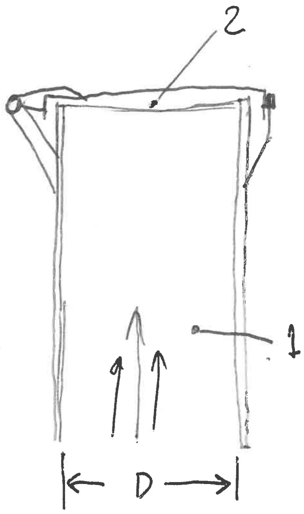
Bernoulli



$$\hookrightarrow A = \frac{\pi D^2}{4}$$

$$P_1 + \frac{1}{2}\rho V_1^2 + \rho g h_1 = P_2 + \frac{1}{2}\rho V_2^2 + \rho g h_2$$

$$\rho g(h_1 - h_2) \approx 0$$
$$P_1 - P_2 \approx 0$$
$$V_2 = 0$$

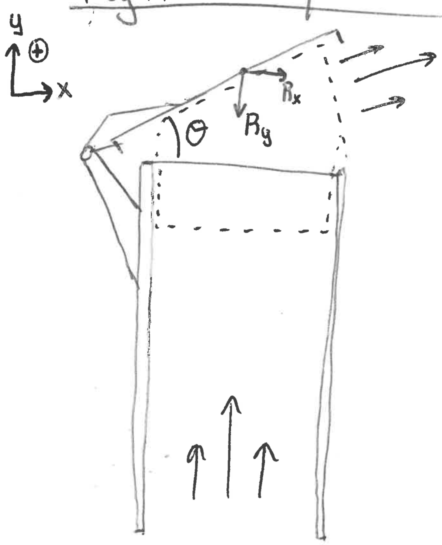
$$\frac{1}{2}\rho V_1^2 = P_2$$

$$\frac{1}{2}\rho\left(\frac{\dot{m}}{A\rho}\right)^2 = P_2$$

$$\frac{\dot{m}^2}{2A^2\rho} = P_2 \rightarrow F = PA$$

$$F = \frac{\dot{m}^2}{2A\rho}$$

Reynold Transport Theorem



$$\frac{d}{dt} mV = \underbrace{\cancel{\frac{d}{dt}\int_{CV} V\, dm}}_{0,\ \text{STEADY STATE}} + \sum_{\text{OUTLETS}} \vec{V}_o \dot{m}_o - \sum_{\text{INLETS}} \vec{V}_i \dot{m}_i$$

$$\sum F = \sum \vec{V}_o \dot{m}_o - \sum \vec{V}_i \dot{m}_i$$

$$\vec{V}_i = \underbrace{\cancel{\vec{u}_i}}_{(x)}^{0} + \underbrace{\vec{v}_i}_{(y)}$$

$$\vec{V}_o = \underbrace{\vec{u}_o}_{(x)} + \underbrace{\vec{v}_o}_{(y)}$$

$$= V\cos\theta + V\sin\theta$$

Neglecting Losses

$$|\vec{V}_o| = |\vec{V}_i| = V$$
$$\dot{m}_o = \dot{m}_i = \dot{m} = \rho A V$$

$$\sum F_y = \dot{m} V \sin\theta - \dot{m} V$$
$$= \dot{m} V(\sin\theta - 1)$$

$$-R_y = \dot{m} V(\sin\theta - 1)$$

$$R_y = \dot{m} V(1 - \sin\theta)$$

$$= \frac{\dot{m}^2}{A\rho}(1 - \sin\theta)$$

$$\sum F_x = \dot{m} V \cos\theta - 0$$

$$R_x = \dot{m} V \cos\theta$$

As $\theta \to 0$, $R_y \to \dfrac{\dot{m}^2}{A\rho}$, $R_x \to 0$