1. **Lattice Energy, NaCl**
   a) Calculate the lattice energy (or cohesive energy) for NaCl, in eV using the following energies: Formation energy of NaCl (from metallic Na and gas phase Cl$_2$) = 411 kJ/mol; Covalent bond Cl$_2$ energy = 244 kJ/mol; ionization energy of Na atom = 5.14 eV; Electron affinity of Cl atom = 3.62 eV.

   b) Calculate the parameter $a$ in the repulsive Energy equation $V_{rep}(r) = be^{-ar}$ between first neighbor ions, knowing that the equilibrium distance is 2.82 Ang.

2. **Kittel, Ch. 3 Problem 9:**
   Show that the velocity of a longitudinal wave in the [111] direction of a cubic crystal is $v_s = [1/3(C_{11} + 2C_{12} + 4C_{44})/\rho]^{1/2}$. Hint for such a wave $u = v = w$. Let $u = u_0 e^{i(k(x+y+z)/\sqrt{3}) - iw t}$, and use eq. (57a)

3. **Kittel, Ch. 4 Problem 1**
   1. **Monatomic linear lattice.** Consider a longitudinal wave
      
      $u_i = u \cos(ot - sKa)$
      
      which propagates in a monatomic linear lattice of atoms of mass $M$, spacing $a$, and nearest-neighbor interaction $C$.
      
      (a) Show that the total energy of the wave is
      
      \begin{equation}
      E = \frac{1}{2} M \sum_i \left(\frac{du_i}{dt}\right)^2 + \frac{1}{2} C \sum_i (u_i - u_{i+1})^2,
      \end{equation}
      
      where $s$ runs over all atoms.
      
      (b) By substitution of $u_i$ in this expression, show that the time-average total energy per atom is
      
      \begin{equation}
      \frac{1}{4} M \omega^2 u^2 + \frac{1}{2} C (1 - \cos Ka)u^2 = \frac{1}{2} M \omega^2 u^2,
      \end{equation}
      
      where in the last step we have used the dispersion relation (9) for this problem.

      This is not just time-average, because energy is constant during the motion, and equals, per atom the maximum kinetic energy of the atom (monatomic only).

4. **Kittel, Ch. 4 Problem 3**
   3. **Basis of two unlike atoms.** For the problem treated by (18) to (26), find the amplitude ratios $u/v$ for the two branches at $K_{max} = \pi/a$. Show that at this value of $K$ the two lattices act as if decoupled: one lattice remains at rest while the other lattice moves.