3.3 A system consisting of liquid water undergoes a process. At the end of the process, some of the liquid water has frozen, and the system contains liquid water and ice. Can the system be viewed as being a pure substance during the process? Explain.

3.5 Determine the phase or phases in a system consisting of H_2O at the following conditions and sketch p–v and T–v diagrams showing the location of each state.

(a) $p = 80$ lbf/in.^{2}, $T = 312.07°F$.
(b) $p = 80$ lbf/in.^{2}, $T = 400°F$.
(c) $T = 400°F$, $p = 360$ lbf/in.^{2}
(d) $T = 320°F$, $p = 70$ lbf/in.^{2}
(e) $T = 10°F$, $p = 14.7$ lbf/in.^{2}

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

$p = 1.0$ MPa		$p = 1.5$ MPa	
T (°C)	v (m^3/kg)	T (°C)	v (m^3/kg)
200	0.2060	200	0.1325
240	0.2275	240	0.1483
280	0.2480	280	0.1627

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 $T = 240°C$, $p = 1.25$ MPa, in m^3/kg.
(b) the temperature at $p = 1.5$ MPa, $v = 0.1555$ m^3/kg, in °C.
(c) the specific volume at $T = 220°C$, $p = 1.4$ MPa, in m^3/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 $p = 14.7$ lbf/in.^{2}, $T = 100°$F. Find v, in ft^3/lb.
(b) Ammonia at $T = -30°$C, $x = 50\%$. Find v, in m^3/kg.
(c) Refrigerant 134a at $p = 1.5$ MPa, $T = 100°$C. Find v, in m^3/kg.

3.13 For H_2O, determine the specific volume at the indicated state, in m^3/kg. Locate the states on a sketch of the T–v diagram.

(a) $T = 400°$C, $p = 20$ MPa.
(b) $T = 40°$C, $p = 20$ MPa.
(c) $T = 40°$C, $p = 2$ MPa.

3.20 A two-phase liquid–vapor mixture of a substance has a pressure of 150 bar and occupies a volume of 0.2 m^3. The masses of saturated liquid and vapor present are 3.8 kg and 4.2 kg, respectively. Determine the specific volume of the mixture, in m^3/kg.

3.24 Water contained in a closed, rigid tank, initially saturated vapor at 200°C, is cooled to 100°C. Determine the initial and final pressures, each in bar. Locate the initial and final states on sketches of the p–v and T–v diagrams.

3.31 As shown in Fig. P3.31, a cylinder fitted with a piston is filled with 600 lb of saturated liquid ammonia at 45°F. The piston weighs 1 ton and has a diameter of 2.5 ft. What is the volume occupied by the ammonia, in ft^3? Ignoring friction, is it necessary to provide mechanical attachments, such as stops, to hold the piston in place? Explain.

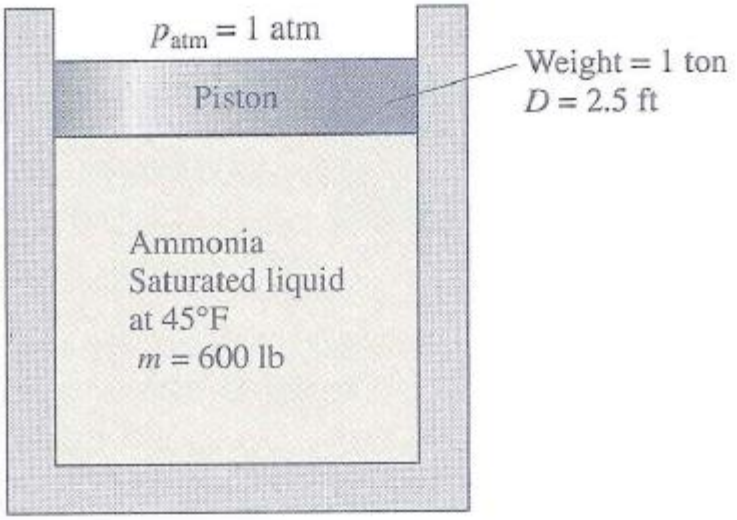

Fig. P3.31

3.35 From an initial state where the pressure is p_1, the temperature is T_1, and the volume is V_1, water vapor contained in a piston–cylinder assembly undergoes each of the following processes:

Process 1–2: Constant-temperature to $p_2 = 2p_1$.

Process 1–3: Constant-volume to $p_3 = 2p_1$.

Process 1–4: Constant-pressure to $V_4 = 2V_1$

Process 1–5: Constant-temperature to $V_5 = 2V_1$

On a p–V diagram, sketch each process, identify the work by an area on the diagram, and indicate whether the work is done by, or on, the water vapor.

3.44 Using the tables for water, determine the specified property data at the indicated states. In each case, locate the state by hand on sketches of the p–v and T–v diagrams.

(a) At $p = 3$ bar, $v = 0.5$ m^3/kg, find T in °C and u in kJ/kg.
(b) At $T = 320$°C, $v = 0.03$ m^3/kg, find p in MPa and u in kJ/kg.
(c) At $p = 28$ MPa, $T = 520$°C, find v in m^3/kg and h in kJ/kg.
(d) At $T = 10$°C, $v = 100$ m^3/kg, find p in kPa and h in kJ/kg.
(e) At $p = 4$ MPa, $T = 160$°C, find v in m^3/kg and u in kJ/kg.