



# CONTENTS

## CHAPTER 1 SPECIAL RELATIVITY

- 1.1 The Michelson-Morley experiment 1
- 1.2 Consequences of the constancy of  $c$  4
- 1.3 Relativistic rulers and clocks 7
- 1.4 Relativistic mass 10
- 1.5 The ultimate speed and mass-energy 14

## CHAPTER 2 THE ELECTRON

- 2.1 Free electron extraction: a. Cold cathode emission b. Thermionic emission 21
- 2.2 Basic electron devices 24
- 2.3 Electrostatic lenses 24
- 2.4 Magnetic lenses 29
- 2.5 Electron microscopes 33
- 2.6 Secondary electron emission 36
- 2.7 Electron- and photo-multipliers 39

## CHAPTER 3 BEGINNINGS OF MODERN PHYSICS

- 3.1 The photoelectric effect 47
- 3.2 Models of the atom 51
- 3.3 Potential scattering 55
- 3.4 Waves and particles 56
- 3.5 The Bohr atom 58
- 3.6 Nonhydrogen Bohr atom 62
- 3.7 The Bohr magneton 66

<b>CHAPTER 4</b>	<b>THE QUANTUM ATOM</b>
4.1	DeBroglie waves and the uncertainty principle 71
4.2	The mechanics of waves 75
4.3	Transition rates; radiation and absorption 83
4.4	Fine structure; electron spin 88
4.5	Application of atomic interactions; the Zeeman effect 90
4.6	Multiple electron atoms; the Pauli principle 93
<b>CHAPTER 5</b>	<b>THE QUANTUM MOLECULE</b>
5.1	Formation of molecules 105
5.2	Additional degree of freedom; rotation and vibration 108
5.3	Radiation absorption 113
5.4	Fluorescence 116
5.5	Frequency shifting 117
5.6	Phosphors 118
5.7	Stimulated emission 119
<b>CHAPTER 6</b>	<b>APPLIED ATOMIC AND MOLECULAR PHYSICS; LASERS</b>
6.1	Light amplification by stimulated emission 123
6.2	Types of laser operation 126
6.3	Laser applications; holography 130
6.4	Acoustic holography 133
<b>CHAPTER 7</b>	<b>THE SOLID STATE OF MATTER</b>
7.1	Band theory 139
7.2	Spatial extent of electron wave functions 141
7.3	Conduction properties 143
7.4	Thermal excitation 146
7.5	Charge transport by holes 150
7.6	Semiconductor materials 151
7.7	Doping 151
7.8	Superconductors 155
<b>CHAPTER 8</b>	<b>APPLIED SOLID STATE PHYSICS</b>
8.1	Semiconductor junction devices 161
8.2	Electron tunnelling 166
8.3	Zener, avalanche, and tunnel diode 169
8.4	Negative resistance and the Gunn effect 171
8.5	Optical properties of semiconductors 174
8.6	Solar cell 176
8.7	Electron or photon detector 178
8.8	Electron-hole recombination 180
8.9	The solid state laser 182

- 8.10 Crystal imperfections 183
- 8.11 Pressure sensitivity 186

## CHAPTER 9 THE NUCLEUS

- 9.1 The nuclear potential 191
- 9.2 Nucleus-atom similarities and differences 192
- 9.3 Mass-energy equivalence and binding energy 194
- 9.4 Nuclear stability; gamma and beta decay 196
- 9.5 Gamma and beta radiation source applications 200
- 9.6 Nuclear saturation and the Coulomb force 203
- 9.7 The overall ground state of nuclear matter 208
- 9.8 Nucleon decays of nuclei 209
- 9.9 Large cluster decay and fission 214

## CHAPTER 10 PRACTICAL NUCLEAR ENERGY

- 10.1 Spontaneous and induced fission 221
- 10.2 Choice of fuel 223
- 10.3 Neutron moderation 224
- 10.4 Static cycle parameters 226
- 10.5 Control of criticality 228
- 10.6 Cycle time and the importance of being supercritical 229
- 10.7 Delayed neutrons and reactor control 231
- 10.8 The physical reactor 233
- 10.9 Fuel breeding 238
- 10.10 Fusion power 239
- 10.11 Fission-fusion symbiosis 244

- APPENDICES
- 1 Interaction cross sections 249
  - 2 Rutherford scattering 251
  - 3 Nuclear masses 255

- INDEX 267