

Solid State Physics I (2012)

Re-examination

This is a closed book exam. You are not allowed to bring books, notes etc. You can use a basic or scientific calculator, but no other electronic equipment having capabilities to display or pronounce the course content.

Do not forget to indicate your full name and student number on each sheet.

Please write in a clear way. The maximum points for exercise are indicated, the total amount of points will be re-normalized to 10.

1. The angles between the tetrahedral bonds of diamond are the same as the angles between the body diagonals of a body-centered cubic lattice. Use elementary vector analysis to find the value of the angle. (15 points)
2. Show that the volume of the first Brillouin zone is $(2\pi)^3/V_C$ where V_C is the volume of a crystal primitive cell. (10 points)
3. (a) What is a phonon? (5 points)
(b) Consider the normal modes of a linear chain in which the force constants between nearest neighbor atoms are alternately C and $10C$. Let the masses be equal and let the nearest neighbor separation be $a/2$. Find $\omega(K)$ at $K = 0$ and $K = \pi/a$. (15 points)
4. (a) Consider a free electron gas with N electrons. Calculate and sketch the electron density of states and the Fermi level in a 2 and 3-dimensional system. (15 points)
(b) What is the Fermi energy? (5 points)
(c) What is the Fermi surface? Is the Fermi surface in three dimensions always a sphere? (5 points)
5. Explain what the differences between metal and semiconductor from their electronic band perspectives are. (5 points)
6. For a p-n junction, draw the energy levels at the interface after diffusive equilibrium is established! (5 points)