

# Contents

CONTRIBUTORS TO THIS VOLUME . . . . .	v
PREFACE . . . . .	vii
CONTENTS OF VOLUMES 10-II AND 10-III . . . . .	xiii
TABLE OF ATOMIC UNITS . . . . .	xv
1. Preliminaries . . . . .	1
H. Margenau	
1. Historical Survey . . . . .	2
2. Differential Operators . . . . .	7
3. Matrices . . . . .	15
4. Equivalence of Differential Operators and Matrices . . . . .	27
References . . . . .	30
2. Fundamental Principles of Quantum Mechanics . . . . .	31
H. Margenau	
1. General Definitions . . . . .	32
2. Axiomatic Basis . . . . .	33
3. Consequences of First Three Postulates . . . . .	42
4. The Properties of Angular Momentum Derived by Matrix Methods . . . . .	49
5. Time-Dependent States . . . . .	60
References . . . . .	75
Appendix 1. The Dirac $\delta$ -Function . . . . .	75
1. Closure of a Complete Orthonormal Set . . . . .	76
2. Transformation Theory . . . . .	78
Appendix 2. Eigenstates and Eigenvalues of the Electron Spin . . . . .	79
3. Exactly Soluble Bound State Problems . . . . .	81
R. A. Buckingham	
1. Rectangular Potential Wells . . . . .	82
2. Harmonic Oscillators . . . . .	89
3. System of Two Particles . . . . .	95
4. Spherically Symmetrical Potentials . . . . .	104
5. The Coulomb Potential . . . . .	114
6. Two-Centre Coulomb Potentials . . . . .	127
7. Momentum Wave Functions . . . . .	132

References . . . . .	136
Appendix 1. Hermite Polynomials . . . . .	137
Appendix 2. Legendre Polynomials and Spherical Harmonics . . . . .	138
Associated Legendre Polynomials . . . . .	139
Appendix 3. Laguerre Polynomials . . . . .	141
Associated Laguerre Polynomials . . . . .	142
Appendix 4. Spherical Bessel Functions . . . . .	143
<b>4. The Continuum . . . . .</b>	<b>147</b>
<b>R. A. Buckingham</b>	
1. Free Particle. Energy Wave Functions . . . . .	147
2. Delta Function Normalization . . . . .	154
3. Spherically Symmetric Potentials . . . . .	162
References . . . . .	167
Appendix. Coulomb Wave Functions . . . . .	167
<b>5. Stationary Perturbation Theory . . . . .</b>	<b>171</b>
<b>A. Dalgarno</b>	
1. The Rayleigh-Schrödinger Perturbation Theory . . . . .	172
2. The Nondegenerate Case . . . . .	173
3. The Degenerate Case . . . . .	194
4. Perturbation Theory in Matrix Form . . . . .	199
5. Reduction of the Degenerate Case to the Nondegenerate . . . . .	201
6. Relative Degeneracy . . . . .	202
7. The Lennard-Jones-Brillouin-Wigner Series Expansion . . . . .	204
References . . . . .	208
<b>6. The Variational Method . . . . .</b>	<b>211</b>
<b>B. L. Moiseiwitsch</b>	
1. The Rayleigh-Ritz Variational Method . . . . .	211
2. Lower Bounds for the Ground State Eigenenergy . . . . .	214
3. Method of Linear Combinations . . . . .	215
4. Two-Electron Systems . . . . .	220
5. The Virial Theorem . . . . .	227
References . . . . .	228
<b>7. The Asymptotic Approximation (AA) Method . . . . .</b>	<b>229</b>
<b>Bertha Swirles Jeffreys</b>	
1. History and Description of the Method . . . . .	229
2. Applications of the Method to Potential Well Problems . . . . .	236
3. Application of the Method to Potential Barrier Problems . . . . .	238
4. Radial Problems . . . . .	245
References . . . . .	248

## CONTENTS

xi

<b>8. Transitions . . . . .</b>	<b>251</b>
D. R. Bates	
1. Variation of Constants . . . . .	252
2. Transient Perturbations . . . . .	253
3. Persistent Perturbations . . . . .	261
4. Sudden Approximation . . . . .	262
5. Time-Independent and Harmonic Perturbations . . . . .	264
6. Adiabatic Approximation . . . . .	287
References . . . . .	297
<b>9. Theory of Collisions . . . . .</b>	<b>299</b>
E. H. S. Burhop	
1. Classical Considerations . . . . .	300
2. Quantum Theory of Scattering by a Centre of Force . . . . .	305
3. Applications of Preceding Theory . . . . .	313
4. Methods of Determining Scattering Phases . . . . .	321
5. Non-Coulomb Field . . . . .	329
6. Coulomb Field . . . . .	335
7. Scattering of Identical Particles . . . . .	339
8. Use of Variation Methods in the Solution of Scattering Problems . . . . .	342
9. Scattering by a Spin Dependent Interaction . . . . .	352
10. General Collision Theory . . . . .	359
11. Inelastic Collisions . . . . .	377
12. Application of Quantum Collision Theory to the Scattering of Electrons by Atoms . . . . .	392
13. Application of Quantum Collision Theory to Problems of Nuclear Physics .	401
References . . . . .	435
AUTHOR INDEX . . . . .	437
SUBJECT INDEX . . . . .	440