

INDEX

- acceleration
 - angular, 240
 - average, 56
 - centripetal, 119-121
 - definition of, 56
 - instantaneous, 57
 - sign significance, 59-62
 - velocity vs. time graph, 58
- angular acceleration
 - average, 240
 - instantaneous, 241
 - of massive pulley, 271
 - torque and Newton's Second Law, 269
- angular displacement, 236
- angular momentum
 - in general, 291-297
 - in orbital systems, 314
- angular velocity
 - as function of translational velocity, 241-242
 - average, 236
 - instantaneous, 239
 - sign significance, 237-239
- anti-derivative, 46
- Atwood machine
 - energy considerations, 186
 - N.S.L. with massive pulley, 272

- beats, 376-377
- Brahe, Tycho, 307

- center of mass
 - area mass-density fct., 202
 - for continuous masses, 199
 - for discrete masses, 198
 - frame of reference, 204, 225-230
 - in general, 197-203
 - volume mass-density fct., 200
- centrifugal force, 124
- centripetal acceleration
 - definition of, 116
 - derivation of, 119-122
- centripetal force
 - deadman's curve, 114
 - hammer throw, 113
 - in general, 110-122
 - inclined curve, 116
 - M.O.B. maneuver, 110
 - planetary motion, 113
 - tires on a road, 112
- chain rule, 31-33
- coefficient of friction
 - kinetic, 90
 - static, 92
- collisions
 - elastic, inelastic, and perfectly inelastic, 218
 - in general, 209-220
 - with energy conserved, 217-219
- conservation of energy
 - derivation of modified version, 175-185
 - in celestial systems, 323
 - in multi-body systems, 185-187
 - in rotational systems, 284-290
 - symmetry in celestial systems, 328-329
- conservation of momentum
 - derivation of modified version, 205-209
 - in general, 205-220
- conservative force
 - commentary, 164
 - example--gravity, 157-160
 - in general, 160
- cross product
 - direction of, 16, 22
 - in polar notation, 15
 - in unit vector notation, 17
 - matrix evaluation, 18
 - physical significance, 20-21
 - right hand rule, 17
- curl, 38-40

- del operator
 - definition of, 34
 - used on potential energy fct's., 174-175
- derivatives
 - a geometric approach, 30
 - families of fcts., 29
 - formal definition, 27
 - Gauss's Law, 37
 - general rules, 30
 - notation, 26
 - partial derivatives
 - in theory, 33
 - slope of a tangent, 26
 - the chain rule, 31, 33
 - the del operator
 - the curl, 38
 - the divergence, 36
 - the gradient, 35
 - the del operator, 34
 - vector fields, 36
- differential displacement dx , 30
- differential displacement vector
 - in polar notation, 146, 148
 - in unit vector notation, 144, 150
- differential time interval dt , 30
- displacement from time-dependent velocity function, 56
- displacement from velocity vs. time graph, 55
- divergence, 36-37
- Doppler shift, 377-381
- dot product
 - in polar notation, 12
 - in unit vector notation, 13
 - physical significance, 14
- energy
 - a definition of, 153
 - gravitational potential energy (general fct.), 169, 321
 - gravitational potential energy (near-Earth fct.), 162
 - gravitational potential energy and rotating systems, 283
 - in center of mass frame of ref., 227
 - in collisions, 218
 - energy (con't.)
 - in orbital systems, 324-329
 - in rotational systems, 281-290
 - in the rotation of a pinned beam, 284
 - in vibrational system, 349
 - of a rolling ball
 - from center-of-mass perspective, 287
 - from pure-rotation perspective, 288
 - rotation and translation combined, 285-290
 - rotational kinetic energy, 249
 - spring potential energy, 172
 - translational kinetic energy, 153
 - equilibrium and rigid bodies, 266
- fictitious forces
 - centrifugal force, 124-127
 - linear, 127-128
- forces
 - centripetal, 110
 - derived from potential energy fct., 174-175
 - frictional
 - kinetic friction, 90
 - static friction, 92
 - gravitational, 87
 - normal, 88
 - push-me pull-you, 92
 - tension, 89
- freefall with friction, 106-110
- Gauss's Law
 - differential form, 37
- gradient, 35
- gravitation
 - energy considerations, 323-328
 - energy symmetry, 328-329
 - inside a massive object, 317
 - Newton's Law of, 309-312
 - potential energy
 - multibody systems, 322
 - potential energy fct. for, 321
- Hooke's Law, 172, 336

- ideal spring, 171
- impulse
 - definition of, 195
 - the integral form, 224
- impulse, the integral form
 - when work/energy won't do, 224-225
- inertia, 122
- integral
 - area under curve, 43
 - differential interval, 44
 - notation, 45
 - theoretical basis, 46
- integrals
 - Examples, 47

- Kepler's Laws
 - in general, 312-317
 - Law of Areas, 313
 - Law of Orbits, 312
 - Law of Periods, 315
- Kepler, Johannes, 307
- kinematics
 - equations derived, 64-69
 - graphical relationships, 67
 - projectile motion
 - horizontal displacement, 75
 - in general, 72-79
 - maximum height, 77
 - preliminaries, 73
 - time of flight, 75
 - touchdown velocity, 77
 - velocity at max. height, 76
 - simple examples, 69-72
 - statement of, 62-64
 - two-dimensional motion, 72-79
- kinetic energy
 - derivation of, 151-153
 - rotational, 289
 - translational, 153

- mass
 - area density fct., 202, 252
 - gravitational, 123
 - inertial, 122
 - linear density fct., 254
 - volume density fct., 200, 253
- moment of inertia
 - area mass-density fct., 252
 - chart showing various forms, 257
 - moment of inertia (con't.)
 - for a continuous mass, 251-256
 - for discrete masses, 249-251
 - in general, 248-256
 - linear mass-density fct., 254
 - the parallel axis theorem, 251
 - volume mass-density fct., 253
- momentum
 - conservation of, 205-219
 - definition of, 195
 - vector addition of, 196
- momentum and energy
 - what when, 222-224
- momentum and impulse, the integral form
 - when work/energy won't do, 224-225

- Newton's Laws
 - a statement of, 85-87
 - types of forces, 87-92
- Newton's Second Law
 - angular acceleration, 269
 - approach to use,
 - approaches, 93
 - examples
 - Atwood Machine with massive pulley, 272-274
 - ball rolling down incline, 274
 - centripetal motion, 110-119
 - gravitational force inside massive object, 319
 - in a pendulum system, 351
 - incline plane with massless pulley, 99-106
 - orbital motion, 312
 - rigid bodies, 266
 - translational motion only, 94-110
 - with Kepler's Third Law, 316
 - free body diagrams, 94
 - non-linear acceleration (freefall with friction), 106-110
 - rolling objects
 - summary of approaches, 281
 - rotation and translation combined, 270-281
 - rotation viewed from center of mass perspective, 274-276
 - rotation viewed from pure rotation perspective, 276-278
 - rotational analogue, 269-281
 - the formal approach, 94-98, 99-104

- Newton's Second Law (con't.)
 - the seat-of-pants approach, 98, 104-106
 - time dependent velocity, 128-131
 - torque and pure rotation, 269-270
- Newton, Sir Isaac, 85, 307

- parallel axis theorem, 251
- potential energy
 - derivation for known conservative force, 166-173
 - for an ideal spring, 172
 - gravitational
 - preamble, 160-163
 - in general, 160-174
 - Newton's general gravitational fct., 321
 - with work/energy theorem, 164-166
- power
 - definition of, 187-188
 - units, 188
- projectile motion, 72-79

- radian measure, 235
- resonance
 - in a string system, 362
 - in an air column, 373
 - in general wave motion, 361
 - sound in a steel bar, 369
 - standing waves
 - constraints test, 372
- rigid bodies, 266-269
- rolling
 - angular and translational motion related, 241-242
- rolling with sliding (skidding)
 - the bowling ball problem, 297-300
- rotational kinematics, 242-246
- rotational parameters
 - a plug for, 246-248

- scalar
 - definition, 1
- simple harmonic motion
 - mathematics of, 336-340, 352
- slope of a secant, 25
- speed
 - average, 51
 - instantaneous, 52

- standing waves
 - in a column of air, 373-376
 - in a steel bar, 369-371
 - on a string system, 362-368
- systems of units, 88

- torque
 - direction of, 263
 - in general, 261-266
 - magnitude of, 262
 - rotational version of Newton's Second Law, 269
 - to calculate
 - by definition, 263
 - by F perpendicular, 265
 - by r perpendicular, 263-265

- vectors
 - direction of, 2
 - example of, 1
 - graphical manipulation, 3
 - graphical representation, 2
 - in polar notation, 5
 - in unit vector notation, 7
 - magnitude of, 2
 - multiplied by scalar, 4
 - polar to unit vector, 11
 - resultant, 3
 - unit vector to polar
 - in general, 9
 - quadrants problem, 10

- velocity
 - angular, 236
 - definition of, 52
 - direction of, 53
 - instantaneous, 53
 - magnitude of, 53
 - position vs. time graph, 54
 - sign significance, 59
 - time dependent
 - frictional freefall, 106-110
 - general, 128-131
- vibrational motion
 - amplitude of, 335
 - angular frequency of, 341
 - criteria for, 333
 - displacement, 335
 - force functions, 335
 - frequency of, 335

- vibrational motion (con't.)
 - in an ideal spring, 333
 - period of, 335
 - periodic motion, 335
 - simple harmonic motion
 - angular frequency, 340-342
 - derivation of, 336-340
 - energy within, 349
 - phase shift, 342-349
 - summary, 349-350
 - simple harmonic motion, 335
 - simple pendulum, 350-352

- waves
 - definition of, 355
 - Doppler shift
 - in astronomy, 380
 - frequency of, 359
 - longitudinal waves, 357
 - mathematical characterization of, 360
 - nodes and anti-nodes, 359
 - period of, 359
 - reflection of, 358
 - resonance
 - explanation of, 361-362
 - sonic boom, 379
 - standing waves
 - constraints test, 372
 - in a column of air, 373-376
 - in a steel bar, 369-371
 - on a string system, 362-368
 - superposition of, 359
 - transverse waves, 357
 - velocity of, 359
 - wave train
 - longitudinal, 356
 - transverse, 355
 - wave-length of, 359

- work
 - definition, 139
 - differential displacement
 - in polar notation, 146, 148
 - done by variable forces, 143-151
 - due to frictional forces, 140, 142
 - due to normal forces, 141
 - due to variable force
 - differential displacement in polar notation, 148

- work (con't.)
 - due to variable force
 - differential displacement in unit vector notation, 144, 150
 - sign significance, 143
 - work/energy theorem, 151-157