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: $(dP/dT)_V(dT/dV)_P(dV/dP)_T = -1$

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

$\Delta U = m_s/M_s\ \Delta U_{comb} + m_{H2O}/M_{H2O}\ C_{v,m}(H2O)\Delta T + \Delta TC_{calorimeter}$

$\Delta H^o = m_{salt}/M_{salt}\ \Delta H^o_{solution} + m_{H2O}/M_{H2O}\ C_{p,m}(H2O)\Delta T + \Delta TC_{calorimeter}$

S=k ln(W) W=#of states

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

$\Delta H^o_{rt} = \Delta H^o_{298} + \int \Delta C_p(T)\ dT$ from 298 to T

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

For Solids & Liquids: $\Delta H \sim= \Delta U$

$\Delta s = -nR\ln(P_f/P_i) + \int nC_{pm}/T\ dT$ for P_i to P_f

$\Delta s = nR\ln(V_f/V_i) + \int nC_{vm}/T\ dT$ for V_i to V_f

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

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

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

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

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

Internal Energy (ΔU)

General	$\Delta U = q + w$
Constant Volume	$\Delta U = C_v\Delta T = q_v$
Adiabatic, Reversible	$\Delta U = w = n(C_{pm} - R)\Delta T = nC_{vm}\Delta T$
Ideal	$\Delta U = nC_{vm}\Delta T$

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	$\Delta H = nC_{pm}\Delta T + V\Delta P$
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	$\Delta H = (U_f + P_fV_f) - (U_i + P_iV_i)$
Isobaric	$\Delta H = n\int C_{pm}(T)\ dT = nC_{pm}\Delta T$

Exam 2 Material

$S_m(T) = S_m(0^o k) + \int C_{pm}/T\ dT(\text{solid } 0\text{-}T_f) + \Delta H_{fus}/T_f + \int C_{pm}/T\ dT(\text{liquid } T_f\text{-}T_b) + \Delta H_{vap}/T_b \int C_{pm}/T\ dT(\text{gas } T_b\text{-}T)$ `

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^o_r only include non-pure substances.

Exam 3

$\Delta G_R = \Delta G°_R + RT \ln(Q_P)$
$\ln(K_P) = -\Delta G°_R/RT$
$K_x = K_P(P/P°)^{-\Delta V}$
$dA = \gamma\, d\sigma$ gamma is surface tension
Work = 8piγr dr
Force = 8piγr
h(capillary rise/depression) = $2\gamma/\rho gr$
$u_B = u°_B + RT\ln(\gamma[B])$ gamma is activity coefficient
$\Delta G_R = \Delta G°_R - 2.303vRT(pH)$
$q_x = kA(T_{si} - T_{so})/L$
$q''_x = -k\, dT/dx = q_x/A$
$\dot{E}_{in} + \dot{E}_g - \dot{E}_{out} = \dot{E}_{internal}$
$q_{12} = \varepsilon\sigma A(T_1^4 - T_2^4)$ - Heat xchange via radiation b/t 2 surfaces
$q''_s = h(T_s - T_\infty)$ - Newton's Law of Cooling