VARIOUS DISTRIBUTIONS

FERMI-DIRAC $\dfrac{1}{e^{(\varepsilon-\mu)/k_BT}+1}$

BOSE-EINSTEIN $\dfrac{1}{e^{(\varepsilon-\mu)/k_BT}-1}$

BOLTZMANN $\dfrac{1}{e^{(\varepsilon-\mu)/k_BT}}$

(DEGENERATE FERMI GAS)

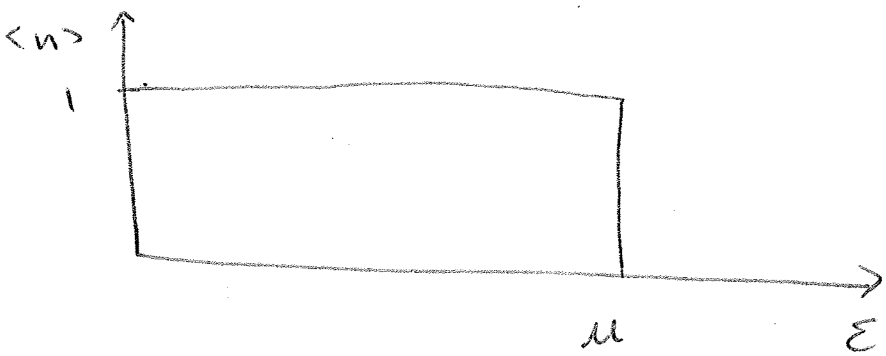
ELECTRONS IN SOLID?

$$V_Q = \left(\frac{h}{\sqrt{2\pi m k_B T}}\right)^3 = (4.3\,nm)^3$$

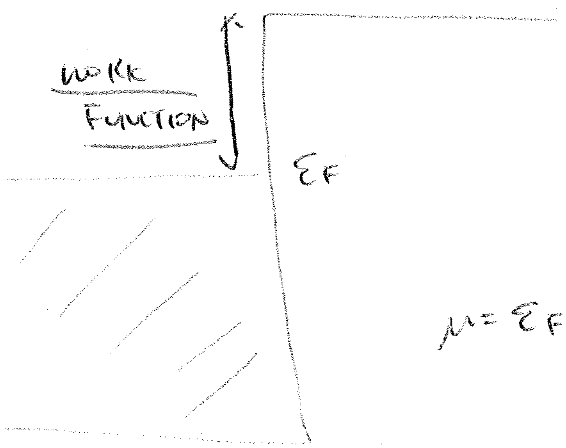
METAL $\dfrac{V}{N} = (0.2\,nm)^3$

NOW IT HAS TO BE NOT BOLTZMANN

AT $T = 0$



IN METALS



$\mu = \varepsilon_F$ <u>FERMI ENERGY</u>

Q.M. WHAT IS THE NUMBER OF STATES?

$$\lambda_n = \frac{2L}{n} \qquad p_n = \frac{h}{\lambda_n} = \frac{hn}{2L}$$

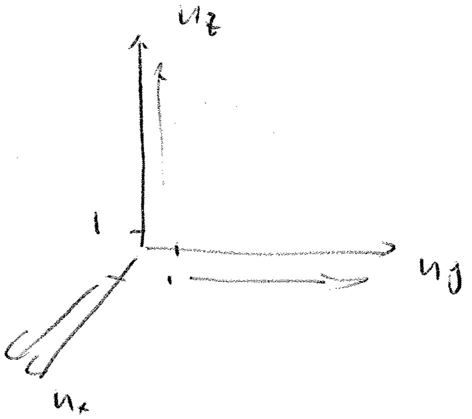
$$\varepsilon = \frac{|p|^2}{2m} = \frac{h^2}{8mL^2}\left(n_x^2 + n_y^2 + n_z^2\right)$$

$$\varepsilon_F = \frac{h^2}{8mL^2} n_{max}^2$$

RD

~~...~~ NB

REMEMBER $V = L^3$



$$N = 2 \times \frac{1}{8} \times \frac{4\pi n_F^3}{3}$$

$$N = \frac{\pi n_{max}^3}{3}$$

$$\varepsilon_F = \frac{h^2}{8m}\left(\frac{3N}{\pi V}\right)^{2/3}$$

$$\varepsilon(n) = \frac{h^2}{8m}\left(\frac{3n}{\pi}\right)^{2/3}$$

$$\left(\frac{3n}{\pi}\right)^{2/3} = \frac{8m}{h^2}\varepsilon(n)$$

$$n = \frac{\pi}{3}\left(\frac{8m}{h^2}\varepsilon(n)\right)^{3/2}$$

$$n = \frac{\pi}{3}\left(\frac{8m}{h^2}\right)^{3/2}\varepsilon^{3/2}$$

$$\frac{\partial n}{\partial \varepsilon} = \frac{\pi}{3}\left(\frac{8m}{h^2}\right)^{3/2}\frac{3}{2}\varepsilon^{1/2}$$

$$\frac{\partial n}{\partial \varepsilon} = \frac{\pi}{2}\left(\frac{8m}{h^2}\right)^{3/2}\varepsilon^{1/2}$$

$$\frac{\partial N}{\partial \varepsilon} = \frac{\pi V}{2}\left(\frac{8m}{h^2}\right)^{3/2} \varepsilon^{1/2} = DOS = D(\varepsilon)$$

$$N = \int_0^\infty D(\varepsilon)\, f(\varepsilon)\, d\varepsilon \qquad f(\varepsilon) = \frac{1}{e^{(\varepsilon-\mu)/k_B T}+1}$$

AT T=0

$$N = \int_0^{\varepsilon_F} D(\varepsilon)\, d\varepsilon = \int_0^{\varepsilon_F} \frac{\pi V}{2}\left(\frac{8m}{h^2}\right)^{3/2} \varepsilon^{1/2}\, d\varepsilon$$

$$N = \frac{2}{3}\left(\frac{\pi V}{2}\right)\left(\frac{8m}{h^2}\right) \varepsilon_F^{3/2}$$

$$U = \int_0^{\varepsilon_F} \varepsilon\, D(\varepsilon)\, d\varepsilon$$

COME BACK

$$= \int_0^{\varepsilon_F} \varepsilon \frac{\pi V}{2}\left(\frac{8m}{h^2}\right)^{3/2} \varepsilon^{1/2}\, d\varepsilon$$

$$= \int_0^{\varepsilon_F} \frac{\pi V}{2}\left(\frac{8m}{h^2}\right)^{3/2} \varepsilon^{3/2}\, d\varepsilon$$

$$= \frac{\pi V}{2}\left(\frac{8m}{h^2}\right)^{3/2} \frac{2}{5} \varepsilon_F^{5/2}$$

$$= \frac{3}{5} N \varepsilon_F$$

~~$N\frac{\pi}{2}\left(\frac{2m}{h^2}\right)^{3/2}$~~ $\frac{2}{5}\varepsilon_F^{5/2}$

$$U = \frac{3}{5} N \varepsilon_F$$

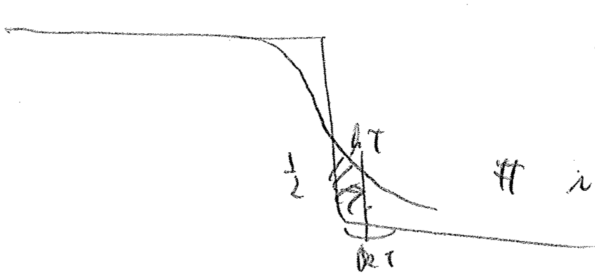
$$\varepsilon_F = \frac{h^2}{8m}\left(\frac{3}{\pi}\frac{N}{V}\right)^{2/3}$$

$$U = \frac{3}{5} N \frac{h^2}{8m}\left(\frac{3N}{\pi V}\right)^{2/3}$$

$$\left(P = -\left(\frac{\partial U}{\partial V}\right) \Rightarrow \ldots \frac{2}{3}\frac{U}{V} \right)$$

$$B = -V\left(\frac{\partial P}{\partial V}\right) \rightarrow \frac{10}{9}\frac{U}{V}$$

NOT



$\Delta E \approx kT$

$\sim kT$ ENERGY $\approx kT$

$\Delta E \approx (kT)^2$

$\frac{\Delta E}{\Delta T} \approx T \qquad C_V \sim T$