

$$\textcircled{1} Z_1 = 0$$

$$Z_2 = 2.0 \text{ m}$$

$$V_1 = 5 \text{ m/s}$$

$$V_2 = 2 \text{ m/s}$$

$$\text{The pressure, } h, \frac{P}{w} = 2.5 \text{ m}$$

$$\frac{P_2}{w} = ??$$

$$\begin{aligned} hf &= \frac{0.35 (V_1 - V_2)^2}{2g} \\ &= \frac{0.35 (5-2)^2}{2 \times 9.81} = \frac{0.35 \times 9}{2 \times 9.81} \\ &= 0.1606 \text{ m} \end{aligned}$$

Applying Bernoulli's equation.

$$\frac{P_1}{w} + \frac{V_1^2}{2g} + Z_1 = \frac{P_2}{w} + \frac{V_2^2}{2g} + Z_2 + hf$$

$$\frac{P_2}{w} = \frac{P_1}{w} + \frac{V_1^2}{2g} + Z_1 - \frac{V_2^2}{2g} - Z_2 - hf$$

$$= 2.5 + \frac{5^2}{2 \times 9.81} + 0 - \frac{2^2}{2 \times 9.81} - 2.0 - 0.1606$$

$$= 2.5 + 1.274 - 0.204 - 0.1606 - 2.0$$

$$= 1.4094 \text{ m}$$

$$= 1.41 \text{ m}$$

$$\therefore h_2, \frac{P_2}{w} = 1.41 \text{ m}$$

$$\textcircled{2} d_1 = \frac{20}{100} = 0.2 \text{ m}$$

$$d_2 = \frac{10}{100} = 0.1 \text{ m}$$

$$A_1 = \frac{\pi d^2}{4} = \frac{\pi (0.2)^2}{4}$$

$$= 0.0314 \text{ m}^2$$

$$A_2 = \frac{\pi d^2}{4} = \frac{\pi (0.1)^2}{4}$$

$$= 0.00785 \text{ m}^2$$

$$P_1 = 17.658 \text{ N/cm}^2$$

$$= 17.658 \times 10^4$$

$$= 176580 \text{ N/m}^2$$

$$P_2 = 30 \text{ cm of mercury}$$

$$= 0.3 \text{ m of Hg}$$

$$= -0.3 \text{ m Hg} \times 13.6$$

$$h_2 = -4.08 \text{ m}$$

$$P_2 \quad h_1 = \frac{P_1}{\rho g} = \frac{176580}{1000 \times 9.81}$$

$$= 18 \text{ m}$$

$$\therefore h = h_1 - h_2$$

$$h = 18 - (-4.08)$$

$$= 18 + 4.08$$

$$= 22.08$$

$$Q = \frac{C_d (A_1 - A_2) \sqrt{2gh}}{\sqrt{A_1^2 - A_2^2}}$$

$$= \frac{0.98 \times 0.0314 \times 0.00785 \times \sqrt{2 \times 9.81 \times 22}}{\sqrt{(0.0514)^2 - (0.00736)^2}}$$

$$Q = \frac{0.00503}{0.0304}$$

$$Q = 0.1653 \text{ m}^3/\text{s}$$

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Orifice diameter, $d_o = 15 \text{ cm} = 0.15 \text{ m}$

Pipe diameter, $d_i = 30 \text{ cm} = 0.3 \text{ m} \therefore C_d = 0.61$

$$A_o = \frac{\pi d_o^2}{4} = \frac{\pi (0.15)^2}{4} = 0.01767 \text{ m}^2$$

$$A_i = \frac{\pi d_i^2}{4} = \frac{\pi (0.30)^2}{4} = 0.070686 \text{ m}^2$$

Differential head

$$y = 50 \text{ cm}$$

$$= 0.5 \text{ m}$$

$$h = \frac{P}{w} = y \left(\frac{\text{S.G. of mercury} - 1}{\text{S.G. of oil}} \right)$$
$$= 0.5 \left(\frac{13.6 - 1}{0.9} \right)$$

$$= 0.5(14.11) = 7.06 \text{ m}$$

$$h = 7.06 \text{ m}$$

$$Q = \frac{Cd \times A_1 A_2 - \sqrt{2gh}}{\sqrt{A_1^2 - A_2^2}}$$

$$= \frac{0.64 \times 0.01767 \times 0.07068 - \sqrt{2 \times 9.81 \times 7.06}}{\sqrt{(0.07068)^2 - (0.01767)^2}}$$

$$= \frac{0.045407}{0.06844}$$

$$0.06844$$

$$Q = 0.1374 \text{ m}^3/\text{s} \approx 0.137 \text{ m}^3/\text{s}$$

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Difference of Hg (g)

$$y = 170 \text{ mm} = \frac{170}{1000} = 0.17 \text{ m}$$

$$\text{S.G. of mercury} = 13.6$$

$$\text{S.G. of sea water} = 1.026$$

$$\therefore h = y \left(\frac{\text{S.G. of Hg} - 1}{\text{S.G. of sea water}} \right)$$

$$= y \left(\frac{13.6}{1.026} - 1 \right)$$

$$= 0.17(12.255)$$

$$= 2.08 \text{ m}$$

$$\text{Velocity} = \sqrt{2gh}$$

$$= \sqrt{2gh}$$

$$= \sqrt{2 \times 9.81 \times 2.08}$$

$$V = 6.39 \text{ m/s}$$