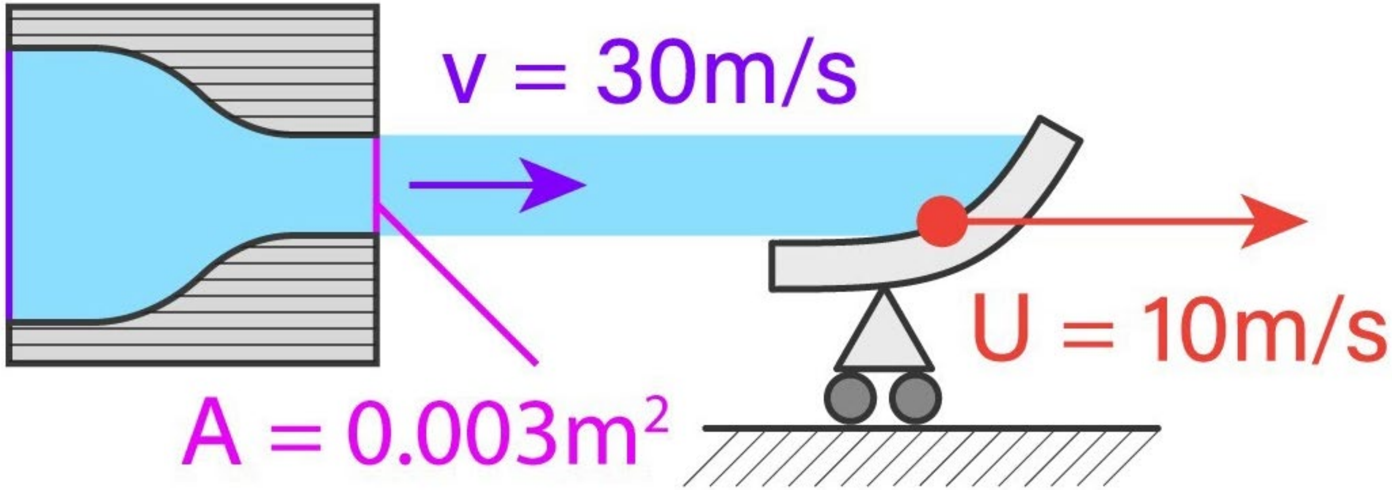
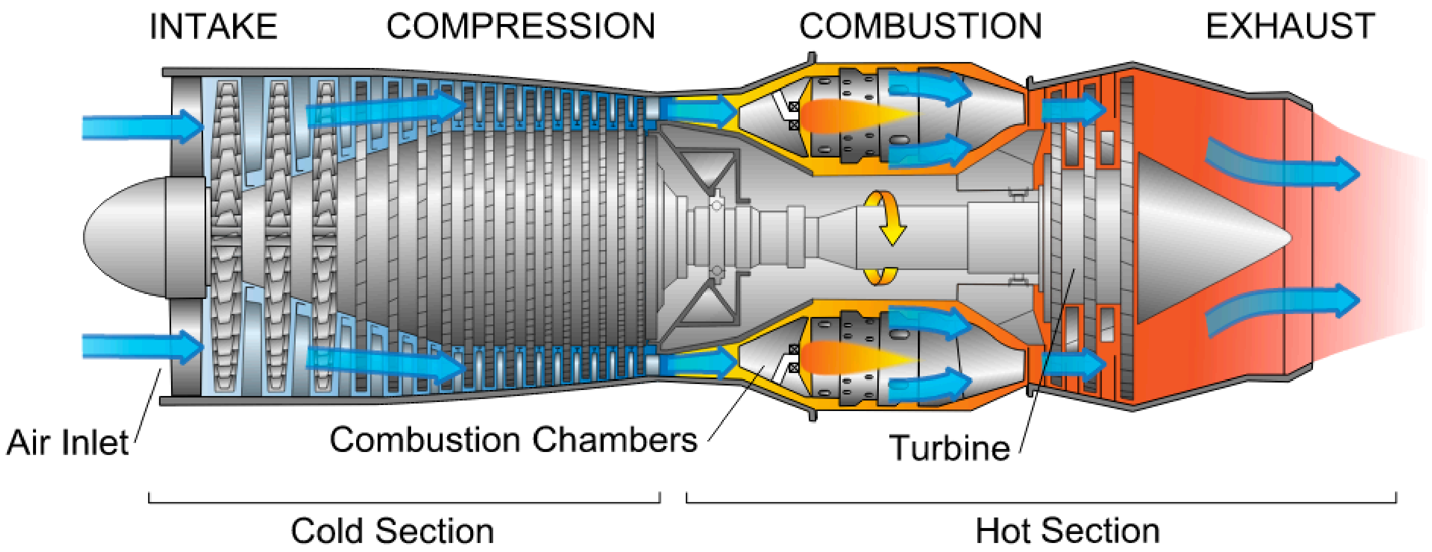

v = 30m/s
U = 10m/s
A = 0.003m²


INTAKE
COMPRESSION
COMBUSTION
EXHAUST
Air Inlet
Combustion Chambers
Turbine
Cold Section
Hot Section

Exercise 4.

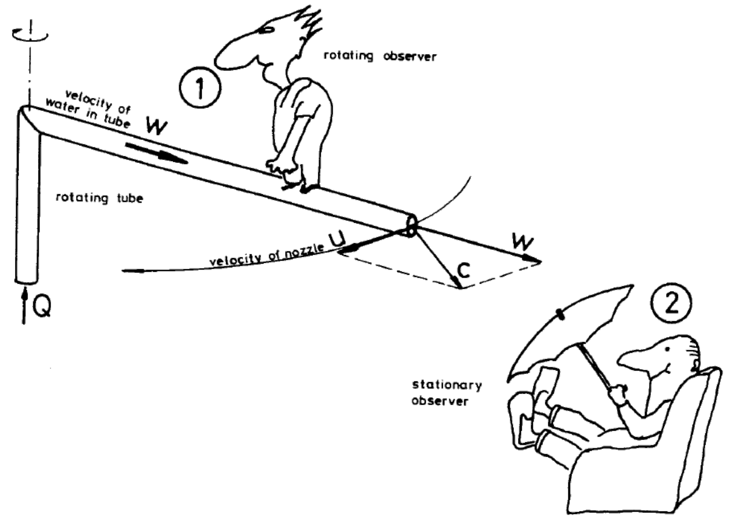
- Conservation of **Linear Momentum** with RTT Eq. (3.16)
  - Setting $B_{\text{syst}} = (m\tilde{v})_{\text{syst}}, \quad \beta_{\text{syst}} = \left.\frac{\mathrm{d}m\tilde{v}}{\mathrm{d}m}\right|_{\text{syst}} = \tilde{v}_{\text{syst}}$, gives:

$$\frac{\mathrm{d}}{\mathrm{d}t}(m\tilde{v})_{\text{syst}} = \sum\tilde{F} = \frac{\mathrm{d}}{\mathrm{d}t}\left(\int_{\text{CV}}\tilde{v}\rho\,\mathrm{d}V\right) + \int_{\text{CS}}\tilde{v}\rho(\tilde{v}_r \circ \tilde{n})\mathrm{d}A \qquad \text{(Eq. 3.35)}$$

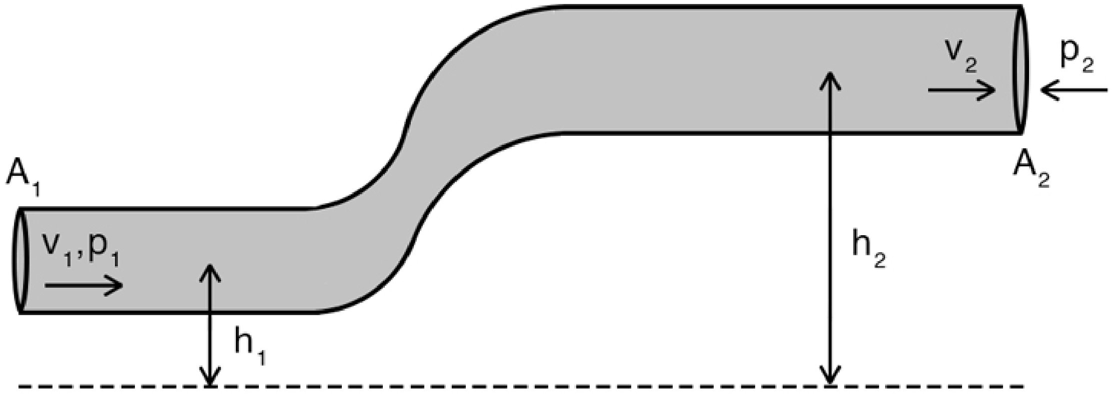
  - Note the LHS remains if external forces acts on the system:

$$\frac{\mathrm{d}}{\mathrm{d}t}(m\tilde{v})_{\text{syst}} = m\frac{\mathrm{d}\,\tilde{v}_{\text{syst}}}{\mathrm{d}t} + \tilde{v}_{\text{syst}}\frac{\mathrm{d}m}{\mathrm{d}t} = m\,\tilde{a}_{\text{syst}} = \sum F_{syst}$$

- The relative velocity $\tilde{v}_r$ is used in (3.35), for moving CV
  - $\tilde{v}_r = \tilde{v} - \tilde{v}_s$, where $\tilde{v}_s$ is the velocity of the CV



Bernoulli's Equation



$$p_1 + \frac{1}{2}\rho v_1^2 + \rho g h_1 = p_2 + \frac{1}{2}\rho v_2^2 + \rho g h_2$$

A_1, A_2 : Cross-sectional areas at points 1 and 2

p_1, p_2 : Pressures

v_1, v_2 : Velocities

h_1, h_2 : Elevations

Exercise 4.

- Bernoulli's equation
  - Combine the **continuity** and **linear momentum** equations along a **streamline**
  - Assume steady-state $\left(\frac{\mathrm{d}}{\mathrm{d}t} = 0\right)$, friction less (no viscous effects) and incompressible $\left(\frac{\mathrm{d}\rho}{\mathrm{d}} = 0\right)$ flow, gives:

$$p_1 + \frac{\rho v_1^2}{2} + \rho g z_1 = p_2 + \frac{\rho v_2^2}{2} + \rho g z_2 \qquad \text{Eq. (3.54)}$$

  - Can be used to convert between different types of pressure in the system.
  - Is a type of energy conservation.
  - Can be extended to include energy losses/addition between 1→2 as:

$$p_1 + \frac{\rho v_1^2}{2} + \rho g z_1 = p_2 + \frac{\rho v_2^2}{2} + \rho g z_2 + \Delta p_{\mathrm{friction}} - \Delta p_{\mathrm{pump}} + \Delta p_{\mathrm{turbine}} \qquad \text{Eq. (3.73)}$$