

Subject Index

- Action, classical, 57, 68, 136, 183, 185
Adiabatic expansion, 142
Adiabatic cut-off (screening), 61, 191, 196, 263
Adiabatic interaction, 104, 112, 118, 133
See also: Interaction potentials
Angular momentum and action, 183
 center of mass, 42
 collisional (impact parameter), 31, 70
 collisional (wave mechanics), 69, 70, 79
 molecular, 99
 orbital, 269
Arrhenius, reaction rate, 208, 212
 and diffusion, 229
Atmosphere, equilibrium, scale height, 9
See also: Ionosphere
Atomic units, 273
Attachment, 211, 252
Autoionizing state, 183, 210
- Backscattering, 16, 227, 228
Bessel functions
 modified, 136, 260, 262, 265
 spherical, 69, 70, 100
Bethe-Born approximation, 191
Binary encounter approximation, 38, 56, 58, 151, 190, 204, 213, 237, 264
Biological damage, 4, 233
Bohr
 adiabatic cut-off; *see*: Screening
 radius, 96, 273
 straggling cross section, 121
- Born approximation, 89, 163, 168, 213, 229, 256
 inelastic, 149, 265
See also: Impulse approximation
Born-Mayer potential, 162
See also: Interaction potentials, exponential
Born-Oppenheimer separation, 104, 116, 122, 200
Bragg Curves, energy-loss, 230, 231, 241
- Center of mass
 system, 41
 transformations, 42, 45
Chapman-Enskog diffusion, 172
Chapman profile, 249
Charge distribution, 93
 classical, 94
 and interaction potential, 107
 quantum mechanical, 95
Charge exchange, 15, 24, 125, 141, 143, 147, 174, 248, 255
 double (two electrons), 186
 ‘harpooning’, 205
 mutual neutralization, 252
Charge state fraction, 194
 effective charge, 195
Collision complex, 204, 208
Collision frequency, 8, 23, 171, 240
 electron-ion, 211, 213
 ion-neutral, 254
 momentum transfer, 9, 171

- Collision time, 32, 106
 Constants, 273, 274
 Correlation diagrams, 121, 123, 124
 Coulomb interaction, 51, 94, 150, 155, 191, 241, 262
See also: Rutherford cross section
 Covalent bond; *see*: Exchange interaction
 Cross section
 absorbing sphere, 272
 damage, 25, 236, 237
 definitions, 7, 19, 28
 elastic, 22, 30, 81, 92, 166
 See also: Differential cross section
 hard sphere, 39, 40, 224, 244
 hit, 234, 237
 inelastic, 23, 47, 57, 270
 Langevin, 206, 210
 measurements, 20, 33, 46, 75, Chapter 5
 power law, 52, 53, 92, 163, 166, 172, 224
 size estimates, 21, 32, 33
 total, 19, 82, 166
 total differential, 159
See also: Binary encounter
 approximation; Born approximation;
 Charge exchange; Ionization;
 Rutherford; etc.
 Curve crossing, 120, 138, 176, 181, 188
See also: Landau-Zener-Stueckleberg
- Damage cross section, 25, 236, 237
 Damage density, 234
 Deflection function, 36
 calculation in CM, 47, 62, 260
 impulse approximation, 50, 260
 Lindhard's 'magic' formula, 51
 plots, 53
 semiclassical, 85
 Delta function, 37, 71, 94, 259
 Delta rays, 234, 238
 Demkov model, 141, 147, 177, 271
 Density of states, 209
 Differential cross section
 angular
 and average interaction potential, 159
 classical, 33, 43, 267
 experimental, 159, 186
 inelastic, 145, 186
 ρ vs τ , 52, 160, 189
 semiclassical, 86, 145
 wave mechanics, 75, 92
 Differential cross section angular (*cont.*)
 See also: Scattering amplitude
 double differential, 46, 47, 151, 181, 182
 energy transfer, 40, 43, 47, 53, 93, 151, 190, 224, 226
 total differential, 159
 Diffraction: small angle scattering, 81, 92, 160, 163, 168
 Diffusion
 ambipolar, 254
 in atmosphere, 252
 constant, 8, 9, 15, 171
 cross section, 171, 198, 240, 244
 in solids, 228, 229
 thermal, 242
 Dipole excitation, 151, 191, 204
 of classical oscillator, 262
 Dipole moment, 110, 114
 induced, 113, 115
 See also: Polarizability
 long range interaction, 111
 Displacement damage, 230
 Dissociation, molecular, 59, 60, 199
 See also: Recombination
 Distortion approximation, 137, 138
 Dose, 4, 234
- Electron gas, 197, 269
 Electronic binding energy
 diatomic molecule, 117
 hydrogenic, 96
 Electron promotion, 125
 Energy loss
 cross section; *see*: Differential cross section
 elastic-nuclear, 28, 39, 43, 45
 energy deposition, 230, 235
 inelastic, 44, 135, 190
 See also: Transition probability spectra, 48, 182
 and uncertainty principle, 107, 136
 See also: Stopping cross section
 Equations of motion, 38, 39, 48
 Escape, planetary, 243
 See also: Sputtering
 Exchange interaction, 103
 covalent, 125
 electron-electron, 103, 131, 143
- Fermi gas: *see*: Electron gas

- Firsov
 cross section estimation, 271
 screening constant, 109
- Fluence, 234
- Franck-Condon factors, 201, 211
- Gamma functions, 261, 265
- Glory, forward, 169
- Hamiltonian, 68, 117
See also: Wave equation
- Harmonic oscillator
 interaction with, 262
 potential, 97, 99, 204
See also: Oscillator strength
- Heitler-London interaction, 129
- Hit cross section, 234, 237
See also: Damage cross section
- Impact parameter
 and angular momentum, 31, 70, 71, 79
 cross section, 30, 35, 82, 136, 173, 237
 definition, 29
 and phase shift, 183, 260
 probability; *see*: Transition probability
 in wave mechanics, 70, 80, 82, 131
See also: Deflection function
- Implantation, ion, 225
- Impulse approximation
 deflection function, 50, 260
 phase shift, 89, 136, 166, 185, 260
See also: Born approximation;
 Differential cross section; Transition
 probability
- Inelastic effects; *see*: Cross section;
 Stopping power; Transition
 probability
- Interaction potentials
 adiabatic, definition, 104, 116
 with a barrier, 55, 73, 79
 electrostatic, 105, 107, 118
 examples, 13, 16, 17, 55, 73, 79, 120,
 126, 128, 130, 133, 139, 149
 exponential, 162, 176, 264, 265, 272
 hard sphere, 39, 40, 224, 244
 power-law, 51, 92, 154, 220, 224, 233,
 261, 265
 screened coulomb, 92, 109, 150, 161,
 263, 264, 269
- Interaction potentials (*cont.*)
See also: Adiabatic interaction;
 Coulomb interaction; Exchange;
 Harmonic oscillator; Heitler-
 London; Lennard-Jones;
 Polarization; Screened coulomb;
 van der Waals
- Inversion methods, 53, 159
- Ionization, 36, 59, 62, 190
See also: W values
- Ionosphere, 2, 14, 248
- Jean's escape, 245
- Kitchin-Pease approximation, 231, 233
- Kinematics
 elastic collisions, 38
 inelastic collisions, 44
- Landau-Zener-Stueckleberg method, 138,
 147, 176, 181, 188, 271
- Langevin cross section, 206, 210
- Lasers, 10
- Legendre polynomials, 70, 72, 78, 80,
 109, 146
 approximate forms, 83
- Lennard-Jones interaction potential, 54,
 100, 115, 116, 164, 173, 176
See also: van der Waals interaction
- Lenz-Jensen potential, 167, 270
- LET, 237
- Lichten-Fano, 125, 143
See also: Curve crossing
- Lindhard; *see*: Screening constant;
 Electron gas
- Lindhard-Scharff stopping power, 198
- Massey criterion, 136
- Massey-Mohr approximation, 82, 166,
 169
- Maxwell-Boltzmann distribution, 61, 171,
 245
- Mean-free path, 6, 23, 223, 226, 242, 267
 for escape, 240, 241, 244
- Mean ionization potential, 191
- Mobility, 9, 173, 213
- Molecular targets
 deflection by, 38, 56, 101

- Molecular targets (*cont.*)
 dipole moment, 110, 114
 electronic levels, 118, 122
 excitation and dissociation, 199
See also: Dissociation; Recombination
 interaction potential, 110
 large molecule cross section, 237
 polarizability, 114
 rotational energy, 99, 101
 vibrational energy, 98, 101
See also: Binary encounter; Harmonic oscillator; Vibrational excitation
- Momentum distribution; *see*: Velocity distribution
- Momentum transfer; *see*: Collision
 frequency; Differential cross section, double differential; energy transfer
- Multiple scattering, 165, 229
- Optical theorem, 82, 213
- Orbiting collision, 55
- Oscillator strength, 113, 115, 119, 154, 191
 generalized; *see*: Differential cross section, double differential
- Pauli principle, 129
- Perturbation methods
 Born method, 89
 stationary, for molecular binding energies, 118
 time dependent, 134
- Phase shift
 elastic scattering, 79
 impulse approximation, 89, 135, 166, 260
 JWKB (semiclassical), 87, 100
 in LZS approximation, 138
- Plasma, 14
 ambipolar diffusion, 254
 frequency, 61
 screening, 196
See also Electron gas; Ionosphere
- Poisson distribution, 234, 236, 256
- Polarization, 105
 interaction, 112, 119, 255
 polarizability, 113, 119, 154, 173, 206
- Potential; *see*: Interaction potential
- Probability, collisional; *see*: Transition probability
- Quadrupole moment, 110, 111
- Radiation damage
 biological, 2, 233
 materials, general, 3, 230, 239
See also: Transport equations
- Rainbow effect, 53, 62, 88, 100, 164, 169
- Ramsauer-Townsend effect, 168
- Range, 219, 256
 distribution, 225
 projected range, 219, 227, 256
 range straggling, 220
- Rate constants, 25, 211
 Arrhenius, 208
 Langevin, 207, 210
 size estimate, 33, 61
 thermal averaging, 61
 three body, 212
See also: Cross section
- Rate equations, 15, 26, 195, 213, 249, 251
- Reaction cross section, 32, 56, 61, 137
See also: Cross section; Rate constants; Rearrangement collision; Transition probability
- Rearrangement collision, 20, 44, 45, 142, 143, 199
See also: Charge exchange
- Recoil cascade, 233, 240
- Recombination, 15, 210, 241, 246, 247, 250
- Resonance, 73
See also: Charge exchange
- Rosen-Zener approximation, 141, 147, 177, 271
- Rotational energy, molecular, 98, 101, 210
- Rutherford cross section, 59, 62, 92, 151
- Saturation, 237
- Scale height, 9, 254
- Scattering amplitude
 Born approximation, 89, 149
 definition, 75
 potential scattering, 77
 semiclassical, 80, 83, 86, 146
See also: Differential cross section
- Screened coulomb; *see*: Interaction potentials

- Screening lengths (constants), 61, 92, 93,
109, 126, 128, 154, 161, 162, 176
adiabatic, Bohr, 61, 191, 196, 263
plasma, 196
Thomas-Fermi, Lindhard, 61, 104, 109,
166, 270
- Secondary-particle cascades, 230, 239
- Selection rules, 143, 154, 181
- Semiclassical method, 66, 68, 83
inelastic transition, 145
short wavelength, 80
WKB, 74, 86, 100
See also: Differential cross section;
Phase shift; Scattering angle
- Solid angle, 33, 34
- Spherical harmonics, 69
- Spin, 103, 129, 269
spin-orbit interaction, 177
- Sputtering, 15, 239, 247
- Stationary phase approximation, 83, 138,
146, 154, 180, 213, 267
- Statistical model of reactions, 208
- Stopping cross section; *see*: Stopping
power
- Stopping power, 27, 28, 219
electronic, 7, 60, 190, 226, 230, 239,
241, 242, 244
of a harmonic oscillator, 262
nuclear-elastic, 60, 173, 226, 230, 239,
242
- Straggling, 190, 220
See also: Ranges; Multiple scattering
- Surfaces, 16, 17
binding potential, 240
See also: Sputtering
- Thermal
conductivity, 242
diffusion, 242, 256, 257
spike, 241
velocity distribution; *see*: Maxwell-Boltzmann
- Thomas-Fermi model, 167, 269
See also: Electron gas; Screening lengths
- Thomson ionization cross section, 59, 62,
190
- Trajectories
classical, 35, 36, 50, 54, 55, 57
and wave mechanics, 65, 133, 139, 183
- Transition probability
elastic (momentum change), 30, 35, 260
- Transition probability (*cont.*)
inelastic, 31, 131, 146, 174, 200, 204,
265, 270
See also: Born approximation;
Differential cross section; double
differential
- Transmission, beam, 228
- Transport equations (processes)
diffusion, 8, 15, 228, 252
particle radiation,
incident beam flux, 5, 218, 265
range, 222
stopped particle distribution, 225
thermal, 242
See also: Diffusion; Range
- Uncertainty principle, 61, 107, 136, 209
- United atom, 56, 105, 106, 108, 112
- Units, 273, 274
- van der Waals interaction, 8, 115, 154,
163, 168
- Velocity distribution, 97, 101, 151, 195,
196
- Vibrational excitation, 11, 97, 179, 201,
210
- Wave equation, 67
harmonic oscillator, 97
molecular-electronic, 117
one-dimensional, 72
one electron, 95
plane wave, 67
radial, 69
spherical polar coordinates, 69
- Wave function
atomic, 268
diatomic molecule, electronic, 117
extended source, 72
hydrogenic, 96, 268
hydrogen molecular ion, 127
hydrogen molecule, 129
plane wave, 67, 70, 151
point source, 71
and probability, 67, 76, 77
radial, 78
scattered waves, 75
spherical, 69
spin, 130
WKB, 74
- WKB; *see*: Semiclassical methods
- W*-values, 231