

Relationships FOR MIDTERM #2 CHEMISTRY 163B

definitions for U, H, A, and G (student fills in at exam time):

total differentials for: dU, dH, dA, and dG (student fills in at exam time):

For reversible adiabatic path, ideal gas:

- $T_1^{\bar{C}_V} V_1 = T_2^{\bar{C}_V} V_2$ (adiabatic reversible path)
- $P_1 V_1^{\frac{\bar{C}_p}{\bar{C}_V}} = P_2 V_2^{\frac{\bar{C}_p}{\bar{C}_V}}$ (adiabatic reversible path, $PV^\gamma = \text{constant}$)
- $\frac{T_1^{\bar{C}_p}}{P_1} = \frac{T_2^{\bar{C}_p}}{P_2}$ (adiabatic reversible path)

Energy and enthalpy:

- $(\Delta H_{\text{reaction}})_T = \Delta U_{\text{reaction}} + \Delta n_{\text{gas}} RT$
- $\left(\frac{\partial H}{\partial T}\right)_P = C_p = n\bar{C}_p$; $\Delta H(T_2) = \Delta H(T_1) + \int_{T_1}^{T_2} \Delta C_p dT$

For ideal gas:

- $\Delta U = C_V \Delta T = n\bar{C}_V \Delta T$
- $\Delta H = C_p \Delta T = n\bar{C}_p \Delta T$
- $(\bar{C}_p - \bar{C}_V) = R$
- $\bar{C}_V = \frac{3}{2}R$ (monatomic ideal gas)

For ideal, reversible, Carnot Engine:

- $\varepsilon = \frac{-W_{\text{total}}}{q_H} = 1 - \frac{T_L}{T_H}$

Some entropy relationships:

- $\left(\frac{\partial S}{\partial T}\right)_P = \frac{C_p}{T} = \frac{n\bar{C}_p}{T}$; $\left(\frac{\partial S}{\partial T}\right)_V = \frac{C_V}{T} = \frac{n\bar{C}_V}{T}$
- $\Delta S_{\text{mixing, ideal gasses}} = -n_{\text{total}} R \sum_i X_i \ln X_i$ (where X_i is mole fraction component i)

[see reverse side for more relationships]:

Free energy relationships:

- $\Delta G = \Delta G^\circ + RT \ln Q$
- $\Delta G^\circ = -RT \ln K_{eq}$
- $\left(\frac{\partial \ln K_{eq}}{\partial T} \right)_P = \frac{\Delta H^\circ}{RT^2}$
- $\ln \left[\frac{(K_{eq})_{T_2}}{(K_{eq})_{T_1}} \right] = \frac{\Delta H^\circ}{R} \left(\frac{1}{T_1} - \frac{1}{T_2} \right)$

Partial molar properties:

- $\bar{V}_i = \left(\frac{\partial V}{\partial n_i} \right)_{T,P,n_j \neq n_i}$
- $\bar{G}_i = \mu_i = \left(\frac{\partial G}{\partial n_i} \right)_{T,P,n_j \neq n_i}$
- $V = \sum_i^N n_i \bar{V}_i$
- $X_A \left(\frac{\partial \bar{V}_A}{\partial n_A} \right)_{T,P,n_B} = -X_B \left(\frac{\partial \bar{V}_B}{\partial n_A} \right)_{T,P,n_B}$ *Gibbs-Duhem for volume of two-component system*