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)