1- Explain the difference between heat and temperature. (10 points)

Heat is the transfer of energy across a system boundary by virtue of a temperature difference only. It is measured in Joules. Temperature is a thermodynamic property and a function of the state of the system. It is measured in Kelvin.

2- Describe briefly below statements; (10 points)

- **Cycle**: if the it returns to its initial state at the end of the process.
- **System**: Quantity of matter or a region in space chosen for study
- **First law of thermodynamics**: Energy can change from one form to another but the total amount of energy remains constant
- **Pure substance**: A substance that has a fixed chemical composition

3- A fixed mass of an ideal gas is heated from 50 to 80°C at a constant pressure of (a) 1 atm and (b) 3 atm. For which case do you think the energy required will be greater? Why? (10 points)

The energy required is $mc_p \Delta T$, which will be the same in both cases. This is because the $c_p$ of an ideal gas does not vary with pressure.

4- A piston-cylinder device initially contains 50 L of liquid water at 40°C and 200 kPa. Heat is added to the water at constant pressure until the entire liquid is vaporized. (20 points)

(a) What is the mass of the water?

$$m = \frac{V_1}{\nu_1} = \frac{0.05}{0.001008} = 49.61 \text{ kg}$$

(b) What is the final temperature?

$$T = T_{\text{sat,200kPa}} = 120.21 \text{ C}$$

(c) Determine the total enthalpy change.

$$h_2 = h_{g,200 \text{ kPa}} = 2706.3 \frac{kJ}{kg}$$

$$\Delta H = m(h_2 - h_1) = 49.61 (2706.3 - 167.53) = 125944 \text{ kJ}$$

(d) Show the process on a T-v diagram with respect to saturation lines.
5- A well-insulated rigid tank having a volume of 0.25 m$^3$ contains saturated water vapor at 100$^\circ$C. The water is rapidly stirred until the pressure is 1.5 bars. Determine the temperature at the final state, in $^\circ$C, and the work during the process, in kJ. (25 points)

\[
v_1 = v_{g,100^\circ C} = 1.673 \text{ m}^3/\text{kg}, u_1 = u_{g,100^\circ C} = 2506 \text{ kJ/kg}
\]

\[\text{for } P_2 = 1.5 \text{ Bars, from Table } \rightarrow T_2 = 273^\circ \text{C, } u_2 = 2767.8 \text{ kJ/kg}\]

\[
\Delta U + \Delta KE + \Delta PE = Q - W
\]

\[
W = -(U_2 - U_1) = -m(u_2 - u_1) \Rightarrow m = \frac{V}{v_1} = \frac{0.25}{1.673} = 0.149 \text{ kg}
\]

\[
W = -0.149(2767.8 - 2506.5) = -38.9 \text{ kJ}
\]

6- Complete the blank cells in the table of properties. (25 points)

<table>
<thead>
<tr>
<th>Substance</th>
<th>P(kPa)</th>
<th>T($^\circ$C)</th>
<th>v(m$^3$/kg)</th>
<th>x</th>
<th>condition</th>
</tr>
</thead>
<tbody>
<tr>
<td>a) H$_2$O</td>
<td>198.53</td>
<td>120</td>
<td>0.5</td>
<td>0.558</td>
<td>Saturated mixture</td>
</tr>
<tr>
<td>b) H$_2$O</td>
<td>525.62</td>
<td>300</td>
<td>0.5</td>
<td>-</td>
<td>Superheated vapor</td>
</tr>
<tr>
<td>c) R-12</td>
<td>300</td>
<td>-5</td>
<td>0.0007078</td>
<td>-</td>
<td>Compressed liquid</td>
</tr>
<tr>
<td>d) Air</td>
<td>200</td>
<td>20</td>
<td>0.420</td>
<td>-</td>
<td>Ideal Gas</td>
</tr>
<tr>
<td>e) R-134a</td>
<td>2116.2</td>
<td>70</td>
<td>0.0048</td>
<td>0.5</td>
<td>Saturated mixture</td>
</tr>
</tbody>
</table>

Good Luck!
Duration: 75 minutes
No cellular phones allowed