



Index

- 4-vector, 564
- acceleration
 - angular, 9
 - centripetal, 28
 - constant, 21
- action, 99, 111
- action at a distance, 213, 215
- active interpretation, 435
- adjoint matrix, 436
- air resistance, 63
- amplitude, 348
- angular momentum, 177, 240, 456
 - conservation, 179
 - of a system of particles, 180
 - relative to center of mass, 184
 - tensor notation, 459
- angular velocity, 9
- angular velocity vector, 185
- antisymmetric matrix, 452
- Archimedes' principle, 516
- areal velocity, 261
- Aries
 - first point in Aries, 241
- attractor, 579
- Atwood's machine, 72
- axial vector, 191
- azimuthal angle, 38
- BAC – CAB rule, 186
- barometric equation, 517
- Bernoulli's equation, 530, 532
- Bernoulli's theorem, 531
- beta decay, 205
- binomial expansion, 269, 325
- body axes, 431
- body force, 497
- boundary conditions, 539
 - for string, 362
- brachistochrone, 109
- Brahe, Tycho, 237
- bulk modulus, 501
- cable, 495
- Calculus of Variations, 95
- canonical conjugates, 103
- catenary, 497
- center of gravity, 503
- center of mass, 140, 503
 - angular momentum relative to, 184
- center of oscillation, 327
- center-of-mass coordinates, 165
- central force, 236, 238
- centroid, 502
- chaos, 575
- charge conjugation, 200, 205
- closed-form solution, 67
- coefficient of restitution, 162
- collision, 154
 - elastic, 155
 - glancing, 159
 - head on, 157
 - inelastic, 161
- comets, 249
- commensurability, 272, 309
- computational physics, 68, 69
- configuration space, 576
- conic section, 249
- conjugate momentum, 92
- conservation
 - of angular momentum, 179, 181
 - of energy, 134
 - of parity, 205
- conservation laws, 200
- conservative force, 124
- constant of the motion, 92, 139, 236
- constraint, 85, 90, 430, 504
 - holonomic, 504
- continuous systems, 395
- convective derivative, 520
- coordinate systems, 19, 29
 - accelerated, 405
 - Cartesian, 32, 35
 - cylindrical, 36
 - inertial, 405
 - plane polar, 32
 - rotating, 406
 - spherical, 38
- coordinate transformation, 125
- Coriolis force, 412
- cosmological constant, 229
- Cotes spiral, 278
- couple, 494
- coupled homogeneous equations, 379
- coupled pendulums, 387
- coupled systems, 371
- CP violation, 205
- CPT invariance, 205
- Cramer's rule, 310, 311, 381, 444
- cross product, 30
- curl, 121
- cylindrical coordinates, 128
- d'Alembert's principle, 504
- damped harmonic oscillator, 291
- damping coefficient, 293
- degeneracy, 463
- degree of freedom, 89
- del, 121
- Descartes, René, 50
- deterministic system, 575
- differential equation
 - homogeneous, 286
 - inhomogeneous, 298

- direction cosines, 432
 divergence, 121
 divergence theorem, 224
 dot product, 30
 drag coefficient, 63
 dyad, 459
 dyadic, 459
 dynamics, 53
 rotational, 430
- Eötvös, Baron, 53
 eccentricity, 256, 257
 effective potential, 247, 335
 effective potential energy, 236, 246
 eigenvalue, 379, 443, 445, 461, 462
 degenerate, 455, 463
 equation, 443
 eigenvalue
 equation, 388
 eigenvalue equation, 379
 eigenvector, 381, 443, 445, 462
 equation, 381, 388
 Einstein, Albert, 53, 546
 Einstein field equations, 229
 Einstein summation convention, 433
 Einstein's theory of gravity, 226
 elastic collision, 155
 electrostatic force, 239
 ellipse, 255
 elliptic integral, 322, 324
 endoergic, 161
 energy, 115
 of system of particles, 140
 energy diagram, 137
 energy integral, 138, 139
 equation of continuity, 521, 522, 529
 equation of motion, 52, 80
 equilibrant, 494
 equilibrium, 12
 equivalence, principle of, 53
 Euler
 angles, 430, 439
 equations of motion, 472, 473
 method, 70
 theorem, 442
 Euler's equation, 526, 527
 Euler's formula, 287
 Euler–Cromer algorithm, 70
 Euler–Lagrange equation, 98, 99
 exoergic, 161
- Feynman diagrams, 215
 Feynman, Richard, 204, 216
 fictitious force, 408
 field
 lines, 221
 theory, 211
 first integral, 92, 139
 force
 as function of position, 64
 central, 236, 238
 Coriolis, 406
 fictitious, 406, 408
 function of time, 59
 function of velocity, 61
 generalized, 505
 gravitational, 212, 239
 internal, 163
 Lennard-Jones, 239
 Foucault pendulum, 418
 four scalar, 565
 Fourier series, 299, 348, 352, 356,
 396
 frequency, 348
 functional, 96
- Galilean transformation, 548
 Galileo Galilei, 19, 50, 204
 Gauss's divergence theorem, 224
 Gauss's law, 222
 Gaussian surface, 224
 gedanken experiment, 549
 general relativity, 226
 generalized coordinate, 90
 generalized momentum, 90, 202
 geodesic, 229
 gradient, 121
 geometrical interpretation, 121
 Gram–Schmidt procedure, 463
 gravitational
 field, 211, 213
 field equations, 222
 potential, 219
 gravity
 center of, 503
 gyroscope, 189
- Hamilton's equations, 101
 Hamilton's principle, 82, 99, 397
 Hamiltonian, 101, 203
 harmonic motion, 65, 283
 harmonic oscillator
 coupled, 309
 normal modes, 313
 critically damped, 297
 damped, 285, 291
 forced, 297
 damped, 285, 303
 undamped, 302
 normal modes, 313
 overdamped, 295
 underdamped, 293
 Helmholtz theorem, 224
 Henon–Heiles Hamiltonian, 582
 hermitian matrix, 436
 hermitian tensor, 461
 hodograph, 28
 holonomic, 90
 holonomic constraint, 504
 homogeneous algebraic equations,
 310, 421, 444
 homogeneous fluid, 525
 Hooke's law, 500
 Hubble, Edwin, 229
 hyperbola, 257
- ideal gas law, 517
 ignorable coordinate, 91, 202, 477
 impact parameter, 154
 impulse, 162
 inelastic collision, 161
 inertia, 20, 50
 law of, 50
 moment of, 457
 product of, 457
 inertia tensor, 187, 457
 inertial axes, 431
 inertial reference frame, 51, 405
 integrating factor, 301
 irrotational flow, 525
 isothermal atmosphere, 518
- KAM theorem, 579
 Kater's pendulum, 345
 Kepler, Johannes, 236
 Kepler's laws, 238, 261
 kinematics, 19, 21
 rotational, 430
 kinetic energy
 rotating body, 460
 Kolmogorov, 579
 Kronecker delta, 432, 457
- Lagrange's equations, 86, 506
 Lagrangian, 80, 82, 245
 Lagrangian density, 396
 Laplace vector, 275
 Laplace's equation, 226
 law of cosines, 46
 Lee, T. D., 205
 length contraction, 551
 lever arm, 11
 Levi-Civita density tensor, 485
 Liapunov exponent, 580
 limit cycle, 579
 line integral, 116
 line of action, 10
 line of nodes, 475
 linear differential equation, 286

- lines of force, 221
 Lorentz transformation, 549, 552
- Mach, Ernst, 53, 58
 mass
 gravitational, 53
 inertial, 53
 reduced, 165
 mass matrix, 372
 metric, 127, 565
 Michelson–Morley experiment, 547
 Minkowski, Hermann, 561
 Minkowski, Hermannn, 227
 modal matrix, 384, 445, 447
 moment
 of force, 10
 moment of inertia, 187, 188, 457
 momentum
 angular, 456
 conservation of, 150
 linear, 150
 of system of particles, 163
- Newton, Isaac, 50
 law of universal gravitation, 212
 Newton's laws
 Newton's first law, 50
 Newton's second law, 52
 Newton's third law, 55
 strong form, 55
 weak form, 55
 Newton's laws of motion, 49
 Newton's rule, 161, 162
 Nielsen form, 508
 Noether, Emmy, 199
 normal coordinates, 385
 normal frequencies, 383
 normal modes, 313, 376, 379, 389, 541
 numerical methods, 68
 numerical solution, 68, 69
 nutation, 191, 430, 480
- Oort Cloud, 249
 orthogonal
 coordinate system, 125
 matrices, 435
 transformations, 430, 432, 445
 orthogonality, 30, 36, 42, 353, 382, 432
 orthogonality condition, 432
 orthonormality, 382, 384
 oscillations
 small, 371
- Pappus, theorem of, 502
 parabola, 257
 parallel axis theorem, 188
- parity, 204
 Pascal's law, 515
 passive interpretation, 435
 pendulum
 compound, 320, 326
 conical, 320, 336
 physical, 320, 326
 simple
 plane, 320
 spherical, 320, 333, 338
 perpendicular axis theorem, 188
 perturbation analysis, 413
 perturbed orbit, 267
 phase space, 576
 Poincaré map, 581
 Poisson's equation, 225
 polar angle, 38
 polar vector, 192, 201
 position, 21
 potential
 effective, 236, 246
 gravitational, 219
 potential energy, 120, 123
 effective potential energy, 246
 potential matrix, 374
 power, 7
 precession, 190, 430, 479
 principal axes, 445, 461, 462
 principle of equivalence, 53
 principle of superposition, 53, 216
 principle of virtual work, 505
 product of inertia, 457
 pseudowork, 141, 142
- Q factor, 306
 Q value, 161
- radius of gyration, 327
 reduced mass, 165, 239
 relative coordinate, 164
 relativity, 547
 general theory, 547
 special theory, 547
 resistance of air, 63
 resonance, 272, 297, 303, 304
 rest mass, 569
 restitution
 coefficient of, 162
 resultant, 494
 Reynold's number, 519
 Riemann, Bernhard, 228
 rigid body, 430
 RLC circuit, 308
 rotation of a rigid body
 about a fixed axis, 185
 rotational dynamics, 456
 rotations
 infinitesimal, 451
- row vector, 462
 Runge–Kutta, 175
 Runge–Lenz vector, 275
 Rutherford, 156
- scalar product, 30
 scale factor, 127
 secular equation, 419, 444
 separation of variables, 348, 351, 539
 shear modulus, 501
 similarity transformation, 438, 445
 simple harmonic motion, 65
 simultaneity, 557
 slingshot effect, 158
 small oscillations
 frequency of, 270
 solenoidal flow, 525
 spherical coordinates, 38, 129
 stability of circular orbit, 267
 stability of orbit, 268
 static equilibrium, 12
 statics, 11, 12, 53
 steady flow, 527
 stochastic behavior, 575
 strain, 500
 strange attractor, 579
 strangeness, 206
 streamline, 528
 stress, 500
 stress tensor, 501
 string, 495
 successive approximations, 338, 413, 416
 summation convention, 433
 surface of section, 581
 symmetry, 200
- tau–theta puzzle, 205
 Taylor series, 268, 341
 tensor, 457
 tide, 182, 277, 422
 time, 21
 time dilation, 550
 time reversal, 201
 torque, 10, 11, 178, 326
 transformation equations, 39, 82
 transformations
 improper, 192
 proper, 192
 trivial solution, 311
 turning point, 138, 248, 249, 254
 Twin Paradox, 559
- unit vectors, 30
 unitary matrix, 436
 universality, 212

-
- van der Pol equation, 579
Varignon, Theorem of, 491
vector
 4-vector, 564
vector product, 30
velocity
 angular, 9
 areal, 261
Venturi effect, 532
virial theorem, 242
virtual displacement, 397, 505
virtual photon, 215
virtual work, 504, 505
 principle of, 505
viscosity, 526
vorticity, 525
wave vector, 536
wavelength, 348
waves, 348
 longitudinal, 348
 speed, 348
 standing, 348
 transverse, 348
wave number, 349
weak force, 205
Wheeler, John, 229
work, 115
 virtual, 504, 505
work-energy theorem, 115, 461
world line, 561
world scalar, 565
Wu, C. S., 205
Yang, C. N., 205
Young's modulus, 500