



سرای کتابهای کمک آموزشی کارشناسی ارشد

زبان تخصصی

مجموعه شیمی

مؤلف: عباس محمدی

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کلیه حقوق مادی و معنوی این اثر متعلق به موسسه آموزش عالی آزاد ماهان می باشد و هرگونه اقتباس و کپی برداری از این اثر بدون اخذ مجوز پیگرد قانونی دارد.

مقدمه ناشر

آیا آنانکه می‌دانند با آنانکه نمی‌دانند برابرند؟ (قرآن کریم)

پس از حمد و سپاس و ستایش به درگاه بی‌همتای احدیت و درود بر محمد مصطفی، عالی‌نمونه بشریت که در تاریخ دور تاریخ، بنا به فرمان نافذ صمدیت از میان مردمی برخاست که خود بودند در پست‌ترین حد توحش و ضلال و بربریت و آنگاه با قوانین شامل خویش هم ایشان را راهبری نمود و رهانید از بدویت و استعانت جوییم از قرآن کریم، کتابی که هست جاودانه و بی‌نقص تا ابدیت.

کتابی که در دست دارید آخرین ویرایش از مجموعه کتب خودآموز مؤسسه آموزش عالی آزاد ماهان است که بر مبنای خلاصه درس و تأکید بر نکات مهم و کلیدی و تنوع پرسش‌های چهار گزینه‌ای جمع‌آوری شده است. در این ویرایش ضمن توجه کامل به آخرین تغییرات در سرفصل‌های تعیین شده جهت آزمون‌های ارشد تلاش گردیده است که مطالب از منابع مختلف معتبر و مورد تأکید طراحان ارشد با ذکر مثال‌های متعدد بصورت پرسش‌های چهار گزینه‌ای با کلید و در صورت لزوم تشریح کامل ارائه گردد تا دانشجویان گرامی را از مراجعه به سایر منابع مشابه بی‌نیاز نماید.

لازم به ذکر است شرکت در آزمون‌های آزمایشی ماهان که در جامعه آماری گسترده و در سطح کشور برگزار می‌گردد می‌تواند محک جدی برای عزیزان دانشجو باشد تا نقاط ضعف احتمالی خود را بیابند و با مرور مجدد مطالب این کتاب، آنها را برطرف سازند که تجربه سال‌های مختلف موکد این مسیر به عنوان مطمئن‌ترین راه برای موفقیت می‌باشد.

لازم به ذکر است از پورتال ماهان به آدرس www.mahanportal.ir می‌توانید خدمات پشتیبانی را دریافت دارید.

و نیز بر خود می‌بالیم که همه ساله میزان تطبیق مطالب این کتاب با سؤالات آزمون‌های ارشد- که از شاخصه‌های مهم ارزیابی کیفی این کتاب‌ها می‌باشد- ما را در محضر شما سربلند می‌نماید.

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مؤسسه آموزش عالی آزاد ماهان

معاونت آموزش

مقدمه مولف

بی تردید یکی از ابزارهای مهم برای گسترش سطح دانش شیمی، آگاهی از زبان تخصصی شیمی می باشد. بنابراین در این کتاب سعی بر بالابردن مهارت دانشجویان در درک متون انگلیسی شیمی شده است.

معمولا دانشجویان شیمی اهمیت کمتری برای تقویت زبان تخصصی نسبت به دیگر زمینه های شیمی قائل می شوند. بنابراین دانشجویان باید توجه کنند که اگر به دنبال ادامه تحصیل در مقاطع بالاتر هستند باید به سطح قابل قبولی در خواندن و نوشتن زبان تخصصی شیمی رسیده باشند.

کتاب حاضر تلاشی است در جهت کمک به دانشجویانی که مایلند که توانایی خود را در زبان تخصصی شیمی بالا ببرند و آمادگی لازم را برای آزمون ورودی کارشناسی ارشد پیدا کنند.

این کتاب شامل پنج فصل می باشد. فصل اول شامل تعاریف کوتاه انگلیسی از اصطلاحات مهم شیمی می باشد که دانشجویان در صورت نیاز به معنای فارسی یک واژه تخصصی می توانند به واژه نامه مراجعه کنند. در فصل دوم نیز، متون انگلیسی تخصصی شیمی در زمینه های متفاوت به همراه ترجمه لغات مهم آن آورده شده است و دانشجویان می بایست به ترجمه آنها بپردازند. در فصل سوم، چند دسته از تمرین های متفاوت به همراه ترجمه لغات مهم آن آورده شده است و دانشجویان هر زمان که نیاز به دانستن ترجمه لغات تخصصی داشتند نیز سوالات زبان انگلیسی کنکورهای کارشناسی ارشد سالهای گذشته به همراه پاسخ گردآوری شده است. همچنین در فصل پنجم، واژگان پرکاربرد شیمی به همراه ترجمه آورده شده است دانشجویان هر زمان که نیاز به دانستن ترجمه لغات تخصصی داشتند می توانند به این فصل رجوع کنند. به دانشجویان عزیز پیشنهاد می شود که در یادگیری لغات نهایت تلاش خود را به کار گیرند.

بی تردید این کتاب بی عیب و نقص نخواهد بود و از همه دانشجویان عزیز تقاضا دارم نظرات و پیشنهادات خود را از طریق پست الکترونیکی زیر و یا تماس با انتشارات موسسه ماهان در اختیار بنده قرار دهند.

موفق و سربلند باشید

عباس محمدی

E-mail: abbaspolymer66@gmail.com

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فصل اول

تعريف اصطلاحات شیمی

Definitions

of some chemical terms

Definitions of some chemical terms

A

absolute scale (also *Kelvin scale*) The preferred temperature scale in scientific work, which has absolute zero (0 K, or -273.15°C) as the lowest temperature.

absorption spectrum The spectrum produced when atoms absorb specific wavelengths of incoming light and become excited from lower to higher energy levels.

accuracy The closeness of a measurement to the actual value.

acid In common laboratory terms, any species that produces H^+ ions when dissolved in water.

acid anhydride A compound, sometimes formed by dehydration-condensation reaction of an oxoacid, that yields two molecules of the acid when it reacts with water.

acid-base buffer (also *buffer*) A solution that resists change in pH when a small amount of either strong acid or strong base is added.

acid-base indicator A species whose color is different in acid and in base, which is used to monitor the equivalence point of a titration or the pH of a solution.

acid-base reaction Any reaction between an acid and a base.

acid-base titration curve A plot of the pH of a solution of acid (or base) versus the volume of base (or acid) added to the solution.

actinides The Period 7 elements that constitute the second inner transition series (*f* block).

activated complex (See *transition state*.)

activation energy (E_a) The minimum energy with which molecules must collide to react.

active site The region of an enzyme formed by specific amino acid side chains at which catalysis occurs.

activity (also *decay rate*) The change in number of nuclei of a radioactive sample divided by the change in time (t).

activity series of the metals A listing of metals arranged in order of their decreasing strength as reducing agents in aqueous reactions.

actual yield The amount of product actually obtained in a chemical reaction.

addition polymer (also *chain reaction*, or *chain-growth polymer*) A polymer formed when monomers (usually containing $\text{C}=\text{C}$) combine through an addition reaction.



addition reaction A type of organic reaction in which atom slinked by a multiple bond become bonded to more atoms.

adductThe product of a Lewis acid-base reaction characterized by the formation of a new covalent bond.

adenosine triphosphate (ATP) A high-energy molecule that serves most commonly as a store and source of energy in organisms.

alkyl group A saturated hydrocarbon chain with one bond available.

alkyneA hydrocarbon that contains at least one $C\equiv C$ bond (general formula, C_nH_{2n-2}).

allotropeOne of two or more crystalline or molecular forms of an element. In general, one allotrope is more stable than another at a particular pressure and temperature.

alloyA mixture with metallic properties that consists of solid phases of two or more pure elements, a solid-solid solution, or distinct intermediate phases.

alpha (α) decay A radioactive process in which an alpha particle is emitted from a nucleus.

alpha particle (α) A positively charged particle, identical to a helium-4 nucleus, that is one of the common types of radioactive emissions.

amino acid An organic compound [general formula, $H_2N-CH(R)-COOH$] with at least one carboxyl and one amine group on the same molecule; the monomer unit of a protein.

amorphous solid A solid that occurs in different shapes because it lacks extensive molecular-level ordering of its particles.

ampere (A) The SI unit of electric current; 1 ampere of current results when 1 coulomb flows through a conductor in 1 second.

amphoteric Able to act as either an acid or a base.

amplitudeThe height of the crest (or depth of the trough) of a wave; related to the intensity of the energy.

anionA negatively charged ion.

anodeThe electrode at which oxidation occurs in an electrochemical cell. Electrons are given up by the reducing agent and leave the cell at the anode.

antibonding MO A molecular orbital formed when wavefunctions are subtracted from each other, which decreases electron density between the nuclei and leaves a node. Electrons occupying such an orbital destabilize the molecule.

aqueous solution A solution in which water is the solvent.

aromatic hydrocarbon A compound of C and H with one or more rings of C atoms (often drawn with alternating C-C and C=C bonds), in which there is extensive delocalization of π electrons.

Arrhenius acid-base definition A model of acid-base behavior in which an acid is a substance that has H in its formula and produces H^+ in water, and a base is a substance that has OH in its formula and produces OH^- in water.

Arrhenius equation An equation that expresses the exponential relationship between temperature and the rate constant.

atomThe smallest particle of an element that retains the chemical nature of the element. A neutral, spherical entity composed of a positively charged central nucleus surrounded by one or more negatively charged electrons.



atomic mass (also *atomic weight*) The average of the masses of the naturally occurring isotopes of an element weighted according to their abundances.

atomic mass unit (amu) [also *dalton (Da)*] A mass exactly equal to the mass of a carbon-12 atom.

atomic number (Z) The unique number of protons in the nucleus of each atom of an element (equal to the number of electrons in the neutral atom). An integer that expresses the positive charge of a nucleus in multiples of the electronic charge.

atomic orbital (also *wave function*) A mathematical expression that describes the motion of the electron's matter-wave in terms of time and position in the region of the nucleus. The term is used qualitatively to mean the region of space in which there is a high probability of finding the electron.

atomic size A term referring to the atomic radius, one-half the distance between nuclei of identical bonded elements.

atomic solid A solid consisting of individual atoms held together by dispersion forces; the frozen noble gases are the only examples.

aufbau principle (or *building-up principle*) The conceptual basis of a process of building up atoms by adding one proton (and one or more neutrons) at a time to the nucleus and one electron around it to obtain the ground-state electron configurations of the elements.

autoionization (also *self-ionization*) A reaction in which two molecules of a substance react to give ions. The most important example is for water: $2\text{H}_2\text{O} \rightleftharpoons (\text{l}) \text{H}_3\text{O}^+(\text{aq}) + \text{OH}^-(\text{aq})$

average rate The change in concentration of reactants (or products) divided by a finite time period.

Avogadro's law The gas law stating that, at fixed temperature and pressure, equal volumes of any ideal gas contain equal numbers of particles, and, therefore, the volume of a gas is directly proportional to its amount (mol): $V \propto n$.

Avogadro's number A number (6.022×10^{23} to four significant figures) equal to the number of atoms in exactly 12 g of carbon-12; the number of atoms, molecules, or formula units in one mole of an element or compound.

axial group A group (or atom) that lies above or below the trigonal plane of a trigonal bipyramidal molecule, or a similar structural feature in a molecule.

B

background radiation Natural ionizing radiation, the most important form of which is cosmic radiation.

balancing coefficient (also *stoichiometric coefficient*) A numerical multiplier of all the atoms in the formula immediately following it in a chemical equation.

band of stability The narrow band of stable nuclides that appears on a plot of number of neutrons vs. number of protons for all nuclides.

band theory An extension of molecular orbital (MO) theory that explains many properties of metals, in particular, the differences in electrical conductivity of conductors, semiconductors, and insulators.



barometer A device used to measure atmospheric pressure. Most commonly, a tube open at one end, which is filled with mercury and inverted into a dish of mercury.

base In common laboratory terms, any species that produces OH^- ions when dissolved in water.

base pair Two complementary bases in mononucleotides that are H bonded to each other; guanine (G) always pairs with cytosine (C), and adenine (A) always pairs with thymine (T) (or uracil, U).

base unit (also *fundamental unit*) A unit that defines the standard for one of the seven physical quantities in the International System of Units (SI).

battery A self-contained group of voltaic cells arranged in series.

bent shape (also *V shape*) A molecular shape that arises when a central atom is bonded to two other atoms and has one or two lone pairs; occurs as the AX_2E shape class (bond angle $<120^\circ$) in the trigonal planar arrangement and as the AX_2E_2 shape class (bond angle $<109.5^\circ$) in the tetrahedral arrangement.

β^- **decay** A radioactive process in which a beta particle is emitted from a nucleus.

beta (β) decay A class of radioactive decay that includes β^- decay, β^+ emission, and e^- capture.

beta particle (β) A negatively charged particle identified as a high-speed electron that is one of the common types of radioactive emissions.

bimolecular reaction An elementary reaction involving the collision of two reactant species.

binary covalent compound A compound that consists of atoms of two elements in which bonding occurs primarily through electron sharing.

binary ionic compound A compound that consists of the oppositely charged ions of two elements.

body-centered cubic unit cell A unit cell in which a particle lies at each corner and in the center of a cube.

boiling point (bp or T_b) The temperature at which the vapor pressure of a gas equals the external (atmospheric) pressure.

boiling point elevation (ΔT_b) The increase in the boiling point of a solvent caused by the presence of dissolved solute.

bond angle The angle formed by the nuclei of two surrounding atoms with the nucleus of the central atom at the vertex.

bond energy (BE) (or *bond strength*) The enthalpy change accompanying the breakage of a given bond in a mole of gaseous molecules.

bond length The distance between the nuclei of two bonded atoms.

bond order The number of electron pairs shared by two bonded atoms.

bonding MO A molecular orbital formed when wave functions are added to each other, which increases electron density between the nuclei. Electrons occupying such an orbital stabilize the molecule.

bonding pair (also *shared pair*) An electron pair shared by two nuclei; the mutual attraction between the nuclei and the electron pair forms a covalent bond.

Boyle's law The gas law stating that, at constant temperature and amount of gas, the volume occupied by a gas is inversely proportional to the applied (external) pressure: $V \propto 1/P$.



Brønsted-Lowry acid-base definition A model of acid-base behavior based on proton transfer, in which an acid and a base are defined, respectively, as species that donate and accept a proton.

buffer capacity A measure of the ability of a buffer to resist a change in pH; related to the total concentrations and relative proportions of buffer components.

buffer range The pH range over which a buffer acts effectively; related to the relative component concentrations.

C

calibration The process of correcting for systematic error of a measuring device by comparing it to a known standard.

calorie (cal) A unit of energy defined as exactly 4.184 joules; originally defined as the heat needed to raise the temperature of 1 g of water 1°C (from 14.5°C to 15.5°C).

calorimeter A device used to measure the heat released or absorbed by a physical or chemical process taking place within it.

capillarity (or *capillary action*) A property that results in a liquid rising through a narrow space against the pull of gravity.

carbonyl group The C=O grouping of atoms.

catalyst A substance that increases the rate of a reaction without being used up in the process.

cathode The electrode at which reduction occurs in an electrochemical cell. Electrons enter the cell and are acquired by the oxidizing agent at the cathode.

cathode ray The ray of light emitted by the cathode (negative electrode) in a gas discharge tube; travels in straight lines, unless deflected by magnetic or electric fields.

cation A positively charged ion.

cell potential (E_{cell}) (also *electromotive force*, or *emf*; *cell voltage*) The potential difference between the electrodes of an electrochemical cell when no current flows.

Celsius scale (formerly *centigrade scale*) A temperature scale in which the freezing and boiling points of water are defined as 0°C and 100°C, respectively.

chain reaction In nuclear fission, a self-sustaining process in which neutrons released by splitting of one nucleus cause other nuclei to split, which releases more neutrons, and so on.

change in enthalpy (ΔH) The change in internal energy plus the product of the constant pressure and the change in volume: $\Delta H = \Delta E + P\Delta V$; the heat lost or gained at constant pressure: $\Delta H = q_p$.

charge density The ratio of the charge of an ion to its volume.

Charles's law The gas law stating that at constant pressure, the volume occupied by a fixed amount of gas is directly proportional to its absolute temperature.

chelate A complex ion in which the metal ion is bonded to a bidentate or polydentate ligand.

chemical bond The force that holds two atoms together in a molecule (or formula unit).

chemical change (also *chemical reaction*) A change in which a substance is converted into a substance with different composition and properties.

chemical equation A statement that uses chemical formula to express the identities and quantities of the substances involved in a chemical or physical change.



chemical formula A notation of atomic symbols and numerical subscripts that shows the type and number of each atom in a molecule or formula unit of a substance.

chemical kinetics The study of the rates and mechanisms of reactions.

chemical property A characteristic of a substance that appears as it interacts with, or transforms into, other substances.

chemistry The scientific study of matter and the changes it undergoes.

chiral molecule One that is not superimposable on its mirror image; an optically active molecule. In organic compounds, a chiral molecule typically contains a C atom bonded to four different groups (asymmetric C).

chlor-alkali process An industrial method that electrolyzes concentrated aqueous NaCl and produces Cl_2 , H_2 , and NaOH.

Clausius-Clapeyron equation An equation that expresses the relationship between vapor pressure P of a liquid and temperature T .

colligative property A property of a solution that depends on the number, not the identity, of solute particles.

collision theory A model that explains reaction rate as the result of particles colliding with a certain minimum energy.

combustion analysis A method for determining the formula of a compound from the amounts of its combustion products; used commonly for organic compounds.

common-ion effect The shift in the position of an ionic equilibrium away from formation of an ion that is caused by the addition (or presence) of that ion.

complex ion An ion consisting of a central metal ion bonded covalently to molecules and/or anions called ligands.

composition The types and amounts of simpler substances that make up a sample of matter.

compound A substance composed of two or more elements that are chemically combined in fixed proportions.

concentration A measure of the quantity of solute dissolved in a given quantity of solution.

concentration cell A voltaic cell in which both compartments contain the same components but at different concentrations.

condensation The process of a gas changing into a liquid.

condensation polymer A polymer formed by monomers with two functional groups that are linked together in a dehydration condensation reaction.

conduction band In band theory, the empty, higher energy portion of the band of molecular orbitals into which electrons move when conducting heat and electricity.

conductor A substance (usually a metal) that conducts an electric current well.

conjugate acid-base pair Two species related to each other through the gain or loss of a proton; the acid has one more proton than its conjugate base.)

constitutional isomers (also *structural isomers*) Compounds with the same molecular formula but different arrangements of atoms.

controlled experiment An experiment that measures the effect of one variable at a time by keeping other variables constant.



conversion factor A ratio of equivalent quantities that is equal to 1 and used to convert the units of a quantity.

coordinate covalent bond A covalent bond formed when one atom donates both electrons to give the shared pair; once formed, it is identical to any covalent single bond.

coordination compound (also *complex*) A substance containing at least one complex ion.

coordination isomers Two or more coordination compounds with the same composition in which the complex ions have different ligand arrangements.

coordination number In a crystal, the number of nearest neighbors surrounding a particle. In a complex, the number of ligand atoms bonded to the central metal ion.

corrosion The natural redox process that results in unwanted oxidation of a metal.

coulomb (C) The SI unit of electric charge. One coulomb is the charge of 6.242×10^{18} electrons; one electron possesses a charge of 1.602×10^{-19} C.

counter ion A simple ion associated with a complex ion in a coordination compound.

coupling of reactions The pairing of reactions of which one releases enough free energy for the other to occur.

covalent bond A type of bond in which atoms are bonded through the sharing of two electrons; the mutual attraction of the nuclei and an electron pair that holds atoms together in a molecule.

covalent bonding The idealized bonding type that is based on localized electron-pair sharing between two atoms with little difference in their tendencies to lose or gain electrons (most commonly nonmetals).

covalent compound A compound that consists of atoms bonded together by shared electron pairs.

covalent radius One-half the distance between nuclei of identical covalently bonded atoms.

critical mass The minimum mass needed to achieve a chain reaction.

critical point The point on a phase diagram above which the vapor cannot be condensed to a liquid; the end of the liquid-gas curve.

crystal field splitting energy (Δ) The difference in energy between two sets of metal-ion *d* orbitals that results from electrostatic interactions with the surrounding ligands.

crystal field theory A model that explains the color and magnetism of coordination compounds based on the effects of ligands on metal-ion *d*-orbital energies.

crystalline solid Solid with a well-defined shape because of the orderly arrangement of the atoms, molecules, or ions.

cubic closest packing A crystal structure based on the face-centered cubic unit cell in which the layers have an *abcabc...* pattern.

curie (Ci) The most common unit of radioactivity, defined as the number of nuclei disintegrating each second in 1 g of radium-226; $1 \text{ Ci} = 3.70 \times 10^{10} \text{ d/s}$ (disintegrations per second).

cyclic hydrocarbon A hydrocarbon with one or more rings in its structure.



D

dorbital An atomic orbital with $l = 2$.

dalton (Da) A unit of mass identical to *atomic mass unit*.

Dalton's law of partial pressures A gas law stating that, in a mixture of unreacting gases, the total pressure is the sum of the partial pressures of the individual gases: $P_{\text{total}} = P_1 + P_2 + P_3 + \dots$

data Pieces of quantitative information obtained by observation.

decay constant The rate constant k for radioactive decay.

decay series (also *disintegration series*) The succession of steps a parent nucleus undergoes as it decays into a stable daughter nucleus.

dehydration-condensation reaction A reaction in which H and OH groups on two molecules react to form water as one of the products.

delocalization (See *electron-pair delocalization*.)

density (d) An intensive physical property of a substance at a given temperature and pressure, defined as the ratio of the mass to the volume: $d = m/V$.

deposition The process of changing directly from gas to solid.

derived unit Any of various combinations of the seven SI base units.

deuterons Nuclei of the stable hydrogen isotope deuterium, ${}^2\text{H}$.

diagonal relationship Physical and chemical similarities between a Period 2 element and one located diagonally down and to the right in Period 3.

diamagnetism The tendency of a species not to be attracted (or to be slightly repelled) by a magnetic field as a result of its electrons being paired.

diffraction The phenomenon in which a wave striking the edge of an object bends around it. A wave passing through a slit as wide as its wavelength forms a semicircular wave.

diffusion The movement of one fluid through another.

dimensional analysis (also *factor-label method*) A calculation method in which arithmetic steps are accompanied by the appropriate canceling of units.

dipole-dipole force The intermolecular attraction between oppositely charged poles of nearby polar molecules.

dipole-induced dipole force The intermolecular attraction between a polar molecule and the oppositely charged pole it induces in a nearby molecule.

dipole moment (μ) A measure of molecular polarity; the magnitude of the partial charges on the ends of a molecule (in coulombs) times the distance between them (in meters).

disaccharide An organic compound formed by a dehydration condensation reaction between two simple sugars (monosaccharides).

disintegration series (See *decay series*).

dispersion force (also *London force*) The intermolecular attraction between all particles as a result of instantaneous polarizations of their electron clouds; the intermolecular force primarily responsible for the condensed states of nonpolar substances.



disproportionation reaction A reaction in which a given substance is both oxidized and reduced.

donor atom An atom that donates a lone pair of electrons to form a covalent bond, usually from ligand to metal ion in a complex.

double bond A covalent bond that consists of two bonding pairs; two atoms sharing four electrons in the form of one σ and one π bond.

double-displacement reaction (See *metathesis reaction*.)

double helix The two intertwined polynucleotide strands held together by H bonds that form the structure of DNA (deoxyribonucleic acid).

Downs cell An industrial apparatus that electrolyzes molten NaCl to produce sodium and chlorine.

dynamic equilibrium In a chemical or physical change, the condition at which the forward and reverse processes are taking place at the same rate, so there is no net change in the amounts of reactants or products.

E

e_g orbitals The set of orbitals (composed of e_g and t_{2g}) that results when the energies of the metal-ion d orbitals are split by a ligand field. This set is higher in energy than the other (t_{2g}) set in an octahedral field of ligands and lower in energy in a tetrahedral field.

effective collision A collision in which the particles meet with sufficient energy and an orientation that allows them to react.

effective nuclear charge (Z_{eff}) The nuclear charge an electron actually experiences as a result of shielding effects due to the presence of other electrons.

effusion The process by which a gas escapes from its container through a tiny hole into an evacuated space.

electrochemical cell A system that incorporates a redox reaction to produce or use electrical energy.

electrochemistry The study of the relationship between chemical change and electrical work.

electrode The part of an electrochemical cell that conducts the electricity between the cell and the surroundings.

electrolysis The nonspontaneous lysing (splitting) of a substance, often to its component elements, by supplying electrical energy.

electrolyte A substance that conducts a current when it dissolves in water.

electrolytic cell An electrochemical system that uses electrical energy to drive a nonspontaneous chemical reaction ($\Delta G > 0$).

electromagnetic (EM) radiation (or *electromagnetic energy, radiant energy*) Oscillating, perpendicular electric and magnetic fields moving simultaneously through space as waves and manifested as visible light, x-rays, microwaves, radio waves, and soon.

electromagnetic spectrum The continuum of wavelengths of radiant energy.

electromotive force (emf) (See *cell potential*.)



electron (e^-) A subatomic particle that possesses a unit negative charge (1.60218×10^{-19} C) and occupies the space around the atomic nucleus.

electron affinity (EA) The energy change (in kJ) accompanying the addition of one mole of electrons to one mole of gaseous atoms or ions.

electron capture (EC) A type of radioactive decay in which a nucleus draws in an orbital electron, usually one from the lowest energy level, and releases energy.

electron cloud An imaginary representation of an electron's rapidly changing position around the nucleus over time.

electron configuration The distribution of electrons within the orbitals of the atoms of an element; also the notation for such a distribution.

electron deficient Referring to a bonded atom, such as Be or B, that has fewer than eight valence electrons.

electron density diagram (or *electron probability density diagram*) The pictorial representation for a given energy sublevel of the quantity ψ^2 (the probability density of the electron lying within a particular tiny volume) as a function of r (distance from the nucleus).

electron volt (eV) The energy (in joules, J) that an electron acquires when it moves through a potential difference of 1 volt; $1 \text{ eV} = 1.60218 \times 10^{-19} \text{ J}$.

electronegativity (EN) The relative ability of a bonded atom to attract shared electrons.

electronegativity difference (ΔEN) The difference in electronegativities between the atoms in a bond.

electron-pair delocalization (also *delocalization*) The process by which electron density is spread over several atoms rather than remaining between two.

electron-sea model A qualitative description of metallic bonding proposing that metal atoms pool their valence electrons into a delocalized "sea" of electrons in which the metal cores (metal ions) are submerged in an orderly array.

element The simplest type of substance with unique physical and chemical properties. An element consists of only one kind of atom, so it cannot be broken down into simpler substances.

elementary reaction (or *elementary step*) A simple reaction that describes a single molecular event in a proposed reaction mechanism.

elimination reaction A type of organic reaction in which C atoms are bonded to fewer atoms in the product than in the reactant, which leads to multiple bonding.

emission spectrum The line spectrum produced when excited atoms return to lower energy levels and emit photons characteristic of the element.

empirical formula A chemical formula that shows the lowest relative numbers of atoms of elements in a compound.

end point The point in a titration at which the indicator changes color.

endothermic process One occurring with an absorption of heat from the surroundings and therefore an increase in the enthalpy of the system ($\Delta H > 0$).

energy The capacity to do work, that is, to move matter.

enthalpy (H) A thermodynamic quantity that is the sum of the internal energy plus the product of the pressure and volume.



enthalpy diagram A graphic depiction of the enthalpy change of a system.

entropy (*S*) A thermodynamic quantity related to the number of ways the energy of a system can be dispersed through the motions of its particles.

enzyme A biological macromolecule (usually a protein) that acts as a catalyst.

equatorial group A group (or atom) that lies in the trigonal plane of a trigonal bipyramidal molecule, or a similar structural feature in a molecule.

equilibrium constant (*K*) The value obtained when equilibrium concentrations are substituted into the reaction quotient.

equivalence point The point in a titration when the number of moles of the added species is stoichiometrically equivalent to the original number of moles of the other species.

exact number A quantity, usually obtained by counting or based on a unit definition, that has no uncertainty associated with it and, therefore, contains as many significant figures as a calculation requires.

excited state Any electron configuration of an atom or molecule other than the lowest energy (ground) state.

exclusion principle A principle developed by Wolfgang Pauli stating that no two electrons in an atom can have the same set of four quantum numbers. The principle arises from the fact that an orbital has a maximum occupancy of two electrons and their spins are paired.

exothermic process One occurring with a release of heat to the surroundings and therefore a decrease in the enthalpy of the system ($\Delta H < 0$).

expanded valence shell A valence level that can accommodate more than 8 electrons by using available *d* orbitals; occurs only for elements in Period 3 or higher.

experiment A clear set of procedural steps that tests a hypothesis.

extensive property A property, such as mass, that depends on the quantity of substance present.

F

face-centered cubic unit cell A unit cell in which a particle occurs at each corner and in the center of each face of a cube.

Faraday constant (*F*) The physical constant representing the charge of 1 mol of electrons: $F = 96,485 \text{ C/mol e}^-$.

fatty acid A carboxylic acid that has a long hydrocarbon chain and is derived from a natural source.

fission The process by which a heavier nucleus splits into lighter nuclei with the release of energy.

formal charge The hypothetical charge on an atom in a molecule or ion, equal to the number of valence electrons minus the sum of all the unshared and half the shared valence electrons.

formation constant (*K_f*) An equilibrium constant for the formation of a complex ion from the hydrated metal ion and ligands.

formation equation An equation in which 1 mole of a compound forms from its elements.

formula mass The sum (in amu) of the atomic masses of a formula unit of an ionic compound.

formula unit The chemical unit of a compound that contains the number and type of atoms (or ions) expressed in the chemical formula.



fossil fuel Any fuel, including coal, petroleum, and natural gas, derived from the products of the decay of dead organisms.

fraction by mass (also *mass fraction*) The portion of a compound's mass contributed by an element; the mass of an element in a compound divided by the mass of the compound.

free energy (G) A thermodynamic quantity that is the difference between the enthalpy and the product of the absolute temperature and the entropy: $G = H - TS$.

free radical A molecular or atomic species with one or more unpaired electrons, which typically make it very reactive.

freezing The process of cooling a liquid until it solidifies.

freezing point depression (ΔT_f) A lowering of the freezing point of a solvent caused by the presence of dissolved solute particles.

frequency factor (A) The product of the collision frequency Z and an orientation probability factor p that is specific for a reaction.

fuel cell (or *flow battery*) A battery that is not self-contained and in which electricity is generated by the controlled oxidation of a fuel.

functional group A specific combination of atoms, typically containing a carbon-carbon multiple bond and/or carbon-heteroatom bond, that reacts in a characteristic way no matter what molecule it occurs in.

fusion (nuclear) The process by which light nuclei combine to form a heavier nucleus with the release of energy.

G

galvanic cell (See *voltaic cell*.)

gamma emission The type of radioactive decay in which gamma rays are emitted from an excited nucleus.

gamma (γ) ray A very high-energy photon. (786)

gas One of the three states of matter. A gas fills its container regardless of the shape.

genetic code The set of three-base sequences that is translated into specific amino acids during the process of protein synthesis.

geometric isomers (also *cis-trans isomers* or *diastereomers*) Stereoisomers in which the molecules have the same connections between atoms but differ in the spatial arrangements of the atoms. The *cis* isomer has similar groups on the same side of a structural feature; the *trans* isomer has them on opposite sides.

Graham's law of effusion A gas law stating that the rate of effusion of a gas is inversely proportional to the square root of its density (or molar mass).

ground state The electron configuration of an atom or ion that is lowest in energy.

group A vertical column in the periodic table.



H

H bond (See *hydrogen bond*.)

Haber process An industrial process used to form ammonia from its elements.

half-cell A portion of an electrochemical cell in which a half reaction takes place.

half-life ($t_{1/2}$) In chemical processes, the time required for half the initial reactant concentration to be consumed.

half-reaction method A method of balancing redox reactions by treating the oxidation and reduction half-reactions separately.

haloalkane (also *alkyl halide*) A hydrocarbon with one or more halogen atoms (X) in place of H.

heat (q) The energy transferred between objects because of differences in their temperatures only; thermal energy.

heat capacity The quantity of heat required to change the temperature of an object by 1 K.

heat of fusion (ΔH_{fus}) The enthalpy change occurring when 1 mol of a solid substance melts.

heat of hydration (ΔH_{hydr}) (also *enthalpy of hydration*) The enthalpy change occurring when 1 mol of a gaseous species is hydrated.

heat of reaction (ΔH_{rxn}) The enthalpy change of a reaction.

heat of solution (ΔH_{soln}) (also *enthalpy of solution*) The enthalpy change occurring when a solution forms from solute and solvent.

heat of sublimation (ΔH_{subl}) The enthalpy change occurring when 1 mol of a solid substance changes directly to a gas.

heat of vaporization (ΔH_{vap}) The enthalpy change occurring when 1 mol of a liquid substance vaporizes.

heating-cooling curve A plot of temperature vs. time for a substance when heat is absorbed or released by the system at a constant rate.

Henderson-Hasselbalch equation An equation for calculating the pH of a buffer system.

Henry's law A law stating that the solubility of a gas in a liquid is directly proportional to the partial pressure of the gas above the liquid.

Hess's law of heat summation A law stating that the enthalpy change of an overall process is the sum of the enthalpy changes of the individual steps of the process.

heteroatom Any atom in an organic compound other than C or H.

heterogeneous catalyst A catalyst that occurs in a different phase from the reactants, usually a solid interacting with gaseous or liquid reactants.

heterogeneous mixture A mixture that has one or more visible boundaries among its components.

hexagonal closest packing A crystal structure based on the hexagonal unit cell in which the layers have an *abab...* pattern.

high-spin complex Complex ion that has the same number of unpaired electrons as in the isolated metal ion; contains weak-field ligands.

homogeneous catalyst A catalyst (gas, liquid, or soluble solid) that exists in the same phase as the reactants.



homogeneous mixture (also *solution*) A mixture that has no visible boundaries among its components.

homonuclear diatomic molecule A molecule composed of two identical atoms.

Hund's rule A principle stating that when orbitals of equal energy are available, the electron configuration of lowest energy has the maximum number of unpaired electrons with parallel spins.

hybrid orbital An atomic orbital postulated to form during bonding by the mathematical mixing of specific combinations of nonequivalent orbitals in a given atom.

hybridization A postulated process of orbital mixing to form hybrid orbitals.

hydrate A compound in which a specific number of water molecules are associated with each formula unit.

hydration shell The oriented cluster of water molecules that surrounds an ion in aqueous solution.

hydrocarbon An organic compound that contains only H and C atoms.

hydrogen bond (H bond) A type of dipole-dipole force that arises between molecules that have an H atom bonded to a small, highly electronegative atom with lone pairs, usually N, O, or F.

hydrogenation The addition of hydrogen to a carbon-carbon multiple bond to form a carbon-carbon single bond.

hydrolysis Cleaving a molecule by reaction with water, in which one part of the molecule bonds to the water -OH and the other to the water H.

hydronium ion (H_3O^+) A proton covalently bonded to a water molecule.

I

ideal gas A hypothetical gas that exhibits linear relationships among volume, pressure, temperature, and amount (mol) at all conditions; approximated by simple gases at ordinary conditions.

ideal gas law (or *ideal gas equation*) An equation that expresses the relationships among volume, pressure, temperature, and amount (mol) of an ideal gas: $PV = nRT$.

ideal solution A solution whose vapor pressure equals the mole fraction of the solvent times the vapor pressure of the pure solvent; approximated only by very dilute solutions.

indicator (See *acid-base indicator*.)

infrared (IR) Radiation in the region of the electromagnetic spectrum between the microwave and visible regions.

infrared (IR) spectroscopy An instrumental technique for determining the types of bonds in a covalent molecule by measuring the absorption of IR radiation.

initial rate The instantaneous rate occurring as soon as the reactants are mixed, that is, at $t = 0$.

inner electrons (also *core electrons*) Electrons that fill all the energy levels of an atom except the valence level; electrons also present in atoms of the previous noble gas and any completed transition series.

inner transition elements The elements of the periodic table in which f orbitals are being filled; the lanthanides and actinides.



instantaneous rate The reaction rate at a particular time, given by the slope of a tangent to a plot of reactant concentration vs. time.

insulator A substance (usually a nonmetal) that does not conduct an electric current.

integrated rate law A mathematical expression for reactant concentration as a function of time.

intensive property A property, such as density, that does not depend on the quantity of substance present.

intermolecular forces (or *interparticle forces*) The attractive and repulsive forces among the particles, molecules, atoms, or ions in a sample of matter.

internal energy (E) The sum of the kinetic and potential energies of all the particles in a system.

ion A charged particle that forms from an atom (or covalently bonded group of atoms) when it gains or loses one or more electrons.

ion-dipole force The intermolecular attractive force between an ion and a polar molecule (dipole).

ion-induced dipole force The intermolecular attractive force between an ion and the dipole it induces in the electron cloud of a nearby particle.

ion pair A pair of ions that form a gaseous ionic molecule; sometimes formed when a salt boils.

ionic atmosphere A cluster of ions of net opposite charge surrounding a given ion in solution.

ionic bonding The idealized type of bonding based on the attraction of oppositely charged ions that arise through electron transfer between atoms with large differences in their tendency to lose or gain electrons (typically metals and nonmetals).

ionic compound A compound that consists of oppositely charged ions.

ionic radius The size of an ion as measured by the distance between the centers of adjacent ions in a crystalline ionic compound.

ionic solid A solid whose unit cell contains cations and anions.

ionization The process by which a substance absorbs energy from high-energy radioactive particles and loses an electron to become ionized.

ionization energy (IE) The energy (in kJ) required to remove completely one mole of electrons from one mole of gaseous atoms or ions.

ionizing radiation The high-energy radiation that forms ions in a substance by causing electron loss.

isoelectronic Having the same number and configuration of electrons as another species.

isomer One of two or more compounds with the same molecular formula but different properties, often as a result of different arrangements of atoms.

isotopes Atoms of a given atomic number (that is, of a specific element) that have different numbers of neutrons and therefore different mass numbers.

isotopic mass The mass (in amu) of an isotope relative to the mass of the carbon-12 isotope. **J**

joule (J) The SI unit of energy; $1 \text{ J} = 1 \text{ kg}\cdot\text{m}^2/\text{s}^2$. (190)

K

kelvin (K) The SI base unit of temperature. The kelvin is the same size as the Celsius degree.

kilogram (kg) The SI base unit of mass.

kinetic energy (E_k) The energy an object has because of its motion.

kinetic-molecular theory The model that explains gas behavior in terms of particles in random motion whose volumes and interactions are negligible.

**L**

lanthanide contraction The additional decrease in atomic and ionic size, beyond the expected trend, caused by the poor shielding of the increasing nuclear charge by f electrons in the elements following the lanthanides.

lanthanides (also *rare earths*) The Period 6 ($4f$) series of inner transition elements, which includes cerium (Ce; $Z = 58$) through lutetium (Lu; $Z = 71$).

lattice The three-dimensional arrangement of points created by choosing each point to be at the same location within each particle of a crystal; thus, the lattice consists of all points with identical surroundings.

lattice energy ($\Delta H_{\text{lattice}}$) The enthalpy change (always positive) that occurs when 1 mol of an ionic compound separates into gaseous ions, with all components in their standard states.

law of chemical equilibrium (also *law of mass action*) The law stating that when a system reaches equilibrium at a given temperature, the ratio of quantities that make up the reaction quotient has a constant numerical value.

law of conservation of energy (also *first law of thermodynamics*) A basic observation that the total energy of the universe is constant: $\Delta E_{\text{universe}} = \Delta E_{\text{system}} + \Delta E_{\text{surroundings}} = 0$.

law of definite (or constant) composition A mass law stating that, no matter what its source, a particular compound is composed of the same elements in the same parts (fractions) by mass.

law of mass conservation A mass law stating that the total mass of substances does not change during a chemical reaction.

law of multiple proportions A mass law stating that if elements A and B react to form two compounds, the different masses of B that combine with a fixed mass of A can be expressed as a ratio of small whole numbers.

Le Châtelier's principle A principle stating that if a system in a state of equilibrium is disturbed, it will undergo a change that shifts its equilibrium position in a direction that reduces the effect of the disturbance.

level (also *shell*) A specific energy state of an atom given by the principal quantum number n .

Lewis acid-base definition A model of acid-base behavior in which acids and bases are defined, respectively, as species that accept and donate an electron pair.

Lewis electron-dot symbol A notation in which the element symbol represents the nucleus and inner electrons, and surrounding dots represent the valence electrons.

Lewis structure (or *Lewis formula*) A structural formula consisting of electron-dot symbols, with lines as bonding pairs and dots as lone pairs.

ligand A molecule or anion bonded to a central metal ion in a complex ion.

like-dissolves-like rule An empirical observation stating that substances having similar kinds of intermolecular forces dissolve in each other.

limiting reactant (or *limiting reagent*) The reactant that is consumed when a reaction occurs and therefore the one that determines the maximum amount of product that can form.

line spectrum A series of separated lines of different colors representing photons whose wavelengths are characteristic of an element.



linear arrangement The geometric arrangement obtained when two electron groups maximize their separation around a central atom.

linear shape A molecular shape formed by three atoms lying in a straight line, with a bond angle of 180° (shape class AX_2 or AX_2E_3).

linkage isomers Coordination compounds with the same composition but with different ligand donor atoms linked to the central metal ion.

lipid Any of a class of biomolecules, including fats and oils, that are soluble in nonpolar solvents.

liquid One of the three states of matter. A liquid fills a container to the extent of its own volume and thus forms a surface.

liter (L) A non-SI unit of volume equivalent to 1 cubic decimeter (0.001 m^3).

London force (See *dispersion force*.)

lone pair (also *unshared pair*) An electron pair that is part of an atom's valence shell but not involved in covalent bonding.

low-spin complex Complex ion that has fewer unpaired electrons than in the free metal ion because of the presence of strong field ligands.

M

macromolecule (See *polymer*.)

magnetic quantum number (m_l) (or *orbital-orientation quantum number*) An integer from $-l$ through 0 to $+l$ that specifies the orientation of an atomic orbital in the three-dimensional space about the nucleus.

mass The quantity of matter an object contains. Balances are designed to measure mass.

mass fraction (See *fraction by mass*.)

mass number (A) The total number of protons and neutrons in the nucleus of an atom.

mass percent (also *mass %* or *percent by mass*) The fraction by mass expressed as a percentage. A concentration term [% (w/w)] expressed as the mass in grams of solute dissolved per 100. g of solution.

mass spectrometry An instrumental method for measuring the relative masses of particles in a sample by creating charged particles and separating them according to their mass-charge ratio.

matter Anything that possesses mass and occupies volume.

melting (also *fusion*) The change of a substance from a solid to a liquid.

melting point (m_p or T_f) The temperature at which the solid and liquid forms of a substance are at equilibrium.

metal A substance or mixture that is relatively shiny and malleable and is a good conductor of heat and electricity. In reactions, metals tend to transfer electrons to nonmetals and form ionic compounds.

metallic bonding An idealized type of bonding based on the attraction between metal ions and their delocalized valence electrons.

metallic radius One-half the distance between the nuclei of adjacent individual atoms in a crystal of an element.

metallic solid A solid whose individual atoms are held together by metallic bonding.



metalloid (also *semimetal*) An element with properties between those of metals and nonmetals.

metathesis reaction (also *double-displacement reaction*) A reaction in which atoms or ions of two compounds exchange bonding partners.

millimeter of mercury (mmHg) A unit of pressure based on the difference in the heights of mercury in a barometer or manometer.

miscible Soluble in any proportion.

mixture A group of two or more elements and/or compounds that are physically intermingled.

MO bond order One-half the difference between the numbers of electrons in bonding and antibonding MOs.

model (also *theory*) A simplified conceptual picture based on an experiment that explains how an aspect of nature occurs.

molality (*m*) A concentration term expressed as number of moles of solute dissolved in 1000 g (1 kg) of solvent.

molar heat capacity (*C*) The quantity of heat required to change the temperature of 1 mol of a substance by 1 K. (196)

molar mass (*M*) (or *gram-molecular weight*) The mass of 1 mol of entities (atoms, molecules, or formula units) of a substance, in units of g/mol.

molar solubility The solubility expressed in terms of amount (mol) of dissolved solute per liter of solution.

molarity (*M*) A concentration term expressed as the moles of solute dissolved in 1 L of solution.

mole (mol) The SI base unit for amount of a substance. The amount that contains a number of objects equal to the number of atoms in exactly 12 g of carbon-12.

mole fraction (*X*) A concentration term expressed as the ratio of moles of one component of a mixture to the total moles present.

molecular equation A chemical equation showing a reaction in solution in which reactants and products appear as intact, undissociated compounds.

molecular formula A formula that shows the actual number of atoms of each element in a molecule.

molecular mass (or *molecular weight*) The sum (in amu) of the atomic masses of a formula unit of a compound.

molecular orbital (MO) An orbital of given energy and shape that extends over a molecule and can be occupied by no more than two electrons.

molecular orbital (MO) diagram A depiction of the relative energy and number of electrons in each MO, as well as the atomic orbitals from which the MOs form.

molecular orbital (MO) theory A model that describes a molecule as a collection of nuclei and electrons in which the electrons occupy orbitals that extend over the entire molecule.

molecular polarity The overall distribution of electronic charge in a molecule, determined by its shape and bond polarities.

molecular shape The three-dimensional structure defined by the relative positions of the atomic nuclei in a molecule.

molecular solid A solid held together by intermolecular forces between individual molecules.



molecularity The number of reactant particles involved in an elementary step.

molecule A structure consisting of two or more atoms that are chemically bound together and behave as an independent unit.

monatomic ion An ion derived from a single atom.

monomer A small molecule, linked covalently to others of the same or similar type to form a polymer, on which the repeat unit of the polymer is based.

mononucleotide A monomer unit of a nucleic acid, consisting of an N-containing base, a sugar, and a phosphate group.

monosaccharide A simple sugar; a polyhydroxy ketone or aldehyde with three to nine C atoms.

N

Nernst equation An equation stating that the voltage of an electrochemical cell under any conditions depends on the standard cell voltage and the concentrations of the cell components:

$$E_{\text{cell}} = E_{\text{cell}}^{\circ} - \frac{RT}{nF} \ln Q$$

net ionic equation A chemical equation of a reaction in solution in which spectator ions have been eliminated to show the actual chemical change.

network covalent solid A solid in which all the atoms are bonded covalently.

neutralization In the Arrhenius acid-base definition, the combination of the H^+ ion from the acid and the OH^- ion from the base to form H_2O .

neutralization reaction An acid-base reaction that yields water and a solution of a salt; when a strong acid reacts with a stoichiometrically equivalent amount of a strong base, the solution is neutral.

neutron (n^0) An uncharged subatomic particle found in the nucleus, with a mass slightly greater than that of a proton.

node A region of an orbital where the probability of finding the electron is zero.

nonelectrolyte A substance whose aqueous solution does not conduct an electric current.

nonmetal An element that lacks metallic properties. In reactions, nonmetals tend to bond with each other to form covalent compounds or accept electrons from metals to form ionic compounds.

nonpolar covalent bond A covalent bond between identical atoms that share the bonding pair equally.

nuclear binding energy The energy required to break 1 mol of nuclei of an element into individual nucleons.

nuclear transmutation The induced conversion of one nucleus into another by bombardment with a particle.

nucleic acid An unbranched polymer consisting of mononucleotides that occurs as two types, DNA and RNA (deoxyribonucleic and ribonucleic acids), which differ chemically in the nature of the sugar portion of the mononucleotides.

nucleon A subatomic particle that makes up a nucleus; a proton or neutron.

nucleus The tiny central region of the atom that contains all the positive charge and essentially all the mass.

nuclide A nuclear species with specified numbers of protons and neutrons.

**O**

observation A fact obtained with the senses, often with the aid of instruments. Quantitative observations provide data that can be compared objectively.

octahedral arrangement The geometric arrangement obtained when six electron groups maximize their space around a central atom; when all six groups are bonding groups, the molecular shape is octahedral (AX_6 ; ideal bond angle = 90°).

octet rule The observation that when atoms bond, they often lose, gain, or share electrons to attain a filled outer shell of eight electrons.

optical isomers (also *enantiomers*) A pair of stereoisomers consisting of a molecule and its mirror image that cannot be superimposed on each other.

optically active Able to rotate the plane of polarized light.

orbital diagram A depiction of electron number and spin in an atom's orbitals by means of arrows in a series of small boxes, lines, or circles.

organic compound A compound in which carbon is nearly always bonded to at least one other carbon, to hydrogen, and often to other elements.

osmosis The process by which solvent flows through a semipermeable membrane from a dilute to a concentrated solution.

osmotic pressure (π) The pressure that results from the inability of solute particles to cross a semipermeable membrane. The pressure required to prevent the net movement of solvent across the membrane.

outer electrons Electrons that occupy the highest energy level (highest n value) and are, on average, farthest from the nucleus.

overvoltage The additional voltage, usually associated with gaseous products, that is required above the standard cell voltage to accomplish electrolysis.

oxidation The loss of electrons by a species, accompanied by an increase in oxidation number.

oxidation number (O.N.) (also *oxidation state*) A number equal to the magnitude of the charge an atom would have if its shared electrons were held completely by the atom that attracts them more strongly.

oxidation-reduction reaction (also *redox reaction*) A process in which there is a net movement of electrons from one reactant (reducing agent) to another (oxidizing agent).

oxidizing agent The substance that accepts electrons in a redox reaction and undergoes a decrease in oxidation number.

oxoanion An anion in which an element is bonded to one or more oxygen atoms.

P

p orbital An atomic orbital with $l = 1$.

packing efficiency The percentage of the available volume occupied by atoms, ions, or molecules in a unit cell.

paramagnetism The tendency of a species with unpaired electrons to be attracted by an external magnetic field.



partial ionic character An estimate of the actual charge separation in a bond (caused by the electronegativity difference of the bonded atoms) relative to complete separation.

partial pressure The portion of the total pressure contributed by a gas in a mixture of gases.

particle accelerator A device used to impart high kinetic energy to nuclear particles.

penetration The process by which an outer electron moves through the region occupied by the core electrons to spend part of its time closer to the nucleus; penetration increases the average effective nuclear charge for that electron.

percent yield (% yield) The actual yield of a reaction expressed as a percentage of the theoretical yield.

period A horizontal row of the periodic table.

periodic law A law stating that when the elements are arranged by atomic number, they exhibit a periodic recurrence of properties.

periodic table of the elements A table in which the elements are arranged by atomic number into columns (groups) and rows (periods).

pH The negative common logarithm of $[H_3O^+]$.

phase A physically distinct portion of a system.

phase change A physical change from one phase to another, usually referring to a change in physical state.

phase diagram A diagram used to describe the stable phases and phase changes of a substance as a function of temperature and pressure.

photoelectric effect The observation that when monochromatic light of sufficient frequency shines on a metal, an electric current is produced.

photon A quantum of electromagnetic radiation.

physical change A change in which the physical form (or state) of a substance, but not its composition, is altered.

physical property A characteristic shown by a substance itself, without interacting with or changing into other substances.

pi (π) bond A covalent bond formed by sideways overlap of two atomic orbitals that has two regions of electron density, one above and one below the internuclear axis.

pi (π) MO A molecular orbital formed by combination of two atomic (usually *p*) orbitals whose orientations are perpendicular to the internuclear axis.

Planck's constant (h) A proportionality constant relating the energy and the frequency of a photon, equal to 6.626×10^{-34} J.s.

polar covalent bond A covalent bond in which the electron pair is shared unequally, so the bond has partially negative and partially positive poles.

polar molecule A molecule with an unequal distribution of charge as a result of its polar covalent bonds and shape.

polarizability The ease with which a particle's electron cloud can be distorted.

polyatomic ion An ion in which two or more atoms are bonded covalently.

polymer (also *macromolecule*) An extremely large molecule that results from the covalent linking of many simpler molecular units (monomers).



polyprotic acid An acid with more than one ionizable proton.

polysaccharide A macromolecule composed of many simple sugars linked covalently.

positron (β^+) The antiparticle of an electron.

positron (β^+) emission A type of radioactive decay in which a positron is emitted from a nucleus.

potential energy (E_p) The energy an object has as a result of its position relative to other objects or because of its composition.

precipitate The insoluble product of a precipitation reaction.

precipitation reaction A reaction in which two soluble ionic compounds form an insoluble product, a precipitate.

precision (also *reproducibility*) The closeness of a measurement to other measurements of the same phenomenon in a series of experiments.

pressure (P) The force exerted per unit of surface area.

pressure-volume work (PV work) A type of work in which a volume change occurs against an external pressure. (189)

principal quantum number (n) A positive integer that specifies the energy and relative size of an atomic orbital.

probability contour A shape that defines the volume around an atomic nucleus within which an electron spends a given percentage of its time.

product A substance formed in a chemical reaction.

property A characteristic that gives a substance its unique identity.

protein A natural, linear polymer composed of any of about 20 types of amino acid monomers linked together by peptide bonds.

proton (p_+) A subatomic particle found in the nucleus that has a unit positive charge ($1.60218 \times 10^{-19} \text{ C}$).

proton acceptor A substance that accepts an H^+ ion; a Brønsted-Lowry base.

proton donor A substance that donates an H^+ ion; a Brønsted-Lowry acid.

Q

quantum A packet of energy equal to $h\nu$. The smallest quantity of energy that can be emitted or absorbed.

quantum mechanics The branch of physics that examines the wave motion of objects on the atomic scale.

quantum number A number that specifies a property of an orbital or an electron.

R

radial probability distribution plot The graphic depiction of the total probability distribution (sum of ψ^2) of an electron in the region near the nucleus.

radioactivity The emissions resulting from the spontaneous disintegration of an unstable nucleus.

radioisotope An isotope with an unstable nucleus that decays through radioactive emissions.