

## Practice Problems: Quantum Theory

CHEM 1A

1. Hydrogen has a red emission line at 656.3 nm, what is the energy and frequency of a photon of this light? Note: Planck's constant =  $6.626 \times 10^{-34}$  J·s, speed of light =  $2.998 \times 10^8$  m/s

$$E_{\text{photon}} = h\nu = \frac{hc}{\lambda}$$

$$E_{\text{photon}} = \frac{(6.626 \times 10^{-34} \text{ J}\cdot\text{s}) (2.998 \times 10^8 \text{ m/s})}{656.3 \text{ nm} \left( \frac{10^{-9} \text{ m}}{1 \text{ nm}} \right)}$$

$$E_{\text{photon}} = \underline{3.02677861 \times 10^{-19} \text{ J}}$$

$$\nu = \frac{c}{\lambda}$$

$$\nu = \frac{(2.998 \times 10^8 \text{ m/s})}{656.3 \text{ nm} \left( \frac{10^{-9} \text{ m}}{1 \text{ nm}} \right)}$$

$$\nu = \underline{4.568032912 \times 10^{14} \text{ s}^{-1}}$$

Answer (E):  $3.027 \times 10^{-19} \text{ J}$ Answer ( $\nu$ ):  $4.568 \times 10^{14} \text{ s}^{-1}$  or Hz

2. What is the de Broglie wavelength for an electron moving at  $2.42 \times 10^6$  m/s?  
Note:  $m_e = 9.109 \times 10^{-31}$  kg

$$\lambda = \left( \frac{h}{mv} \right)$$

$$\lambda = \left( \frac{6.626 \times 10^{-34} \text{ J}\cdot\text{s}}{(9.109 \times 10^{-31} \text{ kg}) (2.42 \times 10^6 \text{ m/s})} \right) = \underline{3.00583657 \times 10^{-10} \text{ m}}$$

Answer:  $3.01 \times 10^{-10} \text{ m}$   $\longleftarrow$  many orders of magnitude larger than the diameter of an electron

3. Using the Bohr equation, calculate is the change in energy when an electron transitions from  $n = 3$  to  $n = 2$  in a hydrogen atom.

$$\Delta E = -2.18 \times 10^{-18} \text{ J} \left( \frac{Z^2}{n_{\text{final}}^2} - \frac{Z^2}{n_{\text{initial}}^2} \right)$$

$$\Delta E = -2.18 \times 10^{-18} \text{ J} \left( \frac{1^2}{2^2} - \frac{1^2}{3^2} \right)$$

$$\Delta E = \underline{-3.02777778 \times 10^{-19} \text{ J}}$$

Answer:  $-3.03 \times 10^{-19} \text{ J}$

# Practice Problems Chapter Quantum Theory

**Yi-Tong Ma**



## **Practice Problems Chapter Quantum Theory:**

Quantum Physics Workbook For Dummies Steven Holzner, 2009-12-04 Hands on practice in solving quantum physics problems Quantum Physics is the study of the behavior of matter and energy at the molecular atomic nuclear and even smaller microscopic levels Like the other titles in our For Dummies Workbook series Quantum Physics Workbook For Dummies allows you to hone your skills at solving the difficult and often confusing equations you encounter in this subject Explains equations in easy to understand terms Harmonic Oscillator Operations Angular Momentum Spin Scattering Theory Using a proven practice and review approach Quantum Physics Workbook For Dummies is all you need to get up to speed in problem solving

**Contemporary Quantum Mechanics in Practice** Lilia M. Woods, Pablo Rodríguez López, 2024-04-30 This helpful and pedagogical book offers problems and solutions in quantum mechanics from areas of current research rarely addressed in introductory courses or textbooks It is based on the authors own experience of teaching undergraduate and graduate courses in quantum mechanics and adapts problems from contemporary research publications to be accessible to students Each section introduces key quantum mechanical concepts which are followed by exercises that grow progressively more challenging throughout the chapter The step by step solutions provide detailed mathematical derivations and explore their application to wider research topics This is an indispensable resource for undergraduate and graduate students alike expanding the range of topics usually covered in the classroom as well as for instructors and early career researchers in quantum mechanics quantum computation and communication and quantum information

**Survival Guide to General Chemistry** Patrick E. McMahon, Rosemary McMahon, Bohdan Khomtchouk, 2019-02-13 This work evolved over thirty combined years of teaching general chemistry to a variety of student demographics The focus is not to recap or review the theoretical concepts well described in the available texts Instead the topics and descriptions in this book make available specific detailed step by step methods and procedures for solving the major types of problems in general chemistry Explanations instructional process sequences solved examples and completely solved practice problems are greatly expanded containing significantly more detail than can usually be devoted to in a comprehensive text Many chapters also provide alternative viewpoints as an aid to understanding Key Features The authors have included every major topic in the first semester of general chemistry and most major topics from the second semester Each is written in a specific and detailed step by step process for problem solving whether mathematical or conceptual Each topic has greatly expanded examples and solved practice problems containing significantly more detail than found in comprehensive texts Includes a chapter designed to eliminate confusion concerning acid base reactions which often persists through working with acid base equilibrium Many chapters provide alternative viewpoints as an aid to understanding This book addresses a very real need for a large number of incoming freshman in STEM fields

A Comprehensive Guide to Advanced Quantum Mechanics Sanjay Nair, 2025-02-20 Embark on a journey into the captivating realm of quantum physics with our comprehensive guide tailored for undergraduate

students in the United States Building upon the foundational principles of introductory quantum mechanics our book delves into the deeper complexities and cutting edge advancements of the quantum world We cover a wide range of advanced quantum mechanics topics equipping students with the theoretical framework and mathematical tools to understand and analyze complex quantum phenomena From quantum field theory principles to the intricacies of quantum entanglement and decoherence each chapter offers clear explanations and illustrative examples to help grasp key concepts Emphasizing both theoretical understanding and practical application our guide includes thought provoking exercises and real world examples that challenge students to deeply engage with the material Through this rigorous yet accessible approach students will expand their knowledge of quantum mechanics and develop valuable problem solving skills essential for further study and research in physics Whether pursuing a career in theoretical physics quantum information science or simply seeking to deepen their understanding of the quantum world students will find our guide to be an invaluable resource that illuminates the complexities and wonders of one of the most fascinating fields in modern physics

**Quantum Physics** Mircea S. Rogalski, Stuart B. Palmer, 2020-11-17 This book presents the basic concepts and methods of quantum mechanics for upper level undergraduate students allowing them to master its application to real physical situations A postulate based treatment is adopted together with a gradual development of the quantum formalism of wave functions operators measurement and temporal evolution Standard topics of one dimensional and atomic motion angular momentum and approximation methods are presented in addition to detailed discussions of many particle systems atomic and nuclear radiation Appropriate mathematical tools and techniques are provided wherever necessary The core text is supplemented by 77 worked examples some of which address more complex issues and aspects of present day research The aim is to make this textbook a realistic introduction to more advanced and specialized texts The material provides full coverage of the subject matter 94 problems with solutions and a further 93 with answers only

**Introduction to Applied Modern Physics** Abebe Henok, 2008-01-01 Most of the materials in this book originated from the author's lecture notes for an applied modern physics course The author made a significant effort to show students the practical applications of modern physics concepts to semiconductors and semiconductor devices and their use in electronics circuits in a single book that is very difficult to find in any other popular text The material in this book is intended for upper division undergraduate and graduate students majoring in science and engineering

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**Cracking the GRE Chemistry Subject Test** Princeton Review (Firm), 2005 The GRE subject tests are among the most difficult standardized exams Rather than

testing general problem solving skills they require highly specialized knowledge The experts at The Princeton Review have thoroughly research each subject test to provide students with the most thorough up to date information available Students don t need to relearn the entire histories of their fields just what they need to know to earn high scores on the exams Each guide includes one full length practice exam complete with comprehensive explanations for every solution

*Physics for Global Scientists and Engineers, Volume 2* Raymond A. Serway, John W. Jewett, Wayne (California State Polytechnic University Rowlands, Pomona), Kate Wilson, Wayne Rowlands, Anna (University of Canberra Wilson, Australian National University), 2016-10-01 This second edition of Serway s *Physics For Global Scientists and Engineers* is a practical and engaging introduction for students of calculus based physics Students love the Australian Asia Pacific and international case studies and worked examples concise language and high quality artwork in two easy to carry volumes NEW key topics in physics such as the Higgs boson engage students and keep them interested NEW Maths icons highlight mathematical concepts in the text and direct students to the relevant information in the Maths Appendix NEW Index of Symbols provides students with a quick reference for the symbols used throughout the book This volume two includes Electricity and magnetism Light and optics and Quantum physics Volume one covers Mechanics Mechanical properties of solids and fluids Oscillations and mechanical waves and Thermodynamics

**Ebook: Chemistry** Julia Burdge, 2014-10-16 Chemistry Third Edition by Julia Burdge offers a clear writing style written with the students in mind Julia uses her background of teaching hundreds of general chemistry students per year and creates content to offer more detailed explanation on areas where she knows they have problems With outstanding art a consistent problem solving approach interesting applications woven throughout the chapters and a wide range of end of chapter problems this is a great third edition text

*Worldviews* Richard DeWitt, 2018-04-16 Winner of the 2018 Choice Award for Outstanding Academic Title PRAISE FOR PREVIOUS EDITIONS This is a brilliantly clear introduction and indeed reframing of the history and philosophy of science in terms of worldviews and their elements In addition the book is incredibly well informed from both a scientific and philosophical angle Highly recommended Scientific and Medical Network Unlike many other introductions to philosophy of science DeWitt s book is at once historically informative and philosophically thorough and rigorous Chapter notes suggested readings and references enhance its value Choice Written in clear and comprehensible prose and supplemented by effective diagrams and examples *Worldviews* is an ideal text for anyone new to the history and philosophy of science As the reader will come to find out DeWitt is a gifted writer with the unique ability to break down complex and technical concepts into digestible parts making *Worldviews* a welcoming and not overwhelming book for the introductory reader History and Philosophy of the Life Sciences vol 28 2 Now in its third edition *Worldviews An Introduction to the History and Philosophy of Science* strengthens its reputation as the most accessible and teachable introduction to the history and philosophy of science on the market Geared toward engaging undergraduates and those approaching the history and philosophy of science for the first time this

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*Soft X-Rays and Extreme Ultraviolet Radiation* David Attwood, 2007-02-22 This detailed comprehensive book describes the fundamental properties of soft X-rays and extreme ultraviolet (EUV) radiation and discusses their applications in a wide variety of fields including EUV lithography for semiconductor chip manufacture and soft X-ray biomicroscopy. The author begins by presenting the relevant basic principles such as radiation and scattering, wave propagation, diffraction, and coherence. He then goes on to examine a broad range of phenomena and applications. The topics covered include spectromicroscopy, EUV astronomy, synchrotron radiation, and soft X-ray lasers. The author also provides a wealth of useful reference material such as electron binding energies, characteristic emission lines, and photo-absorption cross sections. The book will be of great interest to graduate students and researchers in engineering, physics, chemistry, and the life sciences. It will also appeal to practising engineers involved in semiconductor fabrication and materials science.

*Computational Physics* Jos Thijssen, 2007-03-22 First published in 2007, this second edition describes the computational methods used in theoretical physics. New sections were added to cover finite element methods and lattice Boltzmann simulation, density functional theory, quantum molecular dynamics, Monte Carlo simulation, and diagonalisation of one-dimensional quantum systems. It covers many different areas of physics research and different computational methodologies, including computational methods such as Monte Carlo and molecular dynamics, various electronic structure methodologies, methods for solving partial differential equations, and lattice gauge theory. Throughout the book, the relations between the methods used in different fields of physics are emphasised. Several new programs are described and can be downloaded from [www.cambridge.org](http://www.cambridge.org). 9781107677135. The book requires a background in elementary programming, numerical analysis, and field theory, as well as undergraduate knowledge of condensed matter theory and statistical physics. It will be of interest to graduate students and researchers in theoretical, computational, and experimental physics.

**AP Physics 2 Premium, Fourth Edition: Prep Book with 4 Practice Tests + Comprehensive Review + Online Practice (2025)** Barron's Educational Series, Kenneth Rideout, Jonathan Wolf, 2025-01-07 Be prepared for exam day with Barron's Trusted content from AP experts. Barron's AP Physics 2 Premium Fourth Edition is fully revised for

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**Quantum Theory: Concepts and Methods** A. Peres, 2006-06-01 There are many excellent books on quantum theory from which one can learn to compute energy levels transition rates cross sections etc The theoretical rules given in these books are routinely used by physicists to compute observable quantities Their predictions can then be compared with experimental data There is no fundamental disagreement among physicists on how to use the theory for these practical purposes However there are profound differences in their opinions on the ontological meaning of quantum theory The purpose of this book is to clarify the conceptual meaning of quantum theory and to explain some of the mathematical methods which it utilizes This text is not concerned with specialized topics such as atomic structure or strong or weak interactions but with the very foundations of the theory This is not however a book on the philosophy of science The approach is pragmatic and strictly instrumentalist This attitude will undoubtedly antagonize some readers but it has its own logic

quantum phenomena do not occur in a Hilbert space they occur in a laboratory      Global Philosophy Nicholas Maxwell, 2014-11-05 This book is about education learning rational inquiry philosophy science studies problem solving academic inquiry global problems wisdom and above all the urgent need for an academic revolution Despite this range and diversity of topics there is a common underlying theme Education ought to be devoted much more than it is to the exploration real life open problems it ought not to be restricted to learning up solutions to already solved problems especially if nothing is said about the problems that provoked the solutions in the first place A central task of philosophy ought to be to keep alive awareness of our unsolved fundamental problems especially our most fundamental problem of all encompassing all others How can our human world and the world of sentient life more generally imbued with the experiential consciousness free will meaning and value exist and best flourish embedded as it is in the physical universe This is both our fundamental intellectual problem and our fundamental problem of living The essays in this volume seek to provoke a concerted effort to transform our institutions of learning so that they become rationally and effectively devoted to helping us learn how to create a wiser world Our most serious problems of living are so grim so imbued with suffering wasted lives and unnecessary death that the idea of approaching them in a playful spirit seems sacrilegious We need to keep alive tackling of intellectual problems so that playful capacities can be exercised if for no other reason and other reasons there are of course aplenty There are two really worthy impulses behind all rational inquiry delight and compassion      *IIT Physics-II* ,      **The**

**Feynman Integral and Feynman's Operational Calculus** , 2000-03-16 The aim of this book is to make accessible to mathematicians physicists and other scientists interested in quantum theory the beautiful but mathematically difficult subjects of the Feynman integral and Feynman's operational calculus Some advantages of the approaches to the Feynman integral which are treated in detail in this book are the following the existence of the Feynman integral is established for very general potentials in all four cases under more restrictive but still broad conditions three of these Feynman integrals agree with one another and with the unitary group from the usual approach to quantum dynamics these same three Feynman integrals possess pleasant stability properties Much of the material covered here was previously available only in the research literature and the book also contains some new results The background material in mathematics and physics that motivates the study of the Feynman integral and Feynman's operational calculus is discussed and detailed proofs are provided for the central results      **Carl Friedrich von Weizsäcker: Major Texts in Physics** Michael

Drieschner, 2014-06-13 This book presents a collection of texts by the German physicist and philosopher Carl Friedrich von Weizsäcker 1912-2007 for use in seminars on the history epistemology and structure of physics Most texts appear in English for the first time Weizsäcker became famous through his works in physics mainly in the early development of nuclear physics Later he would also become well known as a philosopher and analyst of contemporary culture Texts include the original publications of the Weizsäcker-Bethe formula of nuclear masses and the Bethe-Weizsäcker cycle which explains the source of



energy in the sun both were developed by Bethe at the same time and independently of Weizsäcker Further texts deal with Weizsäcker's explanation of the origin of planets his explanation of the time arrow in Statistical Mechanics and his analyses of Quantum Mechanics and the structure of physics in general

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