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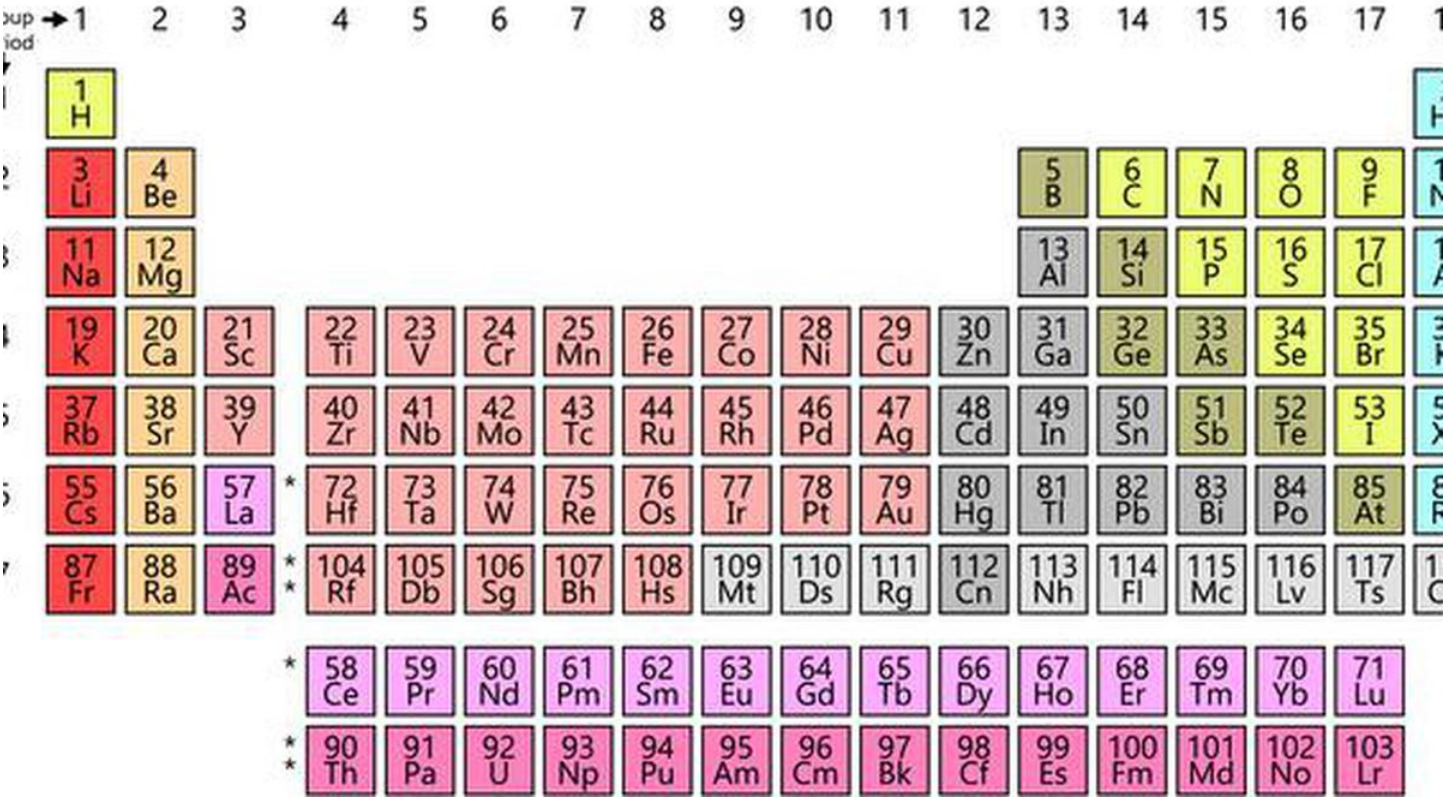
# The Table that defines chemistry turns 150

T. Pradeep




The majestic table of elements that hangs on the walls of chemistry classrooms across the world has turned 150 years old in 2019.

The ‘Periodic Table of Elements’, or simply, ‘The Table’ for many, was written by Dmitri Ivanovich Mendeleev on 17th February 1869. Looking back, the Table opens a window to the world of inanimate matter. Mendeleev’s profound impact on chemistry is comparable to those of his contemporaries, Gregor Mendel and Charles Darwin in genetics and evolution, respectively. Therefore, the United Nations General Assembly and UNESCO have decided to celebrate 2019 as the “International Year of the Periodic Table of Chemical Elements (IYPT2019)”.

Mendeleev was not the first one to create a table of elements. Earliest of such efforts was due to the father of modern chemistry, Antoine Lavoisier in 1789 who classified them in terms of their properties. John Newlands introduced the concept of octaves in chemistry, wherein properties repeat for every eighth element. There were other attempts too.

However, the proposal of Mendeleev was unique. On February 17, 1869, he sent out a single-page note to the Russian Chemical Society outlining his findings and it was published in the first volume of the society’s journal. In the same year, its German abstract with a table and eight comments was published in Zeitschrift für Chemie, taking it to larger Europe.

Mendeleev’s finding was that “The elements if arranged according to their atomic weights, exhibit an evident stepwise variation of properties.” In his Faraday Lecture, delivered in 1889 the statement of the periodic law appeared in the more familiar form: “The elements, if arranged according to their atomic weights, exhibit an evident periodicity of properties.”

While putting together all the 63 elements known at that time, his periodic table placed four slots between the known ones with question marks. He labeled them with a prefix, eka. All eka elements were discovered subsequently: eka-aluminum (gallium) in 1875; eka-boron (scandium) in 1879; eka-silicon (germanium) in1886 and eka-manganese (technitium) in 1937. Periodic table predicted the properties such as metallicity, density, melting point, etc., of the eka elements. Today, all 118 elements are put in the periodic table based on the periodic law.

Mendeleev put emphasis on chemical properties. As a result, in a few cases systematically increasing atomic weights did not match well with chemical properties. He hesitatingly placed tellurium before iodine with a question mark, although tellurium is heavier than iodine. Today we know that his placing was indeed justified.

Periodicity in properties made systematisation of information. Modern periodic law states that “the properties of the elements are periodic functions of their atomic numbers.” This restatement is due to Moseley who worked on the topic in 1913. Here, we must note that Mendeleev related the properties to atomic weights at a time when atomic numbers or the number of protons in the atomic nucleus was unknown. They were found to be part of nuclei in 1917 and the nucleus itself was discovered in 1911, both by Rutherford. In 1869, atomic weights were considered the single most important property of elements.

Mendeleev had a compelling reason to discover the periodic table. He was deeply concerned about the prevailing systematization of chemical knowledge and decided to write textbooks (Principles of Chemistry, Vol. I & II). He could cover only eight elements in his first volume of the book, which was finished in January 1869, and wanted to condense information in the form of a table for the second volume. It is said that the first version of the Table appeared in his dream.

Intense passion of the man to study science should motivate anyone. He was the youngest of 17 siblings who lost his father at the age of 13 and saw the destruction of his mother's factory by fire. She took him across Russia, walking all the way from Siberia to Moscow, a distance of 3,500 km. Having denied a place in Moscow, they next went to St.Petersburg where Mendeleev joined the pedagogy course. After graduation and a few years of work, he returned to St. Petersburg for his Masters degree.

The current periodic table decorating the walls of classrooms, printed on tea cups, T-shirts, and memorabilia is far removed from the original version of Mendeleev. Yet, the core principle that 'properties of elements are periodic functions of the inherent properties of its atoms' remains. This would indeed be one of the most fundamental insights into the puzzles of nature for which Mendeleev would be known for eternity. For that reason, element 101 is aptly named Mendelevium (Md). Although narrowly missed the Nobel Prize of 1906, he became one of the 15 scientists to be remembered with an element, a more illustrious recognition considering that 181 have won a Nobel Prize in chemistry so far.

(T. Pradeep is an Institute Professor at IIT Madras. Email: pradeep@iitm.ac.in)

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