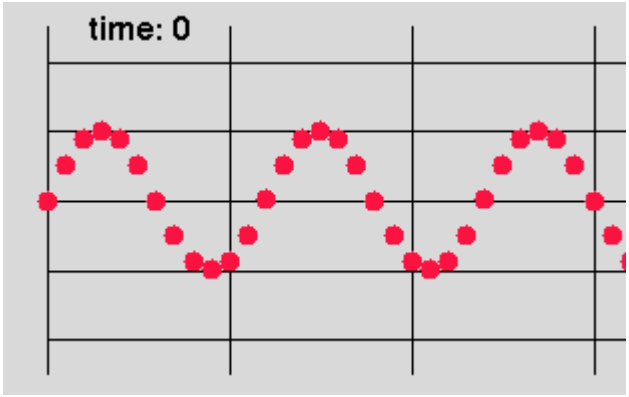
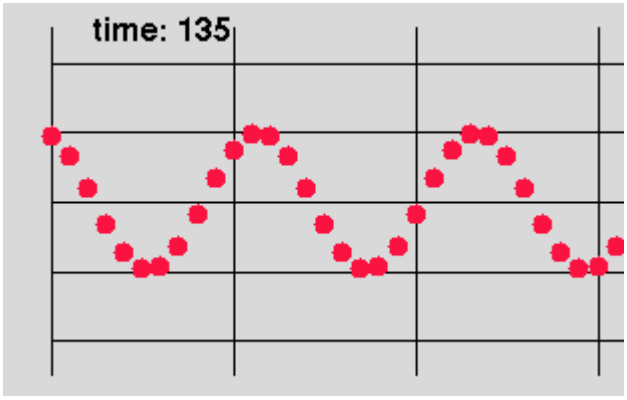
Physics 412 Solid State Physics

Homework 1, due Oct. 16

Name:





1. The figures show the "born" display at two different times of a traveling wave moving to the right. The clock measures time in units of 10^{-14} s and the lattice constant is a=2.00 Å.

(a) What is the wave vector of this wave?

Hint: What multiple of the lattice constant represents the period of the wave?

(b) What is a possible value of the phase velocity? What assumption did you use in obtaining this value?

(c) What is the wave's angular frequency using the same assumption as in (b)?

2. Consider a longitudinal wave $u_s = u\cos(\omega t - ska)$ which propagates in a monatomic linear lattice of atoms of mass M, spacing *a* and nearest-neighbor interaction constant C.

(a) Show that the total energy of the wave is

$$E = \frac{1}{2}M\sum_s\left(\frac{du_s}{dt}\right)^2 + \frac{1}{2}C\sum_s\left(u_s - u_{s+1}\right)^2,$$ where s runs over all atoms.

(b) By substitution of u_s in this equation, show that the time average total energy per atom is

$$\frac{1}{4}M\omega^2u^2 + \frac{1}{2}C(1-\cos ka)u^2 = \frac{1}{2}M\omega^2u^2$$

Hint: Use the 1D lattice dispersion relation.