1. Brillouin scattering of a monochromatic light, the wavelength $\lambda_i = 514.53$ nm, from water at room temperature leads to a Brillouin peak shifted from the excitation line by $\Delta \nu = 4.3 \times 10^9$ Hz at the scattering angle 90°. The refractive index of water is 1.33. What is the sound velocity at this temperature?

2. NaCl has a high-frequency value of the optical index of refraction 1.5 and longitudinal and transverse optical phonon frequencies $\omega_L = 5.0 \times 10^{13}$ rad/s, $\omega_T = 3.08 \times 10^{13}$ rad/s. Calculate the static dielectric constant $\varepsilon_r(0)$ and the percentage contribution of the ionic polarizability.

3. Calculate the plasma frequency for n-type GaAs (at room temperature) for the concentration of shallow donors $5 \times 10^{17}$ cm$^{-3}$. Electronic effective mass is $m_e = 0.063 m_0$. At what donor concentration the plasma frequency is equal to that of the longitudinal optical phonon (which energy is 36 meV)?

4. Which crystal has this phonon dispersion diagram?

5. Calculate the temperature dependence of the Stokes-to-AntiStokes intensity ratio. Use Planck formula for the number of phonons vs. $T$ and energy. Plot this function for the phonon frequency of 100 cm$^{-1}$. You may find it useful to convert phonon energy to the units of $kT$ to simplify calculations.

Hint:

Number of phonons is given by: \[
\frac{1}{(T - \text{temperature})} \quad n = \frac{1}{e^{\frac{\hbar \omega}{kT}} - 1} \]

$Stokes \sim n + 1$

$anti-Stokes \sim n$