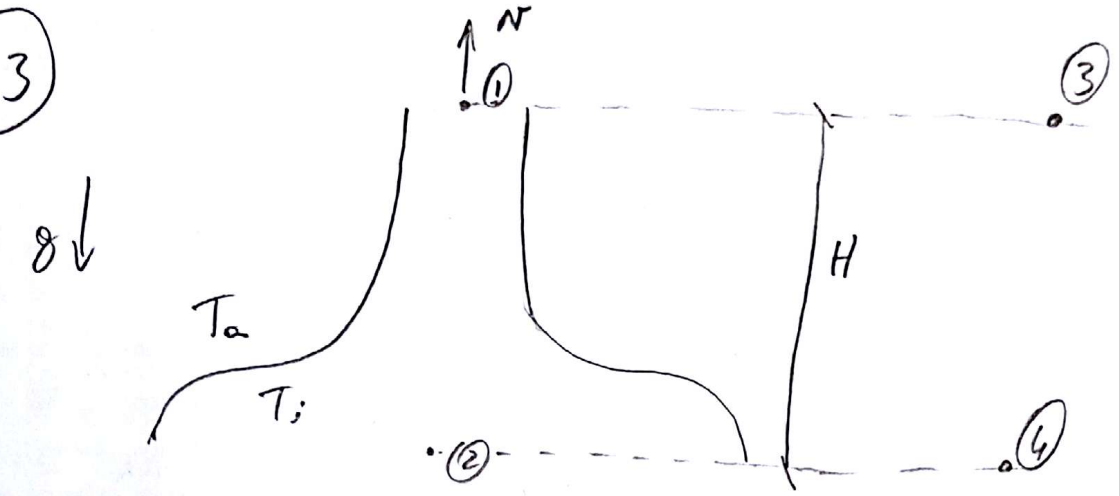
(13)



Eq. de Bernoulli diferencial: $\frac{dp}{\rho} + \frac{d(V^2)}{2} + g\,dz = 0$

Mas, $\rho = P/RT$

$\Rightarrow RT\frac{dp}{p} + \frac{d(V^2)}{2} + g\,dz = 0$, Integrar entre ① e ②

$RT_i \ln\left(\frac{p_1}{p_2}\right) + \frac{V^2}{2} + gH = 0$ (*), onde usamos $V_2 \ll V_1$

Analogamente, para ③ e ④, temos:

$RT_a \ln\left(\frac{p_3}{p_4}\right) + gH = 0$ (**) (Não há velocidade)

Fazendo $[(*) \div RT_i] - [(**) \div RT_a]$:

$\ln\left(\frac{p_1}{p_2}\right) - \ln\left(\frac{p_3}{p_4}\right) = -\frac{V^2}{2RT_i} - \frac{gH}{RT_i} + \frac{gH}{RT_a}$

$$\ln\left(\frac{\frac{p_1}{p_2}}{\frac{p_3}{p_4}}\right) = -\frac{v^2}{2RT_i} - \frac{gH}{R}\left(\frac{1}{T_i} - \frac{1}{T_a}\right)$$

Note que: $\frac{p_1}{p_2}\left(\frac{p_3}{p_4}\right)^{-1} = \frac{p_1}{p_3} \cdot \frac{p_4}{p_2} = 1$

pois: $\frac{p_1}{p_3} = \frac{\rho_i T_i}{\rho_a T_a}$, $\frac{p_4}{p_2} = \frac{\rho_a T_a}{\rho_i T_i}$

Logo: $v^2 = -2gH\left(1 - \frac{T_i}{T_a}\right)$

$$v = \sqrt{2gH\left(\frac{T_i}{T_a} - 1\right)} = 31{,}6 \text{ m/s}$$