

periodic waveforms, 428*t*, 429
periodic waves, 383–387, 383*f*, 384*f*, 385*f* (*see also waves*)
permanent magnets, 679, 691, 691*f*, 693, 693*f*
permittivity, 603
phase changes, 318, 318*t*
phase difference: beats and, 430–431, 430*f*; coherence and, 527, 541, 542; interference and, 430, 431, 527, 527*f*
phosphors, 736
photoelectric effect, 756–759, 756*f*, 756*t*, 757*f*, 761
photoelectrons, 756–759, 756*f*, 756*t*, 757*f*, 761
photons, 734 (*see also electromagnetic waves*); Bohr model and, 766–768, 766*f*, 767*f*; Compton shift in, 760, 760*f*; in early universe, 816; electromagnetic force mediated by, 812, 812*f*, 812*t*, 817; energy of, 734, 754, 757, 759, 766; as gamma rays, 797, 797*t*, 800; photoelectric effect and, 757, 759; Planck's blackbody theory and, 754; wave-particle duality and, 771–772
photosensitive materials, 756, 761
phototubes, 761
physics (*see also experiments; measurements*): applications of, 4–5, 4*f*, 5*f*; areas of, 5, 5*t*; equations in, 854–865; goal of, 4; mathematics in, 21–25, 22*f*, 23*f*; models in, 6–9, 7*f*, 8*f*, 22; symbols of, 848–853
physics teacher, high school, 221
piano tuner, 432
pickup, 707, 715
pitch, 409; Doppler effect and, 412–413, 412*f*; fundamental frequency and, 429
pixels, 470, 470*f*
Planck, Max, 753–754, 922
Planck's constant, 754, 772, 776, 922
Planck's equation, 766, 772
planetary motion (*see also orbiting objects*): historical theories of, 248, 248*f*; Kepler's laws of, 248–251, 249*f*
planets, data on, 250*t*
plane waves, 411, 411*f*, 489, 489*f*
plug, in schematic diagrams, 640, 640*f*, 641*t*

p-n junction, 646
point charge: electric field lines of, 576–577, 576*f*; electric field of, 573–574; potential difference in field of, 597–598, 597*f*
polarization: of electrical insulators, 562, 563, 563*f*; of light, 472–474, 472*f*, 473*f*, 474*f*
position (*see also displacement*): frame of reference for, 40–41, 41*f*; one-dimensional change in, 41–42, 41*f*, 42*f*, 42*t*; potential energy and, 169–171, 169*f*, 170*f*; uncertainty principle and, 775–776, 775*f*
position-time graph, 45–46, 45*f*, 46*f*
positive charge, 558*t*, 559, 559*f*
positrons: in beta decay, 797, 797*t*, 798–800, 799*f*; discovery of, 930; in nuclear fusion, 809; in pair production and annihilation, 930–931, 931*f*
potential difference, 596–598, 599, 600, 642 (*see also batteries; electrical potential energy; electric potential; emf*); of batteries, 596, 596*f*, 600, 644–645; of capacitor plates, 602–603, 604, 605–606; in circuits, 642, 644–645; in complex circuits, 659–661, 659*t*; current and, 611; electric power and, 620–621; in field of point charge, 597–598; of household outlet, 618, 623, 656, 657, 726; induced in moving wire, 709, 709*f*; measurement with voltmeter, 693, 693*f*; in parallel circuits, 652–656, 653*t*; of power lines, 623, 623*f*; reference point for, 597–598, 600, 604; resistance and, 612–613, 613*f*, 614, 615; in series circuits, 648–650, 653*t*; shock and, 722; supplied to motor, 720, 720*f*; unit of, 596
potential energy, 169–171, 169*f* (*see also elastic potential energy; electrical potential energy; gravitational potential energy*); chemical, 168, 174; conservation of energy and, 309–310; as mechanical energy, 173–174, 174*f*; unit of, 169
potential well, 924, 924*f*, 925*f*
potentiometers, 616
power, 179–180, 180*f* (*see also electric power*); sound intensity and, 414; unit of, 180

precision, 16–17, 17*f*, 845; significant figures and, 17–19, 18*f*, 18*t*, 19*t*, 20*t*; uncertainty principle and, 775–776
pressure, 280–283, 380; absolute, 282–283; atmospheric, 280, 282, 283, 910, 910*f*; Bernoulli's equation and, 911, 911*f*; density and, 282–283, 283*f*; depth in fluid and, 280*f*, 282–283, 283*f*, 911; of ideal gas, 908–909, 908*f*; kinetic theory of gases and, 910; Pascal's principle and, 280–281, 281*f*; of real gases, 909; sound waves and, 409, 416; speed of flow and, 286, 286*f*, 911; unit of, 280; work done by, 337–338, 337*f*, 345
pressure waves, 385 (*see also longitudinal waves; sound*)
primary circuit, 721, 721*f*; in electronic ignition, 730, 730*f*
primary coil, 721, 721*f*, 727, 727*f*, 729
primary colors, 469–471, 470*f*, 470*t*, 471*f*
prisms, 446, 446*f*, 492, 509, 509*f*; total internal reflection in, 506
probability, of finding particle, 776–777, 776*f*, 777*f*, 924, 925*f*
projectile motion, 95–100, 95*f*, 96*f*, 99*f*; of center of mass, 904, 904*f*
proton-proton cycle, 809, 810
protons: 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 stability and, 793–794, 793*f*, 801, 801*f*; in nucleus, 790–791, 790*t*; positive charge of, 559, 560, 560*t*; quark structure of, 814, 814*f*; strong force and, 792–793, 811
Ptolemy, Claudius, 248
pulleys, 258, 259*f*
pulse waves, 383, 383*f*, 390–392, 390*f*, 391*f*, 392*f*
Pythagorean theorem, 87–89, 87*f*, 844–845, 844*f*

Q

quadratic equations, 835–836
quantization of electric charge, 560, 560*f*, 560*t*
quantization of energy, 754, 759
quantum, 754