1.7) The jet engine fitted to a small aircraft uses 35 kg/s of air when the aircraft is flying at a speed of 800 km/h. The jet efflux velocity is 590 m/s. If the pressure on the engine discharge plane is assumed to be equal to the ambient pressure and if effects of the mass of the fuel used are ignored, find the thrust developed by the engine.

Solution:

Given:

Inlet $\rightarrow V_1 = 800\,\text{km/h} = 800/3.6 = 222.22\,\text{m/s}$, $\dot{m}_1 = 35\,\text{kg/s}$

Outlet $\rightarrow V_2 = 590\,\text{m/s}$, $\dot{m}_2 = 35\,\text{kg/s}$ (ignoring fuel), $p_2 = p_1 = p_{\text{ambient}}$

The schematic diagram of the problem description is shown in Fig. 1.

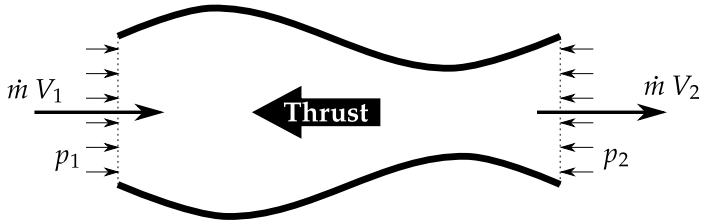

Fig. 1: Schematic diagram for problem description

Using the conservation of momentum along horizontal direction,

$$\begin{aligned}
\text{Thrust} &= \text{rate of momentum exiting} - \text{rate of momentum entering} \\
&\quad + \text{pressure force at exit} - \text{pressure force at inlet} \\
\text{Thrust} &= \dot{m}V_2 - \dot{m}V_1 + (p_2 - p_1)\,A_{\text{exit}} \\
\text{Thrust} &= \dot{m}V_2 - \dot{m}V_1 + 0 \\
\text{Thrust} &= \dot{m}\,(V_2 - V_1) \\
\text{Thrust} &= 35 \times (590 - 222.22)
\end{aligned}$$

$$\boxed{\text{Thrust} = 12872.3\,\text{N}}$$