1.5. CsCl can be thought of as a simple cubic lattice with two different atoms [at (0, 0, 0) and \((\frac{1}{2}, \frac{1}{2}, \frac{1}{2})\)] in the cubic unit cell. Let \(f_+\) and \(f_-\) be the atomic scattering factors of the two constituents.

(a) What is the structure amplitude \(F(h_1, h_2, h_3)\) for this crystal?
(b) An x-ray source has a continuous spectrum with wave numbers \(k\) satisfying: \(k\) is parallel to the [110] direction and \(2^{-1/2} \left(\frac{2\pi}{a}\right) \leq |k| \leq 3 \times 2^{1/2} \left(\frac{2\pi}{a}\right)\), where \(a\) is the edge distance of the simple cube. Use the Ewald construction for a plane that contains the direction of incidence to show which reciprocal lattice points display diffraction maxima.
(c) If \(f_+ = f_-\), which of these maxima disappear?

1.6. A simple cubic structure is constructed in which two planes of \(A\) atoms followed by two planes of \(B\) atoms alternate in the [100] direction.

(i) What is the crystal structure (viewed as a non-Bravais lattice with four atoms per unit cell)?
(ii) What are the primitive translation vectors of the reciprocal lattice?
(iii) Determine the structure amplitude \(F(h_1, h_2, h_3)\) for this non-Bravais lattice.
1.9. Consider $2N$ ions in a linear chain with alternating $\pm e$ charges and a repulsive potential $AR^{-n}$ between nearest neighbors.

(i) Show that, at the equilibrium separation $R_0$, the internal energy becomes

$$U(R_0) = -2 \ln 2 \times \frac{Ne^2}{R_0} (1 - \frac{1}{n}).$$

(ii) Let the crystal be compressed so that $R_0 \rightarrow R_0 (1 - \delta)$. Show that the work done per unit length in compressing the crystal can be written $\frac{1}{2}C\delta^2$, and determine the expression for $C$.

1.10. For a BCC and for an FCC lattice, determine the separations between nearest neighbors, next nearest neighbors, ... down to the 5th nearest neighbors. Also determine the separations between $n^{th}$ nearest neighbors ($n = 1, 2, 3, 4, 5$) in units of the cube edge $a$ of the simple cube.