WEEKS 9 and 10

Balances on Nonreactive Systems

Estimation of ΔH and ΔU

- Page 365 Changes in pressure at constant temperature
  - Observe that at fixed T, ΔU is independent of pressure

$$\Delta\hat{U} \approx 0 \quad \text{and} \quad \Delta\hat{H} = \Delta\hat{U} + \Delta P\hat{V}$$

$$\Delta\hat{H} = \hat{V}\Delta P$$

- Section 8.3. Changes in T
  Closed system Q = ΔU; Open system: $\dot{Q} = \Delta\dot{H}$

<u>Heat Capacity at constant volume</u>: $C_v(T) = \lim_{\Delta T \to 0} \frac{\Delta\hat{U}}{\Delta T} = \left(\frac{\partial\hat{U}}{\partial T}\right)_V$

$$\Delta\hat{U} = \int_{T_1}^{T_2} C_v(T)\,dT$$

- ideal gas: exact
- solid or liquid: good approximation
- Nonideal gas: valid if V is constant

<u>Heat Capacity at constant pressure</u>:

$$C_p(T) = \lim_{\Delta T \to 0} \frac{\Delta\hat{H}}{\Delta T} = \left(\frac{\partial\hat{H}}{\partial T}\right)_p$$

Estimation of ΔH and ΔU

- Change in enthalpy

$$\Delta\hat{H} = \int_{T_1}^{T_2} C_p(T)\,dT$$

- ideal gas: exact
-- Nonideal gas: exact if P is constant

$$\Delta\hat{H} = \hat{V}\Delta P + \int_{T_1}^{T_2} C_p(T)\,dT$$

- Solid or liquid

- 8.3 b Heat Capacity formulas

$$C_p \approx C_v$$

- Solid or liquid

$$C_p = C_v + R$$

- Ideal gas

Estimation of heat capacity

- Heat capacity of a mixture:

$$C_{pMix}(T) = \sum_i y_i C_{pi}(T)$$

Heat capacity of a mixture — Mass or mole fraction

$$\Delta\hat{H} = \int_{T_1}^{T_2} C_{pMix}(T)\,dT$$

- These equations can be used to solve energy balance problems (closed-system and open-system)
- p 329, 7.5-3; p 330, 7.6-1; p 331, 7.6-2; p 335, 7.7-2; p 736, 7.7-3; p 367, 8.3-1; p 369, 8.3-2; p 371, 8.3-3; p373, 8.3-4; p 374, 8.3-5 **To do in class**
- **Extra problems**

HMK: **8.1, 8.7, 8.9 (a, b), 8.14 (a, b)**