Problem Set #4: Atomic Vibrations

1. The speed of sound in a certain linear monatomic chain is 1.08×10^4 m/s.   The mass of each atom is 6.81×10^{-26} kg and the atomic separation at equilibrium is 4.85Å.

(a) Find Hooke's law constant for this linear monatomic chain (assume long-wavelength limit).

(b) Would sound audible to the human ear be able to propagate through this material without significant dispersion? Explain your answer.

2. Consider vibrational waves traveling in a one-dimensional monatomic crystal in which equilibrium sites are 5.00Å apart.

(a) If the chain contains 6.00×10^8 atoms:

        (i) What is the range in values of the propagation constant?

        (ii) What is the interval between allowed values of the propagation constant?

(b) If the number of atoms in the chain is double to 12.00×10^8 atoms:

        (i) What is the range in values of the propagation constant?

        (ii) What is the interval between allowed values of the propagation constant?

(c) Comment on the effect of increasing the number of atoms in the chain.

3.   When you rub a wet finger along the rim of a crystal glass you can hear a high-pitched sound. What process is responsible for this? Explain.