

**PHYS-E0421 Solid State Physics (5cr), Spring 2016**  
**2nd midterm exam, 17 May 2016**

Even quite short answers to the questions are sufficient in most cases (preferably with supporting schematic figures and equations) as long as you focus on the main points. The points after questions hint how long answers are expected.

1. Long wave length optical phonons in ionic solids. Why cannot they be described as those in metals or covalent solids? How can they be described? What are the main features in their dispersion relations? Can you explain the origin of these features? (4 p)
2. Figure 1 shows the reflectivities of three different n-doped InSb samples. Interpret the results! What can you say about the carrier concentrations of the different samples? (2 p)
3. Explain the main features! How can the complex dielectric function  $\epsilon(\omega)$  be determined from experimental results or from band electronic structure calculations (it is not necessary to remember the exact equations but rather the main ideas)? List at least two examples where  $\epsilon(\omega)$  is used to understand phenomena in materials. (4 p)
4. Semiconductors absorb light already at energies lower than the energy band gap. How is this possible? Explain the model which describes the phenomenon quantitatively! (3 p)
5. Explain qualitatively the response of different types of materials to an external magnetic field. Please remember to focus on the following aspects. How do different types of materials respond depending on their characteristic microscopic properties? In the case of a single material, can the response be divided to several different types of responses? How is the temperature dependence for different types of materials in different temperature regions? (6p)
6. Ferromagnetism. Explain the origin of the interaction leading to the ferromagnetic ordering! Describe the two models used to understand the stability of the ferromagnetic phase and the temperature dependence of magnetization! (6p)

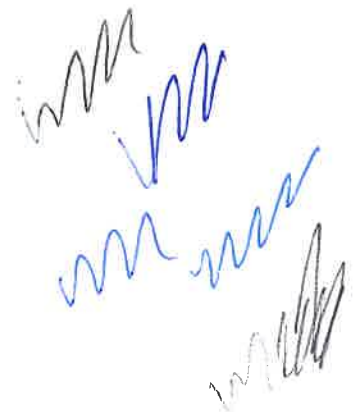
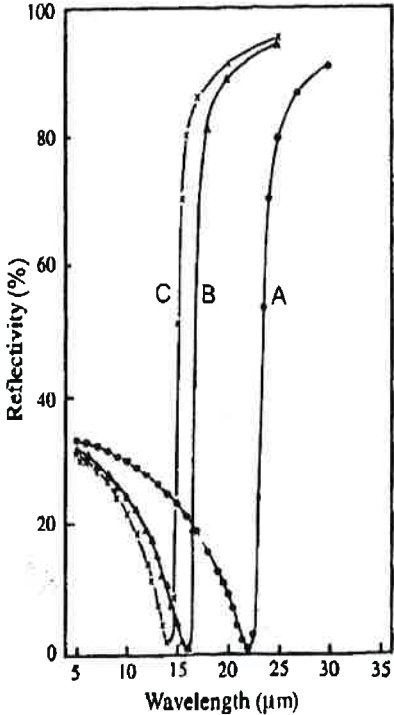


Fig. 1. Reflectivity of different n-doped InSb samples



Handwritten blue scribbles and a squiggle.