

CONTENTS

CHAPTER I

KINETIC THEORY OF GASES

1. Atomic Theory in Chemistry	1
2. Fundamental Assumptions of the Kinetic Theory of Gases	3
3. Calculation of the Pressure of a Gas	5
4. Temperature of a Gas	6
5. Specific Heat	8
6. Law of Distribution of Energy and Velocity	9
7. Free Path	17
8. Determination of Avogadro's Number	19

CHAPTER II

ELEMENTARY PARTICLES

1. Conduction of Electricity in Rarefied Gases	24
2. Canal Rays and Anode Rays (Positive Rays)	28
3. X-rays	29
4. Radiations from Radioactive Substances	30
5. Prout's Hypothesis, Isotopy, the Proton	38
6. The Neutron	44
7. Cosmic Rays. Positrons	45
8. Mesons and Nuclear Forces	49

CHAPTER III

THE NUCLEAR ATOM

1. Lorentz's Electron Theory	55
2. The Theorem of the Inertia of Energy	57
3. Investigation of Atomic Structure by Scattering Experiments	60
4. Mass Defect and Nuclear Binding Energy. The Neutrino	64
5. Heavy Hydrogen and Heavy Water	68
6. Nuclear Reactions and Radioactive Decay	70

CHAPTER IV

WAVE-CORPUSCLES

1. Wave Theory of Light. Interference and Diffraction	78
2. Light Quanta	81

3. Quantum Theory of the Atom	84
4. Compton Effect	87
5. Wave Nature of Matter. De Broglie's Theory	89
6. Experimental Demonstration of Matter Waves	92
7. The Contradiction between the Wave Theory and the Corpuscular Theory, and its Removal	94

CHAPTER V

ATOMIC STRUCTURE AND SPECTRAL LINES

1. The Bohr Atom; Stationary Orbits for Simply Periodic Motions	103
2. Quantum Conditions for Simply and Multiply Periodic Motions	113
3. Matrix Mechanics	128
4. Wave Mechanics	131
5. Angular Momentum in Wave Mechanics	141
6. Parity	144
7. The Statistical Interpretation of Wave Mechanics	145
8. Emission and Absorption of Radiation	148

CHAPTER VI

SPIN OF THE ELECTRON AND PAULI'S PRINCIPLE

1. Alkali Doublets and the Spinning Electron	153
2. The Anomalous Zeeman Effect	157
3. The Hydrogen Atom and X-ray Terms	165
4. The Helium Atom	171
5. Pauli's Exclusion Principle	177
6. The Periodic System. Closed Shells	179
7. Magnetism	184
8. Wave Theory of the Spin Electron	187
9. Density of the Electronic Cloud	196

CHAPTER VII

QUANTUM STATISTICS

1. Heat Radiation and Planck's Law	204
2. Specific Heat of Solids and of Polyatomic Gases	213
3. Quantisation of Black Body Radiation	221
4. Bose-Einstein Statistics of Light Quanta	223
5. Einstein's Theory of Gas Degeneration	230
6. Fermi-Dirac Statistics	234
7. Electron Theory of Metals. Energy Distribution	237
8. Thermionic and Photoelectric Effect in Metals	240
9. Magnetism of the Electron Gas	243
10. Electrical and Thermal Conductivity. Thermoelectricity	244

CHAPTER VIII

MOLECULAR STRUCTURE

1. Molecular Properties as an Expression of the Distribution of Charge in the Electronic Cloud	246
2. Experimental Determination of the Molecular Constants	248
3. Band Spectra and the Raman Effect	256
4. Chemical Binding. Classification of Types of Binding	266
5. Theory of Heteropolar Ionic Binding	268
6. Theory of Co-valency Binding	271
7. Theory of van der Waals Forces and other Types of Binding	275

CHAPTER IX

QUANTUM THEORY OF SOLIDS

1. Introduction	278
2. Modes of Lattice Vibration	280
3. Quantisation of the Lattice Vibrations	282
4. Inelastic Scattering of Neutrons	285
5. The Mössbauer Effect	286
6. Electrons in a Periodic Lattice Band	288
7. Metals and Insulators	293
8. Metals	294
9. Superconductivity	297
10. Ferromagnetism	298
11. Insulators and Semiconductors	300

CHAPTER X

NUCLEAR PHYSICS

1. The Size of the Nucleus and α -Decay	307
2. Angular Momentum and Magnetic Moment	311
3. The Deuteron and Nuclear Forces	317
4. Nuclear Structure and Nuclear Saturation	323
5. The Nuclear Shell Model	325
6. The Nuclear Collective Model	333
7. β -Decay and K-Capture	334
8. Nuclear Electromagnetic Interactions	343
9. The Drop Model, Nuclear Reactions and Fission	347
Conclusion by M. Born	356

APPENDICES

I. Evaluation of Some Integrals Connected with the Kinetic Theory of Gases	359
II. Heat Conduction, Viscosity, and Diffusion	361
III. Van der Waals' Equation of State	365
IV. The Mean Square Deviation	367

V. Theory of Relativity	370
VI. Electron Theory	373
VII. The Theorem of the Inertia of Energy	375
VIII. Calculation of the Coefficient of Scattering for Radiation by a Free Particle	376
IX. Rutherford's Scattering Formula for α -rays	377
X. The Compton Effect	380
XI. Phase Velocity and Group Velocity	382
XII. Elementary Derivation of Heisenberg's Uncertainty Relation	383
XIII. Hamiltonian Theory and Action Variables	384
XIV. Quantisation of the Elliptic Orbits in Bohr's Theory	387
XV. The Oscillator according to Matrix Mechanics	392
XVI. The Oscillator according to Wave Mechanics	396
XVII. The Vibrations of a Circular Membrane	398
XVIII. Solution of Schrödinger's Equation for the Kepler (Central Force) Problem	399
XIX. The Orbital Angular Momentum	404
XX. Deduction of Rutherford's Scattering Formula by Wave Mechanics	406
XXI. Deduction of the Selection Rules for Electric Dipole Radiation	409
XXII. Anomalous Zeeman Effect of the D Lines of Sodium	414
XXIII. Enumeration of the Terms in the Case of Two p -Electrons	416
XXIV. Atomic Form Factor	419
XXV. The Formalism of Quantum Mechanics	426
XXVI. General Proof of the Uncertainty Relation	433
XXVII. Transition Probabilities	435
XXVIII. Quantum Theory of Emission of Radiation	439
XXIX. The Electrostatic Energy of Nuclei	444
XXX. Theory of α -Disintegration	444
XXXI. The Ground State of the Deuteron	447
XXXII. Meson Theory	448
XXXIII. The Stefan-Boltzmann Law and Wien's Displacement Law	451
XXXIV. Absorption by an Oscillator	455
XXXV. Temperature and Entropy in Quantum Statistics	459
XXXVI. Thermionic Emission of Electrons	460
XXXVII. Temperature Variation of Paramagnetism	462
XXXVIII. Theory of Co-valency Binding	466
XXXIX. Time-independent Perturbation Theory for Non-degenerate States	469
XL. Theory of the van der Waals Forces	471
XLI. The Modes of Vibration of a Linear Monatomic Chain	474
Bibliography	477
Index	483