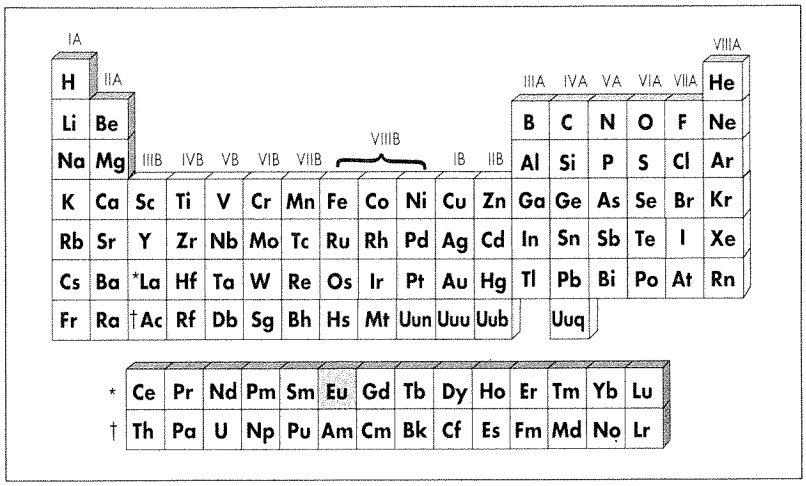
EUROPIUM

Atomic Number **63**

Chemical Symbol **Eu**

Group **IIIB—Rare Earth Element (Lanthanides)**

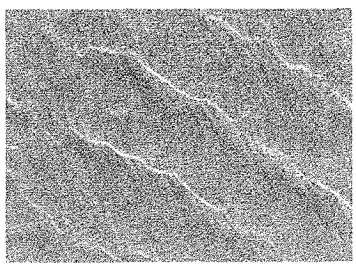


Eu

Europium is one of the rarest of the rare earth elements. In 1901, the French chemist Eugène-Anatole Demarcay finally isolated an impurity in a samarium-gadolinium sample he was studying and identified the impurity as a new element. He named his new element for the continent of Europe. It took many more years before the pure metal was isolated.

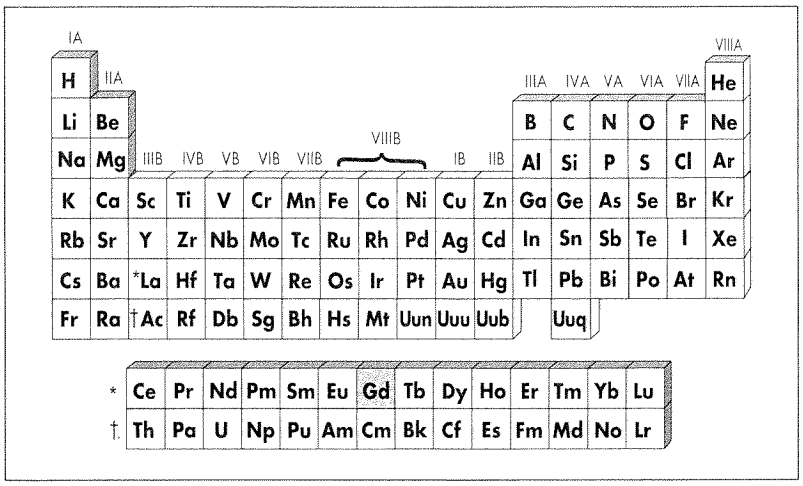
As with most of the rare earth elements, the principal ores containing europium are monazite and bastnasite. Monazite contains all of the rare earths as well as thorium and calcium. Monazite is found in river sands in India and Brazil and in beach sand in Florida. Substantial deposits of bastnasite are also found in Southern California. Like most of the other rare earth elements, europium is separated from its ores by an ion-exchange process. Some europium is also recovered from the fission fragments produced in nuclear reactors.

Pure europium metal is a fairly soft, silvery-white metal. It is quite ductile and is one of the most reactive of the rare earth metals. It oxidizes fairly rapidly in air and reacts with water to produce hydrogen. It will ignite spontaneously in air at temperatures above 150°C.



The mineral monazite, found in Florida beach sand, contains traces of all of the rare earth elements—including europium.

Europium oxide is fairly widely used as an additive to improve the efficiency of the red phosphor in color television tubes and computer monitors. It is also used to improve the energy efficiency of fluorescent lamps.



GADOLINIUM

Gd

Gadolinium is a rare earth element that is the sixth most common of these elements in the Earth's crust. The honor for its discovery is shared by the French chemists Jean de Marignac and Paul-Émile Lecoq de Boisbaudran. In 1886, de Boisbaudran finally isolated and identified the element from the mineral gadolinite, for which he named it. The mineral itself was named for the distinguished Finnish chemist Johan Gadolin.

As with so many of the rare earth elements, the principal ores of gadolinium are monazite and bastnasite. Monazite, a mixture of rare earth elements, thorium, and calcium, is found in river sands in India and Brazil and in beach sand in Florida. Deposits of bastnasite are found in Southern California. The commercial separation of gadolinium from its ores is done with ion-exchange techniques.

In its pure metallic form, gadolinium is a shiny, silvery-white metal that is malleable and ductile. It tarnishes very slowly in moist air, forming an oxide that flakes off the surface of the metal. This process exposes fresh gadolinium to the oxygen in the air, and the corrosion continues.

Two isotopes of gadolinium are among the most potent known absorbers of neutrons. Although their scarcity limits their use, they are often used in making the control rods for nuclear reactors, whose function is to absorb neutrons and in so doing effectively stop the chain reaction in a reactor. Gadolinium is also used as an alloying agent in the production of special steels.

Compounds of gadolinium, like those of many of the rare earth elements, are used to make phosphors for color television

Atomic Number **64**

Chemical Symbol **Gd**

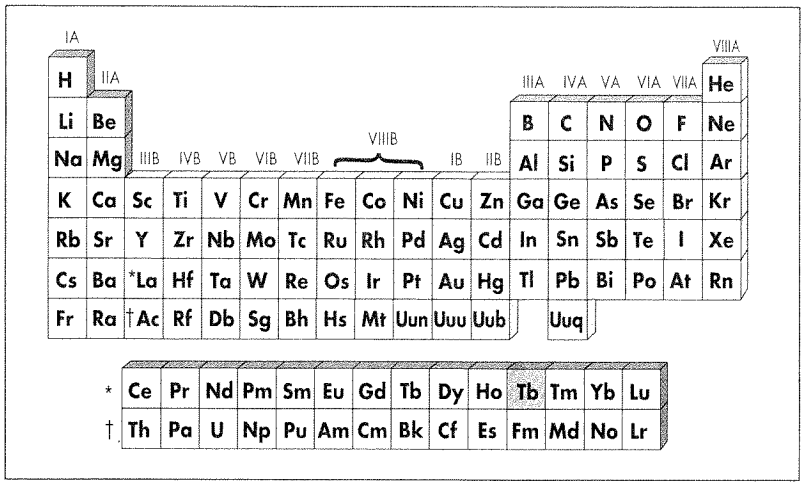
Group **IIIB—Rare Earth Element (Lanthanides)**

Gadolinium was discovered in 1886 and named for the distinguished Finnish chemist Johan Gadolin.

tubes and computer monitors. Gadolinium is ferromagnetic, which means that like iron and cobalt, it is strongly attracted by magnets. An interesting property of gadolinium is that its Curie point, the temperature at which a magnetic material loses its magnetism, is only about 17°C, or approximately room temperature.

Gadolinium has proven of value in a new technique for probing the interior of metals, known as neutron radiography. It is used in the airline and shipbuilding industries to search for hidden flaws and structural weakness in hulls and fuselages. Like the more traditional X ray picture, it produces a shadowgram of the materials that make up a structure, since some materials are more opaque to neutrons than others.

In addition to the usual film required for X rays, an additional screen called a conversion screen is needed in neutron radiography. This screen, commonly made of gadolinium, is placed in close contact with the film. Neutrons that penetrate the sample being investigated interact with the screen, making it radioactive. The radiation then given off by the screen darkens the film and an image is formed.



TERBIUM

Tb

Terbium is one of the least abundant of the rare earth elements. Carl Gustaf Mosander discovered the element in 1843 by isolating its oxide from the mineral yttria. He named it for the mineral, which is itself named for Ytterby, a Swedish village where yttria and terbium are often found.

Terbium is recovered commercially from the mineral monazite, a mixture of rare earth elements combined with thorium and calcium. It is found in river sands in India and Brazil and in beach sand in Florida. Terbium is recovered from monazite by ion-exchange techniques.

In its pure metallic form, terbium is silvery-white, malleable, ductile, and soft enough to be cut with a knife. It bears a resemblance to lead, but it is much heavier. Like lead, it is fairly resistant to corrosion.

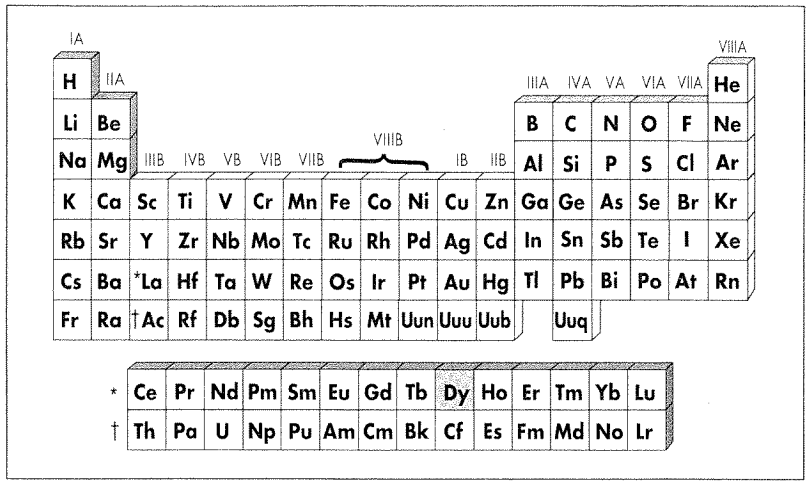
Compounds of terbium have found use in special lasers and as phosphors that produce the green color in television tubes and computer monitors. Other applications include the production of alloys with special magnetic properties for use in compact discs and in the fabrication of high-definition X-ray screens.

Atomic Number **65**

Chemical Symbol **Tb**

Group **IIIB—Rare Earth Element (Lanthanides)**

DYSPROSIUM



Atomic Number **66**

Chemical Symbol **Dy**

Group **IIIB—Rare Earth Element (Lanthanides)**

Dy

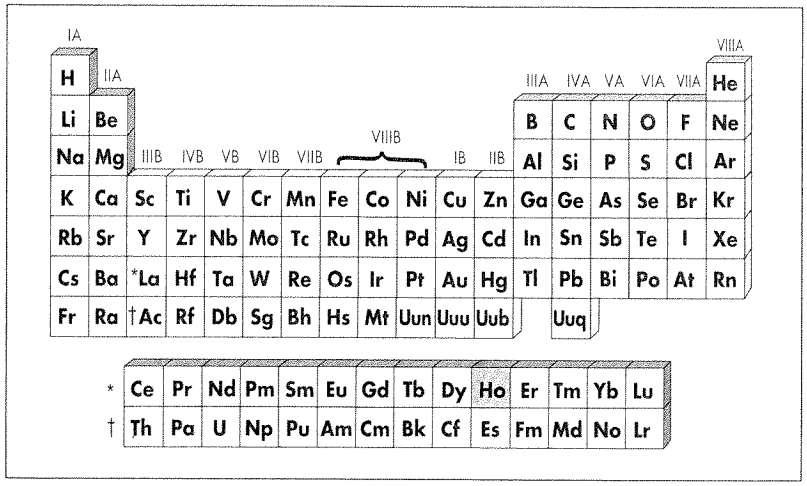
Dysprosium is a metal that ranks ninth in abundance among the rare earth elements in the Earth's crust. It was discovered in 1886 by the French chemist Paul-Émile Lecoq de Boisbaudran in a sample of erbium oxide. He based its name on the Greek word *dysprositos,* which means "hard to get at."

Although discovered in 1886, pure dysprosium was not actually available until 1950, when modern chemical techniques such as ion-exchange separation were developed.

The important sources of dysprosium, as for most of the rare earth elements, are monazite and bastnasite. Monazite, found in river sands in India and Brazil and in beach sand in Florida, contains most of the rare earth elements, often in concentrations as high as 50 percent, along with strontium, thorium, and calcium. Bastnasite exists in substantial deposits in Southern California.

Dysprosium metal resembles most of the other rare earth metals. It is soft enough to be cut with a knife; has a shiny, silvery color; and is relatively stable in air.

Some isotopes of dysprosium are effective absorbers of neutrons and are being considered for use in the control rods in nuclear reactors. Dysprosium is also used in color television tubes and mercury lamps. Like terbium it forms alloys whose magnetic properties are used to help compact discs function more effectively.



HOLMIUM

Ho

Holmium is a fairly scarce rare earth element. In 1878, two Swiss scientists noticed its characteristic spectral lines but could not identify them. They called the unknown source of the spectral lines element X. Soon afterward, in 1879, the Swedish chemist Per Teodor Cleve isolated and identified the element while working with a mineral called erbia. He named the new element for his native city of Stockholm, using the Latin version of its name, Holmia.

The most important commercial source of holmium is monazite, which contains almost all of the rare earth elements, often in concentrations as high as 50 percent. It is found in river sand in India and Brazil and in beach sand in Florida. Holmium is separated from the other rare earth elements by ion-exchange.

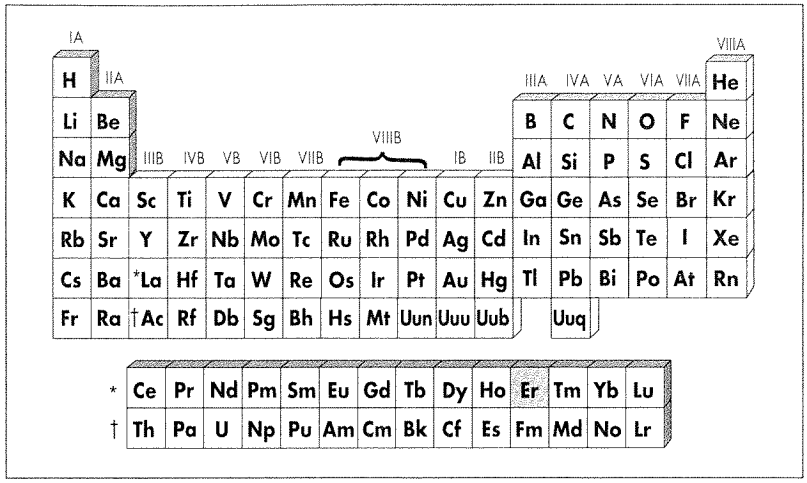
Pure metallic holmium, which was not available until quite recently, resembles most rare earth metals. It has a bright silvery color and is malleable, ductile, and quite soft. It is fairly corrosion-resistant in dry air but tarnishes quickly in moist air, forming a yellowish oxide. Other than its use as a color for glass it has few commercial applications.

Atomic Number **67**

Chemical Symbol **Ho**

Group **IIIB—Rare Earth Element (Lanthanides)**

ERBIUM



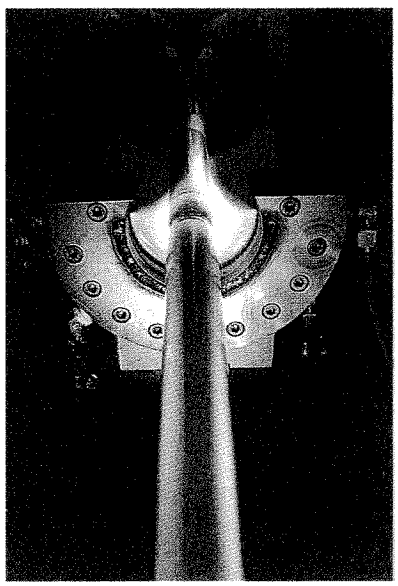
Er

Erbium is a fairly scarce rare earth metal. It was discovered in 1843 by Carl Gustaf Mosander in a yellow oxide that he isolated from the mineral called yttria. Mosander named the element for the Swedish village of Ytterby, the site of large concentrations of yttria and erbium.

The principal sources of erbium are the minerals xenotime and euxerite. Erbium, as well as other rare earth elements, is actually an impurity in these ores. It is separated from the other rare earth elements by ion-exchange.

Erbium in its pure metallic form resembles most of the other rare earth metals. It is soft and malleable and has the usual silvery luster of these metals. By comparison with the other rare earths, it is fairly corrosion-resistant.

The commercial applications of erbium are rather limited. It is used to form special alloys with metals such as vanadium in order to improve their workability and malleability. Erbium oxides are often added to glass and enamel glazes to color them pink. The glass is often used for sunglasses and inexpensive jewelry.

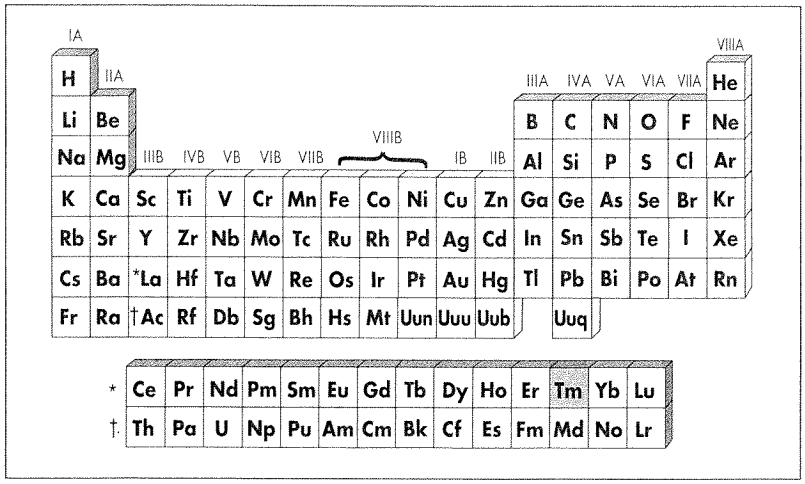


A lathe at AT&T Bell Laboratories heats a glass rod treated with erbium in the first step toward making optical amplifiers for use in AT&T's telephone network.

Atomic Number **68**

Chemical Symbol **Er**

Group **IIIB—Rare Earth Element (Lanthanides)**



THULIUM

Tm

Thulium is a rare earth metal that is extremely scarce. It occurs in very small quantities in the company of other rare earths. The Swedish chemist Per Teodor Cleve discovered the element in 1879 by isolating its greenish oxide from the mineral erbia. He named his new element for Thule, the ancient name for Scandinavia.

The principal source of thulium is the mineral monazite, which consists of approximately seven thousandths of 1 percent thulium. Monazite, which contains all of the rare earth elements in addition to thorium and calcium, is found in river sands in India and Brazil and in beach sand in Florida. Thulium is separated from the other rare earth elements in monazite by ion-exchange techniques.

Like many of the rare earth metals, thulium is a bright silvery metal that is ductile, malleable, and soft enough to be cut with a knife. It is fairly resistant to corrosion in dry air.

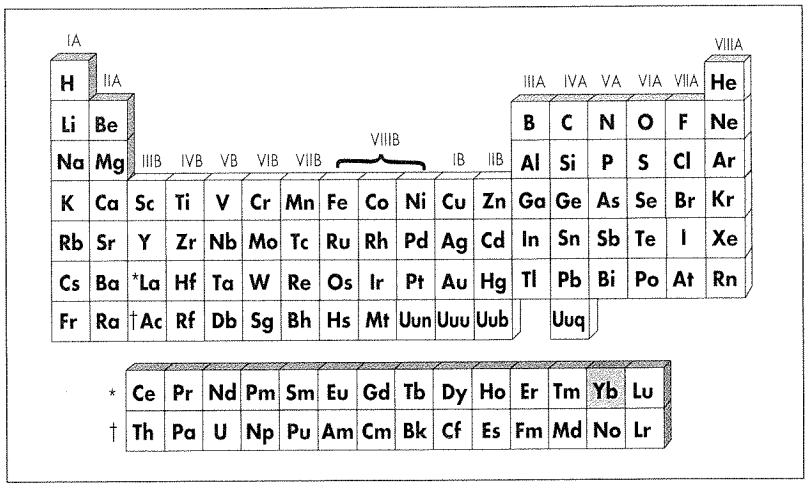
Thulium has few commercial applications although it has been used in lasers. It is expensive, and very little of the metal is available for experimentation.

Atomic Number **69**

Chemical Symbol **Tm**

Group **IIIB—Rare Earth Element (Lanthanides)**

YTTERBIUM



Yb

Ytterbium is a rare earth metal found in modest abundance in the Earth's crust and always in the company of other rare earths. The French chemist Jean de Marignac discovered this element in 1878 as a component of the mineral known as erbia. Ytterbium, which Marignac named for the Swedish village of Ytterby on the basis of its high concentrations of erbium, was actually the first rare earth element to be discovered.

The principal source of ytterbium is the mineral monazite. Monazite, as has been noted throughout the discussion of the rare earth elements, contains all of these elements in addition to thorium and calcium. Found in river sand in India and Brazil and in beach sand in Florida, it contains ytterbium in concentrations of approximately three hundredths of 1 percent. Ytterbium is separated from the other rare earths by ion-exchange.

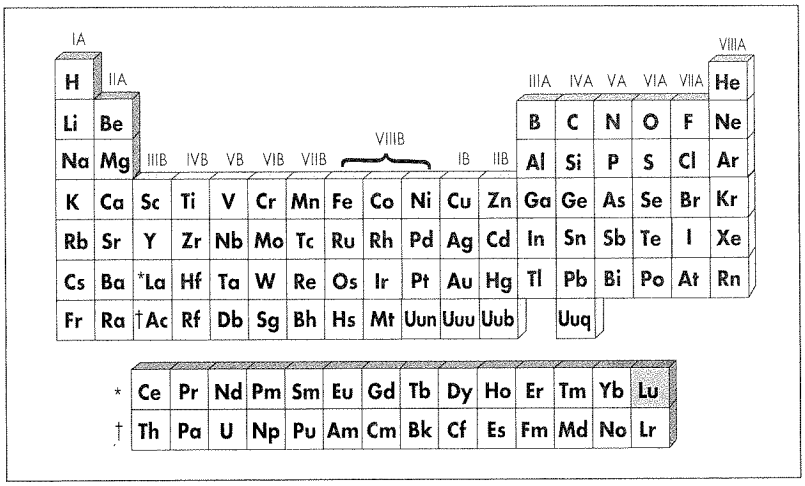
Pure ytterbium metal was not available for study until 1953. Like so many of the rare earth metals, it has a bright silvery luster and is soft, malleable, and ductile. It oxidizes when exposed to air and is therefore usually stored in sealed containers.

The commercial applications of ytterbium are rather limited. As an alloying agent, it improves the strength of stainless steel. Certain alloys have been used in dentistry.

Atomic Number **70**

Chemical Symbol **Yb**

Group **IIIB—Rare Earth Element (Lanthanides)**



LUTETIUM

Lu

Lutetium is one of the least abundant of the rare earth elements. It was discovered in 1907 by the Austrian mineralogist Baron Carl Auer von Welsbach and the French scientist Georges Urbain as an impurity in a mineral sample thought to contain only ytterbium. After some confusion, Urbain composed the name for his newly identified element from *Lutetia,* the ancient name for Paris. Welsbach had wanted *cassiopium,* a name taken from the constellation Cassiopeia. Many German scientists still refer to lutetium by the name *cassiopium.*

Although he never formally published his results, the American chemist Charles James, known to his colleagues and students as "King" James, is now considered by many scientists to have independently discovered lutetium in 1907. Working during the early 1900s at the University of New Hampshire, James became a major force in the production of rare earth elements. He and his students would often process tons of ore, and labor through thousands of crystallizations to produce a single sample. His work was recognized in 1999 by the American Chemical Society, and his laboratory, known today as Conant Hall, was designated a National Historic Chemical Landmark. Lutetium is thus the only naturally occurring element discovered in the United States.

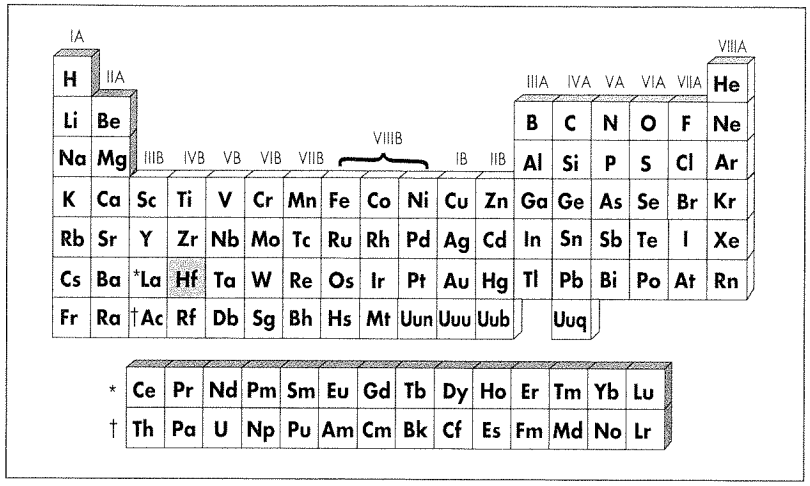
The principal commercial source of lutetium is the mineral monazite, which contains all of the rare earth elements and in which lutetium is present at a concentration of about three thousandths of 1 percent. Monazite is found in river sands in India and Brazil and in beach sand in Florida. Lutetium is separated from the other rare earth elements by ion-exchange. Pure lutetium metal is difficult and expensive to prepare. Like most of the other rare earth metals, it is silvery white and corrosion-resistant. As befits its position as the last lanthanide, it is the hardest and heaviest rare earth element. Almost no commercial applications have been developed for lutetium.

Atomic Number **71**

Chemical Symbol **Lu**

Group **IIIB—Rare Earth Element (Lanthanides)**

HAFNIUM



Hf

Hafnium is a bright, silvery-white metal that is extremely ductile. Its properties as well as its history are closely tied to the element zirconium. The two metals are so chemically similar that it is almost impossible to prepare one without traces of the other.

Although hafnium is a fairly abundant metal, it was not discovered until 1923. Numerous investigators, including Mendeleyev, had predicted the existence of element 72, but the omnipresence of its chemical twin zirconium interfered with its identification. Finally, Dirk Coster, a Dutch physicist, and George Karl von Hevesy, a Hungarian physicist, found the element using a prediction of its electron configuration based on the new quantum theory of electron shells and subshells developed by Niels Bohr. They used an X-ray analysis of the electronic structure of hafnium to discover it in zircon, the ore that is the principal source of zirconium metal. To honor Bohr, Coster and de Hevesy named their new element for his native city, Copenhagen, using the Latin form of its name, Hafnia.

Hafnium is extremely resistant to corrosion. It reacts with the oxygen in air to form a protective film that prevents its further oxidation. It is less dense than zirconium, but its chemistry is almost identical to that of zirconium. Hafnium is obtained commercially from zircon and baddeleyite ores. As with zirconium, its extraction is done with the Kroll process, in which these ores are first treated with chlorine gas to produce hafnium chloride, which is reduced to yield hafnium metal by the addition of either magnesium or sodium.

The principal use of hafnium is based on one of its few differences from zirconium. Unlike zirconium, hafnium is an excellent absorber of thermal neutrons. These are neutrons that

Atomic Number **72**

Chemical Symbol **Hf**

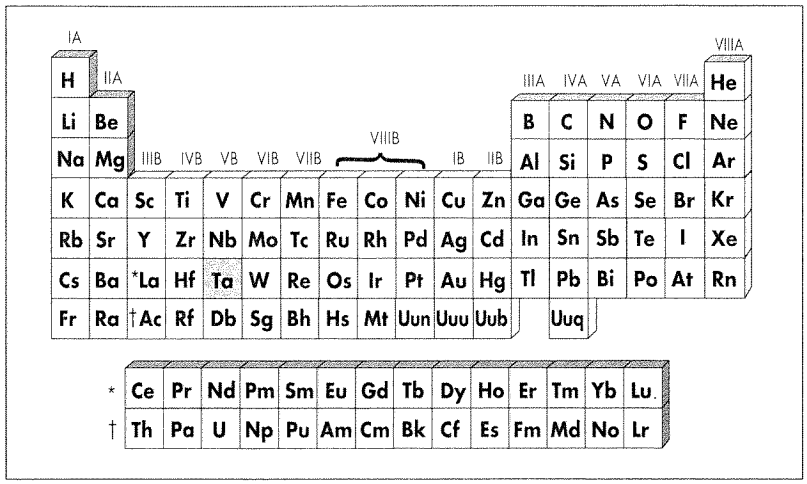
Group **IVB—Transition Element**

have been slowed down by the so-called moderator in a nuclear reactor and are more easily absorbed by uranium-235 than are fast-moving neutrons. The ability of hafnium to absorb slow-moving neutrons has made it a most useful material for the construction of the reactor control rods that are lowered into the heart of a reactor to absorb neutrons. By removing neutrons, the rods can effectively slow or halt the chain reaction taking place in the reactor. The reactors used on nuclear submarines often use hafnium control rods. The main advantage of hafnium, compared to other common control rod materials such as cadmium and boron, is its strength and resistance to corrosion. Unfortunately, hafnium is rather expensive. In a fairly large reactor, one that may contain 40 to 50 control rods, the cost of the hafnium rods can be $1 million or more.

Other applications of hafnium are rather limited, but it is used to some extent in incandescent lamps and as a "getter" in many gas-filled systems. A hafnium "getter" removes—that is, "gets" rid of—unwanted gases such as oxygen and nitrogen from systems in which these gases are not wanted.

Many chemists had predicted the existence of element 72, but the omnipresence of its chemical twin zirconium interfered with its identification. It was not discovered until 1923.

TANTALUM



Ta

Tantalum is a gray metal that is extremely hard and very heavy. Its ability to be drawn into fine wires has led to its use in many commercial applications. Anders Gustav Ekeberg, a Swedish chemist, discovered the element in 1802 by isolating and identifying it from minerals found near the Swedish town of Ytterby, which has played an astonishing role in the history of chemistry, particularly as a source of minerals for the discovery of rare earth elements. Ekeberg named the new element for Tantalos, the father of Niobe, who was queen of the city of Thebes, in Greek mythology. The name was well chosen. For almost half a century after Ekeberg's announcement, many chemists thought that he had confused tantalum with niobium. Pure tantalum metal was not produced until 1903.

The principal ore of tantalum is the mineral columbite, which is distributed throughout the world, with substantial deposits in Africa, Thailand, Portugal, and Canada. Tantalum has an extremely high melting point (2,996°C), surpassed only by those of tungsten and rhenium, and resembles such metals as gold and platinum in its ability to resist any chemical attack at temperatures below 150°C. Less costly than platinum, it is often substituted for it. The chemical inertness of tantalum makes it highly resistant to attack by substances in the human body. The ability of the body to tolerate the metal has led to a host of applications in dental and medical surgery. Tantalum is often used as a replacement for hip joints, for example, and the metal serves extremely well as a plate for replacing parts of the skull that have been damaged. Tantalum screws and staples are also used to hold together fragments of broken bones.

Atomic Number **73**

Chemical Symbol **Ta**

Group **VB—Transition Element**

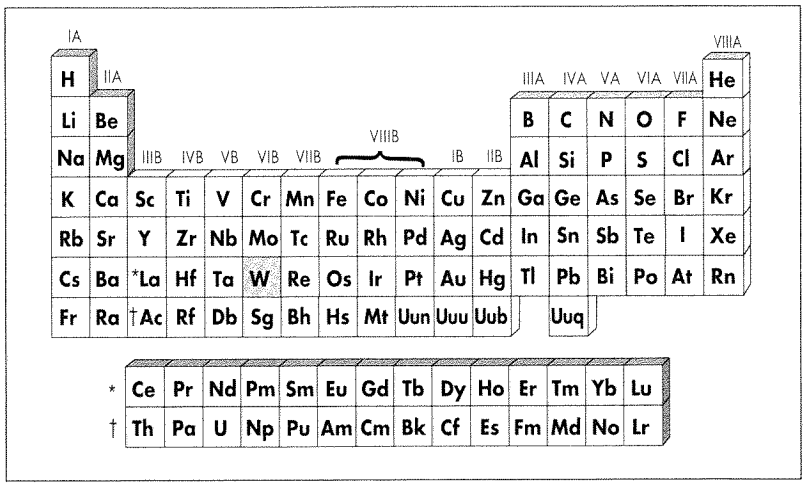
The ability of tantalum and its compounds to resist corrosion has also made it useful for many industrial processes and specialized industrial products. One of the major uses of tantalum is in the construction of chemical equipment to be used with extreme corrosive chemicals, such as the production of hydrochloric and sulfuric acids. Tantalum metal as an alloying agent contributes not only corrosion resistance, but ductility, hardness, and a high melting point to a variety of other metals. Thus the pure metal, as well as its alloys, are used for fabricating parts for aircraft, nuclear reactors, missiles, as well as specialized scientific, medical, and dental instruments. Another interesting application is the use of tantalum for the production of special glass for camera lenses.

Yet another major use of tantalum is in the construction of small but powerful electrolytic capacitors. These capacitors are used to store electric charge, and are especially useful in the miniaturized electronic circuitry that lies at the heart of such devices as cellular phones and computers. In a tantalum electrolytic capacitor, tantalum in the form of a grid of metal plates, or rolled into a cylinder, is immersed in an electrolyte. The electrolyte, usually in the form of a paste, substitutes for one of the two electrodes that form the more conventional capacitor. To increase the surface area of the tantalum plate, powdered tantalum is often pressed into a solid but porous metallic electrode.

Research continues on other uses for tantalum. A group of scientists working at the National Laboratory at Los Alamos, New Mexico, have created a tantalum carbide that is supposed to be the hardest material ever made. In a completely different kind of application, a radioactive isotope of tantalum, tantalum-182 (which has a half-life of 114 days), is used in some laboratories as a source of gamma rays.

Tantalum was isolated and identified in 1802 from minerals found near the Swedish town of Ytterby, which has played an astonishing role in the history of chemistry, particularly as a source of minerals for the discovery of rare earth elements.

TUNGSTEN



Atomic Number **74**

Chemical Symbol **W**

Group **VIB—Transition Element**

W

In its raw form, tungsten is a steel-gray metal that is often fairly brittle and hard to work. Yet if all of its impurities are removed, it is soft enough to be cut with a sharp saw. The history of chemistry during the 18th century is often difficult to disentangle, but it seems that two Spanish brothers, Juan José and Fausto de Elhuar, discovered tungsten in 1783, isolating it from the mineral known as wolframite. There is evidence, however, that the element was known before that time and was called wolfram. Many chemists, particularly in Germany, still refer to tungsten as wolfram. Moreover, the chemical symbol for tungsten is W and is taken from that name. The more widely accepted name for the element is taken from the Swedish words *tung stem,* which mean "heavy stone."

The principal ores of tungsten are wolframite and scheelite. Approximately 75 percent of the world's tungsten resources are thought to exist in China.

One of the most important uses of tungsten is in the manufacture of filaments for the common light bulb. Tungsten has the highest melting point (3,410°C) and highest boiling point (5,900°C) of any metal. The high-temperature applications of tungsten range from heating elements in electric heaters to the nozzles on the rocket motors of space vehicles. Electricity flowing through a coiled wire of tungsten produces enough heat to make the wire white hot. To prevent the metal from overheating, inert gases such as nitrogen and argon are enclosed in the bulb containing a tungsten filament.

Even though tungsten has the lowest vapor pressure of any metal, some of it does slowly vaporize with use, forming a dark deposit on the insides of bulbs. Tungsten filaments are also used

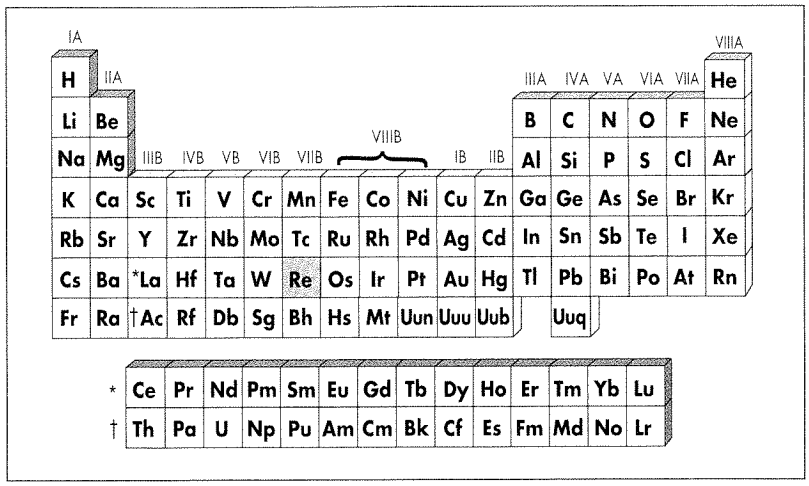
Because tungsten has the highest melting point of any metal, it is used in the filaments of ordinary light bulbs.

in television tubes and in the cathode ray tubes used in computer monitors.

Tungsten is often added to steel to form an alloy called tungsten steel. Cutting tools made of common carbon steel are often unable to hold their edge at high temperatures. By contrast, tools made of tungsten steel remain sharp even under red-hot temperature conditions.

The compound known as tungsten carbide is extremely hard and chemically inert even at very high temperatures. It finds important industrial use in the manufacture of high-speed cutting tools.

RHENIUM



Re

Rhenium is one of the rarest of elements. Early investigators during the latter part of the 1920s worked through approximately 1 million pounds of the mineral molybdenite to recover one gram of rhenium. Because of the difficulty in extracting it, the price of the element rose to an extraordinary $10,000 per gram in 1928. With more efficient extraction techniques, rhenium has become considerably less expensive today.

Rhenium is an extremely dense metal with a silvery-gray luster and a melting point exceeded only by those of tungsten and carbon. It was discovered in platinum ores in 1925 by the German chemists Ida Tacke, Walter Nodack, and Otto Carl Berg. Illustrating the power of the periodic table, they knew that element 75 should fill a gap in column VIIB of the table and were able to predict many of the reactions of this element even before its discovery. They named the element for the Rhine River, using the Latin version of its name, Rhenus.

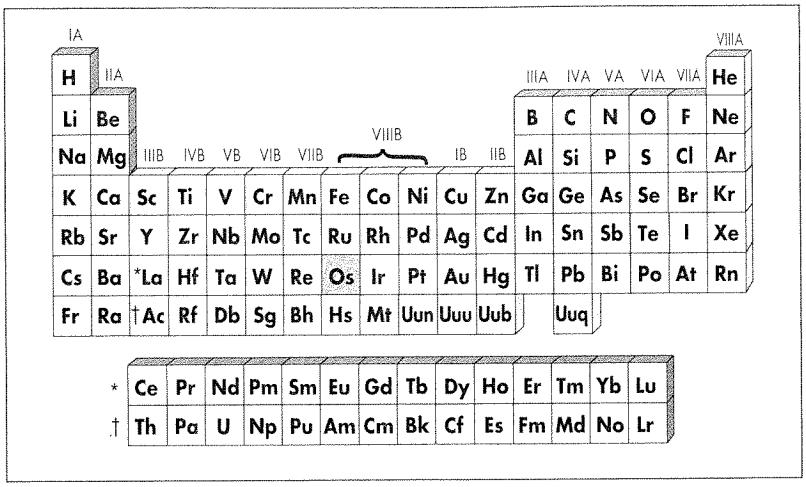
The principal commercial sources of rhenium are the ores molybdenite and copper sulfide (CuS). Approximately 1,000 pounds of rhenium are produced each year in the United States.

Rhenium is chiefly used as an alloying agent for fabricating metals that are resistant to wear, such as those required for electrical switch contacts and electrodes. The high melting point of rhenium is also the basis for its use in combination with tungsten to make thermocouples for measuring temperatures as high as 2,000°C.

Atomic Number **75**

Chemical Symbol **Re**

Group **VIIB—Transition Element**



OSMIUM

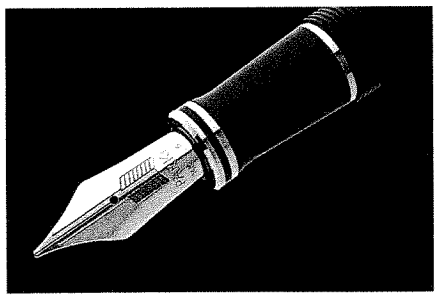
Os

Osmium is a hard, brittle, bluish-white metal with an extremely high melting point (3,054°C). Because the pure metal is difficult to make, it is often fabricated as a powder, which is then formed into a solid mass by heating. The powder oxidizes in air to form osmium tetroxide (OsO_4), which is slowly emitted as a strong-smelling toxic gas capable of causing lung and skin damage.

Osmium was discovered in 1803 by the English chemist Smithson Tennant, who isolated it by examining the residue formed by treating platinum ores with aqua regia, a mixture of nitric and hydrochloric acids. Tennant named the newly discovered element for its noxious odor, using the Greek word *osme,* which means "smell."

Osmium is chiefly found in nickel- and platinum-bearing ores. The difficulty in refining it from these ores is offset by the platinum and nickel that are also recovered.

The emission of its poisonous oxide gas makes the use of osmium metal impractical. As an alloying additive, however, it is quite safe and is chiefly used to make hard alloys with such metals as platinum and iridium. These alloys are used for electrical switch contacts, phonograph needles, and fountain-pen tips. Furthermore, although it is dangerous, osmium tetroxide in very dilute solutions is widely used to stain substances to be viewed on microscope slides.



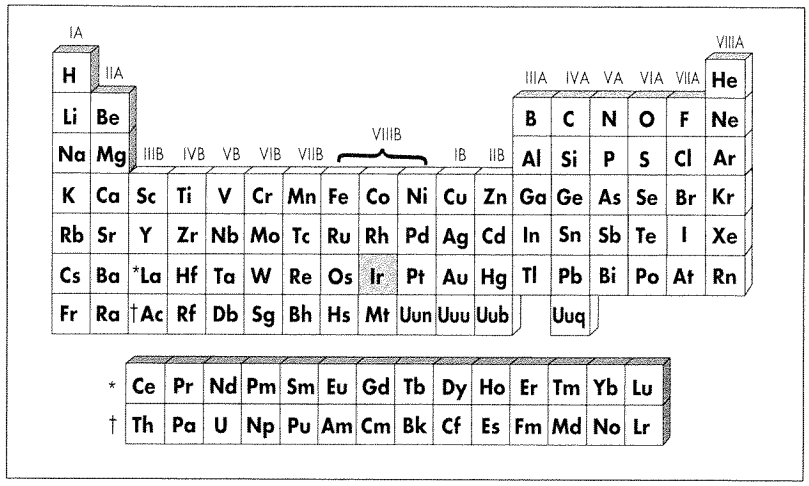
Osmium's hardness makes it an ideal ingredient for the alloy used to make fountain-pen tips.

Atomic Number **76**

Chemical Symbol **Os**

Group **VIIIB—Transition Element**

IRIDIUM



Ir

Iridium is one of the hardest and most corrosion-resistant metals known. It is considered a precious metal, similar to platinum. It is a yellowish-white metal that is more than 20 times denser than water, and it is too brittle to machine easily or form into specific shapes by compression or extension. The English chemist Smithson Tennant discovered iridium in 1803, using the same procedure that led him to the discovery of osmium. He isolated the element in the residue of platinum ores treated with aqua regia, a mixture of nitric and hydrochloric acids. Tennant named it iridium from the Latin word *iris,* meaning "rainbow," because its salts are highly colored.

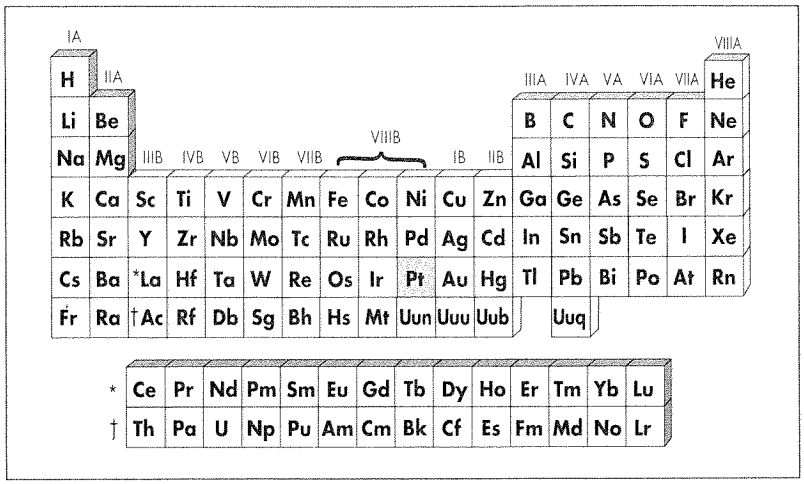
Iridium is generally found in ores containing platinum or nickel. Separating it from these ores is a laborious and costly task that is justified only by the simultaneous recovery of valuable platinum and nickel.

The chief application of iridium is as an additive to platinum, creating alloys that increase the hardness of the latter metal. Its resistance to corrosion has made it useful in the fabrication of items that require absolute purity such as hypodermic needles and rocket engines. The stability of iridium led to its being used to fabricate the platinum bar whose length was defined as the standard meter. Kept in Paris, the bar consisted of an alloy of 90 percent platinum and 10 percent iridium. The bar has since been replaced by a standard based on the wavelength of the natural vibrations of the krypton atom.

Atomic Number **77**

Chemical Element **Ir**

Group **VIIIB—Transition Element**

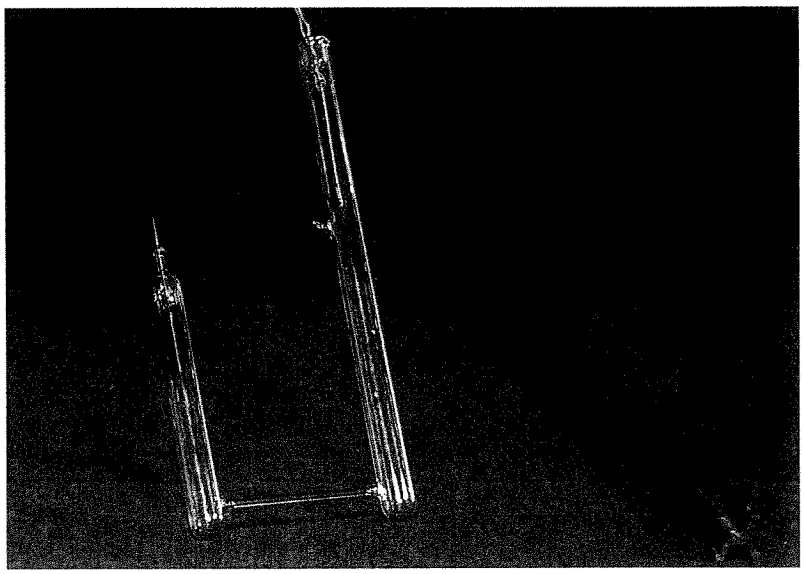


PLATINUM

Pt

Platinum is a precious metal that, like gold, is highly prized in the making of jewelry. Platinum is also a major industrial metal that is actively traded in commodity markets throughout the world. Its current price can be determined from any financial newspaper. It has been estimated that one of every five products made today uses platinum, either directly in the product itself or as part of the manufacturing process for the product.

Platinum is a durable, heavy, silver-white metal that is malleable, or easily rolled or hammered into thin sheets, and is extremely resistant to corrosion. It does not react with the oxygen



From 1889 until 1960, two marks on the bar on the right, a platinum and iridium alloy, were the standard used to define the meter. The bar was kept in France by the Bureau of International Weights and Measures. The meter is now defined using a krypton lamp (left).

Atomic Number **78**

Chemical Symbol **Pt**

Group **VIIIB—Transition Element** (Precious Metal)

Platinum is a major industrial metal that is actively traded in commodity markets throughout the world.

in air and is therefore usually found in nature as a pure metal. Retrieving the metal is more difficult than simply picking nuggets of it off the ground, however, because other metals are usually mixed with platinum in its ore. Usually, some form of industrial and chemical "cleanup" is needed to recover pure platinum.

More than 80 tons of platinum are produced each year. Although fairly large deposits of the metal exist in the Ural Mountains in Russia, most of the world's supply comes from the Republic of South Africa.

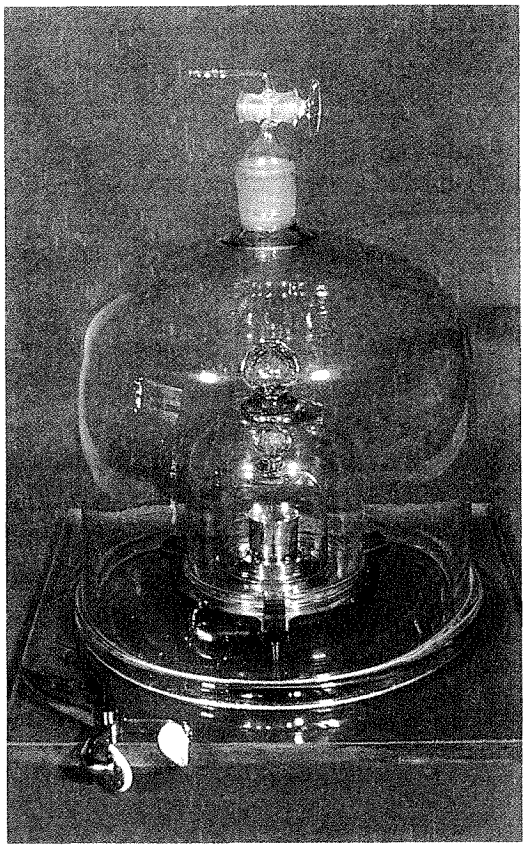
Platinum was discovered by Charles Wood, an Englishman, in 1741. There is evidence, however, that it was used by the pre-Columbian Indians of the Americas. It takes its name from the Spanish word *platina,* which means "silver."

Platinum is used in petroleum refining, dentistry, the chemical industry, the ceramics industry, and the electrical and electronics industries. In recent years, the automobile industry has found a major use for the metal. A platinum-coated ceramic grid serves as the catalyst in the catalytic converter attached to the exhaust system of all automobiles manufactured in the United States. The platinum assists chemical reactions that "clean up" the exhaust gases coming from the engine of the car, converting carbon monoxide and unburned fuel into water and carbon dioxide.

Many uses of platinum take advantage of its chemical stability and inertness. A bar of a platinum-iridium alloy, for example, is stored in a special vault in Paris where it serves as the world's standard for the kilogram, the basic unit of mass in the metric system. Platinum alloys are also used in the glass industry to contain and handle molten glass, and because the rate at which platinum expands upon heating is almost the same as that of glass, platinum wires can be sealed into glass and used to conduct electricity through glass tubes and bulbs. In medicine, stable platinum electrodes are used in the electronic pacemakers that are implanted in the bodies of people with heart ailments to insure that the heart maintains a steady rhythm.

Its ability to be hammered into incredibly thin sheets, some only 100 atoms thick, makes platinum ideal for thin protective coatings. It is used to coat the nose cones of missiles, the fuel nozzles of jet engines, and even the cutting edges of razor blades.

The catalytic converter used in automobiles is only one example of how effective platinum is as a catalyst for many different types of chemical reactions. As an example of the catalytic power of platinum, a mixture of hydrogen and oxygen will explode



The International Bureau of Weights and Measures uses this piece of a platinum and iridium alloy as the official standard for the kilogram. The bar is kept in a vault at the organization's headquarters in France.

in the presence of the metal, and platinum is used to sustain the reaction in the hydrogen-oxygen fuel cells used in spacecraft. Platinum is often ground up into a fine powder to increase both its surface area and its ability to interact with other chemicals. It is commonly used in this form on airplanes that fly at high altitudes, which employ platinum catalysts in their air filters for converting the harmful ozone found in the upper layers of the atmosphere into oxygen. Many industrial processes depend on platinum catalysts. An example is the famous Ostwald process for making nitric acid, in which ammonia is burned in the presence of a platinum catalyst to produce nitric oxide. Platinum catalysts are also used to increase the rate of hydrogenation of fats and oils and the distillation of petroleum products from crude oil.

Recent research has shown that certain platinum compounds inhibit the growth of several kinds of cancerous tumors. The medical reason for this is not known, but progress has been reported in the use of platinum compounds to treat ovarian and testicular tumors, which are difficult to treat by more traditional methods.