

## Solutions to Problems in Solid State Physics II

### Problem 2005-I

$\varepsilon_A$  is the maximum energy of band 1 (follows from the specification of the Fermi surface). The number of electronic states in one band, within the 1. Brillouin zone, is twice the number of  $k$  states, i.e. twice the number of unit cells in the system. If  $\varepsilon_h < \varepsilon_e$  all states in band 1, and no states in band 2, would be occupied by electrons at zero temperature, implying that

1) the system would be an insulator (or semiconductor).

The reciprocal lattice of an fcc is a bcc lattice. In the bcc reciprocal lattice there are 8 equivalent (111) reciprocal lattice points lying at the corners of the 1. Brillouin zone, each counting one-eighth. This implies that there is, effectively, one hole and one electron Fermi surface in one Brillouin zone. With the use of the notation introduced on the figure, we have:

$$\varepsilon_F = \varepsilon_e + \frac{(\hbar k_e)^2}{2m_e} = \varepsilon_h - \Delta + \frac{(\hbar k_h)^2}{2m_h}, \quad \varepsilon_F = \varepsilon_h - \frac{(\hbar k_h)^2}{2m_h}. \quad (1)$$

The number of holes (i.e. the number of missing electrons) in band 1 is equal to the number of electrons occupying band 2, i.e.

$$n = p. \quad (2)$$

and since both bands are parabolic, we may use Marder eq. (6.29) to obtain the lengths of the two Fermi wave vectors:

$$k_e = (3\pi^2 n)^{1/3}, \quad \text{and equivalently} \quad k_h = (3\pi^2 p)^{1/3}. \quad (3)$$

These equations are straightforwardly solved, and we get

$$2) \quad \varepsilon_F = \varepsilon_A - \frac{m_e}{m_e + m_h} \Delta.$$

$$3) \quad n = p = \frac{1}{3\pi^2} \left( \frac{2\Delta}{\hbar^2} \frac{m_e m_h}{m_e + m_h} \right)^{3/2}.$$

According to Marder eqs. (6.77) and (6.23), the specific heat is

$$c_V = \frac{\pi^2}{3} k_B^2 T D(\varepsilon_F), \quad D(\varepsilon_F) = \frac{m}{\hbar^3 \pi^2} \sqrt{2m\varepsilon_F} = \frac{mk_F}{\hbar^2 \pi^2}, \quad (4)$$

in the case of a parabolic band, when  $T \ll \varepsilon_F/k_B$ . In the present case, we need to require  $T \ll \Delta/k_B$ , and adding the electron- and hole-like contributions,

$$D(\varepsilon_F) = \frac{m_e k_e}{\hbar^2 \pi^2} + \frac{m_h k_h}{\hbar^2 \pi^2} = \frac{m_e + m_h}{\hbar^2 \pi^2} \left( \frac{2\Delta}{\hbar^2} \frac{m_e m_h}{m_e + m_h} \right)^{1/2} \quad (5)$$

the result is

$$4) \quad \gamma = c_V/T = \frac{k_B^2}{3\hbar^2} \sqrt{2m_e m_h (m_e + m_h) \Delta}.$$

# Solid State Physics Problems And Solutions

**R. N. Chaudhuri**



## **Solid State Physics Problems And Solutions:**

**Problems In Solid State Physics With Solutions** Fuxiang Han,2011-10-31 This book provides a practical approach to consolidate one's acquired knowledge or to learn new concepts in solid state physics through solving problems It contains 300 problems on various subjects of solid state physics The problems in this book can be used as homework assignments in an introductory or advanced course on solid state physics for undergraduate or graduate students It can also serve as a desirable reference book to solve typical problems and grasp mathematical techniques in solid state physics In practice it is more fascinating and rewarding to learn a new idea or technique through solving challenging problems rather than through reading only In this aspect this book is not a plain collection of problems but it presents a large number of problem solving ideas and procedures some of which are valuable to practitioners in condensed matter physics **Solid State Physics** László Mihály,Michael C Martin,2009-02-24 The ideal companion in condensed matter physics now in new and revised edition Solving homework problems is the single most effective way for students to familiarize themselves with the language and details of solid state physics Testing problem solving ability is the best means at the professor's disposal for measuring student progress at critical points in the learning process This book enables any instructor to supplement end of chapter textbook assignments with a large number of challenging and engaging practice problems and discover a host of new ideas for creating exam questions Designed to be used in tandem with any of the excellent textbooks on this subject Solid State Physics Problems and Solutions provides a self study approach through which advanced undergraduate and first year graduate students can develop and test their skills while acclimating themselves to the demands of the discipline Each problem has been chosen for its ability to illustrate key concepts properties and systems knowledge of which is crucial in developing a complete understanding of the subject including Crystals diffraction and reciprocal lattices Phonon dispersion and electronic band structure Density of states Transport magnetic and optical properties Interacting electron systems Magnetism Nanoscale Physics *Problems and Solutions in Solid State Physics* S. O. Pillai,1994-01-01 Modern Physics And Solid State Physics (problems And Solutions) S O Pillai,2006 The Purpose Of This Book Is To Motivate The Students To Organize Their Thoughts And Prepare Them For Problem Solving In The Vital Areas Of Modern Physics And Physics Of Condensed Materials Each Chapter Begins With A Quick Review Of The Basic Concepts Of The Topics And Also A Brief Discussion Of The Equation And Formulae That Are To Be Used For Solving The Problems Examples And Illustrations Are Provided Then And There To Expedite The Learning Process And The Working Knowledge About Six Hundred Problems Have Been Treated In Total Two Hundred Problems Have Been Worked Out Providing All Minute Details Answers For The Other Four Hundred Problems Have Been Provided At The End Of The Book This Book Will Cater The Needs Of Undergraduate And Postgraduate Students Of Physics Chemistry Materials Science And All Branches Of Engineering Except Civil Engineering Candidates Appearing For The Gate And Other Competitive Examinations Would Find This Book Useful Understanding

Solid State Physics Jacques Cazaux,2016-03-23 The correlation between the microscopic composition of solids and their macroscopic electrical optical thermal properties is the goal of solid state physics This book is the deeply revised version of the French book *Initiation physique du solide exercices commentes avec rappels de cours* written more than 20 years ago It has five sections

**Problems and Solution in Solidstate Physics** Pillai S O,2001

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activities The focus is deliberately limited to key concepts of atoms molecules and solids examining the basic structural aspects without paying detailed attention to the related properties For many topics the aim has been to start from the beginning and to guide the reader to the threshold of advanced research This edition includes four new chapters dealing with relevant phases of solid matter magnetic electric and superconductive and the related phase transitions The book is based on a mixture of theory and solved problems that are integrated into the formal presentation of the arguments Readers will find it invaluable in enabling them to acquire basic knowledge in the wide and wonderful field of condensed matter and to understand how phenomenological properties originate from the microscopic quantum features of nature

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**Solid State Physics** ,2015 **Introduction To Solid State Physics** Amnon Aharony,Ora Entin-wohlman,2018-08-03 Written by two professors emeriti with a long and distinguished career both in research and teaching the book clearly shows the wide experience of its authors This is a good book carefully prepared full of details and appropriate for its scope Those who will profit the most from it are the students who are obliged or prefer to study independently They will appreciate the clarity of exposition and will find the numerous problems both stimulating and rewarding What sets the book apart are undoubtedly the detailed solutions to all of the problems Contemporary PhysicsThis is an introductory book on solid state physics It is a translation of a Hebrew version written for the Open University in Israel Aimed mainly for self study the book contains appendices with the necessary background explains each calculation in detail and contains many solved problems The bulk of the book discusses the basic concepts of periodic crystals including lattice structures radiation scattering off crystals crystal bonding vibrations of crystals and electronic properties On the other hand the book also presents brief reviews of advanced topics e g quasicrystals soft condensed matter mesoscopic physics and the quantum Hall effect There are also many specific examples drawn from modern research topics e g perovskite oxides relevant for high temperature superconductivity graphene electrons in low dimensions and more

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**Solid State Physics** Mircea S. Rogalski,Stuart B. Palmer,2000-05-30 Solid State Physics opens with the adiabatic approximation to the many body problem of a system of ions and valence electrons After chapters on lattice symmetry structure and dynamics it then proceeds with four chapters devoted to the single electron theory of the solid state Semiconductors and dielectrics are covered in depth and chapters on m

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