text{ kg/(m}^3) \]

\[ 500 \text{ kg/(m}^3) \]

\[ 626 \text{ kg/(m}^3) \]

\[ 893 \text{ kg/(m}^3) \]

Same idea as above.
What is the area of the smallest cylindrical slab of ice, 0.5 m thick, that will just support a man of mass 100 kg. The density of the ice is $0.917 \times (10^{+3})$ kg/(m$^2$), and it is floating on fresh water.

A. 2.41 m$^2$
B. 0.20 m$^2$
C. 0.10 m$^2$
D. none of these answers
E. 1.20 m$^2$

\[
Mg + mg = F_w = \rho g V
\]

\[
Mg + \rho_i g V = \rho w g V
\]

\[
V = AR \Rightarrow M g = (\rho_w - \rho_i) g A R
\]

\[
A = \frac{2.41 m^2}{(1000 - 917) \times 0.5}
\]

The rate of flow of water through a horizontal pipe is 4.0 m$^3$/minute. What is speed of flow at point where the radius of the pipe is 0.05 m?

A. 8.5 m/s
B. 7.4 m/s
C. 7.6 m/s
D. 6.5 m/s
E. 5.5 m/s

\[
A v = \text{Constant}
\]

\[
\frac{4}{60} = 0.067 m^3 \Rightarrow \pi R^2 v
\]

\[
v = \frac{0.067}{\pi (0.05)^2} \Rightarrow 8.5 m/s
\]

Water flows through a horizontal pipe of non-uniform cross-section. The pressure is 4.50 $\times (10^{+5})$ Pascals at a point where the speed is 2.00 m/s and the cross-sectional area is "A". Find the pressure at a point where the area is "$A/4". The density of water is 1000 kg/(m$^2$).

A. 3.14$\times (10^{+5})$ Pascals
B. 3.83$\times (10^{+5})$ Pascals
C. 4.50$\times (10^{+5})$ Pascals
D. 4.20$\times (10^{+5})$ Pascals
E. 4.02$\times (10^{+5})$ Pascals

\[
P + \frac{1}{2} \rho v_1^2 = P + \frac{1}{2} \rho v_2^2
\]

\[
A_1 v_1 = A_2 v_2
\]

\[
A_1 \frac{4 \times 2}{A_2} = \frac{4 \times 2}{8 m^2}
\]

\[
4.5 \times 10^5 + \frac{1}{2} (1000) (2)^2 = P_2 + \frac{1}{2} (1000) (8)^2
\]

\[
\Rightarrow P_2 = 4.2 \times 10^5 \text{ Pa}
\]
Water is flowing at 5.00 m/s in a pipe where the cross section is 6.00 cm² and the pressure is 1.5 * 10⁵ N/m². If the area gradually becomes 8.00 cm² at a point 10.0 m below the first point, find the pressure at the second point.

\[ P_1 + \frac{1}{2} \rho v_1^2 + \rho g h_1 = P_2 + \frac{1}{2} \rho v_2^2 + \rho g h_2 \]
\[ A_1 v_1 = A_2 v_2 \Rightarrow v_2 = \frac{A_1}{A_2} v_1 = 5 \frac{v_1}{2} \]

\[ 1.5 \times 10^5 + \frac{1}{2} \left( 1000 \right) \left( 5 \right)^2 + \left( 1000 \right) \left( 9.8 \right) \left( 10 \right) = P_2 + \frac{1}{2} \left( 1000 \right) \left( 2.5 \right)^2 \]

\[ P_2 = 2.57 \times 10^5 \text{ N/m}^2 \]

Water enters the first floor of a house through a pipe 2.0 cm in diameter and at an absolute pressure of 4 * (10⁵) Pa. The pipe leads to a second floor room 5 m above (see figure) where the diameter is 1.0 cm. The flow velocity in the inlet pipe is 4 m/s. What is the flow velocity and pressure in the second room?

\[ A_1 v_1 = A_2 v_2 \Rightarrow v_2 = \frac{A_1}{A_2} v_1 \]
\[ v_2 = \left( \frac{1}{0.5} \right)^2 v_1 = 16 \text{ m/s} \]

Water flows at the rate of 8.00 liter/min from a small hole at the bottom of a tank which is 0.900 m deep (see figure). Find the area of the hole.

\[ A v = \frac{8 \times 10^{-3}}{60} \text{ m}^{-3} \]
\[ A v = \frac{8 \times 10^{-3}}{60} \]
\[ v = 0.131 \text{ m/s} \]
\[ p = p_0 = p_0 \]
\[ v_1 = 0 \]

\[ P_0 + \frac{1}{2} \rho v_1^2 + \rho g h_1 = \rho_0 + \frac{1}{2} \rho v_2^2 + \rho g h_2 \]
\[ v_2 = \sqrt{2gh_1} = 4.2 \text{ m/s} \]
\[ A = \frac{1.3 \times 10^{-4}}{3.17 \times 10^{-4}} = 3.17 \times 10^{-3} \]
A siphon is used to remove water from a container, as shown in the figure. The cross-sectional area of the siphon is 1 cm². Assume that the cross-sectional area of the container is much greater than that of the siphon. How much water is removed from the container in 10 s?

A. $1.51 \times 10^{-3} \text{ m}^3$
B. $0.53 \times 10^{-3} \text{ m}^3$
C. $1.25 \times 10^{-3} \text{ m}^3$
D. $0.23 \times 10^{-3} \text{ m}^3$
E. $4.85 \times 10^{-3} \text{ m}^3$

A tank is filled with water. A hole is punched at a depth of 0.30 m below the surface of the water. The stream strikes the floor at a distance of 0.50 m from bottom of the tank (see figure). Find the depth of water in the tank.

A. 0.031 m
B. 10 m
C. 0.51 m
D. 0.61 m
E. 0.29 m

\[ x = \alpha t \]
\[ y = \frac{1}{2} g t^2 \]
\[ V_0 + \frac{1}{2} g L \sqrt{v_1^2 + y g} = \frac{v_0 + \frac{1}{2} g v_1^2 + y g L}{2 g L} \]
\[ v_2 = \sqrt{2 g h} = 2.42 \text{ m/s} \]
\[ t = \frac{x}{v} = \frac{0.5}{2.42} = 0.21 \]  
\[ y = \frac{1}{2} g t^2 = \frac{1}{2} \times 9.8 \times (0.2)^2 \approx 0.2 \text{ m} \]

D. 0.51 m