Ideal Gas

4-70C Propane (molar mass = 44.1 kg/kmol) poses a greater fire danger than methane (molar mass = 16 kg/kmol) since propane is heavier than air (molar mass = 29 kg/kmol), and it will settle near the floor. Methane, on the other hand, is lighter than air and thus it will rise and leak out.

4-71C A gas can be treated as an ideal gas when it is at a high temperature or low pressure relative to its critical temperature and pressure.

4-72C R_u is the universal gas constant that is the same for all gases whereas R is the specific gas constant that is different for different gases. These two are related to each other by $R = R_u / M$, where M is the molar mass of the gas.

4-73C Mass m is simply the amount of matter; molar mass M is the mass of one mole in grams or the mass of one kmol in kilograms. These two are related to each other by $m = NM$, where N is the number of moles.

4-74E The specific volume of oxygen at a specified state is to be determined.

Assumptions At specified conditions, oxygen behaves as an ideal gas.

Properties The gas constant of oxygen is R = 0.3353 psia·ft^3/lbm·R (Table A-1E).

Analysis According to the ideal gas equation of state,

$$v = \frac{RT}{P} = \frac{(0.3353\ \text{psia}\cdot\text{ft}^3/\text{lbm}\cdot\text{R})(80+460\ \text{R})}{25\ \text{psia}} = \mathbf{7.242\ ft^3/lbm}$$

4-75 The pressure in a container that is filled with air is to be determined.

Assumptions At specified conditions, air behaves as an ideal gas.

Properties The gas constant of air is R = 0.287 kJ/kg·K (Table A-1).

Analysis The definition of the specific volume gives

$$v = \frac{V}{m} = \frac{0.100\ \text{m}^3}{1\ \text{kg}} = 0.100\ \text{m}^3/\text{kg}$$

Using the ideal gas equation of state, the pressure is

$$P = \frac{RT}{v} = \frac{(0.287\ \text{kPa}\cdot\text{m}^3/\text{kg}\cdot\text{K})(27+273\ \text{K})}{0.100\ \text{m}^3/\text{kg}} = \mathbf{861\ kPa}$$