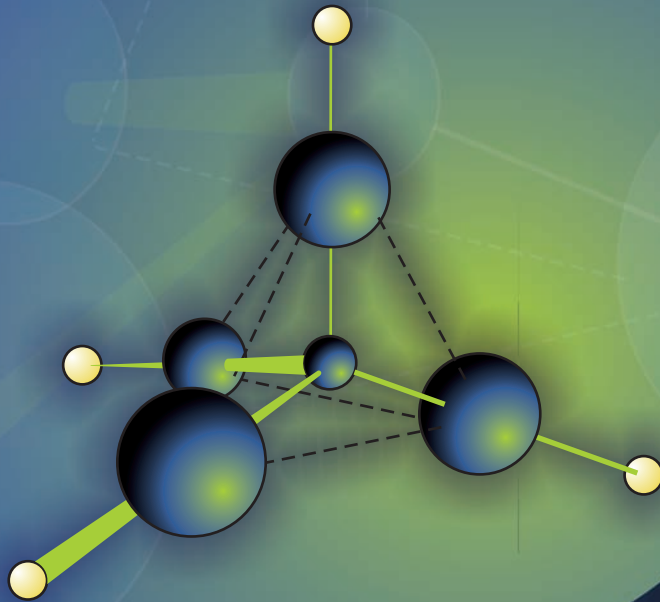


Eastern
Economy
Edition

Second Edition

Quantum Mechanics



G. Aruldas

QUANTUM MECHANICS

SECOND EDITION

G. ARULDHAS

*Formerly, Professor and Head of Physics
and Dean, Faculty of Science
University of Kerala*

PHI Learning Private Limited

New Delhi-110001

2009

QUANTUM MECHANICS, 2nd Ed.

G. Aruldas

© 2009 by PHI Learning Private Limited, New Delhi. All rights reserved. No part of this book may be reproduced in any form, by mimeograph or any other means, without permission in writing from the publisher.

ISBN-978-81-203-3635-3

The export rights of this book are vested solely with the publisher.

Eighth Printing (Second Edition) November, 2008

Published by Asoke K. Ghosh, PHI Learning Private Limited, M-97, Connaught Circus, New Delhi-110001 and Printed by Rajkamal Electric Press, B-35/9, G.T. Karnal Road Industrial Area, Delhi-110033.

To
My Parents
Gnanasigamoni & Rajammal
*who taught me the merits of discipline
and the rewards of education*

Contents

<i>Preface</i>	<i>xiii</i>	
<i>Preface to the First Edition</i>	<i>xv</i>	
1	Origin of the Quantum Theory	1–24
1.1	Limitations of Classical Physics	1
1.2	Planck's Quantum Hypothesis	4
1.3	Einstein's Theory of Photoelectric Effect	5
1.4	Compton Effect	6
1.5	Quantum Theory of Specific Heat	7
1.6	Bohr Model of Hydrogen Atom	7
1.7	Existence of Stationary States	10
1.8	Wilson–Sommerfeld Quantization Rule	11
1.9	Elliptic Orbits of Hydrogen Atom	12
1.10	The Harmonic Oscillator	14
1.11	The Rigid Rotator	15
1.12	Particle in a Box	16
1.13	The Correspondence Principle	17
1.14	The Stern-Gerlach Experiment	17
1.15	Inadequacy of Quantum Theory	18
	<i>Worked Examples</i>	19
	<i>Review Questions</i>	22
	<i>Problems</i>	23
2	Wave Mechanical Concepts	25–57
2.1	Wave Nature of Particles	25
2.2	The Uncertainty Principle	27

2.3	The Principle of Superposition	32
2.4	Wave Packet	32
2.5	Time-Dependent Schrödinger Equation	34
2.6	Interpretation of the Wave Function	37
2.7	Ehrenfest's Theorem	40
2.8	Time-Independent Schrödinger Equation	42
2.9	Stationary States	43
2.10	Admissibility Conditions on the Wave Function	45
	<i>Worked Examples</i>	45
	<i>Review Questions</i>	54
	<i>Problems</i>	55

3 General Formalism of Quantum Mechanics 58–98

3.1	Linear Vector Space	58
3.2	Linear Operator	62
3.3	Eigenfunctions and Eigenvalues	64
3.4	Hermitian Operator	64
3.5	Postulates of Quantum Mechanics	66
3.6	Simultaneous Measurability of Observables	71
3.7	General Uncertainty Relation	72
3.8	Dirac's Notation	74
3.9	Equations of Motion	75
3.10	Momentum Representation	79
	<i>Worked Examples</i>	83
	<i>Review Questions</i>	95
	<i>Problems</i>	96

4 One-Dimensional Energy Eigenvalue Problems 99–140

4.1	Square-Well Potential with Rigid Walls	99
4.2	Square-Well Potential with Finite Walls	102
4.3	Square Potential Barrier	105
4.4	Alpha Emission	109
4.5	Bloch Waves in a Periodic Potential	110
4.6	Kronig-Penney Square-Well Periodic Potential	111
4.7	Linear Harmonic Oscillator: Schrödinger Method	114
4.8	Linear Harmonic Oscillator: Operator Method	119
4.9	The Free Particle	123
	<i>Worked Examples</i>	124
	<i>Review Questions</i>	138
	<i>Problems</i>	139

5	Three-Dimensional Energy Eigenvalue Problems	141–176
5.1	Particle Moving in a Spherically Symmetric Potential	141
5.2	System of Two Interacting Particles	147
5.3	Rigid Rotator	149
5.4	Hydrogen Atom	150
5.5	Hydrogenic Orbitals	156
5.6	The Free Particle	158
5.7	Three-Dimensional Square-Well Potential	160
5.8	The Deuteron	162
	<i>Worked Examples</i>	163
	<i>Review Questions</i>	174
	<i>Problems</i>	175
6	Heisenberg Method	177–192
6.1	The Heisenberg Method	177
6.2	Matrix Representation of Wave Function	178
6.3	Matrix Representation of Operator	178
6.4	Properties of Matrix Elements	179
6.5	Schrödinger Equation in Matrix Form	180
6.6	Eigenvalue Problems	180
6.7	Unitary Transformations	182
6.8	Linear Harmonic Oscillator: Matrix Method	185
	<i>Worked Examples</i>	189
	<i>Review Questions</i>	191
	<i>Problems</i>	191
7	Symmetry and Conservation Laws	193–205
7.1	Symmetry Transformations	193
7.2	Translation in Space: Conservation of Linear Momentum	194
7.3	Translation in Time: Conservation of Energy	197
7.4	Rotation in Space: Conservation of Angular Momentum	198
7.5	Space Inversion: Parity Conservation	200
7.6	Time Reversal	201
	<i>Worked Examples</i>	203
	<i>Review Questions</i>	205
	<i>Problems</i>	205

8	Angular Momentum	206–236
8.1	The Angular Momentum Operators	206
8.2	Angular Momentum Commutation Relations	207
8.3	Eigenvalues and Eigenfunctions of L^2 and L_z	209
8.4	General Angular Momentum	209
8.5	Eigenvalues of J^2 and J_z	210
8.6	Angular Momentum Matrices	213
8.7	Spin Angular Momentum	216
8.8	Spin Vectors for Spin-(1/2) System	217
8.9	Addition of Angular Momenta	218
	<i>Worked Examples</i>	224
	<i>Review Questions</i>	234
	<i>Problems</i>	235
9	Time-Independent Perturbation Theory	237–263
9.1	Basic Concepts	237
9.2	Nondegenerate Energy Levels	238
9.3	Anharmonic Oscillator: First-order Correction	241
9.4	The Ground State of Helium	242
9.5	Effect of Electric Field on the Ground State of Hydrogen	244
9.6	Degenerate Energy Levels	247
9.7	Effect of Electric Field on the $n = 2$ State of Hydrogen	248
9.8	Spin-Orbit Interaction	250
	<i>Worked Examples</i>	252
	<i>Review Questions</i>	261
	<i>Problems</i>	262
10	The Variation Method	264–279
10.1	The Variational Principle	264
10.2	Rayleigh–Ritz Method	265
10.3	Variation Method for Excited States	266
10.4	The Hellmann–Feynman Theorem	267
10.5	The Ground State of Helium	268
10.6	The Ground State of the Deuteron	270
	<i>Worked Examples</i>	272
	<i>Review Questions</i>	278
	<i>Problems</i>	279

11	WKB Approximation	280–293
11.1	The WKB Method	280
11.2	The Connection Formulas	282
11.3	Validity of WKB Method	284
11.4	Barrier Penetration	284
11.5	Alpha Emission	287
11.6	Bound States in a Potential Well	288
	<i>Worked Examples</i>	290
	<i>Review Questions</i>	292
	<i>Problems</i>	293
12	Time-Dependent Perturbation Theory	294–319
12.1	Introduction	294
12.2	First-Order Perturbation	296
12.3	Harmonic Perturbation	297
12.4	Transitions to Continuum States	298
12.5	Absorption and Emission of Radiation	299
12.6	Einstein's <i>A</i> and <i>B</i> Coefficients	304
12.7	Selection Rules	306
12.8	Rayleigh Scattering	308
12.9	Raman Scattering	310
	<i>Worked Examples</i>	313
	<i>Review Questions</i>	318
	<i>Problems</i>	319
13	Many Electron Atoms	320–347
13.1	Indistinguishable Particles	320
13.2	Pauli Principle	323
13.3	Inclusion of Spin	324
13.4	Spin Functions for Two-Electrons	326
13.5	Spin Functions for Three-Electrons	326
13.6	The Helium Atom	327
13.7	Central Field Approximation	330
13.8	Thomas–Fermi Model of the Atom	330
13.9	Hartree Equation	332
13.10	Hartree–Fock Equation	335
	<i>Worked Examples</i>	337
	<i>Review Questions</i>	346
	<i>Problems</i>	346

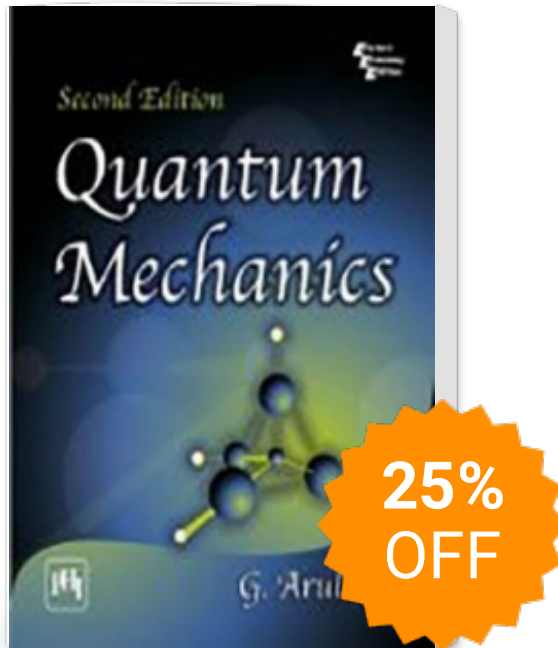
14 Scattering 348–378

14.1	Scattering Cross-Section	349
14.2	Scattering Amplitude	350
14.3	Partial Waves	351
14.4	Scattering by a Central Potential: Partial Wave Analysis	352
14.5	Significant Number of Partial Waves	356
14.6	Scattering by an Attractive Square-well Potential	357
14.7	Breit-Wigner Formula	358
14.8	Scattering Length	360
14.9	Expression for Phase Shifts	361
14.10	Integral Equation	362
14.11	The Born Approximation	364
14.12	Scattering by Screened Coulomb Potential	365
14.13	Validity of Born Approximation	366
14.14	Laboratory and Centre of Mass Coordinate Systems	367
	<i>Worked Examples</i>	370
	<i>Review Questions</i>	376
	<i>Problems</i>	376

15 Relativistic Wave Equations 379–409

15.1	Klein–Gordon Equation	379
15.2	Interpretation of the Klein–Gordon Equation	380
15.3	Particle in a Coulomb Field	382
15.4	Dirac’s Equation for a Free Particle	384
15.5	Dirac Matrices	385
15.6	Covariant Form of Dirac Equation	387
15.7	Probability Density	388
15.8	Plane Wave Solution	389
15.9	Negative Energy States	391
15.10	Spin of the Dirac Particle	392
15.11	Magnetic Moment of the Electron	394
15.12	Spin–Orbit Interaction	396
15.13	Radial Equation for an Electron in a Central Potential	398
15.14	The Hydrogen Atom	401
15.15	Lamb Shift	404
	<i>Worked Examples</i>	404
	<i>Review Questions</i>	408
	<i>Problems</i>	409

Quantum Mechanics



Publisher : **PHI Learning**

ISBN : **9788120336353**

Author : **ARULDHAS, G.**

Type the URL : <http://www.kopykitab.com/product/7361>



Get this eBook