Example 1

A large tank open to the atmosphere is filled with water to a height of 5 m from the outlet tap. A tap near the bottom of the tank is now opened, and water flows out from the smooth and rounded outlet. Determine the water velocity at the outlet.
Example 2

During a trip to the beach ($P_{\text{atm}} = 1 \text{ atm} = 101.3 \text{ kPa}$), a car runs out of gasoline, and it becomes necessary to siphon gas. The siphon is a small-diameter hose, and to start the siphon it is necessary to insert one siphon end in the full gas tank, fill the hose with gasoline via suction, and then place the other end in a gas can below the level of the gas tank. The difference in pressure between point 1 (at the free surface of the gasoline in the tank) and point 2 (at the outlet of the tube) causes the liquid to flow from the higher to the lower elevation. Point 2 is located 0.75 m below point 1 in this case, and point 3 is located 2 m above point 1. The siphon diameter is 4 mm, and frictional losses in the siphon are to be disregarded. Determine (a) the minimum time to withdraw 4 L of gasoline from the tank to the can and (b) the pressure at point 3. The density of gasoline is 750 kg/m$^3$.

Conservation of Energy

The work required to change the energy between points 1 and 2 in a fluid (not in the same streamline)

$$- \frac{dW}{dt} = \dot{m} \left[ \left( \frac{p_2}{\rho} + \frac{v_2^2}{2} + g z_2 \right) - \left( \frac{p_1}{\rho} + \frac{v_1^2}{2} + g z_1 \right) \right]$$
Conservation of Energy

- Energy units are Watts and Horsepower typically
  - 1 Watt = kg m^2 s^(-3) (kilogram meter^2 second^(-3))
  - 1 HP = 745.7 W
  - 1 HP = 550 ft lbf s^(-1)

\[-\frac{dW}{dt} = \dot{m} \left( \frac{p_2}{\rho} + \frac{v_2^2}{2} + gz_2 \right) - \left( \frac{p_1}{\rho} + \frac{v_1^2}{2} + gz_1 \right)\]

Example 3

- Underground water is to be pumped by a 70 percent efficient 3-kW submerged pump to a pool whose free surface is 30 m above the underground water level. The diameter of the pipe is 7 cm on the intake side and 5 cm on the discharge side. Determine (a) the maximum flow rate of water and (b) the pressure difference across the pump. Assume the elevation difference between the pump inlet and the outlet and the effect of the kinetic energy correction factors to be negligible.
Example 4

The water level in a tank is 20 m above the ground. A hose is connected to the bottom of the tank, and the nozzle at the end of the hose is pointed straight up. The tank cover is airtight, and the air pressure above the water surface is 2 atm gage. The system is at sea level. Determine the maximum height to which the water stream could rise.

Homework 11-1

3.54 Water flows into a 1 cm-diameter tank at a rate of 0.006 m³/s, as illustrated in Figure P3.54. Water also leaves the tank through a 5 cm-diameter hole near the bottom. At a certain height h, the efflux equals the influx. Determine the equilibrium height h.

FIGURE P3.54
Homework 11-2

3.60 A siphon is used to drain a tank of water, as shown in Figure P3.60. The siphon tube has an inside diameter of 3 in., and at the exit there is a nozzle that discharges liquid in a 2-in.-diameter jet. Assuming no losses in the system, determine the volume flow rate through the siphon. Also calculate the flow velocity in the 3-in.-ID tube.

![Figure P3.60](image)

Homework 11-3

3.45 A pump is used in a piping system to move oil from one tank to another tank at a higher elevation, as indicated in Figure P3.45. The flow velocity in the piping system is 2 m/s, and the oil has a specific gravity of 0.87. The pipe has an inside diameter of 10.23 cm. Determine the power required to pump the oil under these conditions.

![Figure P3.45](image)