a) Shock relations for $M_1 = 2.6$: $\frac{P_2}{P_1} = 7.72$, $\frac{\rho_2}{\rho_1} = 3.449$, $\frac{T_2}{T_1} = 2.238$, $\frac{P_{O_2}}{P_1} = 9.181$, $M_2 = 0.5038$

$\therefore \boxed{P_2 = P_1 \cdot \frac{P_2}{P_1} = 7.72 \text{ atm}}$ $\boxed{T_2 = T_1 \cdot \frac{T_2}{T_1} = 288K \cdot \frac{T_2}{T_1} = 644.54 K}$

$\rho_1 = \frac{P_1}{RT_1} = \frac{1.013 \times 10^5 \text{ Pa}}{287 \text{ J/kg K} \cdot 288 K} = 1.226 \text{ kg/m}^3$, $\boxed{\rho_2 = \rho_1 \frac{\rho_2}{\rho_1} = 4.227 \text{ kg/m}^3}$

$\boxed{P_{O_2} = P_1 \cdot \frac{P_{O_2}}{P_1} = 9.181 \text{ atm}}$, $\boxed{T_{O_2} = T_{O_1} = T_1 \left[1 + \frac{\gamma-1}{2} M_1^2\right] = 288K \left[1 + \frac{\gamma-1}{2} 2.6^2\right] = 677.4 K}$

b) Given: $\frac{P_2}{P_1} = \frac{10.33 \text{ atm}}{1 \text{ atm}} = 10.33$. From shock $\frac{P_2}{P_1}(M_1)$ function, this gives $\boxed{M_1 = 3.0}$

Also given: $T_2 = 1390°R$ and $\frac{T_2}{T_1}(M_1 = 3.0) = 2.679$, $\therefore \boxed{T_1 = T_2 \frac{1}{T_2/T_1} = 518.85°R}$

$\boxed{T_{O_2} = T_{O_1} = T_1 \left[1 + \frac{\gamma-1}{2} M_1^2\right] = 1452.8°R}$, $\frac{P_{O_2}}{P_1}(M_1 = 3) = 12.06$, $\boxed{P_{O_2} = P_1 \left(\frac{P_{O_2}}{P_1}\right) = 12.06 \text{ atm}}$

c) Given $\frac{P_{O_2}}{P_1} = \frac{7712.8 \text{ lb/ft}^2}{2116 \text{ lb/ft}^2} = 3.645$ this is on the shock table, for $M_1 = 1.56$

For $T_1 = 519°R = 288°K$, $a_1 = \sqrt{\gamma R T_1} = 340.4 \text{ m/s}$, $\boxed{V_1 = M_1 a_1 = 531 \text{ m/s} = 1742 \text{ ft/s}}$

d) $V_1 = 2112 \text{ mi/h} = 943.9 \text{ m/s}$, At altitude 80000 ft: $T_\infty = 390°R = 216.7°K$

$P_\infty = 5.8125 \text{ lb/ft}^2 = 278.3 \text{ Pa}$

Ahead of bow shock, we have $\begin{cases} T_1 = T_\infty = 216.7°K \\ P_1 = P_\infty = 278.3 \text{ Pa} \end{cases}$, $a_1 = \sqrt{\gamma R T_1} = 295 \text{ m/s}$

$M_1 = \frac{V_1}{a_1} = 3.2 \rightarrow T_{O_1} = T_1 \left[1 + \frac{\gamma-1}{2} M_1^2\right] = \boxed{660.5°K = 1189°R = T_{O_2}}$

For $M_1 = 3.2$: $\frac{P_{O_2}}{P_1} = 13.66$, $\boxed{P_{O_2} = P_1 \cdot \frac{P_{O_2}}{P_1} = 3801.6 \text{ Pa}}$