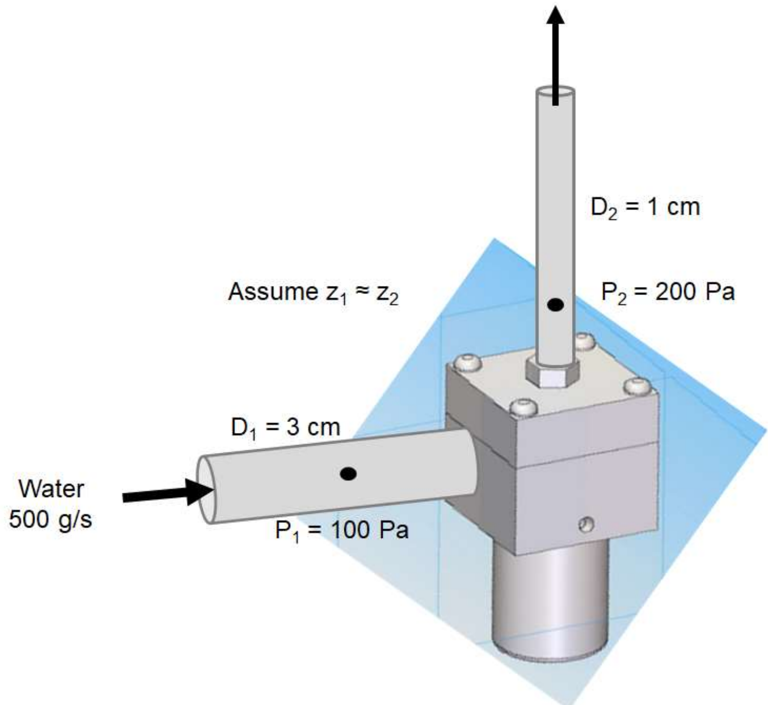
Given and Required:
Determine the mechanical work the pump imparts to the water.



Solution:
The inlet and outlet conditions are defined as

$P_1 := 100\ \text{Pa}$ $\qquad$ $P_2 := 200\ \text{Pa}$

$D_1 := 3\ \text{cm}$ $\qquad$ $D_2 := 1\ \text{cm}$

The mass flow rate is defined as

$m' := 500\ \frac{\text{g}}{\text{s}}$

The rate of work done by the pump will be the change in the rate of mechanical energy done to the working fluid. This is shown below.

$$\Delta E'_{mech} = m' \cdot \left(\frac{P_2 - P_1}{\rho} + \frac{V_2^{\ 2} - V_1^{\ 2}}{2} + g_e \cdot \left(z_2 - z_1 \right) \right)$$

The velocity terms are the only terms needed for this expression. The average velocity at the inlet and outlet may be estimated by using the mass flow rate and the cross sectional area. This is shown below.

$$\left(V = \frac{m'}{\rho \cdot A} \right) = \frac{m'}{\rho \cdot \frac{\pi}{4} \cdot D^2}$$

Water's density is

$\rho_w := 1000\ \frac{\text{kg}}{\text{m}^3}$

Solution (cont.):
Thus the velocity at the inlet and outlet are

$$V_1 := \frac{m'}{\rho_w \cdot \frac{\pi}{4} \cdot D_1^{\,2}} = 0.7074 \ \frac{\text{m}}{\text{s}} \qquad V_2 := \frac{m'}{\rho_w \cdot \frac{\pi}{4} \cdot D_2^{\,2}} = 6.366 \ \frac{\text{m}}{\text{s}}$$

Substituting everything into the pump work rate expression yields

$$\boxed{\Delta E'_{mech} := m' \cdot \left(\frac{P_2 - P_1}{\rho_w} + \frac{V_2^{\,2} - V_1^{\,2}}{2} \right) = 10.06 \ \text{W}}$$

Remember: The z terms go to zero.