TABLE OF THERMODYNAMIC POTENTIALS, THEIR INTEGRATED FORMS, TRANSFORM EQUATIONS AND THE CHARACTERISTIC FUNCTIONS

Differential Forms	Transforms to dU	Integrated Form	Characteristic Function	Fixed Variables/Fluctuations
Gibbs Fundamental Equation In the Energy Representation $$dU = TdS - PdV + \sum_i \mu_i dn_i$$		$$U = TS - PV + \sum_i \mu_i n_i$$		
Gibbs Fundamental Equation in the Entropy Representation $$dS = \frac{1}{T} dU + \frac{P}{T} dV - \frac{1}{T} \sum_i \mu_i dn_i$$		$$S = \frac{U}{T} + \frac{PV}{T} - \frac{1}{T} \sum_i \mu_i n_i$$	**Microcanonical Ensemble** $$S = k \log \Omega(N,V,E)$$	**N,V,E Fixed** **No Fluctuations**
$$dH = TdS + VdP + \sum_i \mu_i dn_i$$	$$H = U + PV$$ $$-PdV \rightarrow VdP$$	$$H = TS + \sum_i \mu_i n_i$$		
$$dA = -SdT - PdV + \sum_i \mu_i dn_i$$	$$A = U - TS$$ $$TdS \rightarrow -SdT$$	$$A = -PV + \sum_i \mu_i n_i$$	**Canonical Ensemble** $$A = -kT \log Q(N,V,T)$$	**N,V,T Fixed** **Fluctuations in E, P**
$$dG = -SdT + VdP + \sum_i \mu_i dn_i$$	$$G = U + PV - TS$$ $$-PdV \rightarrow VdP$$ $$TdS \rightarrow -SdT$$	$$G = \sum_i \mu_i n_i$$	**Isobaric, Isothermal Ensemble** $$G = -kT \log \Delta(N,T,P)$$	**N,T,P Fixed** **Fluctuations in E, V**
Massieu Function $$d\Phi_1 = -Ud(\tfrac{1}{T}) + (\tfrac{P}{T})dV - \frac{1}{T}\sum_i \mu_i dn_i$$	**Use the Entropy Representation**	$$\Phi_1 = \frac{PV}{T} - \frac{1}{T}\sum_i \mu_i n_i = -\frac{A}{T}$$		
Planck Function $$d\Phi_2 = -Ud(\tfrac{1}{T}) - Vd(\tfrac{P}{T}) - \frac{1}{T}\sum_i \mu_i dn_i$$	**Use the Entropy Representation**	$$\Phi_2 = -\frac{1}{T}\sum_i \mu_i n_i = -\frac{G}{T}$$		
Grand Potential Function $$d\Omega = -SdT - PdV - \sum_i n_i d\mu_i$$	$$\Omega = U - TS - \sum \mu n$$ $$TdS \rightarrow -SdT$$ $$\sum \mu dn \rightarrow -\sum n d\mu$$	$$\Omega = -PV$$	**Grand Canonical Ensemble** $$\Omega = -kT \log \Xi(V,T,\mu)$$	**V,T,μ Fixed** **Fluctuations in E, N**