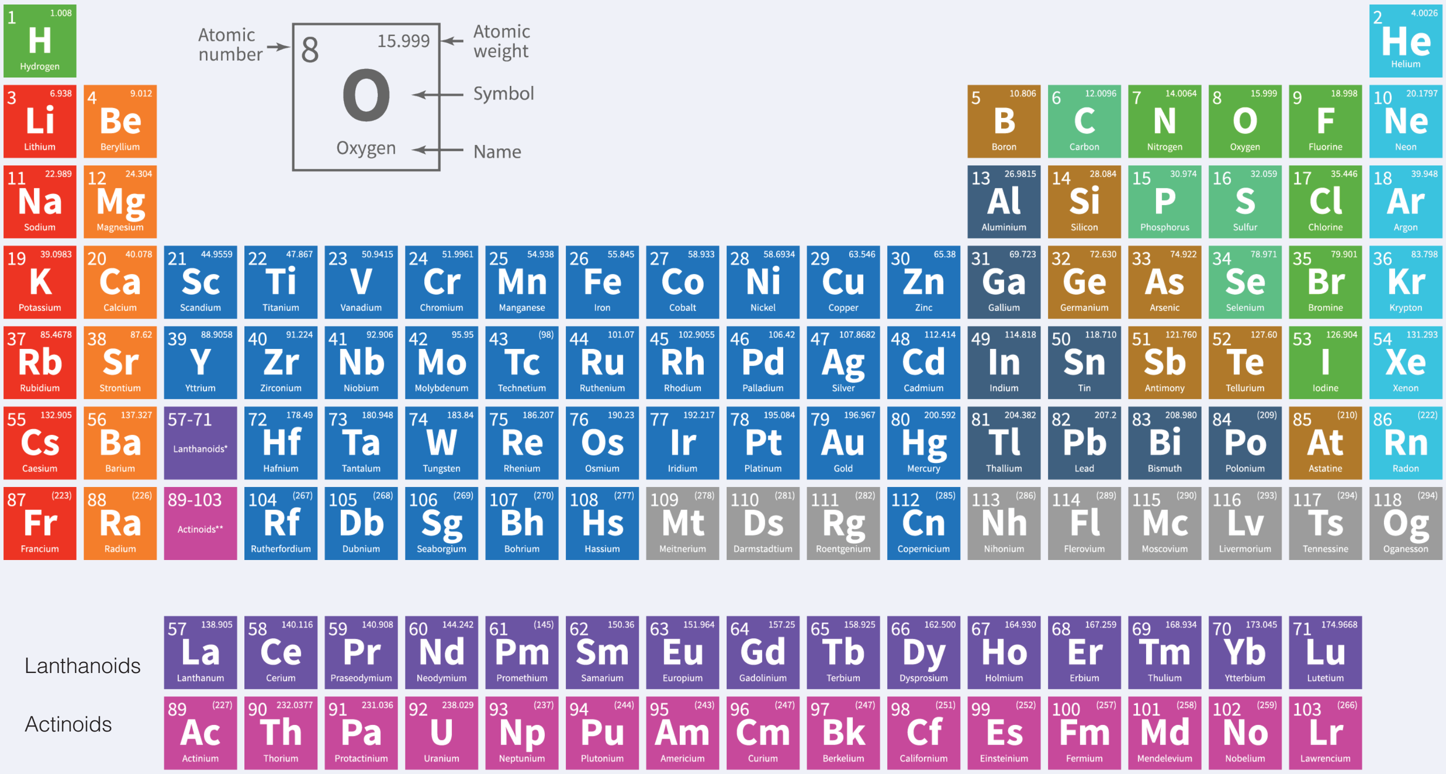
The Periodic Table Of Elements



The periodic table of elements represents a collaborative discovery that crosses centuries, continents, and scientific disciplines. Many researchers contributed to solving the atomic puzzle, and in so doing, created a valuable tool for both practical and pedagogical chemistry.

By the late 1860s, University of Saint Petersburg chemistry professor Dmitri Mendeleev was working on a second volume of his 1861 textbook, "Principles of Chemistry." Looking to find a simple way to classify elements "by some exact, definite principle," he drew up a table. A pattern emerged: a very obvious periodicity of chemical behaviors as a function of atomic mass. "I am quite conscious that this attempt is not final," Mendeleev wrote. Nonetheless, he believed that the periodicity would be proven to apply to "all elements whose atomic weights have been determined with some reliability."

In March of 1869, Mendeleev delivered his discovery in a roughly drawn sketch to the Russian Chemical Society and published it later that year. Two contemporary chemists, Karlsruhe professor Lothar Meyer (Germany) and industrial chemist John Newlands (England), envisioned and published similar charts around the same time.

The table's form has evolved over the decades. Starting with Mendeleev's first published work on the periodic table in 1869, there were question marks noting gaps in knowledge, and copious disagreements on what should be placed where and why. Mendeleev's work was groundbreaking to be sure, but it was an unfinished symphony that enticed chemists around the world to use the latest discoveries and refined calculations to fill in the missing notes and tweak some of its suspect aspects.

In the U.S., several prominent chemists made vital contributions that substantially enhanced and fortified the periodic table over the next century. At Harvard University, Theodore W. Richards and his graduate students remeasured the atomic weight of over 30 elements to pinpoint accuracy, work that ultimately earned Richards a Nobel Prize in Chemistry. Later, during his investigation of lead, he found that its atomic mass depended on the metal's source. The discovery validated British chemist Frederick Soddy's theory of isotopes and provided nuance and depth to the ever-more-robust periodic table.

Richards and others provided sophisticated atomic mass measurements to U.S. Geological Survey Chief Chemist Frank W. Clarke, who in 1872 had been tasked to compile and produce an annual table of elemental weights. Clarke also chaired the International Committee on Atomic Weights, which published the table for an international audience, revising it annually until the work stalled in 1918 because of the ongoing First World War.

While Clarke and others were compiling data, Francis Preston Venable, a chemistry professor

Written by Victoria Bruce

at the University of North Carolina, wondered why the periodic table was not used more, especially by teachers. He came to the conclusion that Mendeleev's table and those created by others were not terribly inspiring. A clearer table, he believed, could be the basis for teaching an entire chemistry course.

In 1896, Venable published the first history of the periodic law. With his students in mind, Venable redrew the periodic table without the transition "periods" to simplify the graphic representation. He argued that his changes to Mendeleev's table were minor, but that they "certainly make the table an easier, more intelligible, and more useful one to the student." Confident in his ability to get complex topics across to students, in 1898 Venable co-wrote a chemistry textbook with James Lewis Howe, "Inorganic Chemistry According to the Periodic Law."

A quarter century after Venable's well-received textbook, one of the most popular chemistry texts ever written was published by Horace G. Deming, a University of Nebraska chemistry professor. Deming's 1923 "General Chemistry" was an instant hit.

In Deming's chapter on the periodic law he provided "Mendelejeff's [another of the multiple romanized spellings of his name] form, slightly modified." However, he directed students to his own "long form" periodic table, which was strategically printed inside the back cover of the book. Deming's new table separated elements in periods 2 and 3 by moving the first two all the way to the left and the following elements to the right. He also delineated the columns into A and B groups. For the first time, a periodic table design made clear how elements transition from main group elements to transition elements.

Deming's graphical representation of the elements also got positive reviews. In 1927, Royce H. LeRoy wrote that Deming's table represented a "very marked improvement over the original Mendeleef type as far as presentation to beginning classes is concerned."

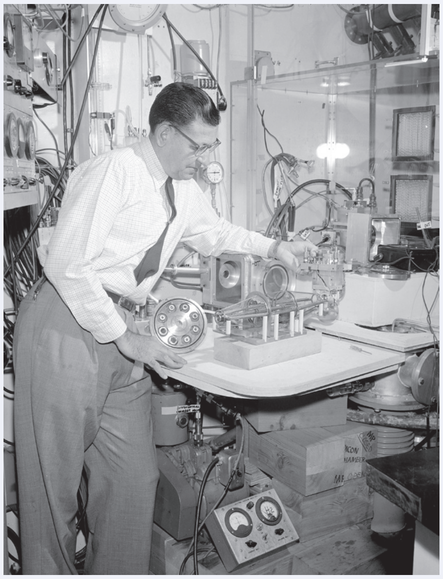
The textbook continued into its sixth edition in 1952, more than a quarter-century after its launch. Chemical companies took Deming's user-friendly table, branded it with their company logos and printed charts the size of student notebooks. "General Chemistry" helped standardize and promote the use of an enduring periodic table in a format that is still familiar today.

While Deming's version remained the most popular form of the periodic table into the mid-20th century, other discoveries were yet to come. Enter nuclear chemist and Manhattan Project scientist Glenn Seaborg. In 1944, Seaborg, Albert Ghiorso, and their colleagues at the Radiation Laboratory at the University of California, Berkeley (predecessor to the Lawrence Berkeley National Laboratory), were attempting to synthesize new elements beyond their newly created element plutonium.

Many scientists believed that the transuranic elements would fit within the periodic table's main body. Seaborg disagreed, arguing that the newest elements would behave like actinium and therefore needed to be grouped with it in their own pullout row beneath the lanthanide series.

In 1945 Seaborg published his hypothesis along with a table showing an "actinide series" that fell beneath the lanthanide row with empty squares following plutonium for yet-to-be-determined elements. "My theory required a major realignment of the periodic table of the elements," wrote Seaborg. "Senior colleagues counseled that advocating such a radical concept would ruin my scientific reputation. Fortunately for me, at the time my scientific reputation was nothing to worry about losing. And even more fortunate, I was right."

In 1951, Seaborg received the Nobel Prize in Chemistry, which he shared with Edwin M. McMillan "for their discoveries in the chemistry of the transuranium elements." The work of Seaborg and others in the Berkeley lab was extraordinary, and contributed to the synthesis of nine more transuranium elements in the actinide series, making a substantial addition to the periodic table. The final transactinide synthesized by Seaborg's team was element number 106 in 1974, which was later named after its creator. Colleagues said that Seaborg considered the addition of "seaborgium" to the periodic table be an honor even greater than winning the Nobel Prize.



Albert Ghiorso with the target and detection apparatus used to discover element 104 (undated photo). Credit: Lawrence Berkeley National Laboratory

In 2009, it was a partnership between American researchers from Vanderbilt University, Oak Ridge National Laboratory, the University of Tennessee-Knoxville and Lawrence Livermore National Laboratory, along with the Joint Institute for Nuclear Research in Russia, that filled in the second-to-final square in the periodic table's seventh row. Element 117 — the most recent element to be discovered — was later named tennessine to honor the state from which many of the researchers came. But this addition might not be the last periodic table revision. Researchers are now trying to discover elements even heavier than the heaviest known element: oganesson, element 118.

The tennessine team clearly stood on the shoulders of giants with their contribution, as did other researchers around the world and across the decades since Mendeleev's original table. It is with great reverence for one of the most important scientific collaborations of the last 150 years that we celebrate their collective achievements during the International Year of the Periodic Table.

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