Dmitrií Ivanovich Mendeleev

Dmitrií Ivanovich Mendeleev was a versatile genius. He worked on physical properties of gases and liquids, on isomorphism of solids, on the nature and composition of minerals, alloys, solutions and smokeless powders and on natural resources of Russia. He played a key role in modernizing Russian petroleum industry and also theorized on the origin of petroleum. He did agricultural experiments and the high yields of crops surprised peasants. He developed a spectroscope, invented an accurate differential barometer, studied meteorology and during a solar eclipse ascended alone in a balloon to make scientific observations.

But the highest ascent of Mendeleev was the discovery of the periodic law of elements. 'Elements arranged according to the size of atomic weights show clear periodic properties.' The law was first announced on March 6, 1869 at a meeting of the newly formed Russian Chemical Society and the paper titled 'The Relation between the Properties and Atomic Weights of the Elements' was published in the first volume of the *Journal of Russian Chemical Society*. The periodic law enshrines one of the great generalizations of science.

Dmitrií was born on January 27, 1834 at Tobolsk, Siberia. He was the youngest of fourteen children of the Mendeleevs, Ivan Pavlovich and Marya Dmitrievna. Ivan died in 1848 and Marya, then fifty seven, spent 'her last resources and strength' to take Dmitrií to distant St Petersburg with the hope of fulfilling her dream of 'devoting him to science.' Dmitrií finally received a grant to study in the Physico-Mathematical Faculty of the Central Pedagogic Institute. Marya soon died of exhaustion and in deathbed she told her son, ''Patiently search divine and scientific truth''. Marya was a remarkable woman and remains an unforgettable mother in the history of science.

In 1855 Mendeleev graduated from the Pedagogic Institute with a gold medal to his credit. His dissertation was 'On Isomorphism and Other Relations of Form to Composition'. Professors like Alexander Woskressensky, a notable organic chemist and teacher, had inspired him. He then taught for sometime in Crimea and Odessa but returned to St Petersburg in 1856 where he completed his master's degree in chemistry, studied properties of liquids, became a privat docent, taught theoretical and organic chemistry and wrote a textbook of organic chemistry which won him a prize. Then in 1865 he became a doctor of chemistry for his work 'On the Compounds of Alcohol with Water'. Mendeleev was progressing like an unerring Siberian crane migrating to a distant land.

In between he spent two fruitful years of study leave with Regnault in Paris and Bunsen in Heidelberg. This gave him an opportunity to attend the first International Chemical Congress at Karlsruhe in 1860. At that time there was widespread confusion about elementary quantities like the atomic weight. The work of the Italian chemist Stanislao Cannizzaro, which found focus in the Congress was crucial in clarifying the misconceptions. Cannizzaro employed a common standard, $H = 1$, and thus a universal system of atomic weights was finally on its way and Mendeleev would need it soon. For him, the Karlsruhe Congress was a harbinger of the periodic law.

In 1866 Dr Mendeleev, then 32, became Professor of General Chemistry at the University of St Petersburg. In those days general chemistry meant inorganic chemistry. It lacked unifying principles and was in disarray. In organising his course, Mendeleev felt the urgent need for a textbook. The result was *Osovy Khimi* or *General Chemistry*, better known in English as *Principles of Chemistry*. First published in 1868,

it ran into numerous editions and translations. This famous book was the potter's wheel that shaped the periodic law.

'In undertaking to prepare a textbook called *Principles of Chemistry,* I wished to establish some sort of a system of elements in which their distribution is guided by some definite and exact principle.' Mendeleev wanted the system to be based on 'numbers, which can be determined accurately' and chose atomic weight because it is a number, which is related 'to the material part which is common to the element and all its compounds'. What did he do then? 'So I began to write down the elements and their atomic weights on separate cards and this soon convinced me that the properties of the elements are in periodic dependence upon their atomic weights.' A genius making his discovery look trivial!

In 1869 only sixty three elements were known and Mendeleev could recognise vacant spaces in his table of elements. He boldly proclaimed, 'We should still expect to discover many *unknown* elements, for example those similar to aluminium and silicon....' He used Sanskrit eka (one) as prefix calling these elements eka-aluminium and eka-silicon. The discovery of gallium by Boisbaudron in 1875 and germanium by Winkler in 1886 brought more name and fame to Mendeleev than the law itself had done. Prediction in science has so often been like a shadow that is taller than the object.

To Mendeleev, science was an instrument of change and a philosophy, 'at the present day...a double number of Newtons is required to discover the secrets of nature, and bring life into harmony with the laws of nature'. He was also deeply interested in art and reflected on its symbiotic relationship to science, '....it will probably come to pass that our age be known as the epoch of natural science in philosophy, and of landscape in art'. His beloved wife Anna was herself an artist who adorned his study with pencil drawings of Newton, Lavoisier and their likes.

As in science, so in personal features Mendeleev was tall in stature with penetrating bright blue eyes. This and the flowing abundance of hair set him apart from all others. Strict but warm-hearted, liberal and democratic, unconventional and absent-minded, he was a legendary teacher who could instantly kindle a desire for knowledge in students. He actively supported many student causes and finally serious disagreement in this matter with a conservative and rigid administration led him to resign his Professorship in 1890. Thereafter he became Director of the Bureau of Weights and Measures, a position he held with much distinction till the end.

The end came on January 20, 1907. By then eighty six elements had become known and Mendeleev had the satisfaction of seeing his table virtually complete. Not really! Many more elements will be discovered in future, because man will make them and one of these, number 101, will be named mendelevium, Md. But that is another story.

Sources

1. W A Tilden, *Famous Chemists, The Men and Their Work*, George Routledge and Sons, 1921.
2. H M Leicester and H S Klickstein, *A Source Book in Chemistry*, McGraw-Hill, 1952.
3. *Great Chemists,* Ed. E Farber, Interscience Publishers, 1961.
4. W H Brock, *The Fontana History of Chemistry*, Fontana Press, 1992.

Animesh Chakravorty
Indian Association for the Cultivation of Science, Calcutta 700 032, India.