

Contents

1. Application Areas

Introduction	1
Radiation Cascades	2
Gas Dynamics	7
Gas Lasers	10
Plasmas	14
Studies of Interaction Potentials and Surfaces	16
Summary	17
Suggested Reading	17

2. Cross Sections and Rate Constants

Introduction	19
Total Cross Sections	19
Inelastic Cross Sections	23
Rate Constants	25
Cross Section Calculations	28
Angular Differential Cross Sections	33
Calculation of Angular Differential Cross Sections	35
Collision Kinematics: Elastic Collisions	38
Center of Mass System	41
Kinematics of Inelastic Collisions	44
The Classical Deflection Function	47
Classical Inelastic Cross Sections	57
Exercises	61
Suggested Reading	62

3. Waves and Trajectories

Introduction	65
The Wave Equation	67
Solutions to the Wave Equation	69
Scattering of a Plane Wave	75

Scattering Amplitude for Potential Scattering	77
The Semiclassical Approximation	83
The Born Approximation	89
Charge Distributions	93
Vibrational and Rotational Levels of Molecules.	98
Exercises	100
Suggested Reading	101

4. Interaction Potentials and Transition Probabilities

Introduction	103
Electrostatic Interaction between Atomic Charge Distributions.	107
Induced Moments: The Polarizability and the van der Waals Forces	112
Wave-Mechanical Treatment of the Interactions	116
State Identification and Molecular Symmetries	122
The Exchange Interaction.	125
Transition Probabilities: The Impact Parameter Method	131
Rearrangement Collisions: Charge Exchange	143
Semiclassical Approximation for Inelastic Differential Cross Sections	145
Transitions in the Born Approximation.	149
Detailed Balance	154
Exercises	154
Suggested Reading	156

5. Cross Sections and Rate Constants: Results

Introduction	159
Total Differential Cross Sections and Interaction Potentials.	159
Integrated Total Cross Sections and the Diffusion Cross Section	166
Charge Exchange.	174
Inelastic Energy-Loss Cross Sections	189
Molecular Processes	199
Exercises	212
Suggested Reading	213

6. Application of Results

Introduction	217
Energetic Particle Transport	218
The Continuous Slowing-Down Approximation	219
Integral Equations for Range and Projected Range.	222
Stopped-Particle Distribution	225
Diffusion of Implanted Particles, Backscattering, and Transmission	228
Energy Deposition Effects	230
Biological Damage.	233
Sputtering	239
Planetary Escape.	243
The Ionosphere.	248
Final Summary.	255
Exercises	256
Suggested Reading	257

Appendixes

A. Delta Functions	259
B. CM Deflection Function and Semiclassical Phase Shift	260
C. Collision with an Oscillator.	262
D. Born-Approximation Cross Section and Transition Probabilities.	264
E. Transport Equations.	265
F. The Stationary-Phase Approximation.	267
G. Atomic State Labels	268
H. Thomas-Fermi Interaction: Results	269
I. Low Energy, Inelastic Cross Sections	270
J. Constants and Units	273
<i>Subject Index.</i>	277
<i>Author Reference Index</i>	283
<i>Interactions, Reactions, and Collisions: References and Results</i>	287