时代教育。国外高校优秀教材精选

大学物理

下册

University Physics

(美) 罗纳德・莱恩・里斯(Ronald Lane Reese) 著

(英文版)





时代教育 · 国外高校优秀教材精选

大 学 物 理

下 册

(英文版)

University Physics

(美) 罗纳德·莱恩·里斯(Ronald Lane Reese) 著



机械工业出版社

Ronald Lane Reese: University Physics (ISBN 0-534-24655-9)

Original Edition Copyright © 2002 by Brooks/Cole Publishing Company, a division of Thomson Leaning. All rights reserved.

Reprinted for People's Republic of China by Thomson Learning Asia and China Machine Press under the authorization of Thomson Learning.

No Part of this book may be reproduced in any form without the express written permission of Thomson Learning Asia and China Machine Press.

981-243-400-3

本书英文影印版由汤姆森学习出版集团 **THOMSON** 授权机械工业出版社独家出版。未经出版者书面许可,不得以任何方式抄袭、复制或节录本书的任何部分。

版权所有,侵权必究。

北京市版权局著作权合同登记号:图字:01-2002-4190

图书在版编目(CIP)数据

大学物理/(美) 里斯 (Reese, R.L.) 著.-北京: 机械工业出版社, 2002 (时代教育・国外高校优秀教材精选) ISBN 7-111-10944-9

Ⅰ.大… Ⅱ.里… Ⅲ.物理学-高等学校-教材-英文 Ⅳ.04

中国版本图书馆 CIP 数据核字 (2002) 第 069612 号

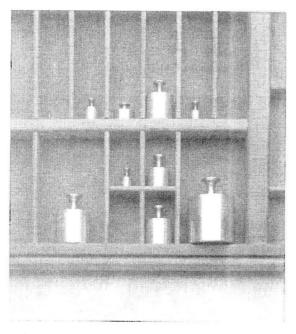
机械工业出版社(北京市百万庄大街 22 号 邮政编码 100037) 责任编辑: 刘小慧

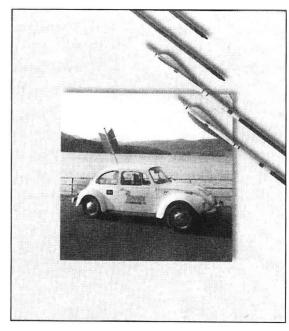
李永联 封面设计: 饶 薇 责任印制: 李 妍北京蓝海印刷有限公司印刷·新华书店北京发行所发行 2004年7月第1版·第2次印刷 787mm×1092mm¹/₁₆·86印张·4插页·2125千字 定价: 86.00元(上、下册)

凡购本书,如有缺页、倒页、脱页,由本社发行部调换本社购书热线电话:(010)68993821、88379646 封面无防伪标均为盗版

CONTENTS

出版说明 序 IV V





CHAPTER 1 Preludes 1

- 1.1 Nature and Mathematics: Physics as Natural Philosophy 2
- 1.2 Contemporary Physics: Classical and Modern 3
- 1.3 Standards for Measurement 6
- 1.4 Units of Convenience and Unit Conversions 11
- 1.5 The Meaning of the Word Dimension 14
- 1.6 The Various Meanings of the Equal Sign 15
- 1.7 Estimation and Order of Magnitude 16
- 1.8 The Distinction Between Precision and Accuracy 18
 Chapter Summary 22
 Summary of Problem-Solving Tactics 22
 Questions 22

Problems 25

Investigative Projects 32

CHAPTER 2 A Mathematical Toolbox 35

AN INTRODUCTION TO VECTOR ANALYSIS

- 2.1 Scalar and Vector Quantities 36
- 2.2 Multiplication of a Vector by a Scalar 38
- 2.3 Parallel Transport of Vectors 39
- 2.4 Vector Addition by Geometric Methods: Tail-to-Tip Method 40
- 2.5 Determining Whether a Quantity Is a Vector* 42
- 2.6 Vector Difference by Geometric Methods 44
- 2.7 The Scalar Product of Two Vectors 45
- 2.8 The Cartesian Coordinate System and the Cartesian Unit Vectors 47
- 2.9 The Cartesian Representation of Any Vector 49
- 2.10 Multiplication of a Vector Expressed in Cartesian Form by a Scalar 52

IV Contents

- 2.11 Expressing Vector Addition and Subtraction
 in Cartesian Form 52
- 2.12 The Scalar Product of Two Vectors Expressed in Cartesian Form 53
- 2.13 Determining the Angle Between Two Vectors Expressed in Cartesian Form 53
- 2.14 Equality of Two Vectors 54
- 2.15 Vector Equations 54
- 2.16 The Vector Product of Two Vectors 55
- 2.17 The Vector Product of Two Vectors Expressed in Cartesian Form 57
- 2.18 Variation of a Vector 59
- 2.19 Some Aspects of Vector Calculus 60

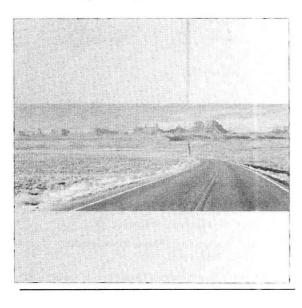
Chapter Summary 61

Summary of Problem-Solving Tactics 62

Questions 62

Problems 63

Investigative Projects 71



CHAPTER 3 Kinematics I 73

RECTILINEAR MOTION

- 3.1 Rectilinear Motion 75
- 3.2 Position and Changes in Position 75
- 3.3 Average Speed and Average Velocity 80
- 3.4 Instantaneous Speed and Instantaneous Velocity 83

- 3.5 Average Acceleration 86
- 3.6 Instantaneous Acceleration 88
- 3.7 Rectilinear Motion
 with a Constant Acceleration 92
- 3.8 Geometric Interpretations* 100

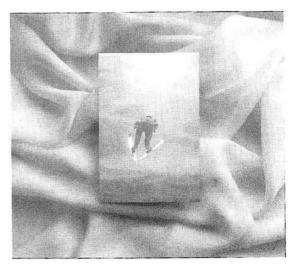
Chapter Summary 102

Summary of Problem-Solving Tactics 102

Questions 103

Problems 106

Investigative Projects 115



CHAPTER 4 Kinematics II 117

MOTION IN TWO AND THREE DIMENSIONS

- 4.1 The Position, Velocity, and Acceleration Vectors in Two Dimensions 118
- 4.2 Two-Dimensional Motion
 with a Constant Acceleration 121
- 4.3 Motion in Three Dimensions 129
- 4.4 Relative Velocity Addition and Accelerations 129
- 4.5 Uniform Circular Motion: A First Look 133
- 4.6 The Angular Velocity Vector 135
- 4.7 The Geometry and Coordinates for Describing Circular Motion 136
- 4.8 The Position Vector for Circular Motion 137
- 4.9 The Velocity and Angular Velocity in Circular Motion 137
- 4.10 Uniform Circular Motion Revisited 138

上为试法 需要完整PDF请访问: www.ertonghook.com

- 4.11 Nonuniform Circular Motion and the Angular Acceleration 141
- 4.12 Nonuniform Circular Motion with a Constant Angular Acceleration 143

Chapter Summary 151
Summary of Problem-Solving Tactics 152
Questions 152
Problems 154
Investigative Projects 168



CHAPTER 5 Newton's Laws of Motion 169

- 5.1 Fundamental Particles* 170
- 5.2 The Fundamental Forces of Nature* 171
- 5.3 Newton's First Law of Motion and a Qualitative Conception of Force 173
- 5.4 The Concept of Force and Its Measurement 174
- 5.5 Newton's Second Law of Motion 176
- 5.6 Newton's Third Law of Motion 179
- 5.7 Limitations to Applying Newton's Laws of Motion 180
- 5.8 Inertial Reference Frames: Do They Really Exist?* 181
- 5.9 Second Law and Third Law Force Diagrams 182
- 5.10 Weight and the Normal Force of a Surface 182
- 5.11 Tensions in Ropes, Strings, and Cables 187

- 5.12 Static Friction 197
- 5.13 Kinetic Friction at Low Speeds 205
- 5.14 Kinetic Friction Proportional to the Particle Speed* 207
- 5.15 Fundamental Forces and Other Forces Revisited* 209
- 5.16 Noninertial Reference Frames* 209

 Chapter Summary 212

 Summary of Problem-Solving Tactics 213

 Questions 213

 Problems 216

 Investigative Projects 229



CHAPTER 6 The Gravitational Force and the Gravitational Field 231

- 6.1 How Did Newton Deduce the Gravitational Force Law? 232
- 6.2 Newton's Law of Universal Gravitation 234
- 6.3 Gravitational Force of a Uniform Spherical Shell on a Particle 239
- 6.4 Gravitational Force of a Uniform Sphere on a Particle 239
- 6.5 Measuring the Mass of the Earth 241
- 6.6 Artificial Satellites of the Earth 242
- 6.7 Kepler's First Law of Planetary Motion and the Geometry of Ellipses 244

VI Contents

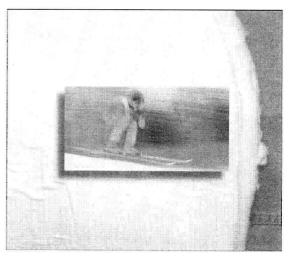
- 6.8 Spatial Average Position of a Planet in an Elliptical Orbit* 247
- 6.9 Kepler's Second Law of Planetary Motion 247
- 6.10 Central Forces, Orbital Angular Momentum, and Kepler's Second Law* 248
- 6.11 Newton's Form for Kepler's Third Law of Planetary Motion 251
- 6.12 Customized Units 254
- 6.13 The Gravitational Field 256
- 6.14 The Flux of a Vector* 261
- 6.15 Gauss's Law for the Gravitational Field* 264
 Chapter Summary 268
 Summary of Problem-Solving Tactics 269
 Questions 269
 Problems 271
 Investigative Projects 279



CHAPTER 7 Hooke's Force Law and Simple Harmonic Oscillation 281

- 7.1 Hooke's Force Law 282
- 7.2 Simple Harmonic Oscillation 286
- 7.3 A Vertically Oriented Spring 293
- 7.4 Connection Between Simple Harmonic
 Oscillation and Uniform Circular Motion 296
- 7.5 How to Determine Whether an Oscillatory Motion Is Simple Harmonic Oscillation 297
- 7.6 The Simple Pendulum 298
- 7.7 Through a Fictional Earth in 42 Minutes 301

- 7.8 Damped Oscillations* 302
- 7.9 Forced Oscillations and Resonance* 304
 Chapter Summary 306
 Summary of Problem-Solving Tactics 306
 Questions 307
 Problems 309
 Investigative Projects 317



CHAPTER 8 Work, Energy, and the CWE Theorem 319

- 8.1 Motivation for Introducing the Concepts of Work and Energy 320
- 8.2 The Work Done by Any Force 321
- 8.3 The Work Done by a Constant Force 323
- 8.4 The Work Done by the Total Force 325
- 8.5 Geometric Interpretation of the Work Done by a Force 328
- 8.6 Conservative, Nonconservative, and Zero-Work Forces 330
- 8.7 Examples of Conservative, Nonconservative, and Zero-Work Forces 331
- 8.8 The Concept of Potential Energy 334
- 8.9 The Gravitational Potential Energy of a System near the Surface of the Earth 335
- 8.10 The General Form for the Gravitational Potential Energy 337
- 8.11 The Relationship Between the Local Form for the Gravitational Potential Energy and the More General Form* 338

| 8.12 | The Potential Energy Fu | nction Associated |
|------|-------------------------|-------------------|
| | with Hooke's Force Law | 339 |

- 8.13 The CWE Theorem 340
- 8.14 The Escape Speed 347
- 8.15 Black Holes* 349
- 8.16 Limitations of the CWE Theorem: Two Paradoxical Examples* 351
- 8.17 The Simple Harmonic Oscillator Revisited 352
- 8.18 The Average and Instantaneous Power of a Force 354
- 8.19 The Power of the Total Force Acting on a System 358
- 8.20 Motion Under the Influence of Conservative Forces Only: Energy Diagrams* 359

Chapter Summary 363

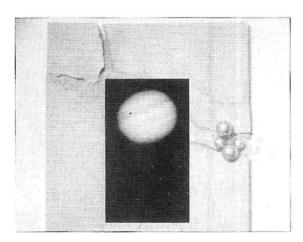
Summary of Problem-Solving Tactics

364

Questions 365

Problems 368

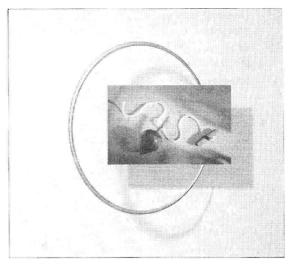
Investigative Projects 379



CHAPTER 9 Impulse, Momentum, and Collisions 381

- 9.1 Momentum and Newton's Second Law of Motion 382
- 9.2 Impulse-Momentum Theorem 384
- 9.3 The Rocket: A System with Variable Mass* 388
- 9.4 Conservation of Momentum 390
- 9.5 Collisions 390
- 9.6 Disintegrations and Explosions 396

- 9.7 The Centripetal Acceleration Revisited* 397
- 9.8 An Alternative Way to Look at Force Transmission* 398
- 9.9 The Center of Mass 400
- 9.10 Dynamics of a System of Particles 404
- 9.11 Kinetic Energy of a System of Particles 405
- 9.12 The Velocity of the Center of Mass for Collisions* 407
- 9.13 The Center of Mass Reference Frame* 408
 Chapter Summary 410
 Summary of Problem-Solving Tactics 410
 Questions 410
 Problems 412
 Investigative Projects 423

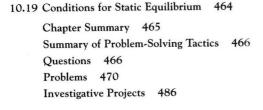


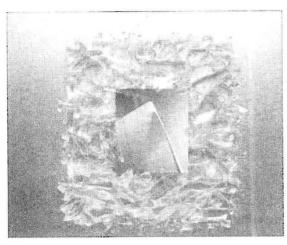
CHAPTER 10 Spin and Orbital Motion 425

- 10.1 The Distinction Between Spin and Orbital Motion 426
- 10.2 The Orbital Angular Momentum of a Particle 427
- 10.3 The Circular Orbital Motion of a Single Particle 429
- 10.4 Noncircular Orbital Motion 435
- 10.5 Rigid Bodies and Symmetry Axes 436
- 10.6 Spin Angular Momentum of a Rigid Body 436
- 10.7 The Time Rate of Change of the Spin Angular Momentum 438

VIII Contents

| 10.8 | The Moment of Inertia of Various Rigid Bodies 440 |
|-------|---|
| 10.9 | The Kinetic Energy of a Spinning System 442 |
| 10.10 | Spin Distorts the Shape of the Earth* 444 |
| 10.11 | The Precession of a Rapidly Spinning Top* 445 |
| 10.12 | The Precession of the Spinning Earth* 447 |
| 10.13 | Simultaneous Spin and Orbital Motion 450 |
| 10.14 | Synchronous Rotation and the Parallel Axis Theorem 451 |
| 10.15 | Rolling Motion Without Slipping 452 |
| 10.16 | Wheels* 455 |
| 10.17 | Total Angular Momentum and Torque 457 |
| 10.18 | Conservation of Angular Momentum 460 |



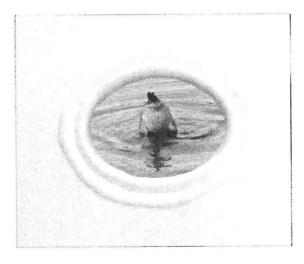


CHAPTER 11 Solids and Fluids 489

- 11.1 States of Matter 49011.2 Stress, Strain, and Young's Modulus for Solids 491
- 11.3 Fluid Pressure 494
- 11.4 Static Fluids 496
- 11.5 Pascal's Principle 501

- 11.6 Archimedes' Principle 501
- 11.7 The Center of Buoyancy* 505
- 11.8 Surface Tension* 508
- 11.9 Capillary Action* 509
- 11.10 Fluid Dynamics: Ideal Fluids 510
- 11.11 Equation of Flow Continuity 511
- 11.12 Bernoulli's Principle for Incompressible Ideal Fluids 511
- 11.13 Nonideal Fluids* 514
- 11.14 Viscous Flow* 515

Chapter Summary 516
Summary of Problem-Solving Tactics 517
Questions 517
Problems 520
Investigative Projects 528



CHAPTER 12 Waves 531

- 12.1 What Is a Wave? 532
- 12.2 Longitudinal and Transverse Waves 533
- 12.3 Wavefunctions, Waveforms, and Oscillations 535
- 12.4 Waves Propagating in One, Two, and Three Dimensions 535
- 12.5 One-Dimensional Waves Moving at Constant Velocity 537
- 12.6 The Classical Wave Equation for One-Dimensional Waves* 537
- 12.7 Periodic Waves 539

| | 100 |
|----------|-----|
| Contents | IX |
| omens | 10 |

| 120 | C:idal | (Harmonic) | Wayee | 541 |
|------|------------|------------|-------|-----|
| 12.8 | Sinusoidal | (Harmonic) | waves | 241 |

- 12.9 Waves on a String 544
- 12.10 Reflection and Transmission of Waves 545
- 12.11 Energy Transport via Mechanical Waves 547
- 12.12 Wave Intensity 548
- 12.13 What Is a Sound Wave?*
- 12.14 Sound Intensity and Sound Level*
- 12.15 The Acoustic Doppler Effect* 552
- 12.16 Shock Waves* 556
- 12.17 Diffraction of Waves
- 12.18 The Principle of Superposition 558
- 12.19 Standing Waves 559
- 565 12.20 Wave Groups and Beats*
- 12.21 Fourier Analysis and the Uncertainty Principles* 569

Chapter Summary 573

Summary of Problem-Solving Tactics 574

574 Questions

576 Problems

Investigative Projects 584



CHAPTER 13 Temperature, Heat Transfer, and the First Law of Thermodynamics

- 13.1 Simple Thermodynamic Systems
- 13.2 Temperature 588
- 13.3 Work, Heat Transfer, Temperature, and Thermal Equilibrium
- 13.4 The Zeroth Law of Thermodynamics

- 13.5 Thermometers and Temperature Scales
- 13.6 Temperature Conversions Between the Fahrenheit and Celsius Scales*
- 13.7 Thermal Effects in Solids and Liquids: Size
- 13.8 Thermal Effects in Ideal Gases
- 13.9 Calorimetry 601
- 13.10 Reservoirs 606
- 13.11 Mechanisms for Heat Transfer*
- 13.12 Thermodynamic Processes 615
- 13.13 Energy Conservation: The First Law of Thermodynamics and the CWE Theorem 615
- 13.14 The Connection Between the CWE Theorem and the General Statement of Energy Conservation 618
- 13.15 Work Done by a System on Its Surroundings
- 13.16 Work Done by a Gas Taken Around a Cycle 622
- 13.17 Applying the First Law of Thermodynamics: Changes of State 623

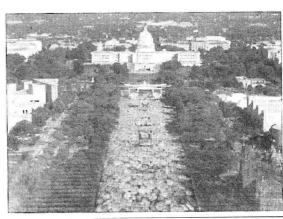
Chapter Summary 625

Summary of Problem-Solving Tactics 626

Questions 626

Problems 628

Investigative Projects 636



CHAPTER 14 Kinetic Theory 639

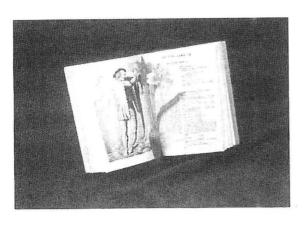
- 14.1 Background for the Kinetic Theory of Gases 640
- 14.2 The Ideal Gas Approximation 641
- 14.3 The Pressure of an Ideal Gas
- 14.4 The Meaning of the Absolute Temperature

X Contents

- 14.5 The Internal Energy of a Monatomic Ideal Gas 647
- 14.6 The Molar Specific Heats of an Ideal Gas 647
- 14.7 Complications Arise for Diatomic and Polyatomic Gases 649
- 14.8 Degrees of Freedom and the Equipartition of Energy Theorem 649
- 14.9 Specific Heat of a Solid* 650
- 14.10 Some Failures of Classical Kinetic Theory 651
- 14.11 Quantum Mechanical Effects* 653
- 14.12 An Adiabatic Process for an Ideal Gas 655
 Chapter Summary 657
 Summary of Problem-Solving Tactics 658
 Questions 658

Problems 660

Investigative Projects 664



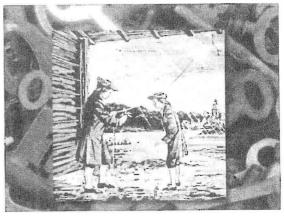
CHAPTER 15 The Second Law of Thermodynamics 667

- 15.1 Why Do Some Things Happen, While Others Do Not? 668
- 15.2 Heat Engines and the Second Law of Thermodynamics 669
- 15.3 The Carnot Heat Engine and Its Efficiency 672
- 15.4 Absolute Zero and the Third Law of Thermodynamics 674
- 15.5 Refrigerator Engines and the Second Law of Thermodynamics 675
- 15.6 The Carnot Refrigerator Engine 677
- 15.7 The Efficiency of Real Heat Engines and Refrigerator Engines 677

- 15.8 A New Concept: Entropy 679
- 15.9 Entropy and the Second Law of Thermodynamics 685
- 15.10 The Direction of Heat Transfer: A Consequence of the Second Law 688
- 15.11 A Statistical Interpretation of the Entropy* 689
- 15.12 Entropy Maximization and the Arrow of Time* 694
- 15.13 Extensive and Intensive State Variables* 695
 Chapter Summary 695
 Summary of Problem-Solving Tactics 696
 Questions 696

Investigative Projects 703

Problems 697



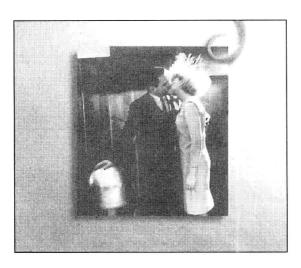
CHAPTER 16 Electric Charges, Electrical Forces, and the Electric Field 705

- 16.1 The Discovery of Electrification 706
- 16.2 Polarization and Induction 712
- 16.3 Coulomb's Force Law for Pointlike Charges:The Quantification of Charge 713
- 16.4 Charge Quantization 717
- 16.5 The Electric Field of Static Charges 720
- 16.6 The Electric Field of Pointlike Charge Distributions 722
- 16.7 A Way to Visualize the Electric Field: Electric Field Lines 726
- 16.8 A Common Molecular Charge Distribution:The Electric Dipole 728

- 16.9 The Electric Field of Continuous Distributions of Charge 733
- 16.10 Motion of a Charged Particle in a UniformElectric Field: An Electrical Projectile 739
- 16.11 Gauss's Law for Electric Fields* 741
- 16.12 Calculating the Magnitude of the Electric Field Using Gauss's Law* 744
- 16.13 Conductors* 748
- 16.14 Other Electrical Materials* 750

Investigative Projects 764

Chapter Summary 750
Summary of Problem-Solving Tactics 751
Questions 751
Problems 754

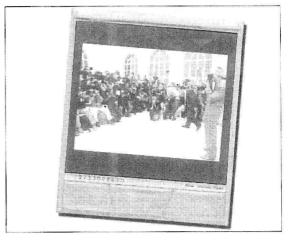


CHAPTER 17 Electric Potential Energy and the Electric Potential 767

- 17.1 Electrical Potential Energy and the Electric Potential 768
- 17.2 The Electric Potential of a Pointlike Charge 771
- 17.3 The Electric Potential of a Collection of Pointlike Charges 774
- 17.4 The Electric Potential of Continuous Charge Distributions of Finite Size 774
- 17.5 Equipotential Volumes and Surfaces 778
- 17.6 The Relationship Between the Electric Potential and the Electric Field 782

- 17.7 Acceleration of Charged ParticlesUnder the Influence of Electrical Forces 783
- 17.8 A New Energy Unit: The Electron-Volt 784
- 17.9 An Electric Dipole in an External Electric Field Revisited 786
- 17.10 The Electric Potential and Electric Field of a Dipole* 788
- 17.11 The Potential Energy of a Distribution of Pointlike Charges 789
- 17.12 Lightning Rods 792

Chapter Summary 793
Summary of Problem-Solving Tactics 794
Questions 794
Problems 795
Investigative Projects 804



CHAPTER 18 Circuit Elements, Independent Voltage Sources, and Capacitors 805

- 18.1 Terminology, Notation, and Conventions 806
- 18.2 Circuit Elements 808
- 18.3 An Independent Voltage Source: A Source of Emf 808
- 18.4 Connections of Circuit Elements 809
- 18.5 Independent Voltage Sources in Series and Parallel 811
- 18.6 Capacitors 813
- 18.7 Series and Parallel Combinations of Capacitors 816

XII Contents

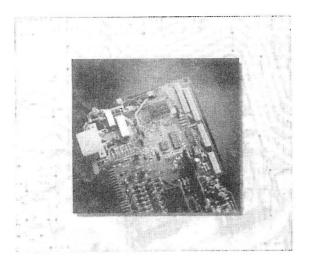
- 18.8 Energy Stored in a Capacitor 819
- 18.9 Electrostatics in Insulating Material Media* 821
- 18.10 Capacitors and Dielectrics* 822
- 18.11 Dielectric Breakdown* 825

Chapter Summary 825 Summary of Problem-Solving Tactics 826

Occasiona 826

Questions 826 Problems 828

Investigative Projects 833



CHAPTER 19 Electric Current, Resistance, and dc Circuit Analysis 835

- 19.1 The Concept of Electric Current 836
- 19.2 Electric Current 838
- 19.3 The Pièce de Résistance: Resistance and Ohm's Law 842
- 19.4 Resistance Thermometers 845
- 19.5 Characteristic Curves 846
- 19.6 Series and Parallel Connections Revisited 847
- 19.7 Resistors in Series and in Parallel 848
- 19.8 Electric Power 850
- 19.9 Electrical Networks and Circuits 853
- 19.10 Electronics 853
- 19.11 Kirchhoff's Laws for Circuit Analysis 854
- 19.12 Electric Shock Hazards* 864

- 19.13 A Model for a Real Battery 865
- 19.14 Maximum Power Transfer Theorem 868
- 19.15 Basic Electronic Instruments: Voltmeters, Ammeters, and Ohmmeters 869
- 19.16 An Introduction to Transients in Circuits:
 A Series RC Circuit* 872

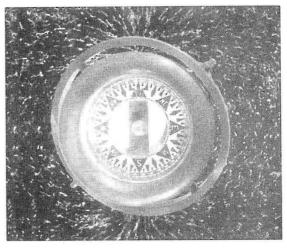
Chapter Summary 877

Summary of Problem-Solving Tactics 877

Questions 878

Problems 881

Investigative Projects 893



CHAPTER 20 Magnetic Forces and the Magnetic Field 895

- 20.1 The Magnetic Field 896
- 20.2 Applications 899
- 20.3 Magnetic Forces on Currents 904
- 20.4 Work Done by Magnetic Forces 906
- 20.5 Torque on a Current Loop in a Magnetic Field 907
- 20.6 The Biot-Savart Law 912
- 20.7 Forces of Parallel Currents on Each Other and the Definition of the Ampere 917
- 20.8 Gauss's Law for the Magnetic Field* 918
- 20.9 Magnetic Poles and Current Loops 919
- 20.10 Ampere's Law* 919

- 20.11 The Displacement Current and the Ampere-Maxwell Law* 927
- 20.12 Magnetic Materials* 930
- 20.13 The Magnetic Field of the Earth* 931

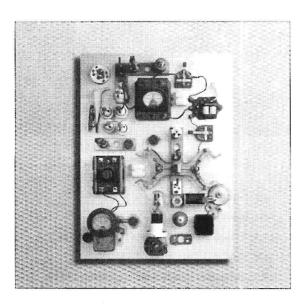
Chapter Summary 933

Summary of Problem-Solving Tactics 934

Questions 934

Problems 937

Investigative Projects 950



CHAPTER 21 Faraday's Law of Electromagnetic Induction 953

- 21.1 Faraday's Law of Electromagnetic Induction 954
- 21.2 Lenz's Law 960
- 21.3 An ac Generator 963
- 21.4 Summary of the Maxwell Equations of Electromagnetism 965
- 21.5 Electromagnetic Waves* 966
- 21.6 Self-Inductance* 971
- 21.7 Series and Parallel Combinations of Inductors* 973
- 21.8 A Series LR Circuit* 974
- 21.9 Energy Stored in a Magnetic Field* 979
- 21.10 A Parallel LC Circuit* 980

- 21.11 Mutual Inductance* 983
- 21.12 An Ideal Transformer* 985

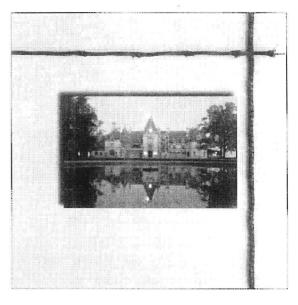
Chapter Summary 988

Summary of Problem-Solving Tactics 989

Questions 989

Problems 993

Investigative Projects 1002



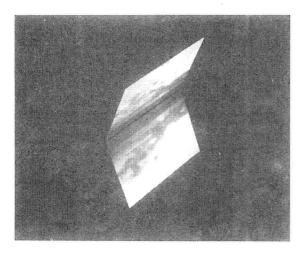
CHAPTER 22 Sinusoidal ac Circuit Analysis 1005

- 22.1 Representations of a Complex Variable 1006
- 22.2 Arithmetic Operations
 with Complex Variables 1009
- 22.3 Complex Potential Differences and Currents: Phasors 1013
- 22.4 The Potentiat Difference and Current Phasors for Resistors, Inductors, and Capacitors 1015
- 22.5 Series and Parallel Combinations of Impedances 1019
- 22.6 Complex Independent ac Voltage Sources 1020
- 22.7 Power Absorbed by Circuit Elements in ac Circuits 1021
- 22.8 A Filter Circuit 1022
- 22.9 A Series RLC Circuit 1026

Chapter Summary 1031

XIV Contents

Summary of Problem-Solving Tactics 1032
Questions 1032
Problems 1034
Investigative Projects 1039



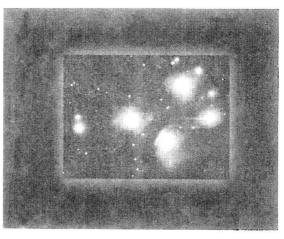
CHAPTER 23 Geometric Optics 1041

- 23.1 The Domains of Optics 1042
- 23.2 The Inverse Square Law for Light 1044
- 23.3 The Law of Reflection 1045
- 23.4 The Law of Refraction 1048
- 23.5 Total Internal Reflection 1051
- 23.6 Dispersion 1053
- 23.7 Rainbows* 1054
- 23.8 Objects and Images 1056
- 23.9 The Cartesian Sign Convention 1056
- 23.10 Image Formation by Spherical and Plane Mirrors 1057
- 23.11 Ray Diagrams for Mirrors 1063
- 23.12 Refraction at a Single Spherical Surface 1064
- 23.13 Thin Lenses 1069
- 23.14 Ray Diagrams for Thin Lenses 1072
- 23.15 Optical Instruments 1074

Chapter Summary 1082

Summary of Problem-Solving Tactics 1083

Questions 1083
Problems 1086
Investigative Projects 1099



CHAPTER 24 Physical Optics 1103

- 24.1 Existence of Light Waves 1104
- 24.2 Interference 1104
- 24.3 Young's Double Slit Experiment 1106
- 24.4 Single Slit Diffraction 1108
- 24.5 Diffraction by a Circular Aperture 1111
- 24.6 Resolution 1112
- 24.7 The Double Slit Revisited 1114
- 24.8 Multiple Slits: The Diffraction Grating 1116
- 24.9 Resolution and Angular Dispersion of a Diffraction Grating 1117
- 24.10 The Index of Refraction and the Speed of Light 1120
- 24.11 Thin-Film Interference* 1121
- 24.12 Polarized Light* 1125
- 24.13 Polarization by Absorption* 1128
- 24.14 Malus's Law* 1129
- 24.15 Polarization by Reflection: Brewster's Law* 1130
- 24.16 Polarization by Double Refraction* 1132
- 24.17 Polarization by Scattering* 1133
- 24.18 Rayleigh and Mie Scattering* 1133

Chapter Summary 1136
Summary of Problem-Solving Tactics 1137
Questions 1138
Problems 1139
Investigative Projects 1146



CHAPTER 25 The Special Theory of Relativity 1149

- 25.1 Reference Frames 1150
- 25.2 Classical Galilean Relativity 1151
- 25.3 The Need for Change and the Postulates of the Special Theory 1154
- 25.4 Time Dilation 1155
- 25.5 Lengths Perpendicular to the Direction of Motion 1160
- 25.6 Lengths Oriented Along the Direction of Motion: Length Contraction 1162
- 25.7 The Lorentz Transformation Equations 1162
- 25.8 The Relativity of Simultaneity 1165
- 25.9 A Relativistic Centipede 1166
- 25.10 A Relativistic Paradox and Its Resolution* 1168
- 25.11 Relativistic Velocity Addition 1171
- 25.12 Cosmic Jets and the Optical Illusion of Superluminal Speeds* 1174

- 25.13 The Longitudinal Doppler Effect 1176
- 25.14 The Transverse Doppler Effect* 1178
- 25.15 A General Equation for the Relativistic Doppler Effect* 1179
- 25.16 Relativistic Momentum 1180
- 25.17 The CWE Theorem Revisited 1183
- 25.18 Implications of the Equivalence Between Mass and Energy 1186
- 25.19 Space-Time Diagrams* 1187
- 25.20 Electromagnetic Implications of the Special Theory* 1188
- 25.21 The General Theory of Relativity* 1190

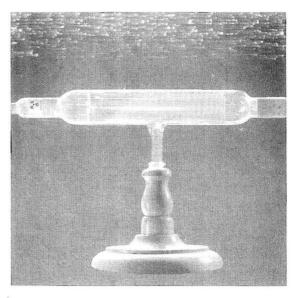
 Chapter Summary 1192

 Summary of Problem-Solving Tactics 1194

 Questions 1194

 Problems 1196

 Investigative Projects 1202

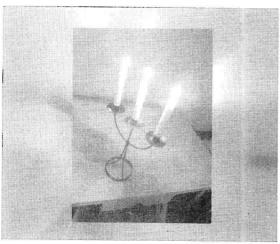


CHAPTER 26 An Aperitif: Modern Physics 1205

- 26.1 The Discovery of the Electron 1206
- 26.2 The Discovery of X-rays 1207
- 26.3 The Discovery of Radioactivity 1208
- 26.4 The Appearance of Planck's Constant h 1209

XVI Contents

| 26.5 | The Photoelectric Effect 1211 |
|-------|---|
| 26.6 | The Quest for an Atomic Model: Plum Pudding 1216 |
| 26.7 | The Bohr Model of a Hydrogenic Atom 1218 |
| 26.8 | The Bohr Correspondence Principle 1223 |
| 26.9 | A Bohr Model of the Solar System?* 1224 |
| 26.10 | Problems with the Bohr Model 1225 |
| 26.11 | Radioactivity Revisited 1225 |
| 26.12 | Carbon Dating 1229 |
| 26.13 | Radiation Units, Dose, and Exposure* 1230 |
| 26.14 | The Momentum of a Photon 1231 |
| 26.15 | The de Broglie Hypothesis 1235 |
| | Chapter Summary 1239 |
| | Summary of Problem-Solving Tactics 1240 |
| | Questions 1240 |
| | Problems 1242 |
| | Investigative Projects 1247 |
| | |



CHAPTER 27 An Introduction to Quantum Mechanics 1249

- 27.1 The Heisenberg Uncertainty Principles 1250
- 27.2 Implications of the Position–Momentum Uncertainty Principle 1252
- 27.3 Implications of the Energy-Time Uncertainty Principle 1254

- 27.4 Observation and Measurement 1257
- 27.5 Particle-Waves and the Wavefunction 1257
- 27.6 Operators* 1261
- 27.7 The Schrödinger Equation* 1263

Chapter Summary 1265

Questions 1265

Problems 1266

Investigative Projects 1267

EPILOGUE 1268

APPENDIX A Proofs of the Gravitational Shell Theorems A.1

- A.1 A Mass Within a Uniform Spherical Shell A.1
- A.2 A Mass Outside a Uniform Spherical Shell A.2

Answers to Problems A.5
Quotations Index I.1
Reference Index I.2
General Index I.7
Credits C.1