

PHYS 4050.03/PHYS 5100.03 - Concepts Review (part 2).

- What is the electron wave function in the free electron model of metals? Use the periodic boundary condition to obtain possible values of the wave vector k for the electron wave function.
- Derive the expression for the energy using the free electron model of metals.
- Define the Fermi energy. Show that the Fermi energy is proportional to the concentration of electrons.
- Explain the meaning of the Fermi-Dirac distribution function. Sketch this function at $T = 0$ K, $T = 300$ K and $T = 5000$ K.
- Under what conditions is the Fermi-Dirac distribution function well approximated by the classical Maxwell-Boltzmann distribution function?
- Use the free electron model to show that the density of states function $D(\epsilon)$ is proportional to $\epsilon^{1/2}$. Explain qualitatively why $D(\epsilon)$ increases with energy ϵ .
- Define the Fermi energy. What is the typical value of the Fermi energy in metals? How does it compare with the thermal energy at room temperature?
- Define the Fermi temperature, Fermi momentum and Fermi velocity and give typical values of these quantities (order of magnitude in convenient units).
- What is the Fermi sphere?
- Calculate the ratio of the Fermi radius to the shortest distance across the Brillouin zone for copper (fcc lattice), which has one valence electron per atom.
- Based on the classical statistical mechanics, the heat capacity of metals is (T_F/T) times larger than the value predicted by the free electron model of metals. Explain why. (T_F is the Fermi temperature).
- According to the free electron model the electrical conductivity $\sigma = ne^2\tau/m$. Explain the meaning of τ .
- State the Wiedemann-Franz law.
- What is meant by "Pauli paramagnetism"?
- Why alkali metals are "colourless"?
- Explain why is the resistivity of metals at high temperature is proportional to the temperature.
- Define π ("flipp over") scattering processes of electrons?
- The Hall coefficient R_H does not agree for many metals with predictions based on the free electron model. Why?
- Derive the central equation for a one-dimensional crystal.