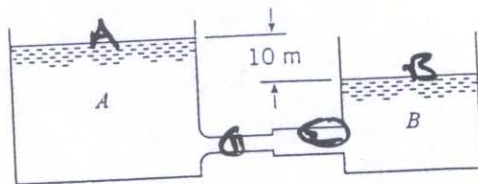


7.41 Water is draining from tank A to tank B. The elevation difference between the two tanks is 10 m. The pipe connecting the two tanks has a sudden expansion section as shown. The cross-sectional area of the pipe from A is  $10 \text{ cm}^2$ , and the area of the pipe into B is  $20 \text{ cm}^2$ . Assume the head loss in the system consists only of that due to the sudden expansion section and the loss due to flow into tank B. Find the discharge between the two tanks.



PROBLEM 7.41

$$\frac{P_A}{\rho} + \frac{V_A^2}{2g} + z_A = \frac{P_B}{\rho} + \frac{V_B^2}{2g} + z_B + h_{L1} + h_{L2}$$

$$h_{L1} = \frac{1}{2g} [V_1 - V_2]^2 \quad h_{L2} = \frac{1}{2g} [V_2^2]$$

$$z_A - z_B = \frac{1}{2g} [V_1 - V_2]^2 + \frac{1}{2g} V_2^2$$

Continuity from (1)  $\rightarrow$  (2)

$$\rho A_1 V_1 = \rho A_2 V_2 \Rightarrow V_1 = V_2 \frac{A_2}{A_1} = 2V_2$$

$$z_A - z_B = \frac{1}{2g} [2V_2 - V_2]^2 + \frac{1}{2g} V_2^2 = \frac{V_2^2}{g}$$

$$V_2 = \sqrt{g(z_A - z_B)} = \sqrt{g(10)}$$

$$Q = V_2 A_2 = \sqrt{g(10)} \cdot 20 \text{ cm}^2 \times 10^{-4} \frac{\text{m}^2}{\text{cm}^2} = 0.0198 \text{ m}^3/\text{s}$$