Assignment # 1: Solid State Physics 476
Due: Sept. 19, 2008

Point values are given with each question.

1. **Tetrahedral angles.** The angles between the tetrahedral bonds of diamond are the same as the angles between the body diagonals of a cube, as in Fig. 10 Ch. 1 Kittel. Use elementary vector analysis to find the value of the angle. (10)

   The given body diagonal axes in Fig. 10 are:

$$\mathbf{a_1} = \frac{1}{2}a(\hat{\mathbf{x}} + \hat{\mathbf{y}} - \hat{\mathbf{z}}) \tag{1}$$

$$\mathbf{a_2} = \frac{1}{2}a(-\hat{\mathbf{x}} + \hat{\mathbf{y}} + \hat{\mathbf{z}}) \tag{2}$$

$$\mathbf{a_3} = \frac{1}{2}a(\hat{\mathbf{x}} - \hat{\mathbf{y}} + \hat{\mathbf{z}}) \tag{3}$$

2. **Indicies of planes.** Consider the planes with indicies (100) and (001); the lattice is fcc, and the indicies refer to the conventional cubic unit cell. What are the indicies of these planes when referred to the primitive axes of Fig. 11 Ch. 1 Kittel? (10)

   The rhombohedral primitive cell axes for a face-centred cubic lattice given in Fig. 11 are:

$$\mathbf{a_1} = \frac{1}{2}a(\hat{\mathbf{x}} + \hat{\mathbf{y}}) \tag{4}$$

$$\mathbf{a_2} = \frac{1}{2}a(\hat{\mathbf{y}} + \hat{\mathbf{z}}) \tag{5}$$

$$\mathbf{a_3} = \frac{1}{2}a(\hat{\mathbf{z}} + \hat{\mathbf{x}}) \tag{6}$$

3. Imagine a 2-D "rhombohedral" lattice such that $a = b$, $\gamma \neq 90^\circ$, and $\gamma \neq 120^\circ$.

   (a) Which one of the two-dimensional Bravais lattices is it? (2)

   (b) Give the new a, b, and γ for the new lattice in terms of the old parameters. (3)

   (c) Give the point group operators and their positions in the new unit cell and also indicate where the original unit cell is.located. (5)

   (d) Suppose one of the atoms of the basis is at lattice coordinates (x, y) in the new lattice. Where is the corresponding position in the unit cell for a glide in the (01) plane with a translation of half a unit cell? (5)