To the 150th Anniversary of the Periodic Law by Dmitriy I. Mendeleev

DISCOVERY OF THE PERIODIC LAW BY DMITRIY I. MENDELEEV

Dmitriy Yu. Pushcharovsky Lomonosov Moscow State University, dmitp@geol.msu.rut



1. Periodic table on the Main Chamber of Weights and Measures in Saint Petersburg.

2. Dmitriy Ivanovich Mendeleev (1834–1907).



he first version of the renowned periodic table, developed by the distinguished Russian chemist Dmitriy Ivanovich Mendeleev (*Fig.* 2), was published in 1869. To mark its 150th anniversary in 2019, the UN proclaimed it the International Year of the Periodic Table of Chemical Elements (*Fig.* 1). It is on the basis of the periodic table that scientists search for answers to the many mysteries concealed by Mother Nature. Besides, the history of the table's creation highlights the nonlinear process that usually accompanies scientific progress (Pushcharovsky, 2019).

Mendeleev was born on the 27th of January 1834 (8th of February 1834, Gregorian calendar) in Tobolsk, the first Siberian city, founded in 1587 on the border of the Urals and Western Siberia. Dmitriy was the last of seventeen children in the family of Ivan Mendeleev, director of the local gymnasium, and Maria Kornilieva, daughter of a middle-class landowner. Dmitriy was not a brilliant pupil at the gymnasium. He received modest grades in Latin and Holy Scripture, but he demonstrated a notable interest in mathematics and physics. In 1849, Dmitriy graduated from high school, and in the same year the family moved to Moscow and then Saint Petersburg. A year later, in 1850, Mendeleev was admitted to the Faculty of Physics and Mathematics at the Saint Petersburg Imperial University. At first, there were issues with his studies: he failed all examinations in his first year except for mathematics. However, in 1855, he graduated from the university with a gold medal and took the post of a senior teacher in the Crimean city of Simferopol. It was a critical period of the Crimean War, and Dmitriy transferred to Odessa, where he started teaching at the Richelieu Lyceum.

In 1856, Mendeleev returned to Saint Petersburg and defended his Master thesis in chemistry. In 1864, he was elected Professor of Chemistry at Saint Petersburg State Institute of Technology, and a year later, in 1865, he defended his Doctoral thesis. After another two years, he took up a position at the Department of Inorganic Chemistry at Saint Petersburg University.

In 1862, Mendeleev married Feozva Leshcheva, six years his senior. She was the stepdaughter of the poet Pyotr Ershov, who taught Dmitriy Russian literature at the Tobolsk gymnasium. The relationship between the spouses did not work out, and they divorced in 1881. Anna Popova, Mendeleev's second wife, was 26 years younger than him. In 1876–1880, she studied at the Saint Petersburg Imperial Academy of Arts. Anna's stepfather was opposed to her relationship with Mendeleev, and, in December 1880, he sent his stepdaughter to Rome, Italy. However, on the 14th of March 1881, Dmitriy Ivanovich came after her, and, on the 5th of May, they returned to Saint Petersburg. In the same year, the Orthodox Church approved Mendeleev's divorce with his first wife, but the church imposed a penance: he was not to marry in the next six years. However, already in April 1882, Kuntsevich, a priest at the Admiralty 3. Mendeleev's manuscript *Essay on the system of elements according to their atomic weights and chemical qualities*, 17 February 1869. 3a: the first version of the periodic system, used before his presentation for the members of the Russian Chemical Society and 3b: published at the beginning of the first two editions of the Foundations of Chemistry in March 1869. Published with the permission of the Mendeleev Museum-Archive (Saint Petersburg State University).



Church, wed Mendeleev to Anna Popova in exchange for 10,000 roubles, for which he paid the price and was defrocked. Mendeleev had seven children from two marriages. One of his daughters, the eldest from the second marriage, Lyubov Mendeleeva, became the wife of Alexander Blok, a famous Russian poet of the Silver Age, who dedicated his *Verses on a Beautiful Lady* (1905) to her.

Atomic Weights of Elements was presented by Professor Mendeleev worked at the Saint Petersburg University until N.A Menshutkin, the first editor of the Journal of the Russian 1890, and it is this period that is linked to his most significant Chemical Society, to the assembly of the Russian Chemical achievement: the discovery of the Periodic Law and creation Society. It is not clear whether the presentation was made by of the Periodic Table of Chemical Elements. In October 1867, the author. According to some sources, he had to leave Saint the scientist started teaching the Foundations of Chemistry Petersburg on the 17th of February to inspect a cheese factory course to students. In 1868–1871, he presented it in five books in the Tver Province, but his departure was postponed to the under the same title. While working on this publication, beginning of March due to the discovery of the Periodic Table. Mendeleev noticed that the properties of chemical elements However, according to other reports, Dmitriv Ivanovich deare clearly subject to a certain periodicity. This pattern belivered the presentation himself at the meeting of the Checame especially clear when he arranged the elements accordmical Society on the 6th of March. ing to their atomic weights, although, as it turned out later, some values did require adjustment. Later, this approach al-Mendeleev continued to gradually improve the first version of lowed him to predict the existence of some chemical elements which were vet unknown at the time.

History does not provide a clear answer to the question of (*Fig.* 4). In the same year, he lectured on the periodic table in several well-known chemical centres and presented his article *The Periodic Law of Chemical Elements.* pared a manuscript under the French title: "*Essai d'une sys-*teme des elements d'apres leur poids atomiques et fonctions chimiques" (Smirnov, 1974). This is fascinating, considering that Mendeleev's grades in foreign languages were far off from dis-

	3b				
3	опытъ системы элементовъ				
1. 1.14 Kenter 1 = 16	основанной на ихъ атомномъ въсъ и хиническоиъ сходствъ				
1-51 No-94 10-189 Carse Argo 10 16 Mass: Ka-199 Habby			T1 = 50	Zr = 90	? = 180.
K= 50 Qu= 124 2 - 195.			V = 51	Nb = 94	Ta = 182
Kales H = 1.86 (Sopp			Cr = 52	Mo= 96	W = 186.
1 Andist Cinte 2			Mn = 55	Rh = 104,4	PI = 197.4
1 1= 68 45-116 da-115.			Fe = 56	Ru = 104,4	Ir = 198
1 . di= A = 100 A:= 210 !		Nim	Co = 59	PI = 106,6	Os = 199.
5 hi- to 7-142	H=1		Cu = 63.4	Ag = 108	Hg = 200
1. 154 Gall A. 12 Pr - 201	Be= 9.	MR = 24	Zn = 65,2	Cd = 112	
G.te	B= 11	A1 = 27.4	2 = 68	Ur - 116	Au - 197?
1 4 - 14 3 Stall	C= 12	Si= 28	? = 70	Sn = 118	
1. H. 111	N=14	P = 31	AS = 75	Sb - 122	$B_1 = 210?$
Maljo air	0 = 16	S = 32	Se = 79.4	Te = 128?	and the second s
des demants some to habie	F = 19	CI - 35	Br = 80	1=127	
miques et intraction	$Li = 7 N_{R} = 23$	K = 39	Rb = 85.4	$C_{S} = 133$	$T_{1} = 204$
· harder	Carl Contractor Contractor	Ca = 40	Sr = 87.6	Ba = 137	Ph = 207
minory. & Alanda successified a fina		?=45	Ce = 92		
1 4 + ments		?Er=56	La = 94		
Tunning and an intering		2Y1 = 60	Di = 95		
manif no an anyon		?in = 75,4	Th = 118	E .	
1 that some 1					
and y -				Д. Мендел	13680

For tinction. At this time, he also finished working on the correed. sponding article, which was published in the same year in the *Journal of the Russian Chemical Society*, the first Russian chemical journal (Mendeleev, 1869) (*Fig.* 3b). Recognising the need for international recognition, Mendeleev sent the table to his colleagues in Western Europe. Besides, on the 6th of March, his famous report *On the Relationship between Properties and*

h al-Mendeleev continued to gradually improve the first version of the Periodical System until 1871, which is when the table took the familiar format that we know today (Mendeleev, 1871)
on of (*Fig.* 4). In the same year, he lectured on the periodic table in It is several well-known chemical centres and presented his article pre-*The Periodic Law of Chemical Elements*.