20-P-MOM-DY-33
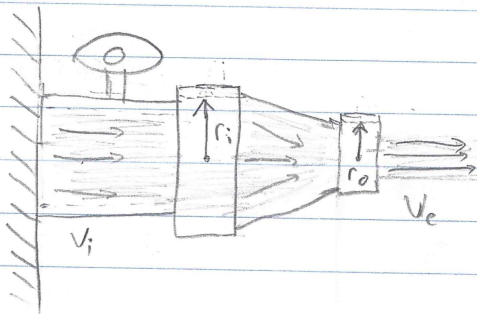
A nozzle attachment has a different sized input and output radius. The input has a radius $r_i = 1.5$ cm and the output has a radius $r_o = 0.5$ cm. Water has the density $\rho = 997$ kg/m³ and the input velocity of the water is $2 \frac{m}{s}$. Determine the exit velocity of the water and the force required to keep the attachment on. (magnitude)

Solution: conservation of mass

$$\text{mass in} = \text{mass out}$$

$$\rho A_A V_A = \rho A_B V_B$$

$$\rho \pi r_A^2 V_A = \rho \pi r_B^2 V_B \qquad V_B = V_A \frac{r_A^2}{r_B^2} = 18 \frac{m}{s}$$

$$\Sigma F = \frac{dm}{dt}(V_B - V_A) = \rho A_A V_A (V_B - V_A) = 22.55 \text{ N}$$