

3 EQNS: $\frac{T_2}{T_1} = \left(\frac{P_2}{P_1}\right)^{\frac{\gamma-1}{\gamma}}$

$$\frac{T_T}{T} = 1 + \frac{\gamma-1}{2} M^2$$

$$\frac{P_T}{P} = \left[1 + \frac{\gamma-1}{2} M^2\right]^{\frac{\gamma}{\gamma-1}}$$

a) $\frac{T_T}{T} = 1 + 0.2(0.8)^2 = 1.128 \Rightarrow \boxed{T_T = 245\text{K} \quad T = T_{\text{atm}} = 217\text{K}}$

$\frac{P_T}{P} = 1.524 \quad \boxed{P_T = 34.4\text{kPa}, \quad P = P_{\text{atm}} = 22.6\text{kPa}}$

b) T_T & P_T ARE SAME AS ABOVE (INLET IS ADIABATIC & Q-S SO STAG. QUANTITIES ARE CONSTANT & WE HAVEN'T CHANGED REFERENCE FRAMES)

$T = \frac{T_T}{1 + \frac{\gamma-1}{2} M^2} \quad \boxed{T_T = 245\text{K}, \quad T = 233\text{K}}$

$P = \frac{P_T}{\left[1 + \frac{\gamma-1}{2} M^2\right]^{\frac{\gamma}{\gamma-1}}} \quad \boxed{P_T = 34.4\text{kPa}, \quad P = 29\text{kPa}}$

c) $P_T = 40(34.4) = 1376\text{kPa} \quad \boxed{P_T = 1376\text{kPa}}$
 $P = \frac{P_T}{\left(1 + \frac{\gamma-1}{2} M^2\right)^{\frac{\gamma}{\gamma-1}}}, \quad M = 0.03 \quad \boxed{P = 1375\text{kPa}}$

$\frac{T_{T_a}}{T_{T^*}} = (40)^{0.4} = 2.87 \quad \boxed{T_{T_a} = 703\text{K}}$
 $T_a = \frac{T_{T_a}}{1 + \frac{\gamma-1}{2} M^2} \quad \boxed{T_a = 703\text{K}}$

$$d) \quad \frac{T_T}{T} = 1 + \frac{\gamma-1}{2} M^2, \quad M=3 \quad T_{\text{atm}} = 217 \text{ K}$$

$$\frac{P_T}{P} = \left[1 + \frac{\gamma-1}{2} M^2 \right]^{\gamma/(\gamma-1)} \quad P_{\text{atm}} = 7.5 \text{ kPa}$$

$$\boxed{T_T = 607.6 \text{ K} \quad T = T_{\text{atm}} = 217 \text{ K}}$$

$$\boxed{P_T = 275.5 \text{ kPa} \quad P = P_{\text{atm}} = 7.5 \text{ kPa}}$$

$$a) \quad \text{IF } T_{T_1} = 607.6 \quad \& \quad T_{T_2} = 703 \text{ K}$$

$$\text{THEN } \frac{T_{T_2}}{T_{T_1}} = 1.16 \quad \& \quad \boxed{\frac{P_{T_2}}{P_{T_1}} = (1.16)^{\gamma/(\gamma-1)} = 1.67}$$

THIS SHOWS THAT AS M [↑] THE RAM PRESSURIZATION (DUE TO RAMMING AIR IN THE INLET) CAN BE QUITE SIGNIFICANT. INDEED, FOR FLIGHT AT VERY HIGH SPEEDS ($> M=3$) COMPRESSORS AREN'T REQUIRED. THE ENGINES ARE CALLED RAMJETS. NOTE THAT THEY STILL NEED SOMETHING TO GET THEM FROM $M=0$ TO $M=3$. IN SOME CASES A ROCKET IS USED (CRUISE MISSILES FOR EXAMPLE), IN OTHER CASES THE ENGINE IS CAPABLE OF BEING RE-CONFIGURED (BYPASSING FLOW AROUND THE COMPRESSOR) IN FLIGHT.