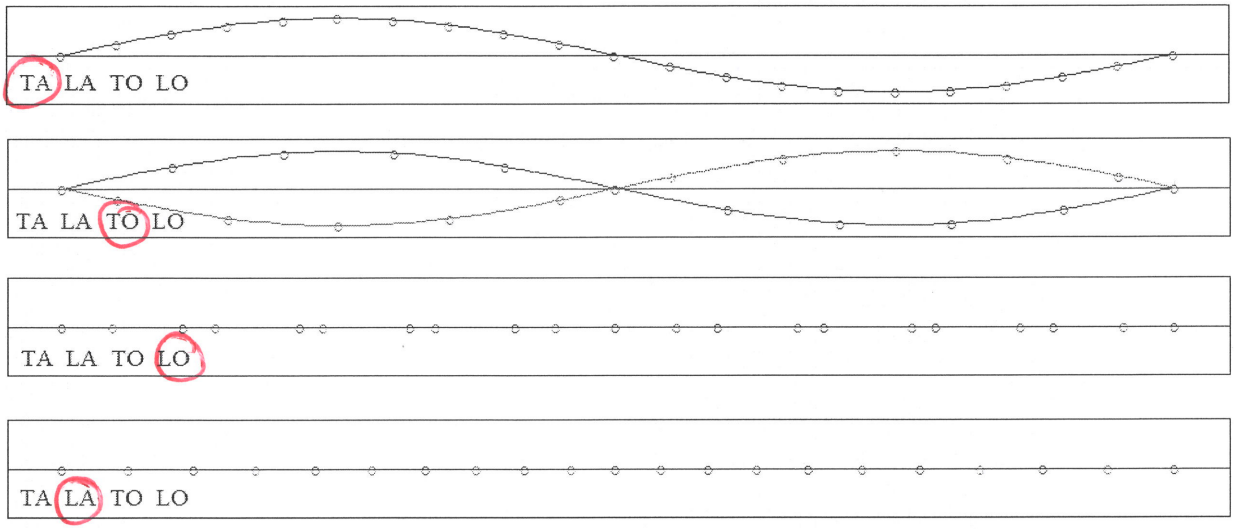
Week 4 - Lattice Vibrations
Comprehension Check
Total points = 25 (scaled by a factor of 1/10 in the system)

Question 1 (8 points)



For the four different phonon modes sketched above, circle the label corresponding to the correct type of phonon (TA=Transverse Acoustic; LA=Longitudinal Acoustic; TO=Transverse Optical; LO=Longitudinal Optical)

Question 2 (8 points)

Match the crystal structure to the corresponding description of phonon branches:

I. A. Gold, fcc lattice, 1 atom in the primitive cell → I. 3 acoustic branches

III. B. Diamond, fcc lattice, 2 atoms in the primitive cell → II. 3 acoustic branches, 9 optical branches

IV. C. Zinc sulfide, fcc lattice, 2 atoms in the primitive cell → III. 3 acoustic branches, 3 optical branches, no frequency gap

II. D. Graphite, hexagonal structure, 4 atoms in the primitive cell → IV. 3 acoustic branches, 3 optical branches, frequency gap

Question 3 (4 points)

What is the total energy of a phonon mode of frequency ω_o if the occupation number for that mode is 5.

$(5+1/2)\hbar\omega_o$

Question 4 (5 points)

A 1D chain of atoms is vibrating according to a mode that can be described by a wavevector K and frequency ω. What is the average physical momentum of the atomic chain?

0, atomic chain is not displaced
∴ 0 physical momentum