1. (50 %) Air flows into a constricting channel which has an electrical resistive heater in it. There is low speed flow throughout, which in this case means $V^2 \ll h$. All the quantities shown in the figure are known. The objective is to determine the remaining flow quantities at the exit location 2.

a) Draw a suitable control volume, and apply the integral mass and integral enthalpy equations to relate stations 1 and 2.

b) Determine the exit enthalpy $h_2$.

c) Determine the exit density $\rho_2$.

d) Determine the exit velocity $V_2$
2. (50 %) A mosquito is hovering in still air having the initial conditions

\[ a_i = 350 \text{ m/s} \quad p_i = 100000 \text{ Pa} \]

A shock wave traveling at \( V_s = 420 \text{ m/s} \) then passes the mosquito.

\[ V_s \quad V_s \]
\[ \begin{array}{c|c}
  a_i & a_f \\
  p_i & p_f \\
  \text{before} & \text{after}
\end{array} \]

a) Sketch the air velocity distribution \( V(x) \) in the mosquito’s frame.

b) Sketch the air velocity distribution \( V(x) \) in the steady shock frame.

c) Determine the final pressure \( p_f \) and speed of sound \( a_f \) the mosquito feels after it goes through the shock.