

# GLOSSARY

## A

- absolute zero** the temperature  $-273.15^{\circ}\text{C}$ , given a value of zero in the Kelvin scale (317)
- accuracy** the closeness of measurements to the correct or accepted value of the quantity measured (44)
- acid-base indicator** a compound whose color is sensitive to pH (493)
- acid-ionization constant** the term  $K_a$  (569)
- actinide** one of the 14 elements with atomic numbers from 90 (thorium, Th) through 103 (lawrencium, Lr) (126)
- activated complex** a transitional structure that results from an effective collision and that persists while old bonds are breaking and new bonds are forming (535)
- activation energy** the minimum energy required to transform the reactants into an activated complex (534)
- activity series** a list of elements organized according to the ease with which the elements undergo certain chemical reactions (265)
- actual yield** the measured amount of a product obtained from a reaction (293)
- addition polymer** a polymer formed by chain addition reactions between monomers that contain a double bond (686)
- addition reaction** a reaction in which an atom or molecule is added to an unsaturated molecule and increases the saturation of the molecule (682)
- alcohol** an organic compound that contains one or more hydroxyl groups (663)
- aldehyde** an organic compound in which a carbonyl group is attached to a carbon atom at the end of a carbon-atom chain (672)
- alkali metal** one of the elements of Group 1 of the periodic table (lithium, sodium, potassium, rubidium, cesium, and francium) (132)
- alkaline** a solution in which a base has completely dissociated in water to yield aqueous  $\text{OH}^-$  ions (461)
- alkaline-earth metal** one of the elements of Group 2 of the periodic table (beryllium, magnesium, calcium, strontium, barium, and radium) (132)
- alkane** a hydrocarbon that contains only single bonds (634)
- alkene** a hydrocarbon that contains double covalent bonds (647)
- alkyl group** a group of atoms that is formed when one hydrogen atom is removed from an alkane molecule (637)
- alkyl halide** an organic compound in which one or more halogen atoms—fluorine, chlorine, bromine, or iodine—are substituted for one or more hydrogen atoms in a hydrocarbon (666)
- alkyne** a hydrocarbon with triple covalent bonds (651)
- alpha particle** two protons and two neutrons bound together and emitted from the nucleus during some kinds of radioactive decay (706)
- amine** an organic compound that can be considered to be a derivative of ammonia,  $\text{NH}_3$  (677)
- amorphous solid** a solid in which the particles are arranged randomly (368)
- amphoteric** any species that can react as either an acid or a base (471)
- angular momentum quantum number** the quantum number that indicates the shape of the orbital (101)
- anion** a negative ion (149)
- anode** the electrode where oxidation takes place (607)
- aromatic hydrocarbon** a hydrocarbon with six-membered carbon rings and delocalized electrons (652)
- Arrhenius acid** a chemical compound that increases the concentration of hydrogen ions,  $\text{H}^+$ , in aqueous solution (459)
- Arrhenius base** a substance that increases the concentration of hydroxide ions,  $\text{OH}^-$ , in aqueous solution (459)

- artificial transmutation** bombardment of stable nuclei with charged and uncharged particles (711)
- atmosphere of pressure** exactly equivalent to 760 mm Hg (311)
- atom** the smallest unit of an element that maintains the properties of that element (10)
- atomic mass unit** a unit of mass that is exactly  $1/12$  the mass of a carbon-12 atom, or  $1.660\,540 \times 10^{-27}$  kg (78)
- atomic number** the number of protons in the nucleus of each atom of an element (75)
- atomic radius** one-half the distance between the nuclei of identical atoms that are bonded together (140)
- Aufbau principle** an electron occupies the lowest-energy orbital that can receive it (105)
- autooxidation** a process in which a substance acts as both an oxidizing agent and a reducing agent (605)
- average atomic mass** the weighted average of the atomic masses of the naturally occurring isotopes of an element (79)
- Avogadro's law** equal volumes of gases at the same temperature and pressure contain equal numbers of molecules (334)
- Avogadro's number**  $6.022\,1367 \times 10^{23}$ ; the number of particles in exactly one mole of a pure substance (81)

## B

- band of stability** the stable nuclei cluster over a range of neutron-proton ratios (702)
- barometer** a device used to measure atmospheric pressure (310)
- benzene** the primary aromatic hydrocarbon (652)
- beta particle** an electron emitted from the nucleus during some kinds of radioactive decay (706)
- binary acid** an acid that contains only two different elements: hydrogen and one of the more-electronegative elements (454)

**binary compound** a compound composed of two different elements (206)

**binding energy per nucleon** the binding energy of the nucleus divided by the number of nucleons it contains (702)

**boiling** the conversion of a liquid to a vapor within the liquid as well as at its surface; occurs when the equilibrium vapor pressure of the liquid equals the atmospheric pressure (378)

**boiling point** the temperature at which the equilibrium vapor pressure of a liquid equals the atmospheric pressure (378)

**boiling-point elevation** the difference between the boiling point of a pure solvent and a nonelectrolyte of that solvent, directly proportional to the molal concentration of the solution (440)

**bond energy** the energy required to break a chemical bond and form neutral isolated atoms (167)

**bond length** the distance between two bonded atoms at their minimum potential energy, that is, the average distance between two bonded atoms (167)

**Boyle's law** the volume of a fixed mass of gas varies inversely with pressure at constant temperature (314)

**Brønsted-Lowry acid** a molecule or ion that is a proton donor (464)

**Brønsted-Lowry acid-base reaction** the transfer of protons from one reactant (the acid) to another (the base) (465)

**Brønsted-Lowry base** a molecule or ion that is a proton acceptor (465)

**buffered solution** a solution that can resist changes in pH (570)

## C

**calorimeter** a device used to measure the heat absorbed or released in a chemical or physical change (511)

**capillary action** the attraction of the surface of a liquid to the surface of a solid (365)

**carboxylic acid** an organic compound that contains the carboxyl functional group (674)

**catalysis** the action of a catalyst (540)

**catalyst** a substance that changes the rate of a chemical reaction without itself being permanently consumed (540)

**catenation** the covalent binding of an element to itself to form chains or rings (630)

**cathode** the electrode where reduction takes place (607)

**cation** a positive ion (149)

**chain reaction** a reaction in which the material that starts the reaction is also one of the products and can start another reaction (717)

**change of state** a physical change of a substance from one state to another (12)

**Charles's law** the volume of a fixed mass of gas at constant pressure varies directly with the Kelvin temperature (317)

**chemical** any substance that has a definite composition (6)

**chemical bond** a mutual electrical attraction between the nuclei and valence electrons of different atoms that binds the atoms together (161)

**chemical change** a change in which one or more substances are converted into different substances (13)

**chemical equation** a representation, with symbols and formulas, of the identities and relative amounts of the reactants and products in a chemical reaction (241)

**chemical equilibrium** a state of balance in which the rate of a forward reaction equals the rate of its reverse reaction and the concentrations of its products and reactants remain unchanged (554)

**chemical-equilibrium expression** the equation for the equilibrium constant,  $K$  (556)

**chemical formula** a formula that indicates the relative numbers of atoms of each kind in a chemical compound by using atomic symbols and numerical subscripts (164)

**chemical kinetics** the area of chemistry that is concerned with reaction rates and reaction mechanisms (538)

**chemical property** the ability of a substance to undergo a change that transforms it into a different substance (12)

**chemical reaction** a reaction in which one or more substances are converted into different substances (13)

**chemistry** the study of the composition, structure, and properties of matter and the changes it undergoes (5)

**coefficient** a small whole number that appears in front of a formula in a chemical equation (243)

**colligative properties** properties that depend on the concentration of solute particles but not on their identity (436)

**collision theory** the set of assumptions regarding collisions and reactions (532)

**colloid** a mixture consisting of particles that are intermediate in size between those in solutions and suspensions forming mixtures known as colloid dispersions (397)

**combined gas law** the relationship between the pressure, volume, and temperature of a fixed amount of gas (321)

**combustion reaction** a reaction in which a substance combines with oxygen, releasing a large amount of energy in the form of light and heat (263)

**common ion effect** the phenomenon in which the addition of an ion common to two solutes brings about precipitation or reduced ionization (567)

**composition reaction** a reaction in which two or more substances combine to form a new compound (256)

**composition stoichiometry** calculations involving the mass relationships of elements in compounds (275)

**compound** a substance that is made from the atoms of two or more elements that are chemically bonded (11)

**concentration** a measure of the amount of solute in a given amount of solvent or solution (412)

**condensation** the process by which a gas changes to a liquid (373)

**condensation polymer** a polymer formed by condensation reactions (690)

**condensation reaction** a reaction in which two molecules or parts of the same molecule combine (683)

**conjugate acid** the species that is formed when a Brønsted-Lowry base gains a proton (469)

**conjugate base** the species that remains after a Brønsted-Lowry acid has given up a proton (469)

**continuous spectrum** the emission of a continuous range of frequencies of electromagnetic radiation (94)

**control rod** a neutron-absorbing rod that helps control a nuclear reaction by limiting the number of free neutrons (718)

**conversion factor** a ratio derived from the equality between two different units that can be used to convert from one unit to the other (40)

**copolymer** a polymer made from two different monomers (685)

**covalent bonding** a chemical bond resulting from the sharing of an electron pair between two atoms (161)

**critical mass** the minimum amount of nuclide that provides the number of neutrons needed to sustain a chain reaction (718)

**critical point** indicates the critical temperature and critical pressure of a substance (381)

**critical pressure** the lowest pressure at which a substance can exist as a liquid at the critical temperature (382)

**critical temperature** the temperature above which a substance cannot exist in the liquid state (381)

**crystal** a substance in which the particles are arranged in an orderly, geometric, repeating pattern (368)

**crystal structure** the total three-dimensional arrangement of particles of a crystal (369)

**crystalline solid** a solid consisting of crystals (368)

**cycloalkane** an alkane in which the carbon atoms are arranged in a ring, or cyclic, structure (635)

## D

**Dalton's law of partial pressures** the total pressure of a mixture of gases is equal to the sum of the partial pressures of the component gases (322)

**daughter nuclide** a nuclide produced by the decay of a parent nuclide (710)

**decay series** a series of radioactive nuclides produced by successive radioactive decay until a stable nuclide is reached (710)

**decomposition reaction** a reaction in which a single compound produces two or more simpler substances (259)

**delocalized electron** an electron shared by more than two atoms (627)

**density** the ratio of mass to volume or mass divided by volume (38)

**deposition** the change of state from a gas directly to a solid (380)

**derived unit** a unit that is a combination of SI base units (36)

**diamond** a colorless, crystalline, solid form of carbon (626)

**diatomic molecule** a molecule containing only two atoms (164)

**diffusion** spontaneous mixing of the particles of two substances caused by their random motion (305)

**dipole** equal but opposite charges that are separated by a short distance (190)

**dipole-dipole force** a force of attraction between polar molecules (190)

**diprotic acid** an acid that can donate two protons per molecule (466)

**direct proportion** two quantities that give a constant value when one is divided by the other (55)

**displacement reaction** a reaction in which one element replaces a similar element in a compound (261)

**dissociation** the separation of ions that occurs when an ionic compound dissolves (425)

**double bond** a covalent bond produced by the sharing of two pairs of electrons between two atoms (172)

**double-replacement reaction** a reaction in which the ions of two compounds exchange places in an aqueous solution to form two new compounds (262)

**ductility** the ability of a substance to be drawn, pulled, or extruded through a small opening to produce a wire (182)

## E

**effervescence** the rapid escape of a gas from the liquid in which it is dissolved (407)

**effusion** a process by which gas particles pass through a tiny opening (306)

**elastic collision** a collision between gas particles and between gas particles and container walls in which there is no net loss of kinetic energy (303)

**electrochemical cell** a system of electrodes and electrolytes in which either chemical reactions produce electrical energy or an electric current produces chemical change (607)

**electrochemistry** the branch of chemistry that deals with electricity-related applications of oxidation-reduction reactions (606)

**electrode** a conductor used to establish electrical contact with a non-metallic part of a circuit, such as an electrolyte (607)

**electrode potential** the difference in potential between an electrode and its solution (613)

**electrolysis** the process in which an electric current is used to produce an oxidation-reduction reaction (610); also the decomposition of a substance by an electric current (259)

**electrolyte** a substance that dissolves in water to give a solution that conducts electric current (399)

**electrolytic cell** an electrochemical cell in which electrical energy is required to produce a redox reaction and bring about a chemical change (610)

**electromagnetic radiation** a form of energy that exhibits wavelike behavior as it travels through space (91)

**electromagnetic spectrum** all the forms of electromagnetic radiation (91)

**electron affinity** the energy change that occurs when an electron is acquired by a neutral atom (147)

**electron capture** the process in which an inner orbital electron is captured by the nucleus of its own atom (707)

**electron configuration** the arrangement of electrons in an atom (105)

**electron-dot notation** an electron-configuration notation in which only the valence electrons of an atom of a particular element are shown, indicated by dots placed around the element's symbol (170)

**electronegativity** a measure of the ability of an atom in a chemical compound to attract electrons (151)

**electroplating** an electrolytic process in which a metal ion is reduced and solid metal is deposited on a surface (611)

**element** a pure substance made of only one kind of atom (10)

**elimination reaction** a reaction in which a simple molecule, such as water or ammonia, is removed from adjacent carbon atoms of a larger molecule (684)

**empirical formula** the symbols for the elements combined in a compound with subscripts showing the smallest whole-number mole ratio of the different atoms in the compound (229)

**end point** the point in a titration at which an indicator changes color (498)

**enthalpy change** the amount of energy absorbed or lost by a system during a process at constant pressure (516)

**entropy** a measure of the degree of randomness of the particles, such as molecules, in a system (527)

**equilibrium** a dynamic condition in which two opposing changes occur at equal rates in a closed system (372)

**equilibrium constant** the ratio of the mathematical product of the concentrations of substances formed at equilibrium to the mathematical product of the concentrations of the reacting substances. Each concentration is raised to a power equal to the coefficient of that substance in the chemical equation (556)

**equilibrium vapor pressure** the pressure exerted by a vapor in equilibrium with its corresponding liquid at a given temperature (376)

**equivalence point** the point at which the two solutions used in a titration are present in chemically equivalent amounts (498)

**ester** an organic compound with a carboxylic acid group in which the hydrogen of the hydroxyl group has been replaced by an alkyl group (675)

**ether** an organic compound in which two hydrocarbon groups are bonded to the same atom of oxygen (669)

**evaporation** the process by which particles escape from the surface of a nonboiling liquid and enter the gas state (365)

**excess reactant** the substance that is not used up completely in a reaction (288)

**excited state** a state in which an atom has a higher potential energy than it has in its ground state (94)

**extensive property** a property that depends on the amount of matter that is present (11)

## F

**family** a vertical column of the periodic table (21)

**film badge** a device that uses exposure of film to measure the approximate radiation exposure of people working with radiation (714)

**fluid** a substance that can flow and therefore take the shape of its container; a liquid or a gas (305)

**formula equation** a representation of the reactants and products of a chemical reaction by their symbols or formulas (244)

**formula mass** the sum of the average atomic masses of all the atoms represented in the formula of any molecule, formula unit, or ion (221)

**formula unit** the simplest collection of atoms from which an ionic compound's formula can be established (176)

**fractional distillation** distillation in which components of a mixture are separated, on the basis of boiling point, by condensation of vapor in a fractionating column (644)

**free energy** the combined enthalpy-entropy function of a system (528)

**free-energy change** the difference between the change in enthalpy,  $\Delta H$ , and the product of the Kelvin temperature and the entropy change, which is defined as  $T\Delta S$ , at a constant pressure and temperature (528)

**freezing** the physical change of a liquid to a solid by the removal of heat (366)

**freezing point** the temperature at which a solid and liquid are in equilibrium at 1 atm (101.3 kPa) pressure (379)

**freezing-point depression** the difference between the freezing points of a pure solvent and a solution of a nonelectrolyte in that solvent; is directly proportional to the molal concentration of the solution (438)

**frequency** the number of waves that pass a given point in a specific time, usually one second (91)

**fullerene** a dark-colored solid made of spherically networked carbon-atom cages (626)

**functional group** an atom or group of atoms that is responsible for the specific properties of an organic compound (663)

## G

**gamma ray** a high-energy electromagnetic wave emitted from a nucleus as it changes from an excited state to a ground energy state (707)

**gas** the state of matter in which a substance has neither definite volume nor definite shape (12)

**gas laws** simple mathematical relationships between the volume, temperature, pressure, and quantity of a gas (313)

**Gay-Lussac's law** the pressure of a fixed mass of gas at constant volume varies directly with the Kelvin temperature (319)

**Gay-Lussac's law of combining volumes of gases** at constant temperature and pressure, the volumes of gaseous reactants and products can be expressed as ratios of small whole numbers (333)

**Geiger-Müller counter** an instrument that detects radiation by counting electric pulses carried by gas ionized by radiation (714)

**geometric isomers** isomers in which the order of atom bonding is the same but the arrangement of atoms in space is different (632)

**Graham's law of effusion** the rates of effusion of gases at the same temperature and pressure are inversely proportional to the square roots of their molar masses (352)

**graphite** a soft, black, crystalline form of carbon that is a fair conductor of electricity (626)

**ground state** the lowest energy state of an atom (94)

**group** a vertical column of the periodic table (21)

## H

**half-cell** a single electrode immersed in a solution of its ions (607)

**half-life** the time required for half the atoms of a radioactive nuclide to decay (708)

**half-reaction** the part of a reaction involving oxidation or reduction alone (593)

**halogen** one of the elements of Group 17 (fluorine, chlorine, bromine, iodine, and astatine) (137)

**heat** the energy transferred between samples of matter because of a difference in their temperature (512)

**heat of combustion** energy released as heat by the complete combustion of one mole of a substance (519)

**heat of reaction** the quantity of energy released or absorbed as heat during a chemical reaction (514)

**heat of solution** the net amount of energy absorbed or released as heat when a specific amount of solute dissolves in a solvent (410)

**Heisenberg uncertainty principle** it is impossible to determine simultaneously both the position and velocity of an electron or any other particle (99)

**Henry's law** the solubility of a gas in a liquid is directly proportional to the partial pressure of that gas on the surface of the liquid (407)

**Hess's law** the overall enthalpy change in a reaction is equal to the sum of the enthalpy changes for the individual steps in the process (519)

**heterogeneous** not having a uniform composition throughout (16)

**heterogeneous catalyst** a catalyst whose phase is different from that of the reactants (540)

**heterogeneous reaction** a reaction involving reactants in two different phases (538)

**highest occupied energy level** the electron-containing main energy level with the highest principal quantum number (110)

**homogeneous** having a uniform composition throughout (16)

**homogeneous catalyst** a catalyst that is in the same phase as all the reactants and products in a reaction system (540)

**homogeneous reaction** a reaction whose reactants and products exist in a single phase (532)

**homologous series** a series in which adjacent members differ by a constant unit (634)

**Hund's rule** orbitals of equal energy are each occupied by one electron before any orbital is occupied by a second electron, and all electrons in singly occupied orbitals must have the same spin (106)

**hybrid orbitals** orbitals of equal energy produced by the combination of two or more orbitals on the same atom (188)

**hybridization** the mixing of two or more atomic orbitals of similar energies on the same atom to produce new orbitals of equal energies (187)

**hydration** a solution process with water as the solvent (405)

**hydrocarbon** the simplest organic compound, composed of only carbon and hydrogen (630)

**hydrogen bonding** the intermolecular force in which a hydrogen atom that is bonded to a highly electronegative atom is attracted to an unshared pair of electrons of an electronegative atom in a nearby molecule (192)

**hydrolysis** a reaction between water molecules and ions of a dissolved salt (572)

**hydronium ion** the  $\text{H}_3\text{O}^+$  ion (431)

**hypothesis** a testable statement (30)

## I

**ideal gas** an imaginary gas that perfectly fits all the assumptions of the kinetic-molecular theory (303)

**ideal gas constant** the constant  $R$ , 0.082 057 84 L·atm/mol·K (342)

**ideal gas law** the mathematical relationship of pressure, volume, temperature, and the number of moles of a gas (340)

**immiscible** liquid solutes and solvents that are not soluble in each other (406)

**inner-shell electron** an electron that is not in the highest occupied energy level (110)

**intensive property** a property that does not depend on the amount of matter present (11)

**intermediate** a species that appears in some steps of a reaction but not in the net equation (532)

**intermolecular force** the force of attraction between molecules (189)

**inverse proportion** two quantities that have a constant mathematical product (56)

**ion** an atom or group of bonded atoms that has a positive or negative charge (143)

**ionic bonding** the chemical bond resulting from electrical attraction between large numbers of cations and anions (161)

**ionic compound** a compound composed of positive and negative ions that are combined so that the numbers of positive and negative charges are equal (176)

**ionization** the formation of ions from solute molecules by the action of the solvent (431); any process that results in the formation of an ion (143)

**ionization energy** the energy required to remove one electron from a neutral atom of an element (143)

**isomers** compounds that have the same molecular formula but different structures (630)

**isotopes** atoms of the same element that have different masses (76)

**J**

**joule** the SI unit of heat energy as well as all other forms of energy (511)

**K**

**ketone** an organic compound in which a carbonyl group is attached to a carbon atom within the chain (672)

**kinetic-molecular theory** a theory based on the idea that particles of matter are always in motion (303)

**L**

**lanthanide** one of the 14 elements with atomic numbers from 58 (cerium, Ce) to 71 (lutetium, Lu) (126)

**lattice energy** the energy released when one mole of an ionic crystalline compound is formed from gaseous ions (178)

**law of conservation of mass** mass is neither created nor destroyed during ordinary chemical or physical reactions (66)

**law of definite proportions** a chemical compound contains the same elements in exactly the same proportions by mass regardless of the size of the sample or the source of the compound (66)

**law of multiple proportions** if two or more different compounds are composed of the same two elements, then the ratio of the masses of the second element combined with a certain mass of the first element is always a ratio of small whole numbers (66)

**Le Châtelier's principle** when a system at equilibrium is disturbed by application of a stress, it attains a new equilibrium position that minimizes the stress (374)

**Lewis acid** an atom, ion, or molecule that accepts an electron pair to form a covalent bond (467)

**Lewis acid-base reaction** the formation of one or more covalent bonds between an electron-pair donor and an electron-pair acceptor (468)

**Lewis base** an atom, ion, or molecule that donates an electron pair to form a covalent bond (468)

**Lewis structure** a formula in which atomic symbols represent nuclei and inner-shell electrons, dot-pairs or dashes between two atomic symbols represent electron pairs in covalent bonds, and dots adjacent to only one atomic symbol represent unshared electrons (171)

**limiting reactant** the reactant that limits the amounts of the other reactants that can combine—and the amount of product that can form—in a chemical reaction (288)

**line-emission spectrum** a series of specific wavelengths of emitted light created when the visible portion of light from excited atoms is shined through a prism (94)

**liquid** the state of matter in which the substance has a definite volume but an indefinite shape (12)

**London dispersion force** an intermolecular attraction resulting from the constant motion of electrons and the creation of instantaneous dipoles (193)

**lone pair** a pair of electrons that is not involved in bonding and that belongs exclusively to one atom (171)

**M**

**magic numbers** the numbers of nucleons that represent completed nuclear energy levels—2, 8, 20, 28, 50, 82, and 126 (703)

**magnetic quantum number** the quantum number that indicates the orientation of an orbital around the nucleus (102)

**main-group element** an element in the *s*-block or *p*-block (136)

**malleability** the ability of a substance to be hammered or beaten into thin sheets (182)

**mass** a measure of the amount of matter (10)

**mass defect** the difference between the mass of an atom and the sum of the masses of its protons, neutrons, and electrons (701)

**mass number** the total number of protons and neutrons in the nucleus of an isotope (76)

**matter** anything that has mass and takes up space (10)

**melting** the physical change of a solid to a liquid by the addition of heat (368)

**melting point** the temperature at which a solid becomes a liquid (368)

**metal** an element that is a good conductor of heat and electricity (22)

**metallic bonding** chemical bonding that results from the attraction between metal atoms and the surrounding sea of electrons (181)

**metalloid** an element that has some characteristics of metals and some characteristics of nonmetals (24)

**millimeters of mercury** a common unit of pressure (311)

**miscible** liquid solutes and solvents that are able to dissolve freely in one another in any proportion (406)

**mixture** a blend of two or more kinds of matter, each of which retains its own identity and properties (15)

**model** an explanation of how phenomena occur and how data or events are related (31)

**moderator** a material used to slow down the fast neutrons produced by fission (718)

**molal boiling-point constant** the boiling-point elevation of a solvent in a 1-molal solution of a non-volatile, nonelectrolyte solute (440)

**molal freezing-point constant** the freezing-point depression of the solvent in a 1-molal solution of a non-volatile, nonelectrolyte solute (438)

**molality** the concentration of a solution expressed in moles of solute per kilogram of solvent (416)

**molar heat of formation** the heat released or absorbed when one mole of a compound is formed by the combination of its elements (517)

**molar heat of fusion** the amount of heat energy required to melt one mole of solid at its melting point (380)

**molar heat of vaporization** the amount of heat energy needed to vaporize one mole of liquid at its boiling point (379)

**molar mass** the mass of one mole of a pure substance (81)

**molarity** the number of moles of solute in one liter of solution (412)

**mole** the amount of a substance that contains as many particles as there are atoms in exactly 12 g of carbon-12 (81)

**mole ratio** a conversion factor that relates the amounts in moles of any two substances involved in a chemical reaction (276)

**molecular compound** a chemical compound whose simplest units are molecules (164)

**molecular formula** a formula showing the types and numbers of atoms combined in a single molecule of a molecular compound (164)

**molecular polarity** the uneven distribution of molecular charge (183)

**molecule** a neutral group of atoms that are held together by covalent bonds (164)

**monatomic ion** an ion formed from a single atom (204)

**monomer** a small unit that joins with others to make a polymer (685)

**monoprotic acid** an acid that can donate only one proton (hydrogen ion) per molecule (465)

**multiple bond** a double or triple bond (173)

## N

**natural gas** a fossil fuel composed primarily of alkanes containing one to four carbon atoms (643)

**net ionic equation** an equation that includes only those compounds and ions that undergo a chemical change in a reaction in an aqueous solution (429)

**neutralization** the reaction of hydrogen ions and hydroxide ions to form water molecules (475)

**newton** the SI unit for force; the force that will increase the speed of a one kilogram mass by one meter per second each second it is applied (309)

**noble gas** a Group 18 element (helium, neon, argon, krypton, xenon, and radon) (111)

**noble-gas configuration** an outer main energy level fully occupied, in most cases, by eight electrons (112)

**nomenclature** a naming system (206)

**nonelectrolyte** a substance that dissolves in water to give a solution that does not conduct an electric current (400)

**nonmetal** an element that is a poor conductor of heat and electricity (23)

**nonpolar-covalent bond** a covalent bond in which the bonding electrons are shared equally by the bonded atoms, resulting in a balanced distribution of electrical charge (162)

**nonvolatile substance** a substance that has little tendency to become a gas under existing conditions (436)

**nuclear binding energy** the energy released when a nucleus is formed from nucleons (702)

**nuclear fission** a process in which a very heavy nucleus splits into more-stable nuclei of intermediate mass (717)

**nuclear force** a short-range proton-neutron, proton-proton, or neutron-neutron force that holds the nuclear particles together (74)

**nuclear fusion** the combining of light-mass nuclei to form a heavier, more stable nucleus (719)

**nuclear power plant** a facility that uses heat from nuclear reactors to produce electrical energy (718)

**nuclear radiation** the particles or electromagnetic radiation emitted from the nucleus during radioactive decay (705)

**nuclear reaction** a reaction that affects the nucleus of an atom (704)

**nuclear reactor** a device that uses controlled-fission chain reactions to produce energy or radioactive nuclides (718)

**nuclear shell model** nucleons exist in different energy levels, or shells, in the nucleus (703)

**nuclear waste** radioactive products of fission and fusion reactions (716)

**nucleon** a proton or neutron (701)

**nuclide** the general term for any isotope of any element (77); another term for an atom that is identified by the number of protons and neutrons in its nucleus (701)

## O

**octane rating** a measure of a fuel's burning efficiency and its antiknock properties (645)

**octet rule** chemical compounds tend to form so that each atom, by gaining, losing, or sharing electrons, has an octet of electrons in its highest occupied energy level (169)

**orbital** a three-dimensional region around the nucleus that indicates the probable location of an electron (100)

**organic compound** a covalently bonded compound containing carbon, excluding carbonates and oxides (629)

**osmosis** the movement of solvent through a semipermeable membrane from the side of lower solute concentration to the side of higher solute concentration (442)

**osmotic pressure** the external pressure that must be applied to stop osmosis (442)

**oxidation** a reaction in which the atoms or ions of an element experience an increase in oxidation state (592)

**oxidation number** a number assigned to an atom in a molecular compound or molecular ion that indicates the general distribution of electrons among the bonded atoms (216)

**oxidation-reduction reaction** any chemical process in which elements undergo changes in oxidation number (593)

**oxidation state** a number assigned to an atom in a molecular compound or ion that indicates the general distribution of electrons among the bonded atoms (216)

**oxidized** having experienced an increase in oxidation number (592)

**oxidizing agent** a substance that has the potential to cause another substance to be oxidized (602)

**oxyacid** an acid that is a compound of hydrogen, oxygen, and a third element, usually a non-metal (455)

**oxyanion** a polyatomic ion that contains oxygen (209)

**P**

- pH** the negative of the common logarithm of the hydronium ion concentration of a solution (485)
- pH meter** a device used to determine the pH of a solution by measuring the voltage between the two electrodes that are placed in the solution (494)
- pOH** the negative of the common logarithm of the hydroxide ion concentration of a solution (485)
- parent nuclide** the heaviest nuclide of each decay series (710)
- partial pressure** the pressure of each gas in a mixture (322)
- pascal** the pressure exerted by a force of one newton acting on an area of one square meter (311)
- Pauli exclusion principle** no two electrons in the same atom can have the same set of four quantum numbers (106)
- percent error** a value calculated by subtracting the experimental value from the accepted value, dividing the difference by the accepted value, and then multiplying by 100 (45)
- percent yield** the ratio of the actual yield to the theoretical yield, multiplied by 100 (293)
- percentage composition** the percentage by mass of each element in a compound (227)
- period** a horizontal row of elements in the periodic table (21)
- periodic law** the physical and chemical properties of the elements are periodic functions of their atomic numbers (125)
- periodic table** an arrangement of the elements in order of their atomic numbers so that elements with similar properties fall in the same column, or group (125)
- petroleum** a complex mixture of different hydrocarbons that varies greatly in composition (643)
- phase** any part of a system that has uniform composition and properties (373)
- phase diagram** a graph of pressure versus temperature that shows the conditions under which the phases of a substance exist (381)

- photoelectric effect** the emission of electrons from a metal when light shines on the metal (93)
- photon** a particle of electromagnetic radiation that has zero rest mass and carries a quantum of energy (94)
- physical change** a change in a substance that does not involve a change in the identity of the substance (12)
- physical property** a characteristic that can be observed or measured without changing the identity of the substance (11)
- plasma** a high-temperature physical state of matter in which atoms lose their electrons (12)
- polar** having an uneven distribution of charge (162)
- polar-covalent bond** a covalent bond in which the bonded atoms have an unequal attraction for the shared electrons (162)
- polyatomic ion** a charged group of covalently bonded atoms (180)
- polymer** a large molecule made of many small units joined to each other through organic reactions (685)
- polyprotic acid** an acid that can donate more than one proton per molecule (465)
- positron** a particle that has the same mass as an electron but that has a positive charge, and is emitted from the nucleus during some kinds of radioactive decay (706)
- precipitate** a solid that is produced as a result of a chemical reaction in solution and that separates from the solution (242)
- precision** the closeness of a set of measurements of the same quantity made in the same way (44)
- pressure** the force per unit area on a surface (308)
- primary amine** an organic compound in which one hydrogen atom in an ammonia molecule has been replaced by an alkyl group (677)
- primary standard** a highly purified solid compound used to check the concentration of a known solution in a titration (499)
- principal quantum number** the quantum number that indicates the main energy level occupied by the electron (101)

- product** a substance that is formed by a chemical change (13)
- pure substance** a substance that has a fixed composition and differs from a mixture in that every sample of a given pure substance has exactly the same characteristic properties and composition (17)

**Q**

- quantity** something that has magnitude, size, or amount (33)
- quantum** the minimum quantity of energy that can be gained or lost by an atom (93)
- quantum number** a number that specifies the properties of atomic orbitals and the properties of electrons in orbitals (101)
- quantum theory** a mathematical description of the wave properties of electrons and other very small particles (99)

**R**

- radioactive dating** the process by which the approximate age of an object is determined based on the amount of certain radioactive nuclides present (715)
- radioactive decay** the spontaneous disintegration of a nucleus into a slightly lighter and more stable nucleus, accompanied by emission of particles, electromagnetic radiation, or both (705)
- radioactive nuclide** an unstable nucleus that undergoes radioactive decay (705)
- radioactive tracer** a radioactive atom that is incorporated into a substance so that movement of the substance can be followed by a radiation detector (715)
- rate-determining step** the slowest-rate step for a chemical reaction (543)
- rate law** an equation that relates the reaction rate and concentrations of reactants (542)
- reactant** a substance that reacts in a chemical change (13)
- reaction mechanism** the step-by-step sequence of reactions by which the overall chemical change occurs (531)



**reaction rate** the change in concentration of reactants per unit time as a reaction proceeds (538)

**reaction stoichiometry** calculations involving the mass relationships between reactants and products in a chemical reaction (275)

**real gas** a gas that does not behave completely according to the assumptions of the kinetic-molecular theory (306)

**redox reaction** any chemical process in which elements undergo changes in oxidation number (593)

**reduced** having experienced a decrease in oxidation state (593)

**reducing agent** a substance that has the potential to cause another substance to be reduced (602)

**reduction** a reaction in which the oxidation state of an element decreases (593)

**reduction potential** the measurement of the tendency for a half-reaction to occur as a reduction half-reaction in an electrochemical cell (613)

**rem** the quantity of ionizing radiation that does as much damage to human tissue as is done by 1 roentgen of high-voltage X rays (713)

**resonance** the bonding in molecules or ions that cannot be correctly represented by a single Lewis structure (175)

**reversible reaction** a chemical reaction in which the products re-form the original reactants (246)

**roentgen** a unit used to measure nuclear radiation; equal to the amount of radiation that produces  $2 \times 10^9$  ion pairs when it passes through  $1 \text{ cm}^3$  of dry air (713)

## S

**salt** an ionic compound composed of a cation and the anion from an acid (215); an ionic compound composed of a cation from a base and an anion from an acid (473)

**saturated hydrocarbon** a hydrocarbon in which each carbon atom in the molecule forms four single covalent bonds with other atoms (634)

**saturated solution** a solution that contains the maximum amount of dissolved solute (403)

**scientific method** a logical approach to solving problems by observing and collecting data, formulating hypotheses, testing hypotheses, and formulating theories that are supported by data (29)

**scientific notation** numbers written in the form  $M \times 10^n$  where the factor  $M$  is a number greater than or equal to 1 but less than 10 and  $n$  is a whole number (50)

**scintillation counter** an instrument that converts scintillating light to an electric signal for detecting radiation (714)

**secondary amine** an organic compound in which two hydrogen atoms of an ammonia molecule have been replaced by alkyl groups (677)

**self-ionization of water** a process in which two water molecules produce a hydronium ion and a hydroxide ion by transfer of a proton (481)

**semipermeable membrane** a membrane that allows the movement of some particles while blocking the movement of others (442)

**shielding** radiation-absorbing material that is used to decrease radiation exposure from nuclear reactors, especially gamma rays (718)

**SI** (*Le Système International d'Unités*) the measurement system accepted worldwide (33)

**significant figure** any digit in a measurement that is known with certainty plus one final digit, which is somewhat uncertain or is estimated (46)

**single bond** a covalent bond produced by the sharing of one pair of electrons between two atoms (171)

**single-replacement reaction** a reaction in which one element replaces a similar element in a compound (261)

**solid** the state of matter in which the substance has definite volume and definite shape (12)

**solubility** the amount of a substance required to form a saturated solution with a specific amount of solvent at a specified temperature (404)

**solubility product constant** the product of the molar concentrations of ions of a substance in a saturated solution, each raised to the power that is the coefficient of that ion in the chemical equation (578)

**soluble** capable of being dissolved (395)

**solute** the substance dissolved in a solution (396)

**solution** a homogeneous mixture of two or more substances in a single phase (396)

**solution equilibrium** the physical state in which the opposing processes of dissolution and crystallization of a solute occur at equal rates (402)

**solvated** a solute particle that is surrounded by solvent molecules (409)

**solvent** the dissolving medium in a solution (396)

**specific heat** the amount of heat energy required to raise the temperature of one gram of substance by one Celsius degree ( $1^\circ\text{C}$ ) or one kelvin (1 K) (512)

**spectator ion** an ion that does not take part in a chemical reaction and is found in solution both before and after the reaction (429)

**spin quantum number** the quantum number that has only two possible values,  $+1/2$  and  $-1/2$ , which indicate the two fundamental spin states of an electron in an orbital (104)

**standard electrode potential** a half-cell potential measured relative to a potential of zero for the standard hydrogen electrode (614)

**standard molar volume of a gas** the volume occupied by one mole of a gas at STP, 22.414 L (335)

**standard solution** a solution that contains a precisely known concentration of a solute (499)

**standard temperature and pressure** the agreed-upon standard conditions of exactly 1 atm pressure and  $0^\circ\text{C}$  (312)

**strong acid** an acid that ionizes completely in aqueous solution (460)

**strong electrolyte** any compound of which all or almost all of the dissolved compound exists as ions in aqueous solution (432)

**structural formula** a formula that indicates the number and types of atoms present in a molecule and also shows the bonding arrangement of the atoms (630); a formula that indicates the kind, number, arrangement, and bonds but not the unshared electron pairs of the atoms in a molecule (171)

**structural isomers** isomers in which the atoms are bonded together in different orders (631)

**sublimation** the change of state from a solid directly to a gas (380)

**substitution reaction** a reaction in which one or more atoms replace another atom or group of atoms in a molecule (682)

**supercooled liquid** a substance that retains certain liquid properties even at temperatures at which it appears to be solid (368)

**supersaturated solution** a solution that contains more dissolved solute than a saturated solution contains under the same conditions (403)

**surface tension** a force that tends to pull adjacent parts of a liquid's surface together, thereby decreasing surface area to the smallest possible size (365)

**suspension** a mixture in which the particles in the solvent are so large that they settle out unless the mixture is constantly stirred or agitated (397)

**synthesis reaction** a reaction in which two or more substances combine to form a new compound (256)

**system** a specific portion of matter in a given region of space that has been selected for study during an experiment or observation (29)

## T

**temperature** a measure of the average kinetic energy of the particles in a sample of matter (511)

**tertiary amine** an organic compound in which all three hydrogen atoms of an ammonia molecule have been replaced by alkyl groups (677)

**theoretical yield** the maximum amount of product that can be produced from a given amount of reactant (293)

**theory** a broad generalization that explains a body of facts or phenomena (31)

**thermochemical equation** an equation that includes the quantity of heat released or absorbed during the reaction as written (515)

**thermochemistry** the study of the changes in heat energy that accompany chemical reactions and physical changes (511)

**thermoplastic polymer** a polymer that melts when heated and can be reshaped many times (685)

**thermosetting polymer** a polymer that does not melt when heated but keeps its original shape (685)

**titration** the controlled addition and measurement of the amount of a solution of known concentration required to react completely with a measured amount of a solution of unknown concentration (497)

**transition element** one of the *d*-block elements that is a metal, with typical metallic properties (134)

**transition interval** the pH range over which an indicator changes color (494)

**transmutation** a change in the identity of a nucleus as a result of a change in the number of its protons (704)

**transuranium element** an element with more than 92 protons in its nucleus (712)

**triple bond** a covalent bond produced by the sharing of three pairs of electrons between two atoms (173)

**triple point** the temperature and pressure conditions at which the solid, liquid, and vapor of a substance can coexist at equilibrium (381)

**triprotic acid** an acid able to donate three protons per molecule (466)

## U

**unit cell** the smallest portion of a crystal lattice that shows the three-dimensional pattern of the entire lattice (369)

**unsaturated hydrocarbon** a hydrocarbon in which not all carbons have four single covalent bonds (647)

**unsaturated solution** a solution that contains less solute than a saturated solution under the existing conditions (403)

**unshared pair** a pair of electrons that is not involved in bonding and that belongs exclusively to one atom (171)

## V

**valence electron** an electron that is available to be lost, gained, or shared in the formation of chemical compounds (150)

**vaporization** the process by which a liquid or solid changes to a gas (365)

**volatile liquid** a liquid that evaporates readily (377)

**voltaic cell** an electrochemical cell in which the redox reaction occurs naturally and produces electrical energy (608)

**volume** the amount of space occupied by an object (37)

**VSEPR theory** repulsion between the sets of valence-level electrons surrounding an atom causes these sets to be oriented as far apart as possible (183)

**vulcanization** a cross-linking process between adjacent polyisoprene molecules that occurs when the molecules are heated with sulfur atoms (688)

## W

**wavelength** the distance between corresponding points on adjacent waves (91)

**weak acid** an acid that is a weak electrolyte (460)

**weak electrolyte** a compound of which a relatively small amount of the dissolved compound exists as ions in an aqueous solution (433)

**weight** a measure of the gravitational pull on matter (35)

**word equation** an equation in which the reactants and products in a chemical reaction are represented by words (243)