

group 1
period 1

1 **H**
Rocket fuel, fuel cell (car), H-H battery, Hydrogen bonds of the DNA double helix, Water, sulfuric acid, citric acid, amino acid, MRI diagnosis, the first antineutrino, anti-hydrogen.
1 Hydrogen 1.008

2 **Li**
Lithium ion secondary battery (electric vehicle, smartphone, drone etc.), Lightweight Li alloys used in aircraft construction, Lithium carbonate in medication for manic depression.
3 Lithium 6.941

3 **Na**
Salt NaCl is the main component of sea water, Na lamps inside tunnels, Na/S storage battery, Silver colored metal, reacts vigorously with water, Baking powder (sodium bicarbonate).
11 Sodium 22.99

4 **K**
One of three components of fertilizers, Seed crystals for artificial rain (KCl), Rock dating method (K-Ar method), Emergency oxygen generating agent (KO₂).
19 Potassium 39.10

5 **Rb**
Removes residual oxygen in vacuum tubes, Rubidium atomic clock (0.1 second error per year), Dating method for meteorites and rocks (Rb-Sr method).
37 Rubidium 85.47

6 **Cs**
Standard for the unit of "second" (1967), Cesium clock used in global positioning systems (GPS) (1 second error per 300 thousand years), Radiation measurement and medical diagnosis.
55 Cesium 132.9

7 **Fr**
Discovered by Marguerite Perey in the Curie Institute and named after her birth country, France. The last element discovered from nature in 1939.
87 Francium (223)

8 **C**
typical applications
gas
liquid
solid
unknown
atomic number
element name
6 Carbon 12.01

2 **Be**
A component of emerald (berthstone for May), Parts of strong spring machines (Be alloys), Material used for X-ray windows, Am-Be neutron source for research.
4 Beryllium 9.012

12 **Mg**
Exists within chlorophyll, Component of bitter (magnesium chloride), Lightweight alloys material used in cars and airplanes, Advanced reagents for organic synthesis.
12 Magnesium 24.31

20 **Ca**
Main component of bones, Osteoporosis may result if deficient, The main component of marble, gypsum and cement, Limestone caves, coral reefs.
20 Calcium 40.08

38 **Sr**
Fireworks and warning signal light (scarlet), Radioactive isotopes used as pain reliever for bone tumors, Optical lattice clock (1 second error per 50 billion years).
38 Strontium 87.62

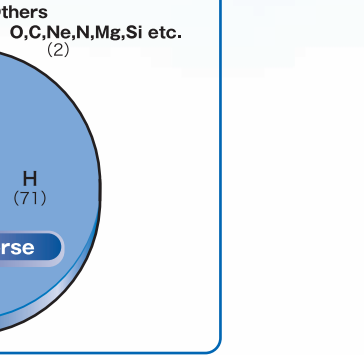
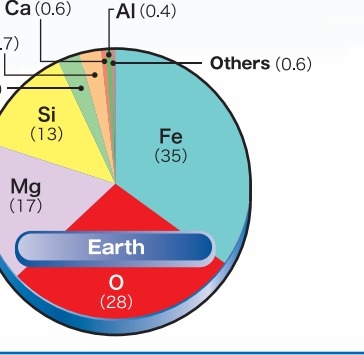
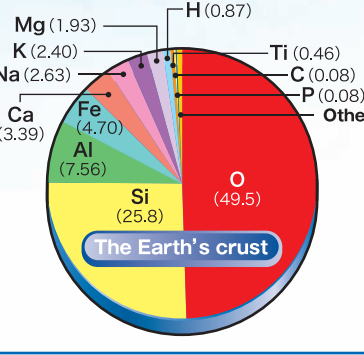
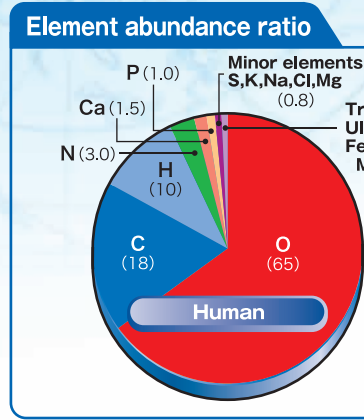
56 **Ba**
Contrast medium for X-ray diagnosis of digestive organs (barium sulfate), Lubricant for oil mining machine, Green component in fireworks, Phosphor for liquid crystal display (blue).
56 Barium 137.3

88 **Ra**
Discovered by the Curies, Pierre and Marie, in 1898. Derived from the Latin word *radius* (radiation). One of the rarest elements in the crust, like Po, Ac, Rn, etc.
88 Radium (226)

89 **Ac**
Discovered from pitchblende in 1898. Derived from the Greek word *actis* (radiation). Used as a neutron source.
89 Actinium (227)

Periodic Table of the Elements

Nature and life are written in the symbols of the elements



13 **B**
Heat-resistant glass, glass fiber, Boronic acid balls, extensoring cockroaches, Neutron capture therapy for brain tumors, Boron nitride is hard like diamond.
5 Boron 10.81

14 **C**
Essential element for living organisms, Plastic, rubber, synthetic fibers, carbon fibers, Diamond, carbon nanotubes, fullerenes, Pencil, ink stick, charcoal (water purifiers, deodorants).
6 Carbon 12.01

15 **N**
Makes up about 78% of volume of air, One of the three components in fertilizers, Ammonia, amino acids, protein, DNA, RNA, an excellent coolant (~-196 °C).
7 Nitrogen 14.01

16 **O**
Makes up about 21% of volume of air, Oxygen on earth is produced through photosynthesis, Essential for combustion and biological respiration, Ozone (O₃) blocks UV rays.
8 Oxygen 16.00

17 **F**
Fluoro-resin is heat resistant and resists water and oil, Decay preventing toothpaste, Hydrogen fluoride dissolves glass, Some fluorocarbons destroy the ozone layer.
9 Fluorine 19.00

18 **Ne**
Neon signs, Medium for laser light generation, Neon tubes are used in lighting towers, Noble gas abundant next to Ar in the air.
10 Neon 20.18

13 **Al**
Aluminum foil, aluminum can, aluminum sash, The main component of alum, Gastric medicine (aluminum hydroxide gel), Sapphire is Al₂O₃ containing metals.
13 Aluminum 26.98

14 **Si**
A leading semiconductor, solar cells, Main component of sand, glass and cement, Silicone (oil, rubber, resin), Optical fiber (SiO₂).
14 Silicon 28.09

15 **P**
Source of energy for living organisms, Components of DNA, RNA and ATP, One of the three components of fertilizers, Calcium phosphate is a component of bone.
15 Phosphorus 30.97

16 **S**
Natural rubber additives to increase elasticity, The main component of neutral detergents, Sulfur smelt in hot spas, garlic and onions, S-containing methionine is an essential amino acid.
16 Sulfur 32.07

17 **Cl**
Bleach (sodium hypochlorite), PVC pipe (polyvinyl chloride), Dry cleaning detergents, Component of salt, HCl is a component of gastric acid.
17 Chlorine 35.45

18 **Ar**
Making up about 1% of the volume of air, Antioxidant gas during welding, Light bulb and fluorescent lamp filled with argon, Ar laser for medical use (retinal detachment surgery).
18 Argon 39.95

19 **K**
One of three components of fertilizers, Seed crystals for artificial rain (KCl), Rock dating method (K-Ar method), Emergency oxygen generating agent (KO₂).
19 Potassium 39.10

20 **Ca**
Main component of bones, Osteoporosis may result if deficient, The main component of marble, gypsum and cement, Limestone caves, coral reefs.
20 Calcium 40.08

21 **Sc**
Lighting for outdoor sports, Light weight frame for racing bicycles, Germicidal promoter (H₂O solution of sulfuric acid salt), Component of reinforced alloys used in aircrafts.
21 Scandium 44.96

22 **Ti**
TiO₂ is a photo-catalyst and white pigment, Artificial bone (non-toxic), Polymerization catalyst for ethylene and propylene, BaTiO₃ is an advanced capacitor material.
22 Titanium 47.87

23 **V**
Vanadium steel is used in hard tools, Oxidation catalyst for preparation of sulfuric acid, Reduces blood sugar, Contained in some types of mushrooms and sea squirts.
23 Vanadium 50.94

24 **Cr**
Chrome plating (brilliant luster), Stainless steel (Cr-Ni-Fe alloys), Nichrome wire for electrical heaters, Colored component of ruby (Cr-containing Al₂O₃).
24 Chromium 52.00

25 **Mn**
Impact resistant manganese steel, Manganese ore, Manganese nodules in the ocean floor, Excessive intake enlarges thyroid glands.
25 Manganese 54.94

26 **Fe**
Structural material for buildings, cars, ships, etc., Magnetic metal, Hemoglobin containing Fe carries oxygen, Magnetic tapes, disc, and ticket.
26 Iron 55.85

27 **Co**
Perpendicular magnetic recording hard disks (Co-Cr alloys), The central atom of vitamin B₁₂ molecule, K₂ magnetic steel, Blue pigment (cobalt blue).
27 Cobalt 58.93

28 **Ni**
Turbine wings for jets (Ni superalloys), NiChrome wire for electric heaters, NiCd batteries, Shape memory alloys (Ti-Ni alloys).
28 Nickel 58.69

29 **Cu**
High-temperature superconductors are copper oxide, Transmits electricity and heat well (electric wire or pans), The main component of bronze or brass, Respiration pigments of pawns, octopus and squid.
29 Copper 63.55

30 **Zn**
Brass (Cu-Zn alloys), ZnO as white paint and ointment, Galvanized iron sheet (Zn-plating), Essential in coffee for sensing taste.
30 Zinc 65.38

31 **Ga**
GaAs semiconductors (blue light emitting diode, LED light bulb), Laser for Blu-ray Disc semiconductors (mobile phones etc.), Metal with low melting point (29.8 °C).
31 Gallium 69.72

32 **Ge**
Early stage semiconductor material, Realized the first transistor radio, Infrared lens or prism, Increases the refraction index of optical fibers.
32 Germanium 72.63

33 **As**
Materials for semiconductors (GaAs, InAs etc.), Barcode readers, Trace constituents in sea weeds (Hijiki), oysters etc., Medicine for a type of leukemia (As₂O₃).
33 Arsenic 74.92

34 **Se**
Optical imaging tube for night-vision cameras, Raw material for shielding glass, Bio essential trace element, Japan is the biggest producer in the world.
34 Selenium 78.97

35 **Br**
Bromide photos (after light-sensitive silver bromide), Component of emper purple dye (Tyrian purple), Red liquid under normal temperature (melting points -7.2 °C).
35 Bromine 79.90

36 **Kr**
Derived from Greek meaning "a hidden item", One of the rarest gases on earth, Bright krypton light bulb, Inhibits makes the voice low.
36 Krypton 83.80

37 **Rb**
Removes residual oxygen in vacuum tubes, Rubidium atomic clock (0.1 second error per year), Dating method for meteorites and rocks (Rb-Sr method).
37 Rubidium 85.47

38 **Sr**
Fireworks and warning signal light (scarlet), Radioactive isotopes used as pain reliever for bone tumors, Optical lattice clock (1 second error per 50 billion years).
38 Strontium 87.62

39 **Y**
Powerful YAG (Y-Al garnet) solid-state laser, Y-Fe garnet is a magneto-optical material, Phosphor for liquid crystal display.
39 Yttrium 88.91

40 **Zr**
Strong ceramics, Used in the tip of the space shuttle, Imitation diamond (zirconia).
40 Zirconium 91.22

41 **Nb**
Nb-Ti alloys superconducting magnet coils (linear motor vehicles and maglev), Active center of several nitrogen fixation enzymes (Rhizobia of leguminous plants), Ultra-thin glasses (Nb-containing glass with high refractive index), Heat-resistant alloys (aircraft engines).
41 Niobium 92.91

42 **Mo**
Solid lubricant for bearings (MoS₂), Active center of several nitrogen fixation enzymes (Rhizobia of leguminous plants), Ultra-thin glasses (Nb-containing glass with high refractive index), Heat-resistant alloys (aircraft engines).
42 Molybdenum 95.95

43 **Tc**
The first artificially produced radioactive element (1937), Derived from Greek *technetium* meaning man-made, glasses (Nb-containing glass with high refractive index), Heat-resistant alloys (aircraft engines).
43 Technetium (99)

44 **Ru**
Hydrogenation catalyst, carbon monoxide synthesis and cross-coupling, Increases the storage capacity of hard disk, Electronic catalysts, resistors, pen tips, Electrodes for fuel cells (chlorine production).
44 Ruthenium 101.1

45 **Rh**
Automotive exhaust gas purification catalyst, Hydrogenation catalyst, catalyst for synthesis of acetic acid, Surface Rh plating of silver ornaments.
45 Rhodium 102.9

46 **Pd**
Catalysts for hydrogenation, acetylene synthesis and cross-coupling, Stores 900 times its volume of hydrogen, Automotive exhaust gas purification catalyst.
46 Palladium 106.4

47 **Ag**
Photographic films, printing paper (AgBr, AgI), Silver coins, tableware, ornaments, backing of mirrors, Alloys for dental treatment, Silver ion has antibacterial and deodorant properties.
47 Silver 107.9

48 **Cd**
NiCd batteries, Cadmium yellow pigment (CdS), Radiation detector (CdTe), Itai-itai disease is Cd poisoning.
48 Cadmium 112.4

49 **In**
Transparent conductive film in liquid crystal display, KCD semiconductors realized energy-saving displays, Semiconductor for infrared detectors, Radiosensors are medical diagnostic agents.
49 Indium 114.8

50 **Sn**
Tin-plated steel plate, The main component of solder, Bronze (Cu-Sn alloys), Tin tableware and pipe organ.
50 Tin 118.7

51 **Sb**
Sb-Pb alloys used as type fonts, Antimony oxide is a flame-retardant promoter for plastics, curtains, and mattresses, Semiconductor, DVD/R laser diode for scanner heads etc.
51 Antimony 121.8

52 **Te**
DVD/Blu-ray disk (Ge-Sb-Te media crystallized by laser-light), Used as type fonts, Tin tableware and pipe organ.
52 Tellurium 127.6

53 **I**
Mouthwash and disinfectants, Chiba prefecture in Japan is the world's number two producer, Iodine-starch reaction, Blue-violet, Accumulates in the thyroid gland.
53 Iodine 126.9

54 **Xe**
Ion engine for deep space exploration machine, Synthes for high-speed photography, Filler gas for plasma display panel (PDP).
54 Xenon 131.3

55 **Cs**
Standard for the unit of "second" (1967), Cesium clock used in global positioning systems (GPS) (1 second error per 300 thousand years), Radiation measurement and medical diagnosis.
55 Cesium 132.9

56 **Ba**
Contrast medium for X-ray diagnosis of digestive organs (barium sulfate), Lubricant for oil mining machine, Green component in fireworks, Phosphor for liquid crystal display (blue).
56 Barium 137.3

57 **La**
Fifteen elements from 57 to 71 have similar chemical properties and are called lanthanoids. Seventeen elements added the 3rd Group elements Sc and Y are collectively referred to rare earth elements.
57 Lanthanum 138.9

58 **Ce**
Yellow phosphor for LED light bulbs, Green phosphor for liquid crystal display, UV cut glass, polish for glass, Cleaning device (ceramics) for automotive exhaust gases.
58 Cerium 140.1

59 **Pr**
Goggles for welding work, Yellow green glaze for pottery (pastel color), Glass coloring (yellow and green).
59 Praseodymium 140.9

60 **Nd**
The strongest neodymium magnet, Nd-Fe-B (electric vehicle motor, wind power generator, speakers, etc.), Nd-containing YAG laser (laser knife).
60 Neodymium 144.2

61 **Pm**
Artificial radioactive element made in a nuclear reactor (1940), Atomic battery (power source in deep space), Nd-containing YAG laser (laser knife).
61 Promethium (145)

62 **Sm**
High heat resistant samarium magnet (the first "WALKMAN" portable audio player (1979)), Dating method of ancient times, Named after the Russian mining engineer Samarsky.
62 Samarium 150.4

63 **Eu**
Red and blue phosphor for liquid crystal displays, Fluorescent labeling agent for immune response, Day-light colored fluorescent lamp, Named in honor of Europe.
63 Europium 152.0

64 **Gd**
Image enhancing agent for medical diagnostic MRI, Thermal neutron absorption (immature response, Day-light colored fluorescent lamp, Named in honor of Europe).
64 Gadolinium 157.3

65 **Tb**
The main element in materials that stretch and shrink under magnetic field (electric assisted bicycle), Luminescent paint combined with Eu, Metal-halide lamp for powerful light source.
65 Terbium 158.9

66 **Dy**
Essential element in heat-resistant Nd magnet (industrial robot arms etc.), Luminescent paint combined with Eu, Metal-halide lamp for powerful light source.
66 Dysprosium 162.5

67 **Ho**
Low heat-generating Ho laser for surgery (lithotripsy, prostatectomy), Coloring for artificial jewels (pink yellow).
67 Holmium 164.9

68 **Er**
Optical fiber amplifier for long-distance optical communication (connected between Kyushu and Okinawa (1993)), Medical laser, Protective goggles for lasers.
68 Erbium 167.3

69 **Tm**
Radiation dosimeter, Blue fluorescence (doped with zinc sulfide), Increases the transmission capacity of the Er-based optical fiber amplifier.
69 Thulium 168.9

70 **Yb**
Named after Ytterby village (Sweden) where four elements (Y, Tb, Er, Yb) were discovered, Glass coloring (yellow green).
70 Ytterbium 173.0

71 **Lu**
¹⁷⁶Lu half-life approx. 36-38 billion years) is used for dating (Lu-Hf method), Used in neutron detectors for PET diagnosis.
71 Lutetium 175.0

72 **Hf**
Zirconium and hafnium have similar chemical properties and are called hafnium. Seventeen elements added the 3rd Group elements Sc and Y are collectively referred to rare earth elements.
72 Hafnium 178.5

73 **Ta**
Dental implants material, Miniature large-capacity capacitor, Contrast agent for X-ray diagnosis, Miniature wave filter for mobile phones.
73 Tantalum 180.9

74 **W**
Filament for incandescent light bulbs, Has the highest melting point of all metals, Cemented carbide (WC-Co alloys) used in drills etc., X-ray shading apron.
74 Tungsten 183.8

75 **Re**
Sensor for high temperature (W-Re thermocouple over 2000°C), Filament for mass spectrometer, Materials for electrical connections such as switches.
75 Rhenium 186.2

76 **Os**
Tips of fountain pens (Re-Ir alloys), Osmium tetroxide OsO₄ is an oxidizing agent, oxidation catalyst and biological tissue fixative, Dating of meteorites (Re-Os method).
76 Osmium 190.2

77 **Ir**
Metals that deteriorate the least, Element concentrated locally by a giant meteorite that hit the earth (a cause of dinosaur extinction), The old metric prototype was Pt-Ir alloy.
77 Iridium 192.2

78 **Pt**
Materials for accessories or coins, Anticancer drugs (cisplatin), The past kilogram prototype (abolished in 2019).
78 Platinum 195.1

79 **Au**
Gold coins and ornaments, Electronic circuit elements, Glass coloring (red cut glass), Anti-rheumatic drugs (Au compounds).
79 Gold 197.0

80 **Hg**
Liquid metal (melting point -38.8°C), Makes alloys (amalgam) with various metals, Gold amalgam was used for gold plating of the Great Buddha of Nara in the mid 8th century, Minamata disease was caused by methylmercury poisoning.
80 Mercury 200.6

81 **Tl**
Radioisotope is used as myocardial diagnostic agents, Metal halogen lamp (green light, Pb-Sn alloys used as type fonts, Radiation shielding materials (lead glass)).
81 Thallium 204.4

82 **Pb**
Lead storage battery and car batteries, IC card or printing head component, Pb-Sn alloys used as type fonts, Radiation shielding materials (lead glass).
82 Lead 207.2

83 **Bi**
A key element for copper-oxide based high-temperature superconducting cables without transition metals, Practical thermoelectric conversion element (Bi₂Te₃ etc.), Low-melting alloys for solder heads etc.
83 Bismuth 208.9

84 **Po**
Discovered by the Curies, Pierre and Marie, in 1898. Named after her home country in Poland, Alpha-ray source and neutron source, Nuclear battery.
84 Polonium (210)

85 **At**
Derived from the Greek *astatos* meaning "unstable", Made artificially in a cyclotron (1940), Expected as a next generation anti-cancer drug using alpha rays.
85 Astatine (210)

86 **Rn**
The heaviest gas, Generated from radioactive Ra in small amounts, Used in gas-filled tubes, Synthes for high-speed photography, Filler gas for plasma display panel (PDP).
86 Radon (222)

87 **Fr**
Discovered by Marguerite Perey in the Curie Institute and named after her birth country, France. The last element discovered from nature in 1939.
87 Francium (223)

88 **Ra**
Discovered by the Curies, Pierre and Marie, in 1898. Derived from the Latin word *radius* (radiation). One of the rarest elements in the crust, like Po, Ac, Rn, etc.
88 Radium (226)

89 **Ac**
Discovered from pitchblende in 1898. Derived from the Greek word *actis* (radiation). Used as a neutron source.
89 Actinium (227)

90 **Th**
Th containing W in several % is an excellent arc welding electrode, ThO₂ is a thermally stable compound (melting point 3300°C).
90 Thorium 232.0

91 **Pa**
²³¹Pa is used for the dating of the manganese nodules (cf., Mn). Named to mean an element prior to actinium.
91 Protactinium 231.0

92 **U**
Enriched uranium ²³⁵U triggers nuclear fission chain reactions (nuclear power generation), Earth dating (U-Pb method), uranium glass.
92 Uranium 238.0

93 **Np**
The first artificial transuranic element (1940), Named after Neptune.
93 Neptunium (237)

94 **Pu**
Fuel for fast-breeder reactors, Nuclear battery (space ship), Named after Pluto.
94 Plutonium (239)

95 **Am**
²⁴¹Am was used in smoke-sensitive fire alarms and thickness meters, Composite with Be is a neutron source, Named in honor of America.
95 Americium (243)

96 **Cm**
Named after the Curies, Pierre and Marie, Made by colliding Pu with alpha particles.
96 Curium (247)

97 **Bk**
Made in a cyclotron at Berkeley, University of California.
97 Berkelium (247)

98 **Cf**
²⁵¹Cf is used as a neutron source by spontaneous fission for nuclear fuel enrichment measurement and non-destructive inspection.
98 Californium (252)

99 **Es**
Named after the physicist Albert Einstein.
99 Einsteinium (252)

100 **Fm**
Discovered by the Curies, Pierre and Marie, Made by colliding Pu with alpha particles.
100 Fermium (257)

101 **Md**
Named after Dmitri Mendeleev, the discoverer of the periodic law of the elements.
101 Mendelevium (258)

102 **No**
Named after Alfred Nobel who invented the dynamite and established the Nobel Prize.
102 Nobelium (259)

103 **Lr**
Named after Ernest Lawrence, the inventor of the cyclotron (1932).
103 Lawrencium (262)

One Periodic Table in Every Home

Science and Technology Week
http://stmw.mext.go.jp/
Production/Editor: Ministry of Education, Culture, Sports, Science and Technology, Japan (MEXT Japan).
Planning/Production: Kagaku-Doin Publishing Company, Inc., Kyoto, Japan.
First edition issued: March 26, 2006
11th edition issued: February 1, 2019
Translation: The Japan Foundation of Public Communication on Science and Technology (PCOST)

● Supervision: The Chemical Society of Japan,