3.7 The following table lists temperatures and specific volumes of water vapor at two pressures:

<table>
<thead>
<tr>
<th></th>
<th>p = 1.0 MPa</th>
<th></th>
<th>p = 1.5 MPa</th>
</tr>
</thead>
<tbody>
<tr>
<td>T (°C)</td>
<td>v (m³/kg)</td>
<td>T (°C)</td>
<td>v (m³/kg)</td>
</tr>
<tr>
<td>200</td>
<td>0.2060</td>
<td>200</td>
<td>0.1325</td>
</tr>
<tr>
<td>240</td>
<td>0.2275</td>
<td>240</td>
<td>0.1555</td>
</tr>
<tr>
<td>280</td>
<td>0.2480</td>
<td>280</td>
<td>0.1627</td>
</tr>
</tbody>
</table>

Data encountered in solving problems often do not fall exactly on the grid of values provided by property tables, and linear interpolation between adjacent table entries becomes necessary. Using the data provided here, estimate

(a) the specific volume at $T = 240^\circ$C, $p = 1.25$ MPa, in m³/kg.
(b) the temperature at $p = 1.5$ MPa, $v = 0.1555$ m³/kg, in °C.
(c) the specific volume at $T = 220^\circ$C, $p = 1.4$ MPa, in m³/kg.

3.11 For each case, determine the specific volume at the indicated state. Locate the state on a sketch of the $T$-$v$ diagram.

(a) Water at $p = 1$ bar, $T = 20^\circ$C. Find $v$, in m³/kg.
(b) Refrigerant 22 at $p = 40$ lb/in.², $x = 0.6$. Find $v$, in ft³/lb.
(c) Ammonia at $p = 200$ lb/in.², $T = 195^\circ$F. Find $v$, in ft³/lb.

3.42 For each case, determine the specified property value and locate the state sketches of the $p$-$v$ and $T$-$v$ diagrams.

(a) For Refrigerant 134a at $T = 160^\circ$F, $h = 1277$ Btu/lb. Find $v$, in ft³/lb.
(b) For Refrigerant 134a at $T = 90^\circ$F, $u = 72.71$ Btu/lb. Find $h$, in Btu/lb.
(c) For ammonia at $T = 160^\circ$F, $p = 60$ lb/in.². Find $u$, in Btu/lb.
(d) For ammonia at $T = 0^\circ$F, $p = 35$ lb/in.². Find $u$, in Btu/lb.
(e) For Refrigerant 22 at $p = 350$ lb/in.², $T = 350^\circ$F. Find $u$, in Btu/lb.

3.54 Ammonia vapor in a piston–cylinder assembly undergoes a constant-pressure process from saturated vapor at 10 bar.
The work is $+16.5$ kJ/kg. Changes in kinetic and potential energy are negligible. Determine (a) the final temperature of the ammonia, in °C, and (b) the heat transfer, in kJ/kg.
2.32 Air contained within a piston–cylinder assembly is slowly compressed. As shown in Fig. P2.32, during this process the pressure first varies linearly with volume and then remains constant. Determine the total work, in kJ.

![Diagram](image)

**Fig. P2.32**

2.60 A gas contained in a piston–cylinder assembly undergoes two processes, A and B, between the same end states, 1 and 2, where \( p_1 = 1 \) bar, \( V_1 = 1 \) m\(^3\), \( U_1 = 400 \) kJ and \( p_2 = 10 \) bar, \( V_2 = 0.1 \) m\(^3\), \( U_2 = 450 \) kJ.

**Process A:** Constant-volume process from state 1 to a pressure of 10 bar, followed by a constant-pressure process to state 2.

**Process B:** Process from 1 to 2 during which the pressure-volume relation is \( pV = \text{constant} \).

Kinetic and potential effects can be ignored. For each of the processes A and B, (a) sketch the process on \( p-V \) coordinates, (b) evaluate the work, in kJ, and (c) evaluate the heat transfer, in kJ.
4.106 A simple gas turbine power cycle operating at steady state with air as the working substance is shown in Fig. P4.106. The cycle components include an air compressor mounted on the same shaft as the turbine. The air is heated in the high-pressure heat exchanger before entering the turbine. The air exiting the turbine is cooled in the low-pressure heat exchanger before returning to the compressor. Kinetic and potential effects are negligible. The compressor and turbine are adiabatic. Using the ideal gas model for air, determine the (a) power required for the compressor, in hp, (b) power output of the turbine, in hp, and (c) thermal efficiency of the cycle.

Fig. P4.106

4.110 A tank whose volume is 0.01 m$^3$ is initially evacuated. A pinhole develops in the wall, and air from the surroundings at 21°C, 1 bar enters until the pressure in the tank is 1 bar. If the final temperature of the air in the tank is 21°C, determine (a) the final mass in the tank, in g, and (b) the heat transfer between the tank contents and the surroundings, in kJ.

4.116 As shown in Fig. P4.116, a 2475-ft$^3$ tank contains saturated vapor water initially at 30 lbf/in.$^2$. The tank is connected to a large line carrying steam at 180 lbf/in.$^2$, 450°F. Steam flows into the tank through a valve until 2.9 lb of steam have been added to the tank. The valve is then closed and the pressure in the tank is 40 lbf/in.$^2$. Determine the specific volume, in ft$^3$/lb, at the final state of the control volume and the magnitude and direction of the heat transfer between the tank and its surroundings, in Btu.
Fig. P4.116

Steam at 180 lb/in.², 450°F

Valve

Tank

V = 247.5 ft³

Initially:
saturated vapor at 30 lb/in.²

Finally:
40 lb/in.²