

QUIZ 2

Problem #1:

A 1-m³ tank containing air at 25°C and 500 kPa is connected through a valve to another tank containing 5 kg of air at 35°C and 200 kPa. Now the valve is opened, and the entire system is allowed to reach thermal equilibrium with the surroundings, which are at 20°C. Determine the volume of the second tank and the final equilibrium pressure of air.

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

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

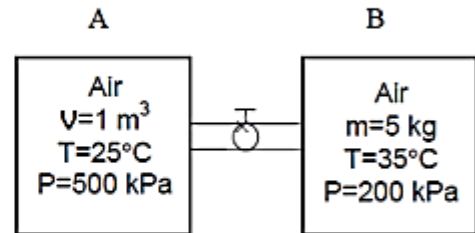
Thus,

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

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

Then the final equilibrium pressure becomes

$$P_2 = \frac{m R T_2}{V} = \frac{(10.846 \text{ kg})(0.287 \text{ kPa} \cdot \text{m}^3/\text{kg} \cdot \text{K})(293 \text{ K})}{3.21 \text{ m}^3} = 284.1 \text{ kPa}$$



Problem #2:

A rigid tank contains an ideal gas at 300 kPa and 600 K. Now half of the gas is withdrawn from the tank and the gas is found at 100 kPa at the end of the process. Determine (a) the final temperature of the gas and (b) the final pressure if no mass was withdrawn from the tank and the same final temperature was reached at the end of the process.

Analysis: (a) The first case is a constant volume process.

$$T_2 = \frac{m_1}{m_2} \frac{P_2}{P_1} T_1 = (2) \left(\frac{100 \text{ kPa}}{300 \text{ kPa}} \right) (600 \text{ K}) = 400 \text{ K}$$

(b) The second case is a constant volume and constant mass process.

$$P_2 = \frac{T_2}{T_1} P_1 = \left(\frac{400 \text{ K}}{600 \text{ K}} \right) (300 \text{ kPa}) = 200 \text{ kPa}$$