1) Complete this table for water:

<table>
<thead>
<tr>
<th>T, °C</th>
<th>P, kPa</th>
<th>h, kJ/kg</th>
<th>x</th>
<th>Phase description</th>
</tr>
</thead>
<tbody>
<tr>
<td>120.21</td>
<td>200</td>
<td>2045.8</td>
<td>0.7</td>
<td>Saturated mixture</td>
</tr>
<tr>
<td>140</td>
<td>361.53</td>
<td>1800</td>
<td>0.565</td>
<td>Saturated mixture</td>
</tr>
<tr>
<td>177.66</td>
<td>950</td>
<td>752.74</td>
<td>0</td>
<td>Saturated liquid</td>
</tr>
<tr>
<td>80</td>
<td>500</td>
<td>335.37</td>
<td>-</td>
<td>Compressed liquid</td>
</tr>
<tr>
<td>350.0</td>
<td>800</td>
<td>3162.2</td>
<td>-</td>
<td>Superheated vapor</td>
</tr>
</tbody>
</table>

2) Complete this table for refrigerant R-134a:

<table>
<thead>
<tr>
<th>T, °C</th>
<th>P, kPa</th>
<th>h, kJ/kg</th>
<th>x</th>
<th>Phase description</th>
</tr>
</thead>
<tbody>
<tr>
<td>21.55</td>
<td>600</td>
<td>180</td>
<td>0.545</td>
<td>Saturated mixture</td>
</tr>
<tr>
<td>-10</td>
<td>200.74</td>
<td>162.13</td>
<td>0.6</td>
<td>Saturated mixture</td>
</tr>
<tr>
<td>-14</td>
<td>500</td>
<td>35.40</td>
<td>-</td>
<td>Compressed liquid</td>
</tr>
<tr>
<td>70</td>
<td>1200</td>
<td>300.61</td>
<td>-</td>
<td>Superheated vapor</td>
</tr>
<tr>
<td>44</td>
<td>1131</td>
<td>272.95</td>
<td>1.0</td>
<td>Saturated vapor</td>
</tr>
</tbody>
</table>

3. (Problem 3.39 in book) Water initially at 300 kPa and 250°C is contained in a piston-cylinder device fitted with stops. The water is allowed to cool at constant pressure until it exists as a saturated vapor and the piston rests on the stops. Then the water continues to cool until the pressure is 100 kPa. On the T-v diagram sketch, with respect to the saturation lines, the process curves passing through both the initial, intermediate, and final states of the water. Label the T, P and v values for end states on the process curves. Find the overall change in internal energy between the initial and final states per unit mass of water.

**Analysis** The process is shown on T-v diagram. The internal energy at the initial state is

\[
\begin{align*}
  & P_1 = 300 \text{ kPa} \\
  & T_1 = 250^\circ \text{C} \\
  \implies & u_1 = 2728.9 \text{ kJ/kg} \text{ (Table A - 6)}
\end{align*}
\]

State 2 is saturated vapor at the initial pressure. Then,

\[
\begin{align*}
  & P_2 = 300 \text{ kPa} \\
  & x_2 = 1 \text{ (sat. vapor)} \\
  \implies & u_2 = 0.6058 \text{ m}^3/\text{kg} \text{ (Table A - 5)}
\end{align*}
\]

Process 2-3 is a constant-volume process. Thus,

\[
\begin{align*}
  & P_3 = 100 \text{ kPa} \\
  & v_2 = 0.6058 \text{ m}^3/\text{kg} \\
  \implies & u_3 = 1163.3 \text{ kJ/kg} \text{ (Table A - 5)}
\end{align*}
\]

The overall change in internal energy is

\[
\Delta u = u_1 - u_3 = 2728.9 - 1163.3 = 1566 \text{ kJ/kg}
\]
4. **(Problem 3.55 in book)** A rigid tank contains water vapor at 250°C and an unknown pressure. When the tank is cooled to 124°C, the vapor starts condensing. Estimate the initial pressure in the tank. *(Answers: 0.30MPa)*

**Analysis** This is a constant volume process \( \nu = \frac{V}{m} = \text{constant} \), and the initial specific volume is equal to the final specific volume that is

\[
\nu_1 = \nu_2 = \nu_{x@124°C} = 0.79270 \text{ m}^3/\text{kg} \quad \text{(Table A-4)}
\]

since the vapor starts condensing at 150°C. Then from Table A-6,

\[
\begin{align*}
T_1 &= 250°C \\
\nu_1 &= 0.79270 \text{ m}^3/\text{kg} \\
\end{align*}
\]

\[
\begin{align*}
\text{P}_1 &= 0.30 \text{ MPa}
\end{align*}
\]

5. **(Problem 3.58 in book)** 100 grams of R-134a initially fill a weighted piston-cylinder devices at 60 kPa and -20°C. The device is then heated until the temperature is 100°C. Determine the change in the device's volume as a result of the heating. *(Answers: 0.0168 m³)*

**Analysis** The initial specific volume is

\[
\begin{align*}
P_1 &= 60 \text{ kPa} \\
T_1 &= -20°C \\
\nu_1 &= 0.33608 \text{ m}^3/\text{kg} \quad \text{(Table A-13)}
\end{align*}
\]

and the initial volume is

\[
\begin{align*}
\nu_1 &= m \nu_1 = (0.100 \text{ kg})(0.33608 \text{ m}^3/\text{kg}) = 0.033608 \text{ m}^3
\end{align*}
\]

At the final state, we have

\[
\begin{align*}
P_2 &= 60 \text{ kPa} \\
T_2 &= 100°C \\
\nu_2 &= 0.50410 \text{ m}^3/\text{kg} \quad \text{(Table A-13)}
\end{align*}
\]

\[
\begin{align*}
\nu_2 &= m \nu_2 = (0.100 \text{ kg})(0.50410 \text{ m}^3/\text{kg}) = 0.050410 \text{ m}^3
\end{align*}
\]

The volume change is then

\[
\Delta \nu = \nu_2 - \nu_1 = 0.050410 - 0.033608 = 0.0168 \text{ m}^3
\]