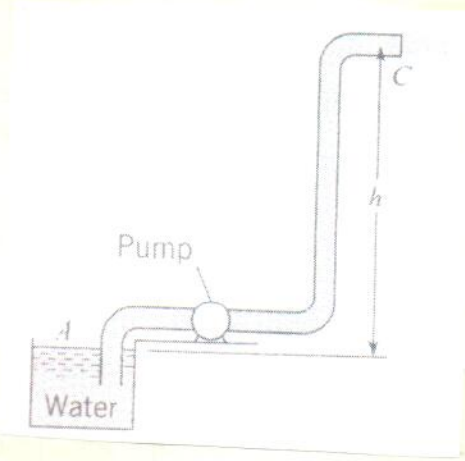
7.34 A pump draws water through a 20 cm suction pipe and discharges it through a 15 cm pipe which has a flow velocity of 5 m/s. To what height, h, above the water surface at pt. A can the water be raised if 35 kW of power is delivered to the pump? Assume that the pump operates at 70% efficiency and that the head loss in the pipe between pts A and C is equal to $2V_c^2/2g$.



35 kW pump is used

reword slightly

The energy eqn between pts A and C is

$$\frac{P_A}{\gamma} + \frac{V_A^2}{2g} + z_A + h_A - h_R - h_L = \frac{P_C}{\gamma} + \frac{V_C^2}{2g} + z_C$$

P_A/γ: free surface; $V_A^2/2g$: free surface; h_R: 0; P_C/γ: free jet

$$\therefore \quad h = z_C - z_A = h_A - h_L - \frac{V_C^2}{2g} = h_A - \frac{3V_C^2}{2g}$$

but $h_L = 2\frac{V_C^2}{2g}$

also

$$Q = A_C V_C = \frac{\pi}{4}(0.15\,m)^2\left(\frac{5\,m}{s}\right) = (0.01767\,m^2)\left(5\,\frac{m}{s}\right)$$

$$= \boxed{0.08836\ m^3/s}$$

$$P_A = \eta P_I = 0.70\,(35\,kW) = 24.5\,kW$$ power added to fluid

power added

$$h_A = \frac{P_A}{\gamma Q} = \frac{24.5\,kW}{\left(9.81\,\frac{kN}{m^3}\right)\left(0.08836\,m^3/s\right)}$$ units $\frac{kN\text{-}m/s}{\frac{kN}{m^3}\,\frac{m^3}{s}} = m$ OK

$$= 28.26\ m$$

$$\frac{V_C^2}{2g} = \frac{(5\,m/s)^2}{2(9.8\,m/s^2)} = 1.276\ m$$

$$\therefore \quad h = 28.26\,m - 3(1.276\,m) = 24.48\,m \Rightarrow \boxed{24.5\,m}$$

ans