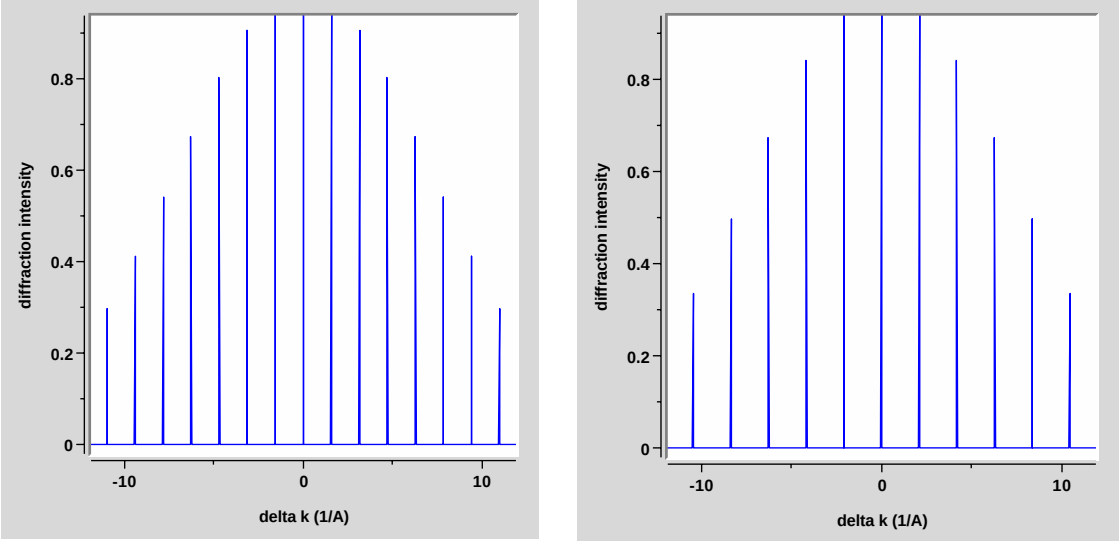
# Physics 412 Solid State Physics

## Homework 3, due Oct. 4

Name:

1. The figure below shows the diffraction patterns for two different, perfect, 1D monoatomic crystals the way SSS "laue" displays them. (Ignore the screen resolution-caused line thickness issues in the diffraction patterns.)




(a) Which crystal has a larger lattice constant? What is the ratio of the two lattice constants?

(b) How will the pattern on the left change if the size of the atoms increases by a factor of 2? (The spacing of the atoms remains the same.)

(c) Estimate the lattice constant of the crystal that corresponds to the diffraction pattern on the right.

2. Using the Lennard-Jones potential, calculate the ratio of the cohesive energies of neon in the body centered cubic and face centered cubic lattices.

The lattice sums for the bcc structures are

$$\sum_j \rho_{ij}^{-12} = 9.11418\,, \quad \sum_j \rho_{ij}^{-6} = 12.2533$$

See Kittel for the fcc structure's lattice sums.
(Check: the answer should be 0.958).

3. Imagine a crystal that exploits for binding the Coulomb attraction of the positive and negative ions of the same atom or molecule R. This is believed to occur with certain organic molecules, but it is not found when R is a single atom. Use the data in Tables 5 and 6 in Kittel to evaluate the stability of such a form of Na in the NaCl structure, relative to the normal metallic Na. Evaluate the energy at the observed interatomic distance in metallic Na, and use 0.78 eV as the electron affinity of Na.