•24 A boat floating in fresh water displaces water weighing 35.6 kN. (a) What is the weight of the water this boat displaces when floating in salt water of density 1.10×10^3 kg/m^3? (b) What is the difference between the volume of fresh water displaced and the volume of salt water displaced?

a) Weight of Water displaced = $m_f\, g$ =

Weight of the object = F_g

$$F_g = 35.6 \times 10^3\ \text{N} = \rho_f V_f\, g$$

$$V_1 = \frac{35.6 \times 10^3}{1.1 \times 10^3 \times 9.8} = 3.3\ \text{m}^3.$$

b) in fresh water

$$V_2 = \frac{35.6 \times 10^3}{1 \times 10^3 \times 9.8} = 3.6\ \text{m}^3.$$

$$\Delta V = 0.3\ \text{m}^3.$$

•25 An iron anchor of density 7870 kg/m^3 appears 200 N lighter in water than in air. (a) What is the volume of the anchor? (b) How much does it weigh in air? **SSM**

a) $W_{air} - W_{fluid} = F_b = 200\text{ N}$

$= \rho V g$

$V = \dfrac{200}{1\times10^3 \times 9.8} = 2\times10^{-2}\ m^3.$

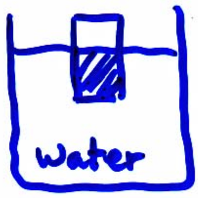
b) $m = \rho V = 7870 \times 2\times10^{-2}$

$=$

$F_g = mg = 7870 \times 2\times10^{-2} \times 9.8$

$= 1.6\times10^3\text{ N}$

•29 A block of wood floats in fresh water with two-thirds of its volume V submerged and in oil with $0.90V$ submerged. Find the density of (a) the wood and (b) the oil. **SSM**



$$F_b = F_g$$

$$\rho_w V_{sub} = \rho_{ob} V_{Total}$$

$$\rho_{ob} = \rho_w \frac{V_{sub}}{V_{Total}}$$

$$= 1\times10^3 \; \frac{2}{3}$$

$$= 6.7\times10^2 \; \frac{Kg}{m^3} .$$

$$F_b = F_g$$

$$\rho_{oil} V_{sub} = \rho_{ob} V_{Total}$$

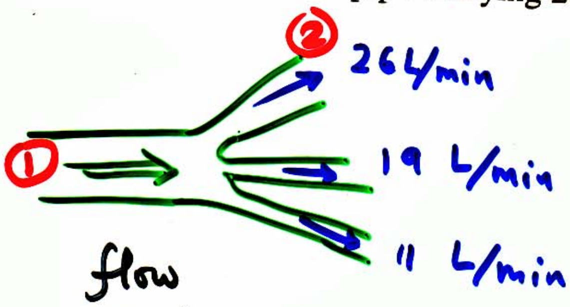
$$\rho_{oil} = \rho_{ob} \frac{V_{Tot}}{V_{sub}}$$

$$= 6.7\times10^2 \; \frac{\cancel{V_{Total}}}{0.9\cancel{V_{Total}}}$$

$$= 741 \; \frac{Kg}{m^3} .$$

••44 The water flowing through a 1.9 cm (inside diameter) pipe flows out through three 1.3 cm pipes. (a) If the flow rates in the three smaller pipes are 26, 19, and 11 L/min, what is the flow rate in the 1.9 cm pipe? (b) What is the ratio of the speed in the 1.9 cm pipe to that in the pipe carrying 26 L/min?

a)



flow In = flow Out

$$R_{in} = (26 + 19 + 11)\frac{L}{min}$$

$$= 56 \frac{L}{min}$$

b)

$$R_1 = A_1 v_1 \Rightarrow v_1 = \frac{R_1}{A_1}$$

$$R_2 = A_2 v_2 \Rightarrow v_2 = \frac{R_2}{A_2}$$

$$\frac{v_1}{v_2} = \frac{R_1}{A_1}\frac{A_2}{R_2} = \frac{56}{26}\frac{\cancel{\pi} r_2^2}{\cancel{\pi} r_1^2}$$

$$= \frac{56}{26}\left(\frac{1.3}{1.9}\right)^2 = 1.$$

•46 The intake in Fig. 14-44 has cross-sectional area of 0.74 m^2 and water flow at 0.40 m/s. At the outlet, distance D = 180 m below the intake, the cross-sectional area is smaller than at the intake and the water flows out at 9.5 m/s. What is the pressure difference between inlet and outlet?

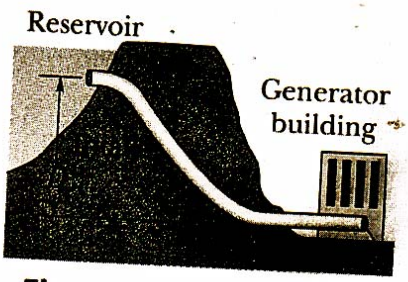


Fig. 14-44 Problem 46.

$$p_1 + \frac{1}{2}\rho v_1^2 + \rho g \underset{\overset{\shortparallel}{D}}{y_1} = p_2 + \frac{1}{2}\rho v_2^2 + \rho g \cancelto{0}{y_2}$$

$$p_2 - p_1 = \frac{1}{2}\rho\left(v_1^2 - v_2^2\right) + \rho g D$$

$$= \frac{1}{2} \times 1000\left(0.4^2 - 9.5^2\right) + 1000 \times 9.8 \times 180$$

$$= 1.76 \times 10^7 \text{ Pa}$$

••**53** In Fig. 14-46, the fresh water behind a reservoir dam has depth D = 15 m. A horizontal pipe 4.0 cm in diameter passes through the dam at depth d = 6.0 m. A plug secures the pipe opening. (a) Find the magnitude of the frictional force between plug and pipe wall. (b) The plug is removed. What water volume exits the pipe in 3.0 h? ILW

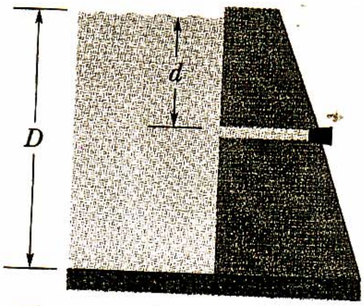
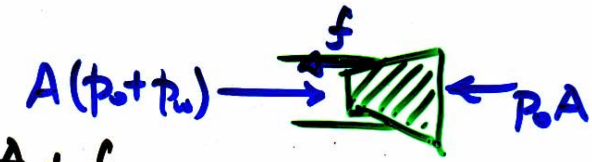


Fig. 14-46 Problem 53.

a)

Newton 2nd law



$$A(p_0+p_w) = p_0 A + f$$

$$f = p_w A = \rho_w g d A = \rho_w g d \pi \underbrace{r^2}_{r = 2\times10^{-2}\,m}$$

$$= \underline{74\,N}$$

b) $$\underbrace{p_1}_{p_0} + \frac{1}{2}\rho \underbrace{v_1^2}_{\simeq 0} + \rho g \underbrace{y_1}_{D} = \underbrace{p_2}_{p_0} + \frac{1}{2}\rho \underbrace{v_2^2}_{?} + \rho g y_2 \quad y_2 = D-d$$

$$\frac{1}{2}\rho v_2^2 = \rho g d$$

$$v_2 = \sqrt{2gd} = 10.8\ m/s$$

$$R = Av\ (m^3/s) \Rightarrow \text{Volume} = Avt = 1.5\times10^{2}\ m^3.$$

••54 In Fig. 14-47, water flows through a horizontal pipe and then out into the atmosphere at a speed $v_1 = 15$ m/s. The diameters of the left and right sections of the pipe are 5.0 cm and 3.0 cm. (a) What volume of water flows into the atmosphere during a 10 min period? In the left section of the pipe, what are (b) the speed v_2 and (c) the gauge pressure?

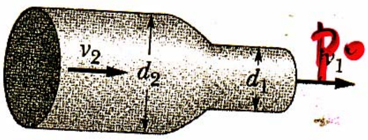


Fig. 14-47 Problem 54.

a) $v_1 = 15$ m/s

$$R = A_1 v_1 = \pi r_1^2 v_1$$

$$= \pi (0.015)^2 \times 15 = 0.01 \ \frac{m^3}{s}$$

$$\text{Volume} = 0.01 \times 10 \times 60 = 6.4 \ m^3.$$

b) $$A_1 v_1 = A_2 v_2$$

$$v_2 = \frac{A_1}{A_2} v_1 = \left(\frac{r_1}{r_2}\right)^2 v_1$$

$$v_2 = 15 \times \left(\frac{0.015}{0.05}\right)^2 = 5.4 \text{ m/s.}$$

c) $$p_1 + \frac{1}{2}\rho v_1^2 + \cancel{\rho g h_1} = p_2 + \frac{1}{2}\rho v_2^2 + \cancel{\rho g h_2}$$

p_0 ″

$$p_2 = p_0 + \underbrace{\frac{1}{2}\rho (v_1^2 - v_2^2)}_{\text{gauge pressure}} = 9.8 \times 10^4 \text{ Pa.}$$