

FINAL – 140A

Mar. 22, 2008

Intentionally more problems are posed than what can be expected to be fully solved. This was done to help you compensate too-hard problems by solving others. Solving 8 problems out of 10 should be sufficient for an A.

1. What can we learn from the elastic and what from the inelastic X-ray scattering?
2. The van-der Waals form describes the dipole-dipole interaction between molecules.
 - (i) What form would you expect for this from classical electrodynamics?
 - (ii) Does the van der Waals form follow this expectation?
 - (iii) If not, why not? If yes, why?
3. What is the relationship between the Bragg reflection formula and the vectors of the reciprocal lattice?
4. What quantity determines the X-ray scattering amplitude for fluids and glasses? Plot this quantity in real space and explain the physics of the various regimes.
5. Give the formula and plot the frequency dependence of the dielectric constant at $q=0$ in the presence of optical phonons. Discuss the physical response of the system in the different frequency regimes. What is the physical meaning of the two characteristic frequencies in this plot?
6. Derive and plot the $\omega(q)$ dispersion relation of polaritons. Explain the physics of the two branches.
7. Determine the frequency dependence of the Drude conductivity by repeating its derivation, but this time assuming that the electric field oscillates in time as $E(t)=E_0e^{-i\omega t}$.
8. (i) Describe the three main regions in the temperature dependence of the resistivity $\rho(T)$ of metals.
(ii) In 1 or 2 sentences each, describe the three main exceptions to the standard low temperature behavior.
9. Provide the derivation of the Drude formula in the presence of a Fermi surface.
10. Give the derivation and final form of the Hall constant R_H . Why is R_H a useful quantity for characterizing metals?