2-1 (Unit A-4)

During a reentry, the space shuttle orbiter experiences high supersonic speed ($M_1 > 1$), associated with strong detached bow shock wave, as shown in the figure. Behind the shock wave, however, it can still be assumed that the flow is subsonic (isentropic and calorically perfect ideal gas of air). At the stagnation point at the nose of the shuttle (point 2), the pressure and temperature are measured: $p_2 = 450 \text{ lb/ft}^2$ and $T_2 = 1,500 \, ^\circ\text{R}$. The static pressure at a nearby location (point 3: outside of boundary layer) is: $p_3 = 250 \, \text{lb/ft}^2$. Calculate temperature (in “R”), velocity (in “ft/s”), and Mach number at point 3.

**Hints . . .**
- You may apply isentropic relation between stagnation point & point 3.
- You may also apply energy equation between stagnation point & point 3.
- Speed of sound is not a constant value (function of the local temperature).
- Flow behind a shock wave must become a subsonic ($M < 1$).
- What’s specific heat ($c_p$) of calorically perfect ideal gas, in terms of $\gamma$ and $R$?