Answer on Question 75823, Physics, Mechanics, Relativity

Question:

A garden hose with a diameter of $0.70\ in$ has water flowing in it with a speed of $0.63\ m/s$ and a pressure of 1.3 atmospheres. At the end of the hose is a nozzle with a diameter of $0.22\ in$.

(a) Find the speed of water in the nozzle.

(b) Find the pressure in the nozzle.

Solution:

(a) We can find the speed of water in the nozzle from the Law of Continuity:

$$A_1 v_1 = A_2 v_2,$$

here, A_1, A_2 are the cross-section areas of the hose and the nozzle, respectively; v_1, v_2 are the speeds of the water flowing through the hose and the nozzle, respectively.

Then, from this formula we can find the speed of water in the nozzle:

$$v_2 = v_1 \frac{A_1}{A_2} = v_1 \frac{\pi d_1^2}{\pi d_2^2} = 0.63\ \frac{m}{s} \cdot \frac{\pi \cdot (0.70\ in)^2}{\pi \cdot (0.22\ in)^2} = 6.38\ \frac{m}{s}.$$

(b) We can find the pressure in the nozzle from the Bernoulli's equation:

$$P_1 + \frac{1}{2}\rho v_1^2 = P_2 + \frac{1}{2}\rho v_2^2,$$

here, P_1, P_2 are the pressures in the hose and nozzle, respectively; v_1, v_2 are the speeds of the water flowing through the hose and the nozzle, respectively; $\rho = 1000\ kg/m^3$ is the density of the water.

From this equation we can find the pressure in the nozzle:

$$\begin{aligned} P_2 = P_1 + \frac{1}{2}\rho(v_1^2 - v_2^2) = \\ = 1.3\ atm \cdot \frac{101325\ Pa}{1\ atm} + \frac{1}{2} \cdot 1000\ \frac{kg}{m^3} \cdot \left(\left(0.63\ \frac{m}{s}\right)^2 - \left(6.38\ \frac{m}{s}\right)^2\right) \\ = 1.1 \cdot 10^5\ Pa = 1.1\ atm. \end{aligned}$$

Answer:

(a) $v_2 = 6.38\ \frac{m}{s}$.

(b) $P_2 = 1.1 \cdot 10^5\ Pa = 1.1\ atm.$