

Problem sheet 1

P1: Free electron approximation

Calculate E_F in eV and K for

- a) Cu, fcc structure, $a = 0.361$ nm and is monovalent (assume that $m^* \approx m_e$)
- b)** a two dimensional electron gas with $3 \times 10^{11} \text{cm}^{-2}$ electrons and $m^* \approx 0.07m_e$

P2: Reciprocal lattice

- a) Show that reciprocal lattice of BCC lattice is an FCC lattice.
- b) Assume a two-dimensional nearly free electron system on a square lattice of lattice spacing a . Draw the corresponding reciprocal lattice in units of $2\pi/a$.

P3: Density of states

Calculate the density of states of electrons in one and two dimensions.

P4: Fermi surface

An electron of mass m moves in a square lattice of lattice spacing a .

- a) With one electron per lattice site in the crystal, draw the Fermi surface on the k_x, k_y plane. Is this a metal or an insulator? Determine the corresponding Fermi wave vector.
- b) If there are two electrons per site, show that $k_F > \pi/a$. Try to draw the Fermi surface in this case.
- c) Show that the ratio between the Fermi wave vectors for a) and b) is $1/\sqrt{2}$.