CHAPTER 2 VOCABULARY - Science, Matter, Energy, and Systems

MILLER LITE, 17th EDITION

acid	See *acid solution*.
acid solution	Any water solution that has more hydrogen ions (H^+) than hydroxide ions ($OH^?$); any water solution with a pH less than 7. Compare *basic solution, neutral solution*.
acidity	Chemical characteristic that helps determine how a substance dissolved in water (a solution) will interact with and affect its environment; based on the comparative amounts of hydrogen ions (H^+) and hydroxide ions ($OH^?$) contained in a particular volume of the solution. See *pH*.
alpha particle	Positively charged matter, consisting of two neutrons and two protons, which is emitted as radioactivity from the nuclei of some radioisotopes. See also *beta particle, gamma rays*.
atom	Minute unit made of subatomic particles that is the basic building block of all chemical elements and thus all matter; the smallest unit of an element that can exist and still have the unique characteristics of that element. Compare *ion, molecule*.
atomic number	Number of protons in the nucleus of an atom. Compare *mass number*.
atomic theory	Idea that all elements are made up of atoms; the most widely accepted scientific theory in chemistry.
basic solution	Water solution with more hydroxide ions ($OH^?$) than hydrogen ions (H^+); water solution with a pH greater than 7. Compare *acid solution, neutral solution*.
beta particle	Swiftly moving electron emitted by the nucleus of a radioactive isotope. See also *alpha particle, gamma ray*.
buffer	Substance that can react with hydrogen ions in a solution and thus hold the acidity or pH of a solution fairly constant. See *pH*.
cell	Smallest living unit of an organism. Each cell is encased in an outer membrane or wall and contains genetic material (DNA) and other parts to perform its life function. Organisms such as bacteria consist of only one cell, but most organisms contain many cells.
cell theory	The idea that all living things are composed of cells; the most widely accepted scientific theory in biology.
chain reaction	Multiple nuclear fissions, taking place within a certain mass of a fissionable isotope, which release an enormous amount of energy in a short time.
chemical	One of the millions of different Such areas suffer serious ecological elements and compounds found naturally and synthesized by humans. See *compound, element*.
chemical change	Interaction between chemicals in which the chemical composition of the elements or compounds involved changes. Compare *nuclear change, physical change*.
chemical formula	Shorthand way to show the number of atoms (or ions) in the basic structural unit of a compound. Examples include H_2O, NaCl, and $C_6H_{12}O_6$.
chemical reaction	See *chemical change*.
chlorinated hydrocarbon	Organic compound made up of atoms of carbon, hydrogen, and chlorine. Examples include DDT and PCBs.
chromosome	A grouping of genes and associated proteins in plant and animal cells that carry certain types of genetic information. See *genes*.
compound	Combination of atoms, or oppositely charged ions, of two or more elements held together by attractive forces called chemical bonds. Examples are NaCl, CO_2, and $C_6H_{12}O_6$. Compare *element*.
concentration	Amount of a chemical in a particular volume or weight of air, water, soil, or other medium.
corrective feedback loop	See *negative feedback loop*.
critical mass	Amount of fisionable nuclei needed to sustain a nuclear fission chain reaction.

data	Factual information collected by scientists.
density	Mass per unit volume.
deuterium (D; hydrogen–2)	Isotope of the element hydrogen, with a nucleus containing one proton and one neutron and a mass number of 2.
dioxins	Family of 75 chlorinated hydrocarbon compounds formed as unwanted by–products in chemical reactions involving chlorine and hydrocarbons, usually at high temperatures.
DNA (deoxyribonucleic acid)	Large molecules in the cells of living organisms that carry genetic information.
electromagnetic radiation	Forms of kinetic energy traveling as electromagnetic waves. Examples include radio waves, TV waves, microwaves, infrared radiation, visible light, ultraviolet radiation, X–rays, and gamma rays. Compare *ionizing radiation, nonionizing radiation*.
electron (e)	Tiny particle moving around outside the nucleus of an atom. Each electron has one unit of negative charge and almost no mass. Compare *neutron, proton*.
element	Chemical, such as hydrogen (H), iron (Fe), sodium (Na), carbon (C), nitrogen (N), or oxygen (O), whose distinctly different atoms serve as the basic building blocks of all matter. Two or more elements combine to form the compounds that make up most of the world's matter. Compare *compound*.
energy	Capacity to do work by performing mechanical, physical, chemical, or electrical tasks or to cause a heat transfer between two objects at different temperatures.
energy quality	Ability of a form of energy to do useful work. High–temperature heat and the chemical energy in fossil fuels and nuclear fuels are concentrated high–quality energy. Low–quality energy such as low–temperature heat is dispersed or diluted and cannot do much useful work. See *high–quality energy, low–quality energy*.
experiment	Procedure a scientist uses to study some phenomenon under known conditions. Scientists conduct some experiments in the laboratory and others in nature. The resulting scientific data or facts must be verified or confirmed by repeated observations and measurements, ideally by several different investigators.
feedback	Any process that increases (positive feedback) or decreases (negative feedback) a change to a system.
feedback loop	Occurs when an output of matter, energy, or information is fed back into the system as an input and leads to changes in that system. See *positive feedback loop* and *negative feedback loop*.
first law of thermodynamics	Whenever energy is converted from one form to another in a physical or chemical change, no energy is created or destroyed, but energy can be changed from one form to another; you cannot get more energy out of something than you put in; in terms of energy quantity, you cannot get something for nothing. This law does not apply to nuclear changes, in which large amounts of energy can be produced from small amounts of matter. See *second law of thermodynamics*.
fissionable isotope	Isotope that can split apart when hit by a neutron at the right speed and thus undergo nuclear fission. Examples include uranium–235 and plutonium–239.
flows	See *throughputs*.
fossil fuel	Products of partial or complete decomposition of plants and animals; occurs as crude oil, coal, natural gas, or heavy oils as a result of exposure to heat and pressure in he earth's crust over millions of years. See *coal, crude oil, natural gas*.
frontier science	See *tentative science*.
gamma ray	Form of ionizing electromagnetic radiation with a high energy content emitted by some radioisotopes. It readily penetrates body tissues. See *alpha particle, beta particle*.
heat	Total kinetic energy of all randomly moving atoms, ions, or molecules within a given substance, excluding the overall motion of the whole object. Heat always flows spontaneously from a warmer sample of matter to a colder sample of matter. This is one way to state the *second law of thermodynamics*. Compare *temperature*.

high	Air mass with a high pressure. Compare *low*.
high–quality energy	Energy that is concentrated and has great ability to perform useful work. Examples include high–temperature heat and the energy in electricity, coal, oil, gasoline, sunlight, and nuclei of uranium–235. Compare *low–quality energy*.
high–quality matter	Matter that is concentrated and contains a high concentration of a useful resource. Compare *low–quality matter*.
hydrocarbon	Organic compound made of hydrogen and carbon atoms. The simplest hydrocarbon is methane (CH_4), the major component of natural gas.
inorganic compounds	All compounds not classified as organic compounds. See *organic compounds*.
input	Matter, energy, or information entering a system. Compare *output, throughput*.
ion	Atom or group of atoms with one or more positive (+) or negative (−) electrical charges. Examples are Na^+ and Cl^-. Compare *atom, molecule*.
ionizing radiation	Fast–moving alpha or beta particles or high–energy radiation (gamma rays) emitted by radioisotopes. They have enough energy to dislodge one or more electrons from atoms they hit, thereby forming charged ions in tissue that can react with and damage living tissue. Compare *nonionizing radiation*.
isotopes	Two or more forms of a chemical element that have the same number of protons but different mass numbers because they have different numbers of neutrons in their nuclei.
junk science	See *unreliable science*.
kinetic energy	Energy that matter has because of its mass and speed, or velocity. Compare *potential energy*.
law of conservation of energy	See *first law of thermodynamics*.
law of conservation of matter	In any physical or chemical change, matter is neither created nor destroyed but merely changed from one form to another; in physical and chemical changes, existing atoms are rearranged into different spatial patterns (physical changes) or different combinations (chemical changes).
law of nature	See *scientific law*.
law of tolerance	Existence, abundance, and distribution of a species in an ecosystem are determined by whether the levels of one or more physical or chemical factors fall within the range tolerated by the species. See *threshold effect*.
low	Air mass with a low pressure. Compare *high*.
low–quality energy	Energy that is dispersed and has little ability to do useful work. An example is low–temperature heat. Compare *high–quality energy*.
low–quality matter	Matter that is dilute or dispersed or contains a low concentration of a useful resource. Compare *high–quality matter*.
mass	Amount of material in an object.
mass number	Sum of the number of neutrons (n) and the number of protons (p) in the nucleus of an atom. It gives the approximate mass of that atom. Compare *atomic number*.
matter	Anything that has mass (the amount of material in an object) and takes up space. On the earth, where gravity is present, we weigh an object to determine its mass.
mixture	Combination of one or more elements and compounds.
model	Approximate representation or simulation of a system being studied.
molecule	Combination of two or more atoms of the same chemical element (such as O_2) or different chemical elements (such as H_2O) held together by chemical bonds. Compare *atom, ion*.
natural law	See *scientific law*.

natural radioactive decay	Nuclear change in which unstable nuclei of atoms spontaneously shoot out particles (usually alpha or beta particles) or energy (gamma rays) at a fixed rate.
negative feedback loop	Feedback loop that causes a system to change in the opposite direction from which is it moving. Compare *positive feedback loop*.
neutral solution	Water solution containing an equal number of hydrogen ions (H^+) and hydroxide ions (OH^-); water solution with a pH of 7. Compare *acid solution, basic solution*.
neutron (n)	Elementary particle in the nuclei of all atoms (except hydrogen–1). It has a relative mass of 1 and no electric charge. Compare *electron, proton*.
nitric oxide (NO)	Colorless gas that forms when nitrogen and oxygen gas in air react at the high–combustion temperatures in automobile engines and coal–burning plants. Lightning and certain bacteria in soil and water also produce NO as part of the *nitrogen cycle*.
nitrogen dioxide (NO_2)	Reddish–brown gas formed when nitrogen oxide reacts with oxygen in the air.
nonionizing radiation	Forms of radiant energy such as radio waves, microwaves, infrared light, and ordinary light that do not have enough energy to cause ionization of atoms in living tissue. Compare *ionizing radiation*.
nuclear change	Process in which nuclei of certain isotopes spontaneously change, or are forced to change, into one or more different isotopes. The three principal types of nuclear change are natural radioactivity, nuclear fission, and nuclear fusion. Compare *chemical change, physical change*.
nuclear fission	Nuclear change in which the nuclei of certain isotopes with large mass numbers (such as uranium–235 and plutonium–239) are split apart into lighter nuclei when struck by a neutron. This process releases more neutrons and a large amount of energy. Compare *nuclear fusion*.
nuclear fusion	Nuclear change in which two nuclei of isotopes of elements with a low mass number (such as hydrogen–2 and hydrogen–3) are forced together at extremely high temperatures until they fuse to form a heavier nucleus (such as helium–4). This process releases a large amount of energy. Compare *nuclear fission*.
nucleus	Extremely tiny center of an atom, making up most of the atom's mass. It contains one or more positively charged protons and one or more neutrons with no electrical charge (except for a hydrogen–1 atom, which has one proton and no neutrons in its nucleus).
organic compounds	Compounds containing carbon atoms combined with each other and with atoms of one or more other elements such as hydrogen, oxygen, nitrogen, sulfur, phosphorus, chlorine, and fluorine. All other compounds are called *inorganic compounds*.
output	Matter, energy, or information leaving a system. Compare *input, throughput*.
parts per billion (ppb)	Number of parts of a chemical found in 1 billion parts of a particular gas, liquid, or solid.
parts per million (ppm)	Number of parts of a chemical found in 1 million parts of a particular gas, liquid, or solid.
parts per trillion (ppt)	Number of parts of a chemical found in 1 trillion parts of a particular gas, liquid, or solid.
peer review	Process of scientists reporting details of the methods and models they used, the results of their experiments, and the reasoning behind their hypotheses for other scientists working in the same field (their peers) to examine and criticize.
pH	Numeric value that indicates the relative acidity or alkalinity of a substance on a scale of 0 to 14, with the neutral point at 7. Acid solutions have pH values lower than 7; basic or alkaline solutions have pH values greater than 7.
physical change	Process that alters one or more physical properties of an element or a compound without changing its chemical composition. Examples include changing the size and shape of a sample of matter (crushing ice and cutting aluminum foil) and changing a sample of matter from one physical state to another (boiling and freezing water). Compare *chemical change, nuclear change*.
positive feedback loop	Feedback loop that causes a system to change further in the same direction. Compare *negative feedback loop*.

potential energy	Energy stored in an object because of its position or the position of its parts. Compare *kinetic energy*.
ppb	See *parts per billion*.
ppm	See *parts per million*.
ppt	See *parts per trillion*.
principles of sustainability	Principles by which nature has sustained itself for billions of years by relying on solar energy, biodiversity, and nutrient recycling.
probability	Mathematical statement about how likely it is that something will happen.
proton (p)	Positively charged particle in the nuclei of all atoms. Each proton has a relative mass of 1 and a single positive charge. Compare *electron, neutron*.
radiation	Fast–moving particles (particulate radiation) or waves of energy (electromagnetic radiation). See *alpha particle, beta particle, gamma ray*.
radioactive decay	Change of a radioisotope to a different isotope by the emission of radioactivity.
radioactive isotope	See *radioisotope*.
radioactivity	Nuclear change in which unstable nuclei of atoms spontaneously shoot out "chunks" of mass, energy, or both at a fixed rate. The three principal types of radioactivity are gamma rays and fast–moving alpha particles and beta particles.
radioisotope	Isotope of an atom that spontaneously emits one or more types of radioactivity (alpha particles, beta particles, gamma rays).
reliable science	Concepts and ideas that are widely accepted by experts in a particular field of the natural or social sciences. Compare *tentative science, unreliable science*.
science	Attempts to discover order in nature and use that knowledge to make predictions about what is likely to happen in nature. See *reliable science, scientific data, scientific hypothesis, scientific law, scientific methods, scientific model, scientific theory, tentative science, unreliable science*.
scientific data	Facts obtained by making observations and measurements. Compare *scientific hypothesis, scientific law, scientific methods, scientific model, scientific theory*.
scientific hypothesis	An educated guess that attempts to explain a scientific law or certain scientific observations. Compare *scientific data, scientific law, scientific methods, scientific model, scientific theory*.
scientific law	Description of what scientists find happening in nature repeatedly in the same way, without known exception. See *first law of thermodynamics, law of conservation of matter, second law of thermodynamics*. Compare *scientific data, scientific hypothesis, scientific methods, scientific model, scientific theory*.
scientific methods	The ways scientists gather data and formulate and test scientific hypotheses, models, theories, and laws. See *scientific data, scientific hypothesis, scientific law, scientific model, scientific theory*.
scientific model	A simulation of complex processes and systems. Many are mathematical models that are run and tested using computers.
scientific theory	A well–tested and widely accepted scientific hypothesis. Compare *scientific data, scientific hypothesis, scientific law, scientific methods, scientific model*.
second law of energy	See *second law of thermodynamics*.
second law of thermodynamics	Whenever energy is converted from one form to another in a physical or chemical change, we end up with lower–quality or less usable energy than we started with. In any conversion of heat energy to useful work, some of the initial energy input is always degraded to lower–quality, more dispersed, less useful energy—usually low–temperature heat that flows into the environment; you cannot break even in terms of energy quality. See *first law of thermodynamics*.
sound science	See *reliable science*.
statistics	Mathematical tools used to collect, organize, and interpret numerical data.

subatomic particles	Extremely small particles—electrons, protons, and neutrons—that make up the internal structure of atoms.
sustainability revolution	Major cultural change in which people learn how to reduce their ecological footprints and live more sustainability, largely by copying nature and using the three principles of sustainability to guide their lifestyles and economies. See *principles of sustainability*.
synergistic interaction	Interaction of two or more factors or processes so that the combined effect is greater than the sum of their separate effects.
synergy	See *synergistic interaction*.
system	Set of components that function and interact in some regular and theoretically predictable manner.
tentative science	Preliminary scientific data, hypotheses, and models that have not been widely tested and accepted. Compare *reliable science, unreliable science*.
threshold effect	Harmful or fatal effect of a small change in environmental conditions that exceeds the limit of tolerance of an organism or population of a species. See *law of tolerance*.
throughput	Rate of flow of matter, energy, or information through a system. Compare *input, output*.
time delay	In a complex system, the period of time between the input of a feedback stimulus and the system's response to it. See *tipping point*.
tipping point	Threshold level at which an environmental problem causes a fundamental and irreversible shift in the behavior of a system. See *climate tipping point, ecological tipping point*.
tolerance limits	Minimum and maximum limits for physical conditions (such as temperature) and concentrations of chemical substances beyond which no members of a particular species can survive. See *law of tolerance*.
trait	Characteristic passed on from parents to offspring during reproduction in an animal or plant.
unreliable science	Scientific results or hypotheses presented as reliable science without having undergone the rigors of the peer review process. Compare *reliable science, tentative science*.