

## Appendix C. Glossary

- absolute pressure** The total pressure in an enclosed volume measured above zero, or perfect vacuum. The sum of atmospheric pressure plus gage pressure (1.2)
- absolute zero** The lower limit of temperature (0 K or  $-273^{\circ}\text{C}$ ) of any substance, where thermal energy is zero (5.4)
- adiabatic process** A process in which no heat is transferred to or from a system (5.4)
- alpha decay** A radioactive decay process in which an unstable nucleus emits an alpha particle (9.2)
- alpha particle** A particle emitted by some radioactive materials. An alpha particle is a helium-4 nucleus consisting of two protons and two neutrons. (9.2)
- alternating current (AC)** A current in which the direction of electric charge flow changes regularly in an electric circuit (1.3.)
- ammeter** A device that measures current (3.3)
- ampere (A)** The unit of current. Defined as one coulomb per second (2.3)
- amplitude** The distance from equilibrium to the crest or the trough of a wave (8.1)
- angle of incidence** The angle between an incident ray and the normal to the surface (10.1)
- angle of reflection** The angle between a reflected ray and the normal to the surface (10.1)
- angle of refraction** The angle between a refracted ray and the normal to the surface (10.1)
- angular acceleration** The ratio of the change in angular speed to the time interval over which the change is measured (3.1)
- angular displacement** The change in angular position, or angular distance traveled, when an object rotates from one position to another (3.1)
- angular impulse** The product of the torque exerted on an object and the time interval over which the torque acts (7.2)
- angular momentum** The product of an object's moment of inertia and its angular velocity (7.2)
- angular speed** The ratio of angular displacement to the time interval over which the displacement is measured (3.1)
- Archimedes' principle** An object immersed in a fluid has an upward (buoyant) force exerted on it equal to the weight of the fluid displaced by the object. (1.2)
- atomic mass unit (u)** A unit of mass used for nuclear calculations. Defined as  $1/12$  the mass of the carbon-12 isotope (9.2)
- atomic number** The number of protons in the nucleus of an atom (9.2)
- average acceleration** The ratio of the change in velocity to the time interval over which the change is measured (3.1)
- average speed** The ratio of the total distance traveled to the time interval over which the distance is measured (3.1)
- average velocity** The ratio of the displacement to the time interval over which the displacement is measured (3.1)
- barometer** An instrument used for measuring atmospheric pressure (1.2)
- battery** A source of electric potential difference in an electric circuit. Converts chemical energy into electric energy and charge flow (1.3)
- beat** A pattern of pulsations or variations in loudness produced by two sound waves having slightly different frequencies (8.2)

- Bernoulli's principle** As the velocity of a fluid increases, the pressure in the fluid decreases. (5.2)
- beta decay** A radioactive decay process in which an unstable nucleus emits a beta particle (9.2)
- beta particle** A particle emitted by some radioactive materials. A beta particle can be an electron or a positron. (9.2)
- binding energy** The energy holding the protons and neutrons together in the nucleus of an atom (9.2)
- Bohr frequency condition** A condition in which an electron in an atom jumps from one energy level to another and a photon is emitted of frequency  $\Delta E/h$ , where  $\Delta E$  is the change in the electron's energy and  $h$  is Planck's constant (10.3)
- boiling point** The temperature at which a material changes state from liquid to gas as thermal energy is added to the material (1.4)
- British thermal unit (Btu)** A unit of energy in the English system. Defined as the energy required to raise the temperature of one pound of water by one degree Fahrenheit (1.4)
- buoyancy or buoyant force** The upward force exerted on an object immersed in a fluid (1.2)
- calorie (cal)** A unit of energy. Defined as the energy required to raise the temperature of one gram of water by one degree Celsius (1.4)
- capacitance** The ratio of the charge stored on a capacitor to the potential difference across the capacitor (5.3)
- capacitor** An electrical device that stores charge and energy. The energy is stored in the electric field across the plates of a charged capacitor. (5.3)
- Carnot efficiency** The maximum possible efficiency of a heat engine (5.4)
- chain reaction** A process of self-sustained fission reaction in which neutrons are absorbed and cause fissions, which release more neutrons, which cause further fissions (9.2)
- closed system** A system that does not gain or lose mass (2.2, 5.2, and 7.1)
- coefficient of friction** The ratio of the maximum force (static or kinetic) of friction to the normal force between the surfaces in contact (4.1)
- coherent waves** Waves for which there is a fixed relation between their phases. Any difference between phases does not change. (10.2)
- concave lens** A lens that is thinner at its center than at its edges (10.1)
- concave mirror** A mirror with an inwardly curved surface ("caved in") as seen by an incident light ray (10.1)
- conductor** A material containing many free electrons that move through the material easily when an electric field is applied (4.3)
- constructive interference** Phenomenon in which the interaction of two waves produces an increase in wave amplitude (8.2)
- convection** The transfer of heat by movement of a fluid (3.4)
- convex lens** A lens that is thicker at its center than at its edges (10.1)
- convex mirror** A mirror with an outwardly curved surface as seen by an incident light ray (10.1)
- coulomb (C)** The SI unit of electrical charge (1.3)
- Coulomb's law** One charged object attracts another charged object with a force that is directly proportional to the product of the objects' charges and inversely proportional to the square of the distance between the objects' centers. (1.3)
- critical angle** The angle of incidence for a light ray traveling through a material for which the refracted angle has a measure of  $90^\circ$  (10.1)

- current** The rate of charge flow in a conductor, measured in amperes. Defined as the ratio of the charge moved through a cross-sectional area to the time interval over which the measurement is made (2.3 and 3.3)
- density** A property of a material, defined as the mass of a sample of the material divided by the volume (1.2)
- destructive interference** Phenomenon in which the interaction of two waves produces a decrease in wave amplitude (8.2)
- diffraction** The bending of light around the edges of an obstacle (10.2)
- diffraction grating** A optical device that uses a large number of parallel slits (or lines) to transmit (or reflect) light to form an interference pattern (10.2)
- direct current (DC)** A current in which electric charge flows in one direction in an electric circuit (1.3)
- displacement** A vector quantity that defines the distance and direction between two points. The magnitude of the displacement vector is the change in position, or distance traveled, when an object moves from the first point to the second point. (3.1)
- drag** The force that opposes motion when a solid object moves through a fluid or when a fluid flows past a solid object. Drag increases with speed. (4.2)
- efficiency** The ratio of output work to input work (2.1)
- elasticity** The tendency of an object or material to return to its original shape after being stretched or compressed (5.2)
- elastic potential energy** Energy stored by an object due to a change in its shape (5.2)
- electrical force** A force acting at a distance between two or more charges (1.3)
- electrical resistance** A measure of the ability of an electrical device to oppose the flow of charge through the device. Defined as the ratio of the potential difference, or voltage drop, across a device to the current through the device (4.3)
- electric charge** The property of an object that causes electrical force (1.3)
- electric field** An imaginary construction of vectors to help us visualize and predict electric forces on charged objects placed in the field (1.3)
- electric field lines** Lines showing the direction and magnitude of the electric field (1.3)
- electric potential difference** Also called voltage or voltage difference. The ability to accelerate an electric charge between two points in an electric field. Defined as the change in potential energy per unit charge (1.3 and 2.3)
- electromagnetic induction** The process of generating a current in a wire due to relative motion between the wire and a magnetic field (5.3)
- electromagnetic radiation** A transfer of energy by means of electromagnetic waves (9.1)
- electromagnetic spectrum** An arrangement of the continuous wavelengths and frequencies of electromagnetic waves (9.1)
- electromagnetic wave** A wave that consists of electric and magnetic fields changing in step with each other and that travels through space at the speed of light (9.1)
- electromotive force (EMF)** The potential difference produced by electromagnetic induction (5.3)
- electron volt (eV)** An amount of work or energy equal to that gained by an electron when accelerated through a potential difference of one volt (9.2)
- elementary charge (q)** The charge on one electron or proton,  $\pm 1.60 \times 10^{-19} \text{ C}$  (1.3)

- emission spectrum** The array of wavelengths emitted by a source of light (10.3)
- energy** The property of a system or object that enables it to do work (5.1)
- energy dissipation** A conversion of work or useful forms of energy into thermal or unusable forms of energy (6.1)
- energy level** A discrete amount of total energy that an electron can have when it is bound to an atom (10.3)
- equilibrium** A state in which the net force acting on an object is zero; or when the forces are balanced (1.1)
- excited state** An energy level above the ground state that an electron can occupy in an atom when the atom absorbs the right amount of energy (10.3)
- farad (F)** The unit of capacitance. Defined as one coulomb per volt (5.3)
- first law of thermodynamics** Law stating that the increase in internal energy of a system is the heat added to the system minus the work done by the system (5.4)
- fission** Reproduction in which a heavy nucleus (such as uranium or plutonium) absorbs a neutron, becomes highly unstable, and splits into two or more smaller nuclei plus other nuclear particles and energy (9.2)
- fluid** A liquid or a gas. A material that can flow, has no definite shape of its own, and conforms to the shape of its container (1.2)
- fluid resistance** A measure of the ability of an object to oppose the flow of fluid across the object's surface. Defined as the ratio of the pressure drop in the fluid to the volume flow rate (4.2)
- focal length** The distance from the focal point to the vertex of a spherical mirror. Also the distance from the focal point to the center of a thin lens (10.1)
- focal point** The point at which a mirror or lens causes parallel light rays to converge or appear to diverge from (10.1)
- foot (ft)** The base unit of length in the English system (1.1)
- foot-pound (ft·lb)** The English unit of energy (2.1)
- force** A push or a pull exerted on an object in a direction (1.1)
- free-body diagram** A diagram that uses arrows representing vectors to show all the forces acting on an object or system (1.1)
- frequency** A measure of how often a pattern repeats itself. Defined as the ratio of the number of complete cycles, or oscillations, of the pattern to the time interval over which the cycles are measured (3.3)
- friction** A force that opposes relative motion of two solids or a solid and liquid (4.1)
- fusion** A union in which two light nuclei combine to form a single heavier nucleus plus energy (9.2)
- gage pressure** The pressure in an enclosed volume measured above atmospheric pressure (1.2)
- gamma decay** A radioactive decay process in which an unstable nucleus emits a gamma ray (9.2)
- gamma ray** Electromagnetic wave in the wavelength band between approximately  $10^{-13}$  m and  $10^{-11}$  m that is emitted by the nucleus of an unstable atom (9.1 and 9.2)
- gravitational acceleration (g)** The acceleration experienced by an object when gravity is the only force acting on it. On the surface of the Earth,  $g = 9.80$  m/s<sup>2</sup> or 32.2 ft/s<sup>2</sup>, and is directed toward the center of the Earth. (4.1)
- gravitational force** An attractive force acting at a distance between two or more masses (1.3)

- gravitational potential energy** Energy stored by an object due to the location of the object in a gravitational field (5.2)
- ground state** The lowest energy level that can be occupied by an electron in an atom (10.3)
- heat** The energy transferred from one object to another because of a temperature difference (1.4)
- heat conduction** The process of transferring thermal energy from a hotter object to a cooler object, as kinetic energy is transferred when particles collide (1.4 and 3.4)
- heat engine** A device that converts thermal energy into mechanical energy (5.4)
- heat flow rate** The ratio of the heat transferred to the time interval over which the transfer is measured (3.4)
- heat of combustion** The amount of heat released when one kilogram or one cubic meter of a substance is burned (6.2)
- heat of fusion** The amount of energy required to melt one gram of a solid substance. Also, the amount of energy released when one gram of a liquid solidifies (1.4)
- heat of vaporization** The amount of energy required to vaporize one gram of a liquid substance. Also, the amount of energy released when one gram of a gas condenses (1.4)
- henry (H)** The unit of inductance. Defined as one volt per ampere per second (5.3)
- hertz (Hz)** The unit of measure of frequency. Defined as one cycle per second, or  $1/s$  (3.3)
- horsepower (hp)** An English unit of power. Defined as 550 foot pounds per second (5.4)
- hydraulic system** A system that uses a liquid as a working fluid (1.2)
- impulse** The product of the force exerted on an object and the time interval over which the force acts (7.1)
- incoherent waves** Waves for which there is no fixed relation between their phases. There are random differences between their phases. (10.2)
- index of refraction** A property of a transparent material defined as the ratio of the speed of light in a vacuum ( $c$ ) to the speed of light in the material (10.1)
- inductance** The ratio of the induced EMF of an inductor to the rate of change of current through the inductor (5.3)
- inductor** An electrical device that stores voltage and energy. The energy is stored in the magnetic field of the inductor. (5.3)
- inertia** A property of an object by which it resists changes in its motion (1.1)
- infrared radiation** Electromagnetic waves in the wavelength band between approximately  $10^{-6}$  m and  $10^{-3}$  m that can be used to transfer heat from a hot object to a cool object (9.1)
- insulation** A layer of a material with a high thermal resistance, used to reduce the heat transfer rate from a region (4.4)
- insulator** A material that does not contain significant numbers of free electrons that can move easily through the material (4.3)
- interference** The interaction of two or more waves of the same type when they occupy the same space at the same time (8.2)
- internal energy** The sum of the microscopic kinetic and potential energies of all the atoms and molecules that make up a system (5.1 and 5.4)
- isolated system** A closed system on which no net external forces act (7.1)
- isotopes** Atoms that have the same number of protons in their nuclei but differing numbers of neutrons (9.2)
- joule (J)** The SI unit of energy. Equal to one newton·meter (2.1)



- kelvin (K)** The interval of temperature measurement on the Kelvin scale (5.4)
- kilogram (kg)** The base unit of mass in the SI system (1.1)
- kilowatt-hour (kWh)** The energy consumed by a 1-kW device operated for one hour (6.3)
- kinetic energy** Energy possessed by an object or system due to motion of the object or system (2.1 and 5.1)
- kinetic friction** The force required to maintain a constant speed between two surfaces in contact (4.1)
- laminar flow** Slow, smooth flow of fluid over a surface, in which the paths of individual particles of fluid do not cross. Also called streamlined flow (4.2)
- laser** A device that is a source of monochromatic, highly directional, coherent light (10.3)
- laser medium** A solid, liquid, or gaseous material that can be used to amplify the intensity of a laser beam (10.3)
- laser pump** A source of energy for exciting atoms or molecules of a laser medium (10.3)
- law of conservation of angular momentum**  
When no net external torque acts on a closed system, the total angular momentum of the system remains constant. (7.2)
- law of conservation of energy** The total energy of an isolated system is constant. (5.2)
- law of conservation of linear momentum**  
When no net external force acts on a closed system, the total linear momentum of the system remains constant. (7.1)
- law of reflection** When light reflects from a surface, the angle of reflection equals the angle of incidence. (10.1)
- lens** A ground or molded piece of transparent glass or plastic used to change the direction of light in optical systems (10.1)
- Lenz's law** A current produced by electromagnetic induction has a magnetic field that opposes the change in the magnetic field that induced the current. (5.3)
- lever arm** The shortest distance from an object's axis of rotation to the line of action of an applied force (1.1)
- linear momentum** The product of the mass of an object and its velocity (7.1)
- longitudinal wave** A wave that displaces particles in the medium parallel to the direction in which the wave travels (8.1)
- magnetic field** An imaginary construction of vectors to help us visualize and predict magnetic forces on charged objects moving through the field (5.3)
- magnification** The ratio of the image size to the object size in an optical system (10.1)
- mass** A measure of an object's inertia or the amount of matter contained within an object (1.1)
- mass defect** The difference between the sum of the masses of the nucleons in a nucleus and the actual mass of the nucleus. The mass defect is converted into energy. (9.2)
- mass flow rate** The ratio of the change in mass to the time interval over which the change is measured (3.2)
- mass number** The number of nucleons (protons plus neutrons) in the nucleus of an atom (9.2)
- mechanical wave** A wave that requires a medium for propagation (8.1)
- melting point** The temperature at which a material changes state from solid to liquid as thermal energy is added to the material (1.4)
- metastable state** An excited state, or elevated energy level, in an atom; distinguished from other excited states because the electron stays in a metastable state for a much longer time
- meter (m)** The base unit of length in the SI system (1.1)

- metric system** A set of measurements in which units are related by powers of ten (1.1)
- microwave** Electromagnetic wave in the wavelength band between approximately  $10^{-3}$  m and 0.1 m (9.1)
- moment of inertia** A property that describes an object's resistance to change in rotational motion. For an object in rotational motion, moment of inertia is analogous to the mass for an object in translational motion. (5.1)
- monochromatic light** Light that has only one wavelength (10.2)
- natural frequency** The frequency at which an object or system oscillates on its own when set into motion (8.2)
- newton (N)** The base unit of force in the SI system (1.1)
- Newton's first law of motion** If the net force on an object or a system is zero, the velocity of the object or system will not change. (1.1)
- Newton's second law of motion** The acceleration of an object is directly proportional to the net force acting on the object and inversely proportional to the mass of the object. Equivalently stated as: A net force exerted on an object equals the rate of change of the object's linear momentum. (4.1 and 7.1)
- Newton's third law of motion** When one body exerts a force on another body, the second body exerts an equal and opposite force on the first. (7.1)
- Newton's universal law of gravitation** One object attracts another object with a force that is directly proportional to the product of the objects' masses and inversely proportional to the square of the distance between the objects' centers. (1.3)
- nuclear radiation** A transfer of energy away from an unstable nucleus by means of alpha particles, beta particles, or gamma rays (9.2)
- ohm ( $\Omega$ )** The unit of electrical resistance. Defined as one volt per ampere (4.3)
- Ohm's law** The linear relationship between applied potential difference and current through an electrical device,  $\Delta V = IR$ , where resistance  $R$  is constant (4.3)
- optical cavity** The region between the mirrors of a laser containing the laser medium (10.3)
- parallel circuit** An electrical circuit in which there are multiple paths for current. Part of the current flows through each branch of the circuit. The total current equals the sum of the currents in the branches. (4.3)
- parallel connection** A connection of electric circuit elements in which there is more than one path for current. The voltage across each element is the same. (3.3)
- Pascal's principle** A change in pressure at any point in a confined fluid is transmitted undiminished throughout the fluid. (1.2)
- period** The time required for one complete cycle of a repeating pattern (3.3)
- periodic wave** A regular, repeating wave that travels through a medium or space (8.1)
- photoelectric effect** The liberation of an electric charge by electromagnetic radiation incident on a surface (9.1)
- photon** A massless particle, the quantum of the electromagnetic field, carrying energy, momentum, and angular momentum (9.1)
- Planck's constant ( $h$ )** A fundamental physical constant, the elementary quantum of action; the ratio of the energy of a photon to its frequency (9.1)
- plasma** A gas containing free electrons and ions (1.2)
- pneumatic system** A system that uses a gas as a working fluid (1.2)

- Poiseuille's law** For a fluid in laminar flow through a tube or pipe, the relationship between volume flow rate, pipe radius, pressure drop, and length of pipe (4.2)
- population inversion** A state in which more electrons are in an excited energy level than in the next lower level (10.3)
- potential energy** Energy stored by an object or system due to the location of the object or system (2.1 and 5.1)
- pound (lb)** The base unit of force in the English system (1.1)
- power** The rate of doing work or the rate of transferring energy (6.1)
- power density** For a source of light, the ratio of radiant power output to the cross-sectional area over which the energy is spread. Common units of power density are watts per cm<sup>2</sup>. (10.3)
- pressure** A force applied over an area, defined as the applied force divided by the area on which it acts (1.2)
- prime mover** The entity responsible for motion in an energy system—*force* in mechanical systems, *pressure* in fluid systems, *potential difference* or *voltage* in electrical systems, *temperature* difference in thermal systems (1.1)
- principal quantum number** An integer that determines the total quantized energy of an electron in an atom (10.3)
- principle of conservation of charge** The net electric charge in an isolated system never changes. (1.3)
- principle of superposition** When two or more waves interfere, the overall wave displacement is the sum of the displacements caused by the individual waves. (8.2)
- property** A quality or trait belonging to a system, such as mass, volume, weight, diameter, color, speed, height above the ground, and temperature (5.1)
- quantized** Some properties (such as energy, momentum, angular momentum) can have only certain discrete values separated by small but measurable increments. These properties cannot have values between the quantized values. (10.3)
- radian** A dimensionless measure of an angle. Defined (for a central angle) as the ratio of the arc length subtended to the radius of the circle for which it is a central angle (2.1)
- radiation** The transfer of energy by electromagnetic waves (3.4 and 9.1)
- radioactive decay** A process by which an unstable nucleus emits radiation and becomes more stable (9.2)
- radio wave** Electromagnetic wave in the wavelength band between approximately 1.0 m and 10<sup>6</sup> m, used to transmit radio and television signals (9.1)
- rate** The ratio of a measured quantity to the time interval over which the measurement is made. Examples are speed, acceleration, mass flow rate, volume flow rate, current, and heat flow rate. (3.1)
- Rayleigh criterion** For an optical instrument such as a telescope or microscope, two objects are just resolved if the central bright disk of one object falls on the first dark ring of the other.
- ray optics** Use of straight lines to model the paths followed by light through a medium or optical system (10.1)
- real image** An image of an object formed by a mirror or lens when light rays from the object converge. A real image can be seen by placing a screen or piece of paper at the point at which the light from the object converges. (10.1)
- reflection** The change in direction of a wave or photon of light when it strikes a surface or different medium but remains in the original medium (9.2 and 10.1)



- refraction** The change in direction of a wave or photon of light as it crosses a boundary into a different medium (10.1)
- resistivity** A property of a material that describes its ability to resist flow of electric charge (4.3)
- resistor** An electrical device that has a specific value of resistance (4.3)
- resolving power** For an optical instrument such as a telescope or microscope, the minimum separation of two objects for which the images appear separate and distinct (10.2)
- resonance** A condition between a source of vibration and an object or system in which the frequency of the source equals the natural frequency of the object or system (8.2)
- resultant vector** A single vector representing the sum of two or more addend vectors (1.1)
- scalar quantity** A quantity that can be described by a magnitude (1.1)
- second (s)** The base unit of time in the SI and English systems (1.1)
- second law of thermodynamics** (1) The natural direction of heat flow is from a high-temperature body to a low-temperature body. (2) A heat engine can convert only some of the heat taken from a reservoir into work. The rest is rejected as heat at a lower temperature. (5.4)
- semiconductor** A material intermediate between a conductor and an insulator in its ability to conduct charge (4.3)
- series circuit** An electric circuit in which there is only one path for current. Charge flows through each device in the circuit, one at a time. (4.3)
- series connection** A connection of electric circuit elements in which there is only one path for current. The current through each element is the same. (3.3)
- slug** The base unit of mass in the English system (1.1)
- Snell's law** The ratio of the sines of the angles of incidence and refraction equals the inverse ratio of the indices of refraction. (10.1)
- solenoid** A series of loops of wire that acts like a magnet when a current flows through it (5.3)
- specific heat** (1.4) The amount of energy that must be added to a material to raise the temperature of a unit mass of the material one degree (1.4)
- standing wave** Waves with stationary nodes that are created by reflections interfering with incident waves (8.2)
- static friction** The force required to start relative motion between two surfaces in contact (4.1)
- steady flow** A process in which the same amount of fluid enters and leaves a system in a given time interval (2.2)
- stimulated emission** A release of a photon from an atom or molecule, caused by another photon whose energy exactly matches the difference in energy levels of the atom. The emitted photon has the same energy, direction, and phase as the incident photon. (10.3)
- Stokes' law** The relationship between the drag force and speed for a small sphere moving through a viscous fluid (4.2)
- strong nuclear force** The force of attraction that holds protons and neutrons together in the nucleus of an atom (9.2)
- temperature** A property of an object that measures its "hotness." Temperature is proportional to the average kinetic energy of the random motion of the atoms and molecules in an object. (1.4)
- terminal speed** The constant speed achieved by a falling object when the downward force of gravity equals the upward drag force (plus the buoyant force if it exists) (4.2)
- thermal conductivity** A property of a material that measures its ability to conduct heat (3.4)

- thermal energy** The total energy of random motion of vibration of all the particles that make up an object (1.4)
- thermal equilibrium** A balance in thermal energy transfer between two objects; when the objects have the same temperature (1.4)
- thermal resistance** A measure of the ability of an object to oppose the flow of heat through the object. Defined as the ratio of the temperature drop across the object to the heat flow rate (4.4)
- thermodynamics** The science dealing with internal energy, heat, and work (5.4)
- thermometer** A device that measures temperature (1.4)
- time interval** The elapsed time or the difference between two clock readings (3.1)
- torque** A quantity that causes rotation in mechanical systems. The product of the applied force and the lever arm (1.1)
- total internal reflection** A phenomenon in which an incident light ray strikes a boundary with a medium of lower index of refraction at a large enough angle that no light is refracted (10.1)
- transverse wave** A wave that displaces particles in the medium perpendicular to the direction in which the wave travels (8.1)
- turbulent flow** Irregular flow of fluid over a surface, with eddies and whorls causing fluid to move in different directions (4.2)
- ultraviolet radiation** Electromagnetic waves in the wavelength band between approximately  $10^{-9}$  m and  $10^{-7}$  m (9.1)
- vector quantity** A quantity that must be described by both a magnitude and a direction (1.1)
- virtual image** An image that apparently causes light to diverge from a mirror or lens. A virtual image cannot be seen on a screen or piece of paper since no light actually converges at the image location. (10.1)
- viscosity** A property of a fluid that describes the internal friction or opposition to relative motion within the fluid (4.2)
- visible light** Electromagnetic waves in the wavelength band between approximately 400 nm and 700 nm that can be detected by the human eye (9.1)
- volt (V)** The unit of measure of electric potential difference (1.3)
- voltmeter** A device that measures potential difference or voltage (3.3)
- volume flow rate** The ratio of the change in volume to the time interval over which the change is measured (3.2)
- watt (W)** The SI unit of power. Defined as one joule per second (6.1)
- wavelength** The shortest length of the repeating pattern in a wave (8.1)
- wave pulse** A single disturbance that travels through a medium (8.1)
- weight** The force on an object caused by the Earth's gravity (1.1)
- weight density** A property of a material, defined as the weight of a sample of the material divided by the volume (1.2)
- work** The amount of energy gained or lost by an object when a force moves the object through a distance. Defined as the product of the force applied (in the direction of motion) and the distance the object moves (2.1 and 5.1)
- work-energy theorem** The work done on an object equals the change in kinetic energy of the object. (5.1)
- work function** The minimum energy needed to remove an electron from the Fermi level of a metal to infinity (9.1)
- X ray** Electromagnetic wave in the wavelength band between approximately  $10^{-11}$  m and  $10^{-8}$  m (9.1)