Solid State Physics- SSP

Free Electron Theory of Metals (T-Sheet 2) M.A.Shah

1. Compute the average kinetic energy of a gas molecule at 27ºC. Express in electron volt. If the gas is hydrogen, what is the order of magnitude of the velocity of molecules at 27ºC?
2. Silver Ag is having density of 10.5×10^3 kg/m^3 and the atomic weight is 107.9.Assuming that each silver provides one conduction electron, calculate the density of electrons. The conductivity of silver at 20ºC is 6.8×10^7 ohm^{-1}m^{-1}. Calculate the mobility of electrons.
3. The resistivity of Al is 2.62×10^{-8}ohm.m at room temp. Calculate (i) drift velocity of the conduction electrons in a field of 50Vm^{-1} (ii) their mobility (iii) their relaxation time and mean free path on the basis of classical free theory.
4. The relaxation time of conduction electron in copper is 2.5×10^{-14} sec. Find the thermal conductivity of copper at 0ºC. assume density of electron to be 8.5x 10^{28}/m^3.
5. A stream of electrons, each of energy E = 3 eV is incident on a potential barrier of height Vo= 4eV. The width of the barrier is 2nm. Cal. the percentage transmission of the beam through this barrier.
6. Find the lowest energy of an electron confined in a box of each side 0.1nm. Find the percentage at which the average energy of molecules of a perfect gas would be equal to the lowest energy of electron.
7. Calculate the number of energy states available for the electrons in a cubical box of side 1 cm lying below an energy of one electron volt.
8. The Fermi energy of sodium is 3eV. Calculate the difference in energy between the neighboring levels at the highest energy state in a cubical box of side 1 cm. Given $n_x = n_y = n_z$
9. Cal. the mean free path of potassium, if its Fermi energy is 2.1eV and the electrical conductivity is 1.5 x 107 ohm-1m-1.
10. Calculate the number of states lying in an energy interval of 0.02 eV above Fermi level for sodium crystal of unit volume.
11. Estimate the relative contribution of electrons and the lattice to specific heat of sodium at 20K. The fermi temperature of sodium is 3.8×10^4K and its Debye temp. is 150K.
12. The resistivity's of copper and nickel at room temperature are 1.65×10^{-8} and 14 x 10^{-8} ohm. m respectively. If the wave mechanical treatment of Widemann-Franz law applies to these materials and find the electronic contribution to the thermal conductivities of these materials.
13. By how many orders of magnitude is the mean free path reduced in a certain metal when temperature increases from 0ºC to 340ºC. Take α = 5x 10^{-3}.
14. Show that for a simple square lattice, the kinetic energy of free electrons at a corner of the first zone is higher than that of an electron at midpoint of a side face of zone by a factor of 2.
15. The electronic specific heat of zinc is 1.5x10-4 T cal mol^{-1}K^{-1}. Find the Fermi energy of zinc. Zinc is a divalent metal. Cal the density of of states of 1m^3 of copper at Fermi level. Take 1eV interval, E_F= 7eV, m=m*