5.1

$M_0 = 2.7 \quad \gamma = 1.4 \quad T_0 = 400°R$

$h = 19{,}000 \frac{Btu}{lbm} \quad C_p = 0.24 \frac{Btu}{lbm\,°R}$.

$\therefore \quad \tau_\lambda = 6.8$

a)

unit conversions: (from Table 5.2)

$C_p = 0.24 \times 4186.8 \frac{J}{kg K} = 1004.832 \; J/kgK$

$h = 19{,}000 \times 2326 \; J/kg = 4.4194 \times 10^7 \; J/kg$

$T_0 = 5/9 \times 400 R = 222.22 K$

Additional variables:

$a_0 = \sqrt{\gamma R T_0} = \sqrt{(\gamma - 1) C_p T_0} = 298.86 \; m/s$

$\tau_r = 1 + \frac{\gamma - 1}{2} M_0^2 = 1 + \frac{1.4 - 1}{2} 2.7^2 = 2.458$

$\tau_c = \pi_c^{\frac{\gamma - 1}{\gamma}} \leftarrow$ vary π_c

$$\frac{F}{\dot{m}} = a_0 \left\{ \left[\frac{2\tau_r}{\gamma - 1} \left(\frac{\tau_\lambda}{\tau_r \tau_c} - 1 \right)(\tau_c - 1) + \frac{\tau_\lambda}{\tau_r \tau_c} M_0^2 \right]^{1/2} - M_0 \right\} m/s$$