

1. EXPAND  $dF = \left. \frac{\partial F}{\partial T} \right|_L dT + \left. \frac{\partial F}{\partial L} \right|_T dL$

FIND COEFFICIENTS  $\left. \frac{\partial F}{\partial L} \right|_T = (a + bT)$  IS GIVEN

$$\left. \frac{\partial F}{\partial T} \right|_L = -1 / \left. \frac{\partial T}{\partial L} \right|_F \left. \frac{\partial L}{\partial F} \right|_T = - \left. \frac{\partial L}{\partial T} \right|_F \left. \frac{\partial F}{\partial L} \right|_T = b(L - L_0)$$

so  $dF = b(L - L_0) dT + (a + bT) dL$

$$F = b(L - L_0)T + f(L)$$

$$\left. \frac{\partial F}{\partial L} \right|_T = bT + f'(L) \stackrel{\text{ALSO}}{=} a + bT \Rightarrow f'(L) = a, f(L) = aL + C$$

$$F = b(L - L_0)T + aL + C \text{ MUST } = 0 \text{ AT } L = L_0 \Rightarrow C = -aL_0$$

$$\underline{F = (a + bT)(L - L_0)}$$

2.  $dQ = dU - dW = dU - HdM$  1<sup>ST</sup> LAW

$$= \left. \frac{\partial U}{\partial T} \right|_M dT + \left( \left. \frac{\partial U}{\partial M} \right|_T - H \right) dM \quad \begin{array}{l} \text{BY EXPERIMENT} \\ \text{EXPANSION OF } U \end{array}$$

$$C_M \equiv \left. \frac{\partial Q}{\partial T} \right|_M = \left. \frac{\partial U}{\partial T} \right|_M \text{ IS A CONSTANT BY EXPERIMENT}$$

$$\text{ADIABATIC} \equiv dQ = 0 = C_M dT - \left( \frac{MT}{a} \right) dM$$

$$\frac{dT}{T} = \frac{1}{aC_M} M dM \Rightarrow \ln \frac{T}{T_0} = \frac{1}{2aC_M} (M^2 - M_0^2)$$

$$\frac{T}{T_0} = e^{\frac{M^2 - M_0^2}{2aC_M}} \quad \underline{T_{\text{FINAL}} / T_0 = e^{-M_0^2 / 2aC_M}}$$

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3. a/  $\Omega = \#$  WAYS OF PLACING  $n$  ATOMS IN  $N$  SURFACE CELLS  
 $\times$   $\#$  WAYS OF PLACING  $N-n$  ATOMS IN  $M$  BULK CELLS

$$= \frac{N!}{(N-n)! n!} \frac{M!}{(M-(N-n))! (N-n)!}$$

$$S(n) = k \ln \Omega = k \left\{ N \ln N - (N-n) \ln(N-n) - n \ln n \right. \\ \left. + M \ln M - (M-N+n) \ln(M-N+n) - (N-n) \ln(N-n) \right\}$$

$$b/ \frac{1}{T} = \frac{\partial S(E)}{\partial E} \Big|_{N,M} = \frac{\partial S}{\partial n} \frac{\partial n}{\partial E} = \frac{\partial S}{\partial n} \left( \frac{-1}{E} \right)$$

$$= \frac{-k}{E} \left\{ \ln(N-n) + 1 - \ln n - 1 - \ln(M-N+n) - 1 + \ln(N-n) + 1 \right\}$$

$$= \frac{-k}{E} \ln \left[ \frac{(N-n)^2}{n(M-N+n)} \right]$$

$$\frac{(N-n)^2}{n(M-N+n)} = e^{-E/kT}$$

$$c/ e^{-E/kT} = 0 \text{ AT } T=0 \Rightarrow \underline{n=N} \left\{ \begin{array}{l} \text{ALL THE ATOMS ARE} \\ \text{ON THE SURFACE} \end{array} \right.$$

$$d/ e^{-E/kT} = 1 \text{ AT } T=\infty$$

$$\Rightarrow N^2 - 2nN + n^2 = nM - nN + n^2 \rightarrow N^2 = (M+N)n$$

$$\underline{\frac{n}{N} = \frac{N}{M+N}}$$

FRACTIONAL OCCUPATION OF SURFACE STATES IS IDENTICAL TO THE FRACTIONAL OCCUPATION OF ALL THE STATES.