THE UNIVERSITY OF NEW SOUTH WALES

SCHOOL OF PHYSICS

MID-TERM EXAMINATION

14. April 2014

PHYS3080 Solid State Physics

PHYS3021 Statistical and Solid State Physics

1. Time Allowed: 1 hour
2. Total number of questions: 4
3. Marks available for each question are shown in the examination paper. The total number of marks is 40.
4. Attempt ALL questions!
5. University-approved calculators may be used.
6. Answers must be written in ink. Except where they are expressly required, pencils may only be used for drawing, sketching or graphical work. Do not use red ink.
7. The exam paper may be retained by the candidate.

Question 1 (10 marks)

Crystallographic phase transition

Upon changing temperature or pressure most materials undergo crystallographic phase transitions. Especially under the application of high hydrostatic pressure, the structural phase transition results in a lowering of the volume of the unit cell.

Factor of 2?

(a) Calculate the change in volume when the crystallographic structure is changed from body centered cubic (bcc) to face centered cubic (fcc). Assume that the ionic radius remains constant.

(b) Calculate the change in the next nearest neighbor distance for this phase transition.

(c) Is there a difference in a symmetry operation between bcc and fcc.

Question 2 (10 marks)

Explain the following, each in a few words

(a) Give the five different types of chemical bonds inside a solid and sort them into three groups by their strength.

(b) What does the Lennnard-Jones potential describe. Plot the schematics of this function (no need to give the equation). Label the equilibrium position, i.e. the atomic distance.

(c) Symmetry operations in a crystal: What are the five possible rotational axis. Give their notation and their rotational angle

(d) Give the names of the 7 lattice systems.

(e) Sketch the branches (Energy versus k) of a bi-atomic one-dimensional linear chain.

Question 3 (10 marks)

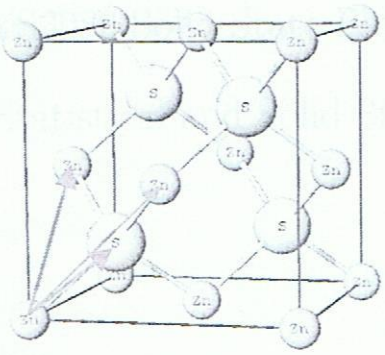
Reciprocal Lattice

(a) Give the expression of the reciprocal lattice vectors.

(b) Calculate for the three-dimensional volume in real and reciprocal space the following: $\vec{R}_n \cdot \vec{G}_h = ...$

(c) Give the three vectors of the atomic positions of the ZnS lattice (bi-atomic Diamond structure), as denoted in the figure.

(d) Calculate the reciprocal lattice vector using these three lattice vectors.



Question 4 (10 marks)

Bragg's Law

(a) Give the expression for Bragg's law and plot a figure which explains this expression.

(b) Powder Diffraction experiment:

The incident wavelength of the neutron beam is $\lambda = 2.662$ Å. The material possesses a simple cubic crystal structure with a lattice parameter of 3.26 Å. Calculate the scattering angle of the following Bragg peaks:

[100], [200], [110], [111], and [112].