1.5. The air in Tunnel C accelerates through a convergent/divergent nozzle until the Mach number is 4 in the test section. The corresponding values for the free-stream pressure and the free-stream temperature in the test section are 23.25 lbf/ft² abs. and −65°F, respectively. What are the corresponding values for the free-stream density, viscosity, and velocity in the test section? Note that $M = U_n/a_o$. Using the values for the static pressure given in Table 1.2, what is the pressure altitude simulated in the wind tunnel by this test condition?

\[ M = 4 \]
\[ P = 23.25 \text{ lbf/ft}^2 \]
\[ T = -65^\circ\text{F} = 395^\circ\text{R} \]

**Density**

\[ \rho = \frac{P}{RT} = \frac{23.25}{1716 \times 395} = 3.43 \times 10^{-5} \text{ slugs/ft}^3 \]

**Viscosity**

\[ \mu = 2.27 \times 10^{-8} \frac{395^{1.5}}{395+198.6} = 3.00 \times 10^{-7} \text{ lb-s/ft}^2 \]

**Velocity**

\[ a = \sqrt{\gamma RT} = \sqrt{(1.4)(1716)(395)} = 9.74 \text{ ft/s} \]

\[ V = aM = (9.74)(4) = 38.97 \text{ ft/s} \]

**Pressure Alt**

*From Table 1.2B*

<table>
<thead>
<tr>
<th>Pressure Alt (ft)</th>
<th>98,000 ft</th>
<th>100,000 ft</th>
</tr>
</thead>
<tbody>
<tr>
<td>25.488</td>
<td>23.272</td>
<td></td>
</tr>
</tbody>
</table>

By extrapolation for 23.25

109,020 ft pressure alt 0.22

\[ P = 3.43 \times 10^{-5} \text{ slugs/ft}^3 \]
\[ M = 3.00 \times 10^{-7} \text{ lb-s/ft}^2 \]
\[ V = 3900 \text{ ft/s} \]
\[ P_{alt} = 100,000 \text{ ft} \]