Answers to Numerical Questions

page 127, Unit A Review

35. (a) 520 000 kJ/m^2
(b) 520 kJ/m^2

page 177, 5.1 Check and Reflect

11. (a) 9
(b) 9

page 183, Learning Checkpoint

4. (a) N
(b) Ni
(c) Pb

page 187, 5.2 Check and Reflect

2. (a) mercury, Hg and bromine, Br
(b) metal (mercury) and non-metal (bromine)

3. (a) germanium, Ge
(b) rubidium, Rb
(c) helium, He
(d) iodine, I
(e) hydrogen, H
(f) oxygen, O
(g) carbon, C
(h) chromium, Cr
(i) mercury, Hg
(j) fluorine, F

4. (a) sodium, Na
(b) iron, Fe
(c) silver, Ag
(d) lead, Pb

5. (a) for example, Cl, C, Ca, Cr, Cu
(b) for example, germanium, magnesium, copper
(c) He, Ne, Ar, Cl, Br

6. S, Si, Ag

8. (a) for example, iron and carbon
(b) hydrogen and oxygen
(c) sodium and chlorine

page 190, Learning Checkpoint

1. (a) 6
(b) 8
(c) 11
(d) 14
(e) 16
(f) 17
(g) 26

2. (a) 3
(b) 7
(c) 9
(d) 13
(e) 29
(f) 79

3. (a) hydrogen
(b) helium
(c) neon
(d) potassium
(e) calcium
(f) gallium
(g) silver

page 193, Learning Checkpoint

1. (a) 1.01 amu
(b) 4.00 amu
(c) 14.01 amu
(d) 19.00 amu
(e) 32.07 amu
(f) 40.08 amu
(g) 107.87 amu

2. (a) carbon
(b) oxygen
(c) potassium
(d) krypton

3. (a) 1+
(b) 2+
(c) 3–
(d) 2–
(e) 3+
(f) 1–

page 195, Learning Checkpoint

1. (a) sodium, Na
(b) boron, B
(c) copper, Cu
(d) iodine, I

2. (a) Period 3, Group 2
(b) Period 3, Group 14
(c) Period 3, Group 17
(d) Period 1, Group 18
(e) Period 6, Group 11
(f) Period 6, Group 14

page 199, Learning Checkpoint

1. (a) 1
(b) 3
(c) 4
(d) 6
(e) 7

2. (a) 1
(b) 2
(c) 5
(d) 8

page 204, 5.3 Check and Reflect

1. (a) Na
(b) mercury
(c) silicon
(d) potassium

4. halogens

7. (a) F
(d) S

10. (a) helium
(b) 2
(c) 2
(d) Group 18, noble gases

11. (b) gallium and germanium

12. Group 1, alkali metals

page 206, Chapter 5 Review

2.

Particle	Charge	Location	Relative Mass
electron	1–	shells	tiny (1)
neutron	0	nucleus	large (1837)

3. 2, 8, 8

5. (a) plumbum
(b) Pb

6. for example, carbon, phosphorus, sulphur, selenium

8. (a) technetium
(b) dysprosium

9. (a) 4
(b) 2
(c) helium

16. (d) germanium

page 213, Learning Checkpoint

2. metal and non-metal

page 217, 6.1 Check and Reflect

6. (a) 3
(b) 2

9. (a) Bohr diagram
(b) ionic compound
(c) magnesium and oxygen

page 220, Learning Checkpoint

3. (a) 2+, Ca^{2+}, calcium ion
(b) 1–, Cl^-, chloride
(c) 3–, P^{3-}, phosphide
(d) 3+, Au^{3+}, gold(III) and 1+, Au^+, gold(I)
(e) 4+, Sn^{4+}, tin (IV) and 2+, Sn^{2+}, tin (II)

page 221, Practice Problems

1. sodium fluoride
2. potassium iodide
3. magnesium chloride
4. aluminum chloride
5. calcium phosphide

page 222, Practice Problems

1. iron(III) chloride
2. lead(IV) oxide
3. nickel(III) sulphide
4. copper(II) fluoride
5. chromium(III) sulphide

page 223, Practice Problems

1. potassium hydroxide
2. zinc carbonate
3. magnesium phosphate
4. calcium sulphate
5. aluminum carbonate

page 224, Practice Problems

1. LiBr
2. MgF_2
3. Ag_3N
4. $FeCl_3$
5. Cr_2S_3

page 225, Practice Problems

1. $Al(OH)_3$
2. $CaSO_4$
3. Na_2CO_3
4. $Fe_2(CO_3)_3$
5. $CuSO_4$

page 226, Practice Problems

1. carbon monoxide
2. carbon tetraiodide
3. oxygen difluoride
4. dinitrogen tetraoxide
5. phosphorus trichloride

page 227, Practice Problems

1. CO_2
2. OF_2
3. NF_3
4. PF_5
5. N_2O_3

page 229, 6.2 Check and Reflect

1. (a) atom
(b) molecular compound
(c) ion
(d) atom
(e) molecular compound
(f) ionic compound
(g) molecular compound

2. (a) Li^+
(b) Sr^{2+}
(c) V^{4+}, V^{5+}
(d) Cl^-
(e) S^{2-}

3. (a) lithium oxide
(b) calcium fluoride
(c) potassium fluoride
(d) sodium nitride
(e) magnesium hydroxide
(f) iron(II) chloride
(g) aluminum sulphate

4. (a) $MgCl_2$
(b) Na_2S
(c) Ca_3P_2
(d) K_3N
(e) CaF_2
(f) Al_2O_3

5. (a) NI_3
(b) CO_2
(c) SF_6
(d) CH_4
(e) $C_{12}H_{22}O_{11}$

6. (a) carbon tetrabromide
(b) nitrogen monoxide
(c) oxygen difluoride
(d) iodine dibromide
(e) phosphorus trichloride
(f) dinitrogen trioxide

9. (c) hydrogen peroxide

page 240, Chapter 6 Review

2. (a) hydrogen and oxygen, 1:1
(b) molecular compound

3. (a) N^{3-}
(b) Li^+
(c) Al^{3+}
(d) O^{2-}
(e) Cl^-
(f) Na^+
(g) does not form ions
(h) Cu^{2+}, Cu^{3+}

4. (a) potassium iodide
(b) calcium chloride
(c) aluminum bromide

5. (a) Li_3N
(b) $FeCl_2$
(c) NaOH

6. (a) phosphorus pentafluoride
(b) dichlorine trioxide
(c) carbon tetrafluoride

7. (a) NO
(b) CS_2
(c) PBr_3

10. (a) $Mg(OH)_2$
(b) Na_2CO_3
(c) $Al_2(SO_4)_3$
(d) cesium hydrogen carbonate
(e) barium carbonate
(f) potassium sulphate

page 246, Unit B Review

16. (a) 1
(b) 3
(c) 4
(d) 6
(e) 7

17. (a) calcium
(b) Group 2, alkaline earth metals
(c) 2+
(d) 20

21. (a) lithium and chlorine, 1:1
(b) aluminum and sulphur, 2:3
(c) silver and fluorine, 1:1
(d) zinc and oxygen, 1:1
(e) nitrogen and sulphur, 2:3
(f) bromine

22. (a) ionic compound
(b) ionic compound
(c) ionic compound
(d) ionic compound
(e) molecular compound
(f) neither (element)

33. (a) does not normally form ions
(b) Ba^{2+}
(c) Be^{2+}
(d) does not form ions
(e) Pb^{2+} or Pb^{4+}
(f) Se^{2-}

38. (a) potassium chloride
(d) MgO

57. (a) magnesium bromide
(b) barium nitride
(c) calcium phosphide
(d) aluminum oxide
(e) sodium iodide
(f) calcium chloride
(g) potassium carbonate
(h) magnesium sulphate
(i) cesium hydrogen carbonate

58. (a) ionic, Mg_3P_2
(b) ionic, Li_3N
(c) molecular, PCl_5
(d) ionic, $AlBr_3$
(e) ionic, CaS
(f) molecular, SO_2
(g) ionic, KI
(h) ionic, Na_2O
(i) ionic, $Ca(OH)_2$
(j) ionic, $Al(HCO_3)_3$
(k) molecular, NCl_3

59. See answer at bottom of page.

page 265, C3 Just-in-Time Math

1. 4×10^{13}
2. 1.5×10^{11}
3. 1.3×10^{10}
4. 1.525×10^{5}
5. 1.99×10^{30}
6. 4.55×10^{9}

page 267, 7.1 Check and Reflect

12. (a) 17.1 years
(b) 513 years

13. 130 years

page 275, C6 Just-in-Time Math

1. 15 cm
2. 41.6 cm
3. 46.4 cm

page 277, 7.2 Check and Reflect

2. 100 000 ly in diameter; 2000 ly thick
3. about 35 000 years

page 321, 8.2 Check and Reflect

2. (a) 5 billion years
(b) 5 billion years

4. 100 000 years

page 331, 8.3 Check and Reflect

1. 1 day
2. 1 year

page 382, Unit C Review

56. (a) 9×10^{13}
(b) 1.5×10^{11}
(c) 2.48×10^{7}

57. (b) 10 000 times
(c) 6000°C

page 460, Practice Problems

1. 45 V
2. 9.0 V
3. 120 V

page 461 (top), Practice Problems

1. 2.5 A
2. 0.2 A
3. 0.067 A

page 461 (bottom), Practice Problems

1. 4 Ω
2. 192 Ω
3. 600 Ω

page 467, 11.3 Check and Reflect

3.

V	*I*	*R*
0.5 V	0.01 A	50 Ω
2000 V	20 A	100 Ω
6.0 V	4.0 A	1.5 Ω

8. 2 Ω

9. (a) 0.5 A
(b) 0.25 A

10. (a) 0.125 A
(b) 1.5 V across the 12-Ω bulb and 4.5 V across the 36-Ω bulb

page 470, Chapter 11 Review

1. (c) 5.0 V
(d) 3.0 A

8. 45 V

9. 12 Ω

10. (a) 1 600 000 V
(b) 1.5 kW
(c) 0.650 A

11. (a) 3000 Ω

Answer to question 59, page 246

Symbol	Name	Atomic Mass	Protons in Atom	Electrons in Atom
H	hydrogen	1.01	1	1
Cl	chlorine	35.45	17	17
Ca	calcium	40.08	20	20
Ag	silver	107.87	47	47
Ne	neon	20.18	10	10
U	uranium	238.03	92	92

page 492, Learning Checkpoint

1.

Appliance	Average Use hours (per day)	kW•h (per year)	Cost ($)
Vacuum cleaner	0.1	38	3.23
Hair dryer	0.25	100	8.50
Computer	4.0	520	44.20
Central air conditioning	12 (60 days/year)	1500	127.50

page 493, Practice Problems

1. 22 %
2. 22 %
3. 88 %

page 500, 12.2 Check and Reflect

4. (a) $0.06
(b) $0.02
(c) $0.60
7. 34 %

page 502, Chapter 12 Review

6. 0.5 kW•h
7. (a) 61%
(b) 38%
10. (a) 900 kW•h/y
(b) 898 kW•h

page 507, Unit D Review

21. (a) 6.0 V
(b) 2.0 A
22. (a) 3.0 V
(b) 1 A
57. 3000 Ω
58. (a) 7.5 V
(b) 4 A
(c) 0.05 Ω
59.

Voltage (V)	Current (A)
2.0	0.017
4.0	0.033
6.0	0.050
8.0	0.067
10.0	0.083

60. (a) 1 600 000 V
(b) 1.5 kV
(c) 0.65 A

62.

Device	Input Energy (kJ)	Output Energy (kJ)	Percent Efficiency
Gas-powered SUV	675	81	12%
Gas-electric hybrid car	675	195	29%
Natural gas furnace	110 000	85 000	77%
Electric baseboard heater	9.5	6.0	63%
Alkaline dry cell	84.52	74.38	88%

Glossary

Notes: The numbers in parentheses at the end of each definition indicates the page number in this book where the term is defined. A pronunciation guide, using the key below, appears in square brackets after selected words. Stressed syllables are capitalized.

a = cat, back
ae = day, lake
ah = barn, large
aw = lawn, not
e = wet, ten
ee = tree, steam
ih = mine, light
i = ditch, mitt
oh = go, phone
oo = room, true
u = fun, done
uh = taken, sun
uhr = fur, burn

A

abiotic [ae-bih-AW-tik] non-living; physical things, such as rocks, air, and water, or things that are measured, such as air temperature, hours of daylight, and salt concentration in seawater (13)

acid rain rain that contains acids formed from nitrogen- and sulphur-containing emissions (70)

acidity abiotic factor that is connected to the chemical environment of soil (74)

adhesion property of sticking to other substances; a physical property of water (150)

alternating current (AC) electric current that flows back and forth at regular intervals called cycles (439)

ammeter [A-mee-tuhr] device used to measure the current in a circuit (439)

ampere (A) [AM-per] unit of electric current; a measure of the amount of charge moving past a point in the circuit every second (439)

aquatic water-based (17)

aquifer large underground lake (25)

artificial satellite a device placed in orbit around Earth or other celestial object (356)

asterisms [A-stu-riz-ums] smaller recognizable star patterns within a larger constellation (294)

asteroid belt region of rocky debris that forms a ring all the way around the Sun at a distance of about 3 AU (262)

astronomer person who studies astronomy (258)

astronomical phenomenon [AS-troh-NAWM-i-kul fen-AWM-e-nun] any observable occurrence relating to astronomy (294)

astronomical unit (AU) distance measure; 1 AU equals the average distance between the Sun and Earth, about 150 million km (261)

astronomy study of the universe and the objects in it (258)

at risk in danger of becoming extinct or disappearing from a region (94)

atmosphere layer of gases that surrounds Earth (19)

atom smallest part of an element that has all of the element's properties (168)

atomic mass average mass of an element's atoms (192)

atomic mass units (amu) measure of an atom's mass (192)

atomic number number of protons in an atom of an element (190)

atomic theory study of the nature of atoms and how they combine to form all types of matter (170)

aurora borealis [uh-ROR-uh bor-ee-A-luhs] display of green, yellow, and red light in the night sky near Earth's northern regions, produced when the charged particles of the solar wind collide with the atoms and molecules in Earth's atmosphere (312)

B

battery combination of electrochemical cells (435)

bedrock solid rock layer under the subsoil (72)

Big Bang theory theory that the universe formed when an infinitely dense point suddenly and rapidly expanded in a single moment 13.7 billion years ago (280)

binary system star system with two stars (263)

bioaccumulation [bih-oh-a-kyoo-myoo-LAE-shuhn] gradual build-up of chemicals in an organism's body (79)

biodiversity [bih-o-di-VUHR-si-tee] number of different types of organisms in an area (9)

biological oxygen demand (BOD) measure of how quickly oxygen is used up by micro-organisms in a given body of water (77)

biomagnification increase in concentration of a harmful substance at each link in the food chain as one animal eats many contaminated animals (79)

biomass [BIH-oh-mas] organic material made up of plant and animal waste (478)

biome [BIH-ohm] large geographical region that contains similar ecosystems (16)

biosphere part of our planet, including water, land, and air, where life exists. Biomes combine to form the biosphere. (18)

biotic [bih-AW-tik] living, biotic factors are organisms such as animals, plants, mushrooms, bacteria, and algae (13)

black hole region of space where gravity is so strong that nothing, not even light, can escape (270)

boiling point temperature at which a liquid turns to a gas (139)

bond connection between atoms or ions (213)

boreal forest biome that has trees, such as spruce and fir, that have cones and needles (17)

C

carnivores organisms that eat mostly meat, for example, wolves (30)

carrying capacity maximum number of individuals that an ecosystem can support without reducing its ability to support future generations of the same species (40)

celestial object object we can see in the sky, including the Sun, the Moon, Earth, other planets, and comets (258)

cellular respiration process organisms use to obtain energy from glucose and other carbohydrates (29)

charging by contact charging process in which electrons transfer from the charged object to the neutral object that it touches (407)

chemical change change in matter that results in the formation of a new substance or substances (152)

chemical family group of elements with certain shared physical and chemical properties; represented by one of the 18 vertical columns in the periodic table of the elements (193)

chemical formula combination of symbols that identifies which elements, and how much of each, are in a compound (219)

chemical property ability of a substance to change into a new substance or substances; e.g., how a substance interacts with other substances, such as acids, or how it reacts to heat or light (152)

chemical reaction process in which a chemical change occurs; produces a new substance or substances (152)

chlorophyll substance in plants that absorbs sunlight and causes leaves to be green (28)

chromosphere [KROH-muhs-feer] thin layer of the Sun, lying above the photosphere, and with a red cast to it (309)

circuit path for electrons to flow; includes energy source, electrical load, and conducting wires (434)

circuit breaker safety device in which a wire heats up and bends when there is excess current in the circuit; this triggers a spring mechanism that turns off the flow of electricity (463)

circuit diagram drawing made with symbols that shows the components and connections in a circuit (450)

clay soil soil that contains small rock particles that pack tightly together (73)

clearcutting removing all trees, regardless of size, in an area at one time (62)

climate average weather conditions that occur in a region over a span of 30 years or more (60)

climate change change of climate characteristics in a region, such as a rise or fall in average temperatures or an increase or decrease in rainfall (60)

cohesion property of sticking together; a physical property of water (150)

combustibility ability of a substance to react quickly with oxygen to produce heat and light (153)

comet celestial object made of ice and dust (318)

commensalism [kuh-MEN-suhl-iz-uhm] type of symbiosis in which one species benefits from the relationship without harming or helping the other species (40)

community populations of different species that live and interact in the same area (14)

competition interaction between two or more organisms competing for the same resource in a given habitat (38)

components parts of a system (11)

compound pure substance made from two or more elements that are combined together chemically (141)

condensation change of state from a gas to a liquid (138)

conduction movement or transmission of electric charges through a substance (400)

conductivity ability of materials to allow electrons to move freely in them (400)

conductor material that allows electrons to change positions (400)

conservation biology modern science that seeks to understand and protect biodiversity (94)

constellation group of stars that, from Earth, resembles a recognizable form (294)

consumer organism that eats other organisms to obtain energy because it cannot produce its own food (30)

corona [kuh-ROH-nuh] outermost layer of the Sun, extending beyond the chromosphere for millions of kilometres (309)

coronal mass ejection extremely powerful kind of solar flare that causes a large amount of plasma to be thrown out through the corona and into space (311)

coulomb (C) [KOO-lawm] metric unit of electric charge; one coulomb equals 6.24×10^{18} electrons added to or removed from a neutral object (399)

crop rotation practice of planting a different type of crop in a particular field each year (75)

current electricity continuous flow of electrons in a circuit (434)

D

dark matter matter in the universe that is invisible because it does not interact with light or any other kind of radiation; at least 90 percent of the universe may be composed of dark matter (271)

deciduous forest biome that has trees, such as maples and oaks, that lose their leaves in the winter (17)

decomposer consumer that breaks down organic matter and releases the nutrients back into the ecosystem; for example, fungi and bacteria (30)

denitrifying bacteria [dee-NIH-tri-fih-ing] bacteria that convert nitrates into nitrogen gas (26)

deposition change of state from a gas directly into a solid (138)

detritivore [de-TRI-ti-vor] consumer that feeds on organic matter; for example, earthworms (30)

direct current (DC) electric current flowing in one direction (439)

dissolved oxygen the level of oxygen present in water (77)

dry cell electrochemical cell that uses a paste instead of a liquid electrolyte (435)

E

ecological footprint estimate of how much land and water is needed to support a person's lifestyle (106)

ecology [ee-KAWL-uh-jee] study of how organisms interact with each other as well as with their environment in a system (12)

ecosystem [EE-koh-sis-tuhm] complex, self-regulating system in which living things interact with each other and with non-living things (13)

efficiency ratio of the useful energy that comes out of a device to the total energy that went in (493)

electric charges charged particles that exert an electric force on each other (394)

electric current measure of the amount of electric charge that passes by a point in an electrical circuit each second (439)

electrical discharge rapid transfer of electric charges (409)

electrochemical cell package of chemicals that converts chemical energy into electrical energy that is stored in charged particles (435)

electrode metal strip that reacts with the electrolyte in an electrochemical cell (435)

electrolyte [e-LEK-truh-liht] liquid or paste that conducts electricity because it contains chemicals that lose or gain electrons to form ions (435)

electromagnetic radiation energy that travels in waves of varying lengths; visible light is one form of electromagnetic radiation (281)

electromagnetic spectrum full range of electromagnetic radiation, organized by wavelength from very long to very short; examples include radio waves, microwaves, infrared, visible light, ultraviolet radiation, and X-rays (281)

electron negatively charged particle in an atom; located outside the nucleus of the atom (172, 396)

electron affinity [e-LEK-trawn a-FIN-i-tee] tendency of a substance to hold on to the electrons (398)

electroscope instrument that can detect static charge (404)

electrostatics [e-LEK-truh-STA-tiks] study of static electric charges (404)

element pure substance that cannot be broken down into a simpler substance (24, 141)

endangered species facing extinction or extirpation (94)

EnerGuide label that states how much energy an appliance will use in a month or year of average use (494)

energy grid web of interconnections between generating stations, substations, and users; also called a distribution grid (476)

energy pyramid diagram that shows the amount of available energy producers and consumers contain as energy flows through an ecosystem (32)

Energy Star symbol identifying the most efficient appliances in each class (494)

environment all the living and non-living things that exist on Earth (8)

environmental steward someone who manages resources wisely, ensuring that they are used in sustainable ways for current and future generations (107)

equilibrium in a population, a state where the number of births equals the number of deaths, so that the number of individuals stays the same over time (40)

equinox [E-kwi-nawks] day when the hours of daylight and the hours of night are of equal length (341)

eutrophication [yoo-tri-fi-KAE-shuhn] addition of nutrients to an aquatic ecosystem causing increased growth of plants such as algae (78)

evaporation change of state from a liquid to a gas; also known as vaporization (138)

ex-situ conservation [eks-SI-too] protection of species by removing them from their natural habitat (96)

extinction the death of every member of a species (54)

extirpated species that no longer exists in a particular region but still occurs elsewhere (94)

F

food chain diagram that shows the feeding relationships among organisms (31)

food web diagram that shows complex feeding relationships among organisms that eat many different things; interconnected food chains (31)

fossil fuel fuel formed from the organic matter of organisms that lived millions of years ago; includes coal, oil, and natural gas (478)

freezing change of state from a liquid to a solid (138)

freezing point temperature at which a liquid turns to a solid; same temperature as the melting point (139)

freshwater biome water-based biome in which the water has a very low salt content (17)

friction force resisting the relative motion of two surfaces in contact (397)

fuel cell electrochemical cell that generates electricity directly from a chemical reaction with a fuel, such as hydrogen (436)

fuse safety device in an electric circuit that has a metal conductor with a low melting point; if the current gets too high, the metal in the fuse melts and the current flow stops (463)

G

galaxy collection of hundreds of billions of stars held together by gravity (254)

generator device that transforms the energy of motion into an electric current (476)

genetic diversity differences among individuals of the same species (54)

geostationary [JEE-oh-STAE-shun-e-ree] orbit in which a satellite orbits Earth at the same rate as Earth rotates (356)

geothermal energy energy from water naturally heated by hot rock in the Earth's crust (479)

global warming increase in Earth's average temperature (60)

grassland biome that has few trees but is covered in various kinds of grasses and shrubs (17)

ground fault circuit interrupter (GFCI) residual current device that detects a change in current and opens the circuit, stopping current flow (464)

grounding process of connecting a charged object to Earth's surface (408)

group classification of elements with certain shared physical and chemical properties; represented by one of the 18 vertical columns in the periodic table of the elements; also known as a chemical family (193)

H

habitat area where an organism lives (14)

habitat change process in which habitats are altered enough by humans so that native species can no longer live there (55)

habitat fragmentation alteration of small areas within a large region, creating a patchwork of altered and original habitats (56)

heavy metal group of substances that have a density of 5 g/mL or higher; for example, mercury, lead, and cadmium (79)

herbivore animal that eats only plants; for example, moose and deer (30)

holistic approach [hoh-LIS-tic] emphasizes an entire system (11)

hydroelectricity electricity generated by harnessing the power of falling water (477)

hydrosphere all the water on Earth (19)

I

induction movement of electrons within a substance, caused by a nearby charged object, without direct contact between the substance and the object (407)

inert does not react easily with other chemicals (133)

in-situ conservation [in-SI-too] protection of species in their natural surroundings (96)

insulator solid, liquid, or gas that resists or blocks the movement of electrons (400)

integrated pest management method of pest control that uses knowledge about a pest's biology and habitats to keep the pest population under control rather than eradicating it (107)

invasive species non-native species that causes harm to the ecosystem into which it has been introduced (59)

ion atom or group of atoms that has lost or gained electrons (192)

ion charge electric charge that an atom or group of joined atoms takes on when it loses or gains electrons (192)

ionic bond attraction between ions; e.g., bond in an ionic compound (213)

ionic compound pure substance consisting of at least one metal and one non-metal (212)

K

kilowatt-hour (kW•h) commonly used unit of electrical energy, equal to a consumption of one kilowatt in one hour (492)

L

law of attraction law stating that particles with opposite charges attract each other (399)

law of repulsion law stating that particles with like charges repel each other (399)

lightning rod metal pole with a wire attached to it that runs down to the ground with the purpose of allowing the electrons that build up on a building to spread out into the air (418)

light-year (ly) distance measure; 1 ly equals the distance that a beam of light can travel through space in 1 year; it is equivalent to 63 000 AU or 9 000 billion km (261)

limiting factor environmental factor that prevents an increase in the number of organisms in a population or prevents them from moving into new habitats (41)

lithosphere [LITH-oh-sfeer] Earth's solid, outer layer (19)

load device that converts electrical energy to another form of energy (434)

loam soil that has rock particles of many different sizes (73)

lunar eclipse occurs when Earth blocks the Sun's light shining on the Moon, making the Moon briefly disappear (328)

M

marine biome water-based biome in which the water has a high salt content (17)

mass measure of the quantity of matter in an object (138)

matter anything that has mass and volume (138)

mechanical mixture combination of pure substances in which the different substances are individually visible (142)

melting change of state from a solid to a liquid (138)

melting point temperature at which a solid turns into a liquid; same temperature as the freezing point (139)

metal element that is malleable and ductile and conducts electricity and heat; most elements are metals (180)

metalloid element with metallic and non-metallic properties; e.g., silicon (181)

meteor a meteoroid (a small piece of rock or metal) that enters Earth's atmosphere and begins to burn up as a result of friction (318)

microgravity condition in which the gravitational forces that act on a mass are greatly reduced (367)

mimicry [MIM-uh-kree] copying the appearance of another species to avoid predators; for example, the viceroy butterfly looks very much like the foul-tasting monarch butterfly (39)

molecular compound pure substance that is formed when non-metals combine chemically (214)

molecule group of atoms that share electrons; molecular compounds contain molecules (214)

mutualism type of symbiosis in which both species benefit from the symbiotic partnership (40)

N

native species species that normally live in a habitat (55)

nebula [NEB-yoo-luh] large cloud of dust and gas (264)

neutron particle that has no electric charge so is neutral; located in the nucleus of the atom (173, 396)

niche [NEESH] all the interactions of a given species with its ecosystem (14)

nitrifying bacteria bacteria that convert ammonia into nitrites and then nitrates (26)

nitrogen fixation conversion of nitrogen gas into ammonia (25)

nitrogen-fixing bacteria bacteria that convert nitrogen gas into ammonia (25)

non-metal elements that are grouped together mainly because they do not resemble metals; e.g., carbon (180)

non-point source pollution pollution that enters bodies of water indirectly when rain or snow travels over land and picks up pollutants from many different sources before entering a stream or a lake; for example, fertilizer and pesticide run-off from farms (58)

non-renewable resource resource that cannot be replaced once it is used up, such as coal or oil (474)

nuclear fusion process in which the nuclei of atoms fuse together and form larger atoms; during this process, an enormous amount of energy is released (261)

nucleus (atomic) centre of the atom, which contains the protons and neutrons (173, 396)

nutrient cycle the process of moving a nutrient from the abiotic part of an ecosystem to the biotic part and back again (24)

nutrients substances that an organism uses to build and repair the cells of its body (22)

O

ohm (Ω) SI unit for measuring resistance (441)

Ohm's law law stating that as long as temperature stays the same, $V = IR$, where V is potential difference, I is current, and R is resistance (460)

ohmmeter device for measuring electrical resistance; usually part of a multifunctional meter called a multimeter (441)

omnivore animal that eats both animals and plants; for example, bears and raccoons (30)

orbital radius planet's distance from the Sun (343)

organic farming farming without the use of chemical fertilizers or pesticides (108)

organic matter remains of dead organisms and animal wastes (30)

overexploitation using a resource faster than it can be replaced (56)

P

parallel circuit electric circuit in which the parts are arranged so that electrons can flow along more than one path (451)

parasitism type of symbiosis in which one species benefits from the relationship at the expense of the other species (40)

particle theory of matter theory stating that all matter is composed of very tiny objects called particles; that all particles have spaces between them; that particles of matter are always in motion; that particles in a substance attract each other (139)

parts per million (ppm) measurement of chemicals that occur in low concentrations; e.g., a sample having a mercury concentration of 1 ppm has 1 part mercury per million parts sample (232)

period one of seven horizontal rows in the periodic table of the elements (193)

pesticides chemicals that kill unwanted organisms, usually ones that attack crops and reduce their yields (80)

photosphere layer of the Sun usually considered to be the boundary between the inside and the outside of the Sun (309)

photosynthesis [foh-toh-SIN-thuh-sis] process plants use to produce carbohydrates from carbon dioxide, water, and sunlight (28)

physical property characteristic of a substance that can be observed or measured (150)

planet celestial object that orbits one or more stars and is capable of forming into a spherical shape as it melds under the weight of its own gravity (313)

point source pollution pollution that enters a body of water at a specific place from an identifiable source; for example, oil spills from tankers and wastewater from pulp and paper mills (58)

pollution any substance added to the environment that produces a condition that is harmful to organisms (58)

population group of members of the same species that live in the same area (14)

potential difference or **voltage (*V*)** difference in electric potential energy between two points that will cause current to flow in a closed circuit (437)

potential energy energy stored in an object; each electric charge has electrical potential energy (437)

predation [pred-AE-shuhn] one organism eating another organism to obtain food (39)

predator animal that catches and feeds on other live animals (30)

prey animals that predators hunt and catch (30)

primary consumer organism that eats producers; for example, a caterpillar, which eats plants (30)

producer organism that carries out photosynthesis (30)

prominence large, often curved, bright stream of particles extending outward from the photosphere into the corona (313)

property characteristic that describes a substance (141)

proton positively charged particle in an atom, found in the nucleus (173, 396)

protostar star in its first stage of formation (296)

pure substance one kind of matter with a unique set of properties, such as colour, hardness, boiling point, and melting point; an element or compound (141)

R

relative mass mass of an object in comparison to the mass of another object (175)

renewable resources resource that can be reused or replaced, such as sunlight and wind (474)

reservoir any place where matter accumulates (24)

resistance degree to which a substance opposes the flow of electric current through it (441)

resistor any material that can slow current flow in a circuit, such as the filament in a light bulb (441)

retrograde motion apparent reversal of a planet's path relative to the starry backdrop (342)

revolution one complete orbit of Earth around the Sun, a journey of one year (325)

rotation one complete spin of Earth on its axis, which takes almost 24 hours (324)

run-off water that runs off the ground into nearby streams or rivers (25)

S

sandy soil soil that contains relatively large rock particles (73)

scavenger carnivore that eats the remains of dead animals; for example, vultures (30)

secondary consumer organism that feeds on primary consumers; for example, a robin, which eats caterpillars (30)

series circuit electric circuit in which the components are arranged one after another in series (451)

short circuit accidental low-resistance connection between two points in a circuit, often causing excess current flow (462)

soil loose covering on the ground containing organic matter, minerals, and moisture (72)

soil conservation use of farming methods that protect soil from erosion and loss of nutrients (108)

soil erosion loss of soil when water or wind wash or blow it away (74)

solar eclipse occurs when the Moon blocks the Sun's light to viewers on Earth; this happens when the Moon lies directly between Earth and the Sun (327)

solar flare massive explosion on the surface of the Sun (311)

solar system the Sun together with all the planets and other celestial objects that are held by the Sun's gravitational attraction and orbit around it (260)

solar wind thin but steady stream of subatomic particles flowing out of the Sun's surface in all directions (312)

solution combination of pure substances in which the different substances are not individually visible; a homogeneous mixture (142)

special concern has characteristics that make a species sensitive to human activities or natural events (94)

species [SPEE-sees] group of similar organisms that can reproduce with each other and their offspring can also reproduce (14)

spectral lines series of dark lines that appears across a star's light spectrum and indicates the chemical elements in the star's composition (282)

spectral shifting change in position of spectral lines to the left or the right of where they normally lie in the spectrum of a light source that is not moving (282)

spectroscope optical instrument that, like a prism, separates light into its spectral colours (281)

spectrum rainbow band of colours into which white light separates when it passes through a prism (278)

spinoff secondary beneficial effect or product of a thing or an activity (354)

star hot ball of plasma, an electrically charged gas, that shines because nuclear fusion is taking place at its core (261)

static charge or **static electricity** electric charge that builds up on the surface of an object (396)

stewardship way of acting that involves taking personal responsibility for the management and care of something (8)

subatomic particles particles that make up an atom, including protons, neutrons, and electrons (175)

sublimation change of state from a solid directly into a gas (138)

subsoil layer below the topsoil (72)

summer solstice day of the year with the longest period of daylight, representing the start of summer (340)

sunspot region on the Sun's surface that is cooler than the surrounding areas (310)

supernova [SOO-puhr-NOH-vuh] star's explosion, caused by the gradual build-up of heavy elements in the star's centre, resulting in the core's collapse (263)

suspension cloudy mixture in which tiny particles of one substance are held within another; a type of heterogeneous mixture (142)

sustainability the ability of populations of organisms to continue to live, to interact, and to reproduce indefinitely in an environment (9)

sustainable use using an ecosystem's resources in a way that meets our current needs without compromising the ability of future generations to meet their needs (54)

switch device that turns a circuit on or off by closing or opening the circuit (434)

symbiosis [sim-bee-OH-sis] close interaction between two different species in which members of one species live in, on, or near members of another species (39)

system group of individual parts that interact as a whole to accomplish a task (11)

T

temperate coniferous forest biome that has different types of needle- and cone-bearing trees than a boreal forest, such as Douglas fir, Sitka spruce, and western hemlock (17)

terrestrial land-based (17)

tertiary consumer [TUHR-shuh-ree] third level of consumer, which eats secondary consumers; for example, a hawk that feeds on small birds (30)

thermoelectric generating plant electricity-generating plant that uses a fuel such as coal or biomass to heat water to create high-pressure steam (478)

thermonuclear term describing electrical energy produced by heat in nuclear power stations (479)

threatened species at risk of becoming endangered if limiting factors are not reversed (94)

topsoil uppermost layer in soil, composed chiefly of decaying organic matter, rock particles, and organisms (72)

transistor tiny device that acts as a switch or amplifier in a circuit (449)

tundra biome that has no trees but only small shrubs, hardy grasses, mosses, and lichens (17)

turbine machine that uses the flow of a fluid to turn a shaft; used in generators to generate electricity (476)

U

universe everything that physically exists: the entirety of space and time, and all forms of matter and energy (255)

urban sprawl unplanned, disorganized growth of urban and suburban development into the surrounding countryside (62)

V

valence electron [VAE-luhns] electron in the valence shell of an atom (197)

valence shell outermost shell or energy level of an atom that has electrons in it (197)

volt (V) SI unit for measuring potential differences (438)

voltage or **potential difference** difference in electrical potential energy between two points that will cause current to flow in a closed circuit (437)

voltmeter device used to measure the potential difference between two locations in a circuit (438)

volume measure of how big an object is or how much space a fluid takes up (138)

W

wet cell electrochemical cell that has a liquid electrolyte (435)

wetland area in which the soil is saturated with water for at least part of the year (4)

winter solstice [SAWL-stis] day of the year with the shortest period of daylight, representing the start of winter (340)

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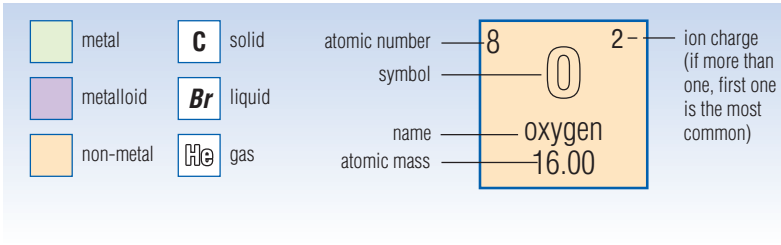
Periodic Table of the Elements



	1	2	3	4	5	6	7	8	9
1	1 H 1+ hydrogen 1.01								
2	3 Li 1+ lithium 6.94	4 Be 2+ beryllium 9.01							
3	11 Na 1+ sodium 22.99	12 Mg 2+ magnesium 24.31							
4	19 K 1+ potassium 39.10	20 Ca 2+ calcium 40.08	21 Sc 3+ scandium 44.96	22 Ti 4+ 3+ titanium 47.87	23 V 5+ 4+ vanadium 50.94	24 Cr 3+ 2+ chromium 52.00	25 Mn 2+ 4+ manganese 54.94	26 Fe 3+ 2+ iron 55.85	27 Co 2+ 3+ cobalt 58.93
5	37 Rb 1+ rubidium 85.47	38 Sr 2+ strontium 87.62	39 Y 3+ yttrium 88.91	40 Zr 4+ zirconium 91.22	41 Nb 5+ 3+ niobium 92.91	42 Mo 6+ molybdenum 95.94	43 Tc 7+ technetium (98)	44 Ru 3+ 4+ ruthenium 101.07	45 Rh 3+ rhodium 102.91
6	55 Cs 1+ cesium 132.91	56 Ba 2+ barium 137.33	57–71	72 Hf 4+ hafnium 178.49	73 Ta 5+ tantalum 180.95	74 W 6+ tungsten 183.84	75 Re 7+ rhenium 186.21	76 Os 4+ osmium 190.23	77 Ir 4+ iridium 192.22
7	87 Fr 1+ francium (223)	88 Ra 2+ radium (226)	89–103	104 Rf rutherfordium (261)	105 Db dubnium (262)	106 Sg seaborgium (266)	107 Bh bohrium (264)	108 Hs hassium (277)	109 Mt meitnerium (268)

	3	4	5	6	7	8	9
6	57 La 3+ lanthanum 138.91	58 Ce 3+ cerium 140.12	59 Pr 3+ praseodymium 140.91	60 Nd 3+ neodymium 144.24	61 Pm 3+ promethium (145)	62 Sm 3+ 2+ samarium 150.36	63 Eu 3+ 2+ europium 151.96
7	89 Ac 3+ actinium (227)	90 Th 4+ thorium 232.04	91 Pa 5+ 4+ protactinium 231.04	92 U 6+ 4+ uranium 238.03	93 Np 5+ neptunium (237)	94 Pu 4+ 6+ plutonium (244)	95 Am 3+ 4+ americium (243)

10	11	12	13	14	15	16	17	18
								2 **He** helium 4.00
			5 **B** boron 10.81	6 **C** carbon 12.01	7 **N** 3− nitrogen 14.01	8 **O** 2− oxygen 16.00	9 **F** 1− fluorine 19.00	10 **Ne** neon 20.18
			13 **Al** 3+ aluminum 26.98	14 **Si** silicon 28.09	15 **P** 3− phosphorus 30.97	16 **S** 2− sulphur 32.07	17 **Cl** 1− chlorine 35.45	18 **Ar** argon 39.95
28 **Ni** 2+ 3+ nickel 58.69	29 **Cu** 2+ 1+ copper 63.55	30 **Zn** 2+ zinc 65.41	31 **Ga** 3+ gallium 69.72	32 **Ge** 4+ germanium 72.64	33 **As** 3− arsenic 74.92	34 **Se** 2− selenium 78.96	35 ***Br*** 1− bromine 79.90	36 **Kr** krypton 83.80
46 **Pd** 2+ 4+ palladium 106.42	47 **Ag** 1+ silver 107.87	48 **Cd** 2+ cadmium 112.41	49 **In** 3+ indium 114.82	50 **Sn** 4+ 2+ tin 118.71	51 **Sb** 3+ 5+ antimony 121.76	52 **Te** 2− tellurium 127.60	53 **I** 1− iodine 126.90	54 **Xe** xenon 131.29
78 **Pt** 4+ 2+ platinum 195.08	79 **Au** 3+ 1+ gold 196.97	80 ***Hg*** 2+ 1+ mercury 200.59	81 **Tl** 1+ 3+ thallium 204.38	82 **Pb** 2+ 4+ lead 207.21	83 **Bi** 3+ 5+ bismuth 208.98	84 **Po** 2+ 4+ polonium (209)	85 **At** 1− astatine (210)	86 **Rn** radon (222)
110 **Ds** darmstadtium (271)	111 **Rg** roentgenium (272)	112 **Uub** ununbium (285)	113 **Uut** ununtrium (284)	114 **Uuq** ununquadium (289)	115 **Uup** ununpentium (288)	116 **Uuh** ununhexium (293)	117 **Uus** ununseptium (?)	118 **Uuo** ununoctium (294)

64 **Gd** 3+ gadolinium 157.25	65 **Tb** 3+ terbium 158.93	66 **Dy** 3+ dysprosium 162.50	67 **Ho** 3+ holmium 164.93	68 **Er** 3+ erbium 167.26	69 **Tm** 3+ thulium 168.93	70 **Yb** 3+ 2+ ytterbium 173.04	71 **Lu** 2+ lutetium 174.97	
96 **Cm** 3+ curium (247)	97 **Bk** 3+ 4+ berkelium (247)	98 **Cf** 3+ californium (251)	99 **Es** 3+ einsteinium (252)	100 **Fm** 3+ fermium (257)	101 **Md** 2+ 3+ mendelevium (258)	102 **No** 2+ 3+ nobelium (259)	103 **Lr** 3+ lawrencium (262)	