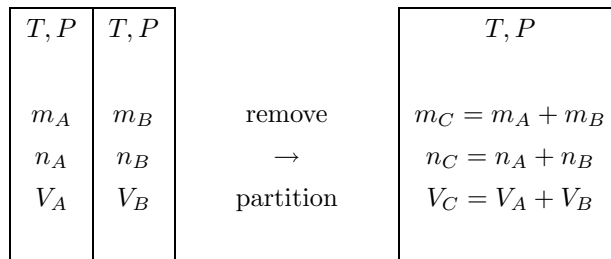


**Week 10: Lecture 2****P-V-T Relationships for Ideal Gas Mixtures**Amagat Model (law of additive volumes)

- each component mixture behaves as an ideal gas as if it existed separately at the pressure,  $P$  and the temperature,  $T$ , of the mixture



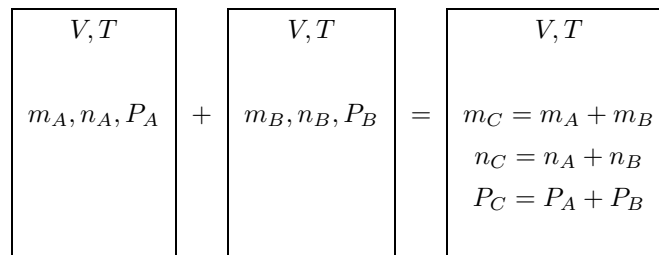
$$\frac{V_i}{V} = \frac{n_i}{n} = X_i$$

which leads to

$$V = \sum_{i=1}^j V_i$$

Dalton Model (law of additive pressures)

- each mixture component behaves as an ideal gas as if it were alone at the temperature,  $T$  and the volume,  $V$  of the mixture



**Week 10: Lecture 2**

for a mixture of ideal gases the pressure is the sum of the partial pressures of the individual components

$$P = \sum_{i=1}^j P_i$$

By combining the results of the Amagat and Dalton models, we obtain

$$\frac{P_i}{P} = \frac{V_i}{V} = \frac{n_i}{n}$$

Ideal Gas Law for a Mixture

- the gas constant can be expressed as

$$R = \sum_{i=1}^j Y_i R_i$$

- the relative mass fractions and mole fractions can be related in terms of the gas constant as

$$X_i = Y_i \left[ \frac{R_i}{\sum_{i=1}^j Y_i R_i} \right]$$

**Week 10: Lecture 2****Non-Reacting Mixtures****Changes in Internal Energy, Enthalpy and Entropy of Mixtures**

$$u_2 - u_1 = \sum Y_i (u_2 - u_1)_i = \int_{T_1}^{T_2} c_v dT$$

$$h_2 - h_1 = \sum Y_i (h_2 - h_1)_i = \int_{T_1}^{T_2} c_p dT$$

$$s_2 - s_1 = \sum Y_i (s_2 - s_1)_i = \int_{T_1}^{T_2} c_p \frac{dT}{T} - R \ln \frac{P_2}{P_1}$$

The above equations can also be expressed on a per mole basis.

**Entropy Change Due to Mixing of Ideal Gases**

- when ideal gases are mixed, a change in entropy occurs as a result of the increase in disorder in the system
- if the initial temperatures of all constituents are the same and the mixing process is adiabatic

$$\mathcal{P}_s = \Delta S = -(m_A R_A \ln \frac{P_A}{P} + m_B R_B \ln \frac{P_B}{P} + \dots)$$

$$= -\sum m_i R_i \ln \frac{P_i}{P}$$

$$= -\mathcal{R} \sum n_i \ln X_i$$