COLLEGE OF ENGINEERING & TECHNOLOGY

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Course : Electronic Materials
Course Code : EC311

Sheet 1
Free Electron Gas Model

[1] In silver, the number of free electrons per unit volume is 5.8*10^28 m^{-3}. What is the Fermi energy for the free electron gas in silver? Also, what is the speed of an electron with this energy?

[2] The electron concentration in sodium, copper and aluminum are 2.5, 8.5 and 18 * 10^22 cm^3 respectively. The Fermi energy of Sodium is 3.1electron volts. Calculate the Fermi energy level and Fermi velocities for all materials in cm/sec.

[3] Show that the kinetic energy of a 3-dimension of N free electrons at 0 Kelvin is $U=3/5\ NE_f$.

[4] Derive a relation connecting the pressure and volume of an electron gas at 0 Kelvin.

[5] If the Fermi temperature is defined as $T_f = 2E_f / 3K_B$, which is not a temperature but a theoretical temperature, where N/V = 5.6 *10^28 m^{-3} and K_B= 1.38*10^{-23} J/k
a. What is the Fermi temperature of the free electron silver?
b. Show that the Fermi momentum $P_f = (2m_eE_f)^{1/2}$

[6] Silver (its molecular weight is 108) has a mass density of 10.5 gm/cm^{-3} and an electrical resistivity of 1.55*10^{-8} Ω.m at room temperature.
Find:
1. The concentration of the conduction electrons (Hint: Concentration = A_{vo} *density / molecular weight).
2. The relaxation time.
3. Fermi energy.
4. Fermi velocity.

[7] The resistance of a copper wire (diameter = 1.03 mm) is 6.51 Ω for 1000m lengths. The concentration of free electron in copper is 8.4 *10^{28} electons/m^3. If the current is 2A, find:
1. Drift velocity.
2. Conductivity.
3. Mobility.