

## Unit I - Worksheet 3: Coulomb's Law Key

1. Given the mathematical representation of Coulomb's Law,  $F = k \frac{q_1 q_2}{r^2}$ , where  $k = 9.0 \times 10^9 \text{ Nm}^2/\text{C}^2$ , describe in words the relationship among electric force, charge, and distance.

*The electric force is proportional to the product of the charges and is inversely proportional to the square of the distance between the charges.*

2. By how much does the electric force between a pair of charged bodies diminish when their separation is doubled? tripled?

$$F_1 = \frac{k}{r^2} \quad F_2 = \frac{k}{(2r)^2} = \frac{k}{4r^2} \quad F_2 = \frac{1}{4}F_1 \quad F_1 = \frac{k}{r^2} \quad F_2 = \frac{k}{(3r)^2} = \frac{k}{9r^2} \quad F_2 = \frac{1}{9}F_1$$

*The force is 1/4th as much.* *The force is 1/9th as much.*

3. Two positive charges of  $6.0 \times 10^{-6} \text{ C}$  are separated by 0.50 m. Draw a force diagram for each of the charges, considering only electrostatic forces. What is the magnitude of the force between the charges? Is this force repulsive or attractive?



$$F = k \frac{q_1 q_2}{r^2} \quad F = \frac{9.0 \times 10^9 \frac{\text{Nm}^2}{\text{C}^2} (6.0 \times 10^{-6} \text{ C})(6.0 \times 10^{-6} \text{ C})}{(.50\text{m})^2} = 1.3\text{N}$$

*Like charge repells, so the force is repulsive.*

4. A negative charge of  $2.0 \times 10^{-4} \text{ C}$  and a positive charge of  $8.0 \times 10^{-4} \text{ C}$  are separated by 0.30 m. What is the magnitude of the force between the charges? Is this force repulsive or attractive?

$$F = k \frac{q_1 q_2}{r^2} \quad F = \frac{9.0 \times 10^9 \frac{\text{Nm}^2}{\text{C}^2} (-2.0 \times 10^{-4} \text{ C})(8.0 \times 10^{-4} \text{ C})}{(.30\text{m})^2} = 1600\text{N}$$

*Opposite charges attract, so the force is attractive.*

5. A young man accumulates a charge  $q_1$  of  $+2.0 \times 10^{-5} \text{ C}$  while sliding out of the front seat of a car. His girlfriend, who had been waiting in the wind, has picked up some extra electrons and now has a charge  $q_2$  of  $-8.0 \times 10^{-5} \text{ C}$ .

Draw a sketch of the situation. Estimate the magnitude of the electrical force that each person exerts on the other when separated by a distance of 6.0 m. Is the force attractive or repulsive?

# Holt Physics Problem 17a Coulombs Law Answers

**Dorland**



# Holt Physics Problem 17a Coulombs Law Answers

**Holt Physics** Raymond A. Serway, 2009-07      **Problem Workbook** Holt Rinehart & Winston, Holt, Rinehart and Winston Staff, 1998-04      **The Physics of Radiation Therapy** Faiz M. Khan, 2012-03-28 Dr Khan's classic textbook on radiation oncology physics is now in its thoroughly revised and updated Fourth Edition. It provides the entire radiation therapy team—radiation oncologists, medical physicists, dosimetrists, and radiation therapists—with a thorough understanding of the physics and practical clinical applications of advanced radiation therapy technologies, including 3D CRT, stereotactic radiotherapy, HDR, IMRT, IGRT, and proton beam therapy. These technologies are discussed along with the physical concepts underlying treatment planning, treatment delivery, and dosimetry. This Fourth Edition includes brand new chapters on image-guided radiation therapy, IGRT, and proton beam therapy. Other chapters have been revised to incorporate the most recent developments in the field. This edition also features more than 100 full-color illustrations throughout. A companion Website will offer the fully searchable text and an image bank.

**Handbook of Modern Sensors** Jacob Fraden, 2006-04-29 Seven years have passed since the publication of the previous edition of this book. During that time, sensor technologies have made a remarkable leap forward. The sensitivity of the sensors became higher, the dimensions became smaller, the sensitivity became better, and the prices became lower. What has not changed are the fundamental principles of the sensor design. They are still governed by the laws of Nature. Arguably, one of the greatest geniuses who ever lived, Leonardo Da Vinci, had his own peculiar way of praying. He was saying, "Oh Lord, thank you for Thou do not violate your own laws." It is comforting indeed that the laws of Nature do not change as time goes by; it is just our appreciation of them that is being renewed. Thus, this new edition examines the same good old laws of Nature that are employed in the designs of various sensors. This has not changed much since the previous edition. Yet, the sections that describe the practical designs are revised substantially. Recent ideas and developments have been added, and less important and nonessential designs were dropped. Probably, the most dramatic recent progress in the sensor technologies relates to the wide use of MEMS and MEOMS (micro electro mechanical systems and micro electro optical mechanical systems). These are examined in this new edition with greater detail. This book is about devices commonly called sensors. The invention of a microprocessor has brought highly sophisticated instruments into our everyday lives.

**Spin-orbit Coupling Effects in Two-Dimensional Electron and Hole Systems** Roland Winkler, 2003-10-10 The first part provides a general introduction to the electronic structure of quasi two-dimensional systems with a particular focus on group theoretical methods. The main part of the monograph is devoted to spin-orbit coupling phenomena at zero and nonzero magnetic fields. Throughout the book, the main focus is on a thorough discussion of the physical ideas and a detailed interpretation of the results. Accurate numerical calculations are complemented by simple and transparent analytical models that capture the important physics.

**Physics of Optoelectronic Devices** Shun Lien Chuang, 1995-09-08 Emphasizes the theory of

semiconductor optoelectronic devices demonstrating comparisons between theoretical and experimental results Presents such important topics as semiconductor heterojunctions and band structure calculations near the band edges for bulk and quantum well semiconductors Details semiconductor lasers including double heterostructure stripe geometry gain guided semiconductor distributed feedback and surface emitting Systematically investigates high speed modulation of semiconductor lasers using linear and nonlinear gains Features new subjects such as the theories on the band structures of strained semiconductors and strained quantum well lasers Covers key areas behind the operation of semiconductor lasers modulators and photodetectors An Instructor s Manual presenting detailed solutions to all the problems in the book is available from the Wiley editorial department     **Holt Physics** ,2001     [Dorland's Dictionary of Medical Acronyms and Abbreviations](#) Dorland,2015-07-24 Medical acronyms and abbreviations offer convenience but those countless shortcuts can often be confusing Now a part of the popular Dorland s suite of products this reference features thousands of terms from across various medical specialties Its alphabetical arrangement makes for quick reference and expanded coverage of symbols ensures they are easier to find Effective communication plays an important role in all medical settings so turn to this trusted volume for nearly any medical abbreviation you might encounter Symbols section makes it easier to locate unusual or seldom used symbols Convenient alphabetical format allows you to find the entry you need more intuitively More than 90 000 entries and definitions Many new and updated entries including terminology in expanding specialties such as Nursing Physical Occupational and Speech Therapies Transcription and Coding Computer and Technical Fields New section on abbreviations to avoid including Joint Commission abbreviations that are not to be used Incorporates updates suggested by the Institute for Safe Medication Practices ISMP     [X-Ray Emission from Clusters of Galaxies](#) Craig L. Sarazin,1988-03-17 First published in 1988 this book is a comprehensive survey of the astrophysical characteristics of the hot gas which pervades clusters of galaxies In our universe clusters of galaxies are the largest organised structures Typically they comprise hundreds of galaxies moving through a region of space ten million light years in diameter The volume between the galaxies is filled with gas having a temperature of 100 million degrees This material is a strong source of cosmic X rays Dr Sarazin describes the theoretical description of the origin dynamics and physical state of the cluster gas Observations by radio and optical telescopes are also summarised This account is addressed to professional astronomers and to graduate students It is an exhaustive summary of a rapidly expanding field of research in modern astrophysics     *Microwave Devices and Circuits* Samuel Y. Liao,1990-09     **Physics of Photonic Devices** Shun Lien Chuang,2012-11-07 The most up to date book available on the physics of photonic devices This new edition of Physics of Photonic Devices incorporates significant advancements in the field of photonics that have occurred since publication of the first edition Physics of Optoelectronic Devices New topics covered include a brief history of the invention of semiconductor lasers the Lorentz dipole method and metal plasmas matrix optics surface plasma waveguides optical ring resonators integrated electroabsorption modulator lasers and solar cells It also

introduces exciting new fields of research such as surface plasmonics and micro ring resonators the theory of optical gain and absorption in quantum dots and quantum wires and their applications in semiconductor lasers and novel microcavity and photonic crystal lasers quantum cascade lasers and GaN blue green lasers within the context of advanced semiconductor lasers Physics of Photonic Devices Second Edition presents novel information that is not yet available in book form elsewhere Many problem sets have been updated the answers to which are available in an all new Solutions Manual for instructors Comprehensive timely and practical Physics of Photonic Devices is an invaluable textbook for advanced undergraduate and graduate courses in photonics and an indispensable tool for researchers working in this rapidly growing field Science of Microscopy P.W. Hawkes, John C.H. Spence, 2008-08-29 This fully corrected second impression of the classic 2006 text on microscopy runs to more than 1 000 pages and covers up to the minute developments in the field The two volume work brings together a slew of experts who present comprehensive reviews of all the latest instruments and new versions of the older ones as well as their associated operational techniques The chapters draw attention to their principal areas of application A huge range of subjects are benefiting from these new tools including semiconductor physics medicine molecular biology the nanoworld in general magnetism and ferroelectricity This fascinating book will be an indispensable guide for a wide range of scientists in university laboratories as well as engineers and scientists in industrial R D departments **Physics** Holt Rinehart & Winston, 2000-12 **Modern Physics** Paul Allen Tipler, 1978 For the intermediate level course the Fifth Edition of this widely used text takes modern physics textbooks to a higher level With a flexible approach to accommodate the various ways of teaching the course both one and two term tracks are easily covered the authors recognize the audience and its need for updated coverage mathematical rigor and features to build and support student understanding Continued are the superb explanatory style the up to date topical coverage and the Web enhancements that gained earlier editions worldwide recognition Enhancements include a streamlined approach to nuclear physics thoroughly revised and updated coverage on particle physics and astrophysics and a review of the essential Classical Concepts important to students studying Modern Physics Applied Many-Body Methods in Spectroscopy and Electronic Structure D. Mukherjee, 2013-11-11 There has been a steady advance of the atomic and molecular many body methodology over the last few years with a concomitant development of versatile computer codes Understanding and interpretation of electronic structural features and the associated spectroscopic properties via many body techniques are becoming competitive with those obtained with the traditional formalisms Since the many body techniques are not yet a part of the repertoire of the black box tools of electronic structure and spectroscopy it seems worthwhile to take stock now of the recent progress in certain selected areas The present volume is more in the nature of proceedings of a Paper Symposium rather than of one which actually took place We did organize in Calcutta between December 10 and 12 1990 a small meeting on Applied Many Body Methods to Spectroscopy and Electronic Structure jointly organized by the Indian Association for the

Cultivation of Science and the S N Bose National Centre for Basic Sciences Several leading practitioners were invited among which some could not come for various reasons

**EXAFS Spectroscopy** B. K. Teo, D. C. Joy, 2013-04-17 This book on Extended X Ray Absorption Fine Structure EXAFS Spectroscopy grew out of a symposium with the same title organized by us at the 1979 Meeting of the Materials Research Society MRS in Boston MA That meeting provided not only an overview of the theory instrumentation and practice of EXAFS Spectroscopy as currently employed with photon beams but also a forum for a valuable dialogue between those using the conventional approach and those breaking fresh ground by using electron energy loss spectroscopy EELS for EXAFS studies This book contains contributions from both of these groups and provides the interested reader with a detailed treatment of all aspects of EXAFS spectroscopy from the theory through consideration of the instrumentation for both photon and electron beam purposes to detailed descriptions of the applications and physical limitations of these techniques While some of the material was originally presented at the MRS meeting all of the chapters have been specially written for this book and contain much that is new and significant

**Quantum Chemistry** John P. Lowe, 2012-12-02 Praised for its appealing writing style and clear pedagogy Lowe's Quantum Chemistry is now available in its Second Edition as a text for senior undergraduate and graduate level chemistry students The book assumes little mathematical or physical sophistication and emphasizes an understanding of the techniques and results of quantum chemistry thus enabling students to comprehend much of the current chemical literature in which quantum chemical methods or concepts are used as tools The book begins with a six chapter introduction of standard one dimensional systems the hydrogen atom many electron atoms and principles of quantum mechanics It then provides thorough treatments of variation and perturbation methods group theory ab initio theory Huckel and extended Huckel methods qualitative MO theory and MO theory of periodic systems Chapters are completed with exercises to facilitate self study Solutions to selected exercises are included Assumes little mathematical or physical sophistication Emphasizes understanding of the techniques and results of quantum chemistry Includes improved coverage of time dependent phenomena term symbols and molecular rotation and vibration Provides a new chapter on molecular orbital theory of periodic systems Features new exercise sets with solutions Includes a helpful new appendix that compiles angular momentum rules from operator algebra

**Physics of Semiconductor Devices** J.-P. Colinge, C.A. Colinge, 2007-05-08 Physics of Semiconductor Devices covers both basic classic topics such as energy band theory and the gradual channel model of the MOSFET as well as advanced concepts and devices such as MOSFET short channel effects low dimensional devices and single electron transistors Concepts are introduced to the reader in a simple way often using comparisons to everyday life experiences such as simple fluid mechanics They are then explained in depth and mathematical developments are fully described Physics of Semiconductor Devices contains a list of problems that can be used as homework assignments or can be solved in class to exemplify the theory Many of these problems make use of Matlab and are aimed at illustrating theoretical concepts in a graphical manner

**Device and**

**Circuit Cryogenic Operation for Low Temperature Electronics** Francis Balestra, Gérard Ghibaudo, 2001-05-31 Device and Circuit Cryogenic Operation for Low Temperature Electronics is a first in reviewing the performance and physical mechanisms of advanced devices and circuits at cryogenic temperatures that can be used for many applications The first two chapters cover bulk silicon and SOI MOSFETs The electronic transport in the inversion layer the influence of impurity freeze out the special electrical properties of SOI structures the device reliability and the interest of a low temperature operation for the ultimate integration of silicon down to nanometer dimensions are described The next two chapters deal with Silicon Germanium and III V Heterojunction Bipolar Transistors as well as III V High Electron Mobility Transistors HEMT The basic physics of the SiGe HBT and its unique cryogenic capabilities the optimization of such bipolar devices and the performance of SiGe HBT BiCMOS technology at liquid nitrogen temperature are examined The physical effects in III V semiconductors at low temperature the HEMT and HBT static high frequency and noise properties and the comparison of various cooled III V devices are also addressed The next chapter treats quantum effect devices made of silicon materials The major quantum effects at low temperature quantum wires quantum dots as well as single electron devices and applications are investigated The last chapter overviews the performances of cryogenic circuits and their applications The low temperature properties and performance of inverters multipliers adders operational amplifiers memories microprocessors imaging devices circuits and systems sensors and read out circuits are analyzed Device and Circuit Cryogenic Operation for Low Temperature Electronics is useful for researchers engineers Ph D and M S students working in the field of advanced electron devices and circuits new semiconductor materials and low temperature electronics and physics

### **Agricultural Biomass Based Potential**

**Materials** Khalid Rehman Hakeem, Mohammad Jawaid, Othman Y. Allothman, 2015-04-01 Agricultural biomass is abundant worldwide and it can be considered as alternative source of renewable and sustainable materials which can be used as potential materials for different applications Despite this enormous production of agricultural biomass only a small fraction of the total biomass is utilized for different applications Industry must be prepared to take advantage of the situation and utilize the available biomass in the best possible manner Agricultural biomass such as natural fibres has been successfully investigated as a great potential to be used as a renewable and sustainable materials for the production of composite materials Natural fibres offer excellent specific properties and have potential as outstanding reinforcing fillers in the matrix and can be used as an alternative material for biocomposites hybrid composites pulp and paper industries Natural fibre based polymer composites made of jute oil palm flex hemp kenaf have a low market cost attractive with respect to global sustainability and find increasing commercial use in different applications Agricultural biomass based composites find applications in a number of fields viz automotive industry and construction industry Future research on agricultural biomass natural fibre based composites should not only be limited to its automotive applications but can be explored for its application in aircraft components construction industry rural housing and biomedical applications In this book we will cover

the chemical physical thermal electrical and biodegradability properties of agricultural biomass based composite materials and its different potential applications The main goal of this volume is to familiarize researchers scientists and engineers with the unique research opportunities and potentials of agricultural biomass based materials Up to date information on alternative biomass utilization Academic and industry leaders discuss unique properties of biomass based composite materials Direct application of agricultural biomass materials as sustainable and renewable alternatives

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