1. (10 points) 1.5-mol of a perfect gas with a $C_v$ of $\frac{5}{2}R$ is initially confined in a piston arrangement at a temperature of 500 K and a volume of 20.0-L. The gas is then carried through the following cycle (a Carnot cycle).

I. The gas is reversibly isothermally expanded to a volume of 40.0-L.
II. It is then reversibly adiabatically expanded to a volume of 45.0-L.
III. It is then reversibly isothermally compressed to a volume of 22.5-L
IV. It is then reversibly adiabatically compressed to its starting volume of 20.0-L.

a. Draw a pressure-volume diagram for this process and label each corner with its pressure, volume, and temperature.
b. Complete the following table. Be sure to include your work on a separate page.

<table>
<thead>
<tr>
<th>Step in the process</th>
<th>q</th>
<th>w</th>
<th>$\Delta U$</th>
<th>$\Delta S$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Step I</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Step II</td>
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<tr>
<td>Step III</td>
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<tr>
<td>Step IV</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sum of all steps</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

c. Find the efficiency of the process using the definition of efficiency as the work output per cycle divided by the energy input per cycle.
d. Find the efficiency of the process using the derived expression $e = 1 - \frac{T_C}{T_H}$. 

2. (10 points) 1.5-mol of a perfect gas with a \( C_v \) of \( \frac{5}{2} R \) is initially confined in a piston arrangement at a temperature of 500 K and a volume of 20.0-L. The gas is then carried through the following cycle (an Otto cycle). This cycle is equivalent to that in an automobile engine.

I. The gas is reversibly adiabatically expanded to a volume of 45.0-L.
II. The gas is reversibly cooled at constant volume to a temperature of 300 K.
III. The gas is reversibly adiabatically compressed to a volume of 20.0-L.
IV. The gas is reversibly heated to return to its original pressure.

a. Draw a pressure-volume diagram for this process and label each corner with its pressure, volume, and temperature.
b. Complete the following table. Be sure to include your work on a separate page.

c. Find the efficiency of the process using the definition of efficiency as the work output per cycle divided by the energy input per cycle.