

Contents

Chapter 1 The Atomic View of Matter

1-1	Introduction	1
1-2	Chemical evidence for the atomic view of matter	3
1-3	Molecular masses	6
1-4	Atomic masses	8
1-5	Periodic table	9
1-6	Physical evidence for the atomic view of matter	9
1-7	Kinetic theory of gases; molar heat capacity	10
1-8	Equipartition of energy	14
1-9	Maxwell's speed distribution law	15
1-10	Collision probability; mean free path	20
1-11	Faraday's law of electrolysis—skepticism	24
1-12	Perrin's verification of the atomic view of matter	25
1-13	Boltzmann's distribution law	28

Chapter 2 The Atomic View of Electricity

2-1	Electrical discharges	33
2-2	Nonrelativistic charged-particle ballistics	35
2-3	Thomson's measurement of q/m	36
2-4	Electronic charge	41
2-5	Mass of the electron; Avogadro constant	45
2-6	Positive rays	45
2-7	Isotopes	48
2-8	Mass Spectroscopy	49

Chapter 3 The Atomic View of Radiation

3-1	Introduction	55
3-2	Particles or waves	55
3-3	Electricity and light	56
3-4	Electrodynamics	57

3-5	The unity of radiation	58
3-6	Thermal radiation	59
3-7	Emission and absorption of radiation	60
3-8	Black-body radiation	61
3-9	Wien and Rayleigh-Jeans' laws	65
3-10	Planck's law; emission quantized	70
3-11	Photoelectric effect	74
3-12	Summary of the atomic view of radiation	78
3-13	The electron volt; photon energies	78
3-14	Thermionic emission	81
3-15	The specific heat of solids	81
 Chapter 4 The Atomic Models of Rutherford and Bohr		
4-1	Introduction	87
4-2	Probing the atom with alpha particles	87
4-3	Rutherford's nuclear atom	90
4-4	Size of the nucleus	94
4-5	Spectra	95
4-6	The hydrogen spectrum	97
4-7	The Bohr model and theory of the atom	99
4-8	Hydrogen energy levels	104
4-9	Ionization potentials	106
4-10	Resonance potentials	108
4-11	Photon absorption	111
4-12	A criticism of Bohr's theory	113
 Chapter 5 Waves and Particles		
5-1	Wave-particle duality of light; Compton scattering	118
5-2	The deBroglie hypothesis	123
5-3	Bohr's first postulate	124
5-4	Matter refraction	125
5-5	The Davisson and Germer experiment	128
5-6	Wave groups	130
5-7	Fourier analysis; orthogonality	136
5-8	Wave-particle duality	141
5-9	The Heisenberg uncertainty principle	143
5-10	The double-slit experiment	145
5-11	Summary	147
 Chapter 6 Wave Mechanics		
6-1	Introduction	151
6-2	The meaning of Ψ	152
6-3	Deductions from the first postulate	154
6-4	Relationship between Ψ and Φ ; operators	155
6-5	The use of operators	157
6-6	Schrödinger's equation	159

6-7	The one-dimensional square well of infinite depth	161
6-8	The one-dimension square well of finite depth	167
6-9	Eigenfunctions and eigenvalues	172
6-10	Momentum eigenfunctions; flux	173
6-11	Barrier penetration	176
6-12	The harmonic oscillator	181
6-13	Parity	184

Chapter 7 Wave Mechanics of the Hydrogen Atom

7-1	The two-body problem in wave mechanics	190
7-2	Schrödinger's equation in spherical coordinates	192
7-3	Orbital angular momentum	197
7-4	The hydrogen problem	200
7-5	Magnetic moments of atoms	203
7-6	Experimental test of spatial quantization	206
7-7	Intrinsic spin of the electron	207
7-8	Total angular momentum J	211
7-9	Fine structure of atomic hydrogen	213
7-10	Further refinements of the theory of hydrogen	216
7-11	Hyperfine structure of hydrogen	219

Chapter 8 Some Methods in Wave Mechanics

8-1	Expansions and orthogonality of wave functions	225
8-2	Time-independent perturbation theory	227
8-3	Examples of perturbation calculations	230
8-4	Matrix diagonalization	233
8-5	Time-dependent perturbation theory	236
8-6	Absorption of radiation	240
8-7	Spontaneous emission	243

Chapter 9 Many-Electron Atoms

9-1	The helium problem	246
9-2	Pauli's exclusion principle; symmetry	249
9-3	The helium atom revisited	251
9-4	Many-electron atoms	256
9-5	The periodic table	257
9-6	L - S coupling	260
9-7	Atomic spectroscopy	263
9-8	The Zeeman effect	265
9-9	Hyperfine structure	268
9-10	Nonresonant absorption	272

Chapter 10 X-Rays and Crystallography

10-1	Discovery	276
10-2	Production of X-rays	277

10-3	The nature of X-rays; X-ray diffraction in crystals	278
10-4	Mechanism of X-ray production	283
10-5	The characteristic X-radiation	285
10-6	X-ray spectra of the elements; atomic number	287
10-7	X-ray absorption	289
10-8	Pair production	293
10-9	Diffraction with ruled gratings	297
10-10	Radiation units	298
10-11	X-ray crystallography	300
10-12	Miller indices	306
 Chapter 11 Molecules, Liquids, and Solids		
11-1	Molecules, polar and homopolar bonds	312
11-2	The H ₂ problem	313
11-3	Molecular spectroscopy	319
11-4	Solids and liquids	323
11-5	Classical theory of electron gas in solids	326
11-6	Wave mechanical theory of electron gas in solids	328
11-7	Energy bands in solids	332
11-8	Impurity semiconductors	337
11-9	Semiconductor diodes	338
11-10	Semiconductor radiation detectors	341
11-11	Transistors	343
11-12	Other properties of solids	346
11-13	Masers and lasers	347
 Chapter 12 The Atomic Nucleus		
12-1	General properties of nuclei	354
12-2	The deuteron	360
12-3	Nucleon-nucleon scattering	365
12-4	Nuclear forces	367
12-5	The nuclear shell model	372
12-6	Radioactivity	377
12-7	The radioactive decay law	382
12-8	Gamma transitions	384
12-9	Alpha decay	387
12-10	Beta decay	390
12-11	Parity violation in beta decay	395
12-12	Nuclear reactions	399
12-13	Fission	402
12-14	Fusion; thermonuclear energy	407
12-15	Elementary particles	410
 Appendix 1 The MKSA System of Units		
Appendix 2 The Periodic Table of Elements		425
		427

Appendix 3	Relativity	433
A3-1	The search for a frame of reference—the ether	433
A3-2	The Michelson interferometer	435
A3-3	The Michelson–Morley experiment	438
A3-4	The constant speed of light	439
A3-5	Classical relativity	440
A3-6	The Einstein–Lorentz transformation equations	444
A3-7	Length contraction	448
A3-8	Time dilation and causal sequence	449
A3-9	The relativistic velocity transformation	452
A3-10	Relativistic mass transformation	454
A3-11	Relativistic mass-energy equivalence	456
A3-12	The upper limit of velocity	460
A3-13	Motion of charged particles in magnetic fields	461
Appendix 4	Matrix Algebra	463
Appendix 5	Addition of Angular Momenta	465
Appendix 6	Relativistic Spin-Orbit Effect	468
	Answers to Selected Odd-numbered Problems	473
	Name Index	478
	Subject Index	481