

Problem Set 5, PS4 due Friday May 28

PS5-1 A spherical balloon has a diameter of 6 meters and is filled with helium at 20 C and 200 kpa. Determine the number of moles and the mass of the helium in the balloon.

PS5-2 The air in a .53 ft³ tire is at 90 F and 20 psig. How much air must be added to the tire to raise the pressure to 30 psig. Assume atmospheric pressure is 14.6 psia the temperature remains constant and volume of the tire does not increase.

$$V_{\text{sphere}} = \frac{4}{3} \pi R^3 = \frac{4}{3} \times 3.1416 \times 3^3 = 113.1 \text{ m}^3$$

$$\text{moles} = \frac{pV}{R^*T} = \frac{200 \text{ kPa} \times 113.1 \text{ m}^3}{8.314 \text{ kPa m}^3/\text{kmole K} \times (273.15 + 20) \text{ K}} = 9.28 \text{ kmole}$$

$$R = \frac{8.314 \text{ kPa m}^3/\text{kmole K}}{4.03 \text{ kmole/kg}} = 2.076 \frac{\text{kPa m}^3}{\text{kg R}}$$

$$\text{mass} = \frac{pV}{RT} = \frac{200 \text{ kPa} \times 113.1 \text{ m}^3}{2.075 \text{ kPa m}^3/\text{kg K} \times (273.15 + 20) \text{ K}} = 37.19 \text{ kg}$$

PS5-2

state 1 before addition of air $p_1 = 20. + 14.6 = 34.6 \text{ psia}$

state 2 after air addition $p_2 = 30 + 14.6 = 44.6 \text{ psia}$

$$m_1 = \frac{pV}{RT} = \frac{34.6 \text{ psia} \times 144 \text{ in}^2/\text{ft}^2 \times .53 \text{ ft}^3}{53.35 \text{ ft lbf/lb}_m \text{ R} \times (459.69 + 90) \text{ R}} = .09 \text{ lb}$$

T and V = constant

$$V = \frac{m R T}{p} = \frac{m_1 T_1}{p_1} = \frac{m_2 T_2}{p_2}$$

$$m_2 = m_1 \frac{p_2}{p_1} = .09 \text{ lb} \times \frac{44.6 \text{ psia}}{35.6 \text{ psia}} = .1128 \text{ lbs}$$

$$\text{air added} = .1128 \text{ lb} - .09 \text{ lb} = .0225 \text{ lb}$$