

Laws

Zeroth Law: If system x = system y & system y = system z, then system x = system z. (Transitive)

First Law: Internal energy(ΔU) of an isolated system is constant. No heat lost, only transferred.

Second Law: The entropy of any isolated system always increases.

Third Law: The entropy of a system approaches a constant value as the temperature approaches absolute zero.

Cyclic Rule: $(\partial P/\partial T)_V (\partial T/\partial V)_P (\partial V/\partial P)_T = -1$

Definitions

Adiabatic: No transfer of heat or matter

Diathermal: Heat allowed to transfer, no matter transfer. Can transfer energy in the form of work

Enthalpy(ΔH): Amount of heat content used or released in a system at constant pressure

Irreversible: A process that cannot return both the system and the surroundings to their original conditions.

Exam 2

$\Delta U = m_s/M_s \Delta U_{\text{comb}} + m_{\text{H}_2\text{O}}/M_{\text{H}_2\text{O}} C_{v,m}(\text{H}_2\text{O})\Delta T + \Delta T C_{\text{calorimeter}}$

$\Delta H^\circ = m_{\text{salt}}/M_{\text{salt}} \Delta H^\circ_{\text{solution}} + m_{\text{H}_2\text{O}}/M_{\text{H}_2\text{O}} C_{p,m}(\text{H}_2\text{O})\Delta T + \Delta T C_{\text{calorimeter}}$

$S = k \ln(W)$ $W = \# \text{ of states}$

Efficiency = $1 - |q_{\text{cd}}|/|q_{\text{ab}}| < 1$

$\Delta H^\circ_{\text{rt}} = \Delta H^\circ_{298} + \int_{298}^T \Delta C_p(T) dT$ from 298 to T

$\Delta H_{\text{combustion}} = \Delta U_{\text{combustion}} + \Delta(PV)$

For Solids & Liquids: $\Delta H \approx \Delta U$

$\Delta S = -nR \ln(P_f/P_i) + \int_{P_i}^{P_f} nC_{p,m}/T dT$ for P_i to P_f

$\Delta S = nR \ln(V_f/V_i) + \int_{V_i}^{V_f} nC_{v,m}/T dT$ for V_i to V_f

Isolated System: $\Delta S = q_p(1/T_1 - 1/T_2)$

Isothermal, Ideal: $\Delta S = nR \ln(V_f/V_i)$

$\Delta S_{\text{total}} = \Delta S + \Delta S_{\text{surroundings}}$

$\Delta G = nRT \sum x_i \ln(x_i)$ x_i is mole fraction

$\Delta G = T\Delta S_{\text{total}}$

Internal Energy (ΔU)

General $\Delta U = q + w$

Constant Volume $\Delta U = C_v \Delta T = q_v$

Adiabatic, Reversible $\Delta U = w = n(C_{p,m} - R)\Delta T = nC_{v,m}\Delta T$

Ideal $\Delta U = nC_{v,m}\Delta T$

Enthalpy (ΔH) (State Fxn)

General $\Delta H = \Delta U + \Delta(PV) = \Delta U + nR\Delta T$

Constant Pressure $\Delta H = C_p \Delta T$

Ideal $\Delta H = q_p$

Constant Volume $\Delta H = nC_{p,m}\Delta T + V\Delta P$

Even More General $dH = (dH/dP)_T dT + (dH/dT)_P dP$

Liquids & Solids $(dH/dP)_T = V(1 - T\beta)$

Constant Pressure, closed system $\Delta H = (U_f + P_f V_f) - (U_i + P_i V_i)$

Isobaric $\Delta H = n \int C_{p,m}(T) dT = nC_{p,m}\Delta T$

Exam 2 Material

$S_m(T) = S_m(0^\circ\text{K}) + \int_0^T C_{p,m}/T dT(\text{solid } 0-T_f) + \Delta H_{\text{fus}}/T_f + \int_{T_f}^T C_{p,m}/T dT(\text{liquid } T_f-T_b) + \Delta H_{\text{vap}}/T_b + \int_{T_b}^T C_{p,m}/T dT(\text{gas } T_b-T)$

For Ideal Gases: $\Delta S_m = R \ln(V_f/V_i) = -R \ln(P_f/P_i)$

$\Delta G(T_2)/T_2 = \Delta G(T_1)/T_1 + \Delta H(T_1)(1/T_2 - 1/T_1)$

Max Work: Reversible, adiabatic, isothermal

Hess's Law: Total Enthalpy change is independent of # of steps (path-independent).

$\Delta A = \Delta U - T\Delta S = \Delta H - nRT$ (Hemholtz)

for ΔG°_r only include non-pure substances.

Exam 3

$$\Delta G_R = \Delta G^\circ_R + RT \ln(Q_P)$$

$$\ln(K_P) = -\Delta G^\circ_R / RT$$

$$K_x = K_P (P/P^\circ)^{-\Delta V}$$

$$dA = \gamma d\sigma \text{ gamma is surface tension}$$

$$\text{Work} = 8\pi\gamma r dr$$

$$\text{Force} = 8\pi\gamma r$$

$$h(\text{capillary rise/depression}) = 2\gamma / \rho g r$$

$$\mu_B = \mu^\circ_B + RT \ln(\gamma[B]) \text{ gamma is activity coefficient}$$

$$\Delta G_R = \Delta G^\circ_R - 2.303 RT (\text{pH})$$

$$q_x = kA(T_{si} - T_{so})/L$$

$$q''_x = -k dT/dx = q_x/A$$

$$\dot{E}_{in} + \dot{E}_g - \dot{E}_{out} = \dot{E}_{internal}$$

$$q_{12} = \epsilon \sigma A (T_1^4 - T_2^4) - \text{Heat xchange via radiation b/t 2 surfaces}$$

$$q''_s = h(T_s - T_\infty) - \text{Newton's Law of Cooling}$$



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