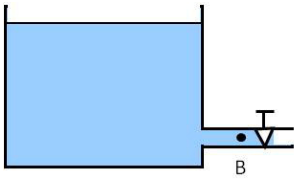

Figure 7.16: Problem 7.6.1

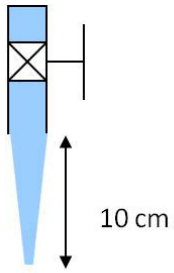

Figure 7.17: Problem 7.6.2

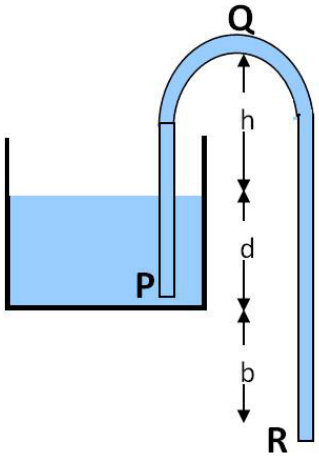

Figure 7.18: Problem 7.6.3

7.6 PROBLEMS

Problem 7.6.1. A filled large water tank has a pipe of cross-sectional area 1.2 cm^2 attached at a depth 30 cm from the top. There is a valve controlling the flow of water through the pipe. Find the pressure at a point B in the pipe, (a) when no water is flowing, and, (b) when water is flowing steadily.

Ans: (a) $p_{\text{atm}} + 2,940$ Pa; (b) p_{atm}.

Problem 7.6.2. As water falls from a faucet it narrows. What will be the area of cross-section of flow 10-cm from the exit of a water faucet that has an opening of 2 cm diameter if 1/4 liter of water flows per second?

Ans: 1.55 cm^2.

Problem 7.6.3. A siphon is an ingenious device for removing fluid from a container that must not be tipped. In a siphon, you fill a U-tube or a flexible pipe with a liquid, close both ends, invert the pipe and place the higher end in the liquid and the other end in another container. Now, when you open the ends, you find that fluid starts to drain out as long as the highest point Q of the pipe is not too high. Find the maximum height h so that water can drain when the open end in the water is at a depth of d and the other end R of the siphon is a height b below. Denote the density of the fluid by ρ and give your answer in terms of p_{atm}, ρ, g, d and b.

Ans check: $h < 76.5\ cm$.

Problem 7.6.4. Refer to the figure in the problem above. If the area of cross-section of the container is A_0, the volume of water in the container is V, and the area of cross-section of the pipe is A, how long will it take to empty the container? Do not assume the speed of flow inside the container to be zero.

Answer check: For $d = 3b$ and $a = 4$, $T = \sqrt{30b/g}$.

Problem 7.6.5. In an intravenous (IV) line, saline water of density 1.1 g/cc from a raised container flows to a needle with an inside diameter of 0.45 mm, which is inserted in a vein in the arm. Assume the gauge pressure in the vein varies between 20 mmHg and 30 mmHg. Assuming steady non-viscous flow (a) find the range of flow speeds in the needle, and (b) volume rate of flow of the solution per minute, if the container is placed 1.2 meters above the needle?

Ans: (a) 1.31 m/s to 2.57 m/s.

Problem 7.6.6. In a high-rise building, water is pumped from the ground floor to the 30th floor in a pipe of diameter 4 cm. The length

of the pipe is 75 meters. What should be the pressure in the pump so that the flow has a Reynolds number of 1,000. Assume 2.5 m height per floor.

Ans: 380 atm.

Problem 7.6.7. A viscometer is a device that measures viscosity of a liquid. In a common viscometer the liquid is put between two drums, one of which is fixed and the other rotated at a constant angular speed. The torque needed to rotate the drum is related to the viscosity. In a particular viscometer the inner drum is rotated at 50 rev/min. The outer diameter of the inner drum is 5 cm and the inner diameter of the outer fixed drum is 6 cm. The height of the drums is 4 cm. If the torque on the inner drum is measured to be 9.75×10^{-4} $N.m$, what is the viscosity of the fluid?

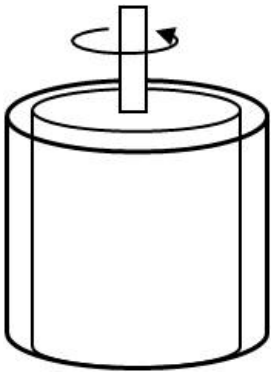

Figure 7.19: Problem 7.6.7