

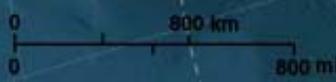


PROGRAM

of stay of participants of
"D.I.Mendeleyev and His Contribution
in the Development of World Science"
International Scientific Conference
in Tobolsk, September 15th – 19th, 2009



Russia



Arctic Ocean

Barents Sea

East Siberian Sea

Bering Sea

Kara Sea

Laptev Sea

Russia

Sea of Okhotsk

Black Sea

Caspian Sea

Kazakhstan

Mongolia

Sea of Japan

China

Yellow Sea



Czar Nicholas II and Alexi at Tobolsk, Siberia in 1917 - Beinecke Library, Yale University



David Clark, Stepan Kalmykov, and
David Hobart in Tobolsk, Siberia



Dr. David Hobart
Los Alamos
National Laboratory

Academician Boris Myasoedov
Secretary General
Russian Academy of Sciences

UNCLASSIFIED

Historical Perspectives and Far Reaching and Unexpected Applications of Mendeleev's Periodic Table of the Elements

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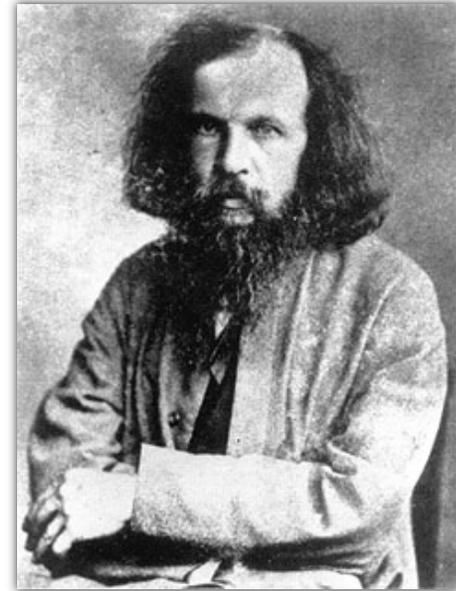
Presented at the

***D. I. Mendeleev and His Contributions to the World Science Conference
Celebrating the 175th Anniversary of the Birth of the Father of the Periodic Table***

Tobolsk, Siberia, Russia, September 16-19, 2009

LA-UR-09-05702

From Modest Beginnings



Dmitri Ivanovich Mendeleev was born on February 8th, 1834 in Verhnie Aremzyani near Tobolsk, Russian Empire

From modest beginnings in a small village in Siberia an extraordinary Russian chemist conceived of a profound and revolutionary scientific contribution to modern science: the Periodic Table of the Elements.

The Greek Periodic Table ~ 400 BC



As with most profound discoveries a number of important developments and observations were made prior to that discovery

Definition of an Element

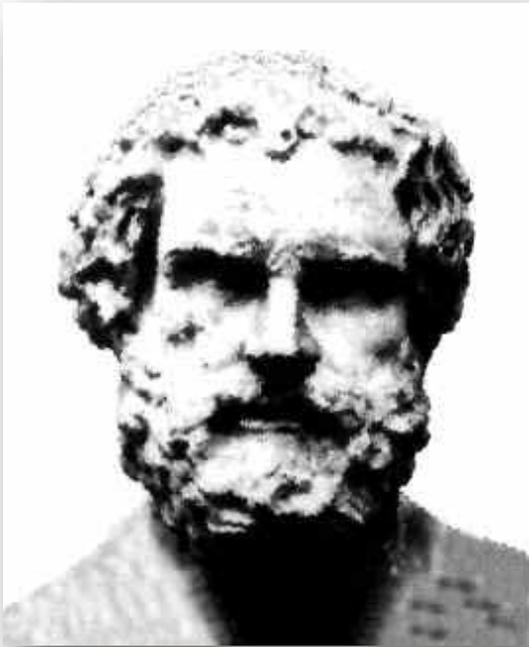


Robert Boyle
1627-1691

In 1661 Boyle criticized the experiments of “*alchemists*”

- Chemistry is the science of the composition of substances - not merely an adjunct to the art of alchemy
- Elements are the un-decomposable constituents of material bodies
- Understanding the distinction between mixtures and compounds, he made progress in detecting their ingredients - which he termed *analysis*

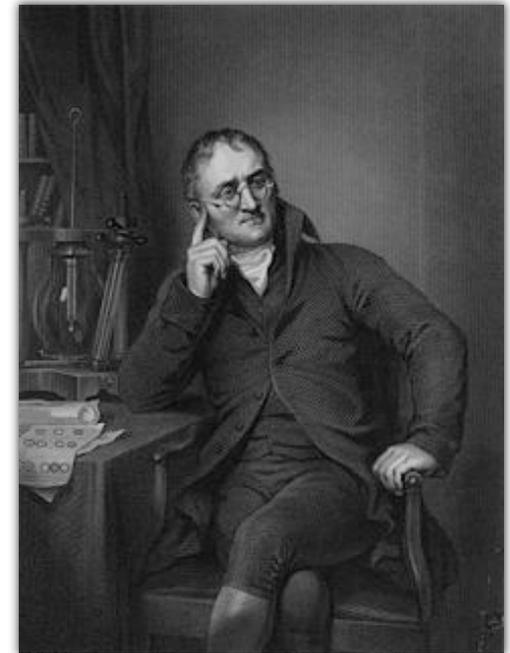
The Atomic Theory



Democritus of Abdera
460-370 BC

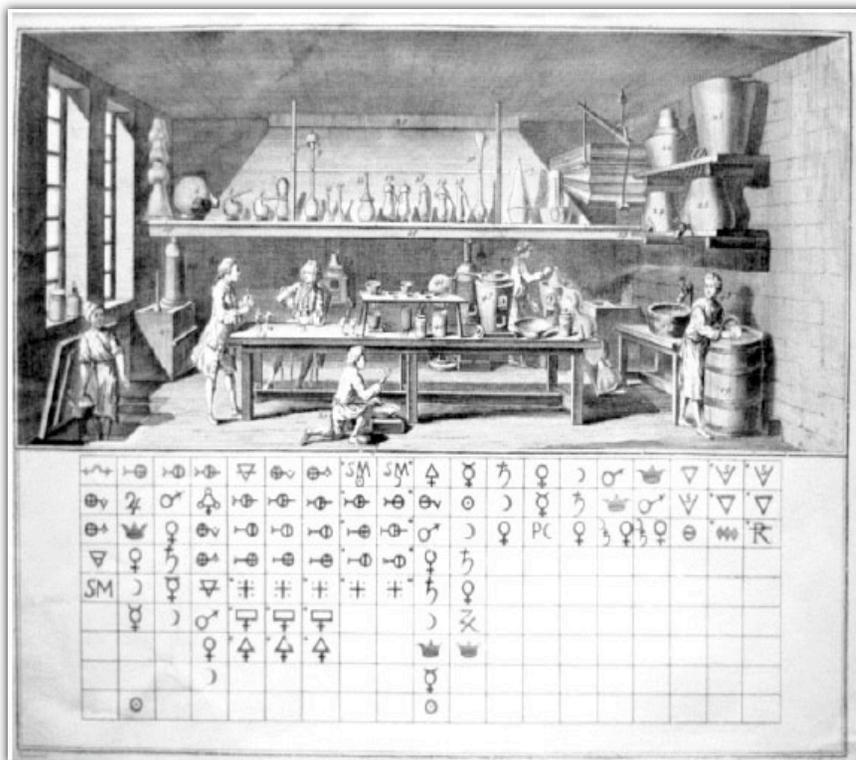
The Greek philosopher Democritus first proposed the atomic theory but centuries later John Dalton established the scientific foundation:

- All atoms of a given element are identical
- The atoms of different elements can be distinguished by their relative weights

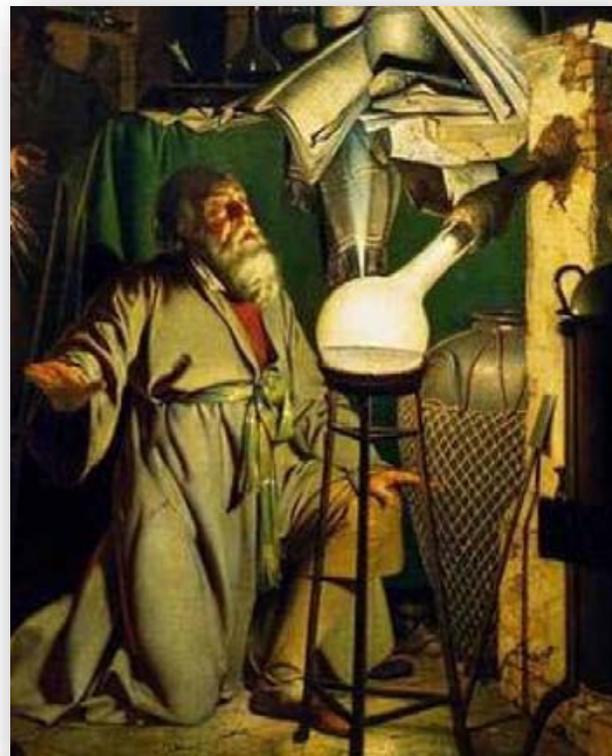


John Dalton
1766-1844

Early Knowledge and Discovery



The elements gold, silver, copper, tin, lead, mercury, and others were known from antiquity.



Searching for the “Philosopher’s Stone” German alchemist Henning Brand discovered **phosphorous** in 1669

Discovery of New Elements

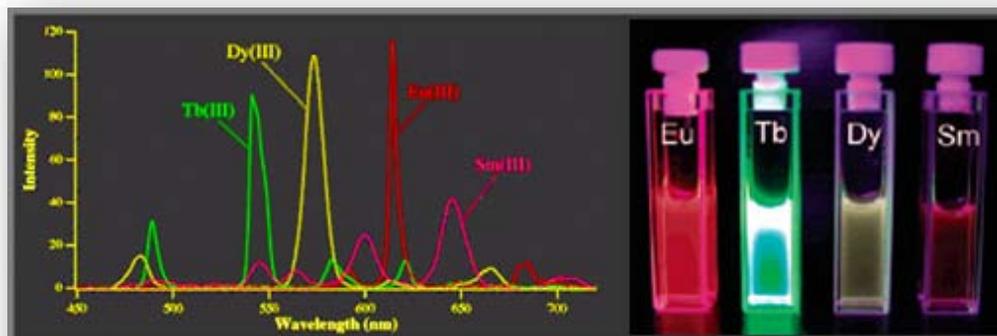


Martin Klaproth (1743-1817)
Ti, Zr, U, Te, Sr, Ce, Cr



Jöns Berzelius (1779-1848)
Si, Se, Ce, Li, V, Th

The lanthanide elements were discovered by many scientists between 1803 and 1907

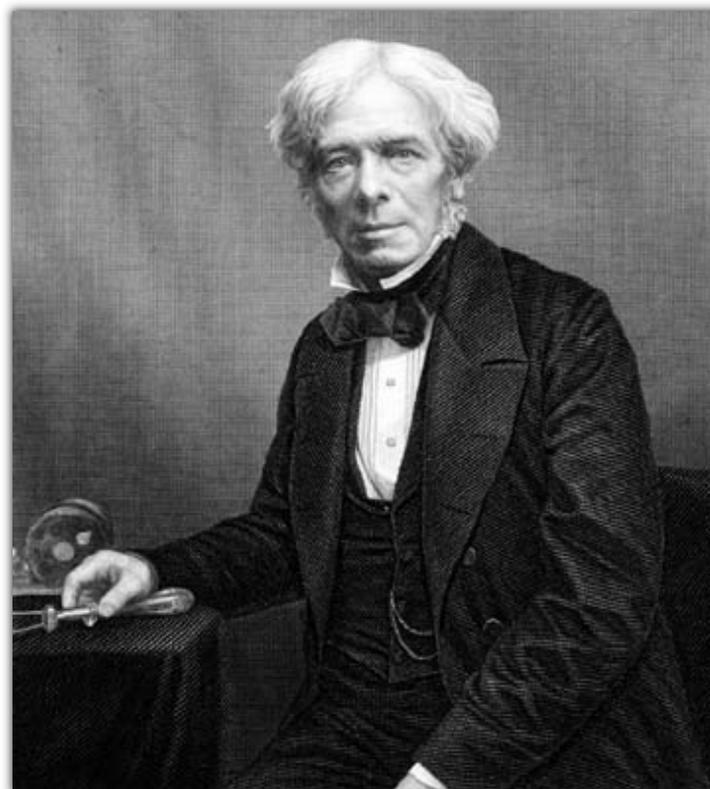


“Electrifying” Discoveries



Sir Humphrey Davy
1778-1829

Using electrochemistry he discovered several **alkali** and **alkaline earth metals** and the elemental nature of **carbon**, **chlorine**, and **bromine**.



Michael Faraday
1791-1867

He electrochemically investigated **chlorine**, invented the system of oxidation numbers, and popularized the terms anode, cathode, electrode, and ion.

More New Elements Discovered

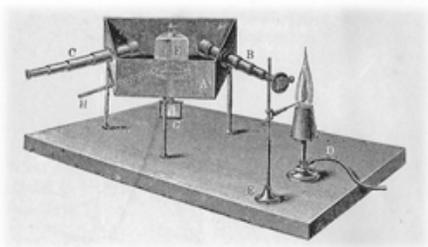
Robert Bunsen and Gustav Kirchhoff contributed to the fundamental understanding of spectroscopy and discovered two alkali metals, **cesium** and **rubidium**, with the aid of the spectroscope they had invented the year before. This inaugurated a new era in the means used to find new elements.



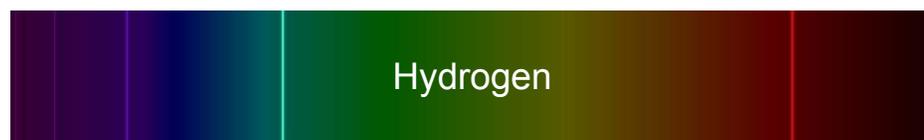
Robert Bunsen
1811-1899



Gustav Robert Kirchhoff
1824-1887



Spectroscope



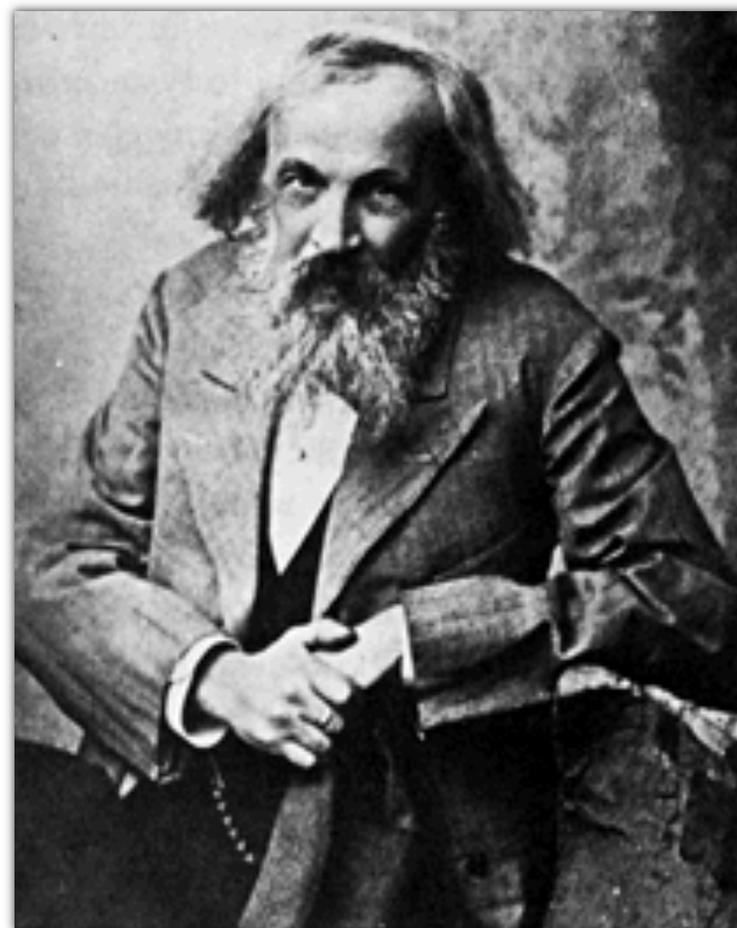
GAS DISCHARGE SPECTRA

Mendeleev's Periodic Table (1869)

ОПЫТЪ СИСТЕМЫ ЭЛЕМЕНТОВЪ.
ОСНОВАННОЙ НА ИХЪ АТОМНОМЪ ВѢСѢ И ХИМИЧЕСКОМЪ СХОДСТВѢ.

	Ti=50	Zr=90	?=180.		
	V=51	Nb=94	Ta=182.		
	Cr=52	Mo=96	W=186.		
	Mn=55	Rh=104,4	Pt=197,4.		
	Fe=56	Rn=104,4	Ir=198.		
	Ni=Co=59	Pi=106,4	O=199.		
H=1	Cu=63,4	Ag=108	Hg=200.		
Be=9,4	Mg=24	Zn=65,2	Cd=112		
B=11	Al=27,4	?=68	Ur=116	Au=197?	
C=12	Si=28	?=70	Sn=118		
N=14	P=31	As=75	Sb=122	Bi=210?	
O=16	S=32	Se=79,4	Te=128?		
F=19	Cl=35,5	Br=80	I=127		
Li=7	Na=23	K=39	Rb=85,4	Cs=133	Tl=204.
	Ca=40	Sr=87,6	Ba=137	Pb=207.	
	?=45	Ce=92			
	?Er=56	La=94			
	?Yt=60	Di=95			
	?In=75,6	Th=118?			

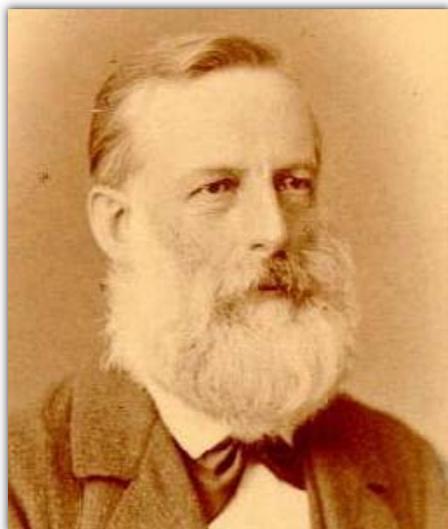
Д. Менделѣевъ



His table including 63 known elements that incorporated triads, octaves, and diagonals

Dmitri Ivanovich Mendeleev
1834-1906

Meyer's Periodic Table (1870)



Julius L. Meyer
1830-1895

Julius Lothar Meyer (1830-1895)
Table from *Annalen der Chemie, Supplementband 7*, 354 (1870)

Periodic table according to Lothar Meyer, 1870

I.	II.	III.	IV.	V.	VI.	VII.	VIII.	IX.
	B=11,0	Al=27,3		--		?In=113,4	Tl=202,7	
			--	--	--			
	C=11,97	Si=28				Sn=117,8		Pb=206,4
			Ti=48		Zr=89,7			
	N=14,01	P=30,9			As=74,9	Sb=122,1		Bi=207,5
			V=51,2		Nb=93,7		Ta=182,2	
	O=15,96	31,98			Se=78	Te=128,7		
			Cr=52,4		Mo=95,6		W=183,5	
--	F=19,1	Cl=35,38			Ru=103,5	J=126,5		
			Mn=54,8		Rh=104,1		Cs=198,6 ?	
			Fe=55,9		Pd=106,2		Ir=196,7	
			Co=Ni=58,6				Pt=196,7	
Li=7,01	Na=22,99	K=39,04			Rb=85,2			
			Cu=63,3		Ag=107,66		Au=196,2	
?Be=9,3	Mg=23,9	Ca=39,9			Sr=87,0			
			Zn=64,9		Cd=111,6		Ba=136,8	
							Hg=199,8	

Julius Meyer was a contemporary and competitor of Mendeleev. He made an abbreviated table with half the known elements in 1864 - the first time that elements had been grouped according to their *valence*.

He later constructed an extended table but unfortunately published it after Mendeleev's table was in print!

Discovery of Noble Gases



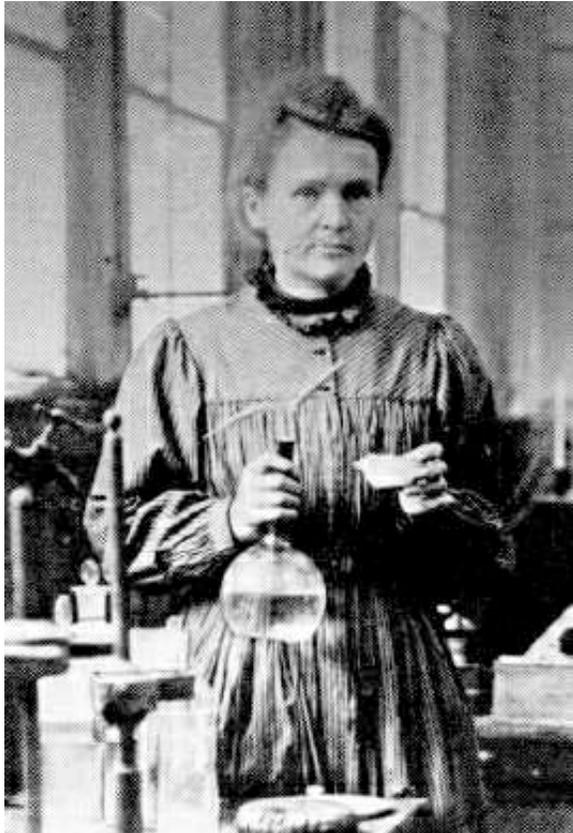
William Ramsay
(1852-1916)



John William Strutt
Third Baron Rayleigh
(1842-1919)

- Lord Rayleigh and William Ramsay discovered the "inert gases."
- In 1895 Rayleigh reported the discovery of **argon** a new gaseous element that was chemically inert that did not fit any of the known periodic groups.
- Ramsey discovered the rest of the inert gases and positioned them on the right side of the periodic table according to their atomic weights.

Discovery of New Elements



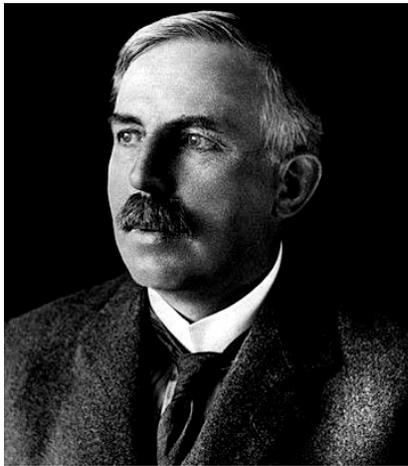
Marie Curie (1867-1934)



Pierre Curie (1859-1906)

In 1898 Madam Curie and her husband Pierre isolated the new elements **polonium** and **radium** from the uranium ore pitchblende - filling additional holes and adding new elements to Mendeleev's table.

The Theory of Atomic Structure



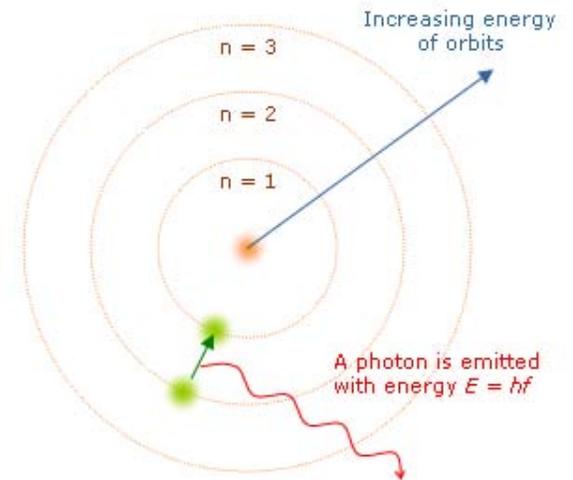
Ernest Rutherford
(1871-1937)



Niels Bohr
(1885-1962)



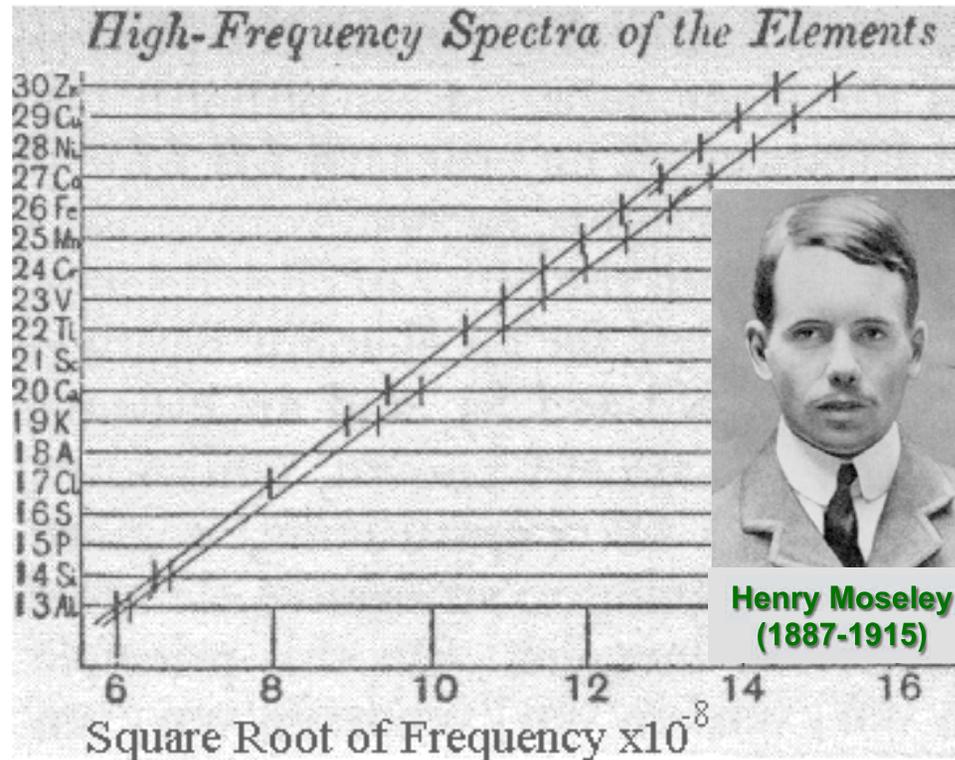
Max Planck
(1858-1947)



Bohr Atom

- Rutherford proposed that all of the mass of the atom was in the nucleus surrounded by nearly empty space.
- Bohr adapted Rutherford's theory to Planck's quantum theory and stated that electrons travel in discrete orbits around the nucleus

Moseley's X-ray Experiments



In 1913 Moseley subjected the known elements to x-rays and derived the relationship between x-ray frequency and number of protons.

When the elements were arranged according to increasing **atomic numbers** and not **atomic masses**, the inconsistencies in Mendeleev's table were eliminated!

Quantum Mechanics



Niels Bohr
(1885-1962)



Werner Heisenberg
(1901-1976)



Erwin Schrödinger
(1887-1961)



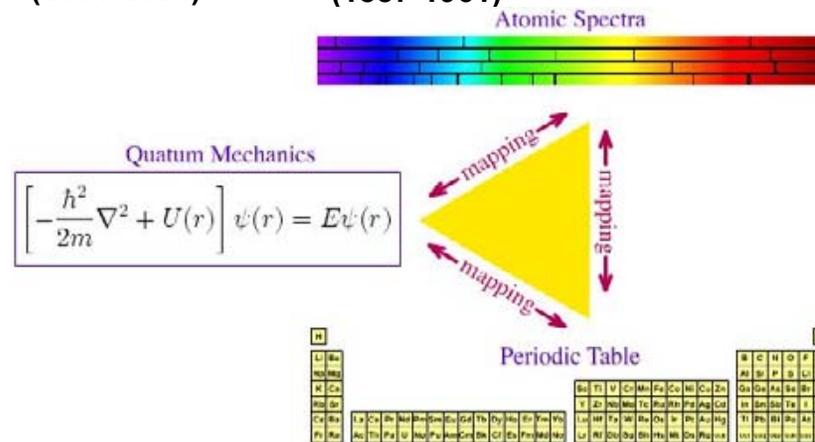
Wolfgang Pauli
(1900-1958)



Albert Einstein
(1879-1955)



Max Born
(1882-1970)



Paul Dirac
(1902-1984)

The uncertainty principle combined with the Bohr atom and the duality of wave and particle properties resulted in the quantum mechanical description of the atom through the collaborative effort of some of the most brilliant minds of the 20th Century

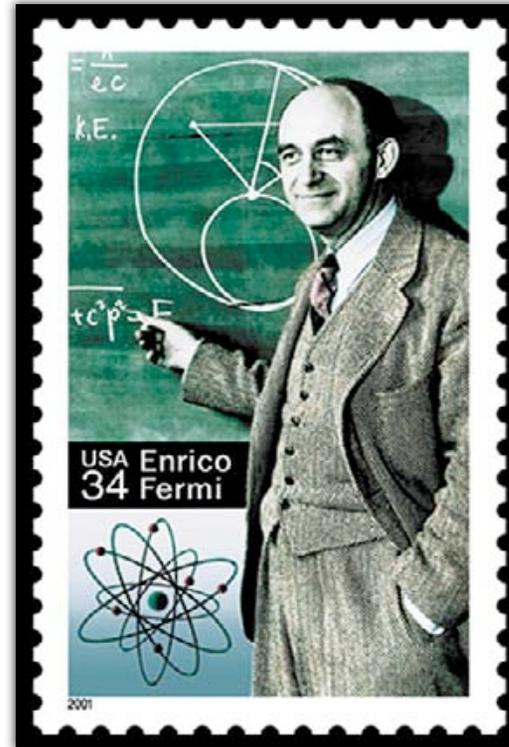
The Periodic Table 1938

H																	He
Li	Be											B	C	N	O	F	Ne
Na	Mg											Al	Si	P	S	Cl	Ar
K	Ca	Sc	Ti	V	Cr	Mn	Fe	Co	Ni	Cu	Zn	Ga	Ge	As	Se	Br	Kr
Rb	Sr	Y	Zr	Nb	Mo	Tc	Ru	Rh	Pd	Ag	Cd	In	Sn	Sb	Te	I	Xe
Cs	Ba	La	Hf	Ta	W	Re	Os	Ir	Pt	Au	Hg	Tl	Pb	Bi	Po	At	Rn
Fr	Ra	Th	Pa	U													
		<i>Lanthanides</i>															
		Ce	Pr	Nd	Pm	Sm	Eu	Gd	Tb	Dy	Ho	Er	Tm	Yb	Lu		

Modern Alchemy by Transmutation?



**Leo Szilard
(1898-1964)**



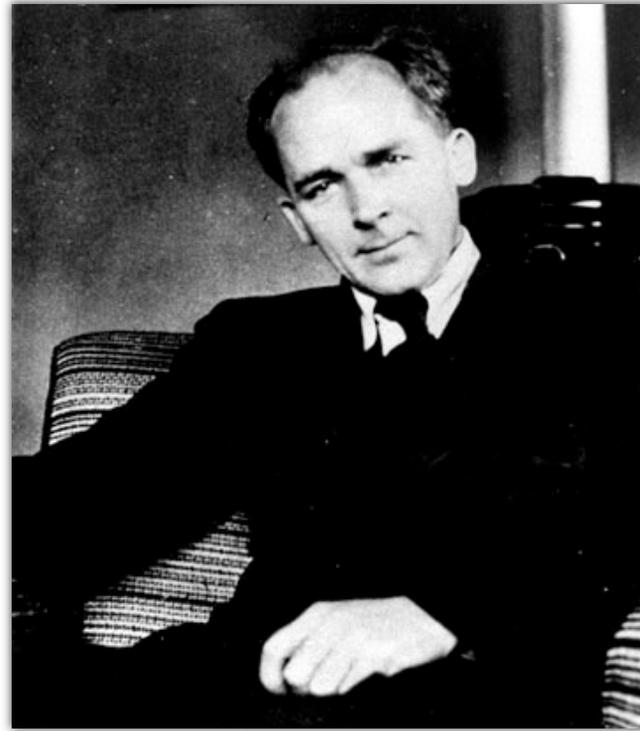
Enrico Fermi (1901-1954)

- In 1934 Enrico Fermi and Leo Szilard proposed using neutron bombardment to cause a “chain reaction.”
- They also attempted synthesizing new elements by neutron bombardment of uranium with mysterious and inconclusive results.

Discovery of Fission

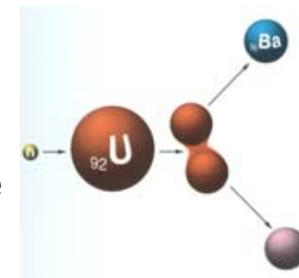


Otto Hahn (1879-1968) Lise Meitner (1878-1968)

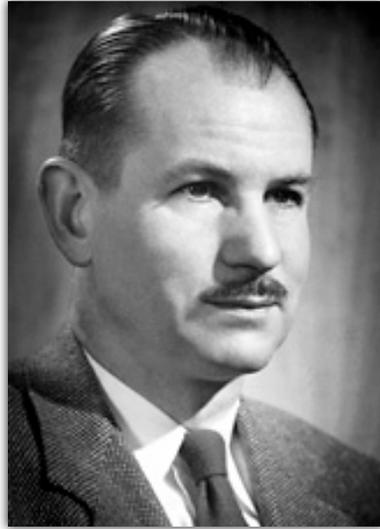


Fritz Strassman (1902-1980)

In the 1930's Hahn, Meitner, and Strassmann bombarded uranium atoms with neutrons and eventually concluded that they had “fissioned” or split the uranium atom into radioactive daughter elements!



Discovery of Neptunium



**Edwin
McMillan
(1907-1991)**



**Philip Abelson
(1913-2004)**

With excitement about fission reaching the University of California, Berkeley, McMillan and Abelson bombarded uranium with moderated (slow) neutrons, resulting in “fusion” of the reactants:

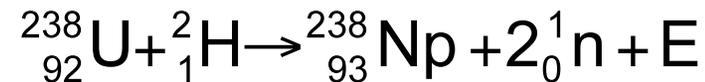


Announced in 1940, the new man-made element was named neptunium (Np) after Neptune, the planet beyond Uranus.

The Discovery of Plutonium

McMillan was called away to work on the new wartime device called "RADAR."

In 1940-1941 Berkeley professor Glenn Seaborg and graduate student Art Wahl bombarded uranium with deuterons to make neptunium and followed its beta decay:



$$t_{1/2} {}_{93}^{238}\text{Np} = 2.1 \text{ days}$$



$$t_{1/2} {}_{94}^{238} = 87.7 \text{ years}$$

The Discovery of Plutonium

Seaborg named the new element **plutonium** after the next planet, Pluto and assigned it the symbol **Pu**.

The announcement of the discovery was withheld because of security when the unusual nuclear behavior of this element was determined.



Glenn T.
Seaborg
1912 – 1999

The Periodic Table 1945

H																	He
Li	Be											B	C	N	O	F	Ne
Na	Mg											Al	Si	P	S	Cl	Ar
K	Ca	Sc	Ti	V	Cr	Mn	Fe	Co	Ni	Cu	Zn	Ga	Ge	As	Se	Br	Kr
Rb	Sr	Y	Zr	Nb	Mo	Tc	Ru	Rh	Pd	Ag	Cd	In	Sn	Sb	Te	I	Xe
Cs	Ba	La	Hf	Ta	W	Re	Os	Ir	Pt	Au	Hg	Tl	Pb	Bi	Po	At	Rn
Fr	Ra	Th	Pa	U	Np	Pu											
		<i>Lanthanides</i>															
		Ce	Pr	Nd	Pm	Sm	Eu	Gd	Tb	Dy	Ho	Er	Tm	Yb	Lu		

The Discovery of Americium and Curium



In 1944/1945, Seaborg and coworkers synthesized two new elements:

- *Element 95, americium* was named after its continent of discovery
- *Element 96, curium* honors Madame Curie

Seaborg inadvertently announced these discoveries on the “Quiz Kids” radio program!

The chemistry of americium and curium was very perplexing and these elements were not behaving as was expected!

Seaborg's Actinide Hypothesis

In 1945, with the discovery of the elements, *americium* and *curium*, and their *rare-earth-like* behavior, Glenn Seaborg proposed a radical rearrangement of the Periodic Table and proposed a new “actinide” series.

He was told by his major professor, G. N. Lewis, that if he published this theory, he would ruin his reputation.

Seaborg said he didn't have a reputation and published anyway! Seaborg' hypothesis was right on target!

Seaborg's Periodic Table 1946



H																	He	
Li	Be											B	C	N	O	F	Ne	
Na	Mg											Al	Si	P	S	Cl	Ar	
K	Ca	Sc	Ti	V	Cr	Mn	Fe	Co	Ni	Cu	Zn	Ga	Ge	As	Se	Br	Kr	
Rb	Sr	Y	Zr	Nb	Mo	Tc	Ru	Rh	Pd	Ag	Cd	In	Sn	Sb	Te	I	Xe	
Cs	Ba	La	Hf	Ta	W	Re	Os	Ir	Pt	Au	Hg	Tl	Pb	Bi	Po	At	Rn	
Fr	Ra																	
		<i>Lanthanides</i>	Ce	Pr	Nd	Pm	Sm	Eu	Gd	Tb	Dy	Ho	Er	Tm	Yb	Lu		
		<i>Actinides</i>	Th	Pa	U	Np	Pu	Am	Cm									

The Discovery of Berkelium and Californium



Street, Thompson, Seaborg, and Ghiorso

In 1949, Seaborg and coworkers at Berkeley synthesized elements 97 and 98 by nuclear bombardment and named them after the city and state of their discovery.

The Discovery of Einsteinium and Fermium



In 1952, a team led by Seaborg discovered einsteinium and fermium in debris from the first thermonuclear (fusion) explosion (“MIKE”) detonated on Eniwetok Island in the South Pacific. The elements were named in honor of the famous scientists.

The Discovery of Mendeleevium

Discovered in 1955 by Ghiorso, Harvey, Choppin, Thompson, and Seaborg at Berkeley by bombardment of Es with He ions.

Seaborg: “It was fitting that the element be named for the Russian chemist Mendeleev who developed the periodic table. In discovering transuranium elements we depended on his table for predicting their chemical properties based on their position in the table.

During the Cold War naming an element for a Russian was a bold gesture that did not sit well with some Americans. However, Md was approved by IUPAC in August 1997



Gregory Choppin, Glenn Seaborg, Bernard Harvey, and Albert Ghiorso at Berkeley Laboratory

31	32	34	35	3
Галлий	Германий	Селен	Бром	Криpton
38	40	41	43	
Иттрий	Цирконий	Молибден	Технеций	
49	50	52		
Иттрий	Сурьма	Свинец	Родий	
56	57	72	73	75
Лантан	Гафний	Тантал	Вольфрам	

101	(258)
Md	
Mendelevium	

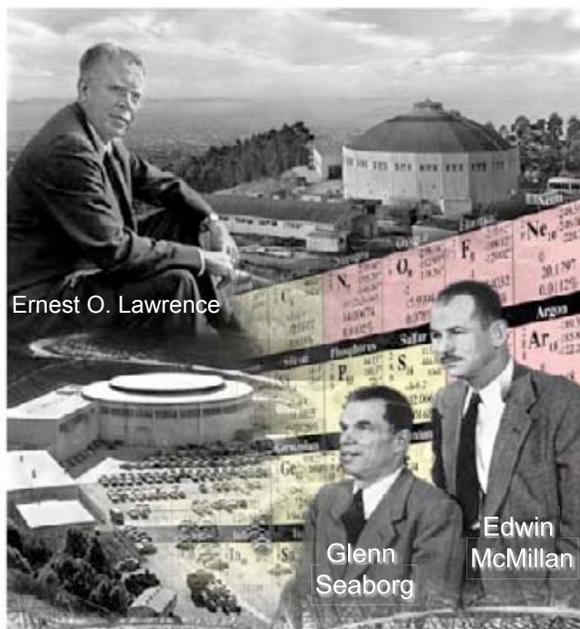


BERKELEY LAB
LAWRENCE BERKELEY NATIONAL LABORATORY



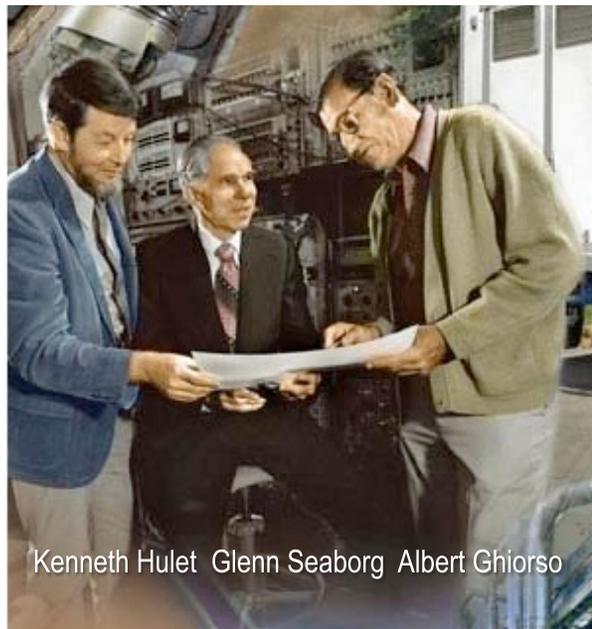
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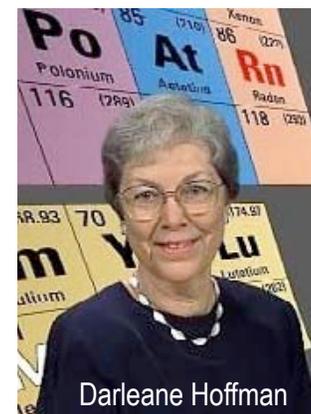


Ernest O. Lawrence

Glenn Seaborg
Edwin McMillan



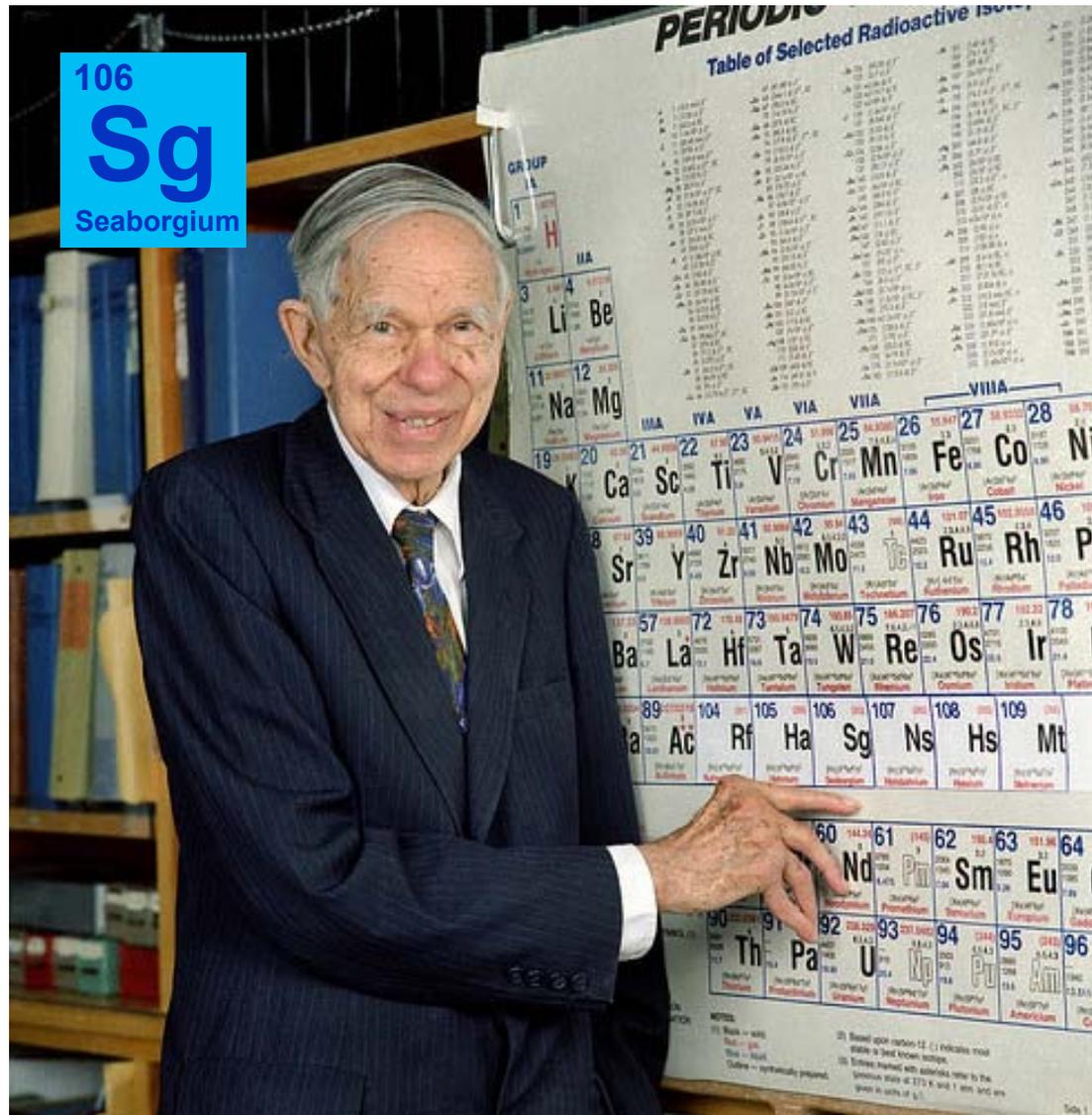
Kenneth Hulet Glenn Seaborg Albert Ghiorso



Darleane Hoffman

1949 -1999 Berkeley scientists synthesized more than a dozen elements beyond curium including berkelium through seaborgium along with many of their isotopes

Element 106 Named Seaborgium



To Dave Hobart,
at the 50th anniversary of plutonium
Glen S. Seaborg



Photographs showing the colors of the various oxidation states of plutonium in solution presented to Prof. Seaborg at the 50th Anniversary of Discovery



**FLEROV LABORATORY OF NUCLEAR REACTIONS
JOINT INSTITUTE FOR NUCLEAR RESEARCH
DUBNA, RUSSIA**



Periodic Table
Периодическая таблица элементов Д.И. Менделеева

периоды период	группы элементов																	
	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	XIII	XIV	XV	XVI	XVII	XVIII
1	H																	He
2	Li	Be	B	C	N	O	F	Ne										
3	Na	Mg	Al	Si	P	S	Cl	Ar										
4	K	Ca	Sc	Ti	V	Cr	Mn	Fe	Co	Ni								
5	Rb	Sr	Y	Zr	Nb	Mo	Tc	Ru	Rh	Pd								
6	Cs	Ba	La	Hf	Ta	W	Re	Os	Ir	Pt								
7	Fr	Ra	Ac	Rf	Db	Sg	Bh	Hs	Mt	Ds								

Лантаноиды Lanthanides
 Actinoids Actinides

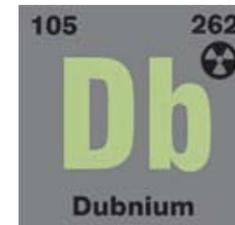


Georgy N. Flerov
1913-1990



Yuri Oganessian

Flerov Laboratory was acknowledged by naming Element 105 "DUBNIUM" They Synthesized super heavy elements at the "Island of Stability" for the first time - Thirty five new Superheavy nuclei with Z = 104 - 118.





LLNL's HEAVY ELEMENT RESEARCH GROUP

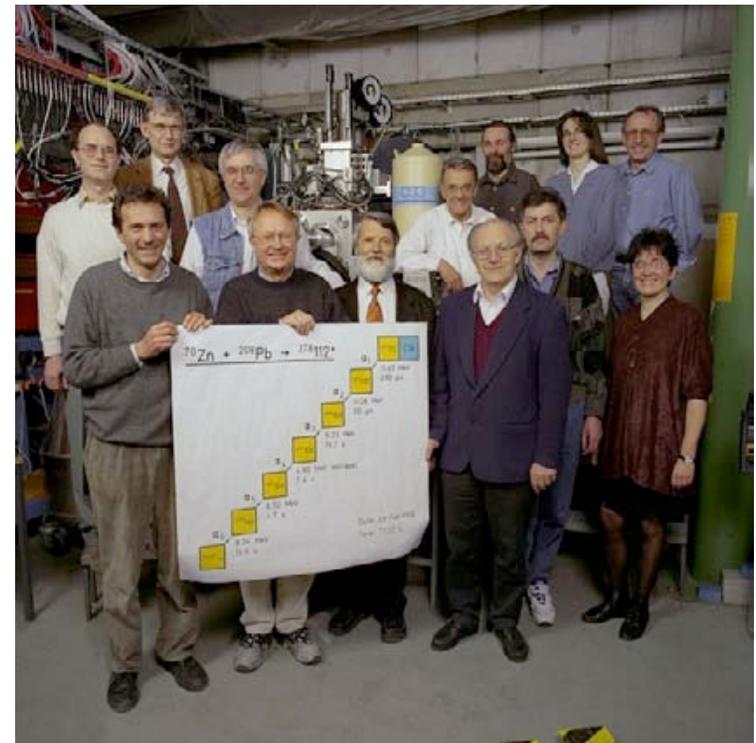
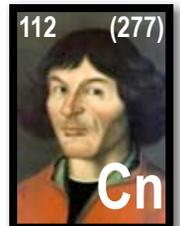
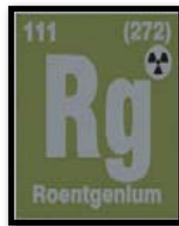
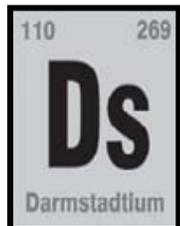
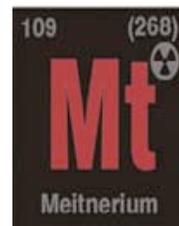
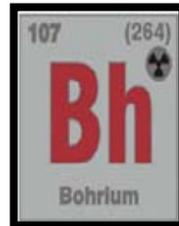
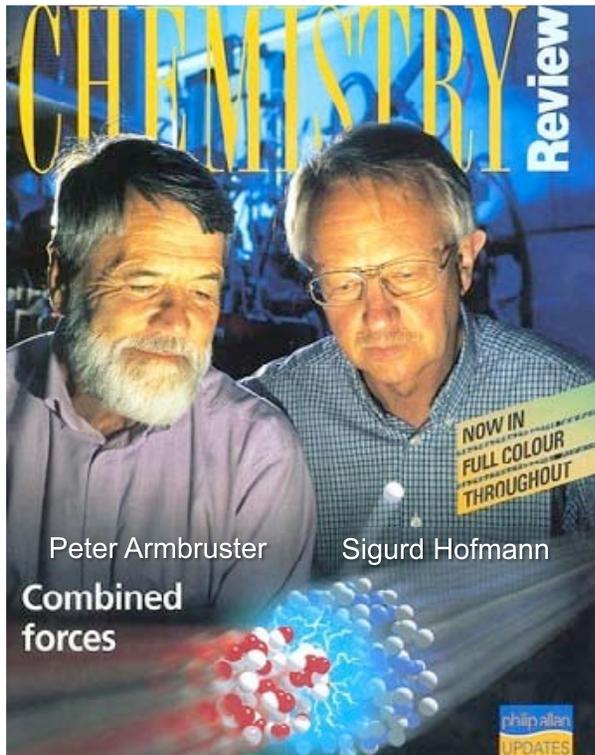


Periodic Table of the Elements

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
1 H 1.008																	2 He 4.003
3 Li 6.941	4 Be 9.012											5 B 10.81	6 C 12.01	7 N 14.01	8 O 16.00	9 F 19.00	10 Ne 20.18
11 Na 22.99	12 Mg 24.31											13 Al 26.98	14 Si 28.09	15 P 30.97	16 S 32.07	17 Cl 35.45	18 Ar 39.95
19 K 39.10	20 Ca 40.08	21 Sc	22 Ti 47.88	23 V 50.94	24 Cr 52.00	25 Mn 54.94	26 Fe 55.85	27 Co 58.93	28 Ni 58.69	29 Cu 63.55	30 Zn 65.38	31 Ga 69.72	32 Ge 72.64	33 As 74.92	34 Se 78.96	35 Br 79.90	36 Kr 83.80
37 Rb 85.47	38 Sr 87.62	39 Y 88.91	40 Zr 91.22	41 Nb 92.91	42 Mo 95.94	43 Tc 97.91	44 Ru 101.1	45 Rh 102.9	46 Pd 106.4	47 Ag 107.9	48 Cd 112.4	49 In 114.8	50 Sn 118.7	51 Sb 121.8	52 Te 127.6	53 I 126.9	54 Xe 131.3
55 Cs 132.9	56 Ba 137.3	57 La* 138.9	72 Hf 178.5	73 Ta 180.9	74 W 183.8	75 Re 186.2	76 Os 190.2	77 Ir 192.2	78 Pt 195.1	79 Au 197.0	80 Hg 200.6	81 Tl 204.4	82 Pb 207.2	83 Bi 209.0	84 Po (209)	85 At (210)	86 Rn (222)
87 Fr (223)	88 Ra (226)	89 Ac (227)	104 Rf (261)	105 Db (262)	106 Sg (266)	107 Bh (264)	108 Hs (277)	109 Mt (268)	110 Ds (271)	111 Uu (272)	112 Uut (277)	113 Uuq (289)	114 Uup (285)	115 Uub (289)	116 Uuq (289)	117 Uuh (294)	118 Uuo (294)
*Lanthanides		58 Ce 140.1	59 Pr 140.9	60 Nd 144.2	61 Pm (145)	62 Sm 150.4	63 Eu 152.0	64 Gd 157.3	65 Tb 158.9	66 Dy 162.5	67 Ho 164.9	68 Er 167.3	69 Tm 168.9	70 Yb 173.0	71 Lu 175.0		
-Actinides		90 Th 232.0	91 Pa (231)	92 U (238)	93 Np (237)	94 Pu (244)	95 Am (243)	96 Cm (247)	97 Bk (247)	98 Cf (251)	99 Es (252)	100 Fm (257)	101 Md (258)	102 No (259)	103 Lr (262)		

- In 1999 and 2001 LLNL announced the discovery of elements 114 and 116.
- In 2004, LLNL working in collaboration with the Joint Institute for Nuclear Research (JINR) in Dubna, Russia observed the existence of elements 113 and 115.
- In 2005 the Livermore-Dubna team discovered element 118.



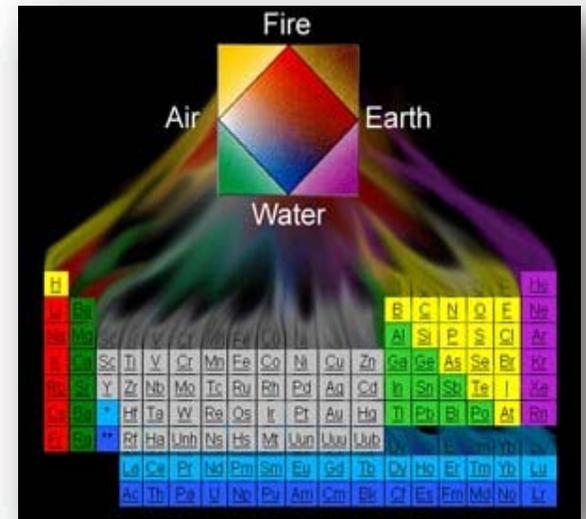
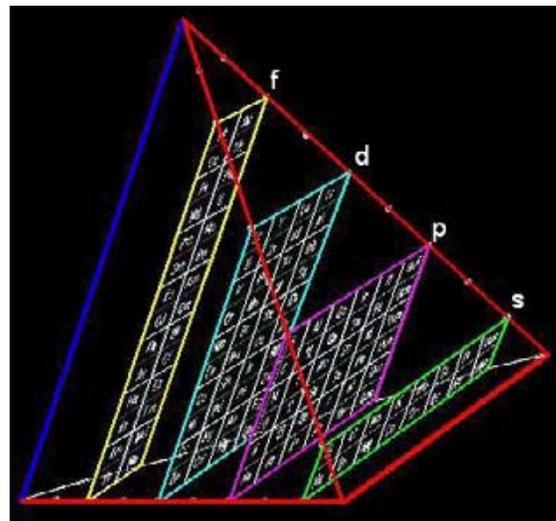
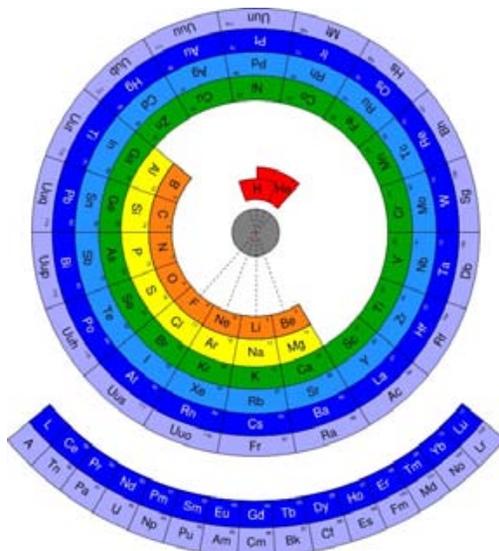
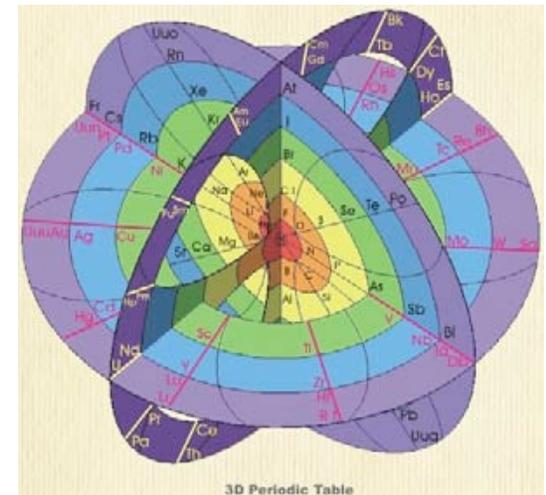
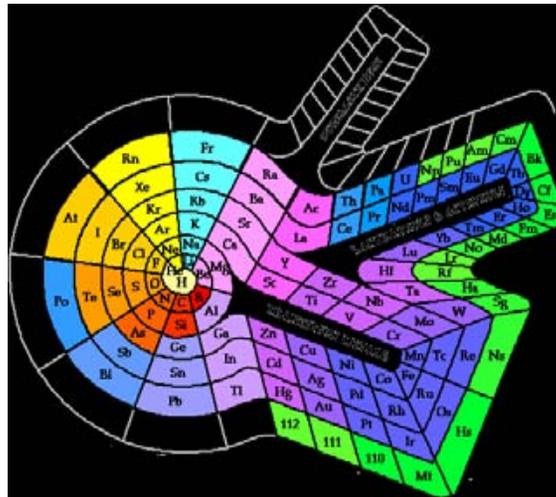
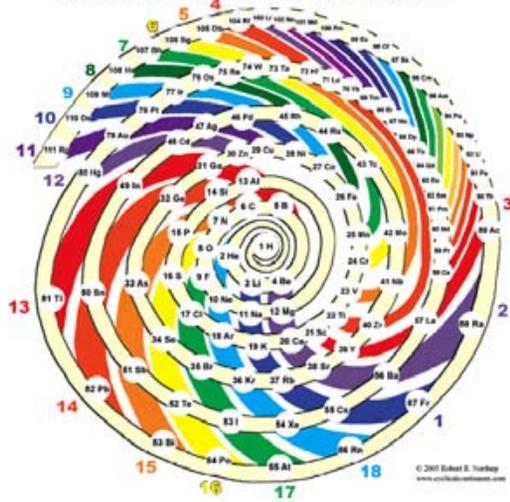


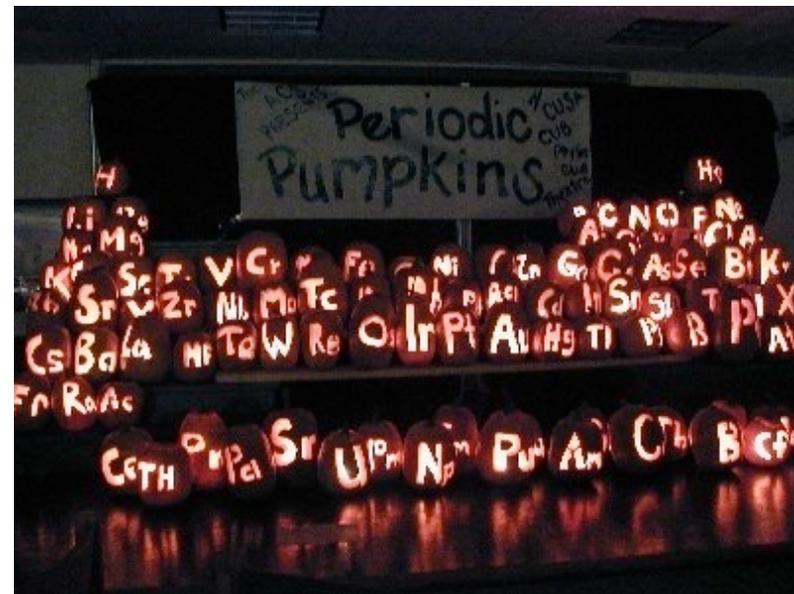
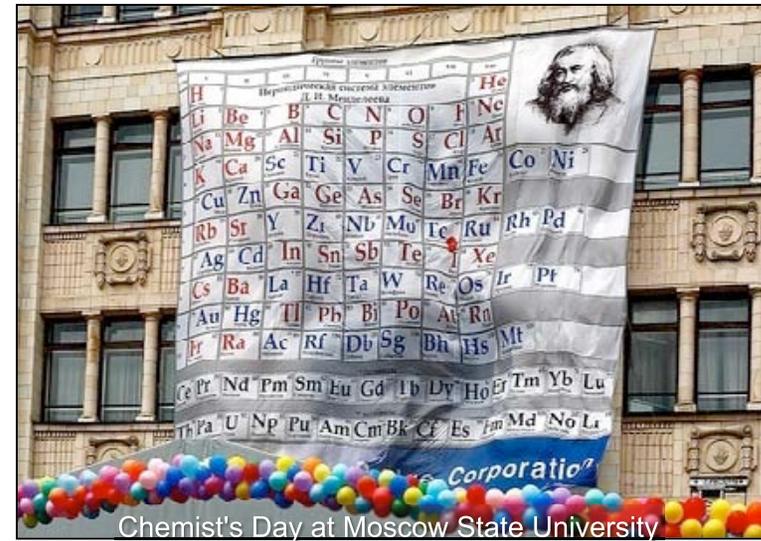
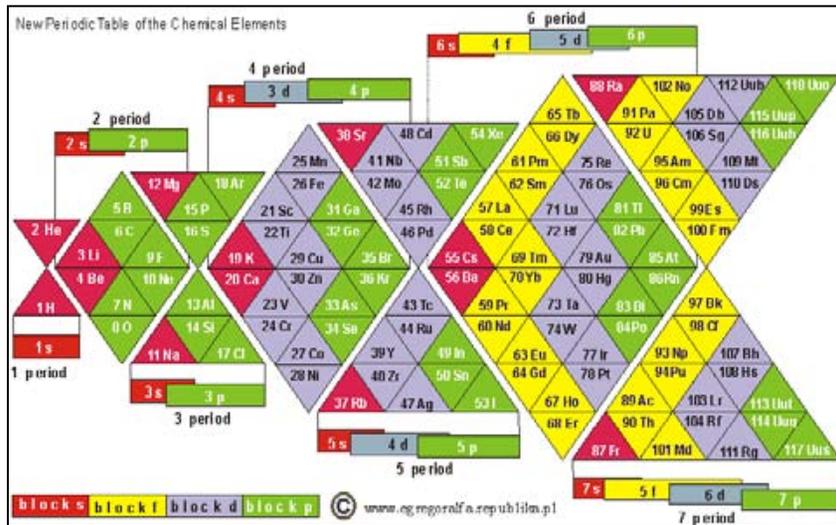
July 2009 - Credited with its discovery, the GSI-Darmstadt group of Sigurd Hofmann proposes the name **COPERNICIUM** for element 112 - IUPAC approved the symbol "Cn".

Periodic Table Variations

<h1>THE ELEMENTS</h1>																		He ² Helium																	
Li ³ Lithium		Be ⁴ Beryllium		B ⁵ Boron		C ⁶ Carbon		N ⁷ Nitrogen		O ⁸ Oxygen		F ⁹ Fluorine		Ne ¹⁰ Neon																					
Na ¹¹ Sodium		Mg ¹² Magnesium		Al ¹³ Aluminum		Si ¹⁴ Silicon		P ¹⁵ Phosphorus		S ¹⁶ Sulfur		Cl ¹⁷ Chlorine		Ar ¹⁸ Argon																					
K ¹⁹ Potassium		Ca ²⁰ Calcium		Sc ²¹ Scandium		Ti ²² Titanium		V ²³ Vanadium		Cr ²⁴ Chromium		Mn ²⁵ Manganese		Fe ²⁶ Iron		Co ²⁷ Cobalt		Ni ²⁸ Nickel		Cu ²⁹ Copper		Zn ³⁰ Zinc		Ga ³¹ Gallium		Ge ³² Germanium		As ³³ Arsenic		Se ³⁴ Selenium		Br ³⁵ Bromine		Kr ³⁶ Krypton	
Rb ³⁷ Rubidium		Sr ³⁸ Strontium		Y ³⁹ Yttrium		Zr ⁴⁰ Zirconium		Nb ⁴¹ Niobium		Mo ⁴² Molybdenum		Tc ⁴³ Technetium		Ru ⁴⁴ Ruthenium		Rh ⁴⁵ Rhodium		Pd ⁴⁶ Palladium		Ag ⁴⁷ Silver		Cd ⁴⁸ Cadmium		In ⁴⁹ Indium		Sn ⁵⁰ Tin		Sb ⁵¹ Antimony		Te ⁵² Tellurium		I ⁵³ Iodine		Xe ⁵⁴ Xenon	
Cs ⁵⁵ Cesium		Ba ⁵⁶ Barium		La ⁵⁷ Lanthanum		Hf ⁷² Hafnium		Ta ⁷³ Tantalum		W ⁷⁴ Tungsten		Re ⁷⁵ Rhenium		Os ⁷⁶ Osmium		Ir ⁷⁷ Iridium		Pt ⁷⁸ Platinum		Au ⁷⁹ Gold		Hg ⁸⁰ Mercury		Tl ⁸¹ Thallium		Pb ⁸² Lead		Bi ⁸³ Bismuth		Po ⁸⁴ Polonium		At ⁸⁵ Astatine		Rn ⁸⁶ Radon	
Fr ⁸⁷ Francium		Ra ⁸⁸ Radium		Rf ¹⁰⁴ Rutherfordium		Db ¹⁰⁵ Dubnium		Sg ¹⁰⁶ Seaborgium		Bh ¹⁰⁷ Bohrium		Hs ¹⁰⁸ Hassium		Mt ¹⁰⁹ Meitnerium		Ds ¹¹⁰ Darmstadtium		Rg ¹¹¹ Roentgenium		Uub ¹¹² Ununbium		Uut ¹¹³ Ununtrium		Uuq ¹¹⁴ Ununquadium		Uup ¹¹⁵ Ununpentium		Uuh ¹¹⁶ Ununhexium		Uus ¹¹⁷ Ununseptium		Uuo ¹¹⁸ Ununoctium			
<p>Radioactive elements</p> <p>Many of the elements shown here are highly unstable and decay rapidly. The half-lives of many of these elements are so short that they have never been observed in nature. The elements shown here are the most stable isotopes of these elements. The half-lives of these elements are given in minutes, hours, days, or years. The half-lives of the elements shown here are given in minutes, hours, days, or years.</p>				La ⁵⁷ Lanthanum		Ce ⁵⁸ Cerium		Pr ⁵⁹ Praseodymium		Nd ⁶⁰ Neodymium		Pm ⁶¹ Promethium		Sm ⁶² Samarium		Eu ⁶³ Europium		Gd ⁶⁴ Gadolinium		Tb ⁶⁵ Terbium		Dy ⁶⁶ Dysprosium		Ho ⁶⁷ Holmium		Er ⁶⁸ Erbium		Tm ⁶⁹ Thulium		Yb ⁷⁰ Ytterbium		Lu ⁷¹ Lutetium			
Ac ⁸⁹ Actinium		Th ⁹⁰ Thorium		Pa ⁹¹ Protactinium		U ⁹² Uranium		Np ⁹³ Neptunium		Pu ⁹⁴ Plutonium		Am ⁹⁵ Americium		Cm ⁹⁶ Curium		Bk ⁹⁷ Berkelium		Cf ⁹⁸ Californium		Es ⁹⁹ Einsteinium		Fm ¹⁰⁰ Fermium		Md ¹⁰¹ Mendelevium		No ¹⁰² Nobelium		Lr ¹⁰³ Lawrencium							

Cyclical Continuum of Elemental Properties

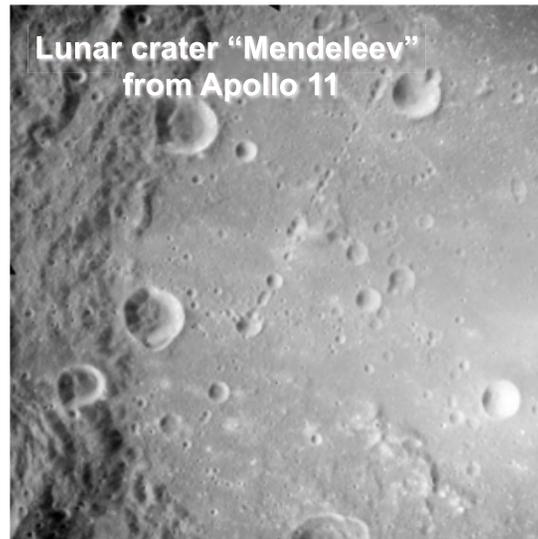
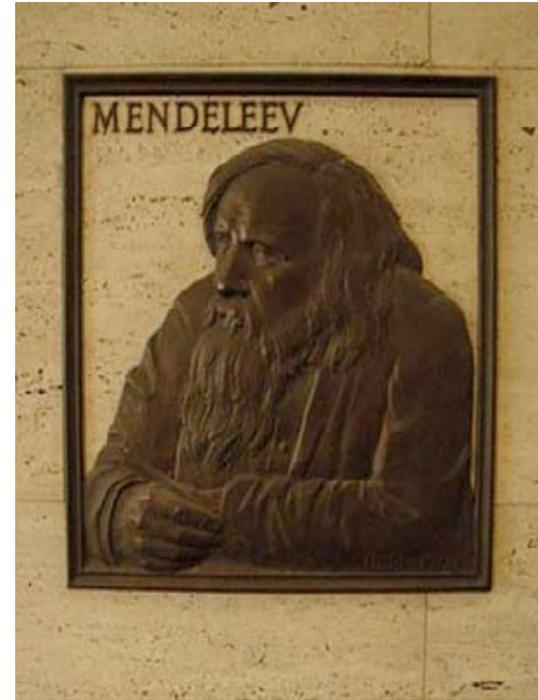
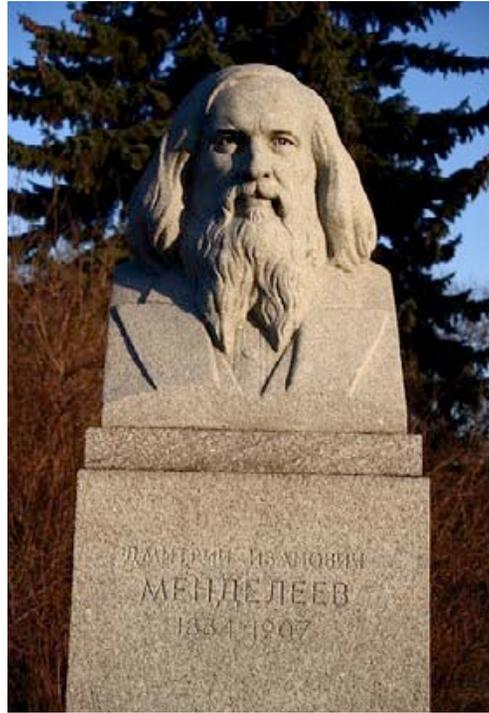




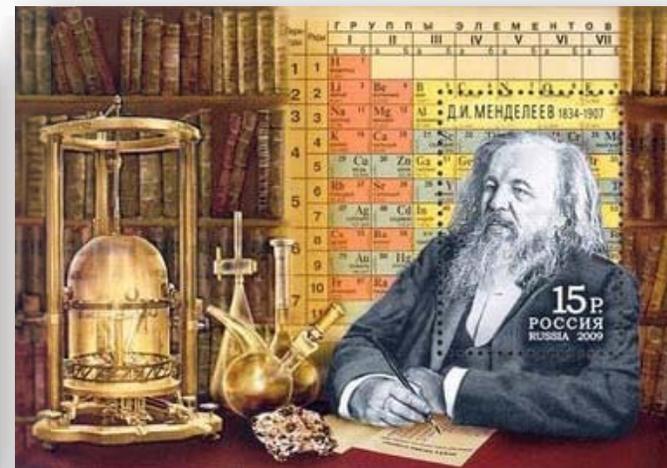
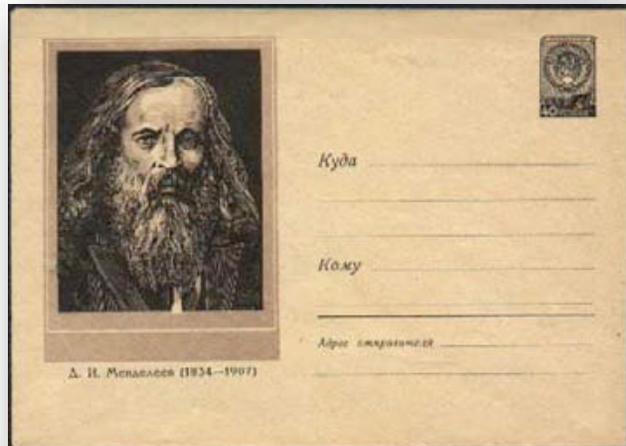
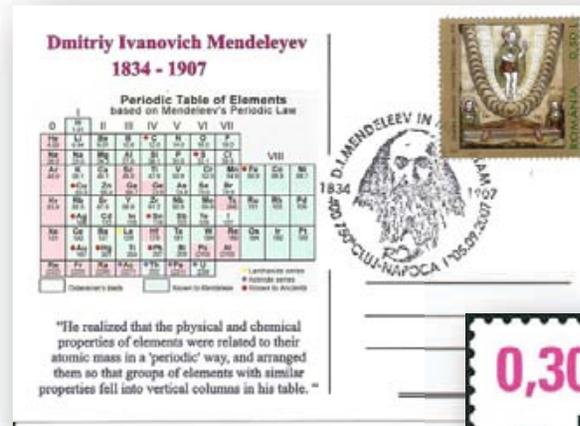
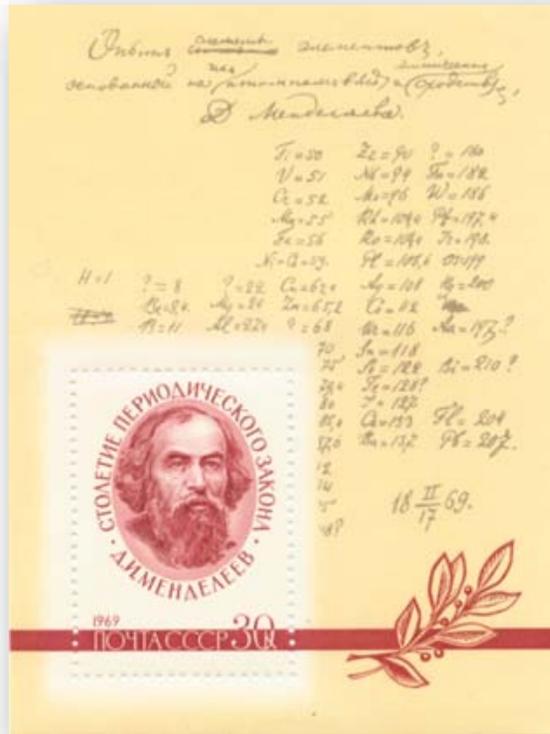
Mendeleev Memorials and Monuments



Slovak University of Technology
Bratislava, Slovakia



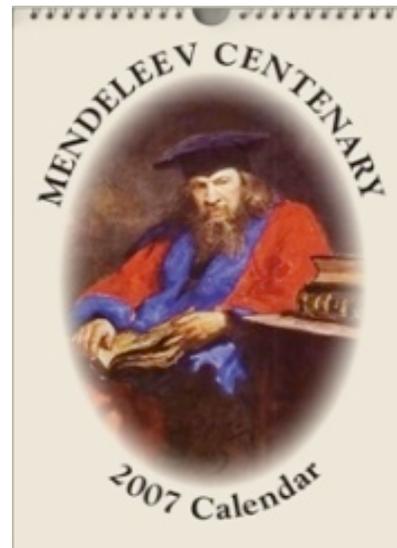
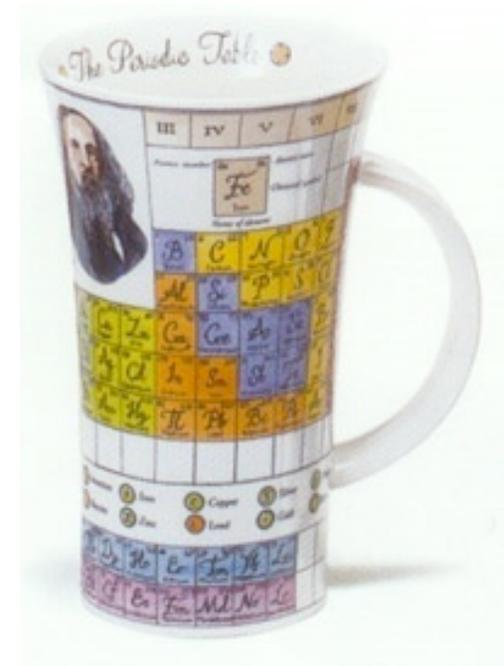
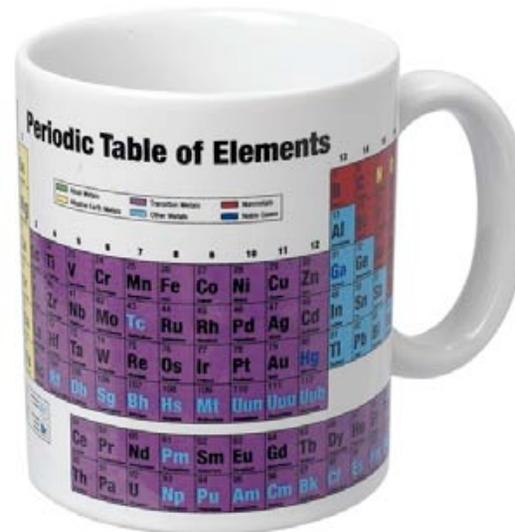
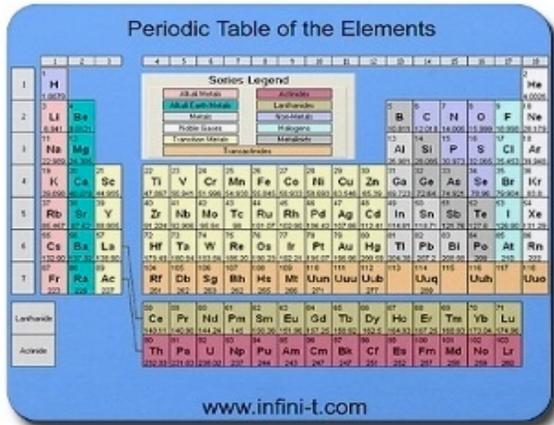
Commemorative Stamps and First Day Covers



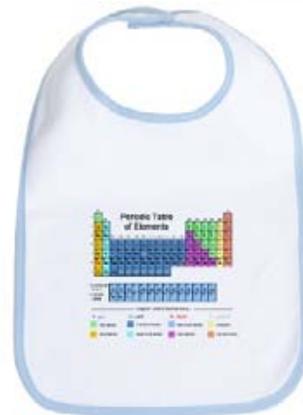
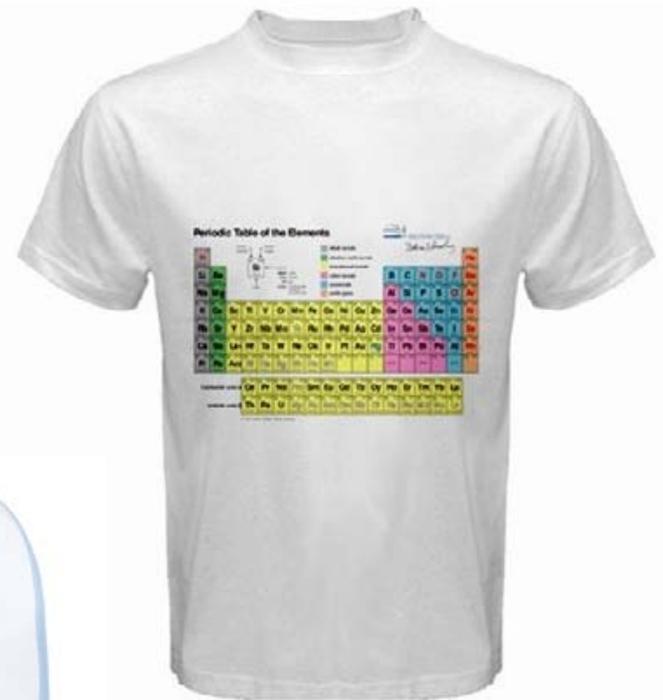
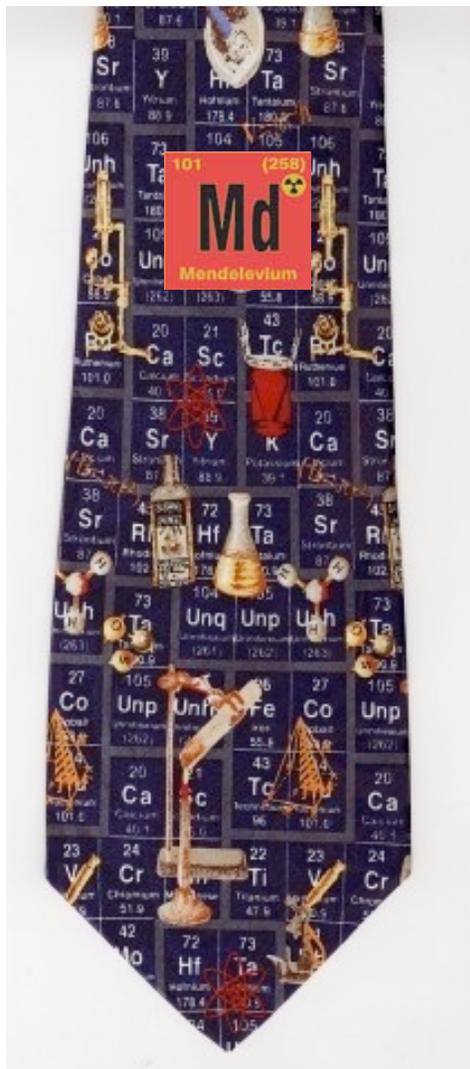
Coins and Medallions



Periodic Paraphernalia



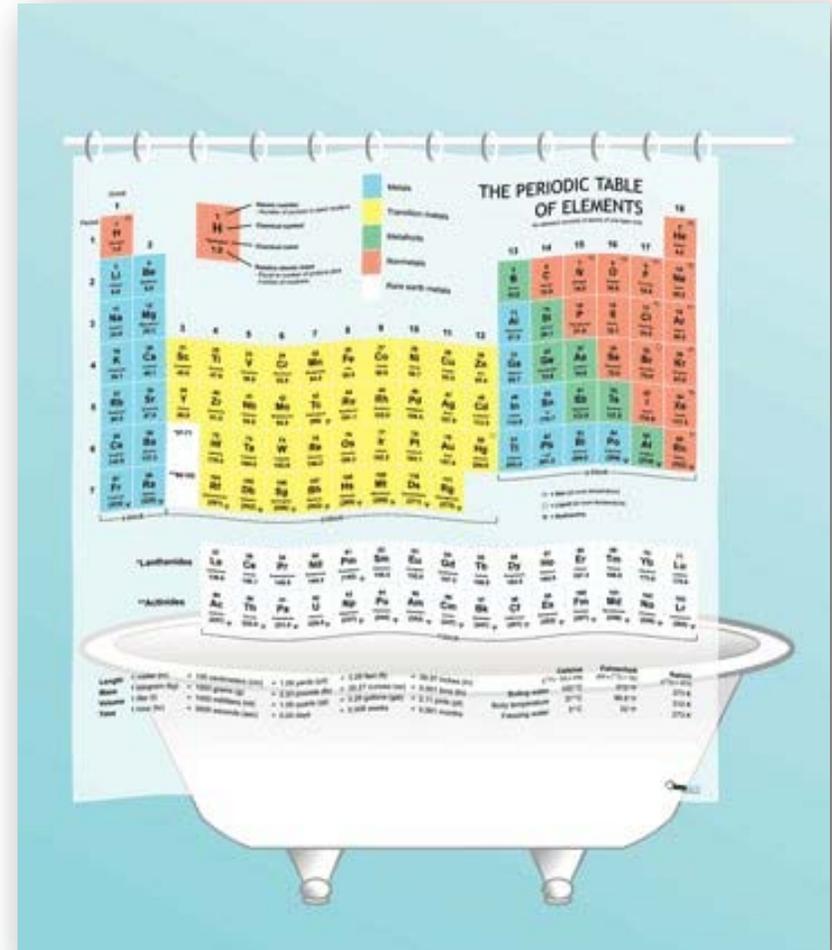
WebElements Shop



Rather Unusual Uses for the Periodic Table



Action hero Chuck Norris destroys the Periodic Table because he only recognizes the “Element of Surprise”!



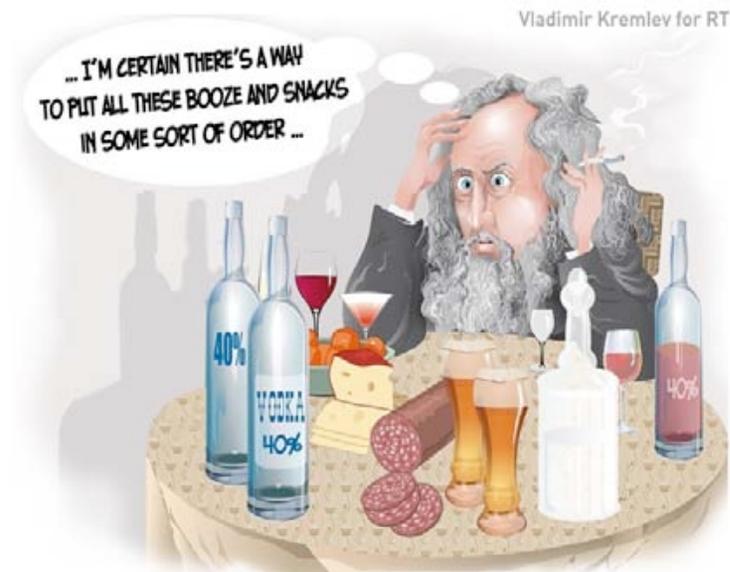
Periodic Table shower curtain

Periodic Table Humor

A moment in the life of the Mendeleev family ...



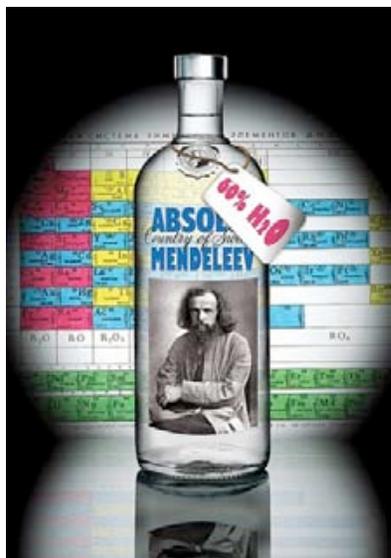
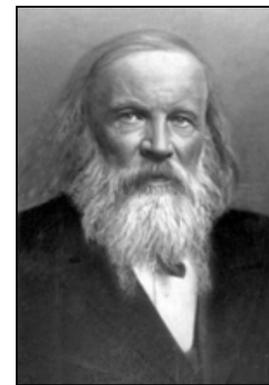
Translation: "One day, maybe we'll understand why Dimitri always arranges his blocks the same way".



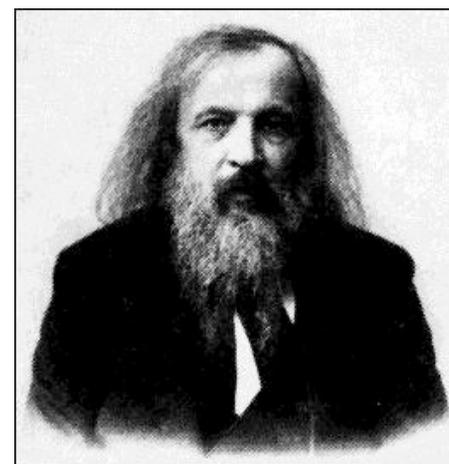
31	32a	34	35	3
33	41	43	44	
49	50	52	53	54
56	57	72	73	74
75	76	77	78	79

Dmitri Mendeleev “Renaissance Man”

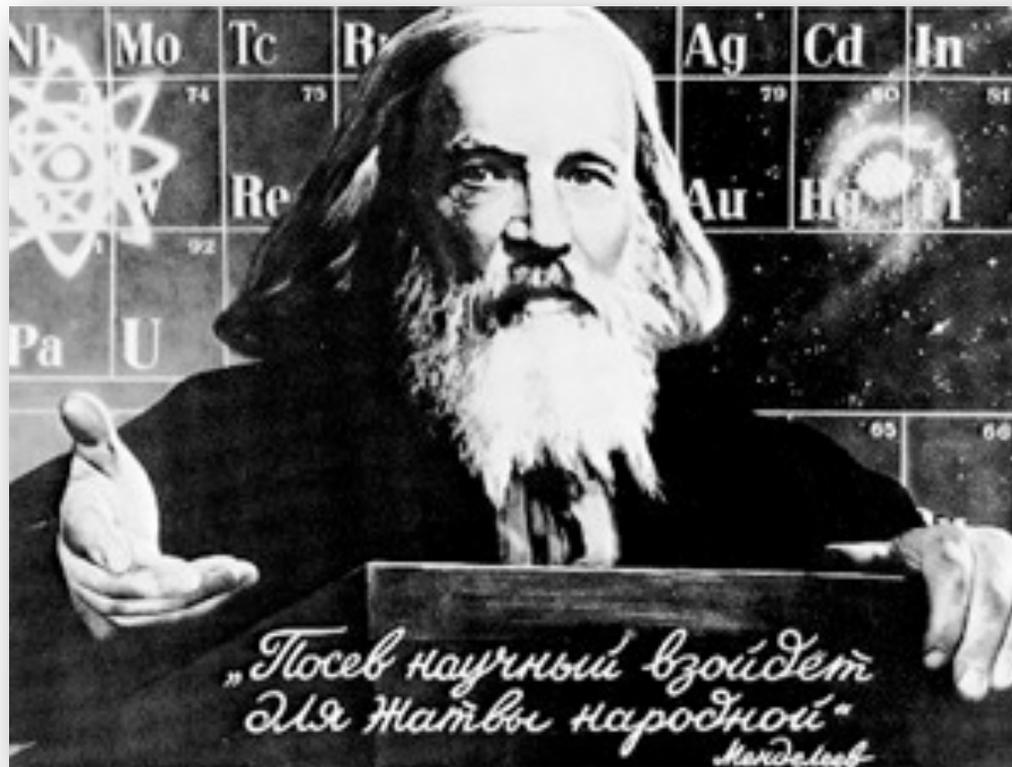
Mendeleev was a great chemist but he was interested in many other fields of science. He promoted development of Russia’s precious natural resources such as coal, petroleum, salt, metals, cheese, beer, and vodka!



He was an author, educator, government economist, inventor, adventurer, and..... In 1887 he ascended high above the clouds in a hot air balloon to observe a solar eclipse.



Mendeleev's Legacy



If some universal catastrophe was to engulf the world and humankind could retain only one scientific concept to rebuild civilization, what would it be? The chemist's answer is almost invariably *the Periodic Table of the Elements*. (Richard P. Feynman)

“The Periodic Table encapsulates the concept of elements, organizes physical and chemical trends of substances, and compares the structure of the different atoms – an enormous amount of information in a small space.” (James L. Marshall)

Acknowledgements

Extensive use of:

- The Internet for photographs, biographies, and periodic table collectables and souvenirs
- *“Dmitriy Mendeleev: A Short CV, and a Story of Life”* by Eugene V. Babaev, Chemistry Department, Moscow State University

Financial support from the U.S. Department of Energy and the Russian Academy of Sciences is greatly appreciated.

***Happy Birthday
Dmitri Ivanovich Mendeleev***
