37. (I) Show that Bernoulli's equation reduces to the hydrostatic variation of pressure with depth (Eq. 10–3b) when there is no flow $(v_1 = v_2 = 0)$.

38. (I) How fast does water flow from a hole at the bottom of a very wide, 4.6-m-deep storage tank filled with water? Ignore viscosity.

39. (II) A $\frac{5}{8}$-inch (inside) diameter garden hose is used to fill a round swimming pool 6.1 m in diameter. How long will it take to fill the pool to a depth of 1.2 m if water issues from the hose at a speed of 0.40 m/s?

40. (II) What gauge pressure in the water mains is necessary if a firehose is to spray water to a height of 15 m?

41. (II) A 6.0-cm-diameter horizontal pipe gradually narrows to 4.0 cm. When water flows through this pipe at a certain rate, the gauge pressure in these two sections is 32.0 kPa and 24.0 kPa, respectively. What is the volume rate of flow?

42. (II) What is the volume rate of flow of water from a 1.85-cm-diameter faucet if the pressure head is 15.0 m?

43. (II) If wind blows at 35 m/s over a house, what is the net force on the roof if its area is 240 m^2 and is flat?

44. (II) What is the lift (in newtons) due to Bernoulli's principle on a wing of area 78 m^2 if the air passes over the top and bottom surfaces at speeds of 260 m/s and 150 m/s, respectively?

45. (II) Estimate the air pressure inside a category 5 hurricane, where the wind speed is 300 km/h (Fig. 10–52).

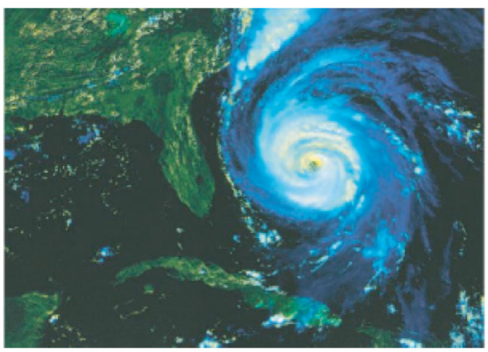

FIGURE 10–52 Problem 45.

46. (II) Water at a gauge pressure of 3.8 atm at street level flows into an office building at a speed of 0.60 m/s through a pipe 5.0 cm in diameter. The pipe tapers down to 2.6 cm in diameter by the top floor, 18 m above (Fig. 10–53), where the faucet has been left open. Calculate the flow velocity and the gauge pressure in such a pipe on the top floor. Assume no branch pipes and ignore viscosity.

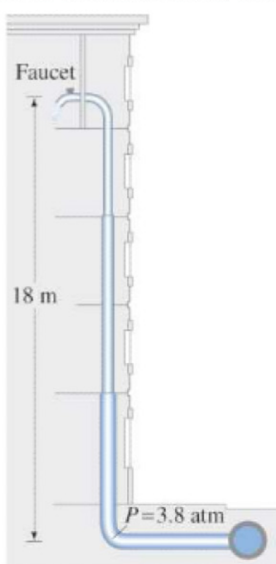

FIGURE 10–53 Problem 46.

47. (III) (*a*) Show that the flow velocity measured by a venturi meter (see Fig. 10–30) is given by the relation

$$v_1 = A_2\sqrt{\frac{2(P_1 - P_2)}{\rho(A_1^2 - A_2^2)}}.$$

(*b*) A venturi tube is measuring the flow of water; it has a main diameter of 3.0 cm tapering down to a throat diameter of 1.0 cm. If the pressure difference is measured to be 18 mm-Hg, what is the velocity of the water?

48. (III) In Fig. 10–54, take into account the speed of the top surface of the tank and show that the speed of fluid leaving the opening at the bottom is

$$v_1 = \sqrt{\frac{2gh}{(1 - A_1^2/A_2^2)}},$$

where $h = y_2 - y_1$, and A_1 and A_2 are the areas of the opening and of the top surface, respectively. Assume $A_1 \ll A_2$ so that the flow remains nearly steady and laminar.

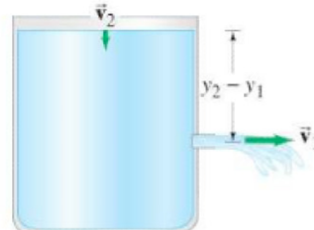

FIGURE 10–54 Problems 48 and 49.

49. (III) Suppose the opening in the tank of Fig. 10–54 is a height h_1 above the base and the liquid surface is a height h_2 above the base. The tank rests on level ground. (*a*) At what horizontal distance from the base of the tank will the fluid strike the ground? (*b*) At what other height, h_1', can a hole be placed so that the emerging liquid will have the same "range"? Assume $v_2 \approx 0$.

* 10–11 Viscosity

* 50. (II) A *viscometer* consists of two concentric cylinders, 10.20 cm and 10.60 cm in diameter. A particular liquid fills the space between them to a depth of 12.0 cm. The outer cylinder is fixed, and a torque of 0.024 m·N keeps the inner cylinder turning at a steady rotational speed of 62 rev/min. What is the viscosity of the liquid?

* 10–12 Flow in Tubes; Poiseuille's Equation

* 51. (I) A gardener feels it is taking him too long to water a garden with a $\frac{3}{8}$-in.-diameter hose. By what factor will his time be cut if he uses a $\frac{5}{8}$-in.-diameter hose? Assume nothing else is changed.

* 52. (II) Engine oil (assume SAE 10, Table 10–3) passes through a 1.80-mm-diameter tube in a prototype engine. The tube is 5.5 cm long. What pressure difference is needed to maintain a flow rate of 5.6 mL/min?

* 53. (II) What must be the pressure difference between the two ends of a 1.9-km section of pipe, 29 cm in diameter, if it is to transport oil $(\rho = 950\ kg/m^3,\ \eta = 0.20\ Pa\cdot s)$ at a rate of 450 cm^3/s?

* 54. (II) What diameter must a 21.0-m-long air duct have if the ventilation and heating system is to replenish the air in a room 9.0 m × 12.0 m × 4.0 m every 10 min? Assume the pump can exert a gauge pressure of 0.71×10^{-3} atm.

* 55. (II) Calculate the pressure drop per cm along the aorta using the data of Example 10–11 and Table 10–3.