

**1.23** The specific volume of 5 kg of water vapor at 1.5 MPa, 440°C is 0.2160 m<sup>3</sup>/kg. Determine (a) the volume, in m<sup>3</sup>, occupied by the water vapor, (b) the amount of water vapor present, in gram moles, and (c) the number of molecules.

**KNOWN:** Mass, pressure, temperature, and specific volume of water vapor.

**FIND:** Determine (a) the volume, in m<sup>3</sup>, occupied by the water vapor, (b) the amount of water vapor present, in gram moles, and (c) the number of molecules.

**SCHEMATIC AND GIVEN DATA:**

$$\begin{aligned}m &= 5 \text{ kg} \\p &= 1.5 \text{ MPa} \\T &= 440^\circ\text{C} \\v &= 0.2160 \text{ m}^3/\text{kg}\end{aligned}$$

**ENGINEERING MODEL:**

1. The water vapor is a closed system.

**ANALYSIS:**

(a) The specific volume is volume per unit mass. Thus, the volume occupied by the water vapor can be determined by multiplying its mass by its specific volume.

$$V = mv = (5 \text{ kg}) \left( 0.2160 \frac{\text{m}^3}{\text{kg}} \right) = \underline{1.08 \text{ m}^3}$$

(b) Using molecular weight of water from Table A-1 and applying the appropriate relation to convert the water vapor mass to gram moles gives

$$n = \frac{m}{M} = \left( \frac{5 \text{ kg}}{18.02 \frac{\text{kg}}{\text{kmol}}} \right) \left| \frac{1000 \text{ moles}}{1 \text{ kmol}} \right| = \underline{277.5 \text{ moles}}$$

(c) Using Avogadro's number to determine the number of molecules yields

$$\# \text{ Molecules} = \text{Avogadro's Number} \times \# \text{ moles} = \left( 6.022 \times 10^{23} \frac{\text{molecules}}{\text{mole}} \right) (277.5 \text{ moles})$$

$$\# \text{ Molecules} = \underline{1.671 \times 10^{26} \text{ molecules}}$$