\[
\frac{E}{m} = a_0 \left\{ \left[ \frac{2 m a_b}{r-1} \left( 1 - \frac{\sqrt{\tau^2}}{(\tau + \sqrt{\tau^2})^2} \right) \right]^{\frac{3}{2}} - M_0^2 \right\}
\]

For the plots, for parts (a) and (b) need

\[a_0 = \sqrt{r R T_0} = \sqrt{(r-1) C_p T_0} = 297.39 \text{ m/s}\]

with \( r = 1.4 \), \( C_p = 1005 \text{ J/kg K} \), \( T_0 = 220 \text{ K} \)

\[\tau_r = 1 + \frac{r-1}{2} M_0^2 = 2.25\]

with \( r = 1.4 \), \( M_0 = 2.5\)

\[f = \frac{C_p T_0}{h} \left( \tau_{a_b} - \tau_r \right)\]

\[S = \frac{-f}{F/m} \]

with \( F/m \) and \( \tau_r \) given above, \( C_p \) and \( T_0 \) given above, \( h = 4.42 \times 10^7 \text{ J/kg} \)

Plot using given ranges of \( \tau_r \) and \( \tau_{a_b} \)