

Index

Page numbers for key terms are printed in **boldface** type.
Page numbers for illustrations, maps, and charts are printed in *italics*.

A

absolute zero 474
AC 739, 753
acceleration 320–325
 calculating 322–323
 direction and 320, 321
 force and mass and 352
 in free fall 346
 graphing 324–325
 gravity and 344, 346
 Newton's second law of motion and 350–352
acids 236, 240
 acid-base reactions 242, 246–247
 organic 271
 properties of 236–238, 243
 in solution 242–245
acoustics 556
actinides 112, 114, 124
action force 354–355
action-reaction pairs 354–355
activation energy 205–206
 for fire 213
actual mechanical advantage 419
air 38, 41, 75, 129, 131, 132
air conditioners 495
aircraft 393, 395, 398–399
airplane wing, Bernoulli's principle and 395
air pressure. *See* atmospheric pressure
air resistance 347
alcohols 270–271
alkali metals 120, 153
alkaline earth metals 121, 154
alloy 122, 173
 magnetic 665
alpha particle 140, 141
alternating current (AC) 739
 AC generator 740
 diodes and change to direct current 753
altitude, speed of sound and 545
amino acids 253, 276, 287, 290
amino group 287
ammeter 710
amorphous solids 72
ampere (amp or A) 693
Ampère, André Marie 693
amplitude 516, 524–526, 547, 760
amplitude modulation (AM) 594, 595, 760

amylase 252
analog signals 751
analog sound recording 758
-ane suffix 269
angle(s) 512
 of incidence 522, 640
 of reflection 522
animals, polymers made by 276
antenna 594, 761
antifreeze 227
antinodes 526
anvil (bone in ear) 559
appliances
 energy used by, calculating 714
 power rating for 713
applications software 767
Archimedes' principle 382
area 790
 pressure and 373
armature
 in electric motor 732, 733
 in generator 740
artificial satellite 362, 363
-ate suffix in ionic compound 161
atmosphere. *See* air
atmospheric pressure 79, 374–378
atom(s) 16, 39, 60, 102–108, 663
 chemical bond between 39, 151. *See also* chemical bonds
 electron spin and magnetic properties of 663
 structure of 663
atomic mass 110, 113, 115
atomic mass unit (amu) 107
atomic number 107, 111, 113, 152
atomic theory 16
atomizers, Bernoulli's principle and 396
audio signal 760, 761
auroras 675
average atomic mass 115
average speed 313
axes on graph 90
axle
 in electric motor 732
 wheel and 428–430

B

Babbage, Charles 766
bacteria, nitrogen fixation by 131
balanced forces 336–337
 terminal velocity and 347
balanced pressure 375

bar graph 786
 digital signal and 751
barometer 378
base-10 number system 763
bases 236, 238, 240, 241
 acid-base reactions 242, 246–247
 properties of 238–239, 243
 in solution 243–245
batteries 697, 702–703, 704–705
 direct current from 738
Becquerel, Henri 139
Bell, Alexander Graham 756
Bernoulli's principle 393, 394–397
beta particle 140, 141
bicarbonate ions 253
binary system 763–764
bits 763
block and tackle 430, 431
blood sugar 285
Bohr, Niels 105
boiling 42, 79, 489
boiling point 79, 168, 227, 489
bonds. *See* chemical bonds
bones and muscles, as levers 432
Boyle, Robert 86, 89
Boyle's law 86, 92–93
brain, vision and 630
brainstorming 24, 784
brass 41, 173
brass instruments 555
bridges 500–507
broadcast waves 580
buoyant force 381–382
 Archimedes' principle and 382
 changing density 384, 385
 gravity and 381
bytes 763

C

calculating, skill of 781
calculator 763
cameras 635
 digital 597
 infrared 581
cancer 143, 582, 583
carbohydrates 251, 285–286, 289
carbon 128, 129, 260–263, 275
 isotopes of 108
 model of atom 39, 106
carbon-14 140
carbonates 238, 239

- carbon compounds 264–272
 esters 271
 hydrocarbons 266–270
 organic 265
 polymers 272, 275
 substituted hydrocarbons 270–271
- carbon dioxide 39, 40, 81, 170, 195, 234, 238
- carbon family 130
- carboxyl group 271, 287
- careers in physical science x–3, 8, 9
- carrier wave 760, 761
- catalyst 209
 enzymes 209, 251, 252, 253
- cathode-ray tubes 762
- cause and effect, relating 797
- CD or compact disc 638, 759
- cellular phones 194, 597
- cellulose 276, 279, 286
- Celsius scale 474, 781
 conversion to kelvins 91
- census counting machine 766
- centimeter (cm) 311
- central processing unit (CPU) 765
- centripetal force 363
- Chadwick, James 106
- changes in matter 50–55
 chemical 52–53, 60, 61
 forms of energy related to 58–61
 physical 51, 60, 186
 thermal energy and 54, 58, 60, 76
- changes of state 51, 76–81, 488–489
- charges, electric. *See* electric charge(s)
- Charles, Jacques 88, 89
- Charles's law 88–89, 92
- chemical bonds 39, 151, 187
 ability of carbon to form 261, 275
 activation energy to break 205
 chemical energy in 450
 covalent 166, 167–171, 275
 double 168, 269
 internal energy stored in 60
 ionic 160, 167, 187
 metallic bond 174–176
 nonpolar 170
 polar 170
 triple 168, 269
- chemical change 52–53. *See also* chemical reaction(s)
 electromagnetic energy and 60
 transforming energy in 61
 transformation of mass 53, 196–197
- chemical compounds. *See* compound(s)
- chemical digestion 251, 252, 253
- chemical energy 58, 60, 450, 703
 in fossil fuels 464
 produced by photosynthesis 61
 transformation into electrical energy 704–705
- chemical equations 194, 195, 198–199
- chemical formula 40, 161, 195, 266–267
- chemical properties 37, 185. *See also* reactivity
 of matter 35, 37
 of metals 119, 120
 of nonmetals 130
- chemical reaction(s) 186, 194, 195, 703. *See also* chemical change
 acid-base 242, 246–247
 of acids 237, 238
 activation energy and 205–206, 209, 213
 balancing chemical equations of 198–199
 of bases 239
 chemical bonds and 151, 187
 classifying 200–201
 conservation of mass during 196–197
 controlling 204–209
 in electrochemical cell 704
 endothermic 190, 206
 evidence for 188–191
 exothermic 190, 206
 rates of 207–209
- chemical symbol 112, 115
- chemistry 8, 35, 184
- chip, integrated circuit 754
- cholesterol 288
- circle graphs 788
- circuit, integrated 754. *See also* electric circuit
- circuit breaker 717
- circular motion 321, 363
- circumference 790
- classifying, skill of 779
- closed system 197
- coal 130, 463
- cochlea 559, 560
- coefficient 198
- coherent light waves 636
- collisions, conservation of momentum in 358, 359
- colloids 224
- color(s)
 absorbed 612, 613, 615
 combining 614–615
 complementary 614
 light and 582, 610–615
 of opaque object 612
 as physical property 36
 pigments 615
 primary 614, 615
 secondary 614, 615
 of transparent or translucent object 613
- color filters 613
- combined magnetic fields 658, 659
- combustion 52, 213, 464
 as exothermic change 54
 external combustion engines 492
 in heat engines 491
 internal combustion engines 492
- communicating, skill of 14, 779
 technology design process and 24
- communication. *See* electronic communication; wireless communication
- communications, optical fibers used in 641
- communications satellites 598–600, 761
 global positioning system (GPS) 600
 satellite phone systems 598
 television satellites 599
- commutator 732, 733, 740
- compact disc (CD) 638, 759
- compass 670
 observing electromagnetism with 724, 725
- complementary colors 614
- complex carbohydrates 286, 289
- composites 278–280
- compound(s) 40, 450
 bonds in 450
 formulas of 195
 ionic 160–163

mixtures compared to 41, 42
 molecular 168–169, 266
 organic 265, 284–285
compound machines 433
compressions 513, 514, 516
 making sound waves 541
 in P waves 530
computer(s) 763–769
 binary system used by 763–764
 development of 766–777
 hardware 765–766
 integrated circuit chip in 754
 photography and 772–773
 software 767–768, 769
computer languages 768
computer models 15
computer mouse 22
 designing 23–25
computer networks 768–769
computer program. *See* software, computer
computer programmers 768
concave lenses 626, 627, 632
concave mirrors 620–621, 634
concentrated solution 230
concentration 208, 230–231
 pH and 245
concept mapping 797
conclusion 14, 783
condensation 80, 489
conduction 480, 481, 686
 charging by 686, 687, 689
conduction electrons 695
conductivity 119
 of ionic compounds 163
 of metals 175, 176, 177
 of molecular compounds 169
 of solutes 225
conductors (of electricity) 695
 low resistance of 698
 metalloids 135
 metals as 121, 122, 134
 nonmetals, as poor 129
conductors (of thermal energy)
 482, 483
cones (in eye) 630, 631
conservation 357
 of charge 686
 of energy, law of 458–459
conservation of mass 53, 196–199
conservation of momentum, law
 of 357–359
constant volume 87
constraints 24, 784
constructive interference 524,
 525, 556
controlled experiment 12, 783
convection 480, 481
convection current 480
converting SI units 781
convex lenses 626
 to correct vision 632
 of eye 630
 in microscope 635
 objective 634
 in refracting telescope 634
convex mirrors 622
cooling systems 494–495
core, Earth's 671
cornea 630, 631, 639
corrosion 119
corrosive, acids as 237
covalent bonds 166, 167–171, 275
CPU (Central Processing Unit)
 765
crests 512, 514, 516, 531
 constructive interference and
 524, 525
 destructive interference and
 525
crystal 162
 diamond 262
 ionic 162, 163
 metal 174
crystalline solids 72
cubic centimeter (cm³) 46
Curie, Marie 139, 154
Curie, Pierre 139
current, electric. *See* electric
 current
cycle diagram 796

D

Daguerre, Louis-Jacques-Mandé
 639
Dalton, John 103
data 13, 783
data tables 786
DC 738, 739, 753
DC generator/motor 740
dead spots, acoustical 556
decibel (dB) 548
decimals 791
decomposition 200
degrees Celsius (°C) 474
degrees Fahrenheit (°F) 474
Democritus 103
density 47–48, 383–384, 385, 544
depth
 sonar to determine 565
 water pressure and 377–378
destructive interference 525, 556
 in standing wave 526
detergent 171, 298, 299
diamond 260, 262
diaphragm (camera) 635
diatomic molecule 131, 132
Difference Engine 766
diffraction 524
 of sound waves 542–543
diffuse reflection 618
digestion 250, 251–253, 286, 287
digestive system, pH in 252–253
digital manipulation 772–773
digital signals 751
digital sound recording 759
dilute 704
dilute solution 230, 245
diodes 753
direct current (DC) 738
 advantage of AC over 739
 DC generator 740
 diodes to change alternating
 current to 753
direction
 acceleration and 320, 321
 of flow of heat 482
 of force, machines that change
 414, 415, 417
 net force and 335, 336–337
 velocity and 314–315
 work and force in same 406,
 407
directly proportional variables 92
disk 766
disk drive 766
distance
 calculating amount of work
 based on 408–409
 calculating speed based on
 312–313
 gravitational force and 345
 input 413, 414, 415
 loudness and 547
 machines that change input
 414, 415
 measuring 310–311
 mechanical advantage of
 machine that increases 416
 output 413
distance-versus-time graph 316, 325
distillation 42, 43, 51

DNA (deoxyribonucleic acid)
289, 290
Doppler effect **550–551**
cause of 550
radar gun and 580
DOS (Disk Operating System)
767
double bond 168, 269
double replacement reaction 201
dry cell 705
dry ice 81
ductile 118, 175

E

ear, human 558–559

ear canal 558

ear drum 558

Earth

core of 671
gravitational pull of 345
magnetic declination and 672
magnetic field of 671, 672–673
as magnet maker 672
magnetosphere and 674–675

earthquake

seismic waves produced by 527,
530, **531–533**
seismographs detecting 533

echo 542

reverberation 556

echolocation 565

Edison, Thomas 588, 738, 739

efficiency 417

calculating 418
friction and 417, 418, 419
of machines 417–419

Einstein, Albert 459, 577

elasticity 544

elastic potential energy 446, 457

electrical conductivity. *See*
conductivity

electrical devices 750

electrical energy 58, 60, 450, 730.

See also conductors (of
electricity)

electric circuit and 708

fossil fuels used to produce
464–465

paying for 714

transformation of chemical
energy to 704–705

transformation of mechanical
energy to 740–741

transformation to mechanical
energy 730, 732

transmission from generating
plants 743

electrical safety 715–717

breaking circuit for 717

personal 715–716

electric charge(s) 169–171, 682,
683

conductor of 695. *See also*
conductors (of electricity)

conservation of charge 686

detecting 688

electric fields and 684

electric force between 684

of electron 683

flow of. *See* electric current

insulators and 695, 698

interactions between 683

of proton 683

static discharge 688–689, 716

static electricity and 685

transferring 686–688

electric circuit 694, 706–712

breaking 717

closed 727

grounding 716

household 712

Ohm's law and 707

open 727

parallel 711–712

series 710

symbols for diagramming 709

electric current 577, 692, 693–699

alternating 739, 740, 753

in calculation of power 713

in circuit 694

conductors of 695

direct 738, 739, 740, 753

induction of 736–739

insulators and 695, 698

magnetism and 725

measuring 710

Ohm's law and 707

resistance and 698–699

voltage and 696, 697, 704, 707,
712, 713, 739, 741, 742–743

electric field 575, 684

around a single charge 684

around multiple charges 684

electric force 684

electric generator 697, 740–741

AC 740

DC 740

using 741

electricity 683, 729

generators of 740–741

induction of current 736–739

from magnetism 736–743. *See*

also electromagnetism

motion and 729, 730

static 685–689

transformers and 741–743

electric motors 732–733, 740

how they work 732

parts of 733

electric power 712–714

calculating 713

power ratings 712–713

electric shocks 716

electrochemical cell 704–705

dry cell 705

wet cell 705

electrodes 60, 704

electrolysis 52, 60, 189

electrolyte 704

electromagnet(s) 727–728

in electric motor 733

in galvanometer 731

in telephone receiver 757

electromagnetic energy 58, 60,

451, 463

transformation in

photosynthesis 61

electromagnetic induction

736–739

electromagnetic radiation 575

electromagnetic spectrum 579

gamma rays 140, 141, 142, 143,
584, 585

infrared rays 581, 584, 589

radio waves 579, 580, 584,

594–596, 598, 599

ultraviolet rays 582, 585

visible light 60, 579, 582, 585,

588–591

wavelengths of 579

X-rays 451, 579, 583, 585

electromagnetic waves 511, 574,

575–577, 578

models of 576–577

producing 575

radio and 760–761

speed of 576

television and 761

- transfer of energy by 451, 480, 575
types of 580–584, 585
- electromagnetism** 724, 725–728
- electron(s)** 60, 104, 577, 663
cloud of 60, 105, 106
conduction 695
covalent bond and sharing of 167–171
energy levels of 105, 150
free 116
in insulator 695
mass of 107
negative charge of 683
static discharge 688–689, 716
static electricity and transfer of 685–689
unequal sharing of 169–171
valence. *See* **valence electrons**
- electron dot diagram** 151, 152
- electronic communication** 756–762
radio 760–761
sound recordings 758–759
telephones 756–757
television 761–762
- electronics** 750. *See also* **computer(s)**
combining electronic components 753
difference between electrical devices and 750
semiconductor devices and 752–754, 757
- electronic signal** 750
analog signals 751
digital signals 751
sound converted into 756, 758, 760–761
- electron spin** 663
- electroscope** 688
- element(s)** 38–39, 109–117, 663.
See also **metal(s)**; **metalloids**; **nonmetals**
atoms as particles of 39
chemical symbols for 112, 115
discovery of 154–155
formation in stars 116–117
list of 801
names, in English and Latin 115
organizing 109–117. *See also* **periodic table**
- periodic table of. See periodic table**
radioactive 138–143
synthetic 124, 125
- elevation, atmospheric pressure and** 376, 377
- Empedocles** 38
- endothermic change** 54
- endothermic reaction** 190, 206
- energy** 8, 54, 58–61, 442, 443, 511–512, 730
activation 205–206, 209, 213
amplitude of wave and 516
change in matter and 54
chemical 58, 60, 61, 450, 464, 703, 704–705
chemical reactions and 190–191, 205–206
conservation of 458–459
electrical. *See* **electrical energy**
electromagnetic 58, 60, 61, 451, 463
electromagnetic radiation 575
forms of 447–451
fossil fuels and 462–465
frequency of electromagnetic wave and 579
kinetic. *See* **kinetic energy**
matter transformed to 459
mechanical 447–448, 458, 491–492, 730, 732, 740–741
nuclear 116, 117, 451, 463
potential *See* **potential energy**.
power and 443
of the sun 60, 116, 463, 464
thermal. *See* **thermal energy**
transfer of 451, 480, 511, 512, 575
work and 443
- energy level** 105, 150, 152
- energy transformation(s)** 454–457, 730
combustion and 464
conservation of energy and 458–459
by electric motor 732
energy from sun 463, 464
by generator 740–741
of potential and kinetic energy 456–457
power as rate of 712
single 455
- energy use, calculating** 714
- ene suffix** 269
- engineer** 22
- engineering**
lasers used in 637
X-rays used in 583
- ENIAC** 767
- enzymes** 209
chemical digestion and 251, 252, 253
- Escher, M. C.** 419
- esters** 271
- evaporation** 42, 43, 78, 79, 489
- exothermic change** 54, 60
- exothermic reaction** 191, 206
- experiment, controlled** 12, 783
- exponent** 444, 793
- external combustion engines** 492
- external memory of computer** 766
- eyepiece** 634, 635
- eyes, human** 629, 630, 631

F

- factor** 793
- Fahrenheit scale** 474
- falling objects. See also gravity**
air resistance and 347
free fall 346
- families (periodic table)** 114
- Faraday, Michael** 738
- Farrington, Frank** 504
- farsightedness** 632
- fats** 288
- fatty acids** 288
- Federal Communications Commission (FCC)** 596
- feedback** 26
- ferrite** 665
- ferromagnetic material** 665
solenoid with core of 727–728
- fertilizers, nitrogen in** 131
- fiber** 286
- fiberglass composites** 280
- filament, light bulb** 589
- filters, color** 613
- filtration**
physical change in 51
separating mixtures by 42
- fire** 212–215
- fire extinguisher** 215
- fire triangle** 213, 214
- first-aid tips** 20
- fixed pulley** 430, 431
- flammability** 37
of hydrocarbons 266

- fleece, polyester 282–283
flexibility 36
 of metals 175
flight
 of aircraft 393, 395, 398–399
 Bernoulli's principle and 395, 397
floating
 buoyant force and 381–382
 density and 383–384, 385
flowchart 768, 796
fluid 73, 374
 air as 384
fluid friction 342, 343
 air resistance 347
fluid motion 393, 394
 Bernoulli's principle and 394–397
fluid pressure 374–378
 cause of 374
 of moving fluid 394
 Pascal's principle and 389–392
 on submerged object, buoyant force and 381–382
 transmitting 389–390
 variations in 376, 377–378
fluorescent light 590
FM radio waves 594, 595, 760
focal point 620
 of concave mirror 621
 of convex lens, light rays at 626
 of convex mirror 622
foods 290
 acidic 237, 240
 digestion of 250, 251–253, 286, 287
 energy transformations in 455
 organic compounds in 240, 251, 271, 276, 284–291
force(s) 334. *See also* friction; gravity; input force; output force; pressure
 action-reaction 354–355
 balanced 336–337, 347
 buoyant 381–382, 384, 385
 calculating work and 408–409
 centripetal 363
 combining 335–337
 machines and 414, 415
 magnetic 656, 657
 motion and 335, 336–337
 net 335, 336–337, 351–352
 Newton's first law of motion and 349–350
 Newton's second law of motion and 351–352
 unbalanced 336, 346, 349
 work and 406, 407
formula
 chemical 40, 161, 195, 266–267
 structural 267, 268, 269, 285
fossil fuels 462–465
four-color printing 615
four-stroke engines 492, 493
fraction 791
Franklin, Benjamin 683
free fall 346
freezing 78, 488
freezing point(s) 78, 488, 489
 of solvents 226
freon 270
frequency(ies) 517, 760
 calculating 518, 519
 Doppler effect and 550
 of electromagnetic waves 579
 natural 527, 553
 pitch and 548–549
 radio 596, 760, 761
 wavelengths and 579
frequency modulation (FM) 594, 595, 760
friction 340, 341–343, 686
 causes of 343
 charging by 685, 686, 687
 efficiency and 417, 418, 419
 energy and 458
 types of 342, 343
fuel(s) 213, 462–465
fulcrum 426
Fuller, Buckminster 263
fullerenes 263
fundamental tone 553
fuse 717
fusion, nuclear 116–117
- G**
- Galileo Galilei 349, 638
Galvani, Luigi 703
galvanometers 731, 737
gamma radiation (gamma rays) 140, 141, 142, 143, 584, 585
gas(es) 75, 487
 chemical reaction producing 189
 changes of state of 78–81, 489
 measuring 84–85
 neon lights and 591
 as nonmetals 129
 particles in 75, 84, 85
 pressure and solubility of 233
 speed of sound in 544
 temperature and solubility of 233
gas behavior 83–89
 Boyle's law of 86, 92–93
 Charles's law of 88–89, 92
 graphing 90–93
 pressure and temperature, relationship between 87
 pressure and volume, relationship between 86, 92–93
 volume and temperature, relationships between 88–89, 91–92
gasohol 271
gasoline 130, 266
generators, electric 697, 740–741
gigabytes 763
Gilbert, William 671
glass 135
 index of refraction of 624
glasses, correcting vision with 632
global positioning system (GPS) 600
glucose 285, 286
glycerol 288
gold 119, 154
 alloys 173
Goodyear, Charles 278
graduated cylinder 46
gram (g) 45, 781
graph(s) 90–93
 of acceleration 324–325
 axes on 90
 creating 786–788
 of motion 316–317
 of pressure and volume 92–93
 of temperature and gas volume 91–92
graphite 262, 263
gravitational potential energy 445, 456, 457
gravity 15, 340, 344–348
 acceleration due to 344, 346
 buoyant force and 381
 factors affecting 344–345
 law of universal gravitation 344
 motion and 340, 346–348
 projectile motion and 348
 satellites in orbit around Earth and 364
grounding of electric circuits 716
group (periodic table) 114, 152, 153

H

- halite 162
- halogens 133, 153, 155, 270, 589
- hammer (bone in ear) 559
- hardness, as physical property 36
- hardware, computer 765–766
 central processing unit (CPU) 765
 external memory 766
 input and output devices 765
 internal memory 766
- hazardous chemicals, transporting 56–57
- hearing 558–560
 ear and 558–559
- hearing aids 560
- heart disease, cholesterol and 288
- heat 176, 475
 chemical reactions and 206
 as part of fire triangle 213
 reaction rates and 208
 specific 476–477
 uses of 491–495
- heat conductivity of metals 175, 176, 177
- heat engines 491–492, 493
- heat lamps 581
- heat transfer 479–483
 by conduction 480, 481–483
 by convection 480, 481
 in cooling systems 494–495
 direction of flow 482
 insulators in 482, 483
 by radiation 480, 481
- height, gravitational potential energy and 445
- helium 134, 153
 nuclear fusion in sun 116–117
- hemoglobin 122
- Henry, Joseph 738
- hertz (Hz) 517, 548
- Hertz, Heinrich 517, 598
- heterogeneous mixture 41
- Hickam, Homer 362
- high-voltage wires 715
- Hollerith, Herman 766
- hologram 638
- holography 638
- homogeneous mixture 41
- horsepower 411
- hot-air balloon 83, 89
- household circuits 712
- human body, simple machines in 432
- hydraulic device 390
- hydraulic systems 391–392
 hydraulic brakes 392
 hydraulic lifts 391
- hydrocarbons 266–271
- hydrogen ion (H^+) 242–243, 244
 pH and concentration of 244–245
- hydroxide ion (OH^-) 243, 244
- hydroxyl group 270
- hypothesis 11, 782
 conclusions about 14
 designing experiment to test 12
 identifying supporting evidence for 797

I

- ice, melting of 54
- iceberg 380, 384
- ideal machines 419
- ideal mechanical advantage 419.
 See also mechanical advantage
- ide suffix in ionic compound 161
- illuminated object 588
- image 619
 in concave lenses 627
 in concave mirrors 621
 in convex lenses 626
 in convex mirrors 622
 formation of 619
 in plane mirrors 619
 real 621, 626
 virtual 619, 621, 622, 626, 627
- incandescent light 588–589
- incidence, angle of 522, 640
- inclined plane 423
 wedge as 424
- incoherent light waves 636
- index of refraction 624
- indicators 238, 239, 245
- induced current 736–739
 alternating current 739
 direct current 738
- induction 686
 charging by 686, 687, 689
- industry
 lasers used in 637
 X-rays used in 583
- inertia 350
 satellite motion and 364
- inferring, skill of 7, 778
- information superhighway 769
 computer networks and 768–769
- infrared cameras 581
- infrared rays 581, 584, 589
- infrasound 549
- inhibitors 209
- inner ear 558, 559
- input 26
- input device 765
- input distance 413
 machines that change 414, 415
- input force 413
 on inclined plane 423
 on lever 426
 machines that change 414, 415
 mechanical advantage and 416–417
 on pulley 430
 on screw 425
 on wedge 424
 on wheel and axle 429
- input work 413
 efficiency of machine and 417, 418
- instantaneous speed 313
- insulators (electricity) 695
 high resistance of 698
- insulators (thermal energy) 482, 483
- integrated circuits 754
- intensity, sound 547
- interference, wave 524–525
 constructive 524, 525, 556
 destructive 525, 526, 556
 of sound waves 543
- internal combustion engines 492
- internal energy. *See* thermal energy
- internal memory of computer 766
- International System of Units (SI) 13, 45, 310–311, 780–781. *See also* units of measurement
- Internet 597, 769
- inversely varying quantities 93
- ionic bonds 160, 167, 187
- ionic compounds 160–163
- ionic crystals 162, 163
- ionic solute 225
- ionosphere, reflection of AM radio waves by 595
- ions 159
 formation of 159
 hydrogen (H^+) 242–243, 244–245
 hydroxide (OH^-) 243, 244
 polyatomic 159, 161
- iris 630, 631
- iron 173, 665

at core of larger stars 117
rusting of 37, 52, 119, 122, 130
isomers 268
isotopes 108, 115, 139
isotopes, radioactive 141–143
-ite suffix in ionic compound 161

J

Jansen, Hans 638
Jansen, Zacharias 638
joule (J) 409, 411, 443, 475
Joule, James Prescott 409

K

kelvins (K) 91, 474
Kelvin scale 474
kilobytes 763
kilogram (kg) 45, 344
kilohertz (kHz), AM radio
frequencies in 596
kilometers (km) 311
kilopascals (kPa) 85
kilowatt-hour (kWh) 714
kilowatts (kW) 411, 714
kinetic energy 58, 59, 443–444,
472
calculating 444
mechanical energy and 448
temperature as measure of
average 472–474
transformation between
potential energy and 456–457

L

laboratory safety 17–20, 798–799
LAN (local area network) 768
languages, computer 768
larynx 549
lasers 636, 639
optical fibers and 640–641
uses of 637–639
Lavoisier, Antoine 53, 196
Lecoq de Boisbaudran, Paul-
Émile 154
lens(es) 626–627
of camera 635
concave 626, 627, 632
contact 632
convex 626, 630, 632, 634, 635
of eye 630, 631
of microscope 635
levers 426, 427
in human body 432
types of 426, 427

lift, Bernoulli's principle and 395,
396

light 575
absorbed 611, 612, 613
coherent 636
color and 582, 610–615
fluorescent 590
incandescent 588–589
incoherent 636
laser 636
mixing colors of 614
neon 591
particle model of 577
polarized 576
primary colors of 614
reflection of rays of 618–622
refraction of 523, 624–625
refraction of, by lens 626–627
secondary color of 614
seeing 629–632
speed of 518, 576
striking objects, interaction of
611, 612
transmitted by transparent or
translucent object, color of
613
using 633–641
visible 579, 582, 585, 588–591
wave model of 576–577

light bulb(s)
power rating of 712
as resistor in circuit 708, 710
types of 588–591

lightning 204, 693
as static discharge 689

lignin 279

limestone 238

line graph 787

lipids 288, 289

liquid(s) 73–74, 487
changes of state 76, 77–80,
488–489

organic 265
speed of sound in 544

liquid crystal display TV 762
liquid-gas changes of state 489

liter (L) 46, 780

litmus 238, 239

living things, role of carbon in
chemistry of 130

local area network (LAN) 768

lodestones 655

longitudinal waves 513
amplitude of 516
diagrams to represent 514

P waves 531, 533
sound waves as 540–543
surface wave as combined
transverse wave and 532
wavelength of 517

loudness 546–548
controlling, on musical
instruments 554–555
distance from sound source and
547
energy of sound source and
547
hearing loss and exposure to
loud sounds 560
measuring 548

Lovelace, Ada 766

luminous object 588

luster of metals 176

M

machines 412, 413–419
compound 433
efficiency of 417–419
mechanical advantage of
416–417. *See also mechanical
advantage*
work made easier by 412,
413–414, 415
maglev train 654, 656
magnesium 117, 121, 187
magnet(s) 655, 662, 666, 667, 672
permanent 666
properties of 655
temporary 666
magnetic attraction, separating
mixtures by 42
magnetic declination 672
magnetic domain 664–665, 666,
667

magnetic Earth 670–675
magnetic field(s) 575, 657–658,
659, 726
around solenoid 726
changing, in transformer 742
combined 658, 659
of Earth 670–675
electromagnetic induction in
736–739
electron spin and 663
energy transformation in 730
in magnetized material 664
produced by electric current
725, 726
strength of 657
magnetic field lines 657

- at magnetic poles 674
- magnetic field map** 725
- magnetic force** 656, 657
- magnetic materials** 665
- magnetic poles** 656
 - of Earth 671, 672
- magnetism** 654–659, 683
 - electric current and 725. *See also* **electromagnetism**
 - electricity from 736–743
 - magnetic materials 665
 - magnetic poles 656, 671, 672, 683
 - of metals 119
- magnetite** 655, 666
- magnetosphere** 674–675
- Maiman, Theodore** 639
- making models, skill of** 779
- malleable** 118, 119, 122, 175
- manipulated variable** 12, 783
- Marconi, Guglielmo** 598
- mass** 45, 344, 544
 - of air 374
 - of atom 107, 110, 115
 - conservation of 53, 196–197
 - conservation of momentum and 359
 - density and 47
 - gravity and 344–345
 - inertia and 350
 - kinetic energy and 444
 - momentum of moving object and 356–357
 - Newton's second law of motion and 351–352
 - units of 45
 - weight and 345
- mass number** 108
- matter** 8, 34–43, 184, 459
 - changes in properties of 188–189
 - chemical properties of 35, 37
 - classifying 36, 37
 - density of 47–48
 - energy and 459
 - mass of 45
 - measuring 44–48
 - physical properties of 35, 36
 - properties of 185
 - states of 70–75, 486–490
 - volume of 46
 - weight of 44, 45
- mean** 789
- measurement, units of.** *See* **units of measurement**
- measurements** 44–48. *See also* *specific measurements*
 - density 47–48
 - mass 45
 - volume 46
 - weight 44, 45
- mechanical advantage** 416–417, 433
 - actual 419
 - of compound machines 433
 - ideal 419
 - of inclined plane 423
 - of lever 426
 - of pulley 430
 - of screw 425
 - of wedge 424
 - of wheel and axle 430
- mechanical digestion** 251, 252, 253
- mechanical energy** 447–448, 730
 - heat engines and 491–492
 - transformation of electrical energy to 730, 732
 - transformation to electrical energy 740–741
 - transformed to thermal energy by friction 458
- mechanical waves** 511. *See also* **longitudinal waves; transverse waves**
 - cause of 512
- median** 789
- medicine**
 - gamma rays used in 584
 - laser surgery 639
 - optical fibers in 641
 - radioactive tracers used in 143
 - ultrasound in 567
- medium(s)** 511
 - density of 544
 - elasticity of 544
 - refraction in different 624
 - speed of sound and 543–545
 - temperature of 545
 - vibration moving through 512
- megabytes** 764
- megaHertz (mHz), FM radio frequencies in** 596
- Meitner, Lise** 155
- melting** 77, 488
 - of ice, as endothermic change 54
- melting point(s)** 77, 488, 489
 - of ionic compounds 162
 - of molecular compounds 168
- memory, computer** 766
- Mendeleev, Dmitri** 110–111, 154, 155
- metal(s)** 118–125, 154, 172–177
 - actinides 112, 114, 124
 - alkali 120, 153
 - alkaline earth 121, 154
 - alloys 122, 173, 665
 - bonding in 174
 - chemical properties of 119, 120, 173
 - ionic bonds between nonmetals and 167
 - lanthanides 112, 114, 122, 123
 - magnetic 665
 - in periodic table 114, 118, 120–124
 - physical properties of 36, 118–119, 173, 175–177
 - reaction of acids with 237
 - reactive 153, 154
 - reactivity with water 110, 114
 - transition 122, 123
- metallic bond** 174–176
- metalloids** 114, 135, 156
- meter (m)** 311, 780
- methane** 266, 267, 270
- microscopes** 634, 635
- microwave ovens** 586–587
- microwaves** 580, 584
 - cellular phones and 597
 - uses of 586
- mid-ocean ridge** 673
- millibar** 378
- milliliter (mL)** 46
- millimeter (mm)** 311
- minerals** 290–291
- mirage** 625
- mirrors** 617–622
 - concave 620–621, 634
 - convex 622
 - plane 619
- mixture(s)** 41–43. *See also* **solution(s)**
 - colloid 224
 - heterogeneous 41
 - homogeneous 41
 - separating 42–43
 - suspension 224
- mode** 789
- model(s)** 15
 - of atoms 103–108
 - of conservation of mass 196
 - of molecules 39
- modems** 765

modulating electromagnetic waves 760

molecular compounds 168–169
chemical formulas of 266

molecular solute 225

molecule(s) 39, 167
attractions between 170–171
diatomic 131, 132
of life 289. *See also* **nutrients**
polar bonds in 170
triatomic 132

momentum 356–357
conservation of 357–359

monitor, computer 765

monomers 272, 275

monounsaturated oils 288

Moseley, Henry 111

motion 308, 309
acceleration and 320–325
circular 321, 363
describing 309–310
detecting 354
fluid 393, 394
force and 335, 336–337
friction and 340, 341–342, 343
graphing 316–317
kinetic energy and 443–444
measuring distance and 310–311
Newton's first law of 349–350
Newton's second law of 350–352
Newton's third law of 353–359, 363
projectile 348, 364
relative 310
satellite 364
velocity and 314–315
work and, as result of force 407

motors, electric 732–733, 740

mouse, computer 22–25

movable pulleys 430, 431

music 552, 553–556
acoustics and 556
pitch and 549
sound quality and 553

musical instruments 554–555
changing pitch on 549, 554–555
percussion instruments 555
sound quality of 553
stringed instruments 554
wind instruments 554, 555

N

nanotubes 263

natural frequencies 527, 553

natural polymers 274, 276, 278, 281

navigation 566, 600

nearsightedness 632

nebula 633

neon light 134, 591

net force 335
balanced and unbalanced forces 336–337
Newton's second law of motion and 351–352

networks, computer 768–769

neutralization 246, 247

neutrons 106, 663
mass number and 108
mass of 107
in unstable atoms 140
in isotopes 108

Newton, Isaac 335, 344, 356, 364
laws of motion 349–359, 363

newton (N) 335, 351, 373

Niépce, Joseph Nicéphore 639

nitrogen family 131

nitrogen fixation 131

noble gases 134, 153, 167

nodes 526

noise 552, 553

noise pollution 562–563

nonmetals 128, 129–134, 155
chemical properties of 130
covalent bonds between 167
ionic bonds between metals and 167
physical properties of 129
reactive 153, 155

nonpolar bond 170

nonpolar molecule 170, 171

north pole (magnetic) 656

notation, scientific 582, 793

n-type semiconductor 752, 753

nuclear energy 451, 463

nuclear fission 451

nuclear fusion 116–117, 451, 463

nuclear reactions 139

nucleic acids 289–290

nucleotides 290

nucleus 105, 106, 663
of atom 39

nutrients 240, 284–291

O

objective 634, 635

observing, skill of 7, 778

Oersted, Hans Christian 724, 738

ohm (Ω) 698

Ohm, Georg 698, 707

Ohm's law 707

oils 288

opaque material 611, 612

open system 197

operating system of computer 767

operational definition 783

optical axis 620

optical fibers 640–641

optical illusion 623

optical instruments 634–635
cameras 581, 597, 635
development of 638–639
microscopes 634, 635
telescopes 584, 633, 634

organic acids 271

organic compounds 265. *See also* **carbon compounds; nutrients**
as building blocks of all living things 284–285

organisms, organic compounds in 265

output 26

output devices 765

output distance 413

output force 413
inclined plane and 423
lever and 426
mechanical advantage and 416–417
pulley and 430
screw and 425
wedge and 424
wheel and axle and 429

output work 413
efficiency and 417, 418

overtones 553

oxidation 52

oxygen 35, 38, 129, 132
chemical reaction with magnesium metal 187
covalent bonds formed by 167
as highly reactive 155
molecule of 39
as part of fire triangle 213
reactivity of metals with 119

oxygen family 132

ozone 132

- P**
- parallel circuits** 711–712
- particle(s)**
- alpha 140, 141
 - in atom 104–105
 - beta 140, 141
 - changes of state and 76–81
 - charges 106
 - in colloid 224
 - in gas 75, 84, 85
 - in liquid 73
 - in solid 72
 - in solution 225
 - in suspension 224
- particle accelerators** 124, 125
- particle model of light** 577
- Pascal, Blaise** 389
- pascal (Pa)** 85, 373
- Pascal's principle** 388, 389–392
- hydraulic systems and 390, 391–392
 - using 390–392
- path of least resistance** 699, 715
- pendulum, energy transformation in** 456–457
- pepsin** 253
- percentage** 792
- percussion instruments** 555
- Perey, Marguerite** 155
- periodic table** 109, 110, 111–115, 118, 120–124, 152–156
- periods (periodic table)** 114
- permanent magnet** 666
- personal computer (PC)** 767
- personal data assistant** 767
- personal safety, electrical safety and** 715–716
- pH** 244–246
- in digestive system 251, 252–253
 - scale 244–245
- phones, cellular** 597
- phone systems, satellite** 598
- photoelectric effect** 577
- photography, computers and manipulation of** 772–773
- photons** 577
- laser light and 636
- photosynthesis, energy transformations in** 61
- physical change** 51, 186
- electromagnetic energy and 60
- physical models** 15
- physical property(ies)** 36, 185
- density as 48
 - mass as 45
 - of matter 35, 36
 - of metalloids 135
 - of metals 36, 118–119, 173
 - of nonmetals 129
- physical science**
- careers in 8, 9
 - definition of 6
 - as study of matter and energy 8–9
- physics** 8
- pigments** 615
- pitch** 548–549
- changing 549
 - controlling, on musical instruments 549, 554–555
 - Doppler effect and 550–551
 - frequency and 548–549
- plane, inclined** 423
- plane mirrors** 619
- plasma** 116
- plasma TV** 762
- plastics** 271, 277, 280–281
- recycling 281, 282–283
- polar bond** 170
- polarized light** 576
- polarizing filters** 576–577
- polar molecules** 170, 171
- polar solvents, compounds soluble in** 233
- poles**
- geographic 671
 - magnetic 656, 671, 672, 683
- pole vault, energy in** 457
- pollution, noise** 562–563
- polyatomic ions** 159, 161
- polyester fleece** 282–283
- polymers** 272, 274–283
- complex carbohydrates as 286
 - composites and 278–280
 - natural 274, 276, 278, 281
 - proteins 287
 - synthetic 272, 274, 277, 278, 280–281
- polyunsaturated oils** 288
- potential difference (voltage)** 696, 697
- potential energy** 58, 59, 445–446, 696–697. *See also fossil fuels*
- chemical energy as 450
 - elastic 446, 457
 - gravitational 445, 456, 457
 - mechanical energy and 448
 - nuclear energy 451, 463
 - transformation between kinetic energy and 456–457
- power** 409, 712
- calculating 410
 - electric 712–714
 - energy and 443
 - units of 411
 - work and 409–411
- power plants** 464–465
- power ratings** 712–713
- precipitate** 188
- precision** 793
- predicting, skill of** 8, 778
- pressure** 85, 372, 373–378
- area and 373
 - atmospheric 374–378
 - balanced 375
 - Boyle's law on volume and 86, 92–93
 - calculating 373
 - fluid. *See fluid pressure*
 - of gas, measuring 85
 - gas temperature and 87
 - measuring 378
 - moving fluids and 393, 394
 - solubility of gases and 233
 - transmitted in fluid, Pascal's principle 389–392
 - unbalanced 375
- primary colors** 614
- of pigments 615
- primary (P) waves** 531, 533
- prism, refraction in** 582, 625
- probability** 789
- process** 26
- products** 195
- in acid-base reactions 247
 - conservation of mass of 196
- programming, computer** 768. *See also software, computer*
- projectile** 348, 364
- properties of matter** 185
- chemical properties 35, 37
 - chemical reactions and changes in 188–189
 - physical properties 35, 36
- proportion** 792
- proteins** 276, 287, 289, 290
- amino acids in 253, 276, 287, 290
 - chemical digestion of 251, 253
 - DNA and 290
- protons** 105, 106, 152, 663
- beta decay and 140
 - mass number and 108
 - mass of 107
 - in nuclear fusion 116

Index

Page numbers for key terms are printed in **boldface** type.
Page numbers for illustrations, maps, and charts are printed in *italics*.

positive charge of 683
prototype 25, 785
p-type semiconductor 752, 753
pulley 430, 431
pupil (eye) 630, 631
P waves 531
 on seismograph 533



qualitative data 13
qualitative observations 7
quantitative data 13
quantitative observations 7
questions, posing 11



radar 580
radiation 139, 480, 481
 electromagnetic 575
 gamma 140–143, 584, 585
 nuclear 139, 140, 141
radio 594–596, 760–761
radioactive decay 139
 types of 140–141
radioactive elements 138–143
radioactivity 139
radio stations, frequencies used
 by 596, 760, 761
radio waves 579, 580, 584
 AM and FM 595
 radio and television signals
 transmitted by 594–596
 spectrum of 596
 television satellites
 transmitting 599
rainbows 523, 625
Ramsay, William 154
random access memory (RAM) 766
rarefactions 513, 514, 516, 531, 541
rates of chemical reactions,
 controlling 207–209
ratio 40, 792
ray diagrams 620
rays 618
 reflection of light 618–622
 refraction of light 523,
 624–625, 626–627
reactants 195
 in acid-base reactions 246
 activation energy to break
 bonds of 205
 classifying chemical reactions
 by action of 200–201
 concentration of 208

conservation of mass of 196
reaction force 354–355
reactions. *See* chemical reaction(s)
reactive metals and nonmetals
 153, 154, 155
reactivity 37, 119
 of halogens 133
 of metals 114, 119, 120, 121
 of nonmetals 130, 133
 of oxygen 132
 of plastics 281
reading comprehension skills
 794–796
read only memory (ROM) 766
real image 621, 626
receiver, phone 757
recycling 281
 polyester fleece from plastics
 282–283
reed 555
reference point 309, 310
reflecting telescope 634
reflection 521, 522, 617–622
 angle of 522
 concave mirrors and 620–621,
 634
 convex mirrors and 622
 diffuse 618
 law of 522
 of light rays 618–622
 plane mirrors and 619
 regular 618
 of sound waves 542
 total internal 640
refracting telescope 634
refraction 523, 623–625
 index of 624
 of light 523, 624–625
 of light, by lens 626–627
 in prism 582, 625
 in water 523
refrigerant 495
refrigerators 494–495
regular reflection 618
relative motion 310
relativity, theory of 459
replacement 200–201
research, technology design and 23
resistance 698–699
 factors that determine 698–699
 Ohm's law and 707
 of parallel circuit 711
 path of least 699, 715
resistors in circuit 708, 710–711
resonance 527

sound quality and 553
responding variable 12, 783
retina 630, 631, 632, 639
RNA (ribonucleic acid) 289, 290
rockets 362, 363
rocks 655, 673
rods (in eye) 630, 631
Roebing, Emily Warren 504, 505
Roebing, John 504
Roebing, Washington 504, 505
rolling friction 342, 343
rust 37, 52, 119, 122, 130
Rutherford, Ernest 104–105



safety
 electrical 715–717
 home fire 214–215
 in the laboratory 17–20,
 798–799
 in using acids and bases 245
safety symbols 19
salt 226, 247
 formation of 130, 133
satellite(s) 362, 363–367
 communications 598–600, 761
 motion 364
saturated fats 288
saturated hydrocarbons 269
saturated solution 231
scales, temperature 474, 781
science 7
 development of 15–16
 how scientists think 7–8
 technology and 22
scientific inquiry 10–14
scientific law 15
scientific models 15
scientific notation 582, 793
scientific theory 16, 103
screws 425
Seaborg, Glenn 155
“sea of electrons” model of solid
 metals 174, 175
search engines 769
secondary colors 614, 615
secondary (S) waves 531, 533
second (unit of time) 781
seismic waves 530, 531–533
seismographs 533
semiconductors 135, 752–754
 diodes 753
 integrated circuits 754
 transistors 753
sequence 796

- series circuits 710
 Seurat, Georges 102
 shape, changes in 51
 shocks, electric 716
 shock waves 551
 short circuits 715
 sight. *See* vision
 signals, electronic 750, 760–761
 analog 751
 digital 751
 sound converted into 756, 758,
 760–761
 significant figures 793
 silk 276
 tarnish (silver sulfide) 37, 40,
 52, 110
 simple carbohydrates 285
 simple machines 422–432
 in human body 432
 inclined plane 423
 levers 426, 427, 432
 pulley 430, 431
 screw 425
 wedge 43, 424
 wheel and axle 428–430
 single replacement reaction 201
 sinking. *See also* buoyant force,
 density and 383, 383–384, 385
 of ship 380
 SI units of measurement 13, 45,
 310–311, 780–781. *See also*
 units of measurement
 skepticism 10
 sliding friction 342, 343
 slip rings in generator 740
 slope(s) 316
 calculating 316
 of distance-versus-time graph
 316, 325
 of speed-versus-time graph 324
 sodium vapor light 590
 software, computer 767–769
 solar wind 674
 solenoid 726
 electromagnet as 727–728
 solid(s) 71–72, 487
 changes of state 76, 77–78, 81,
 488–489
 particles in 72
 speed of sound in 544
 types of 72
 solubility 36, 231–235
 solute(s) 222
 concentrations and 230–231
 conductivity and 225
 effects on solvents 226–227
 ionic 225
 molecular 225
 solution(s) 41, 222–227
 acids in 242–243, 244
 bases in 243
 colloids compared to 224
 concentrated 230
 concentration of 231
 dilute 230, 245
 effects of solutes on solvents
 226–227
 particles in 225
 saturated 231
 supersaturated 235
 suspensions compared to 224
 unsaturated 231
 solution to problem, designing 24
 solvent 222
 boiling point of 227
 concentrations and 230–231
 effects of solutes on 226–227
 freezing point of 226
 solubility and 232, 233
 water as universal 222–223
 sonar 566
 sonic boom 551
 sonogram 567
 sound 540–551
 amplitude modulation
 transmission of 595
 hearing 558–560
 how sound travels 541
 loudness of 546–548
 music 549, 552, 553–556
 properties of 546–551
 speed of 518, 543–545
 using 564–567
 sound converted into electronic
 signal. *See also* electronic
 communication
 in radio 760–761
 in sound recordings 758
 by telephone 756
 sound quality 553
 sound recordings 758–759
 analog 758
 digital 759
 sound waves 511, 540–543
 Doppler effect and 550–551
 interactions of 542–543
 as longitudinal waves 513
 making 541
 space, energy transferred through
 575
 space shuttle 363, 639
 specific heat 476–477
 spectroscope 588
 speed 312
 acceleration and change in
 320–325
 average 313
 calculating 312–313
 equation for 312
 instantaneous 313
 of light 518, 576
 velocity and 314–315
 speed of sound 518, 543–545
 density and 544
 elasticity and 544
 temperature and 545
 speed of waves 518
 refraction and changes in 523
 speed-versus-time graph 324
 Spencer, Percy 586
 Sputnik 362, 599
 standing waves 526–527, 553
 starch 274, 276, 286
 stars, formation of elements in
 116–117
 states of matter 70–75, 486–490. *See*
 also gas(es); liquid(s); solid(s)
 changes of 51, 76–81, 488–489
 gases 75, 487
 liquids 73–74, 487
 as physical property 36
 plasma 116
 solids 71–72, 487
 thermal expansion and 490
 static discharge 688–689, 716
 static electricity 685–689
 static friction 342, 343
 steam engine 492
 steel 173
 step-down transformer 742, 743
 step-up transformer 742, 743
 stringed instruments 554
 structural formula 267
 double and triple bonds in 269
 of hydrocarbons 267
 isomers and 268
 sublimation 81
 subscript 161, 266
 substance(s) 35
 chemical property of pure 37
 elements as simplest 38
 in mixtures 41
 physical property of pure 36
 substituted hydrocarbons
 270–271

- sucrose 285
 sugar 40, 232, 234, 285
 sulfuric acid 132, 704, 705
 sun *See also* stars, formation of
 elements in
 energy from 463, 464
 hydrogen in 116
 plasma in 116
 solar wind from 674
 source of energy 60, 116
 temperature of 116
 supernova 117
 supersaturated solution 235
 surface area, controlling reaction
 rate with 207
 surface tension 74
 surface wave 531, 532
 suspensions 224
 S waves 531, 533
 switch(es)
 in circuit 709
 diodes as a type of 753
 representing binary numbers in
 computer 764
 transistor acting as 753
 symbols
 chemical 112, 115
 safety 19
 synthesis 200
 synthetic composites 280
 synthetic elements 124, 125
 synthetic polymers 272, 274, 277,
 278, 280–281
 Système International d'Unités
 (SI) 13, 45, 310–311, 780–781.
 See also units of measurement
 systems 26
- T**
- table, compare/contrast 796
 tarnish 37, 40, 52, 110
 technology(ies) 22–27
 design process 22, 23–25
 science and 22
 society and 27
 as system 26
 telegraph 756
 telephones 597, 756–757
 telescopes 584, 633, 634
 television 614, 761–762
 television satellites 599
 television stations, frequencies
 used by 596
 temperature 54, 472–474. *See also*
 heat transfer
 changes in energy and 190–191
 controlling reaction rate with 208
 of gas, measuring 84
 gas pressure and 87
 measuring 473
 resistance and 699
 solubility and 232, 234–235
 specific heat and change in
 476–477
 speed of sound and 543, 545
 thermal energy flow and 76
 volume of gas and 88–89,
 91–92
 temperature scales 474, 781
 temporary magnet 666
 terabytes 764
 terminal 697, 704
 terminal velocity 347
 Tesla, Nikola 739
 texture 36
 theory, scientific 16, 103
 thermal energy 54, 59, 60, 61, 76,
 77–81, 449, 474–475
 calculating changes in 477
 changes in matter and 54, 58,
 60, 76
 changes of state and 77–81,
 488–489
 combustion and transformation
 of chemical energy to 464
 cooling systems to transfer
 494–495
 heat engine and transformation
 of 491–492
 heat transfer and 475, 482
 kinetic energy and 59
 mechanical energy transformed
 by friction to 458
 specific heat and absorption of 477
 states of matter and 486–490
 thermal expansion 490
 thermogram 581
 thermometer 473, 751
 thermostats 490
 Thomson, J. J. 104
 time
 in distance-versus-time graphs
 316, 325
 power and 409
 in speed-versus-time graph 324
 total internal reflection 640
 tracers 142–143
 trade-off 24, 784
 transformers 741–743
 transistors 753
 transition metals 122, 123
 translucent material 611, 613
 transmission 760, 761
 transmission antennas 594
 transmitter 756
 radio 760
 telephone 756
 transparent material 611, 613
 transportation 56–57, 314–315
 transverse waves 512
 amplitude of 516
 diagrams to represent 514
 surface wave as combined
 longitudinal wave and 532
 S waves 531, 533
 wavelength of 517
 triatomic molecule 132
 triple-beam balance 800
 triple bonds 168, 269
 troubleshooting 25, 785
 troughs 512, 514, 516, 525, 531
 tsunamis 532
 tungsten-halogen bulb 589
 turbine 741
- U**
- Ultra High Frequency (UHF) 596
 ultrasound 549, 564–567
 echolocation and 565
 ultraviolet rays 582, 585
 unbalanced forces 336, 349
 units of measurement 310–311.
 See also International System
 of Units (SI)
 of acceleration 322, 351
 for area 373
 for energy 443
 for heat 475
 joules 409, 411, 443, 475
 for mass 344
 for momentum 356
 newton (N) 335, 351, 373
 pascal (Pa) 85, 373
 for power 411
 for pressure 373, 378
 for specific heat 476
 universal gravitation, law of 344
 universal solvent 222–223
 unsaturated fatty acids 288
 unsaturated hydrocarbons 269
 unsaturated solution 231
- V**
- vacuum, speed of light in 576
 valence electrons 150–151
 in alkali metals 153

- of carbon atom 261
 - covalent bonds and 167
 - in halogen family 153
 - in hydrogen 156
 - luster of metals due to 176
 - in metalloids 156
 - in metals 174
 - in noble gases 153
 - in nonmetals 155
 - patterns of 152, 153
 - Van Allen belts** 674
 - Van Allen, J. A.** 674
 - vaporization** 78–79, 489
 - variable(s)** 12, 783
 - directly proportional 92
 - inversely varying 93
 - velocity** 314
 - acceleration and change in 320–325
 - air resistance and 347
 - conservation of momentum and 359
 - describing 314–315
 - kinetic energy and 444
 - momentum of moving object and 356–357
 - terminal 347
 - Venn diagrams** 796
 - vertical (y-) axis** 90
 - Very High Frequency (VHF)** 596
 - vibration** 512
 - natural frequency of 527
 - sound wave created by 540, 541
 - virtual image** 619–622, 626, 627
 - viscosity** 74
 - visible light** 60, 579, 582, 585, 588–591
 - vision** 629–632
 - vitamins** 240, 290, 582
 - Volta, Alessandro** 703, 704, 705
 - volt (V)** 696
 - voltage** 696, 697, 704
 - AC 739
 - in calculation of power 713
 - changing, in transformer 741, 742–743
 - in household circuits 712
 - measuring 712
 - Ohm's law and 707
 - voltage sources** 696–697
 - voltmeter** 712
 - volume** 46, 790
 - Boyle's law on pressure and 86, 92–93
 - calculating 46
 - constant 87
 - density and 47, 554
 - of gas 75, 84
 - of liquid 73
 - of solid 71, 72
 - temperature and gas 88–89, 91–92
 - units of 46
-
- W**
- WAN.** *See* wide area network.
 - water**
 - activation energy for reaction producing 205
 - boiling point of 79, 474
 - density of, at room temperature 47, 48
 - fighting fire with 214
 - freezing point of 78, 474
 - index of refraction of 624
 - ionic and molecular solutes in 225
 - melting point of 77, 78
 - molecule of 39
 - as nutrient 291
 - pH of pure 245
 - as product of neutralization reaction 247
 - properties of 185
 - refraction of 523
 - specific heat of 477
 - surface tension of 74
 - tap 222
 - three states of 487
 - as universal solvent 222–223
 - water molecules** 170, 171
 - water vapor** 80
 - watt (W)** 411, 712
 - Watt, James** 411
 - wavelength** 517
 - calculating 518
 - of electromagnetic waves 579
 - frequencies and 579
 - wave model of light** 576–577
 - waves** 451, 510, 511–533. *See also*
 - electromagnetic waves;
 - longitudinal waves; transverse waves
 - amplitude of 516
 - diffraction of 524
 - electromagnetic 451, 480
 - energy and 511–512
 - frequency of 517
 - interactions of 521–527
 - interference of 524–525
 - mechanical 511, 512
 - properties of 515–519
 - reflection of 522
 - refraction of 523
 - seismic 530, 531–533
 - speed of 518, 523
 - types of 510, 511, 512–514, 551
 - wavelength of 517
- wedge(s)** 424, 432
- weight** 44, 45, 345
 - buoyant force and 381–382
 - gravitational potential energy and 445
- wet cell** 705
- wheel and axle** 428–430
- wide area network (WAN)** 768
- wind instruments** 554, 555
- wind, solar** 674
- wire(s)**
 - conducting, in electric circuit 709
 - high-voltage 715
- wireless communication**
 - 594–600, 760–762
- work** 406
 - calculating 408–409
 - energy as transfer of 443
 - input 413, 417
 - made easier by machines 412, 413–414, 415
 - meaning of 406–407
 - mechanical energy as ability to do 448
 - output 413, 417, 418
 - power and 409–411
- World Wide Web (WWW)** 769
- Wright, Wilbur and Orville** 393, 395
-
- X**
- x-axis** 90
 - X-rays** 451, 579, 583, 585
-
- Y**
- y-axis** 90
 - Yeager, Chuck** 545
 - yne suffix** 269
-
- Z**
- zero, absolute** 474