1. The figure below illustrates transverse phonon mode frequencies for propagation in the [100] direction of an alkali-halide crystal. The cubic lattice constant is \( a = 6.6 \, \text{Å} \). On the basis of this figure, estimate the following properties and briefly explain your reasoning.

(a) The speed of sound

(b) The ratio of masses of the two atomic species.
(c) The figure below illustrates the transverse acoustic mode of a diatomic chain. Indicate on this figure the wavelength $\lambda$ and the lattice constant $a$. Estimate the value of $ka$ and compare to the value at the Brillouin zone boundary.
2. High temperature superconductivity was recently discovered in a single atomic layer of CuO$_2$. The structure is illustrated below. The square lattice constant is $a$.

(a) List the positions of the copper ($Z=29$) and the oxygen ($Z=8$) atoms in the basis of the crystal structure.

(b) Draw lattice planes of Miller indices (1,0), (1,1) and (2,1) on the figure and label them.
(c) Evaluate the structure factor $S_{\vec{G}}$ at the (0,0), (1,0) and (1,1) Bragg peaks (recall $S_{\vec{G}} = \sum_j f_j e^{-i\vec{G} \cdot \vec{R}_j}$). Comment on the contribution of the oxygen atoms to the (1,0) peak.