

Brief Contents

Chapter 1 Doing Physics 1

PART ONE

Mechanics 15

Chapter 2 Motion in a Straight Line 16

Chapter 3 Motion in Two and Three Dimensions 34

Chapter 4 Force and Motion 54

Chapter 5 Using Newton's Laws 74

Chapter 6 Energy, Work, and Power 94

Chapter 7 Conservation of Energy 113

Chapter 8 Gravity 134

Chapter 9 Systems of Particles 150

Chapter 10 Rotational Motion 175

Chapter 11 Rotational Vectors and Angular Momentum 196

Chapter 12 Static Equilibrium 211

PART TWO

Oscillations, Waves, and Fluids 228

Chapter 13 Oscillatory Motion 229

Chapter 14 Wave Motion 250

Chapter 15 Fluid Motion 274

PART THREE

Thermodynamics 294

Chapter 16 Temperature and Heat 295

Chapter 17 The Thermal Behavior of Matter 313

Chapter 18 Heat, Work, and the First Law of Thermodynamics 328

Chapter 19 The Second Law of Thermodynamics 345

PART FOUR

Electromagnetism 367

Chapter 20 Electric Charge, Force, and Field 368

Chapter 21 Gauss's Law 389

Chapter 22 Electric Potential 414

Chapter 23 Electrostatic Energy and Capacitors 434

Chapter 24 Electric Current 449

Chapter 25 Electric Circuits 467

Chapter 26 Magnetism: Force and Field 488

Chapter 27 Electromagnetic Induction 516

Chapter 28 Alternating-Current Circuits 545

Chapter 29 Maxwell's Equations and Electromagnetic Waves 564

PART FIVE

Optics 588

Chapter 30 Reflection and Refraction 589

Chapter 31 Images and Optical Instruments 603

Chapter 32 Interference and Diffraction 624

PART SIX

Modern Physics 647

Chapter 33 Relativity 648

Chapter 34 Particles and Waves 674

Chapter 35 Quantum Mechanics 694

Chapter 36 Atomic Physics 711

Chapter 37 Molecules and Solids 730

Chapter 38 Nuclear Physics 749

Chapter 39 From Quarks to the Cosmos 777

Appendix A. Mathematics A-1

Appendix B. The International System of Units (SI) A-9

Appendix C. Conversion Factors A-11

Appendix D. The Elements A-13

Appendix E. Astrophysical Data A-16

Answers to Odd-Numbered Problems A-17

Credits C-1

Index I-2

Detailed Contents

Volume 1 contains Chapters 1–19

Volume 2 contains Chapters 20–39

Chapter 1 Doing Physics 1

- 1.1 Realms of Physics 1
- 1.2 Measurements and Units 2
- 1.3 Working with Numbers 5
- 1.4 Strategies for Learning Physics 8

PART ONE

Mechanics 15

Chapter 2 Motion in a Straight Line 16

- 2.1 Average Motion 16
- 2.2 Instantaneous Velocity 18
- 2.3 Acceleration 20
- 2.4 Constant Acceleration 22
- 2.5 The Acceleration of Gravity 25
- 2.6 When Acceleration Isn't Constant 27

Chapter 3 Motion in Two and Three Dimensions 34

- 3.1 Vectors 34
- 3.2 Velocity and Acceleration Vectors 37
- 3.3 Relative Motion 38
- 3.4 Constant Acceleration 40
- 3.5 Projectile Motion 41
- 3.6 Uniform Circular Motion 46

Chapter 4 Force and Motion 54

- 4.1 The Wrong Question 54
- 4.2 Newton's First and Second Laws 55
- 4.3 Forces 59
- 4.4 The Force of Gravity 60
- 4.5 Using Newton's Second Law 62
- 4.6 Newton's Third Law 65

Chapter 5 Using Newton's Laws 74

- 5.1 Using Newton's Second Law 74
- 5.2 Multiple Objects 77

5.3 Circular Motion 79

5.4 Friction 83

5.5 Drag Forces 88

Chapter 6 Energy, Work, and Power 94

- 6.1 Energy 94
- 6.2 Work 96
- 6.3 Forces That Vary 99
- 6.4 Kinetic Energy 103
- 6.5 Power 105

Chapter 7 Conservation of Energy 113

- 7.1 Conservative and Nonconservative Forces 114
- 7.2 Potential Energy 115
- 7.3 Conservation of Mechanical Energy 119
- 7.4 Nonconservative Forces 122
- 7.5 Conservation of Energy 124
- 7.6 Potential-Energy Curves 125

Chapter 8 Gravity 134

- 8.1 Toward a Law of Gravity 134
- 8.2 Universal Gravitation 135
- 8.3 Orbital Motion 137
- 8.4 Gravitational Energy 140
- 8.5 The Gravitational Field 144

Chapter 9 Systems of Particles 150

- 9.1 Center of Mass 150
- 9.2 Momentum 156
- 9.3 Kinetic Energy of a System 160
- 9.4 Collisions 161
- 9.5 Totally Inelastic Collisions 162
- 9.6 Elastic Collisions 164

Chapter 10 Rotational Motion 175

- 10.1 Angular Velocity and Acceleration 175
- 10.2 Torque 178
- 10.3 Rotational Inertia and the Analog of Newton's Law 180

10.4 Rotational Energy 185	15.4 Fluid Dynamics 280
10.5 Rolling Motion 187	15.5 Applications of Fluid Dynamics 283
Chapter 11 Rotational Vectors and Angular Momentum 196	15.6 Viscosity and Turbulence 287
11.1 Angular Velocity and Acceleration Vectors 196	PART THREE
11.2 Torque and the Vector Cross Product 197	Thermodynamics 294
11.3 Angular Momentum 199	Chapter 16 Temperature and Heat 295
11.4 Conservation of Angular Momentum 201	16.1 Heat, Temperature, and Thermodynamic Equilibrium 295
11.5 Gyroscopes and Precession 203	16.2 Heat Capacity and Specific Heat 297
Chapter 12 Static Equilibrium 211	16.3 Heat Transfer 299
12.1 Conditions for Equilibrium 211	16.4 Thermal-Energy Balance 305
12.2 Center of Gravity 213	Chapter 17 The Thermal Behavior of Matter 313
12.3 Examples of Static Equilibrium 214	17.1 Gases 313
12.4 Stability 216	17.2 Phase Changes 318
PART TWO	17.3 Thermal Expansion 321
Oscillations, Waves, and Fluids 228	Chapter 18 Heat, Work, and the First Law of Thermodynamics 328
Chapter 13 Oscillatory Motion 229	18.1 The First Law of Thermodynamics 328
13.1 Describing Oscillatory Motion 230	18.2 Thermodynamic Processes 330
13.2 Simple Harmonic Motion 231	18.3 Specific Heats of an Ideal Gas 338
13.3 Applications of Simple Harmonic Motion 234	Chapter 19 The Second Law of Thermodynamics 345
13.4 Circular Motion and Harmonic Motion 238	19.1 Reversibility and Irreversibility 345
13.5 Energy in Simple Harmonic Motion 239	19.2 The Second Law of Thermodynamics 346
13.6 Damped Harmonic Motion 241	19.3 Applications of the Second Law 350
13.7 Driven Oscillations and Resonance 242	19.4 Entropy and Energy Quality 353
Chapter 14 Wave Motion 250	PART FOUR
14.1 Waves and Their Properties 250	Electromagnetism 367
14.2 Wave Math 252	Chapter 20 Electric Charge, Force, and Field 368
14.3 Waves on a String 254	20.1 Electric Charge 368
14.4 Wave Energy 255	20.2 Coulomb's Law 369
14.5 Sound Waves 257	20.3 The Electric Field 373
14.6 Interference 258	20.4 Fields of Charge Distributions 375
14.7 Reflection and Refraction 261	20.5 Matter in Electric Fields 380
14.8 Standing Waves 263	Chapter 21 Gauss's Law 389
14.9 The Doppler Effect and Shock Waves 265	21.1 Electric Field Lines 389
Chapter 15 Fluid Motion 274	21.2 Electric Field and Electric Flux 391
15.1 Density and Pressure 274	21.3 Gauss's Law 394
15.2 Hydrostatic Equilibrium 275	21.4 Using Gauss's Law 396
15.3 Archimedes' Principle and Buoyancy 278	

21.5 Fields of Arbitrary Charge Distributions	403	27.5 Magnetic Energy	533
21.6 Gauss's Law and Conductors	404	27.6 Induced Electric Fields	536
Chapter 22 Electric Potential	414	Chapter 28 Alternating-Current Circuits	545
22.1 Electric Potential Difference	414	28.1 Alternating Current	545
22.2 Calculating Potential Difference	418	28.2 Circuit Elements in AC Circuits	546
22.3 Potential Difference and the Electric Field	424	28.3 LC Circuits	550
22.4 Charged Conductors	427	28.4 Driven RLC Circuits and Resonance	553
Chapter 23 Electrostatic Energy and Capacitors	434	28.5 Power in AC Circuits	556
23.1 Electrostatic Energy	434	28.6 Transformers and Power Supplies	557
23.2 Capacitors	435	Chapter 29 Maxwell's Equations and Electromagnetic Waves	564
23.3 Using Capacitors	437	29.1 The Four Laws of Electromagnetism	564
23.4 Energy in the Electric Field	441	29.2 Ambiguity in Ampère's Law	565
Chapter 24 Electric Current	449	29.3 Maxwell's Equations	567
24.1 Electric Current	449	29.4 Electromagnetic Waves	568
24.2 Conduction Mechanisms	452	29.5 Properties of Electromagnetic Waves	572
24.3 Resistance and Ohm's Law	456	29.6 The Electromagnetic Spectrum	576
24.4 Electric Power	458	29.7 Producing Electromagnetic Waves	577
24.5 Electrical Safety	459	29.8 Energy and Momentum in Electromagnetic Waves	578
Chapter 25 Electric Circuits	467		
25.1 Circuits, Symbols, and Electromotive Force	467	PART FIVE	
25.2 Series and Parallel Resistors	468	Optics	588
25.3 Kirchhoff's Laws and Multiloop Circuits	474	Chapter 30 Reflection and Refraction	589
25.4 Electrical Measurements	476	30.1 Reflection	589
25.5 Capacitors in Circuits	477	30.2 Refraction	591
Chapter 26 Magnetism: Force and Field	488	30.3 Total Internal Reflection	593
26.1 What Is Magnetism?	488	30.4 Dispersion	595
26.2 Magnetic Force and Field	489	Chapter 31 Images and Optical Instruments	603
26.3 Charged Particles in Magnetic Fields	491	31.1 Images with Mirrors	603
26.4 The Magnetic Force on a Current	493	31.2 Images with Lenses	608
26.5 Origin of the Magnetic Field	495	31.3 Refraction in Lenses: The Details	611
26.6 Magnetic Dipoles	498	31.4 Optical Instruments	614
26.7 Magnetic Matter	501	Chapter 32 Interference and Diffraction	624
26.8 Ampère's Law	503	32.1 Coherence and Interference	624
Chapter 27 Electromagnetic Induction	516	32.2 Double-Slit Interference	626
27.1 Induced Currents	516	32.3 Multiple-Slit Interference and Diffraction Gratings	629
27.2 Faraday's Law	518	32.4 Interferometry	633
27.3 Induction and Energy	522		
27.4 Inductance	528		

32.5 Huygens' Principle and Diffraction	635	36.3 The Exclusion Principle	718
32.6 The Diffraction Limit	638	36.4 Multielectron Atoms and the Periodic Table	719
PART SIX		36.5 Transitions and Atomic Spectra	723
Modern Physics 647		Chapter 37 Molecules and Solids	730
Chapter 33 Relativity	648	37.1 Molecular Bonding	730
33.1 Speed c Relative to What?	649	37.2 Molecular Energy Levels	732
33.2 Matter, Motion, and the Ether	649	37.3 Solids	735
33.3 Special Relativity	651	37.4 Superconductivity	741
33.4 Space and Time in Relativity	652	Chapter 38 Nuclear Physics	749
33.5 Simultaneity Is Relative	657	38.1 Elements, Isotopes, and Nuclear Structure	749
33.6 The Lorentz Transformations	659	38.2 Radioactivity	754
33.7 Energy and Momentum in Relativity	662	38.3 Binding Energy and Nucleosynthesis	760
33.8 Electromagnetism and Relativity	666	38.4 Nuclear Fission	762
33.9 General Relativity	667	38.5 Nuclear Fusion	768
Chapter 34 Particles and Waves	674	Chapter 39 From Quarks to the Cosmos	777
34.1 Toward Quantum Theory	674	39.1 Particles and Forces	777
34.2 Blackbody Radiation	675	39.2 Particles and More Particles	778
34.3 Photons	677	39.3 Quarks and the Standard Model	782
34.4 Atomic Spectra and the Bohr Atom	680	39.4 Unification	785
34.5 Matter Waves	684	39.5 The Evolving Universe	787
34.6 The Uncertainty Principle	686		
34.7 Complementarity	688		
Chapter 35 Quantum Mechanics	694	APPENDICES	
35.1 Particles, Waves, and Probability	695	Appendix A Mathematics	A-1
35.2 The Schrödinger Equation	696	Appendix B The International System of Units (SI)	A-9
35.3 Particles and Potentials	698	Appendix C Conversion Factors	A-11
35.4 Quantum Mechanics in Three Dimensions	705	Appendix D The Elements	A-13
35.5 Relativistic Quantum Mechanics	705	Appendix E Astrophysical Data	A-16
Chapter 36 Atomic Physics	711	Answers to Odd-Numbered Problems	A-17
36.1 The Hydrogen Atom	711	Credits	C-1
36.2 Electron Spin	715	Index	I-2