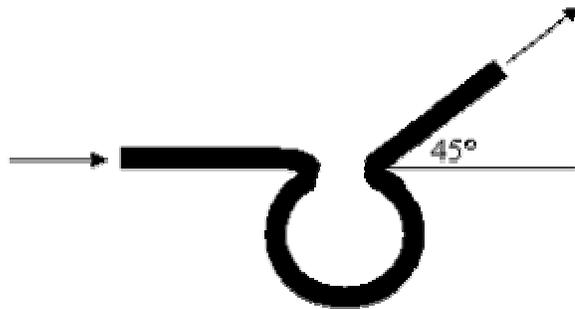


**Question #1:**

Water ( $\rho = 1000 \text{ kg/m}^3$ ,  $\mu = 0.001 \text{ Pa}\cdot\text{s}$ ) is flowing in a horizontal loop of cast iron pipe (inner diameter = 5 cm,  $\varepsilon = 0.25 \text{ mm}$ ) with an average velocity of 2 m/s as shown in the figure below. The water from the loop exits at atmosphere pressure. The total equivalent length of the pipe is 10 meter.

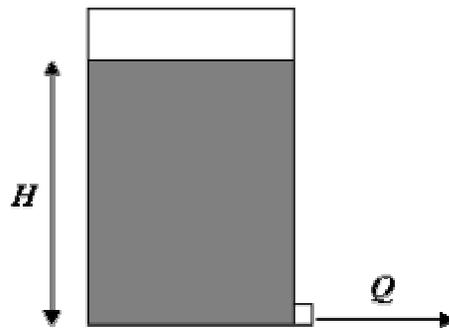
- (a) Calculate the pressure at the entrance of the loop.
- (b) Calculate the magnitude and direction of the force needed to keep the loop in place.



**Question #2:**

A tank (base area,  $A = 0.5 \text{ m}^2$ ) has a hole (cross sectional area,  $a = 8 \times 10^{-5} \text{ m}^2$ ) in its wall adjacent to the bottom as shown in the figure. It is filled with water ( $\rho = 1000 \text{ kg/m}^3$ ) while the hole is blocked. The hole is opened suddenly when the initial level of the water,  $H$ , is 1 meter.

- Obtain an expression of instantaneous volumetric flow rate ( $Q$ ) of water from the hole and calculate its value of the flow rate after 5 minutes.
- Obtain an expression for x-direction force needed to keep the tank in place. Calculate the force required to keep the tank in place after 5 minutes.



**Question # 3:**

An equivalent length of 300 meter of commercial steel pipe (inner diameter = 5.25 cm, roughness = 0.046 mm) is used to pump water ( $\rho = 1000 \text{ kg/m}^3$ ,  $\mu = 0.001 \text{ Pa}\cdot\text{s}$ ) from a lake to a storage tank ( Capacity = 7400 liters) build at the top of a 60 meter high building. The lake and the tank are at atmospheric pressure. Calculate the power of the motor of the pump if the tank is to be filled in in 30 minutes.

**Question 4a:**

A horizontal pipe is designed for a given  $L$ ,  $D$ ,  $Q$ ,  $\mu$ ,  $\rho$ ,  $\varepsilon$  and  $\Delta P$ , where all symbols have their usual meanings. It is anticipated that the roughness will change due to corrosion and the resulting value of the friction factor ( $f_F$ ) will be twice of the value which was used in the original design. Find out the ratio of the new diameter and the design diameter if other parameters are not changed.

**Question 4b:**

Following figure shows two pressure gauges that are mounted on a vertical water pipe of 15 meters apart. Both of these gauges read exactly same pressure of 0.5 atm.

- Is water flowing? Why?
- If yes, in what direction is it flowing?

