

Midterm Exam: Solid State Physics 476
Oct. 17, 2005

One cheat sheet, double sided. Point values are given with each question. Total midterm is worth 38 points with 4 available bonus points. Maximum mark will still be 100%.

1. Consider a simple cubic Bravais lattice.
 - (a) What is the relationship between the lattice vectors (lengths and angles)? (2)
 - (b) Draw a sketch of the plane perpendicular to the 4-fold symmetry axes with the lattice points. Also sketch in the unit cell and indicate the positions of the 4-fold axes with a square. (4)
 - (c) What does it mean to add a “basis”? Give the basis if this is a body centred cubic system. (2)
 - (d) What is one of the extra symmetry operations that a body-centred cubic lattice has as opposed to a simple cubic lattice? (You may have to consider elements that are not in the x-y plane and use results you know from 2-D as a guide. Specifically think of a symmetry operation that maps the basis atoms onto each other.) (2)
 - (e) What is the benefit of using the non-primitive cubic unit cell? (2)

2. Consider a face-centred cubic crystal structure with a lattice constant of 5.5 Å.
 - (a) Give the length of the reciprocal lattice vector associated with the (200) plane. (hint: $\vec{G} = h\vec{A} + k\vec{B} + l\vec{C}$) Feel free to take some shortcuts if you know the values for \vec{A} , \vec{B} , and \vec{C} . (2)
 - (b) What is the Laue condition for scattering? If the magnitude of the wavevector of the incident radiation is 4 \AA^{-1} draw the appropriate scattering diagram showing initial \vec{k}_i , final $-\vec{k}_f$ and \vec{G} . Calculate the scattering angle, what we usually call 2θ . (6).

3.
 - (a) What is the fundamental assumption concerning symmetry in a crystalline lattice? Give a mathematical statement. What are two instances in condensed matter physics studies where this would be violated? (Keywords please.) (5)
 - (b) How are crystal structures classed? Is there an infinite numbers of possible crystal structures? (4)
 - (c) What are the three primary types of beams used for diffraction studies? Give two quick facts for each of the three types (such as type of source, expense, special features or limitations). (9)

4. Bonus: Describe with a diagram a glide transformation. (4)