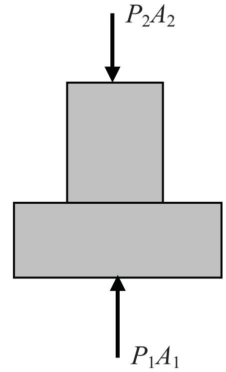
4-114 The volume of chamber 1 of the two-piston cylinder shown in the figure is to be determined.

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

Properties The gas constant of helium is R = 2.0769 kJ/kg·K (Table A-1).

Analysis Since the water vapor in chamber 2 is condensing, the pressure in this chamber is the saturation pressure,



$$P_2 = P_{\text{sat @ 200°C}} = 1555\text{ kPa} \quad \text{(Table A-4)}$$

Summing the forces acting on the piston in the vertical direction gives

$$P_1 = P_2\frac{A_2}{A_1} = P_2\left(\frac{D_2}{D_1}\right)^2 = (1555\text{ kPa})\left(\frac{4}{10}\right)^2 = 248.8\text{ kPa}$$

According to the ideal gas equation of state,

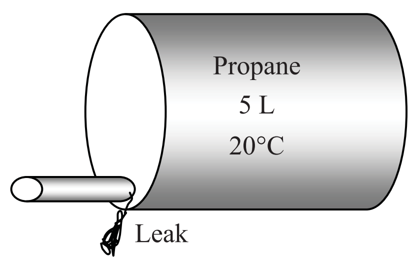
$$V_1 = \frac{mRT}{P_1} = \frac{(1\text{ kg})(2.0769\text{ kPa}\cdot\text{m}^3/\text{kg}\cdot\text{K})(200+273\text{ K})}{248.8\text{ kPa}} = \mathbf{3.95\ m^3}$$

4-115 A propane tank contains 5 L of liquid propane at the ambient temperature. Now a leak develops at the top of the tank and propane starts to leak out. The temperature of propane when the pressure drops to 1 atm and the amount of heat transferred to the tank by the time the entire propane in the tank is vaporized are to be determined.

Properties The properties of propane at 1 atm are T_{sat} = -42.1°C, $\rho = 581\text{ kg/m}^3$, and h_{fg} = 427.8 kJ/kg (Table A-3).

Analysis The temperature of propane when the pressure drops to 1 atm is simply the saturation pressure at that temperature,

$$T = T_{\text{sat @1 atm}} = \mathbf{-42.1°C}$$



The initial mass of liquid propane is

$$m = \rho V = (581\text{ kg/m}^3)(0.005\text{ m}^3) = 2.905\text{ kg}$$

The amount of heat absorbed is simply the total heat of vaporization,

$$Q_{\text{absorbed}} = mh_{fg} = (2.905\text{ kg})(427.8\text{ kJ/kg}) = \mathbf{1243\ kJ}$$