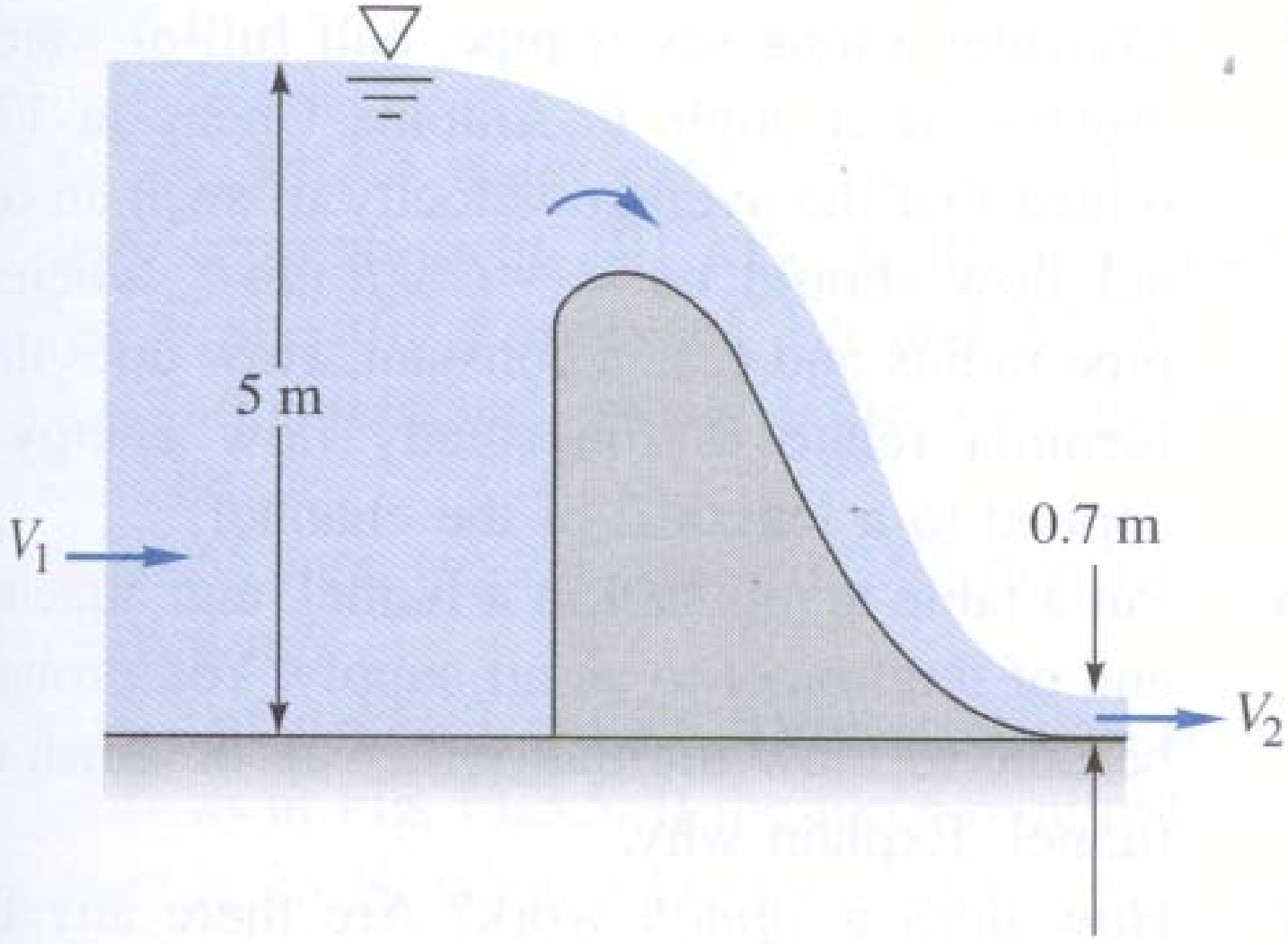
P3.176 In the spillway flow of Fig. P3.176, the flow is assumed uniform and hydrostatic at sections 1 and 2. If losses are neglected, compute (*a*) V_2 and (*b*) the force per unit width of the water on the spillway.



P3.176

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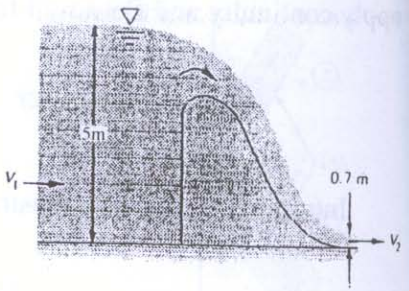

Fig. P3.176

Solution: For mass conservation,

$$V_2 = V_1 h_1/h_2 = \frac{5.0}{0.7} V_1 = 7.14 V_1$$

(a) Now apply Bernoulli from 1 to 2:

$$\frac{p_1}{\gamma} + \frac{V_1^2}{2g} + h_1 \approx \frac{p_2}{\gamma} + \frac{V_2^2}{2g} + h_2; \quad \text{or:} \quad 0 + \frac{V_1^2}{2g} + 5.0 \approx 0 + \frac{(7.14V_1)^2}{2g} + 0.7$$

Solve for $V_1^2 = \dfrac{2(9.81)(5.0-0.7)}{[(7.14)^2 - 1]}$, or $V_1 = \mathbf{1.30}\ \dfrac{\mathbf{m}}{\mathbf{s}}$, $V_2 = 7.14V_1 = \mathbf{9.28}\ \dfrac{\mathbf{m}}{\mathbf{s}}$ *Ans.* (a)

(b) To find the force on the spillway (F ←), put a CV around sections 1 and 2 to obtain

$$\Sigma F_x = -F + \frac{\gamma}{2} h_1^2 - \frac{\gamma}{2} h_2^2 = \dot{m}(V_2 - V_1), \quad \text{or, using the given data,}$$

$$F = \frac{1}{2}(9790)[(5.0)^2 - (0.7)^2] - 998[(1.30)(5.0)](9.28 - 1.30) \approx \mathbf{68300}\ \frac{\mathbf{N}}{\mathbf{m}} \quad \textit{Ans.}\ (b)$$