

APPENDIX 1

PERIODIC TABLE OF THE ELEMENTS

Traditionally, elements are represented in a shorthand form by letters. For example, the formula for water, H₂O, shows that a molecule of water consists of two atoms of hydrogen and one atom of oxygen. These chemical symbols for each of the atoms can be found on any periodic table of the elements. Using the periodic table, we can determine the number and position of the various parts of atoms.

Notice that atoms numbered 3, 11, 19, and so on are in column one. The atoms in this column act in a similar way, since they all

have one electron in their outermost layer. In the next column, Be, Mg, Ca, and so on act alike because these metals all have two electrons in their outermost electron layer. Similarly, atoms numbered 9, 17, 35, and so on all have seven electrons in their outer layer.

Knowing how fluorine, chlorine, and bromine act, you can probably predict how iodine will act under similar conditions. At the far right in the last column, argon, neon, and so on all act alike. They all have eight electrons in their outer electron layer. Atoms with eight electrons in their outer electron layer seldom form bonds with other atoms.

1 1A																			18 8A	
1 H Hydrogen 1.008	2 2A																			2 He Helium 4.003
3 Li Lithium 6.941	4 Be Beryllium 9.012																			
11 Na Sodium 22.99	12 Mg Magnesium 24.31	3 3B	4 4B	5 5B	6 6B	7 7B	8 8B	9 8B	10 8B	11 1B	12 2B	13 3A Al Aluminum 26.98	14 4A Si Silicon 28.09	15 5A P Phosphorus 30.97	16 6A S Sulfur 32.07	17 7A Cl Chlorine 35.45	18 8A Ar Argon 39.95			
19 K Potassium 39.10	20 Ca Calcium 40.08	21 Sc Scandium 44.96	22 Ti Titanium 47.88	23 V Vanadium 50.94	24 Cr Chromium 52.00	25 Mn Manganese 54.94	26 Fe Iron 55.85	27 Co Cobalt 58.93	28 Ni Nickel 58.69	29 Cu Copper 63.55	30 Zn Zinc 65.39	31 Ga Gallium 69.72	32 Ge Germanium 72.59	33 As Arsenic 74.92	34 Se Selenium 78.96	35 Br Bromine 79.90	36 Kr Krypton 83.80			
37 Rb Rubidium 85.47	38 Sr Strontium 87.62	39 Y Yttrium 88.91	40 Zr Zirconium 91.22	41 Nb Niobium 92.91	42 Mo Molybdenum 95.94	43 Tc Technetium (98)	44 Ru Ruthenium 101.1	45 Rh Rhodium 102.9	46 Pd Palladium 106.4	47 Ag Silver 107.9	48 Cd Cadmium 112.4	49 In Indium 114.8	50 Sn Tin 118.7	51 Sb Antimony 121.8	52 Te Tellurium 127.6	53 I Iodine 126.9	54 Xe Xenon 131.3			
55 Cs Cesium 132.9	56 Ba Barium 137.3	57 La Lanthanum 138.9	72 Hf Hafnium 178.5	73 Ta Tantalum 180.9	74 W Tungsten 183.9	75 Re Rhenium 186.2	76 Os Osmium 190.2	77 Ir Iridium 192.2	78 Pt Platinum 195.1	79 Au Gold 197.0	80 Hg Mercury 200.6	81 Tl Thallium 204.4	82 Pb Lead 207.2	83 Bi Bismuth 209.0	84 Po Polonium (210)	85 At Astatine (210)	86 Rn Radon (222)			
87 Fr Francium (223)	88 Ra Radium (226)	89 Ac Actinium (227)	104 Rf Rutherfordium (257)	105 Db Dubnium (260)	106 Sg Seaborgium (263)	107 Bh Bohrium (262)	108 Hs Hassium (265)	109 Mt Meitnerium (266)	110 Ds Darmstadtium (269)	111 Rg Roentgenium (272)	112	(113)	114	(115)	116	(117)	(118)			

Metals																				
	58 Ce Cerium 140.1	59 Pr Praseodymium 140.9	60 Nd Neodymium 144.2	61 Pm Promethium (147)	62 Sm Samarium 150.4	63 Eu Europium 152.0	64 Gd Gadolinium 157.3	65 Tb Terbium 158.9	66 Dy Dysprosium 162.5	67 Ho Holmium 164.9	68 Er Erbium 167.3	69 Tm Thulium 168.9	70 Yb Ytterbium 173.0	71 Lu Lutetium 175.0						
Metalloids																				
	90 Th Thorium 232.0	91 Pa Protactinium (231)	92 U Uranium 238.0	93 Np Neptunium (237)	94 Pu Plutonium (242)	95 Am Americium (243)	96 Cm Curium (247)	97 Bk Berkelium (247)	98 Cf Californium (249)	99 Es Einsteinium (254)	100 Fm Fermium (253)	101 Md Mendelevium (256)	102 No Nobelium (254)	103 Lr Lawrencium (257)						
Nonmetals																				

The 1–18 group designation has been recommended by the International Union of Pure and Applied Chemistry (IUPAC) but is not yet in wide use. In this text we use the standard U.S. notation for group numbers (1A–8A and 1B–8B). No names have been assigned for elements 112, 114, and 116. Elements 113, 115, 117, and 118 have not yet been synthesized.

APPENDIX 2

METRIC UNIT CONVERSION TABLES

The Metric System					
Standard metric units				Abbreviations	
Standard unit of mass		Gram		g	
Standard unit of length		Meter		m	
Standard unit of volume		Liter		L	
Common prefixes				Examples	
Tera (T)	one trillion	1,000,000,000,000	10^{12}	A terawatt is 10^{12} watts.	
Giga (G)	one billion	1,000,000,000	10^9	A gigawatt is 10^9 watts.	
Mega (M)	one million	1,000,000	10^6	A megagram is 10^6 grams.	
Kilo (k)	one thousand	1000	10^3	A kilogram is 10^3 grams.	
Centi (c)	one-hundredth	0.01	10^{-2}	A centimeter is 10^{-2} meter.	
Milli (m)	one-thousandth	0.001	10^{-3}	A milliliter is 10^{-3} liter.	
Micro (μ)	one-millionth	0.000001	10^{-6}	A micrometer is 10^{-6} meter.	
Nano (n)	one-billionth	0.000000001	10^{-9}	A nanogram is 10^{-9} gram.	
Pico (p)	one-trillionth	0.000000000001	10^{-12}	A picogram is 10^{-12} gram.	

Units of Length		
Unit	Abbreviation	Equivalent
Kilometer	km	1000 m
Meter	m	—
Centimeter	cm	10^{-2} m
Millimeter	mm	10^{-3} m
Micrometer	μm	10^{-6} m
Nanometer	nm	10^{-9} m
Angstrom	\AA	10^{-10} m
Length conversions		
1 in = 2.54 cm		1 mm = 0.0394 in
1 ft = 30.5 cm		1 cm = 0.394 in
1 ft = 0.305 m		1 m = 39.4 in
1 yd = 0.914 m		1 m = 3.28 ft
1 mi = 1.61 km		1 m = 1.094 yd
		1 km = 0.621 mi

Units of Area

Unit	Abbreviation	Equivalent
Square meter	m ²	1 m ²
Square kilometer	km ²	1,000,000 m ²
Hectare	ha	10,000 m ²

Area conversions

1 ft ² = 0.093 m ²	1 m ² = 10.76 ft ²
1 yd ² = 0.84 m ²	1 m ² = 1.19 yd ²
1 acre = 0.4 ha	1 ha = 2.47 acre
1 mi ² = 2.6 km ²	1 km ² = 0.386 mi ²
1 mi ² = 259 ha	1 km ² = 247 acres

Units of Volume

Unit	Abbreviation	Equivalent
Liter	L*	1
Milliliter	mL	10 ⁻³ L (1 mL = 1 cm ³ = 1 cc)
Microliter	μL	10 ⁻⁶ L

Volume conversions

1 tsp = 5 mL	1 mL = 0.034 fl oz
1 tbsp = 15 mL	1 L = 2.11 pt
1 fl oz = 30 mL	1 L = 1.057 qt
1 cup = 0.24 L	1 L = 0.265 gal
1 pt = 0.474 L	1 L = 33.78 fl oz
1 qt = 0.946 L	1 cubic meter (m ³) = 61,000 cubic inches
1 gal = 3.77 L	1 cubic meter (m ³) = 35.3 cubic feet
	1 cubic meter (m ³) = 0.00973 acre-inch

*Note: Many people use an uppercase "L" as the symbol for liter to avoid confusion with the number one (1). Similarly, milliliter is written mL.

Units of Weight

Unit	Abbreviation	Equivalent
Tonne (metric ton)	t	10 ³ kg
Kilogram	kg	10 ³ g
Gram	g	1
Milligram	mg	10 ³ g
Microgram	μg	10 ⁶ g
Nanogram	ng	10 ⁻⁹ g
Picogram	pg	10 ⁻¹² g

Weight conversions

1 oz = 28.4 g	1 g = 0.0352 oz
1 lb = 454 g	1 kg = 2.205 lb
1 lb = 0.454 kg	
1 U.S. ton = 0.91 metric ton	1 metric ton = 1.102 U.S. tons

Temperature conversions

$$^{\circ}\text{C} = \frac{(^{\circ}\text{F} - 32)}{9} \times 5$$

$$^{\circ}\text{F} = \frac{(^{\circ}\text{C} \times 9)}{5} + 32$$

Some equivalents

0°C = 32°F
37°C = 98.6°F
100°C = 212°F

GLOSSARY

A

- abiotic factors** Nonliving factors that influence the life and activities of an organism.
- absorbed dose** The amount of energy absorbed by matter, measured in grays or rads.
- abyssal ecosystem** The collection of organisms and the conditions that exist in the deep portions of the ocean.
- acid** Any substance that, when dissolved in water, releases hydrogen ions.
- acid deposition** The accumulation of potential acid-forming particles on a surface.
- acid mine drainage** A kind of pollution, associated with coal mines, in which bacteria convert the sulfur in coal into compounds that form sulfuric acid.
- acid rain (acid precipitation)** The deposition of wet acidic solutions or dry acidic particles from air.
- activated-sludge sewage treatment** Method of treating sewage in which some of the sludge is returned to aeration tanks, where it is mixed with incoming wastewater to encourage degradation of the wastes in the sewage.
- activation energy** The initial energy input required to start a reaction.
- active solar system** A system that traps sunlight energy as heat energy and uses mechanical means to move it to another location.
- acute toxicity** A serious effect, such as a burn, illness, or death, that occurs shortly after exposure to a hazardous substance.
- age distribution** The comparative percentages of different age groups within a population.
- agricultural products** Any output from farming: milk, grain, meat, etc.
- agricultural runoff** Surface water that carries soil particles, nutrients, such as phosphate, nitrates, and other agricultural chemicals as it runs off agricultural land into lakes and streams.
- agricultural waste** Waste from the raising of animals and harvesting and processing of crops and trees.
- air stripping** The process of pumping air through water to remove volatile materials dissolved in the water.

air toxics See **hazardous air pollutants**.

alpha radiation A type of radiation consisting of a particle with two neutrons and two protons.

alpine tundra The biome that exists above the tree line in mountainous regions.

alternative agriculture All nontraditional agricultural practices.

animal rights/welfare A movement that makes an ethical commitment to the well-being of nonhuman animals.

anthropocentrism A theory in ethics that views human values as primary and the environment as solely a resource for humankind.

aquiclude An impervious confining layer of an aquifer.

aquifer A porous layer of earth material that becomes saturated with water.

aquitard A partially permeable layer in an aquifer.

artesian well The result of a pressurized aquifer being penetrated by a pipe or conduit, within which water rises without being pumped.

asthenosphere Part of Earth's mantle capable of plastic flow.

ASTM International (formerly American Society of Testing and Materials) International voluntary consensus standard-setting organization, originally founded in the United States in 1898, that develops and maintains environmental standards and processes.

atom The basic subunit of elements, composed of protons, neutrons, and electrons.

auxin A plant hormone that stimulates growth.

B

base Any substance that, when dissolved in water, removes hydrogen ions from solution; forms a salt when combined with an acid.

benthic Describes organisms that live on the bottom of marine and freshwater ecosystems.

benthic ecosystem A type of marine or freshwater ecosystem consisting of organisms that live on the bottom.

beta radiation A type of radiation consisting of electrons released from the nuclei of many fissionable atoms.

bioaccumulation The buildup of a material in the body of an organism.

biocentrism A theory in ethics that acknowledges the value of all living organisms.

biogeochemical cycles Movement of matter within or between ecosystems; caused by living organisms, geological forces, or chemical reactions. The cycling of nitrogen, carbon, sulfur, oxygen, phosphorus, and water are examples.

biochemical oxygen demand (BOD) The amount of oxygen required by microbes to degrade organic molecules in aquatic ecosystems.

biocide A kind of chemical that kills many different types of living things.

biodegradable Able to be broken down by natural biological processes.

biodiversity A measure of the variety of kinds of organisms present in an ecosystem.

biogeochemical cycles The processes by which atoms are cycled in ecosystems.

biomagnification The increases in the amount of a material in the bodies of organisms at successively higher trophic levels.

biomass Any accumulation of organic material produced by living things.

biome A kind of plant and animal community that covers large geographic areas. Climate is a major determiner of the biome found in a particular area.

biotechnology Inserting specific pieces of DNA into the genetic makeup of organisms.

biotic factors Living portions of the environment.

biotic potential The inherent reproductive capacity.

birthrate The number of individuals born per thousand individuals in the population per year.

black lung disease A respiratory condition resulting from the accumulation of large amounts of fine coal dust particles in miners' lungs.

boiling-water reactor (BWR) A type of light-water reactor in which steam is formed

directly in the reactor and is used to generate electricity.

boreal forest A broad band of mixed coniferous and deciduous trees that stretches across northern North America (and also Europe and Asia); its northernmost edge is integrated with the Arctic tundra.

brownfields Buildings and land that have been abandoned because they are contaminated and the cost of cleaning up the site is high.

brownfields cleanup Cleaning a contaminated industrial site to the point that it is safe to use for specific purposes.

brownfields development The concept that abandoned contaminated sites can be cleaned up sufficiently to allow some specified uses without totally removing all of the contaminants.

bush meat Meat from wild animals.

C

carbamate A class of soft pesticides that work by interfering with normal nerve impulses.

carbon absorption The use of carbon particles to treat chemicals by having the chemicals attach to the carbon particles.

carbon cycle The cyclic flow of carbon from the atmosphere to living organisms and back to the atmospheric reservoir.

carbon dioxide (CO₂) A normal component of the Earth's atmosphere that in elevated concentrations may interfere with the Earth's heat budget.

carbon monoxide (CO) A primary air pollutant produced when organic materials, such as gasoline, coal, wood, and trash, are incompletely burned.

carcinogen A substance that causes cancer.

carcinogenic The ability of a substance to cause cancer.

carnivores Animals that eat other animals.

carrying capacity The optimum number of individuals of a species that can be supported in an area over an extended period of time.

catalyst A substance that alters the rate of a reaction but is not itself changed.

cause-and-effect relationship A relationship between two events or things in which a change in the first leads to a change in the second.

chemical bond The physical attraction between atoms that results from the interaction of their electrons.

chemical weathering Processes that involve the chemical alteration of rock in such a manner that it is more likely to fragment or to be dissolved.

chlorinated hydrocarbon A class of pesticide consisting of carbon, hydrogen, and chlorine; these pesticides are very stable.

chlorofluorocarbons (CFC) Stable compounds containing carbon, hydrogen, chlorine, and fluorine. They were formerly used as refrigerants, propellants in aerosol containers, and expanders in foam products. They are linked to the depletion of the ozone layer.

chronic toxicity A serious effect, such as an illness or death, that occurs after prolonged exposure to small doses of a toxic substance.

clear-cutting A forest harvesting method in which all the trees in a large area are cut and removed.

climax community Last stage of succession; a relatively stable, long-lasting, complex, and interrelated community of plants, animals, fungi, and bacteria.

coevolution Two or more species of organisms reciprocally influencing the evolutionary direction of the other.

combustion The process of releasing chemical bond energy from fuel.

commensalism The relationship between organisms in which one organism benefits while the other is not affected.

community Interacting groups of different species.

competition An interaction between two organisms in which both require the same limited resource, which results in harm to both.

competitive exclusion principle A theory that no two populations of different species will occupy the same niche and compete for exactly the same resources in the same habitat for very long.

composting The process of harnessing the natural process of decomposition to transform organic materials into compost, a humuslike material with many environmental benefits.

compound A kind of matter composed of two or more different kinds of atoms bonded together.

Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) The 1980 U.S. law that addressed the cleanup of hazardous-waste sites.

confined aquifer An aquifer that is bounded on the top and bottom by impermeable confining layers.

conservation To use in the best possible way so that the greatest long-term benefit is realized by society.

conservation approach An approach that seeks a balance between the development and preservation approaches.

conservation tillage A tillage method in which 30 percent or more of the soil surface is left covered with crop residue following planting.

consumers Organisms that use other organisms as food.

contour farming A method of tilling and planting at right angles to the slope, which reduces soil erosion by runoff.

controlled experiment An experiment in which two groups are compared. One, the control, is used as a basis of comparison and the other, the experimental, has one factor different from the control.

coral reef ecosystem A tropical, shallow-water, marine ecosystem dominated by coral organisms that produce external skeletons.

corporation A business structure that has a particular legal status.

corrosiveness Ability of a chemical to degrade standard materials.

cost-benefit analysis A method used to determine the feasibility of pursuing a particular project by balancing estimated costs against expected benefits.

cover A term used to refer to any set of physical features that conceals or protects animals from the elements or their enemies.

criteria air pollutants Those air pollutants for which specific air quality standards have been set by the U.S. Environmental Protection Agency.

crust The thin, outer, solid surface of the Earth.

cultural relativism The view that right and wrong are to be determined from within a particular society or cultural group.

D

death phase The portion of the population growth curve of some organisms that shows the population declining.

death rate The number of deaths per thousand individuals in the population per year.

debt-for-nature exchange The purchase of a nation's debt by a third party that requires conservation on the part of the debtor nation in exchange for relief from the debt.

deceleration phase A part of the population growth curve in which the rate of population increase begins to decline.

decibel A unit used to measure the loudness of sound.

decommissioning Decontaminating and disassembling a nuclear power plant and safely disposing of the radioactive materials.

decomposers Small organisms, such as bacteria and fungi, that cause the decay of dead organic matter and recycle nutrients.

deep ecology The generally ecocentric view that a new spiritual sense of oneness with the Earth is the essential starting point for a more healthy relationship with the environment.

deforestation Activities that destroy forests.

deferred cost A cost that is not paid immediately when an economic decision is made but must be paid at a later date.

demand Amount of a product that consumers are willing and able to buy at various prices.

demographic transition The hypothesis that economies proceed through a series of stages, beginning with growing populations with high birth and death rates and low economic development and ending with stable populations with low birth and death rates and high economic development.

demography The study of human populations, their characteristics, and their changes.

denitrifying bacteria Bacteria that convert nitrogen compounds into nitrogen gas.

design for environment (DFE) U.S. Environmental Protection Agency's (EPA) program for utilizing "green" (environmentally friendly) methods and processes in the development and design of products and services.

density-dependent limiting factors Those limiting factors that become more severe as the size of the population increases.

density-independent limiting factors Those limiting factors that are not affected by population size.

desert A biome that receives less than 25 centimeters (10 inches) of precipitation per year.

desertification The conversion of arid and semiarid lands into deserts by inappropriate farming practices or overgrazing.

detritus Tiny particles of organic material that result from fecal waste material or the decomposition of plants and animals.

development approach An approach that encourages humankind to transform nature as it pleases to satisfy human needs.

dioxins A general term for a group or family of chemicals containing hundreds of members (some of which are toxic) that are persistent in the environment and that are unintentionally formed by-products of industrial processes that involve chlorine and/or incineration.

dispersal Migration of organisms from a concentrated population into areas with lower population densities.

domestic water Water used for domestic activities, such as drinking, air conditioning,

bathing, washing clothes, washing dishes, flushing toilets, and watering lawns and gardens.

dose equivalent The absorbed dose times a quality factor.

E

ecocentrism A theory in ethics that considers the value of ecosystems and larger wholes to be primary.

ecology A branch of science that deals with the interrelationship between organisms and their environment.

ecofeminism The view that there are important theoretical, historical, and empirical connections between how society treats women and how it treats the environment.

ecological or environmental economics An approach to economic accounting that incorporates environmental goods and harms as part of the cost of economic activity.

ecological footprint The area of the Earth's productive land and water required to supply the resources that an individual demands as well as to absorb the wastes that the individual produces.

economic growth The perceived increase in monetary growth within a society.

economics The study of how people choose to use resources to produce goods and services and how these goods and services are distributed to the public.

ecosystem A group of interacting species along with their physical environment.

ecosystem diversity A measure of the number of kinds of ecosystems present in an area.

ectoparasite A parasite that is adapted to live on the outside of its host.

electron The lightweight, negatively charged particle that moves around at some distance from the nucleus of an atom.

element A form of matter consisting of a specific kind of atom.

emergent plants Aquatic vegetation that is rooted on the bottom but has leaves that float on the surface or protrude above the water.

emigration Movement out of an area that was once one's place of residence.

endangered species Those species that are present in such small numbers that they are in immediate jeopardy of becoming extinct.

endoparasite A parasite that is adapted to live within a host.

endothermic reaction Chemical reaction in which the newly formed chemical bonds contain more energy than was present in the compounds from which they were formed.

energy The ability to do work.

entropy The degree of disorder in a system. All systems tend toward a high degree of disorder or entropy.

environment Everything that affects an organism during its lifetime.

environmental aesthetics The study of how to appreciate beauty in the natural world.

environmental cost Damage done to the environment as a resource is exploited.

environmental justice Fair application of laws designed to protect the health of human beings and ecosystems; that no groups suffer unequal environmental harm.

environmental management systems Voluntary management processes and procedures designed to aid private and public agencies in establishing policies and practices for identifying, analyzing, and solving environmental problems.

environmental pragmatism An approach to environmental ethics that maintains that a human-centered ethic with a long-range perspective will come to many of the same conclusions in environmental policy as an ecocentric ethic.

Environmental Protection Agency (EPA) U.S. government organization responsible for the establishment and enforcement of regulations concerning the environment.

environmental resistance The combination of all environmental influences that tend to keep populations stable.

environmental science An interdisciplinary area of study that includes both applied and theoretical aspects of human impact on the world.

environmental site assessment The standard process of evaluating and assessing potential present, historical, and/or future environmental threats to commercial real estate.

environmental terrorism The unlawful use of force against environmental resources so as to deprive populations of their benefits or destroy other property.

enzymes Protein molecules that speed up the rate of specific chemical reactions.

erosion The processes that loosen and move particles from one place to another.

estuaries Marine ecosystems that consist of shallow, partially enclosed areas where freshwater enters the ocean.

ethics A discipline that seeks to define what is fundamentally right and wrong.

euphotic zone The upper layer in the ocean where the sun's rays penetrate.

eutrophication The enrichment of water (either natural or cultural) with nutrients.

eutrophic lake A usually shallow, warm-water lake that is nutrient rich.

evapotranspiration The process of plants transporting water from the roots to the leaves where it evaporates.

evolution A change in the structure, behavior, or physiology of a population of organisms as a result of some organisms with favorable characteristics having greater reproductive success than those organisms with less favorable characteristics.

executive branch The office of the president of the United States.

exothermic reaction Chemical reaction in which the newly formed compounds have less chemical energy than the compounds from which they were formed.

experiment An artificial situation designed to test the validity of a hypothesis.

exponential growth phase The period during population growth when the population increases at an ever-increasing rate.

extended product responsibility The concept that the producer of a product is responsible for all the negative effects involved in its production, including the ultimate disposal of the product when its useful life is over.

external costs Expenses, monetary or otherwise, borne by someone other than the individuals or groups who use a resource.

extinction The death of a species; the elimination of all the individuals of a particular kind.

extrinsic limiting factors Factors that limit population size and that come from outside the population.

F

fecal coliform bacteria Bacteria found in the intestines of humans and other animals, often used as an indicator of water pollution.

first law of thermodynamics A statement about energy that says that under normal physical conditions, energy is neither created nor destroyed.

fissionable The property of the nucleus of some atoms that allows them to split into smaller particles.

fixation A form of waste immobilization in which materials, such as fly ash or cement, are mixed with hazardous waste to prevent the waste from dispersing.

floodplain Lowland area on either side of a river that is periodically covered by water.

floodplain zoning ordinances Municipal laws that restrict future building in floodplains.

food chain The series of organisms involved in the passage of energy from one trophic level to the next.

food web Intersecting and overlapping food chains.

fossil fuels The organic remains of plants, animals, and microorganisms that lived millions of years ago that are preserved as natural gas, oil, and coal.

free-living nitrogen-fixing bacteria Bacteria that live in the soil and can convert nitrogen gas (N_2) in the atmosphere into forms that plants can use.

freshwater ecosystem Aquatic ecosystems that have low amounts of dissolved salts.

friable A soil characteristic that describes how well a soil crumbles.

fungicide A pesticide designed to kill or control fungi.

G

gamma radiation A type of electromagnetic radiation that comes from disintegrating atomic nuclei.

gas-cooled reactor (GCR) A type of nuclear reactor that uses graphite as a moderator and carbon dioxide or helium as a coolant.

gene A unit of heredity; a segment of DNA that contains information for the synthesis of a specific protein, such as an enzyme.

genetic diversity A term used to describe the number of different kinds of genes present in a population or a species.

genetically modified organisms Organisms that have had their genetic makeup modified by biotechnology.

genetic engineering Inserting specific pieces of DNA into the genetic makeup of organisms.

geothermal energy The heat energy from the Earth's molten core.

Global Reporting Initiative Guidelines for reporting on the economic, environmental, and social performance of corporations.

greenhouse effect The property of carbon dioxide (CO_2) that allows light energy to pass through the atmosphere but prevents heat from leaving; similar to the action of glass in a greenhouse.

greenhouse gas Gas in the atmosphere that allows sunlight to enter but retards the outward flow of heat from the Earth.

Green Revolution The introduction of new plant varieties and farming practices that increased agricultural production worldwide during the 1950s, 1960s, and 1970s.

gross national income (GNI) An index that measures the total goods and services generated within a country as well as income earned by citizens of the country who are living in other countries.

gross national product (GNP) An index that measures the total goods and services generated annually within a country.

groundwater Water that infiltrates the soil and is stored in the spaces between particles in the earth.

groundwater mining Removal of water from an aquifer faster than it is replaced.

H

habitat The specific kind of place where a particular kind of organism lives.

habitat management The process of changing the natural community to encourage the increase in populations of certain desirable species.

hard pesticide A pesticide that persists for long periods of time; a persistent pesticide.

hazardous All dangerous materials, including toxic ones, that present an immediate or long-term human health risk or environmental risk.

hazardous air pollutants Certain airborne compounds with high toxicity.

hazardous materials or substances Substances that can cause harm to humans or the environment.

hazardous-waste dump A site in which hazardous waste is disposed of in a dump, landfill, or surface impoundment without any concern for potential environmental or health risks.

hazardous wastes Substances that could endanger life if released into the environment.

heavy-water reactor (HWR) A type of nuclear reactor that uses the hydrogen isotope deuterium in the molecular structure of the coolant water.

herbicide A pesticide designed to kill or control plants.

herbivores Primary consumers; animals that eat plants.

horizon A horizontal layer in the soil. The top layer (*A* horizon) has organic matter. The lower layer (*B* horizon) receives nutrients by leaching. The *C* horizon is partially weathered parent material.

host The organism a parasite uses for its source of food.

humus Partially decomposed organic matter typically found in the top layer of the soil.

hydrocarbons (HC) Group of organic compounds consisting of carbon and hydrogen atoms that are evaporated from fuel supplies or are remnants of the fuel that did not burn completely and that act as a primary air pollutant.

hydrologic cycle Constant movement of water from surface water to air and back to surface water as a result of evaporation and condensation.

hydroxide ion A negatively charged particle consisting of a hydrogen and an oxygen

atom, commonly released from materials that are bases.

hypothesis A logical statement that explains an event or answers a question that can be tested.

I

ignitability Characteristic of materials that results in their ability to combust.

immigration Movement into an area where one has not previously resided.

incineration Method of disposing of solid waste by burning.

industrial ecology A concept that stresses cycling resources rather than extracting and eventually discarding them.

Industrial Revolution A period of history during which machinery replaced human labor.

industrial solid waste A wide variety of materials such as demolition waste, foundry sand, scraps from manufacturing processes, sludge, ash from combustion, and other similar materials produced by industry.

industrial water uses Uses of water for cooling and for dissipating and transporting waste materials.

infrastructure Permanent structural foundations of a society such as highways and bridges.

insecticide A pesticide designed to kill or control insects.

in-stream water uses Use of a stream's water flow for such purposes as hydroelectric power, recreation, and navigation.

integrated pest management A method of pest management in which many aspects of the pest's biology are exploited to control its numbers.

interspecific competition Competition between members of different species for a limited resource.

intraspecific competition Competition among members of the same species for a limited resource.

intrinsic limiting factors Factors that limit population size that come from within the population.

ion An atom or group of atoms that has an electric charge because it has either gained or lost electrons.

ionizing radiation Radiation that can dislodge electrons from atoms to form ions.

irrigation Adding water to an agricultural field to allow certain crops to grow where the lack of water would normally prevent their cultivation.

ISO 14000 Commonly used name for a group of voluntary environmental processes

and practices developed by the International Organization for Standardization, headquartered in Geneva, Switzerland.

isotope Atoms of the same element that have different numbers of neutrons.

J

judicial branch That portion of the U.S. government that includes the court system.

K

keystone species One that has a critical role to play in the maintenance of specific ecosystems.

kinetic energy Energy of moving objects.

kinetic molecular theory The widely accepted theory that all matter is made of small particles that are in constant movement.

K-strategists Large organisms that have relatively long lives, produce few offspring, provide care for their offspring, and typically have populations that stabilize at the carrying capacity.

L

lag phase The initial stage of population growth during which growth occurs very slowly.

land The surface of the Earth not covered by water.

land disposal The placement of unwanted materials on the surface in landfills or impoundments or by injecting them below the surface of the land.

landfill A method of disposing of solid wastes that involves burying the wastes in specially constructed sites.

land-use planning The process of evaluating the needs and wants of the population, the characteristics and values of the land, and various alternative solutions before changes in land use are made.

latent heat Heat transfer that occurs when a substance is changed from one state to another—solid to liquid, gas to liquid—in which heat is transferred but the temperature does not change.

laws Legislative or judicial frameworks determining how members of a particular society should behave.

law of conservation of mass States that matter is not gained or lost during a chemical reaction.

LD₅₀ A measure of toxicity; the dosage of a substance that will kill (lethal dose) 50 percent of a test population.

leachate Contaminant-laden water that flows from landfills or other contaminated sites.

leaching The movement of minerals from the top layers of the soil to the B horizon by the downward movement of soil water.

legislative branch That portion of the U.S. government that is responsible for developing laws.

less-developed countries Countries of the world that typically have a per capita income of less than US \$5000.

life cycle analysis The process of assessing the environmental effects associated with the production, use, reuse, and disposal of a product over its entire useful life.

light-water reactor A nuclear reactor that uses ordinary water as a coolant.

limiting factor The primary condition of the environment that determines the population size for an organism.

limnetic zone Region that does not have rooted vegetation in a freshwater ecosystem.

liquefied natural gas Natural gas that has been converted to a liquid by cooling to -162°C (-260°F).

liquid metal fast-breeder reactor (LMFBR) Nuclear fission reactor using liquid sodium as the moderator and heat transfer medium; produces radioactive plutonium-235, which can be used as a nuclear fuel.

lithosphere A combination of the crust and outer layer of the mantle that forms the plates that move over the Earth's surface.

litter A layer of undecomposed or partially decomposed organic matter on the soil surface.

littoral zone Region with rooted vegetation in a freshwater ecosystem.

loam A soil type with good drainage and good texture that is ideal for growing crops.

M

macronutrient A nutrient, such as nitrogen, phosphorus, or potassium, that is required in relatively large amounts by plants.

mangrove swamp ecosystems Marine shoreline ecosystems dominated by trees that can tolerate high salt concentrations.

mantle The layer of the Earth between the crust and the core.

marine ecosystems Aquatic ecosystems that have high salt content.

marsh Area of grasses and reeds that is flooded either permanently or for a major part of the year.

mass burn A method of incineration of solid waste in which material is fed into a furnace on movable metal grates.

matter Substance with measurable mass and volume.

mechanical weathering Physical forces that reduce the size of rock particles without changing the chemical nature of the rock.

Mediterranean shrublands Coastal ecosystems characterized by winter rains and summer droughts that are dominated by low, woody vegetation with small leaves.

megalopolis A large, regional urban center.

methane (CH₄) An organic compound produced by living organisms that is a greenhouse gas.

micronutrient A nutrient needed in extremely small amounts for proper plant growth; examples are boron, zinc, and magnesium.

migratory birds Birds that fly considerable distances between their summer breeding areas and their wintering areas.

mining waste Waste from the processing of rock from mining operations. It includes solid materials that are typically dumped on the land near the milling site and liquid wastes typically stored in ponds.

mixture A kind of matter consisting of two or more kinds of matter intermingled with no specific ratio of the kinds of matter.

moderator Material that absorbs the energy from neutrons released by fission.

molecule Two or more atoms chemically bonded to form a stable unit.

monoculture A system of agriculture in which large tracts of land are planted with the same crop.

more-developed countries Countries of the world that typically have a per capita income that exceeds US \$10,000; Europe, Canada, United States, Australia, New Zealand, and Japan.

mortality The number of deaths per year.

mulch An organic material that is used to cover the soil.

multiple land use Land uses that do not have to be exclusionary, so that two or more uses of land may occur at the same time.

municipal solid waste landfill A waste storage site constructed above an impermeable clay layer that is lined with an impermeable membrane and includes mechanisms for dealing with liquid and gas materials generated by the contents of the landfill.

municipal solid waste (MSW) All the waste produced by the residents of a community.

mutations Changes in the genetic information of an organism.

mutualism The association between organisms in which both benefit.

mycorrhizae Symbiotic soil fungi, present in most soils, that attach themselves directly onto the roots of most plants. They help the

host plants to absorb more water and nutrients while the host plants provide food for the fungi.

N

natality The number of individuals added to the population through reproduction.

National Priorities List A listing of hazardous-waste dump sites requiring urgent attention as identified by Superfund legislation.

natural capitalism An economic approach that pursues market-based profitability while at the same time preserving (or increasing) environmental quality.

natural resources Those structures and processes that can be used by humans for their own purposes but cannot be created by them.

natural selection A process that determines which individuals within a species will reproduce more effectively and therefore results in changes in the characteristics within a species.

nature centers Teaching institutions that provide a variety of methods for people to learn about and appreciate the natural world.

negligible risk A point at which there is no significant health or environmental risk.

neutralization Reacting acids with bases to produce relatively safe end products.

neutron Neutrally charged particle located in the nucleus of an atom.

niche The total role an organism plays in its ecosystem.

nitrifying bacteria Bacteria that are able to convert ammonia to nitrite, which can be converted to nitrate.

nitrogen cycle The series of stages in the flow of nitrogen in ecosystems.

nitrogen dioxide A compound composed of one atom of nitrogen and two atoms of oxygen; a secondary air pollutant.

nitrogen-fixing bacteria Bacteria that are able to convert the nitrogen gas (N₂) in the atmosphere into forms that plants can use.

nitrogen monoxide A compound composed of one atom of nitrogen and one atom of oxygen; a primary air pollutant.

nitrous oxide N₂O, one of the oxides of nitrogen.

nonpersistent pesticide A pesticide that degrades in a short period of time.

nonpersistent pollutants Those pollutants that do not remain in the environment for long periods.

nonpoint source Diffuse pollutants, such as agricultural runoff, road salt, and acid rain, that are not from a single, confined source.

nonrenewable energy sources Those energy sources that are not replaced by natural processes within a reasonable length of time.

nonrenewable resources Those resources that are not replaced by natural processes, or those whose rate of replacement is so slow as to be noneffective.

nontarget organism An organism whose elimination is not the purpose of pesticide application.

northern coniferous forest See **boreal forest**.

nuclear breeder reactor Nuclear fission reactor designed to produce radioactive fuel from nonradioactive uranium and at the same time release energy to use in the generation of electricity.

nuclear chain reaction A continuous process in which a splitting nucleus releases neutrons that strike and split the nuclei of other atoms, releasing nuclear energy.

nuclear fission The decomposition of an atom's nucleus with the release of particles and energy.

nuclear fusion The union of smaller nuclei to form a heavier nucleus accompanied by the release of energy.

nuclear reactor A device that permits a controlled nuclear fission chain reaction.

nucleus The central region of an atom that contains protons and neutrons.

O

observation Ability to detect events by the senses or machines that extend the senses.

oligotrophic lakes Deep, cold, nutrient-poor lakes that are low in productivity.

omnivores Animals that eat both plants and other animals.

organic agriculture Agricultural practices that avoid the use of chemical fertilizers and pesticides in the production of food, thus preventing damage to related ecosystems and consumers.

organophosphate A class of soft pesticides that work by interfering with normal nerve impulses.

outdoor recreation Leisure activities carried out in the natural out-of-doors.

overburden The layer of soil and rock that covers deposits of desirable minerals.

oxides of nitrogen (NO, N₂O, and NO₂) Primary air pollutants consisting of a variety of different compounds containing nitrogen and oxygen.

ozone (O₃) A molecule consisting of three atoms of oxygen that absorbs much of the sun's ultraviolet energy before it reaches the Earth's surface.

P

parasite An organism adapted to survival by using another living organism (host) for nourishment.

parasitism A relationship between organisms in which one, known as the parasite, lives in or on the host and derives benefit from the relationship while the host is harmed.

parent material Material that is weathered to become the mineral part of the soil.

particulate matter Minute solid particles and liquid droplets dispersed into the atmosphere.

particulates Small pieces of solid materials, such as smoke particles from fires, bits of asbestos from brake linings and insulation, dust particles, or ash from industrial plants, that are dispersed into the atmosphere.

passive solar system A design that allows for the entrapment and transfer of heat from the sun to a building without the use of moving parts or machinery.

patchwork clear-cutting A forest harvest method in which patches of trees are clear-cut among patches of timber that are left untouched.

peat The first stage in the conversion of organic material into coal.

pelagic Those organisms that swim in open water.

pelagic ecosystem A portion of a marine or freshwater ecosystem that occurs in open water away from the shore.

periphyton Attached organisms in freshwater streams and rivers, including algae, animals, and fungi.

permafrost Permanently frozen ground.

permissible exposure limit (PEL) Standard acceptable level or limit of chemicals thought to be "safe" for human exposure utilized by the U.S. Occupational Safety and Health Administration (OSHA) as enforceable criterion for the protection of human health.

persistent pesticide A pesticide that remains unchanged for a long period of time; a hard pesticide.

persistent pollutant A pollutant that remains in the environment for many years in an unchanged condition.

personal ethical commitment A determination of ethical right and wrong made by an individual.

pest An unwanted plant or animal that interferes with domesticated plants and animals or human activity.

pesticide A chemical used to eliminate pests; a general term used to describe

a variety of different kinds of pest killers, such as insecticides, fungicides, rodenticides, and herbicides.

pH The negative logarithm of the hydrogen ion concentration; a measure of the number of hydrogen ions present.

pheromone A chemical produced by one animal that changes the behavior of another.

photochemical smog A yellowish-brown haze that is the result of the interaction of hydrocarbons, oxides of nitrogen, and sunlight.

photosynthesis The process by which plants manufacture food. Light energy is used to convert carbon dioxide and water to sugar and oxygen.

phytoplankton Free-floating, microscopic, chlorophyll-containing organisms.

pioneer community The early stages of succession that begin the soil-building process.

plankton Tiny aquatic organisms that are moved by tides and currents.

plate tectonics The concept that the outer surface of the Earth consists of large plates that are slowly moving over the surface of a plastic layer.

plutonium-239 (Pu-239) A radioactive isotope produced in a breeder reactor and used as a nuclear fuel.

PM₁₀ Particulate matter that is 10 microns or less in diameter.

PM_{2.5} Particulate matter that is 2.5 microns or less in diameter.

point source Pollution that can be traced to a single source.

policy Planned course of action on a question or a topic.

pollution Any addition of matter or energy that degrades the environment for humans and other organisms.

pollution costs The private or public expenditures undertaken to avoid pollution damage once pollution has occurred and the increased health costs and loss of the use of public resources because of pollution.

pollution prevention Action to prevent either entirely or partially the pollution that would otherwise result from some production or consumption activity.

pollution-prevention costs Costs incurred to prevent pollution that would otherwise result from some production or consumption activity.

pollution-prevention hierarchy Regulatory controls that emphasize reducing the amount of hazardous waste produced.

polyculture A system of agriculture that mixes different plant species in the same plots of land.

polyploidy A condition in which the number of sets of chromosomes increases.

population A group of individuals of the same species occupying a given area.

population density A measure of how close organisms are to one another, generally expressed as the number of organisms per unit area.

population growth rate The rate at which additional individuals are added to the population; the birthrate minus the death rate.

porosity A measure of the size and number of spaces in an aquifer.

potable waters Unpolluted freshwater supplies suitable for drinking.

potential energy The energy of position.

prairies Temperate grasslands.

precipitation Removal of materials by mixing with chemicals that cause the materials to settle out of the mixture.

precision agriculture The use of computer technology and geographic information systems to automatically vary the chemicals applied to a crop at different places within a field.

predation The act of killing and feeding by a predator.

predator An animal that kills and eats another organism.

preservation Action to keep from harm or damage; to maintain in its original condition.

preservation approach An approach that seeks to ensure that large areas of nature together with their ecological processes remain intact.

pressurized-water reactor (PWR) A type of light-water reactor in which the water in the reactor is kept at high pressure and steam is formed in a secondary loop.

prey An organism that is killed and eaten by a predator.

price The monetary value of a good or service.

primary air pollutants Types of unmodified materials that, when released into the environment in sufficient quantities, are considered hazardous.

primary consumer An animal that eats plants (producers) directly.

primary sewage treatment Process that removes larger particles by settling or filtering raw sewage through large screens.

primary succession Succession that begins with bare mineral surfaces or water.

probability A mathematical statement about how likely it is that something will happen.

producer An organism that can manufacture food from inorganic compounds and light energy.

profitability The extent to which economic benefits exceed the economic costs of doing business.

proton The positively charged particle located in the nucleus of an atom.

pseudoscience A deceptive practice that uses the appearance or language of science to convince, confuse, or mislead people into thinking something has scientific validity, when it does not.

public resources Those parts of the environment that are owned by everyone.

R

radiation Energy that travels through space in the form of waves or particles.

radioactive Describes unstable nuclei that release particles and energy as they disintegrate.

radioactive half-life The time it takes for half of the radioactive material to spontaneously decompose.

radon Radioactive gas emitted from certain kinds of rock; can accumulate in very tightly sealed buildings.

range of tolerance The ability organisms have to succeed under a variety of environmental conditions. The breadth of this tolerance is an important ecological characteristic of a species.

reactivity The property of materials that indicates the degree to which a material is likely to react vigorously to water or air, or to become unstable or explode.

recycling The process of reclaiming a resource and reusing it for another or the same structure or purpose.

reduced tillage A tillage method that generally leaves 15 to 30 percent of the soil surface covered with crop residue following planting.

reforestation The process of replanting areas after the original trees are removed.

rem A measure of the biological damage to tissue caused by certain amounts of radiation.

remediation A method of providing a remedy or correction for an environmental contamination issue, as in "cleanup" operations.

renewable energy sources Those energy sources that can be regenerated by natural processes.

renewable resources Those resources that can be formed or regenerated by natural processes.

replacement fertility The number of children per woman needed just to replace the parents.

reproducibility A characteristic of the scientific method in which independent

investigators must be able to reproduce the experiment to see if they get the same results.

reserves The known deposits from which materials can be extracted profitably with existing technology under present economic conditions.

Resource Conservation and Recovery Act (RCRA) The 1976 U.S. law that specifically addressed the issue of hazardous waste.

resource exploitation The use of natural resources by society.

resources Naturally occurring substances that can be utilized by people but may not be economic.

respiration The process that organisms use to release chemical bond energy from food.

ribbon sprawl Development along transportation routes that usually consists of commercial and industrial building.

risk The probability that a condition or action will lead to an injury, damage, or loss.

risk assessment The use of facts and assumptions to estimate the probability of harm to human health or the environment that may result from exposures to specific pollutants, toxic agents, or management decisions.

risk-based corrective action (RBCA) Scientific process for "cleaning up" environmental contamination sites through health and safety risk assessments.

risk management Decision-making process that uses input such as risk assessment, technological feasibility, economic impacts, public concerns, and legal requirements.

risk tolerance Ability to adapt to potential loss, damage, or injury.

rodenticide A pesticide designed to kill rodents.

r-strategist Typically, a small organism that has a short life span, produces a large number of offspring, and does not reach a carrying capacity.

runoff The water that moves across the surface of the land and enters a river system.

S

salinization An increase in the amount of salt in soil due to the evaporation of irrigation water.

saltwater intrusion The movement of saltwater into aquifers near oceans when too much water is pumped from aquifers.

savanna Tropical biome having seasonal rainfall of 50 to 150 centimeters (20–60 inches) per year. The dominant plants are grasses, with some scattered fire- and drought-resistant trees.

science A method for gathering and organizing information that involves observation, asking questions about observations hypothesis formation, testing hypotheses, critically evaluating the results, and publishing information so that others can evaluate the process and the conclusions.

scientific law A uniform or constant fact of nature that describes *what* happens in nature.

scientific method A way of gathering and evaluating information. It involves observation, hypothesis formation, hypothesis testing, critical evaluation of results, and the publishing of findings.

secondary air pollutants Pollutants produced by the interaction of primary air pollutants in the presence of an appropriate energy source.

secondary consumers Animals that eat animals that have eaten plants.

secondary recovery Techniques used to obtain the maximum amount of oil or natural gas from a well.

secondary sewage treatment Process that involves holding the wastewater until the organic material has been degraded by bacteria and other microorganisms.

secondary succession Succession that begins with the destruction or disturbance of an existing ecosystem.

second law of thermodynamics A statement about energy conversion that says that whenever energy is converted from one form to another, some of the useful energy is lost.

selective harvesting A forest harvesting method in which individual high-value trees are removed from the forest, leaving the majority of the forest undisturbed.

sensible heat The heat energy stored in a substance as a result of an increase in its temperature.

septic tank Underground holding tank into which sewage is pumped and where biological degradation of organic material takes place; used in places where sewers are not available.

seral stage A stage in the successional process.

sere A stage in succession.

sewage sludge A mixture of organic material, organisms, and water in which the organisms consume the organic matter.

sex ratio Comparison between the number of males and females in a population.

smart growth Land development that emphasizes the concept of livable cities and towns.

Small Business Liability Relief and Brownfield Revitalization Act ("Brownfields Law") U.S. law (January

2002) designed to limit Superfund liability to allow for the environmental remediation and reuse of contaminated sites that were previously industrial or commercial areas.

small-scale chemistry “Green” approach to that chemistry that minimizes the amounts of chemicals used in the laboratory in order to limit wastes.

social ecology The view that social hierarchies between groups of people are directly connected to patterns of behavior that cause environmental destruction.

soft pesticide A nonpersistent pesticide that breaks down into harmless products in a few hours or days.

soil A mixture of mineral material, organic matter, air, water, and living organisms; capable of supporting plant growth.

soil profile The series of layers (horizons) seen as one digs down into the soil.

soil structure Refers to the way that soil particles clump together. Sand has little structure because the particles do not stick to one another.

soil texture Refers to the size of the particles that make up the soil. Sandy soil has large particles, and clay soil has small particles.

solidification The conversion of liquid wastes to a solid form to allow for more safe storage or transport.

solid waste Unwanted objects or particles that accumulate on the site where they are produced.

source reduction Reducing the amount of solid waste generated by using less, or converting from heavy packaging materials to lightweight ones.

speciation The process of developing a new species.

species A group of organisms that can interbreed and produce offspring capable of reproduction.

species diversity A measure of the number of different species present in an area.

stable equilibrium phase The phase in a population growth curve in which the death rate and birthrate become equal.

standard of living The necessities and luxuries essential to a level of existence that is customary within a society.

steam stripping The use of heated air to drive volatile compounds from liquids.

steppe A grassland.

stormwater runoff Stormwater that runs off of streets and buildings and is often added directly to the sewer system and sent to the municipal wastewater treatment facility.

strict joint and several liability Legal phrase used to describe environmental and other

potential liabilities where *strict* liability means liability without fault; *joint and several* liability means that any one of the liable parties involved in a contaminated site may be held liable for the entire cost of cleanup.

strip farming The planting of crops in strips that alternate with other crops. The primary purpose is to reduce erosion.

submerged plants Aquatic vegetation that is rooted on the bottom and has leaves that stay submerged below the surface of the water.

subsidy A gift given to private enterprise by government when the enterprise is in temporary economic difficulty and is viewed as being important to the public.

succession Regular and predictable changes in the structure of a community, ultimately leading to a climax community.

successional stage A stage in succession.

sulfur dioxide (SO₂) A compound containing sulfur and oxygen produced when sulfur-containing fossil fuels are burned. When released into the atmosphere, it is a primary air pollutant.

Superfund The common name given to the U.S. 1980 Comprehensive Environmental Response, Compensation, and Liability Act, which was designed to address hazardous-waste sites.

supply Amount of a good or service available to be purchased.

supply/demand curve The relationship between the available supply of a commodity or service and its demand. The supply and demand change as the price changes.

surface impoundment Pond created to hold liquid materials. Some may hold only water, while others may be used to contain polluted water or liquid contaminants.

surface mining (strip mining) A type of mining in which the overburden is removed to procure the underlying deposit.

survivorship curve A graph that shows the proportion of individuals likely to survive to each age.

sustainable agriculture Agricultural methods used to produce adequate, safe food in an economically viable manner while enhancing the health of agricultural land and related ecosystems.

sustainable development Using renewable resources in harmony with ecological systems to produce a rise in real income per person and an improved standard of living for everyone.

swamp Area of trees that is flooded either permanently or for a major part of the year.

symbiosis A close, long-lasting physical relationship between members of two different species.

symbiotic nitrogen-fixing bacteria Bacteria that grow within a plant’s root system and that can convert nitrogen gas (N₂) from the atmosphere to nitrogen compounds that the plant can use.

synergism The interaction of materials or energy that increases the potential for harm.

T

taiga Biome having short, cool summers and long winters with abundant snowfall. The trees are adapted to winter conditions.

“take back” concept Process that can require the return of goods to the original manufacturer for recycling/reclaiming of usable materials.

target organism The organism a pesticide is designed to eliminate.

technological advances Increasing use of machines to replace human labor.

temperate deciduous forest Biome that has a winter-summer change of seasons and that typically receives 75 to 150 centimeters (30–60 inches) or more of relatively evenly distributed precipitation throughout the year.

temperate grasslands Areas receiving between 25 and 75 centimeters (10–30 inches) of precipitation per year. Grasses are the dominant vegetation, and trees are rare.

temperate rainforest Areas where the prevailing winds bring moisture-laden air to the coast. Abundant rain, fertile soil, and mild temperatures result in a lush growth of plants.

terrace A level area constructed on steep slopes to allow agriculture without extensive erosion.

tertiary sewage treatment Process that involves a variety of different techniques designed to remove dissolved pollutants left after primary and secondary treatments.

theory A unifying principle that binds together large areas of scientific knowledge.

thermal inversion The condition in which warm air in a valley is sandwiched between two layers of cold air and acts like a lid on the valley.

thermal pollution Waste heat that industries release into the environment.

thermal treatment A form of hazardous-waste destruction involving heating waste.

threatened species Those species that could become extinct if a critical factor in their environment were changed.

threshold level The minimum amount of something required to cause measurable effects.

total fertility rate The number of children born per woman per lifetime.

toxic A narrow group of substances that are poisonous and cause death or serious injury to humans and other organisms by interfering with normal body physiology.

toxicity A measure of how toxic a material is.

toxic waste Waste substances that are poisonous and cause death or serious injury to humans and animals when released into the environment.

tract development The construction of similar residential units over large areas.

transuranic waste Nuclear wastes of weapons programs that consist primarily of isotopes of plutonium.

trickling filter system A secondary sewage treatment technique that allows polluted water to flow over surfaces that harbor microorganisms.

trophic level A stage in the energy flow through ecosystems.

tropical dry forest Regions that receive low rainfall amounts, as little as 50 centimeters (20 inches) per year, and are characterized by species well adapted to drought. Trees of dry tropical forests are usually smaller than those in rainforests, and many lose their leaves during the dry season.

tropical rainforest A biome with warm, relatively constant temperatures where there is no frost. These areas receive more than 200 centimeters (80 inches) of rain per year in rains that fall nearly every day.

tundra A biome that lacks trees and has permanently frozen soil.

U

unconfined aquifer An aquifer that usually occurs near the land's surface, receives water by percolation from above, and may be called a water table aquifer.

underground mining A type of mining in which the deposited material is removed without disturbing the overburden.

underground storage tank Tank located below ground level for the storage of materials, such as oil, gasoline, or other chemicals.

uranium-235 (U-235) A naturally occurring radioactive isotope of uranium used as fuel in nuclear reactors.

urban growth limit A boundary established by municipal government that encourages development within the boundary and prohibits it outside the boundary.

urban sprawl A pattern of unplanned, low-density housing and commercial development outside of cities that usually takes place on previously undeveloped land.

V

vadose zone A zone above the water table and below the land surface that is not saturated with water.

variable Things that change from time to time.

vector An organism that carries a disease from one host to another.

volatile organic compounds (VOC)
Airborne organic compounds; primary air pollutants.

W

waste destruction Destruction of a portion of hazardous waste with harmful residues still left behind.

waste immobilization Putting hazardous wastes into a solid form that is easier to handle and less likely to enter the surrounding environment.

waste minimization A process that involves changes that industries could make in the

way they manufacture products that would reduce the waste produced.

waste separation Separating one hazardous waste from another or from nonhazardous material that it has contaminated.

water diversion The physical process of transferring water from one area to another.

water table The top of the layer of water in an aquifer.

waterways Low areas that water normally flows through.

weathering The physical and chemical breakdown of materials; involved in the breakdown of parent material in soil formation.

weed An unwanted plant.

wetlands Areas that include swamps, tidal marshes, coastal wetlands, and estuaries.

wilderness Designation of land use for the exclusive protection of the area's natural wildlife; thus, no human development is allowed.

windbreak The planting of trees or strips of grasses at right angles to the prevailing wind to reduce erosion of soil by wind.

Z

zero population growth The stabilized growth stage of human population during which births equal deaths and equilibrium is reached.

zoning Type of land-use regulation in which land is designated for specific potential uses, such as agricultural, commercial, residential, recreational, and industrial.

zooplankton Weakly swimming microscopic animals.

CREDITS

Design Elements

Standing on a Rocky Peak: © Brand X/Jupiter RF; Students Socializing: © BananaStock/Jupiter RF; Water Ripples: © Comstock/Picture Quest RF; Trail through Shady Forest: © Corbis RF.

Chapter 1

Opener: © Copyright 1997 IMS Communications Ltd./Capstone Design. All Rights Reserved.; 1.2(wolves, elk, dam): © Getty RF; 1.2(willows): © Judy Enger; p. 4: © Getty RF; p. 5: © Stockbyte/PunchStock RF; 1.3: © Getty RF; 1.5(left): © Steve McCutcheon/Visuals Unlimited; 1.5(middle): © Getty RF; 1.5(right): © Corbis RF; 1.6(dust): © Getty RF; 1.6(erosion, pesticides): USDA; 1.6(corn): © Corbis RF; 1.7(grazing): © Digital Vision/PunchStock RF; 1.7(urban): © Getty RF; 1.7(irrigation): USDA; 1.7(grazing): © Brand X/PunchStock RF; 1.8(right): © Corbis RF; 1.8(left): © PunchStock RF; 1.8(middle): © Comstock/PunchStock RF; 1.9(left): © Corbis RF; 1.9(middle,right): © Getty RF; 1.10(left): © Corbis RF; 1.10(middle): © Getty RF; 1.10(right): © Corbis RF; p. 12(top): © Jupiter RF; p. 12(bottom) USFWS (U.S. Fish and Wildlife Service).

Chapter 2

Opener: © PunchStock RF; 2.1: © Getty RF; 2.3(left): Photo by Lynn Betts, USDA Natural Resources Conservation Service; 2.3(middle,right): © Getty RF; p. 20(Emerson, Thoreau): Library of Congress; p. 20(Muir): © Bettmann/Corbis; p. 20(Leopold,Carson): © AP Wide World Photos; 2.5a,b: Courtesy of the North Carolina State Archives, reprinted by permission of Raleigh News & Observer, photographer Harry Lynch; p. 24(left):NASA/Jeff Schmaltz, MODIS Land Rapid Response Team; p. 24(right): Courtesy of U.S. Army/U.S. Coast Guard/photo by Petty Officer 2nd Class Kyle Niemi; 2.7: © Corbis RF; 2.8a: © Getty RF; 2.8b: © Natalie Fobes/Getty Images; 2.9(top left, top right, bottom right): © Corbis RF; 2.9(bottom left): © Getty RF.

Chapter 3

Opener: © Getty RF; p. 39, 3.1: © Getty RF; 3.4: USDA Soil Conservation Service; 3.5: © Dr. Byron Augustin; 3.6(danger): © Jeff Greenberg/PhotoEdit; 3.6(smog): © Vol. 25/PhotoDisc/Getty Images; 3.6(smoking): © PunchStock RF; 3.6(paint,cattle): © Corbis

RF; 3.6(towers): © Getty RF; 3.6(visual pollution): © Michael Newman/PhotoEdit; 3.6(junk): © Getty RF; 3.7(buggy): © Corbis RF; 3.7 (boats): © Vol.10/PhotoDisc/Getty Images; 3.7(signs,hiker): © The McGraw-Hill Companies/Roger Loewenberg, photographer; 3.7(canoe): © Vol.10/PhotoDisc/Getty Images; 3.7(street): © PunchStock RF; 3.8: © Vol.31/PhotoDisc/Getty Images; 3.10b: © AP Wide World Photos.

Chapter 4

Opener: © Getty RF; p. 62: © Stockbyte/PunchStock RF; 4.2: © Getty RF; 4.3: © The McGraw-Hill Companies, Inc./Jim Thoeming, photographer; p. 70: © Jupiter RF; 4.10: © Getty RF; 4.11: © Digital Vision/PunchStock RF; p. 76: © Corbis RF.

Chapter 5

Opener: © Corbis RF; 5.2(both): © Creatas/PunchStock RF; 5.3b: © Getty RF; 5.3c: © PunchStock RF; 5.4: © Corbis RF; 5.5(beaver): © Creatas/PunchStock RF; 5.5(dam): © Getty RF; 5.5(grebe): © Masterfile RF; 5.5(gnawing,pond): © Brand X/PunchStock RF; 5.6(left): © Getty RF; 5.6(right): © It Stock/age fotostock RF; 5.6(middle): © Getty RF; 5.7: © Creatas/PunchStock RF; 5.9: National Library of Medicine; 5.10: © Corbis RF; 5.11: © Pixtal/age fotostock RF; 5.13: © National History Museum, London; 5.14, 5.15: © Corbis RF; 5.16(top): © It Stock/PunchStock RF; 5.16(bottom): © PhotoAlto/PunchStock RF; 5.17: © Creatas/PunchStock RF; 5.18: © PunchStock RF; 5.20(left): U.S. Department of Agriculture; 5.20(middle): © Manfred Kage/Peter Arnold, Inc.; 5.20(right): © Malcom Kitto, Papillo/Corbis; 5.21: © Brand X/PunchStock RF; 5.22a: Eldon Enger; 5.22b: © Getty RF; 5.23: © K. Malowski/Visuals Unlimited; 5.24: © Corbis RF; 5.27(father and son, fish, frog, grasshopper, cattails): © Getty RF; 5.27(spider): © Digital Vision RF; p.100(top): NOAA Great Lakes Environmental Research Laboratory; p. 100(bottom): © Eldon Enger; p. 105: © The McGraw-Hill Companies, Inc./Pat Watson, photographer.

Chapter 6

Opener: © Alamy RF; 6.2: Eldon Enger; 6.5: © Steven P. Lynch; 6.10b,c: © Getty RF; 6.10d: © Corbis RF; p. 117: Photo by Tim McCabe/USDA; 6.11b: © Creatas/PunchStock

RF; 6.11c: © Getty RF; 6.11d: © It Stock/age fotostock RF; 6.11e: © U.S. Fish and Wildlife Service/John and Karen Hollingsworth photographers; 6.12b: © Corbis RF; 6.12c: © Brand X/PunchStock RF; 6.12d,e: © PunchStock RF; 6.13b: © Steven P. Lynch; 6.13c: © U.S. Fish and Wildlife Service/ Lee Karney photographer; 6.13d: © Judy Enger; 6.14b: © Doug Wechsler/Animals Animals/Earth Scenes; 6.14c: © Superstock RF; 6.14d: © David Zurick; p. 123(left): © The McGraw-Hill Companies/Roger Loewenberg, photographer; p. 123(middle): © Harold Hungerford/University of Southern Illinois-Carbondale; p. 123(right): © Carl Bollwinkel/University of Northern Iowa; 6.15b: © Stephen P. Lynch; 6.15c: © Getty RF; 6.15d: © PunchStock RF; 6.16b-d: © Getty RF; 6.17b: U.S. Fish and Wildlife Service; 6.17c: © Corbis RF; 6.17d: © Getty RF; 6.18b: © Stephen P. Lynch; 6.18c: © Creatas/PunchStock RF; 6.18d, 6.19b: © Corbis RF; 6.19c-e: © Getty RF; p.134(all): © Judy Enger; 6.21(left): © Getty RF; 6.21(right): © Corbis RF; 6.22: © Eldon Enger; p. 137: © Digital Vision/PunchStock RF.

Chapter 7

Opener: PunchStock RF; 7.2a: © Getty RF; 7.2b: © John W. Bova/Photo Researchers, Inc.; 7.2c: Courtesy of Monika Al-Mufti; 7.4a,b: © Getty RF; 7.4c: © Corbis RF; p. 147(right): © Julia Sims/Peter Arnold, Inc.; p. 147(right): Photo by Jeff Vanuga, courtesy of USDA Natural Resources Conservation Service; p. 152: © Bettmann/Corbis; p. 159: © Corbis RF; 7.13a: © Peter Ginter/ScienceFaction; 7.13b: © Peter Menzel; p. 163: © PunchStock RF; p. 167: The Hudson Bay Project. Photo provided by Robert Jefferies.

Chapter 8

Opener: © Corbis RF; 8.1: © Corbis RF; 8.2: © Getty RF; 8.3: Library of Congress; 8.5a: © Getty RF; 8.5b: © The McGraw-Hill Companies, Inc./Andrew Resek, photographer; p. 174: © Getty RF; p. 175: © Corbis RF; p. 176: © Getty RF; 8.7a : © Steve McCurry/Magnum Photos; 8.7b: © Galen Rowell/Corbis; 8.8, 8.9: © Getty RF.

Chapter 9

Opener: © Getty RF; 9.8: © William Campbell/Peter Arnold, Inc.; 9.9: © Getty RF; 9.10a: © Matt Meadows/Peter Arnold, Inc.;