Homework #9: Copper has density of $\rho = 8.99\ g/cm^3$

$M = 63.5\ g/mol$

2 free electrons

Calculate the number of electrons per unit volume and the number of electrons in 1kg of metal.

$$n = \frac{N}{V} = \frac{N_A}{M}\rho = \frac{6.022\times10^{23}\ \text{atoms}}{\text{mol}}\ \frac{\text{mol}}{63.5\ g}\ \frac{8.99\ g}{cm^3}$$

$$= \boxed{\frac{8.44\times10^{22}\ \text{atoms}}{cm^3}} \cdot \frac{(100\,cm)^3}{m^3} = \boxed{\frac{8.44\times10^{28}\ \text{atoms}}{m^3}}$$

$$N = \frac{N_A}{M}\cdot m_S = \frac{6.022\times10^{23}}{\text{atoms}}\ \frac{\text{mol}}{63.5\,g}\cdot 1\,kg\cdot\frac{1000\,g}{kg} = \boxed{9.48\times10^{24}\ \text{atoms}}$$

$$N_e = 2N = \boxed{1.896\times10^{25}\ \text{electrons}}$$

Calculate Fermi Energy:

$$\varepsilon_F = \frac{h^2}{8m}\left(\frac{6N}{\pi V}\right)^{2/3} = \frac{h^2c^2}{8mc^2}\left(\frac{3N_e}{\pi V}\right)^{2/3} = \frac{(1240\ eV\,nm)^2}{8\cdot.511\times10^6\ eV}\left(\frac{3\times1.896\times10^{25}}{\pi V}\right)^{2/3}$$

need V though...

instead:

$$= 3\times76\ eV\,nm^2\left(\frac{3n_e}{\pi}\right)^{2/3}$$

$$= \frac{3\times65\ eV\,nm^2}{(10^9\,nm)^2}\ \frac{m^2}{(1)}\left[\frac{8.44\times10^{28}\ \text{atoms}}{m^3}\right]^{2/3}\left[\frac{2\ \text{electrons}}{\text{atom}}\right]^{2/3}$$

$$= 3\times65\times\left[16.88\times10^{28}\right]^{2/3}\times10^{-18}$$

$$= 2.4\times10^{-18}\cdot10^{56/3} = \boxed{11.15\ eV}$$

Calculate the average energy:

$$\langle \varepsilon \rangle = \frac{3}{5} \varepsilon_f = \boxed{6.689\,eV}$$

Calculate the total energy:

$$\varepsilon_T = \langle \varepsilon \rangle N_e = 6.689\,eV \cdot 1.896 \times 10^{25}\,e^-\text{'s} = \boxed{1.268 \times 10^{26}}$$