TFY4245/FY8917 Solid State Physics, Advanced Course

Problemset 1

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Problem 1

(a) Consider a simple hexagonal lattice as shown in the figure, and specify the basis vectors.

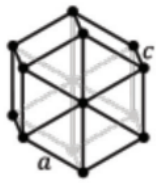

Figure 1: A simple hexagonal lattice. Figure taken from `https://www.phys.ufl.edu/~maslov`.

(b) Find the volume of the unit cell.

(c) Find the basis vectors of the reciprocal lattice. Sketch the reciprocal lattice.

(d) Consider graphene, which is a 2D lattice of carbon atoms arranged in a honeycomb pattern. The honeycomb pattern is made up out of two intercalating hexagonal lattices (red and green dots). Alternatively, one can think of this as a single hexagonal lattice with a two-atom basis.

The red and green dots are inequivalent in the sense that their environment looks different from their individual viewpoints.

Does the graphene lattice have inversion symmetry?

Problem 2

Determine the number of atoms per unit cell in (a) face-centered cubic, (b) body-centered cubic, and (c) diamond lattice.

Problem 3

(a)The lattice constant of GaAs is 5.65 Å. Determine the number of Ga atoms and As atoms per cm^3.

(b) Determine the volume density of germanium atoms in a germanium semiconductor. The lattice constant of germanium is 5.65 Å.

Look up any information you need about the crystal structure of these materials online.

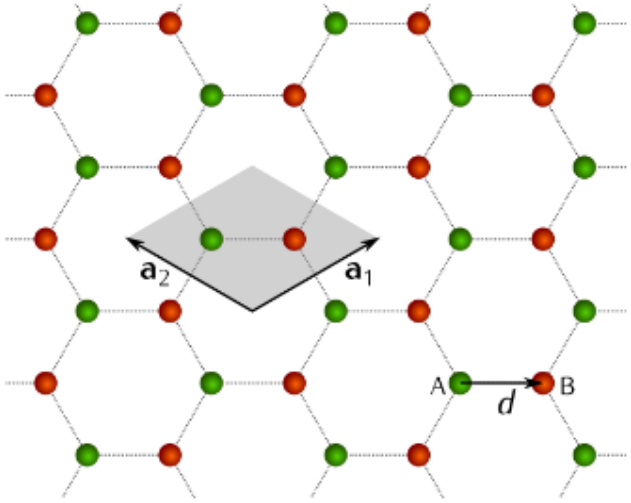

Figure 2: Graphene: a hexagonal lattice with a two-atom basis. A choice for unit cell is shown by the gray area. Figure taken from Physics Stack Exchange.