

Physics 140A: Homework Problem Set 2

Assigned 1/13/05. Due 1/20/05. 10 points each.

1. Reciprocal of the Reciprocal Lattice.

Reciprocal lattice vectors $\vec{G}_1, \vec{G}_2, \vec{G}_3$ are determined from the Bravais lattice vectors $\vec{R}_1, \vec{R}_2, \vec{R}_3$ by a formula that you should know well (or look it up). Show that these are truly reciprocal to each other: specifically, show that the set $\{\vec{R}_j\}$ result from the set $\{\vec{G}_j\}$ using exactly the same relation. Thus the reciprocal lattice of the reciprocal lattice is the original lattice.

2. Hexagonal Lattice.

First write the direct lattice vectors of a simple hexagonal Bravais lattice, where the lattice constants a and c are independent. Then calculate the reciprocal lattice vectors, showing that the reciprocal lattice is again a hexagonal Bravais lattice. Finally, determine the ratio c/a for which the aspect ratio of the reciprocal lattice is the same as it is for the direct lattice.

3. Two Descriptions of the Same Lattice.

A body-centered cubic (bcc) crystalline material has the direct lattice vectors

$$\vec{R}_1 = (1, 1, -1)\frac{a}{2}, \vec{R}_2 = (1, -1, 1)\frac{a}{2}, \vec{R}_3 = (-1, 1, 1)\frac{a}{2}.$$

- (a) Find the reciprocal lattice vectors. Show work.
- (b) This crystal can be described equally well as this bcc Bravais lattice

$$\vec{R}_1 = (1, 0, 0)a, \vec{R}_2 = (0, 1, 0)a, \vec{R}_3 = (1, 1, 1)\frac{a}{2}.$$

Show, using clear descriptive reasoning or a clean mathematical proof, that these lattices are equivalent (i.e. they give the same set of lattice points).