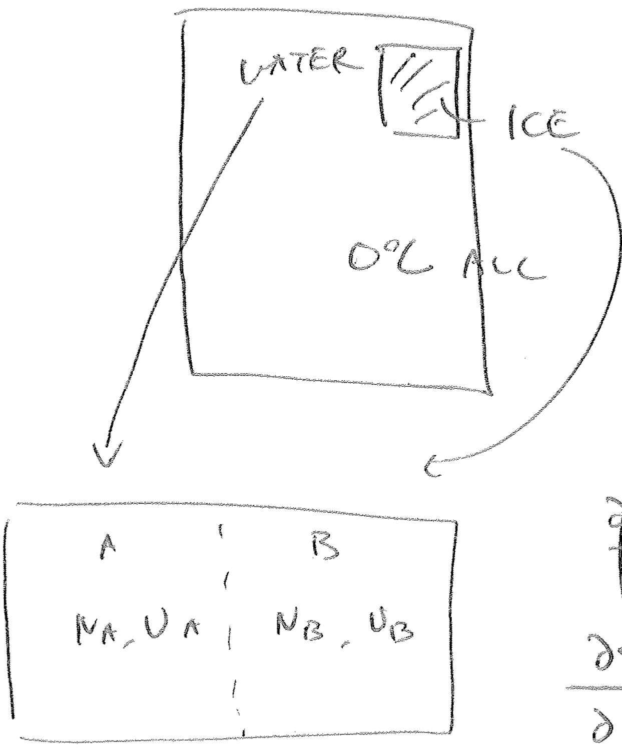
DIFFUSIVE EQUILIBRIUM AND CHEMICAL POTENTIAL

$\left.\frac{\partial S}{\partial N}\right|$ MIGHT BE RELEVANT FOR CASES SUCH AS



μ_{water} μ_{ice} CHANGE

~~$\frac{\partial S_A}{\partial N_A} = \frac{\partial S_B}{\partial i}$~~

$\frac{\partial S_{total}}{\partial N_A} = 0$ AT EQUILIBRIUM

$$\frac{\partial S_{total}}{\partial N_A} = \frac{\partial S_A}{\partial N_A} + \frac{\partial S_B}{\partial N_A} = 0$$

$$\partial N_A = -\partial N_B$$

$$\frac{\partial S_A}{\partial N_A} = \frac{\partial S_B}{\partial N_B}$$ AT EQUILIBRIUM

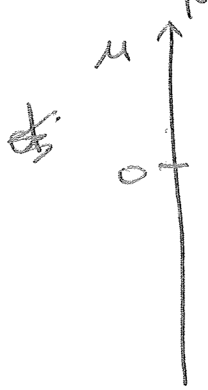
$$\frac{\partial S_A}{\partial N_A} \Rightarrow \frac{J/K}{\#} = J/K$$

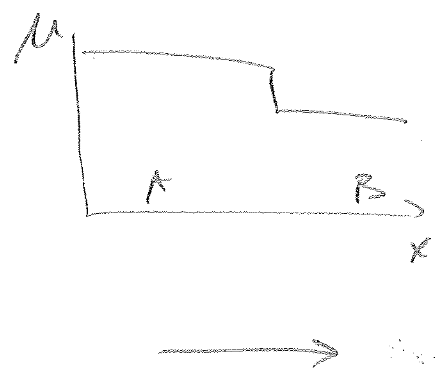
DEFINE $\mu = -T\left(\frac{\partial S}{\partial N}\right)_{V,U}$

= CHEMICAL POTENTIAL

$\mu_A = \mu_B$ AT EQUILIBRIUM

NEGATIVE SIGN SO THAT





PARTICLE FLOW.

$S(U, V, N)$

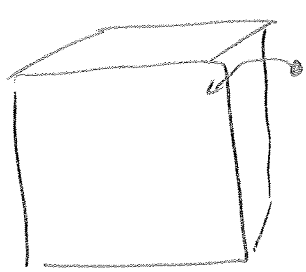
$$dS = \left(\frac{\partial S}{\partial U}\right)_{N,V} dU + \left(\frac{\partial S}{\partial V}\right)_{U,N} dV + \left(\frac{\partial S}{\partial N}\right)_{U,V} dN$$

$$dS = \frac{1}{T} dU + \frac{P}{T} dV - \frac{\mu}{T} dN$$

$$\underline{dU = T\,dS - P\,dV + \mu\,dN}$$

IF $dS = 0$ AND $dV = 0$

$$dU = \mu\,dN$$



μ : AMOUNT OF ENERGY YOU MUST CHANGE TO KEEP $S + V$ FIXED

S CONSTANT : WHAT'S IMPLICATION?

S CONST MEANS Ω CONST

EINSTEIN SOLID?

$$\Omega = \binom{N+q-1}{q} =$$

$$= \frac{(N+q-1)!}{q!\,(N-1)!}$$

EXAMPLE $N = q = 3$

$$\Omega = \frac{(3+3-1)!}{3!\ 2!} = \frac{5!}{3!\ 2!} = \frac{5 \times 4}{2}$$

$$= 10$$

IF $N = 4$ $q = q'$?

$$\frac{(4+q'-1)!}{q'!\ 3!} \Rightarrow$$

IF $q' = 2$ THEN

$\Omega = 10$

SIMA $-U = q \Delta W = q \mathcal{E}$

$\mu = -1$ OR $-\mathcal{E}$

MONATOMIC IDEAL GAS

$$S = Nk\left[\ln\left(V\left(\frac{4\pi m U}{3h^2}\right)^{3/2}\right) - \ln N^{5/2} + \frac{5}{2}\right]$$

$$\frac{\partial S}{\partial N} = -\frac{\mu}{T}$$

$$\mu = -kT\ln\left[\frac{V}{N}\left(\frac{2\pi m kT}{h^2}\right)^{3/2}\right]$$

$\mu = -0.32\,eV$ He AT 300 K $10^5\ N/m^2$.

N → BIGGER

μ → LESS NEGATIVE.

MORE WILLING TO GIVE UP PARTICLES

IF YOU HAVE MULTIPLE TYPES OF PARTICLES

$$\mu dN \rightarrow \sum_i \mu_i \, dN_i$$

$$\left(dU = T\,dS - P\,dV + \sum_i \mu_i \, dN_i \right)$$

IN CHEMISTRY

$$\mu = -T \frac{dS}{dn}$$

IN MOLES

IN CH 4: ENGINES AND REF

CH 5: CHEMISTRY + PHASE TRANSITIONS