

130–132, 130*f*; equilibrium and, 129, 906, 906*f*
neutrinos, 799–800, 800*t*, 809, 813
neutron number (N), 790, 790*f*, 790*t*, 791; nuclear stability and, 793, 793*f*, 801, 801*f*
neutrons: as baryons, 813, 814, 814*f*; in early universe, 816, 816*f*; mass of, 791, 792, 792*t*; nuclear decay and, 797*t*, 798, 799, 800; nuclear fission and, 808, 808*f*; nuclear stability and, 793–794, 793*f*, 801, 801*f*; quark structure of, 814, 814*f*; strong force and, 792–793, 811; zero charge of, 559, 560*t*
newton (N), 120–121, 121*t*
Newton, Isaac, 120, 125, 240, 762
Newton's first law of motion, 125–129, 126*f*, 129*f*; circular motion and, 239
Newton's law of universal gravitation, 241–242, 241*f*; constant G in, 241, 245, 245*f*; gravitational field strength and, 246; Kepler's laws and, 248, 249; ocean tides and, 244, 244*f*
Newton's second law of motion, 130–132, 130*f*, 200; inertial mass and, 247; for rotation, 906–907, 907*t*
Newton's third law of motion, 132–134, 133*f*; conservation of momentum and, 209–210, 210*f*; gravitational force and, 241, 241*f*, 252
nodes, 393, 393*f*, 394, 422–425, 423*t*, 424*f*, 425*f*
noise pollution, 442–443
nonmechanical energy, 174, 174*f*, 178 (see also **internal energy**)
non-ohmic materials, 613, 613*f*
nonviscous fluids, 284
normal: to reflecting surface, 452, 452*f*, 453; to refracting surface, 488, 488*f*, 494
normal force, 135–136, 136*f*; apparent weightlessness and, 252, 252*f*, 253; friction and, 137–141
northern lights, 751, 767
north pole, 678, 680, 680*f*, 681, 681*f*
nuclear bombs, 808, 809, 809*f*
nuclear decay, 797–806, 797*f* (see also **half-life**); decay series, 801–802, 801*f*; in fission reactions, 808, 808*f*; measurement of, 803–806, 806*f*; modes of, 797–800, 797*t*, 799*f*; neutrinos in, 799–800, 800*t*; rules for, 798*t*

nuclear forces, 143, 792–793, 794, 811, 812*t* (see also **strong interaction**; **weak interaction**)
nuclear reactions, 797, 807–810, 807*f*, 808*f*, 809*f*, 919, 919*f*
nuclear reactors, 24, 809, 810, 919
nuclear stability, 792–795, 793*f*, 797; decay series and, 801–802, 801*f*; nuclear reactions and, 807, 807*f*
nuclear waste disposal, 828–829
nucleons, 790, 790*t*, 791, 791*f* (see also **neutrons**; **protons**); binding energy of nucleus and, 794–795
nucleus (plural, **nuclei**), 790–792; atomic number of, 790–791, 790*f*, 790*t*; binding energy of, 794–795, 807, 807*f*, 808, 809; density of, 791, 791*f*; excited state of, 800; mass number of, 790–791, 790*f*, 790*t*; mass of, 791–792, 794–795; in Rutherford model, 763, 763*f*

O

object distance: from flat mirrors, 452, 453*f*; from lenses, 498–499, 499*t*
octave, 429
Oersted, Hans Christian, 684
ohm (Ω), 612
Ohm, Georg Simon, 612
ohmic materials, 612, 613*f*, 620
Ohm's law, 612–613, 613*f*
one-dimensional motion, 39–63; acceleration in, 48–58, 50*f*, 51*f*, 51*t*, 52*f*, 58*t*; displacement in, 41–42, 41*f*, 42*f*, 42*t*; of falling objects, 60–64, 60*f*, 61*f*; frame of reference for, 40–41, 41*f*; velocity in, 43–46, 43*f*, 45*f*, 46*f*, 46*t*
opposite charges, 559, 559*f*
optics: as field within physics, 5*t*; symbols in, 852
optometrist, 512
orbital period, 249, 250–251
orbiting objects: center of mass of, 241, 250; free-fall motion of, 240, 240*f*; gravitational force on, 241, 241*f*; Kepler's laws for, 248–251, 249*f*
order numbers, of interference fringes, 529–530, 530*f*
order-of-magnitude calculations, 24–25
origin, of reference frame, 40
overtones, 429

P

pair production, 930, 931*f*
parabolic mirrors, 467–468, 467*f*, 468*f*
parabolic path, 81, 96, 96*f*
parallel circuits, 639; complex circuits and, 657–662, 657*f*, 659*t*; resistors in, 651–656, 651*f*, 652*f*, 653*t*, 674–675
parallel conducting wires, 691, 691*f*
parallel-plate capacitor: capacitance of, 602–603, 604; charging of, 602, 602*f*; dielectric material in, 604, 604*f*, 605*f*; discharging of, 604–605; electrical breakdown in, 606
paraxial rays, 456
parent nucleus, 797
particle physics, 811–817 (see also **accelerators**, **particle**); classification of particles in, 811, 812–815, 813*f*, 813*t*, 814*f*, 814*t*; early universe and, 815–817, 816*f*; interactions in, 811–812, 812*f*, 812*t*; production of particles in, 811, 811*f*; standard model in, 815–817, 815*f*, 816*f*; symbols in, 853
pascal (Pa), 280
Pascal, Blaise, 280
Pascal's principle, 280–281, 281*f*
path difference, 529, 529*f*, 535, 535*f*
Pauli, Wolfgang, 799
pendulum, physical, 373
pendulum, simple, 373–374, 373*f*, 375*t*; amplitude of, 376, 377, 377*t*, 378; energy of, 374, 374*f*; frequency of, 376, 376*f*, 377*t*; period of, 376–378, 376*f*, 377*t*, 378*f*
Penzias, Arno, 913, 913*f*
perfectly inelastic collisions, 212–217, 212*f*, 213*f*, 220*t*
period: of mass-spring system, 379–380; of pendulum, 376–378, 376*f*, 377*t*, 378*f*, 402–403; of planetary orbit, 249, 250–251; of simple harmonic motion, 376–380, 376*f*, 377*t*, 378*f*; of wave, 386
periodic motion, 368 (see also **simple harmonic motion**)
periodic table of the elements, 872–873