

CHAPTER 2

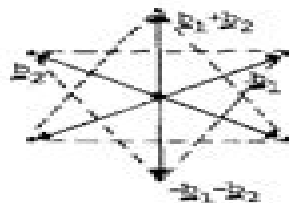
1. The crystal plane with Miller indices hkl is a plane defined by the points \mathbf{a}_1/h , \mathbf{a}_2/k , and \mathbf{a}_3/ℓ . (a) Two vectors that lie in the plane may be taken as $\mathbf{a}_1/h - \mathbf{a}_2/k$ and $\mathbf{a}_1/h - \mathbf{a}_3/\ell$. But each of these vectors gives zero as its scalar product with $\mathbf{G} = h\mathbf{a}_1 + k\mathbf{a}_2 + \ell\mathbf{a}_3$, so that \mathbf{G} must be perpendicular to the plane hkl . (b) If $\hat{\mathbf{n}}$ is the unit normal to the plane, the interplanar spacing is $\hat{\mathbf{n}} \cdot \mathbf{a}_1/h$. But $\hat{\mathbf{n}} = \mathbf{G}/|\mathbf{G}|$, whence $d(hkl) = \mathbf{G} \cdot \mathbf{a}_1/h/|\mathbf{G}| = 2\pi/|\mathbf{G}|$. (c) For a simple cubic lattice $\mathbf{G} = (2\pi/a)(h\hat{\mathbf{x}} + k\hat{\mathbf{y}} + \ell\hat{\mathbf{z}})$, whence

$$\frac{1}{d^2} = \frac{G^2}{4\pi^2} = \frac{h^2 + k^2 + \ell^2}{a^2}.$$

$$2. (a) \text{ Cell volume } \mathbf{a}_1 \cdot \mathbf{a}_2 \times \mathbf{a}_3 = \begin{vmatrix} \frac{1}{2}\sqrt{3}a & \frac{1}{2}a & 0 \\ -\frac{1}{2}\sqrt{3}a & \frac{1}{2}a & 0 \\ 0 & 0 & c \end{vmatrix}$$

$$= \frac{1}{2}\sqrt{3}a^2c.$$

$$(b) \mathbf{b}_1 = 2\pi \frac{\mathbf{a}_2 \times \mathbf{a}_3}{|\mathbf{a}_1 \cdot \mathbf{a}_2 \times \mathbf{a}_3|} = \frac{4\pi}{\sqrt{3}a^2c} \begin{vmatrix} \hat{\mathbf{x}} & \hat{\mathbf{y}} & \hat{\mathbf{z}} \\ 0 & 0 & c \\ \frac{1}{2}\sqrt{3}a & \frac{1}{2}a & 0 \end{vmatrix} \\ = \frac{2\pi}{a} \left(\frac{1}{\sqrt{3}}\hat{\mathbf{x}} + \hat{\mathbf{y}} \right), \text{ and similarly for } \mathbf{b}_2, \mathbf{b}_3.$$



(c) Six vectors in the reciprocal lattice are shown as solid lines. The broken lines are the perpendicular bisectors at the midpoints. The inscribed hexagon forms the first Brillouin Zone.

3. By definition of the primitive reciprocal lattice vectors

$$\mathbf{V}_{\text{rec}} = (2\pi)^3 \frac{(\mathbf{a}_2 \times \mathbf{a}_3) \cdot (\mathbf{a}_3 \times \mathbf{a}_1) \times (\mathbf{a}_1 \times \mathbf{a}_2)}{|\mathbf{a}_1 \cdot \mathbf{a}_2 \times \mathbf{a}_3|^3} = (2\pi)^3 / |\mathbf{a}_1 \cdot \mathbf{a}_2 \times \mathbf{a}_3| \\ = (2\pi)^3 / V_C.$$

For the vector identity, see G. A. Korn and T. M. Korn, *Mathematical handbook for scientists and engineers*, McGraw-Hill, 1961, p. 147.

4. (a) This follows by forming

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Chih Tang Sah



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Fundamentals Of Solid-state Electronics: Solution Manual Chih Tang Sah, 1996-09-30 This Solution Manual a companion volume of the book Fundamentals of Solid State Electronics provides the solutions to selected problems listed in the book Most of the solutions are for the selected problems that had been assigned to the engineering undergraduate students who were taking an introductory device core course using this book This Solution Manual also contains an extensive appendix which illustrates the application of the fundamentals to solutions of state of the art transistor reliability problems which have been taught to advanced undergraduate and graduate students This book is also available as a set with Fundamentals of Solid State Electronics and Fundamentals of Solid State Electronics Study Guide **Solutions to Resnick and Halliday Physics Pt.1-2** , **Understanding Solid State Physics** Sharon Ann Holgate, 2021-04-21 Keeping the mathematics to a minimum yet losing none of the required rigor Understanding Solid State Physics Second Edition clearly explains basic physics principles to provide a firm grounding in the subject This new edition has been fully updated throughout with recent developments and literature in the field including graphene and the use of quasicrystalline materials in addition to featuring new journalistic boxes and the reciprocal lattice The author underscores the technological applications of the physics discussed and emphasizes the multidisciplinary nature of scientific research After introducing students to solid state physics the text examines the various ways in which atoms bond together to form crystalline and amorphous solids It also describes the measurement of mechanical properties and the means by which the mechanical properties of solids can be altered or supplemented for particular applications The author discusses how electromagnetic radiation interacts with the periodic array of atoms that make up a crystal and how solids react to heat on both atomic and macroscopic scales She then focuses on conductors insulators semiconductors and superconductors including some basic semiconductor devices The final chapter addresses the magnetic properties of solids as well as applications of magnets and magnetism This accessible textbook provides a useful introduction to solid state physics for undergraduates who feel daunted by a highly mathematical approach By relating the theories and concepts to practical applications it shows how physics is used in the real world Key features Fully updated throughout with new journalistic boxes and recent applications Uses an accessible writing style and format offering journalistic accounts of interesting research worked examples self test questions and a helpful glossary of frequently used terms Highlights various technological applications of physics from locomotive lights to medical scanners to USB flash drives A Solutions Manual is available for qualifying course adoptions and can be requested under the Support Material tab There is also a dedicated Companion Website available with further student and instructor resources [Solid State Physics](#) Philip Hofmann, 2015-05-26 A must have textbook for any undergraduate studying solid state physics This successful brief course in solid state physics is now in its second edition The clear and concise introduction not only describes all the basic phenomena and concepts but also such advanced issues as magnetism and superconductivity Each section starts with a

gentle introduction covering basic principles progressing to a more advanced level in order to present a comprehensive overview of the subject The book is providing qualitative discussions that help undergraduates understand concepts even if they can't follow all the mathematical detail The revised edition has been carefully updated to present an up to date account of the essential topics and recent developments in this exciting field of physics The coverage now includes ground breaking materials with high relevance for applications in communication and energy like graphene and topological insulators as well as transparent conductors The text assumes only basic mathematical knowledge on the part of the reader and includes more than 100 discussion questions and some 70 problems with solutions free to lecturers from the Wiley VCH website The author's webpage provides Online Notes on x ray scattering elastic constants the quantum Hall effect tight binding model atomic magnetism and topological insulators This new edition includes the following updates and new features Expanded coverage of mechanical properties of solids including an improved discussion of the yield stress Crystal structure mechanical properties and band structure of graphene The coverage of electronic properties of metals is expanded by a section on the quantum hall effect including exercises New topics include the tight binding model and an expanded discussion on Bloch waves With respect to semiconductors the discussion of solar cells has been extended and improved Revised coverage of magnetism with additional material on atomic magnetism More extensive treatment of finite solids and nanostructures now including topological insulators Recommendations for further reading have been updated and increased New exercises on Hall mobility light penetrating metals band structure

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today's bridge building is an elaborate enterprise involving CAD tools, composite materials and acoustic imaging. When technology is pushed to its limits, a working knowledge proves inadequate and an in-depth understanding of core physical principles, both macroscopic and microscopic, top-down vs. bottom-up, becomes essential. We find ourselves today at a similar crossroad in semiconductor device technology where a working knowledge of solid-state electronics is no longer enough. Faced with the prohibitive cost of computing and the slowdown of chip manufacturing, device scaling and the global supply chain, the semiconductor industry is forced to explore alternate platforms such as 2-D materials, spintronics, analog processing and quantum engineering. This book combines top-down classical device physics with bottom-up quantum transport in a single venue to provide the basis for such a scientific exploration. It is essential easy reading for beginning undergraduate and practicing graduate students, physicists unfamiliar with device engineering and engineers untrained in quantum physics. With just a modest pre-requisite of freshman maths, the book works quickly through key concepts in quantum physics: Matlab exercises and original homeworks to cover a wide range of topics from chemical bonding to Hofstadter butterflies, domain walls to Chern insulators, solar cells to photodiodes, FinFETs to Majorana fermions. For the practicing device engineer, it provides new concepts such as the quantum of resistance, while for the practicing quantum physicist, it provides new contexts such as the tunnel transistor.

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