The Building Blocks of Everything

THE WORLD ALMANAC

Elements are made up of atoms, which are made up of protons, neutrons, and electrons—which, in turn, are made up of even smaller particles. However, in day-to-day life, you will not encounter anything more basic than the elements. Everything you see, touch, taste, or even breathe is made up of the elements.

The elements are broken down into two categories: metals and non-metals. Examples of metals are iron (Fe), copper (Cu), and aluminum (Al); while examples of non-metals are hydrogen (H), helium (He), and oxygen (O). Elements are types of atoms—for example, hydrogen (the most common element in the universe) is hydrogen atoms. These atoms can bond together with each other, and most also bond in certain combinations with some other types of atoms. A couple of well-known examples of this are water, which is the combination of two hydrogen atoms with one oxygen atom (dihydrous oxide, or H_2O), and salt, which is the bonding together of one sodium and one chlorine atom (sodium chloride, or NaCl).

✧✧✧**It's a Fact!**✧✧✧

Not all of the elements on the periodic table seem to exist naturally in the universe. These are the *transuranium elements*, and they are all man-made. The first of these was rutherfordium (Rf), first created in 1964.

You may be at least somewhat familiar with the periodic table of elements. This was developed by Russian chemist Dmitry Mendeleyev. About half of the elements were known by then, but no one had been able to see any order. What scientists did see was that certain elements seemed to be naturally organized in groups that had similar types of chemical reactions. For example, they knew that lithium (Li), sodium (Na), and potassium (K) combined with other elements in pretty much the same way. What Mendeleyev saw while trying to group the elements together for a textbook he was writing was that, when you put all of the elements together, there is an overall pattern. In 1871 he published an improved version of his first periodic table, leaving blank spaces on this one where he believed there must be other elements to fill out these patterns. His table began to become accepted in 1879 when scandium (Sc) was discovered to fill exactly the blank space that Mendeleyev had left between calcium (Ca) and titanium (Ti).

Atoms are made up of three parts: protons and neutrons, which group together at the center of the atom to form its nucleus; and electrons, which move around the nucleus at different levels. It was later understood that the pattern of the elements is caused by the number of electrons in an atom, because each of these electron levels can have only a certain number of electrons in it. It is the space for other electrons that allows atoms to combine with other atoms—and that is why some kinds of elements act like other elements: because their electrons are laid out in the same way. You can see this on the periodic table by looking at the vertical columns. Notice how the numbers in the columns increase by the same amounts? Those numbers are how many electrons those atoms have. That's why these numbers are called the elements' *atomic numbers*.

Periodic Table of the Elements

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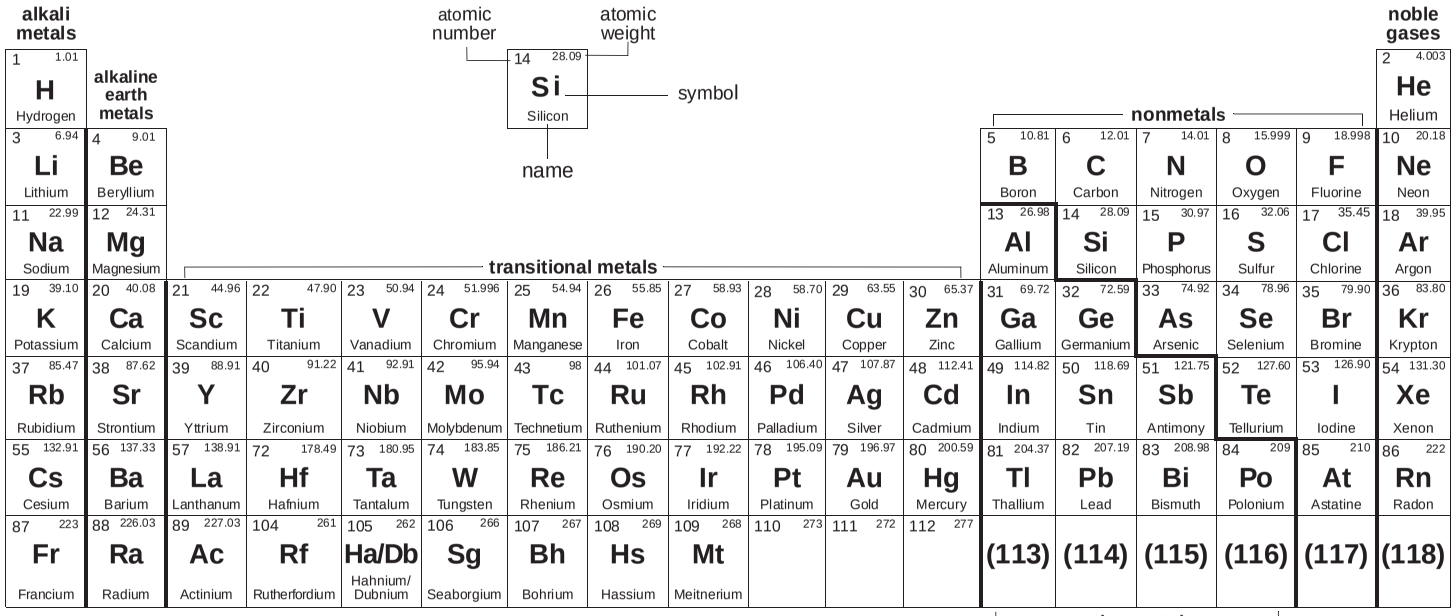
Parentheses indicate undiscovered elements.



Lanthanide series	58 140.12 Ce Cerium	59 140.91 Pr Praseodymium	60 144.24 Nd Neodymium	61 145 Pm Promethium	62 150.35 Sm Samarium	63 151.96 Eu Europium	64 157.25 Gd Gadolinium	65 158.93 Tb Terbium	66 162.50 Dy Dysprosium	67 164.93 Ho Holmium	68 167.26 Er Erbium	69 168.93 Tm Thulium	70 173.04 Yb Ytterbium	71 174.97 Lu Lutetium
Actinide series	90 232.04 Th Thorium	91 231.04 Pa Protactinium	92 238.03 U Uranium	93 237.05 Np Neptunium	94 244 Pu Plutonium	95 243 Am Americium	96 247 Cm Curium	97 247 Bk Berkelium	98 251 Cf Californium	99 252 Es Einsteinium	100 257 Fm Fermium	101 258 Md Mendelevium	102 259 No Nobelium	103 262 Lr Lawrencium

Questions to Ponder

1. What type of atoms is oxygen made up of?
2. In what century was the periodic table created?
3. We breathe in oxygen and breathe out carbon dioxide. What is the atomic make-up of carbon dioxide?
4. As you can see, on the periodic table there are blank spaces for elements 113–118, which are labeled "undiscovered elements." How can scientists be sure that elements go here if they haven't discovered them?
5. Look around you. Does it surprise you that everything—this paper and ink, what you ate for breakfast and what you're breathing now, your teacher and your eyes—is made up of fewer than 120 basic elements? Explain why it does or doesn't.

Answer Key *(cont.)*

3. There was a problem with its mirror that kept the images from being as good as they should have been; $3 billion
4. clear, able to be seen through

The Natural World

The Building Blocks of Everything (p. 30)

1. oxygen atoms
2. the 19th/the 1800s
3. one carbon atom with two oxygen atoms
4. because there are patterns in the atomic make-up of the elements, and so they know—as Mendeleyev was the first to realize—that there must be elements to complete the patterns

Not *the* Solar System, Just Ours (p. 32)

1. having to do with a sun
2. 102 moons
3. H (i.e., hydrogen)
4. Venus and Earth

It's About Where on Earth You Are (p. 33)

1. it's location (where it is)
2. a beach on the equator
3. The climate of an area has a lot to do with where on Earth a place is in relation to where the sun is.
4. yes, because then the equator would be a vertical zone running around the middle of the planet—and the north pole would be right on it

Waves of Energy (p. 34)

1. radio waves; gamma rays
2. no: visible light
3. The wavelength of infrared is beneath that of red visible light, and the wavelength of ultraviolet is beyond that of violet visible light. (Accept any phrasing that demonstrates an understanding of the basic idea.)
4. UV rays are ultraviolet radiation. UV rays have a wavelength longer X-Rays but shorter than visible light. (Accept any phrasing that demonstrates an understanding of the basic idea.)

Space Is Curved (p. 35)

1. gravity
2. that it is the curving of space caused by the mass of an object
3. a major advance or discovery
4. The farther you got away from Earth, the less gravity you would feel. This is because the space would be less and less curved by the Earth's mass as you got farther away.

Fire: What Is It? (p. 36)

1. by friction, by percussion, and by using a lens
2. anything that will burn (combustible material)
3. flint
4. that they were made to move so fast that they started breaking apart from each other

The Northern (and Southern) Lights (p. 37)

1. within 30 degrees latitude of each of the poles
2. the polar lights; a comet's tail
3. lights
4. It collides with gas particles in Earth's atmosphere, which excites them, causing them to give off light.

The Cheetah and the Snail (p. 38)

1. rabbits
2. 2.5 times
3. black mamba snake
4. b. 2,500 years

World Geography and Travel

Be a World Traveler (p.40)

1. 6,250 miles
2. 1 mile
3. 1,998 miles
4. Cairo

From Country to Country (p. 41)

1. A passport is a request from one government to allow the holder of the passport to travel safely through another country.
2. whenever you want to enter a foreign country that does not have a special agreement with your government allowing you to enter without a passport
3. permission from a foreign country to enter it (in the form of a stamp)
4. about 2,450 years

Why They're There (p. 42)

1. crustal uplift and volcanism
2. 19,195 feet
3. of or pertaining to the Earth
4. that they are part of the same mountain range

Country or Continent? (p. 43)

1. Jan. 1, 1901
2. Antarctica
3. 1,150
4. the Netherlands

World's Tallest Buildings (p. 44)

1. Sears Tower; Chicago, IL, U.S.
2. Commerzbank Tower; 981 feet; Frankfurt, Germany
3. Empire State Building; 1931; New York, NY, U.S.
4. 16.85 feet

Water Falls (p. 45)

1. erosion of the weaker part of a streambed
2. a cascade
3. two
4. You can't tell anything about its volume, except that it has some. This is because neither height nor location tell you anything about volume. The reason you know it has some volume is that, for it to be a waterfall, some amount of water must be flowing over the falls.

The Undersea Train (p. 46)

1. It runs between England and France underneath the English Channel.
2. 192 years
3. Eurotunnel
4. about 18 minutes

