ELEMENTS COLLECTOR

A digital companion to **The Elements**

Click here for sample content

ENTER

SCHOLASTIC discover more™

You might not be the first aspiring scientist to discover Earth's elements, but you can find most of them in everyday objects. Click a group and start collecting your own 3-D periodic table.

Periodic table complete collection

It's elemental!
Remember, you will rarely collect the elements in their eleme
but you will find things
compounds and alloys
in combination with ot

Click Noble Gases for sample content

How to use your digital book!

Click Metalloids for sample content

Alkali metals

Alkaline earth metals

Transition metals

Poor metals

Metalloids

Nonmetals

Halogens

Noble gases

Lanthanoids

Actinoids

Warning!
A few elements are dangerous or difficult to collect in any form. Watch out for these signs and find a photo to collect instead.

Silicon [Metalloids]

Click buttons and colored words for sample content

HOME

14
Si

Silicon chips—tiny electronic circuits printed on thin wafers of **silicon**—have been called the most important invention of modern times. Found inside everything from pocket calculators and cell phones to computer games and laptops, they have revolutionized the electronics industry and, with it, our work and leisure activities. Elsewhere in the home, silicones—**polymers** with a core of silicon and oxygen—have transformed kitchen equipment, including ice-cube trays, cake molds, and oven mitts. Silicon is also the main **semiconducting** material in **solar cells**, used in solar panels to turn sunlight into electricity.

Periodic table complete collection

More silicon things to collect

Countries where solar panels could be most effective

The efficiency of silicon solar cells depends on the amount of sunlight they can soak up. This map measures sunlight in each area to show the amount of energy that could be generated each day.

Average daily sunshine, measured in energy hours per 3.3 sq. ft. (1 sq. m.)

1.0–1.9 *2.0–2.9* *3.0–3.9*
4.0–4.9 *5.0–5.9* *6.0–6.9*

Click here for sample content

Nonstick molds made of silicone are an alternative to metal and paper bakeware. Unlike the silicon used for wafers, which is brittle, silicone is rubberlike and flexible.

Silicones used in bakeware are made from silicon and other chemicals. Silicones can be formed into anything from runny liquids to flexible solids, such as these cupcake molds.

Silicone products can handle temperatures from freezing to 500°F (260°C) without melting, cracking, or losing their shape.

Collect more metalloids

Silicon

Silicon is the second-most abundant element in our planet's crust. Oxygen (47.3 percent) and silicon (27.7 percent) make up three-fourths of Earth's crust. Most of the crust's silicon exists as silicon dioxide, or silica; we are familiar with this as sand or quartz. Silica sand is quarried from pits and then undergoes a refining process. Although silicon can be prepared in several ways, it is generally made commercially by heating silicon dioxide in an electric furnace.

Silicon of ordinary purity is used in alloys, which the element forms with most metals. Such alloys include ferrosilicon, used to make very resistant silicon steel and silicon copper, and combined with tin to make the silicon bronze used in telephone and telegraph wires. Silicon is also combined with certain ceramic materials to make cermets (ceramics mixed with metals) and other heat-resistant materials.

The silicon used in silicon chips for the electronics industry has to be exceptionally pure and clean, and it is further refined in dust-free conditions. The lowest acceptable purity for electronics-grade silicon is 99.9999999 percent. Along with elements such as boron, gallium, phosphorus, and arsenic, it is used to make transistors and other semiconductors for use in anything from video games to cars.

A strand of silicon fiber can transmit

trillions

of bits of information a second

More silicon things to collect

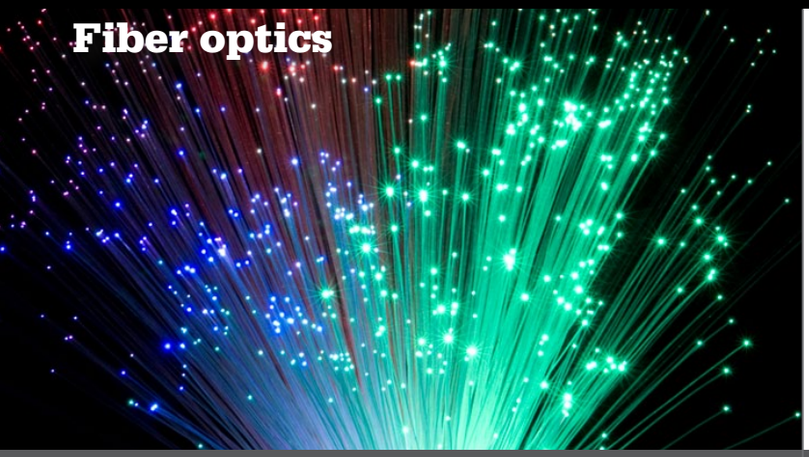
Silicon is the most common metalloid and the second-most abundant element in Earth's crust, making up 27.7 percent of it. Most of this is found as silicon dioxide, or silica, which we usually see as sand or quartz. Silica is used to make glass and ceramics, in food (to keep it from sticking together), in cosmetics, and in computing. Silicones—made from silicon and oxygen, along with carbon, hydrogen, and other chemicals—are flexible materials used to create everything from swimming caps to computer accessories.

Click here for sample content

Periodic table complete collection

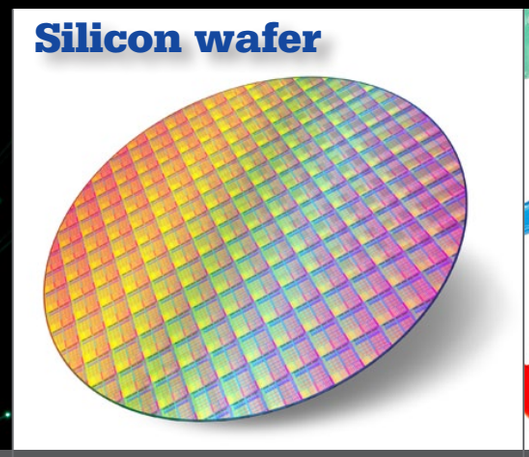
Collect more metalloids

Fiber optics



Thin fibers of pure silica glass, only slightly wider than strands of hair, carry information coded in beams of light. They can carry telephone calls, and the messages and images we send over the Internet.

Silicon wafer



The back of a silicon wafer is pure silicon. On the top, millions of microscopic **transistors** make up a thousand computer microchips.

Gel sticker

Silicones belong to a large family of polymers. Some are rubbery solids, and some are fluid gels, like the gel contained in these stickers.

Sand

Silica is a component of sand, but unlike the sand on beaches, which is mixed with other minerals, the silica sand used in the manufacture of silicon chips is purer and paler and has to be dug from deep pits.

Swimming goggles

Silicone is so tough that despite frequent contact with water and cold temperatures, it will not crack or break.

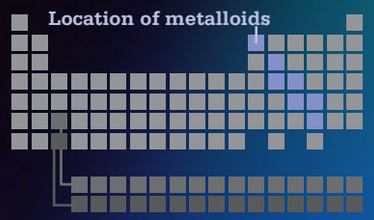
Wristband

To create wristbands, raw silicone material is inserted into metal molds engraved with inscriptions, then heated to 392°F (200°C).

Games controller cover

As well as being flexible and easy to mold, silicone rubber has antidust and nonslip properties that are especially useful for protecting electronics products.

Metalloids [The techy team]



The metalloids—boron, silicon, germanium, arsenic, antimony, tellurium, and polonium—all show some characteristics of metals and some of nonmetals. All of them are semiconductors, so they are useful in creating electronics products. Germanium, antimony, and tellurium are used together to create memory chips. Germanium, like silicon, is used in solar cells, and it is often added to metals to create coins and medals.

Click here to go back

HOME

5 B Boron

Cleaning liquid
Boron, mixed with other chemicals, is widely used in detergents, disinfectants, and other household cleaning products.

32 Ge Germanium

Camera lens
Glass containing germanium dioxide is used in specialized camera equipment, from night-vision lenses to wide-angle lenses.

51 Sb Antimony

Printing
Antimony is used in inks; when blended with tin and lead, it also becomes an alloy used for making type letters.

52 Te Tellurium

Colored glass
Tellurium is used to create tinted glass, like the kind found in some car windshields, and to color ceramics.

84 Po Polonium

Antistatic brush
Radioactive polonium is rarely used, except in antistatic brushes that clean dust off reels of film.

33 As Arsenic

Light-emitting diode
Arsenic is used as a semiconductor inside light-emitting diodes (LEDs), tiny lightbulbs that fit into electrical circuits. They do not get hot (like traditional lightbulbs do), so they can be used in electronics equipment from thin TVs to watches.

Solar cell

A solar, or photovoltaic, cell is a device designed to convert the energy in sunlight into electricity to provide a reliable and environmentally friendly source of energy. Single solar cells are connected together into solar panels, used to provide power for larger objects. Wires attached to the cells gather the electricity, which may be stored in batteries for later use. Most solar cells use silicon as the main semiconducting material that harnesses the Sun's rays, but other elements—including gallium, copper, indium, selenium, and cadmium—can also be used.

Solar cells are used in many products. Single solar cells provide power for wristwatches and handheld calculators. Larger cells are installed in road signs, streetlights, boats, homes, and businesses. Some companies build solar arrays (collections of panels) on rooftops and south-facing walls or as thin layers on window glass to boost their energy supply. More powerful, multiple-panel arrays are used mainly to provide power in remote places, such as oil-drilling platforms, where the alternative—laying long-distance power lines supplied by power plants—is too expensive. Once the equipment is installed, solar energy is free to use and is a renewable source of power that will not run out, unlike traditional electricity, which relies on fossil fuels such as coal, oil, and natural gas.

Enough sunlight falls on Earth in

60 minutes

to meet all the world's energy needs for a whole year!

More silicon things to collect

Transistor

A transistor is a small electronic amplifying device (something that can increase or decrease the power of a force or signal) made from a wafer of semiconducting material, usually silicon or germanium. It acts as a switch, controlling the flow of electrical current in a computer chip. Silicon transistors today are made as parts of integrated circuits (silicon chips) that consist of many transistors and the connections between them.

Since the late 1940s, transistors have transformed electronic equipment, including radios, television receivers, home sound systems, and computers, enabling far slimmer and smaller electronics devices to be built over the years. Millions of tiny transistors may be used in a single computer, saving space and power and reducing heat output.

Because of its small size, the transistor is essential in such miniature devices as hearing aids and heart pacemakers, as well as MP3 players and handheld calculators. Researchers are developing transistors so tiny that about 200 million of them could fit on the head of a pin.

It is estimated that more than 10,000,000,000,000,000,000 transistors are made a year!

polymer *noun*

A polymer is any one of a large number of natural or synthetic (man-made) chemical compounds made up of many molecules strung together to form long chains, and sometimes more complicated structures.

Plastics such as polystyrene and polyethylene are polymers, as are silicones. Many of the things you use every day are made of them. Athletic shoes have polymers in their soles, their fabric, and their gel insoles. “Smart” polymers, developed by scientists, are used in construction, firefighting, and the textile industry.

14
Si

Silicon chips—tiny electronic circuits printed on thin wafers

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Silicon
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semiconductor *noun*

A semiconductor is a substance, such as silicon, that conducts electricity more easily than an insulator (such as rubber) but less easily than a conductor (such as metal).

Silicon is one of the few elements (along with fellow metalloid germanium) that can be made to act as a semiconductor. In pure form, it will not conduct electricity, but if impurities are introduced, it becomes a conductor. The careful placement of impurities in a chip of silicon can produce a circuit of electronic components.

Count

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Average daily sunshine, measured in energy hours per 3.3 sq. ft. (1 sq. m.)

1.0–1.9 *2.0–2.9* *3.0–3.9*
4.0–4.9 *5.0–5.9* *6.0–6.9*

Silicone products can handle temperatures from freezing to 500°F (260°C) without melting, cracking, or losing their shape.

silicon chip *noun*

A silicon chip, or microchip, is an integrated circuit used in electronic equipment that acts like a miniature brain. The miniaturized circuit is etched on a thin wafer of pure silicon and can contain millions of components. A chip is less than 0.2 square inches (1 sq. cm.) in area and just 0.02 inches (0.5 mm) thick, and it can hold more than 20 layers of complex circuit lines and transistors.

Around 1,000 chips are created on one circular wafer. The wafer is then separated into individual integrated circuits, which are tested and surrounded by protective plastic, ceramic, or metal.

Helium [Noble gases]

Click buttons and colored words for sample content

HOME

2
He

Helium is the first member of the group of **inert gases** (also known as noble or rare gases). It is colorless and nontoxic, so it is commonly used for filling balloons used at parties, as well as weather balloons, **airships**, and the **blimps** you see at sports events. It has the lowest melting point of any element and is widely used in **cryogenics**—the study of things at very low **temperatures**—and in refrigeration.

Liquid helium has strange effects on some materials—they lose their **electrical resistance** when they are cooled with it, so liquid helium is useful for creating powerful magnets that can be used in machinery.

Latex (from rubber trees) is used to create most balloons because it is elastic and can expand to take any volume of helium. Foil balloons are less stretchy but longer lasting.

Click here to return to the contents

Party balloons filled with helium gas will rise because the gas is about seven times lighter (less dense) than air.

A popped balloon makes a bang—that is the sound of the gas escaping into the air. Helium is the most unreactive of the elements, so it does not explode.

Periodic table complete collection

How long helium balloons stay up

Helium-filled balloons can stay up from 12 hours to 14 days, depending on size, material, and atmospheric conditions. A weather balloon reaches a height of up to 70,000 feet (21,336 m), then the balloon bursts.

Type	Size	Duration
1 *Foil*	*3 ft. (0.9 m)*	*14+ days*
2 *Foil*	*1.5 ft. (0.5 m)*	*8–11 days*
3 *Latex/rubber*	*16 in. (40.5 cm)*	*24–36 hours*
4 *Latex/rubber*	*11 in. (27.5 cm)*	*12–18 hours*
5 *Weather balloon*	*5 ft. (1.7 m)*	*2 hours*

Click here for sample content

Collect more noble gases

Helium

The name *helium* is derived from the Greek *helios*, meaning "sun," because it was first observed during an 1868 solar eclipse by French astronomer Pierre Janssen. It was isolated on Earth in 1895.

Since helium is an inert gas and not toxic, a mixture of 80 percent helium and 20 percent oxygen is used in a deep-sea diver's breathing tank. When ordinary air is used alone, the diver's body uses the oxygen in the air, but nitrogen builds up, forming nitrogen gas bubbles in the blood (causing a sickness known as the bends). Because helium is less soluble in the human bloodstream than nitrogen is, a helium and oxygen breathing mixture helps prevent the bends.

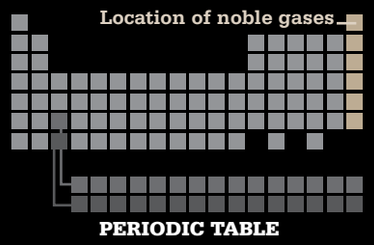
Apart from its use in balloons, helium is used in industry to help grow crystals of silicon and germanium, and to produce titanium and zirconium. It is a cooling medium for nuclear reactors, and it is used as a gas for supersonic wind tunnels. Helium is a relatively rare and expensive natural resource. Its principal source is natural gas wells, where it is extracted from the crude natural gas stream and purified. This is stored and shipped as either a gas or a cryogenic liquid. Many deposits will be used up early this century.

A British man reached a height of

11,000 feet (3,352 m)

strapped to 600 helium balloons

Noble gases [The bright team]



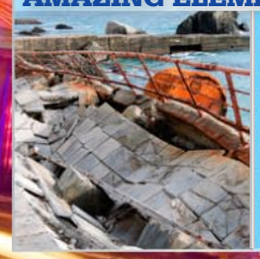
Five of the noble gases—helium, neon, argon, krypton, and xenon—are often seen as bright lights. Neon and argon are the two main gases used in illuminated signs. You can usually tell them apart by the color of the light: Neon is very bright and gives off a red glow, while argon emits a weaker light but can be yellow, blue, green, or purple. They can be mixed with other gases to create other shades. Krypton, on the other hand, does an important invisible job—it is used to detect gas leaks. Radon, the sixth noble gas, is used mainly in scientific equipment.

Periodic table complete collection

10 Ne Neon

Glowing light
Whenever you see a glowing red sign you are probably looking at neon. Neon advertising signs are glass tubes filled with neon gas with an electrical current running through them.

AMAZING ELEMENTS



Predicting earthquakes 86 Rn
Scientists monitor radon levels in groundwater in an effort to predict earthquakes, since radon emissions increase just before an earthquake. Look up more earthquake facts to add to your collection!

18 Ar Argon

Car lightbulb
Bluish argon headlights, called High Intensity Discharge (HID) lamps, are brighter than the usual halogen bulbs.

18 Ar Argon

Prepackaged food
Scientists have found that using argon to fill space inside plastic packs keeps salads and chips fresher.

54 Xe Xenon

Plasma TV
Xenon (and neon) gas is used in a plasma TV, contained in thousands of tiny cells positioned between two plates of glass.

10 Ne Neon

Clock face
Numbers and hands on clock faces that light up in the dark are usually filled with neon or argon gas.

36 Kr Krypton

Krypton flashlight
Krypton-bulb flashlights cast a light that is usually warmer, or more yellow in color, than that of LED flashlights.

54 Xe Xenon

Film projector
Xenon bulbs are the most commonly used lamps in electrical products. For example, they are used with mirrors to reflect light onto film.

2
He

Helium is the first member of the group of inert gases (also known as noble or rare gases). It is colorless and

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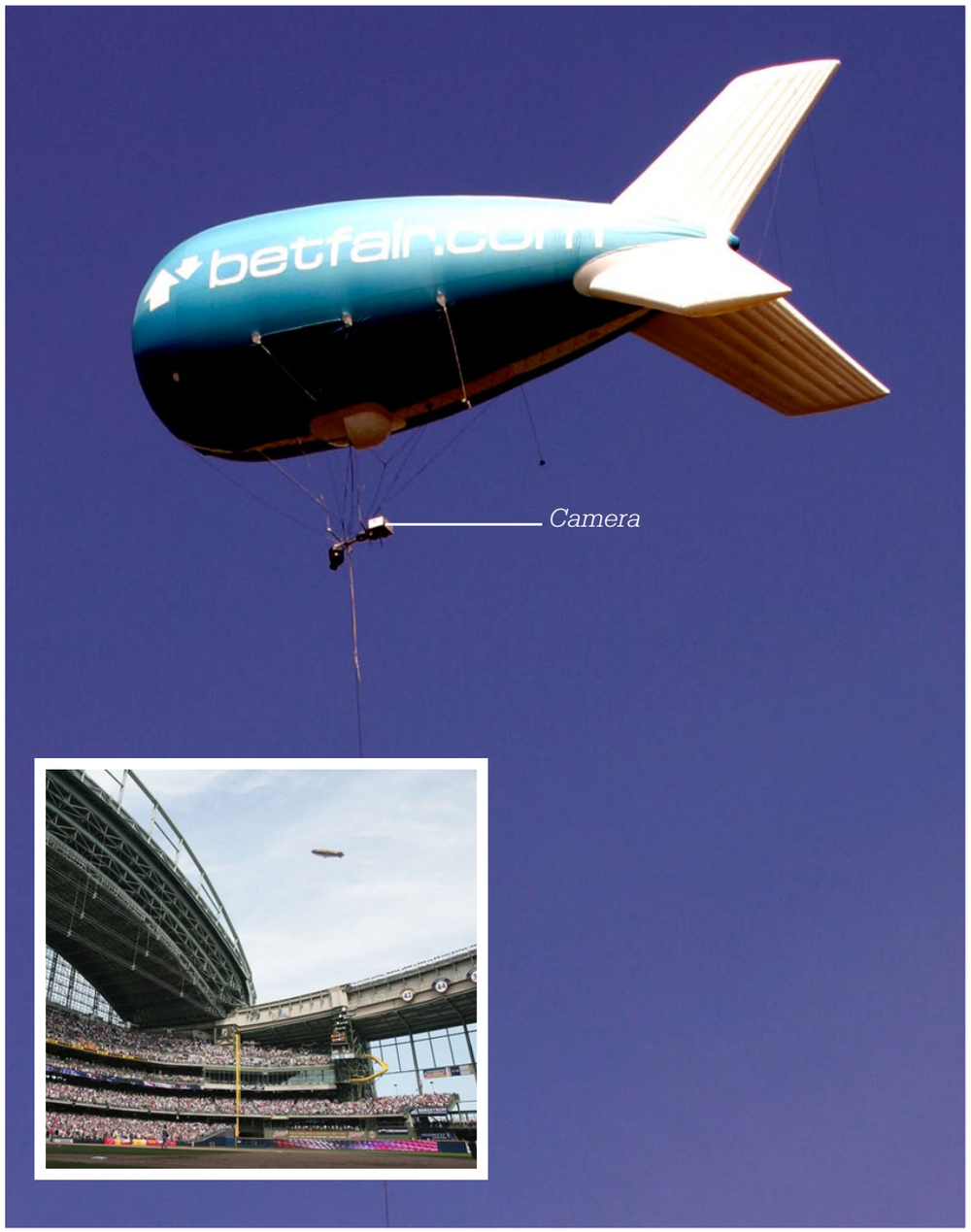


Blimps and airships

Blimps and airships are types of lightweight aircraft with power and steering systems that use a lighter-than-air gas, usually helium, to lift the craft like balloons. Helium is heavier than hydrogen, which was first used to float airships. But hydrogen is flammable (bursts into flames easily), and after an airship exploded with passengers on board in 1937 (the *Hindenburg*), other gases were investigated. The first airships were developed in France in the 1880s and called dirigibles ("steerables"), because they could be steered and could also be flown against the wind.

There are two main types of airship: the rigid airship, which has a frame inside, and the nonrigid blimp, which has no internal frame and loses its shape once the gas is let out. Blimps have become popular in the last few decades. Among new types are small blimps, some remote controlled, that are tethered inside stadiums and used to provide television audiences with bird's-eye views of sports events. Small blimps display advertising logos painted on their sides, and others are once again used to carry passengers, usually groups of tourists, in gentle slow motion over scenic areas such as the California coast.

The *Hindenburg* measured

803.8 feet (245 m)

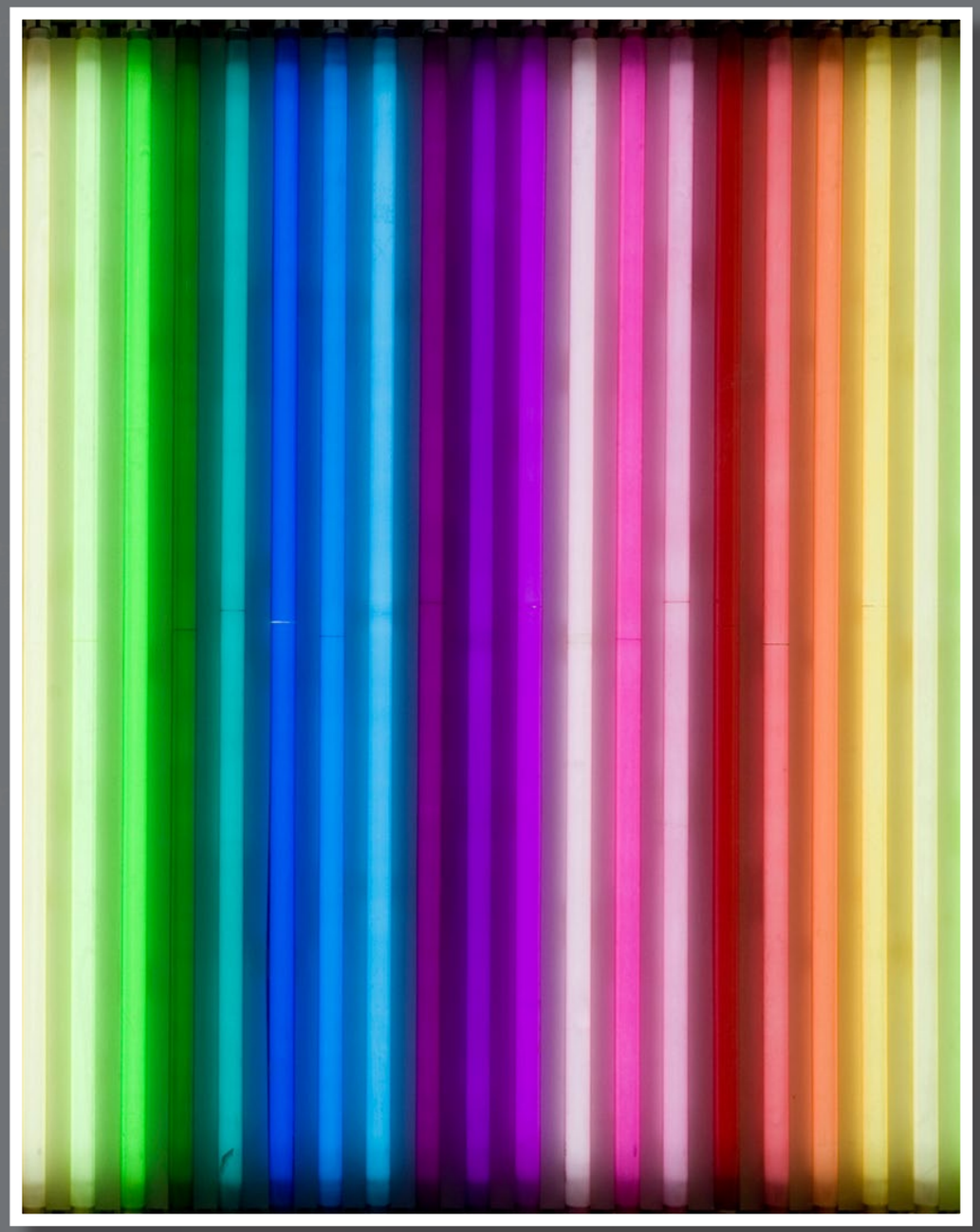
long—the largest airship ever

Collect more noble gases

Helium [Noble gases]

2
He

Helium is the first member of the group of inert gases (also known as noble or rare gases). It is colorless and



Inert gas

The inert gases, or noble gases, are unique not because of the properties they possess, but because of the properties they lack. They lack odor. They lack color. They lack taste. They cannot be detected at all without special equipment. Most important, these six elements resist combining with other elements.

The noble gases are helium, neon, argon, krypton, xenon, and radon. The terms *inert* and *noble* are derived from the extreme resistance of these gases to combining chemically with other elements. Xenon has been found to combine with other elements to form compounds, but generally the noble gases tend to remain apart.

Chemical stability exists because the outermost shell of each noble gas atom is full, filled with eight electrons (octet), except for helium, which has two. Most other chemical elements have to react with one another in order to achieve this stable octet electron configuration—either by losing electrons to their reacting partners or by gaining electrons from them. This is called ionic bonding. Some of the most common bonds between elements occur when the elements share their electrons rather than losing or gaining them. This sharing is called covalent bonding.

Cryogenics

Cryogenics is the study of the properties of matter at incredibly low temperatures. The name comes from the Greek *kryos*, meaning "icy cold." The highest temperature dealt with by cryogenics is about –148°F (–100°C), and the lowest is the absolute zero temperature of –459.67°F (–273.15°C). In cryogenics, temperatures in the lowest range use the Kelvin scale, with absolute zero at 0 K. (Kelvin and Rankine are known as absolute temperature scales, as opposed to the relative temperature scales of Fahrenheit and Celsius.)

All gases, when cooled enough, condense into liquids and even freeze. When helium is cooled below 2.2 K, it develops strange properties. It becomes a superfluid, with the ability to flow uphill and at different speeds in different directions.

Liquid helium is widely used in cryogenic research to enable scientists to experiment with materials. It had been known for many years that the electrical resistance of metals decreases with falling temperatures, eventually making them superconductors—that is, they lose all their electrical resistance. The results are used in equipment for the nuclear industry, in scanning machinery for hospitals, and in computer memories and communication devices.

electrical resistance *noun*

Electrical resistance is the degree to which an object can obstruct the flow of an electric current, either partially or wholly.

The resistance of a metal usually increases as it gets hotter. At very low temperatures, the resistance of some materials falls to zero.

A resistor is a component of an electrical circuit that resists the flow of electrical current.

temperature *noun*

Temperature is the relative hotness or coldness of an object, as measured on a standard scale.

The temperature of an object or of a system is a measure of the tendency of heat to flow into or out of the object or system in its given environment.

Periodic table complete collection

HOME

Start creating your own 3-D periodic table. Look around to find examples of something made from each element, or take photos. Look in the book *The Elements* (pages 22–23) and in this digital book to find out more about how the table is organized, and to discover more about every group and every element.

Click Noble Gases for sample content

Click Metalloids for sample content

GROUPS (VERTICAL COLUMNS)

PERIODS (HORIZONTAL ROWS)

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
1	1 H HYDROGEN																	2 He HELIUM
2	3 Li LITHIUM	4 Be BERYLLIUM											5 B BORON	6 C CARBON	7 N NITROGEN	8 O OXYGEN	9 F FLUORINE	10 Ne NEON
3	11 Na SODIUM	12 Mg MAGNESIUM											13 Al ALUMINUM	14 Si SILICON	15 P PHOSPHORUS	16 S SULFUR	17 Cl CHLORINE	18 Ar ARGON
4	19 K POTASSIUM	20 Ca CALCIUM	21 Sc SCANDIUM	22 Ti TITANIUM	23 V VANADIUM	24 Cr CHROMIUM	25 Mn MANGANESE	26 Fe IRON	27 Co COBALT	28 Ni NICKEL	29 Cu COPPER	30 Zn ZINC	31 Ga GALLIUM	32 Ge GERMANIUM	33 As ARSENIC	34 Se SELENIUM	35 Br BROMINE	36 Kr KRYPTON
5	37 Rb RUBIDIUM	38 Sr STRONTIUM	39 Y YTTRIUM	40 Zr ZIRCONIUM	41 Nb NIOBIUM	42 Mo MOLYBDENUM	43 Tc TECHNETIUM	44 Ru RUTHENIUM	45 Rh RHODIUM	46 Pd PALLADIUM	47 Ag SILVER	48 Cd CADMIUM	49 In INDIUM	50 Sn TIN	51 Sb ANTIMONY	52 Te TELLURIUM	53 I IODINE	54 Xe XENON
6	55 Cs CESIUM	56 Ba BARIUM	57–71 La-Lu LANTHANOIDS	72 Hf HAFNIUM	73 Ta TANTALUM	74 W TUNGSTEN	75 Re RHENIUM	76 Os OSMIUM	77 Ir IRIDIUM	78 Pt PLATINUM	79 Au GOLD	80 Hg MERCURY	81 Tl THALLIUM	82 Pb LEAD	83 Bi BISMUTH	84 Po POLONIUM	85 At ASTATINE	86 Rn RADON
7	87 Fr FRANCIUM	88 Ra RADIUM	89–103 Ac-Lr ACTINOIDS	104 Rf RUTHERFORDIUM	105 Db DUBNIUM	106 Sg SEABORGIUM	107 Bh BOHRIUM	108 Hs HASSIUM	109 Mt MEITNERIUM	110 Ds DARMSTADTIUM	111 Rg ROENTGENIUM	112 Cn COPERNICIUM		114 Uuq UNUNQUADIUM		116 Uuh UNUNHEXIUM		

More elements
Elements 113, 115, 117, and 118 are awaiting official recognition and naming.

57 La LANTHANIUM	58 Ce CERIUM	59 Pr PRASEODYMIUM	60 Nd NEODYMIUM	61 Pm PROMETHIUM	62 Sm SAMARIUM	63 Eu EUROPIUM	64 Gd GADOLINIUM	65 Tb TERBIUM	66 Dy DYSPROSIUM	67 Ho HOLMIUM	68 Er ERBIUM	69 Tm THULIUM	70 Yb YTTERBIUM	71 Lu LUTETIUM
89 Ac ACTINIUM	90 Th THORIUM	91 Pa PROTACTINIUM	92 U URANIUM	93 Np NEPTUNIUM	94 Pu PLUTONIUM	95 Am AMERICIUM	96 Cm CURIUM	97 Bk BERKELIUM	98 Cf CALIFORNIUM	99 Es EINSTEINIUM	100 Fm FERMIUM	101 Md MENDELEVIUM	102 No NOBELIUM	103 Lr LAWRENCIUM

Atomic number — 21
Symbol — Sc
Element name — SCANDIUM

Alkali metals | Alkaline earth metals | Transition metals | Poor metals | Metalloids | Nonmetals | Halogens | Noble gases | Lanthanoids | Actinoids

How to use this digital book

CREDITS

Look out for interactive buttons that light up as you roll over them. Click to discover more about amazing elements. Find out what everyday things they're in, so you can start your periodic table collection.

Look for these clickable buttons:

Periodic table

The full collection in order.

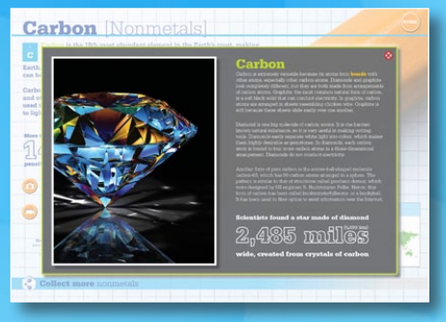
Discover more

Meet the family! Other elements in the same group.

Gallery

Lots of ideas about what to collect.

Green word



Encyclopedia entry on an element or how we use it.

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Credits

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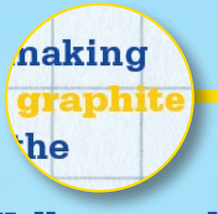
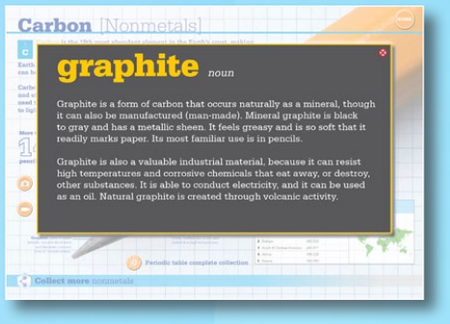


Yellow word



Glossary entry—tricky or scientific words explained.

Credits

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