4-80 Two rigid tanks connected by a valve to each other contain air at specified conditions. The volume of the second tank and the final equilibrium pressure when the valve is opened are to be determined.

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

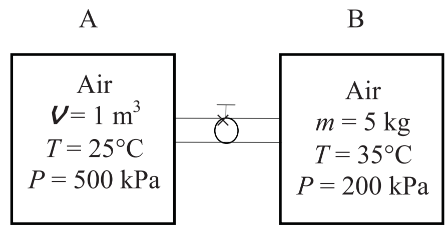
Properties The gas constant of air is $R = 0.287$ kPa.m^3/kg.K (Table A-1).

Analysis Let's call the first and the second tanks A and B. Treating air as an ideal gas, the volume of the second tank and the mass of air in the first tank are determined to be

$$V_B = \left(\frac{m_1 R T_1}{P_1}\right)_B = \frac{(5\text{ kg})(0.287\text{ kPa}\cdot\text{m}^3/\text{kg}\cdot\text{K})(308\text{ K})}{200\text{ kPa}} = \mathbf{2.21\ m^3}$$

$$m_A = \left(\frac{P_1 V}{R T_1}\right)_A = \frac{(500\text{ kPa})(1.0\text{ m}^3)}{(0.287\text{ kPa}\cdot\text{m}^3/\text{kg}\cdot\text{K})(298\text{ K})} = 5.846\text{ kg}$$

Thus,



$$V = V_A + V_B = 1.0 + 2.21 = 3.21\text{ m}^3$$

$$m = m_A + m_B = 5.846 + 5.0 = 10.846\text{ kg}$$

Then the final equilibrium pressure becomes

$$P_2 = \frac{mRT_2}{V} = \frac{(10.846\text{ kg})(0.287\text{ kPa}\cdot\text{m}^3/\text{kg}\cdot\text{K})(293\text{ K})}{3.21\text{ m}^3} = \mathbf{284.1\ kPa}$$

4-81E The validity of a statement that tires lose roughly 1 psi of pressure for every 10°F drop in outside temperature is to be investigated.

Assumptions **1**The air in the tire is an ideal gas. **2** The volume of air in the tire is constant. **3** The tire is in thermal equilibrium with the outside air. **4** The atmospheric conditions are 70°F and 1 atm = 14.7 psia.

Analysis The pressure in a tire should be checked at least once a month when a vehicle has sat for at least one hour to ensure that the tires are cool. The recommended gage pressure in cool tires is typically above 30 psi. Taking the initial gage pressure to be 32 psi, the gage pressure after the outside temperature drops by 10°F is determined from the ideal gas relation to be

$$\frac{P_1 V}{T_1} = \frac{P_2 V}{T_2} \quad \rightarrow \quad P_2 = \frac{T_2}{T_1} P_1 = \frac{(60+460)\text{ R}}{(70+460)\text{ R}}(32 + 14.7\text{ psia}) = 45.8\text{ psia} = 31.1\text{ psig (gage)}$$

Then the drop in pressure corresponding to a drop of 10°F in temperature becomes

$$\Delta P = P_1 - P_2 = 32.0 - 31.1 = \mathbf{0.9\ psi}$$

which is sufficiently close to 1 psi. Therefore, the statement is **valid**.

Discussion Note that we used *absolute* temperatures and pressures in ideal gas calculations. Using gage pressures would result in pressure drop of 0.6 psi, which is considerably lower than 1 psi. Therefore, it is important to use absolute temperatures and pressures in the ideal gas relation.