**UE Problem E4-5**

**a)**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>( \sigma )</td>
<td>( \text{kg/m} \cdot \text{s}^2 )</td>
</tr>
<tr>
<td>( V )</td>
<td>( \text{m/s} )</td>
</tr>
<tr>
<td>( \rho )</td>
<td>( \text{kg/m}^3 )</td>
</tr>
<tr>
<td>( \mu )</td>
<td>( \text{kg/m} \cdot \text{s} )</td>
</tr>
<tr>
<td>( \ell )</td>
<td>( \text{m} )</td>
</tr>
</tbody>
</table>

\[
\Pi_1 = \frac{\sigma}{\rho \ell V^2}
\]

\[
\Pi_2 = \frac{\rho V^2}{\mu} = \text{Re}
\]

Other sets are possible, as always.

**b)**

Must have \( \Pi \)'s match:

\[
\frac{\sigma_1}{\rho_1 \ell_1 V_1^2} = \frac{\sigma_2}{\rho_2 \ell_2 V_2^2} = \frac{\rho V_1 \ell_1}{\mu} = \frac{\rho V_2 \ell_2}{\mu}
\]

From \( \text{Re} \) match \( V_1 \ell_1 = V_2 \ell_2 \),

\[
[\text{Re}] \quad \frac{V_2}{V_1} \ell_1 = 30 \text{m/s}, \quad \frac{V_2}{V_1} \ell_1 = 150 \text{m/s}
\]

Then we will have \( \sigma_2 = 25 \sigma_1 \).

**c)**

Assume \( \mu \) has negligible effect.

Parameter

\( \sigma \)

\( \rho \), \( V \)

These will now always appear together as \( \rho V^2 \) or \( \ell \rho V^2 \), so they are really just one significant parameter, say \( g = \ell \rho V^2 \)

So revised parameter list is

\[
\begin{align*}
\sigma & \quad [\text{Pa}] \\
\rho & \quad [\text{kg/m}^3] \\
V & \quad [\text{m/s}] \\
\ell & \quad [\text{m}] \\
\end{align*}
\]

Note: Part c) is a freebie, since this wasn't covered. No points lost.