APPENDIX

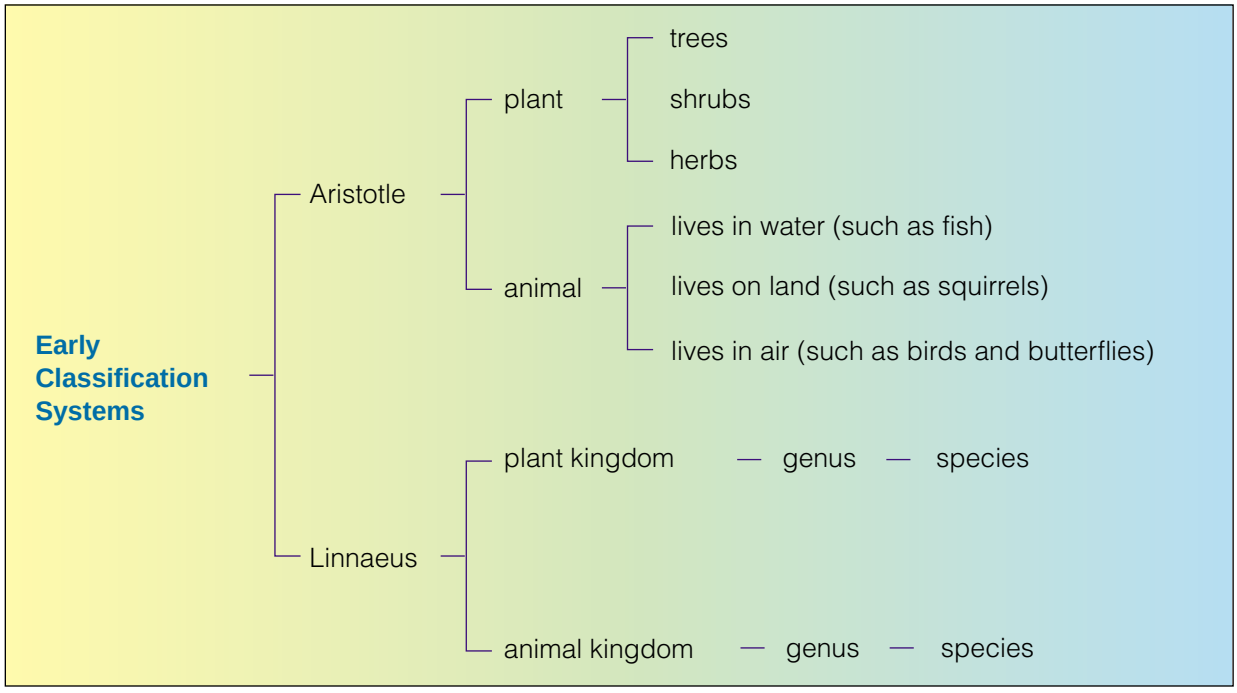
A

Classifying Living Things

Over 2000 years ago, the Greek philosopher Aristotle developed a system of classification that grouped organisms according to whether they were plant or animal. Scientists used Aristotle's system for hundreds of years, but as they discovered more and more living things, the system did not work well because it did not show probable relationships between similar organisms.

In 1735, Carolus Linnaeus produced a new system that also classified all organisms as plant or animal, but this new system was very different in other ways from Aristotle's system.

Linnaeus' system gives a two-word name to each type of organism. This system of naming organisms is still in use today. The two-word name is called the organism's scientific name, and it is given in Latin, a language that is no longer spoken. The first word of the organism's name is its genus, and the second word is its specific name. A **genus** is a group of organisms that are very similar. A **species** is the smaller, more limiting classification grouping. The Canada lynx, shown on the right, and the bobcat, shown on the left, are members of the same genus, *Lynx*, but they are considered different species. The lynx is the species *Lynx canadensis* and the bobcat is *Lynx rufus*.



In the 1900s, as knowledge about the great diversity of organisms on Earth exploded, it became clear that separating organisms into only two kingdoms, plant and animal, was inadequate. For example, bacteria are just too different from either plants or animals to be grouped with either. Likewise, fungi such as bread mould, yeast, and the many kinds of mushrooms are very different from plants and animals. Influential scientists like Robert Whittaker and Lynn Margulis supported the idea that new criteria for classifying organisms were needed. Thus, since the 1960s, a system that classifies organisms into five different kingdoms, still using Linnaeus' basic system at its roots, is largely accepted and used. The organisms and their kingdoms are shown in the table below.

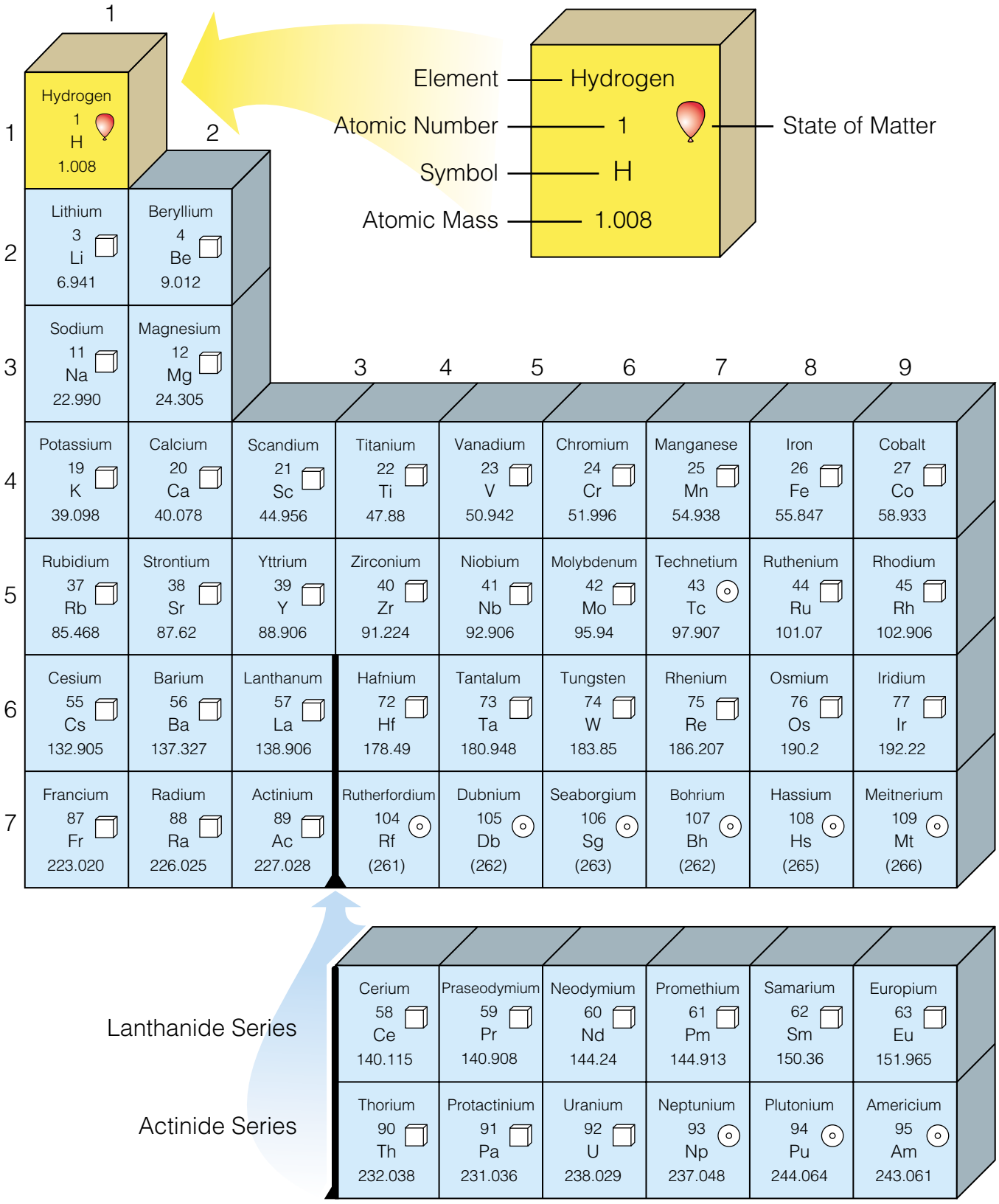
Life's Five Kingdoms

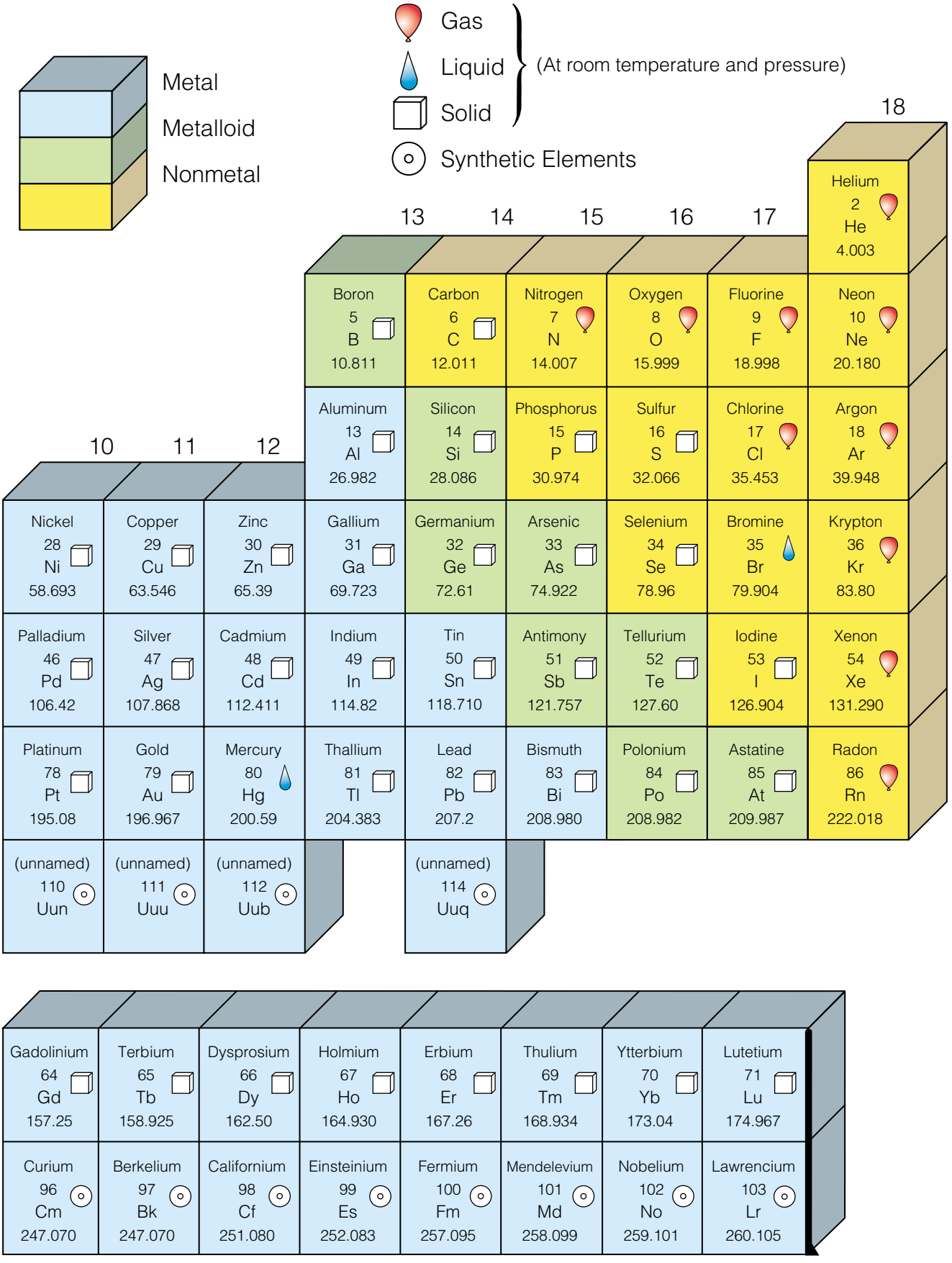
	Monera	Protista	Fungi	Plant	Animal
Number of cells	One-celled	One- and many-celled	One- and many-celled	Many-celled	Many-celled
Movement	Some move	Some move	Don't move	Don't move	Move
Nutrition	Some members make their own food; others obtain it from other organisms.	Some members make their own food; others obtain it from other organisms.	All members obtain food from other organisms.	Members make their own food.	Members eat plants or other organisms.

APPENDIX

B

PERIODIC TABLE OF THE ELEMENTS




Metal
Metalloid
Nonmetal
Gas
Liquid
Solid
(At room temperature and pressure)
Synthetic Elements
18
13 14 15 16 17
10 11 12
Helium 2 He 4.003
Boron 5 B 10.811
Carbon 6 C 12.011
Nitrogen 7 N 14.007
Oxygen 8 O 15.999
Fluorine 9 F 18.998
Neon 10 Ne 20.180
Aluminum 13 Al 26.982
Silicon 14 Si 28.086
Phosphorus 15 P 30.974
Sulfur 16 S 32.066
Chlorine 17 Cl 35.453
Argon 18 Ar 39.948
Nickel 28 Ni 58.693
Copper 29 Cu 63.546
Zinc 30 Zn 65.39
Gallium 31 Ga 69.723
Germanium 32 Ge 72.61
Arsenic 33 As 74.922
Selenium 34 Se 78.96
Bromine 35 Br 79.904
Krypton 36 Kr 83.80
Palladium 46 Pd 106.42
Silver 47 Ag 107.868
Cadmium 48 Cd 112.411
Indium 49 In 114.82
Tin 50 Sn 118.710
Antimony 51 Sb 121.757
Tellurium 52 Te 127.60
Iodine 53 I 126.904
Xenon 54 Xe 131.290
Platinum 78 Pt 195.08
Gold 79 Au 196.967
Mercury 80 Hg 200.59
Thallium 81 Tl 204.383
Lead 82 Pb 207.2
Bismuth 83 Bi 208.980
Polonium 84 Po 208.982
Astatine 85 At 209.987
Radon 86 Rn 222.018
(unnamed) 110 Uun
(unnamed) 111 Uuu
(unnamed) 112 Uub
(unnamed) 114 Uuq
Gadolinium 64 Gd 157.25
Terbium 65 Tb 158.925
Dysprosium 66 Dy 162.50
Holmium 67 Ho 164.930
Erbium 68 Er 167.26
Thulium 69 Tm 168.934
Ytterbium 70 Yb 173.04
Lutetium 71 Lu 174.967
Curium 96 Cm 247.070
Berkelium 97 Bk 247.070
Californium 98 Cf 251.080
Einsteinium 99 Es 252.083
Fermium 100 Fm 257.095
Mendelevium 101 Md 258.099
Nobelium 102 No 259.101
Lawrencium 103 Lr 260.105

APPENDIX C

Properties of Common Substances

KEY TO SYMBOLS:

Common names of substances are enclosed in parentheses.

(*) Water solution of a pure substance (e) Element (c) Compound (n) Not a pure substance

Name	Formula	Melting point (°C)	Boiling point (°C)	Density (g/cm^3 or g/mL)	
acetic acid (vinegar) (c)	CH_3COOH	16.6	118.1	—	
alcohol (see ethanol) (c)					
aluminum (e)	Al	659.7	2519	2.7	
aluminum oxide (alumina) (c)	Al_2O_3	2015	—	—	
ammonia (c)	NH_3	–77.8	–33.4	less dense than air	
ammonium nitrate (c)	NH_4NO_3	169.6	210		
antimony (e)	Sb	631	1587	6.70	
argon (e)	Ar	–189	–185	denser than air	
arsenic (e)	As	—	—	5.727 (grey) 4.25 (black) 2.0 (yellow)	
barium (e)	Ba	727	1897	3.62	
berkelium (e)	Bk	1050	—	14.78	
beryllium (e)	Be	1280	2471	1.85	
bismuth (e)	Bi	271	1560	9.7	
boron (e)	B	2075	4000	2.37(brown) 2.34 (yellow)	
bromine (e)	Br	–7.2	58.8	3.12	
calcium (e)	Ca	845	1484	1.55	
calcium carbonate (limestone) (c)	$CaCO_3$	decomposes at 900°C	—	2.93	
calcium hydroxide (slaked lime) (c)	$Ca(OH)_2$	decomposes at 522°C	—	2.24	
calcium oxide (lime) (c)	CaO	2580	2850	3.3	
carbon (diamond) (e)	C	3500	4827	3.51	
carbon (graphite) (e)	C	3652–3697	4827	2.25	
carbon dioxide (c)	CO_2	—	—	—	
chlorine (e)	Cl_2	–101.6	–34.6	denser than air	
chromium (e)	Cr	1907	2671	7.2	
cobalt (e)	Co	1480	2927	8.9	
copper (e)	Cu	1084	2562	8.95	
copper (II) nitrate (c)	$Cu(NO_3)_2$	—	—	—	
copper (II) sulfate (bluestone) (c)	$CuSO_4.5H_2O$	decomposes at 150°C	—	2.28	
diamond (see carbon) (e)					
ethanol (ethyl alcohol) (c)	C_2H_5OH	–114.5	78.4	0.789	
ethylene (ethene) (c)	C_2H_4	–169	–103.9	—	
fluorine (e)	F_2	–270	–188	—	
gold (e)	Au	1063	2856	19.3	
glucose (c)	$C_6H_{12}O_6$	146	decomposes before it boils	1.54	
graphite (see carbon) (e)					
helium (e)	He	–272.2	–268.93	—	
hematite (c)	Fe_2O_3	1565	—	5.24	

DEFINITIONS:
deliquescent — able to absorb water from the air to form a concentrated solution
sublime — to form a vapour directly from a solid

	Appearance (at room temperature: 20°C)	Comments
	colourless liquid with pungent smell	used in the manufacture of cellulose ethanoate; vinegar is a 5–7 percent solution in water
	silver-white metal	used in aircraft, cooking utensils, and electrical apparatus
	white, crystalline substance	used in refining of aluminum and in cement
	very soluble gas with pungent smell	used as refrigerant and in manufacture of resins, explosives, and fertilizers
	white, soluble, crystalline salt	used in explosives and as a fertilizer
	silver-grey solid	used in infra-red detectors
	inert gas	used in electric lights
	grey, black, or yellow solid	used in semiconductors and alloys; compounds are very poisonous and are used in medicine and as pesticides
	silver-white solid	used in X-ray diagnosis
	—	—
	hard, white metal	used for corrosion-resistant alloys
	brittle, white, crystalline metal with reddish tinge	used in alloys, catalysts, nuclear reactors; compounds used in medicine
	brown amphorous powder or yellow crystals	used for hardening steel and for producing enamels and glasses
	red-brown liquid	liquid causes severe chemical burns; vapour is harmful to lungs; used to make certain pain-relieving drugs
	soft, white metal that tarnishes easily	very abundant; essential to life
	white solid	main ingredient in chalk, marble
	white solid	aqueous solution used to test for CO_2
	white solid	used in cement and to mark lines on playing fields
	colourless, solid crystals	very hard; used for drilling through rock
	grey-black solid	very soft; used in lubricants, pencil leads, electrical apparatus
	colourless gas with a faint tingling smell and taste	does not support combustion and is denser than air; used in fire extinguishers and as a refrigerant at –78.5°C
	green gas	poisonous; used to kill harmful organisms in water
	shiny, silvery solid	very hard metal; used to make stainless steel
	hard, silver-white, magnetic metal	used in alloys; compounds used to produce the colour blue in glass and ceramics
	shiny, reddish solid	soft metal; good conductor of heat
	blue, solid crystals	used in pesticides
	colourless liquid	derived from fermentation of sugar; used as solvent or fuel; found in wine
	colourless, flammable gas with a sweetish smell	made from petroleum; used in manufacture of ethanol and other organic chemicals
	greenish yellow gas	similar to chlorine
	shiny, yellow solid	very soft metal; highly resistant to tarnishing
	white solid	simple sugar; human body converts most sugars and starches to glucose
	nonflammable inert gas	used as refrigerant; provides inert atmosphere for welding; used to fill air ships and balloons
	rusty red colour	found in iron ore; rusty iron

Name	Formula	Melting point (°C)	Boiling point (°C)	Density (g/cm^3 or g/mL)	
hydrochloric acid (*)	HCl	varies	varies	varies	
hydrogen (e)	H_2	–259	–253	much less dense than air	
hydrogen peroxide (c)	H_2O_2	–0.4	150.2	1.45	
iodine (e)	I	114	184	4.95	
iron (e)	Fe	1535	2861	7.86	
lead (e)	Pb	327.4	1750	11.34	
lead (II) nitrate (c)	$Pb(NO_3)_2$	—	—	—	
limestone (see calcium carbonate)					
lithium (e)	Li	179	1340	0.534	
magnesium (e)	Mg	651	1107	1.74	
magnesium chloride (c)	$MgCl_2$	708	1412	2.3	
magnetite (c)	Fe_3O_4	—	—	5.18	
manganese (e)	Mn	1246	2061	7.43	
mercury (e)	Hg	–38.9	356.6	13.6	
methane (c)	CH_4	–182.5	–161.5	—	
molybdenum (e)	Mo	2623	4679	10.28	
neon (e)	Ne	–248	–246	—	
nickel (e)	Ni	1455	2913	8.90	
nitrogen (e)	N_2	–209.9	–195.8	slightly less dense than air	
nitrogen dioxide (c)	NO_2	—	—	—	
oxygen (e)	O_2	–218	–183	slightly denser than air	
ozone (e)	O_3	–192.5	–112	denser than air	
phosphorus (e)	P	44 —	280 —	1.82 (white) 2.20 (red)	
platinum (e)	Pt	1769	3824	21.41	
polyethylene (polythene) (c)	$(C_2H_4)_n$	—	—	—	
potassium (e)	K	63.5	759	0.86	
propane (c)	C_3H_8	—	–42.17	—	
selenium (e)	Se	217	684.9	4.81	
silicon (e)	Si	1410	3265	2.33	
silicon dioxide (silica) (c)	SiO_2	1600	—	—	
silver (e)	Ag	961	2212	10.5	
sodium (e)	Na	97.5	892	0.971	
sodium chloride (table salt) (c)	NaCl	801	1465	2.16	
sodium fluoride (c)	NaF	988	1695	2.56	
steel (n)	varies	varies	varies	varies	
strontium (e)	Sr	777	1412	2.6	
sucrose (sugar) (c)	$C_{12}H_{22}O_{11}$	170	decomposes at 186°C	1.59	
sulfur (brimstone) (e)	S	112.8	444.6	2.07	
technetium (e)	Tc	2157	4265	11.5	
tellurium (e)	Te	450	990	6.25	
tin (e)	Sn	231.9	2602	7.31	
titanium (e)	Ti	1666	3287	4.5	
tungsten (e)	W	3422	5555	19.25	
uranium (e)	U	1130	4131	19.05	
water (c)	H_2O	0	100	1.00	
xenon (e)	Xe	–111.9	–107.1	—	
zinc (e)	Zn	419	907	7.14	
zirconium (e)	Zr	1852	4400	6.51	

	Appearance (at room temperature: 20°C)	Comments
	colourless liquid	corrosive acid; properties vary according to concentration
	colourless gas	highly flammable; liquid form is used as rocket fuel
	colourless liquid	thick and syrupy when pure; an antiseptic
	violet-black, solid crystals	crystals sublime readily to form poisonous violet vapour
	shiny, silver solid	rusts readily; soft when pure
	shiny, blue-white solid	soft metal; forms poisonous compounds
	white or colourless crystals	easily decomposed by heat; soluble in water
	silver-white metal (least dense solid known)	used in alloys; its salts have various medical uses
	light, silvery white metal that tarnishes easily in air	used in alloys, photography; compounds used in medicine; essential to life
	white, deliquescent substance	
	shiny, black crystalline solid	strongly magnetic
	grey-white solid	used in alloys with special magnetic properties
	shiny, silvery liquid	only liquid metal; forms poisonous compounds
	odourless, flammable gas formed from decaying organic matter	main constituent in natural gas
	silver-white solid	used in high-strength steel alloys
	colourless, odourless gas	discharge of electricity at low pressures through neon produces an intense orange-red glow
	silvery white, magnetic metal that resists corrosion	used for nickel plating, coinage, in alloys, and as a catalyst
	colourless gas	will not burn or support burning; makes up 80 percent of air
	brown gas	causes reddish brown colour in smog
	colourless gas	must be present for burning to take place; makes up 20 percent of air
	bluish gas	used for purifying air and water and in bleaching; atmospheric layer blocks most of Sun's ultraviolet light
	dark red powder white, waxy, luminous in the dark	highly poisonous, flammable nonpoisonous, less flammable; compounds used in fertilizers and detergents; occurs only in combined state, mainly calcium phosphate $Ca_3(PO_4)_2$; essential to life
	silver-white solid	used in jewellery; alloyed with cobalt, used in pacemakers
	tough, waxy, thermoplastic material	polymer of ethylene; used as insulating material; flexible and chemically resistant
	silvery white, soft, highly reactive, alkali metal	essential to all life; found in all living matter; salts used in fertilizers
	colourless gas	flammable; used as fuel
	non-metal resembling sulfur; silvery grey, crystalline solid	used in manufacture of rubber and ruby glass; used in photoelectric cells and semiconductors
	steel-grey metalloid similar to carbon in its chemical properties	used in pure form in semiconductors and alloys and in the form of silicates in glass
	hard, granular powder; insoluble in water	main constituent of sand; used in clocks and watches as quartz
	shiny, white solid	soft metal; best known conductor of electricity
	soft, silvery-white metal; very reactive	used in preparation of organic compounds, as coolant, and in some types of nuclear reactors
	white, crystalline solid	used to season or preserve foods
	colorless, crystalline substance	used in water fluoridation and as an insecticide
	metallic grey solid	alloys of iron with carbon and other elements; widely used as structural materials
	silver-white solid	used in the manufacture of colour television tubes
	white solid	made from sugar cane or sugar beets
	yellow solid	used to make dyes, pesticides, and other chemicals
	silver-grey solid	used in gamma ray diagnosis of bone abnormalities
	silver-white solid	used in semiconductors
	shiny, slightly yellow solid	soft metal; rust resistant
	lustrous white solid	alloys are widely used in the aerospace industry
	grey-white solid	used in light bulb filaments
	metallic grey solid	used as a nuclear fuel (usually converted into plutonium)
	colourless liquid	good solvent for non-greasy matter
	inert gas	used in fluorescent tubes and light bulbs
	hard, bluish-white metal	used in alloys such as brass and galvanized iron
	silver-white solid	used in the chemical industry as anti-corrosive material