$dW = TdS + VdP + \mu dN$

$dF = -SdT - PdV + \mu dN$

$d\Phi = -SdT + VdP + \mu dN$ (1)

$\mu = \left(\frac{\partial W}{\partial N}\right)_{S,P}$; $\mu = \left(\frac{\partial F}{\partial N}\right)_{T,V}$; $\mu = \left(\frac{\partial \Phi}{\partial N}\right)_{T,P}$

special

Gibbs $\Phi = N\mu(T,P)$

diff $= N d\mu + \mu dN$ (2)

2 expressions for $d\Phi$

$d\mu = -s dT + v dP$ (Gibbs Duham relation)

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one more "Potential"

"Omega Potential"

$\Omega \equiv F - \Phi = -PV$

$d\Omega = -SdT - PdV + \cancel{\mu dN} - N d\mu - \cancel{\mu dN}$

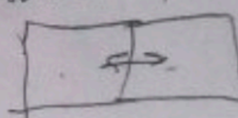
$d\Omega = -SdT - PdV - N d\mu$

$N = -\left(\frac{\partial \Omega}{\partial \mu}\right)_{T,V}$

but $\Omega = -PV$

$N = V\left(\frac{\partial P}{\partial \mu}\right)_{T,N}$

Bodies in contact when particles exchanged



$V = V_1 + V_2 = \text{const}$

In eq. entropy max.

also $N = N_1 + N_2 = \text{const}$

$dN = 0$; $dN_1 = -dN_2$

$S = S_1(N_1) + S_2(N_2)$

S max in eq.

$\frac{\partial S}{\partial N_1} = 0 \quad \frac{\partial S_1}{\partial N_1} + \frac{\partial S_2}{\partial N_1} = 0$

$= \frac{\partial S}{\partial N_1} - \frac{\partial S}{\partial N_2} = 0$

eq. cond

$\frac{\partial S_1}{\partial N_1} = \frac{\partial S_2}{\partial N_2}$

$\left(\frac{\partial S}{\partial N}\right)_{E,V}$