Condensed matter physics 2013
Exercise 4

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*Problem 14 (3)

Calculate the structure factor of NaCl (fcc) and give the condition for destructive interference. To do this assume a simple cubic lattice with a basis containing 8 atoms. In addition, discuss the case of KCl, which has the same structure as NaCl.

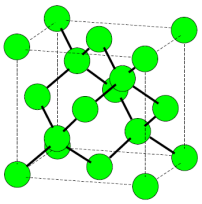
*Problem 15 (2)

Give a simple estimate of the thermal oscillation amplitude of a silicon atom at room temperature ($T = 300$ K). Using the Lindemann criterion find the magnitude of the oscillations at the melting temperature ($T = 1687$ K).

Hint: Use the 'equipartition theorem'. Young's modulus $E = 100$ GN/m^2, and the layer distance along the [111] direction is 3.13 Å.

Problem 16

The crystal structure of diamond is shown in the Figure. The basis consists of eight atoms if the cell is taken as the conventional cube. Find the structure factor S of this basis.



Problem 17

The thermal broadening of the diffraction pattern can be described by folding the function describing the lattice positions, $g(\vec{x})$, with a shape function $w(\vec{x})$. Calculate the Debye-Waller factor in the case that $w(|\vec{x}|)$ is a normalized Gaussian distribution. ($\ll$ *Solid State Physics* $\gg$ *by Charles Kittel*. The Debye-Waller factor: $D(\vec{q}) = e^{-\frac{1}{3}<u^2(t)>q^2}$.)

*Problem 18 (1)

Calculate the intensity reduction of an X-ray diffraction peak for a (110) plane of a 3-dimensional copper lattice at both room temperature (300 K) and at 4 Kelvin. How does this affect the choice of experimental parameters? Assumptions: consider the motion of the scattering center as a harmonic oscillator with characteristic frequency of $\omega = 10^{14} s^{-1}$. Take the Molar mass $m_{Cu} = 0.0635$ kg/mol and the lattice constant $a = 3.61$ Å.