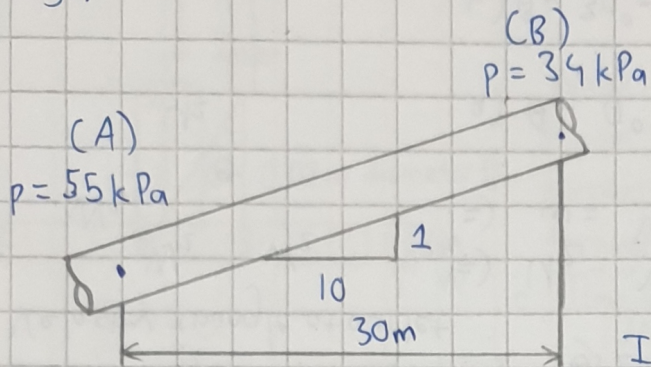


Nguyen Xuan Binh 887799 Round 4 Problem 1



Water flows steadily from one location to another in the inclined pipe. Which way is the water flowing?

Extended Bernoulli equation

$$\frac{p_A}{\rho g} + \frac{v_A^2}{2g} + z_A + h_p = \frac{p_B}{\rho g} + \frac{v_B^2}{2g} + z_B + h_l$$

In this equation, it assumes that water flows from A to B and thus,  $h_p$  and  $h_l$  should be positive. To find out the true direction, the sign of  $h_p$  and  $h_l$  should be known. In this pipe, there is no bumper  $\Rightarrow$  no external force  $\Rightarrow h_p = 0$ . Direction of the flow depends only on  $h_l$  (head loss)

□ Conservation of mass:  $\dot{m}_A = \dot{m}_B \Rightarrow \rho V_A A_A = \rho V_B A_B \Rightarrow V_A = V_B$  (steady flow)

□ Let  $z_A = 0 \Rightarrow z_B = \frac{30}{3 \cdot 10 \times 1} = 3 \text{ m}$ . The extended Bernoulli equation now simplified:

$$\frac{p_A}{\rho g} + h_p = \frac{p_B}{\rho g} + z_B + h_l \Rightarrow \frac{p_A}{\rho g} = \frac{p_B}{\rho g} + 3 + h_l$$

$$\Rightarrow h_l = \frac{(p_A - p_B)}{\rho g} - 3 = \frac{(55000 - 34000)}{1000 \cdot 9.81} - 3 \approx 2.14 - 3 \approx -0.859 \text{ m}$$

$h_l$  is negative  $\Rightarrow$  true flow is reverse of the assumed direction (A)  $\rightarrow$  (B)

Answer: The water flows from (B) to (A) in the pipe