

density of water: $\rho_w = 10^3 \text{ kg/m}^3$

density of air at 20°C: $\rho_{\text{air}} = 1.20 \text{ kg/m}^3$

viscosity of air at 20°C: $\eta = 0.0181 \times 10^{-3} \text{ Pa s}$

gravitational acceleration: $g = 9.8 \text{ m/s}^2$

- 1) The Huka Falls on the Waikato River is one of New Zealand's most visited natural tourist attractions. On average, the river has a flow rate of about 300,000 liter/s. At the gorge, the river narrows to 20 m wide and averages 20 m deep.

- What is the average speed of the river in the gorge?
- What is the average speed of the water in the river downstream of the falls when it widens to 60 m and its depth increases to an average of 40 m?

Fasit: a) 0.75 m/s, b) 0.125 m/s

- 2) A sump pump (used to drain water from the basement of houses built below the water table) is draining a flooded basement at the rate of 0.750 liters/s, with an output pressure of $3.00 \times 10^5 \text{ N/m}^2$. You may neglect frictional losses in both parts of the problem.

- The water enters a hose with a 3.00-cm inside diameter and rises 2.50 m above the pump. What is its pressure at this point?

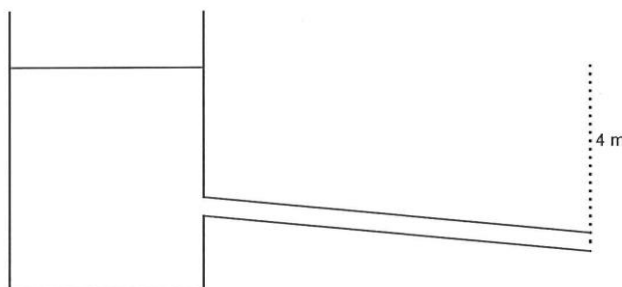
- The hose goes over the foundation wall, losing 0.500 m in height, and widens to 4.00 cm in diameter. What is the pressure now?

Fasit: a) $2.75 \times 10^5 \text{ N/m}^2$, b) $2.8 \times 10^5 \text{ N/m}^2$

- 3) The figure shows a tank of water that is open to the atmosphere. There is a pipe emptying water from the tank. The opening of the pipe is 4 m lower than the water level in the tank. Assume the tank is large enough that we can assume the water does not change.

- Select 2 points and use Bernoulli's equation to determine the speed of the water Leaving the pipe.
- If the pipe has a diameter of 20 cm, what is the volume rate of water from the tank?

Fasit: a) 8.85 m/s, b) $2.78 \text{ m}^3/\text{s}$



- 4) The inside volume of a house is equivalent to that of a rectangular solid 13.0 m wide by 20.0 m long by 2.75 m high. The house is heated by a forced air gas heater. The main uptake air duct of the heater is 0.300 m in diameter and 10 m in length.
- a) What is the average speed of air in the duct if it carries a volume equal to that of the house's interior every 15 minutes?
 - b) What is the flow resistance R in the air duct?
 - c) What is the pressure drop due to flow resistance in the air duct?

Fasit: a) $0.79 \text{ m}^3/\text{s}$, b) 2.86 Pa s/m^3 , c) 2.26 Pa