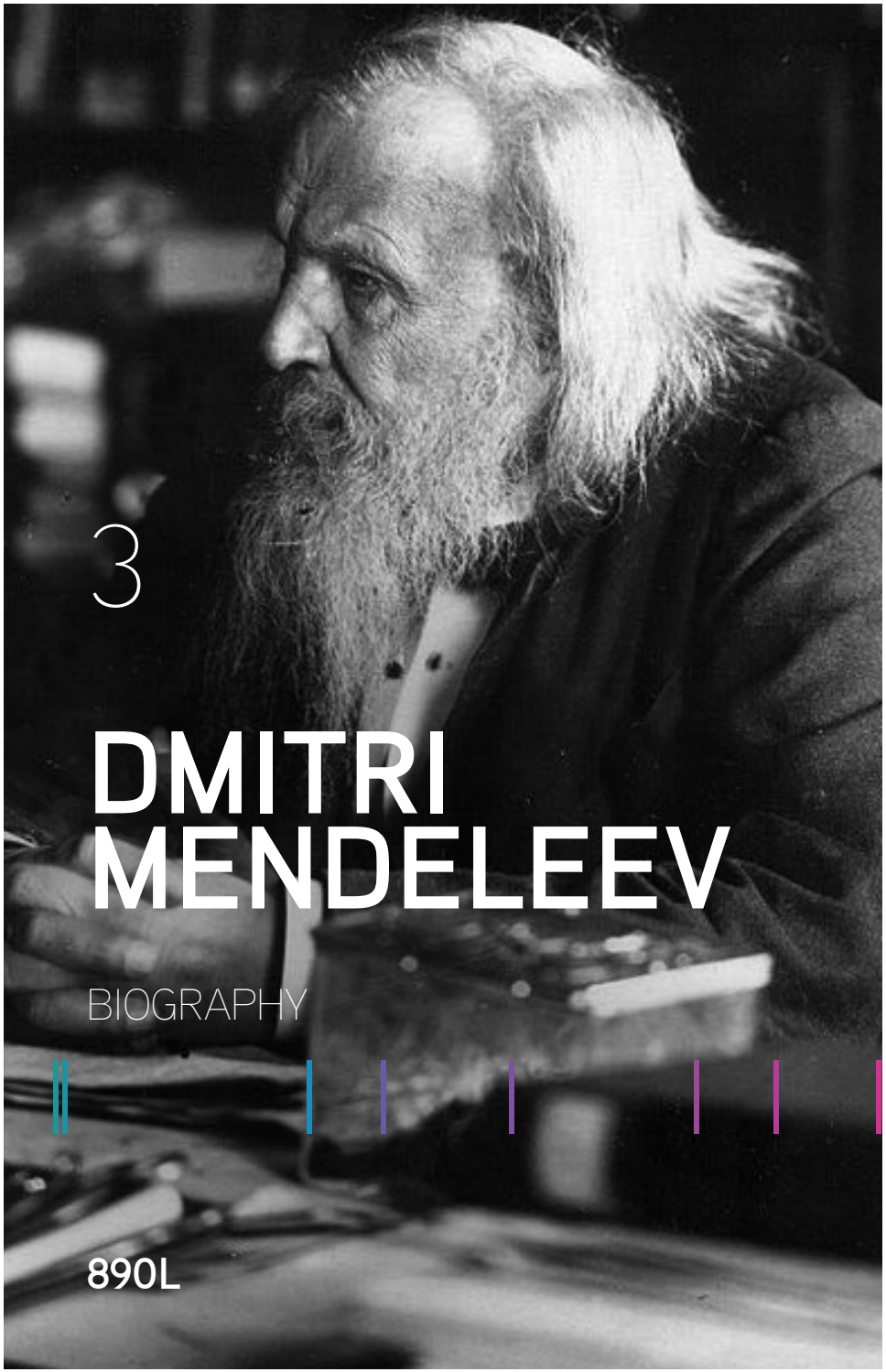

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DMITRI MENDELEEV

BIOGRAPHY

890L

BIG HISTORY PROJECT

Born
February 7, 1834
Tobolsk, Siberia, Russia

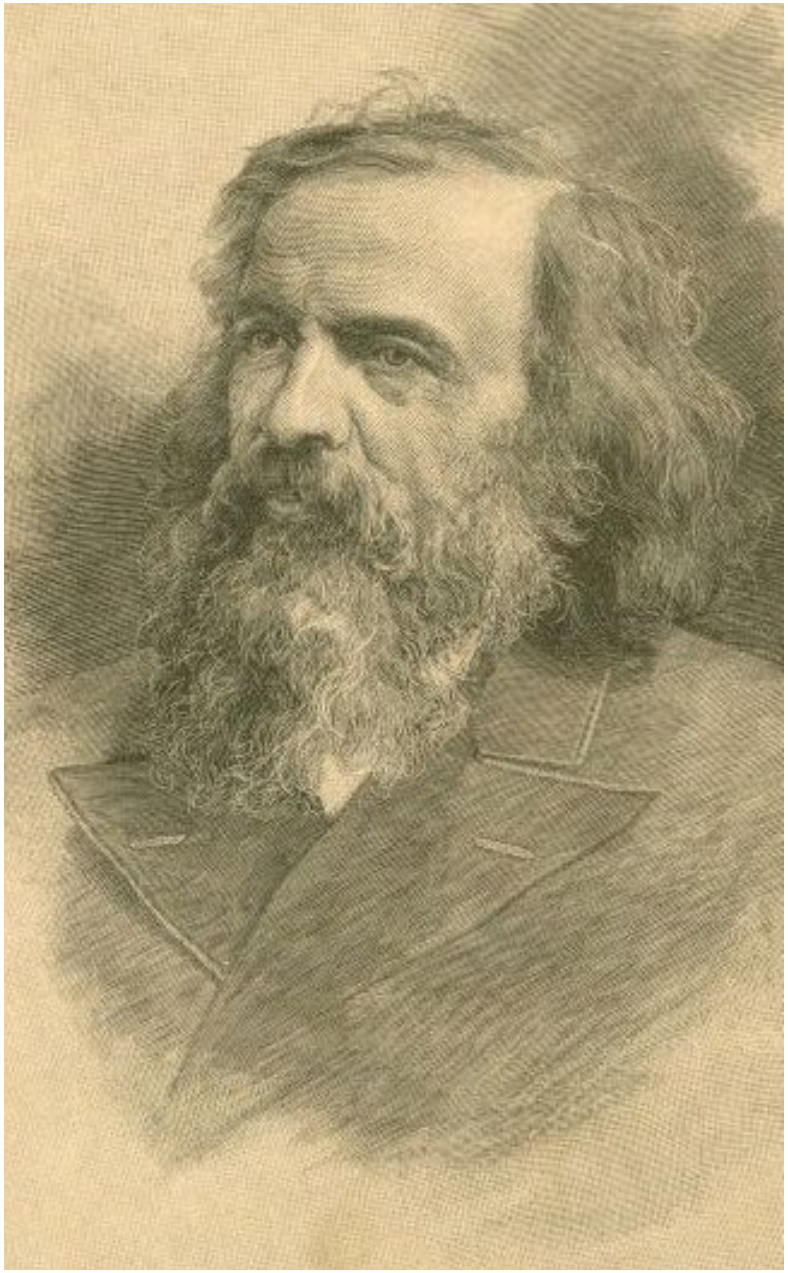
Died
January 20, 1907
St. Petersburg, Russia

DMITRI MENDELEEV

BUILDING THE PERIODIC TABLE OF ELEMENTS

By Michelle Feder, adapted by Newsela

Russian chemist and
teacher Dmitri Mendeleev
created the system
we use to classify the
chemical elements,
called the periodic table.



Organizing matter

In the mid-1700s, chemists began to identify elements, the building blocks of matter. Elements are pure substances made up of just one kind of atom, like gold and silver. Unlike compounds, elements can't be broken down any more.

At the time, scientists used a variety symbols for elements. No common language existed to explain how elements related to each other. In 1869, the Russian chemist Dmitri Mendeleev came up with one. His diagram of elements made him famous and became known as the periodic table. It contains the building blocks of all matter that exists in the world.

Here's what's especially amazing: Mendeleev's chart left spaces for elements that were yet to be discovered. For some of these missing pieces, he predicted what their atomic masses and other chemical properties would be. Later on, scientists discovered the elements Mendeleev expected. It proved the brilliance behind the periodic table.

A difficult childhood

Mendeleev was born in 1834 in the far west of Russia's Siberia. He was the youngest of a dozen or more children. His family faced one crisis after another. When Dmitri was little, his father went blind, and his mother went to work. She became the manager of a glass factory. Tragedy struck again in 1848 when the factory burned down. The family faced poverty.

Yet, Mendeleev's mother was determined to get him an education. She traveled with him a great distance to St. Petersburg to do so. Ten days after he was enrolled in school, his mother died of tuberculosis. The lung disease had also taken his father, and at least one of his siblings. Mendeleev himself would battle it as a young adult.

A young professor

The young Mendeleev went to Europe to study the latest advances in science. Upon his return to Russia in 1861, he found that few of the new developments in the field of chemistry had made their way to his homeland. He was determined to change that. So he lectured enthusiastically about the latest advances. Only 27 years old, he developed an eccentric personality with a flowing beard and long, wild hair that he was known to trim only once a year. Still, he became a popular professor.

Mendeleev saw that there was no modern textbook on organic chemistry. Organic chemists study compounds containing the element carbon, which all life depends on. So, Mendeleev wrote a textbook on organic chemistry. But Mendeleev was painfully aware that many of his students "could not follow" him, as one student observed. He knew that a critical reason for peoples' difficulty in understanding chemistry was the lack of any clear system for classifying elements. Without one, he couldn't explain the relationships between different substances.

A missed train and a dream

Next, Mendeleev began a textbook for inorganic chemistry. Unlike organic chemistry, it is concerned with nonliving, inorganic substances, such as minerals.

In 1867, when Mendeleev began writing his book, he set out to organize and explain the elements. He began with what he called the "typical" elements: hydrogen, oxygen, nitrogen, and carbon. Those substances demonstrated a natural order for themselves. Next he included the halogens. These had low atomic weights, reacted easily with other elements, and were readily available in nature.

At the time, elements were normally grouped in two ways: either by their atomic weight or by their common properties, such as whether they were metals or gases. Mendeleev had a breakthrough. The two ways of grouping elements could be combined.

Mendeleev was said to have been inspired by the card game known as solitaire. In the game, cards are arranged both by suit, horizontally, and by number, vertically. To put some order into his study of chemical elements, Mendeleev made up a set of cards. Each represented one of the 63 elements known at the time. Mendeleev wrote the atomic weight and the properties of each element on a card.

He took the cards everywhere he went. On February 17, 1869, with a train to catch that morning, Mendeleev set to work organizing the elements with his cards. He carried on for three days and nights, forgetting the train. He arranged and rearranged the cards in various orders constantly. Finally, he noticed some gaps in the order of atomic mass.

As one story has it, Mendeleev, exhausted from his three-day effort, fell asleep. He later recalled, "I saw in a dream, a table, where all the elements fell into place as required. Awakening, I immediately wrote it down on a piece of paper." He named his discovery the "periodic table of the elements."

While arranging these cards of atomic data, Mendeleev discovered what is called the Periodic Law. Mendeleev arranged the elements in order of increasing atomic mass. He noticed that the properties were repeated. Because the properties on his chart repeated themselves regularly, or periodically, the system became known as the periodic table.

In devising his table, Mendeleev did not completely follow the order of atomic mass. He swapped some elements around. We now know that the elements in the periodic table are not all in atomic mass order. Although he was unaware of it, Mendeleev had actually placed the elements in order of increasing "atomic number." This number represents the amount of positively charged protons in the atom. It's also the number of negatively charged electrons that orbit the atom.

Timeline of Mendeleev's life

1834
Born in Tobolsk, Siberia, a province of Russia, on February 7

1847
Father, Ivan Pavlovich Mendeleev, dies of tuberculosis

1849
Travels with mother and sister from Tobolsk to Moscow and St. Petersburg

1850
Enrolls in Pedagogical Institute in St. Petersburg; mother and sister die of tuberculosis

1855
Graduates as a science teacher and accepts post in Simferopol in Crimea

1856
Returns to St. Petersburg to defend his master's thesis and lecture in chemistry

1861
Publishes textbook, *Organic Chemistry*, which wins the prestigious Domidov Prize

1866
Becomes a professor of chemistry at University of St. Petersburg

1868
Helps to found the Russian Chemical Society; publishes first edition of *Principles of Chemistry*

1869
Devises the periodic table of elements

1876
Visits the United States to see the Pennsylvania oil fields

1830 | 1840 | 1850 | 1860 | 1870 | 1880

During the time of Mendeleev

1837
Inventor Samuel Morse patents his electric telegraph

1848
Karl Marx publishes *The Communist Manifesto*

1859
Naturalist Charles Darwin publishes *On the Origin of Species*

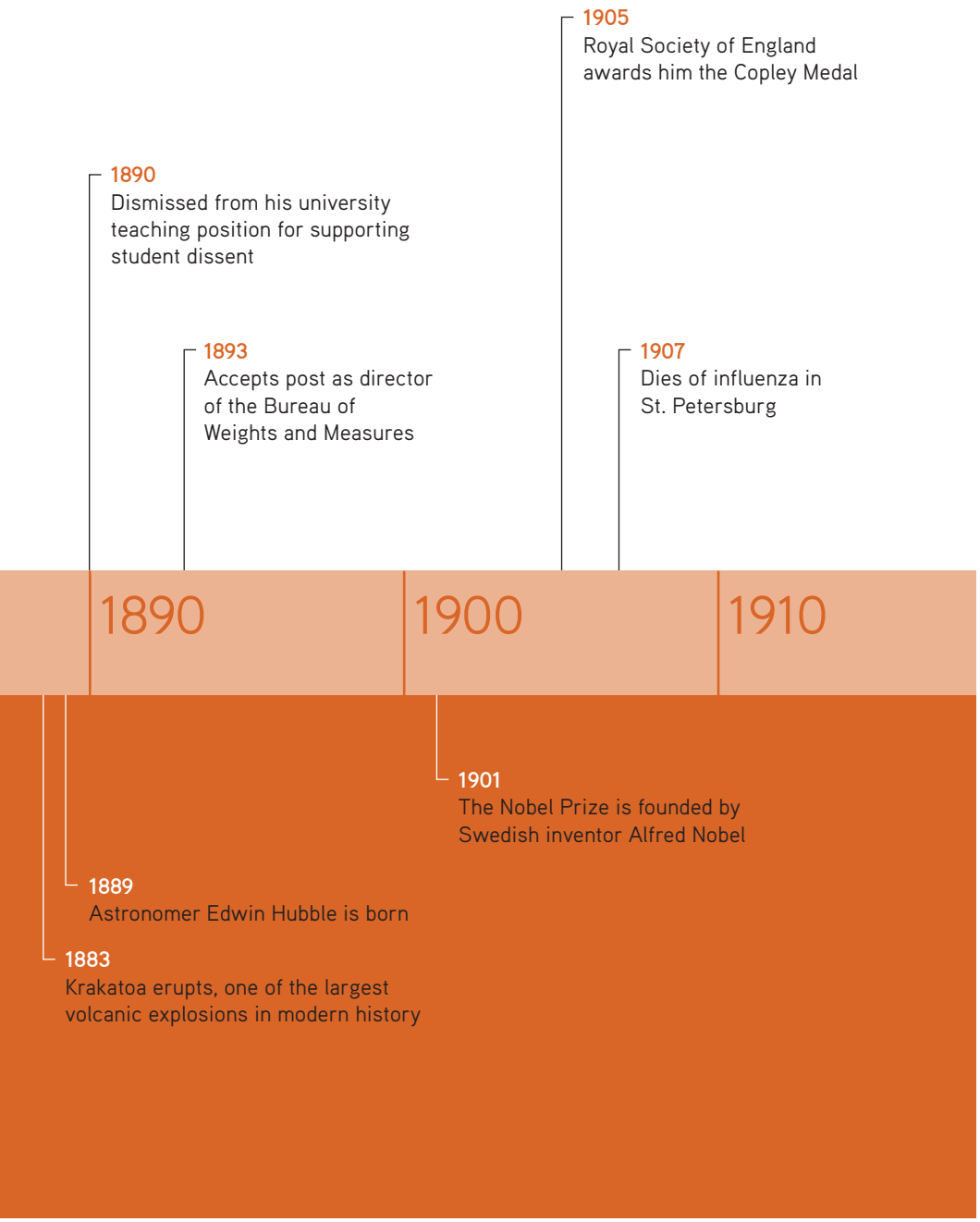
1860
Chemist Stanislao Cannizzaro discovers that molecules can contain more than one kind of atom

1866
Gregor Mendel publishes *Experiments on Plant Hybridization*, becoming the "father of modern genetics"

1867
Chemist and physicist Marie Curie is born Maria Sklowdowska in Warsaw, Poland

1868
Astronomer Henrietta Swan Leavitt is born

1879
Thomas Edison tests his first light bulb



Mendeleev went even further. He corrected the known atomic masses of some elements. And he used the patterns in his table to predict the properties of the elements he thought must exist but had yet to be discovered. He left blank spaces in his chart as placeholders to represent those unknown elements.

He would guess at atomic mass, atomic number, and other properties of hypothetical elements.

Gallium, germanium, and scandium were all unknown in 1871. However, Mendeleev left spaces for each and predicted their atomic masses. Within 15 years, the "missing" elements were discovered. Amazingly, they conformed to the basic characteristics Mendeleev had recorded. The accuracy of those predictions led to the periodic table's acceptance.

Building on others' achievements

Mendeleev did not develop the periodic table entirely on his own; he built on knowledge handed down from chemists who came before him. In the early 1800s, about 30 elements were known. By then chemists knew that some of these elements acted in similar ways or had similar characteristics. However, no one had found an overall pattern in their behaviors.

In 1860, scientists met at one of the first international chemistry conferences. They decided that hydrogen, the lightest element, be given a weight of 1. All other elements' weights would be compared to that of a hydrogen atom. That means that if an element is eight times heavier than hydrogen, its weight is 8.

As can happen in science, another researcher arrived at the same theory as Mendeleev's at about the same time. In 1870, German chemist Julius Lothar Meyer published a paper describing the same organization of elements as Mendeleev's.

Was it fair that Mendeleev received all the credit for the periodic table while Meyer stayed unknown? It's possible that this happened because Mendeleev published his findings first.

Whatever the case, Mendeleev's periodic table provided invaluable at classifying the building blocks of matter.

Completing the puzzle

As invaluable as the periodic table was, it left plenty of room for discovery and improvement. In the 1890s, an entirely new and unexpected group of elements was detected: the noble gases. They were added to the table as a separate column. Helium, the second-most abundant element in the Universe, wasn't found on Earth until 1895. Another 60 or so elements have since been discovered. Others may still be waiting to be found.

Beneath the main periodic table, you can see two rows. They're known as the "lanthanides" (atomic numbers 57 — 71) and "actinides" (atomic numbers 89 — 103). As scientists found the heavier elements and began to create many more, the newer elements have been separated to keep the table's shape intact.

As of 2012, the periodic table has a total of 118 elements. Some elements have been named after scientists. Atomic number 99 is called Einsteinium, for Albert Einstein. Rutherfordium, atomic number 104, is named in honor of physicist Ernest Rutherford, who developed the modern model of the atom. Atomic number 101, Mendelevium, is named after the periodic table's inventor.

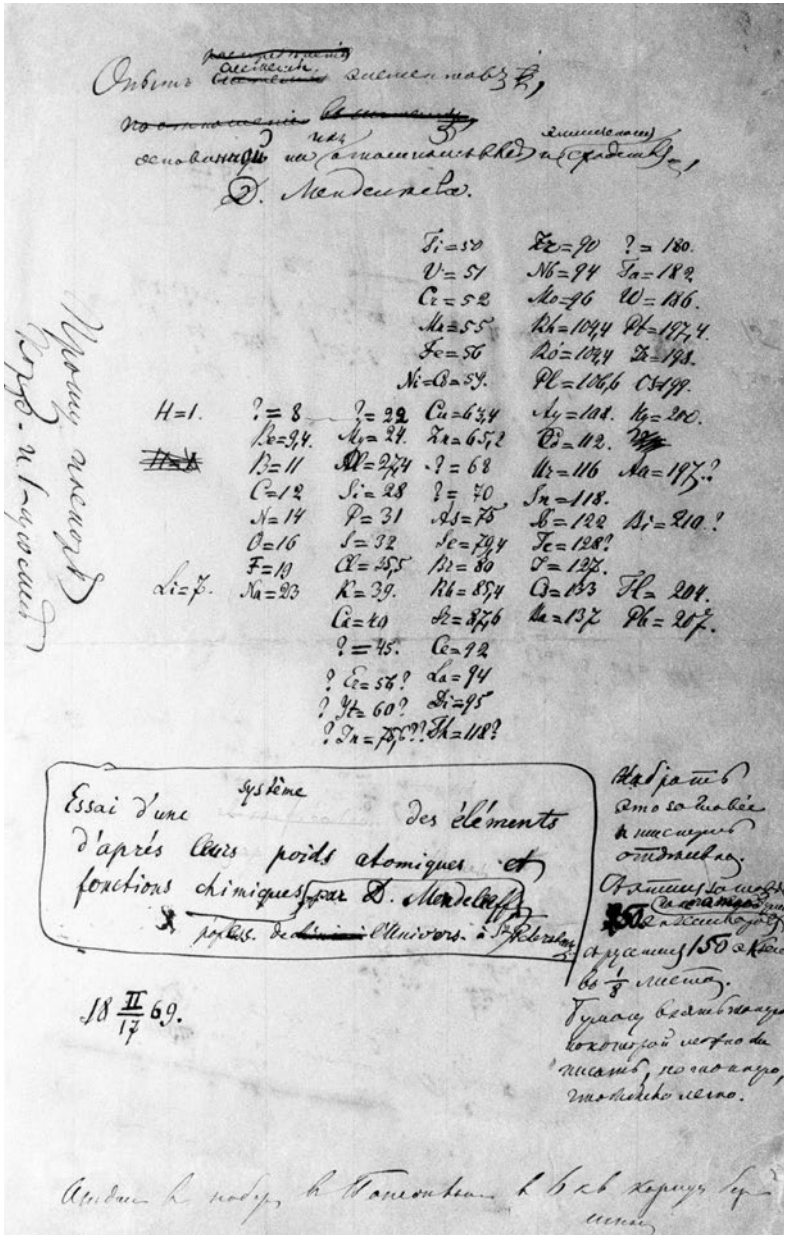
The matrix

Mendeleev's periodic table presented a new standard. Now all of the elements were positioned in a logical order. The elements are arranged in a series of rows called "periods," so that those with similar properties appear in vertical columns. Each vertical column is called a "group," or family, of elements. This instantly shows one set of relationships when read up and down, and another when read from side to side.

Some groups have elements sharing very similar properties, such as their appearance and their behavior. For example, each element has its own melting and boiling point, the temperatures at which it changes from a solid to a liquid and from a liquid to a gas. Another characteristic is how "reactive" an element is, meaning how quick it is to join up with other elements. Scientists recognize how an element will react based on its location on the table.

The elements are known by an atomic symbol of one or two letters. For example, the atomic symbol for gold is "Au," the atom's name is "gold," and its atomic number is 79. The higher the atomic number, the "heavier" an element is said to be.

Hydrogen is 1 on the periodic table, in the upper left corner. Its atomic number is 1; its nucleus contains one proton and one electron. About 98 percent of the Universe consists of the two lightest elements, hydrogen and helium.



The periodic table as first drawn by Mendeleev in 1869

Continuing the mission

Scientists continue to adjust the periodic table as new elements are found. Mendeleev's mission to clarify chemistry lives on. He dedicated his textbook to his mother with what were her last words to him:

> Refrain from illusions; insist on work and not on words. Patiently seek divine and scientific truth.

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Mendeleev's 1869 periodic table

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