Phy 410
Quiz #8, March 30, 2009

The Fermi energy (FE) of an Ideal gas of spin ½ fermions of mass m and density N/V is given by

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

The Fermi energy of electrons (m=m_e) in metal with density 2.5x10^{22} (1/cm^3) is 3.1 eV.

(i) What is the FE of electrons in a semi-conductor with density 2.5x10^{19}(1/cm^3)

$$\frac{\varepsilon_F'}{\varepsilon_F} = \left(\frac{n'}{n}\right)^{2/3} = \left(\frac{2.5x10^{19}}{2.5x10^{22}}\right)^{2/3} = \left(10^{-3}\right)^{2/3} = 10^{-2}$$

$$\varepsilon_F' = 10^{-2}\varepsilon_F = 0.031 \ eV$$

(ii) What is the FE of heavy fermions with mass m=1000m_e with the same metallic density, 2.5x10^{22} (1/cm^3)?

$$\frac{\varepsilon_F'}{\varepsilon_F} = \frac{m}{m'} = \frac{m_e}{1000m_e} = \frac{1}{1000}$$

$$\varepsilon_F' = \frac{\varepsilon_F}{1000} = 0.0031 eV$$