

## Glossary

**acid** A substance that releases  $H^+$  ions when dissolved in water.

**acid-base titration** A procedure in which a solution of a base (or an acid) is carefully added to another solution containing an acid (or a base) until complete reaction occurs. The volume and concentration of the added solution indicate the amount of the other reactant present.

**actinides** The elements after actinium in the seventh period in which the  $5f$  sublevel is being filled.

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

**alkali metals** Those elements (except hydrogen) in Group 1A of the periodic table.

**alkaline earth metals** Those elements in Group 2A of the periodic table.

**alternative science** Another name for pseudoscience; something that masquerades as science.

**amplitude** The height of a wave.

**anion** An atom or group of atoms that has a net negative electric charge; formed by the gain of electrons.

**aqueous solution** A homogeneous mixture consisting of one or more substances dissolved in water.

**Archimedes' principle** An object immersed in a fluid is buoyed up by a force equal to the weight of the displaced fluid.

**atom** The basic unit of matter consisting of a positively-charged nucleus surrounded by a negatively-charged electron cloud.

**atomic emission spectrum** The specific wavelengths of radiation emitted by an atom when its electrons move from higher energy levels to lower ones.

**atomic mass unit (u)** A unit of mass equal to one-twelfth the mass of a  $^{12}C$  atom.

**atomic nucleus** The dense, positively-charged center of an atom containing protons and neutrons.

**atomic number (Z)** The number of protons in the nucleus of an atom.

**atomic weight ( $A_r$ )** The average mass of the atoms of an element relative to the mass of a  $^{12}C$  atom.

## G.2 GLOSSARY

**Avogadro constant ( $N_A$ )** The number of elementary entities per mole of a substance. It has a value of  $6.022 \times 10^{23}$ .

**balanced chemical equation** A chemical equation having the same number of atoms of each type and the same net electric charge on both sides of the equation.

**ball-and-stick model** A molecular model that indicates the positions of and bonding between atoms.

**base** A substance that produces  $\text{OH}^-$  ions when dissolved in water.

**base unit** A fundamental unit of measure in the SI system. It is scaled up or down using a prefix that indicates a specific power of ten.

**binary acid** An acid having the general formula  $\text{H}_n\text{X}(\text{aq})$  where X is a nonmetal.

**binary molecular compound** A compound containing two nonmetals (other than hydrogen).

**calorie (cal)** A unit of energy equal to 4.184 J.

**Calorie (Cal)** The unit of energy often used for nutritional purposes; 1 Cal = 1000 cal.

**cation** An atom or group of atoms that has a net positive electric charge; formed by the loss of electrons.

**Celsius temperature scale** The common laboratory temperature scale on which water freezes at  $0^\circ\text{C}$  and boils at  $100^\circ\text{C}$ .

**chemical change** A process characterized by the formation of at least one new substance.

**chemical element** A pure substance consisting of one type of atom.

**chemical equation** A shorthand notation indicating the chemical formulas of the reactants and products in a chemical reaction.

**chemical formula** A shorthand notation using symbols of the chemical elements to indicate the composition of a pure substance.

**chemical reaction** Another name for a chemical change.

**chemical property** An attribute that involves a substance undergoing a chemical change.

**chemistry** The study of matter and the changes it can undergo.

**combination reaction** A chemical change in which two more substances react to produce a single substance.

**combustion reaction** A chemical change in which a  $C_xH_y$  or  $C_xH_yO_z$  compound reacts with oxygen gas to produce carbon dioxide and water.

**compound** A pure substance containing two or more elements.

**concentrated solution** A solution containing a relatively large amount of dissolved solute.

**concentration** A quantitative expression of the amount of dissolved solute in a solution.

**control experiment** An experiment done to determine the effect of a single variable by keeping all other variables fixed.

**core electrons** The electrons occupying the filled lower energy levels of an atom

**core ideas of science** Fundamental ideas that are generally accepted by all scientists.

**Coulomb's law** A statement about the electrostatic interactions between two electrically charged objects. The force of attraction or repulsion is proportional to the size of each charge and inversely proportional to the square of the distance between the charges.

**covalent bond** The electrostatic attraction between two atoms as a result of sharing a pair of electrons.

**cycle** A distance of one wavelength.

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

**decomposition reaction** A chemical change in which a single substance is converted to two or more different substances.

**density** The mass of an object divided by its volume.

**deionized water** Purified water that has had dissolved ions removed.

**delta function ( $\Delta$ )** The mathematical function that means take the difference between the final value and the initial value;  $\Delta X = X_{\text{fin}} - X_{\text{init}}$ .

**dependent variable** The quantity that changes in response to a change in the independent variable.

**diatomic molecule** A molecule composed of two atoms.

**diatomic elemental forms** Elements that naturally occur as two-atom molecules.

## G.4 GLOSSARY

**dilute solution** A solution containing a relatively small amount of dissolved solute.

**dilution** The process of adding solvent to a solution to reduce the solute concentration.

**dilution equation** The mathematical relationship between the initial solute concentration ( $M_1$ ) and initial solution volume ( $V_1$ ) and the resulting solute concentration ( $M_2$ ) and solution volume ( $V_2$ ) after solvent has been added;  
 $M_1V_1 = M_2V_2$ .

**dimensional analysis** A problem-solving system that uses the units of quantities to guide mathematical calculations.

**directly proportional** A mathematical relationship between two quantities in which the ratio of the quantities is a constant.

**double displacement reaction** A chemical change in which two compounds react to form two new compounds by an exchange of parts.

**effective nuclear charge** The actual positive charge experienced by an electron in an atom.

**electrical conductivity** A measure of a material's ability to allow for the movement of an electric charge.

**electrolyte** A substance that forms an electrically conducting solution when dissolved in water.

**electromagnetic radiation** A form of energy consisting of oscillating electric and magnetic fields moving through space.

**electromagnetic spectrum** The continuous range of all possible frequencies of electromagnetic radiation.

**electron** A negatively-charged subatomic particle that is found outside the nucleus of an atom.

**electron configuration** The complete description of the orbitals occupied by all of the electrons in an atom.

**electrostatic force** The physical interaction between two electrically charged objects.

**endothermic** A physical or chemical change in which heat is absorbed.

**energy** The capacity of a physical system to do work.

**excited state** An unstable state of an atom in which at least one electron does not have its lowest possible energy.

**exothermic** A physical or chemical change in which heat is released.

**experimental variables** Quantities that can be changed when doing an experiment.

**experimentation** The process of testing an idea.

**first law of thermodynamics** Energy can be converted from one form to another but it cannot be created nor destroyed.

**formula unit** The smallest representative unit of a substance. Its composition is indicated by the chemical formula of the substance.

**frequency** The number of wavelengths (or cycles) that pass an observation point per unit time.

**fringe ideas** Ideas or claims that have little scientific support.

**frontiers of science** Promising ideas at the forefront of scientific research.

**gamma radiation** Electromagnetic radiation having the shortest wavelengths and highest energy.

**gram (g)** SI unit of mass equal to 0.001 kg.

**ground state** The state of an atom in which all of the electrons occupy the lowest possible energy levels.

**groups** Vertical groupings of elements in the periodic table. Also known as families.

**halogens** The chemical elements found in Group 7A of the periodic table.

**heat** Energy that flows from a hotter object to a cooler one. Also known as thermal energy.

**hertz (Hz)** The SI unit of frequency; 1 Hz = 1 cycle/s.

**heterogeneous mixture** A mixture that does not have a uniform composition throughout.

**homogeneous mixture** A mixture that has a uniform composition (single phase) throughout. Also known as a solution.

**hydrocarbon** A chemical compound composed of only carbon and hydrogen atoms.

**hypothesis** A tentative explanation for what has been observed.

**ideal gas** A hypothetical gas in which the particles are moving randomly and independently of each other.

**independent variable** A quantity that is being controlled in an experiment.

**infrared (IR) radiation**

Electromagnetic radiation with wavelengths slightly longer than that of visible light.

**insoluble** Dissolving to only a very slight degree or not at all.

**inversely proportional** A mathematical relationship between two quantities in which the product of the quantities is a constant.

**ion** An atom or group of atoms with a net electric charge.

**ionic compounds** A pure substance composed of cations and anions.

**ionic bonds** The strong electrostatic attractions between cations and anions in an ionic compound.

**isotopes** Atoms that have the same number of protons but have a different number of neutrons.

**joule (J)** The derived SI unit of energy.

**Kelvin temperature scale** The temperature scale in the SI system having zero as the lowest possible temperature.

**kilogram (kg)** The basic SI unit of mass.

**kinetic energy (K.E.)** The energy an object possesses because of its motion.

**lanthanides** The elements after lanthanum in the sixth period in which the  $4f$  sublevel is being filled.

**law of conservation of mass** In chemical (and physical) changes mass is neither created nor destroyed.

**law of conservation of mass and energy** In any change, the total amount of mass plus energy is a constant.

**law of constant composition** All samples of a specific compound contain the same proportions of their constituent elements.

**limiting reactant** A substance that is totally consumed in a chemical reaction. It determines the theoretical yield of the reaction.

**line spectrum** Another name for an atomic emission spectrum.

**liter (L)** Unit of volume commonly used in science;  $1 \text{ L} = 10^3 \text{ cm}^3$ .

**main group elements** The chemical elements in the A groups of the periodic table.

**mass** The amount of matter an object possesses.

**mass percent** The ratio of the component mass divided by the total sample mass times 100. Often expressed as the number of grams of a particular component per 100 grams of material.

**mass number (A)** The number of protons plus neutrons in an atomic nucleus.

**mass spectrometry** An analytical technique used to measure atomic and molecular masses.

**matter** Anything that has mass and occupies space.

**mechanical work** The amount of energy transferred by a force acting through a distance.

**metalloids** Chemical elements (B, Si, Ge, As, Sb, Te and Po) that have properties characteristic of both metals and nonmetals.

**metals** Chemical elements that are generally solids at room temperature, malleable, good conductors of heat and electricity and tend to lose electrons to form cations.

**meter (m)** Basic unit of length in the SI system.

**microwave radiation** Electromagnetic radiation with wavelengths between those of IR radiation and radio waves.

**mixture** Matter containing two or more substances which can be present in variable amounts.

**molar mass (M)** The mass of one mole of a substance. It is commonly expressed in units of g/mol.

**molarity (M)** The number of moles of solute per liter of solution.

**mole (mol)** The amount of a substance that contains as many elementary entities as the number of atoms in exactly 12 grams of  $^{12}\text{C}$ .

**molecule** The smallest unit of an element or compound containing two or more atoms covalently bonded together.

**mole ratio** A ratio of the moles of a reactant or product to the moles of another reactant or product in a chemical reaction.

**monatomic ion** A single atom with a net positive or negative charge.

**neutralization reaction** The reaction of an acid and a base to form water and a salt.

**neutron** A subatomic particle that is electrically neutral and found in the nucleus of an atom.

## G.8 GLOSSARY

**noble gases** The chemical elements found in Group 8A of the periodic table.

**nonelectrolyte** A substance that dissolves in water to form an electrically nonconducting solution.

**nonmetals** Chemical elements that are poor conductors of heat and electricity and tend to gain electrons to form anions. They are generally located in the upper right corner of the periodic table.

**nonpolar molecule** A molecule whose average electric charge distribution is neutral throughout.

**nuclear force** The strong, short-range force of attraction between subatomic particles in the nucleus of an atom.

**observations** Acts of noticing or recording something.

**orbital** A mathematical representation of the region of space around the nucleus in which the probability of finding an electron with a particular energy is great.

**oxoacid** An acid having the general formula  $H_mXO_n$  in which at least one hydrogen atom is bonded to oxygen which is bonded to a nonmetal element (X).

**parallel spins** The situation in which two or more electrons in an atom have their spins aligned in the same direction.

**percent (%)** A ratio representing the number of a particular item in a total of 100 items.

**periodic table** An arrangement of the chemical elements based on atomic number.

**periods** Horizontal groupings of elements in the periodic table.

**phase** A part of a sample that has a uniform composition throughout. It is separated from other phases present by a distinguishable physical boundary.

**physical property** An attribute that can be measured without changing the composition of a substance.

**physical state** Matter characterized as a solid, liquid or gas.

**photoelectric effect** The emission of electrons from a surface when illuminated with electromagnetic radiation.

**photon** The elementary particle that is the basic unit of electromagnetic radiation.

**pipet** A laboratory device calibrated to transfer a specific volume of liquid.



**Planck's constant ( $h$ )** The proportionality factor in the relationship between photon energy and frequency ( $E_{\text{photon}} = h\nu$ ); it has a value of  $6.626 \times 10^{-34}$  J·s.

**polar molecule** A molecule with a permanent separation of electric charge due to the unequal sharing of electrons. This results in partial charges at different places in the molecule.

**polyatomic ion** An ion composed of two or more atoms.

**potential energy** Energy stored in an object as a result of its position.

**precipitate** A solid formed in solution as a result of a chemical or physical change.

**predictions** Statements about what will happen in the future.

**principal quantum number ( $n$ )** An integer assigned to each of the allowed main electron energy levels in an atom.

**products** Substances produced in a chemical reaction.

**proton** A positively-charged subatomic particle that is found in the nucleus of an atom.

**pseudoscience** An activity resembling science but lacking any scientific foundation.

**pure substance** Matter that has a definite composition. It can be a chemical element or a chemical compound.

**qualitative results** Nonnumerical observations such as a description of color or texture.

**quantitative results** Numerical information, such as the mass or volume of a substance, expressed in appropriate units.

**quantized** Having a limited set of possible values.

**quantum mechanics** A branch of physics that describes matter in terms of its dual wave and particle properties.

**radio waves** Electromagnetic radiation having the longest wavelengths and lowest energy.

**reactants** Substances that enter into a chemical reaction.

**relative energy diagram** A vertical axis with arbitrary energy units along which the energy level of different materials is noted for comparison.

## G.10 GLOSSARY

**salt** An ionic compound.

**scaled unit** A unit of measure in the SI system that has a power of ten prefix.

**scientific law** A general summary of observations with no known exceptions.

**scientific method** A systematic approach based on making observations and developing a tentative explanation (hypothesis), followed by extensive testing of the predictions made by the hypothesis. Accumulation of supporting evidence results in a well established explanation called a scientific theory.

**scientific notation** A convenient way to express large and small quantities by writing the quantity as a number between 1 and 10 multiplied by the appropriate power of ten.

**scientific principle** A term often used in place of scientific law. It provides a summary statement of observations.

**scientific rule** A term often used in place of scientific law. It provides a summary statement of observations.

**scientific theory** An explanation of observed phenomena that is supported by considerable scientific evidence.

**SI units** An agreed upon set of measurement units used by scientists around the world.

**significant figures** All of the digits in a measurement that are known with certainty plus one estimated digit.

**single displacement reaction** A chemical reaction between an element and a compound in which the free element displaces another element from the compound to produce a new compound and a different free element. Metals displace other metals and halogens displace other halogens.

**slope of the line (m)** The steepness of a straight line graph. Given two points  $(x_1, y_1)$  and  $(x_2, y_2)$  on a line, the slope of the line is calculated by:

$$m = \frac{y_2 - y_1}{x_2 - x_1}$$

**solubility rules** General guidelines that predict the water solubility of various ionic compounds.

**soluble** Capable of dissolving in another substance (usually water).

**solute** A minor component in a solution.

**solution map** An outline of the solution to a problem based on the necessary unit conversions.

**solution** A homogeneous mixture.

**solvent** The most abundant component in a solution.

**space-filling model** A molecular model that indicates the relative size of and bonding between atoms.

**specific heat (c)** The amount of energy needed to raise the temperature of one gram of a substance by 1 °C.

**speed of light (c)** The speed of all forms of electromagnetic radiation in a vacuum; approximately equal to  $3.0 \times 10^8$  m/s.

**static electricity** The build up of electric charge on the surface of an object.

**stoichiometry** The area of chemistry dealing with the quantitative relationships between reactants and products in a chemical reaction

**subatomic particle** Any of the protons, neutrons and electrons that compose atoms.

**sublevel** An allowable electron energy level associated with a specific orbital.

**sublimation** A physical change in which a solid is converted directly into a gas.

**synthesis reaction** Another name for a combination reaction.

**temperature** A measure of the average kinetic energy of the particles that make up a sample of matter.

**theoretical yield** The maximum amount of product that can be produced from a given quantity of reacting material in a chemical reaction.

**transition elements** The chemical elements in the B groups of the periodic table.

**ultraviolet radiation (UV)**  
Electromagnetic radiation with wavelengths slightly shorter than those of visible light.

**valence electron** An electron in the highest occupied principal energy level in an atom.

**visible light** Electromagnetic radiation with a wavelength from approximately 400 nm to 750 nm.

**volumetric flask** A calibrated piece of glassware that when filled to the calibration mark contains a specific volume of liquid.

**wave-particle duality** The idea that all matter exhibits both wave and particle properties.

## G.12 GLOSSARY

**wavelength** The distance between adjacent crests in a wave.

**weight** The force exerted on an object because of gravitational attraction.

**weighted average** A value obtained by multiplying each factor by a specified quantity before averaging. For atomic weights the weighting factor is the fractional isotope abundance.

**word equation** A description of a chemical change using the names of the reactants and products.

**x-axis** The horizontal axis of a two-dimensional plot.

**x-rays** Electromagnetic radiation with wavelengths between those of ultraviolet radiation and gamma rays.

**x-y scatter plot** A two-dimensional plot of data where the distance along the horizontal axis represents the value of one of the experimental quantities and the distance along the vertical axis represents the value of the other.

**y-axis** The vertical axis of a two-dimensional plot.

**y-axis intercept (b)** On a two-dimensional plot, the value of  $y$  when  $x = 0$ .