Problem 1

Consider successively the direct (cubic) simple cubic, body-centered cubic, and face-centered cubic lattices, each with lattice parameter *a* and their associated reciprocal lattices. In reciprocal space, find the corresponding volume of the primitive lattice (order 1).

Problem 2

A beam of monochromatic X-rays with wavelength λ propagates in a vacuum and encounters a spherical atom of radius R. The incident wave with wave vector $k_0=(2\pi/\lambda)u_0$ is partially diffused by the Z electrons of the atom, assumed to have a density distribution of ρ.

(a) Find the amplitude of a wave diffused in the direction u0 by the electrons contained in the volume dV described by the radius vector r (with respect to the wave diffused by a point electron placed at the center 0 of the atom)

In the form of an integral, deduce the expression for the form factor of an electron distribution with spherical symmetry.

(b) Find the atomic diffusion coefficient of a uniform electron distribution at the interior of a sphere of radius R. These results should be expressed as a function of $k=k-k_0$ where $k_0= (2\pi/\lambda)u_0$ and then, state the result in terms of the parameters $\sin\theta/\lambda$ which are more directly related to experiments.

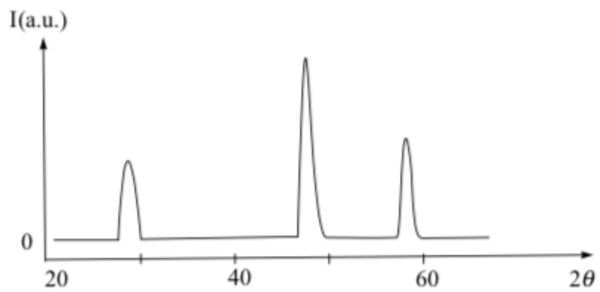
Problem 3 (Bonus)

The figure bellows adapted from a Neuton diffraction pattern of diamond(fcc lattice with 2 C atoms at 000 and 1/4 1/4 1/4; lattice a=3.56Å). Corrected from some experimental factors such as the temperature effects, this figure represents the angular variation of the scattered intensities, by postulating that they are uniquely proportional to the square of the structure factor F(h,k,l).

(a) Give the indices of the three reflections shown in the figure.

(b) Explain why they have unequal weight.

(c) Deduce the associated wavelength λ and the kinetic energy, E_k (in eV) of incident neutrons.



Problem 4

Exercise 10.1, 11.1, 13.4 from Simon.