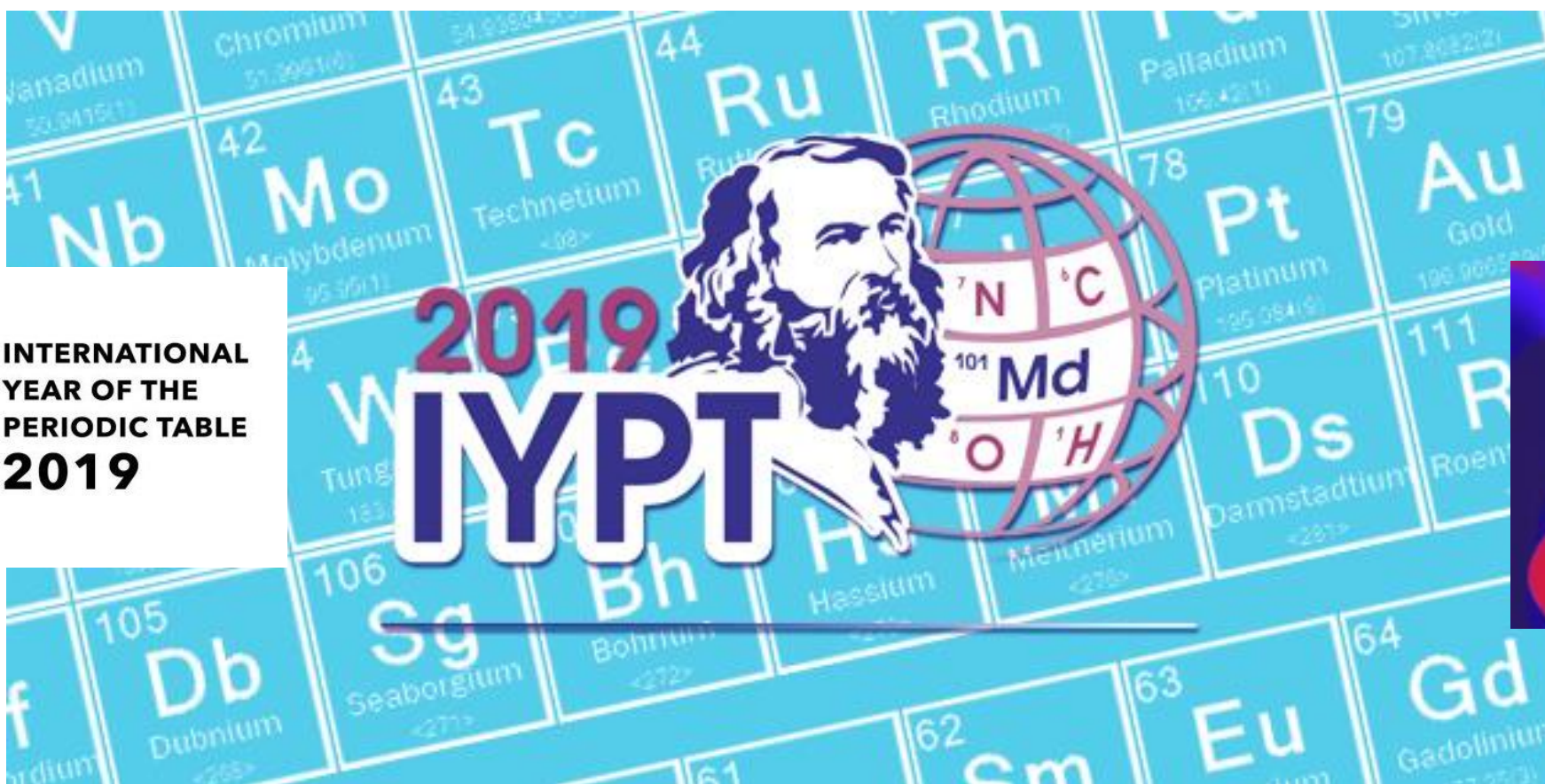




INTERNATIONAL
YEAR OF THE
PERIODIC TABLE
2019



Cheers to IYPT 2019: International Year of
the Periodic Table of Chemical Elements

Metin Karayılan

Brains & Brews – Borderlands Brewing Co. – April 29th, 2019



Acknowledgements



Dr. Iman Daryaei
SAzACS past chair



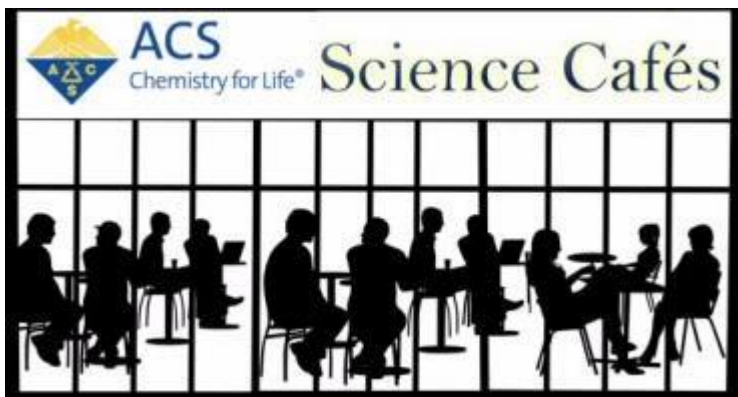
Executive Committee
Members



Kristen Watts



Josh Hoskinson



American Chemical Society





2 0 1 9

Tentative Outline

- Nuclear fusion
- Quantum mechanics
- Transuranium elements
- Bose-Einstein condensation

1	H	2	He
3	Li	4	Be
5	B	6	C
7	N	8	O
9	F	10	Ne
11	Na	12	Mg
13	Al	14	Si
15	P	16	S
17	Cl	18	Ar
19	K	20	Ca
21	Sc	22	Ti
23	V	24	Cr
25	Mn	26	Fe
27	Co	28	Ni
29	Cu	30	Zn
31	Ga	32	Ge
33	As	34	Se
35	Br	36	Kr
37	Rb	38	Sr
39	Y	40	Zr
41	Nb	42	Mo
43	Tc	44	Ru
45	Rh	46	Pd
47	Ag	48	Cd
49	In	50	Sn
51	Sb	52	Te
53	I	54	Xe
55	Cs	56	Ba
57	La	58	Ce
59	Pr	60	Nd
61	Pm	62	Sm
63	Eu	64	Gd
65	Tb	66	Dy
67	Ho	68	Er
69	Tm	70	Yb
71	Lu	72	Hf
73	Ta	74	W
75	Re	76	Os
77	Ir	78	Pt
79	Au	80	Hg
81	Tl	82	Pb
83	Bi	84	Po
85	At	86	Rn
87	Fr	88	Ra
89	Ac	90	Th
91	Pa	92	U
93	Np	94	Pu
95	Am	96	Cm
97	Bk	98	Cf
99	Es	100	Fm
101	Db	102	Sg
103	Bh	104	Hs
105	Mt	106	Ds
107	Rg	108	Cn
109	Nh	110	Fl
111	Mc	112	Lv
113	Ts	114	Og



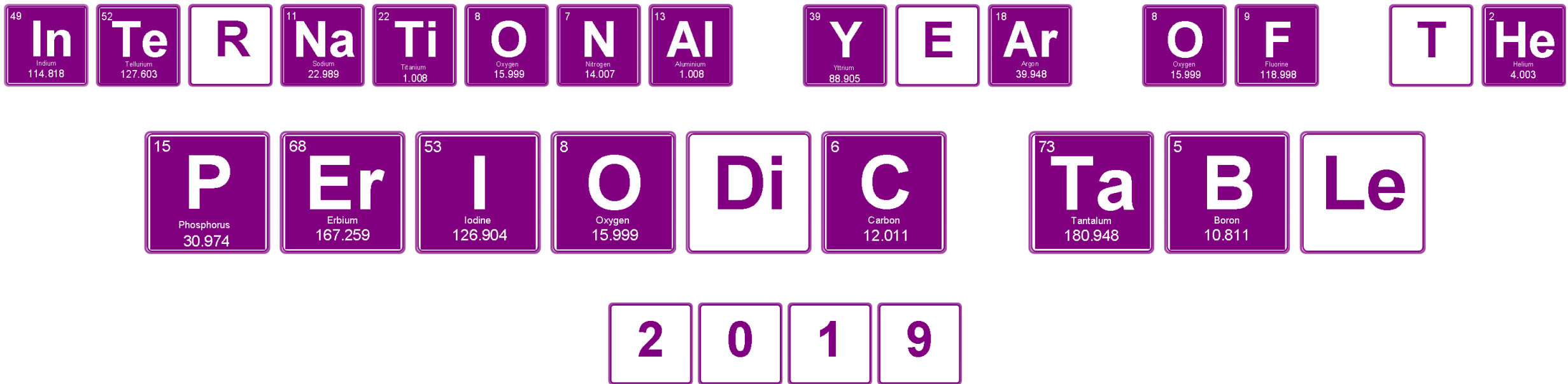
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KISS Principle!!

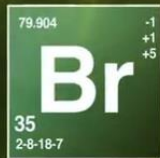
Atomic Number → H ← Symbol
Name → Hydrogen ← Atomic Weight

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
H	He																
19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36
K	Ca	Sc	Ti	V	Cr	Mn	Fe	Co	Ni	Cu	Zn	Ga	Ge	As	Se	Br	Kr
37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54
Rb	Sr	Y	Zr	Nb	Mo	Tc	Ru	Rh	Pd	Ag	Cd	In	Sn	Sb	Te	I	Xe
55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72
Cs	Ba	La	Hf	Ta	W	Re	Os	Ir	Pt	Au	Hg	Tl	Pb	Bi	Po	At	Rn
87	88	89	90	91	92	93	94	95	96	97	98	99	100	101	102	103	104
Fr	Ra	Ac	Th	Pa	U	Np	Pu	Am	Cm	Bk	Cf	Es	Fm	Md	No	Lr	
105	106	107	108	109	110	111	112	113	114	115	116	117	118	119	120	121	122
Db	Sg	Bh	Hs	Mt	Ds	Rg	Cn	Nh	Fl	Mc	Lv	Ts	Og				
123	124	125	126	127	128	129	130	131	132	133	134	135	136	137	138	139	140
Uut	Uuq	Uub	Uut	Uuq	Uub	Uut	Uuq	Uub	Uut	Uuq	Uub	Uut	Uuq	Uub	Uut	Uuq	Uub
141	142	143	144	145	146	147	148	149	150	151	152	153	154	155	156	157	158
Uuh	Uub	Uut	Uuq	Uub	Uut	Uuq	Uub	Uut	Uuq	Uub	Uut	Uuq	Uub	Uut	Uuq	Uub	Uut
159	160	161	162	163	164	165	166	167	168	169	170	171	172	173	174	175	176
Uus	Uub	Uut	Uuq	Uub	Uut	Uuq	Uub	Uut	Uuq	Uub	Uut	Uuq	Uub	Uut	Uuq	Uub	Uut

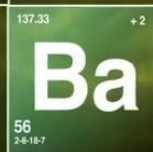

**KEEP
CALM
AND
KEEP IT
SIMPLE**



Making words out of elements in the Periodic Table!!

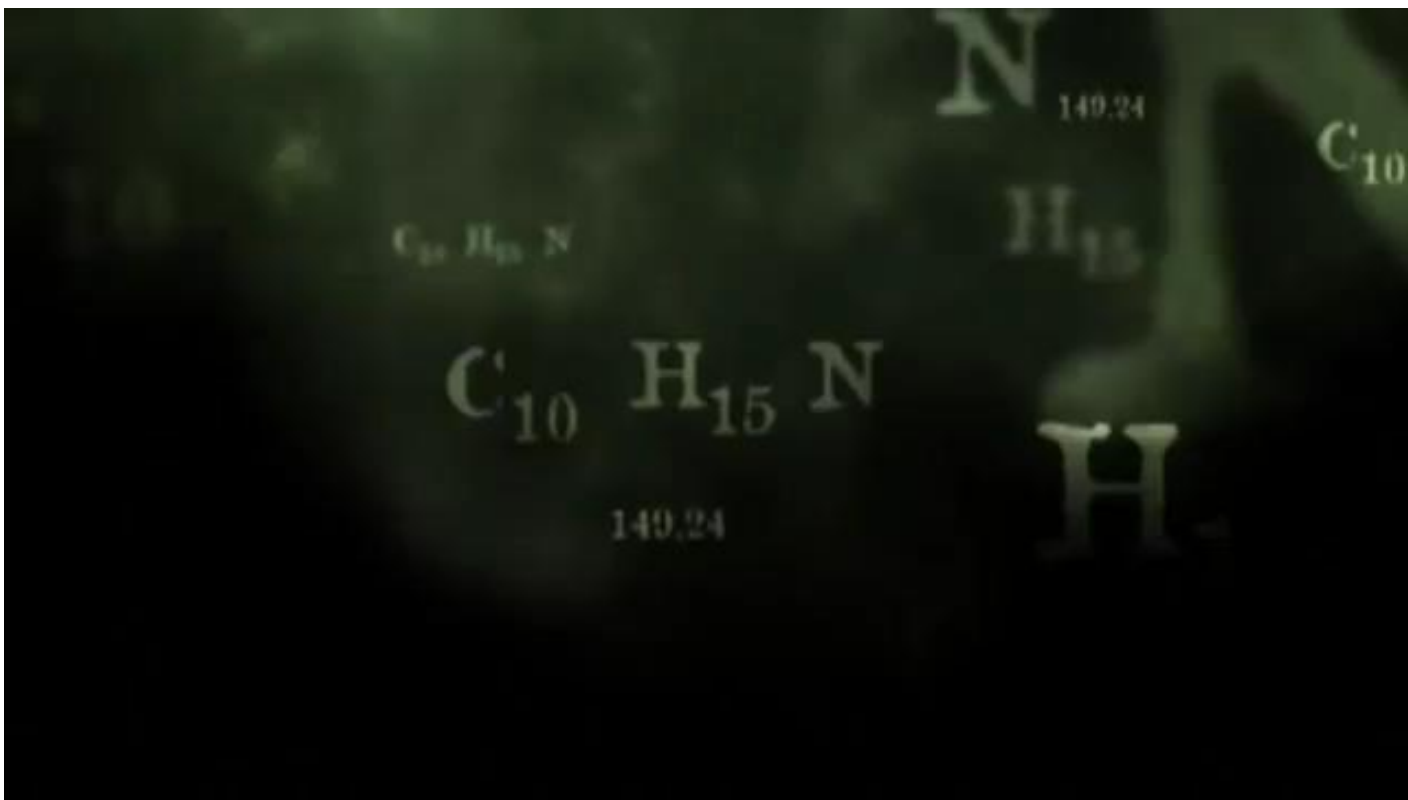


eaking



d







Can you write your name by only using elements in the Periodic Table (without cheating!)?

¹²⁰ L Latinum	²⁵ Mn Manganese	¹²¹ T Tyberium	⁸ O Oxygen	¹²⁰ L Latinum	⁸ O Oxygen	¹¹⁹ G Gundanium	³⁹ Y Yttrium	.	²⁷ Co Cobalt	¹¹⁵ M Mithril
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[Back](#)

Make any words out of Elements in the Periodic Table

Enter Your Words Here Elementize It!

☒ Use Fictional Elements ☐ Use Color

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		Hf	Ta	W	Re	Os	Ir	Pt	Au	Hg	Tl	Pb	Bi	Po	At	Rn
Fr	Ra		Rf	Db	Sg	Bh	Hs	Mt	Ds	Rg	Cn	Nh	Fl	Mc	Lv	Ts	Og

Gaseous
 Liquid
 Metal
 Fictional

La	Ce	Pr	Nd	Pm	Sm	Eu	Gd	Tb	Dy	Ho	Er	Tm	Yb	Lu
Ac	Th	Pa	U	Np	Pu	Am	Cm	Bk	Cf	Es	Fm	Md	No	Lr
G	L	T	Q	D	A	E	J	M	X	R	Z			

- **Fictional Elements** are added to make all words possible.
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Related Links and News

Elementeva.com

lmnology in Hebrew!

History of Element Names

Lots of fun info!

[Periodic Table](#)

[Dynamic Periodic Table](#)

Check out new elements:

[Flerovium \(Fl 114\)](#)

Livermorium (Lv 116)

and proposed:

Nihonium (Nh 113)

Moscovium (Mc 115)

Tennessee (Ts 117)

Oganesson (Og 118)

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Fr	Ra		Rf	Db	Sg	Bh	Hs	Mt	Ds	Rg	Cn	Nh	Fl	Mc	Lv	Ts	Og

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 ■ Liquid
 ■ Metal
 ■ Fictional

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¹²⁷ M Mithril	¹²⁵ E Etherium	²² Ti Titanium	N Nitrogen
---------------------------------------	--	--	----------------------

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Right-click on the lo-resolution image above to save it for later use.

Mithril A durable silvery metal that is very light and easy to work, mined by Dwarves. From 'mith', grey, and 'ril', glitter. (Middle Earth)

Etherium An extremely rare metal created by the sphinx Crucius the Mad. Vedalken wizards strive to infuse everything with etherium. (Magic: The Gathering)

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Nitrogen A gas that makes up 78% of the earth's air. Odorless and colorless, but important for life as fertilizer. (L. *nitrum*, native soda)

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Cs	Ba		Hf	Ta	W	Re	Os	Ir	Pt	Au	Hg	Tl	Pb	Bi	Po	At	Rn
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Gaseous

Liquid

Metal

Fictional

La	Ce	Pr	Nd	Pm	Sm	Eu	Gd	Tb	Dy	Ho	Er	Tm	Yb	Lu
Ac	Th	Pa	U	Np	Pu	Am	Cm	Bk	Cf	Es	Fm	Md	No	Lr
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²⁰ Ca Calcium	²⁶ Fe Iron	⁵³ I Iodine	¹⁰ Ne Neon
---------------------------------------	------------------------------------	-------------------------------------	------------------------------------

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Right-click on the lo-resolution image above to save it for later use.

Calcium	A rather hard, silvery metal found in the earth in many compounds and in bones and teeth. (L. calx, 'lime').
Iron	A cheap, abundant metal used for ages. Important in blood. Alloys produce harder materials such as steel. (L. ferrum)
Iodine	A bluish-black, lustrous solid that is a blue-violet gas. Found in seaweed and used in medicine. (Gr. iodes: violet)
Neon	A rare gas that is very inert. Glows reddish orange when charged. (Gr. neos, new)

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Gaseous
 Liquid
 Metal
 Fictional

La	Ce	Pr	Nd	Pm	Sm	Eu	Gd	Tb	Dy	Ho	Er	Tm	Yb	Lu	
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Be ⁴ Beryllium	Er ⁶⁸ Erbium
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Beryllium	A light metal present in Aquamarine and Emerald gemstones. Used in hi-tech applications. (Gr. beryllos, beryl)
Erbium	A soft, bright, silvery rare-earth metal. Gives pastel colors to ores. Few uses. (Ytterby, a town in Sweden)

[Back](#)

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H																	He
Li	Be											B	C	N	O	F	Ne
Na	Mg											Al	Si	P	S	Cl	Ar
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Fr	Ra		Rf	Db	Sg	Bh	Hs	Mt	Ds	Rg	Cn	Nh	Fl	Mc	Lv	Ts	Og

■ Gaseous
■ Liquid
■ Metal
■ Fictional

La	Ce	Pr	Nd	Pm	Sm	Eu	Gd	Tb	Dy	Ho	Er	Tm	Yb	Lu
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Erbium	A soft, bright, silvery rare-earth metal. Gives pastel colors to ores. Few uses. (Ytterby, a town in Sweden)

³² Ge Germanium	²⁸ Ni Nickel	⁹² U Uranium	¹⁶ S Sulphur
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Germanium	A gray-white metalloid, semiconductor used in electronics (L. Germania, Germany)
Nickel	A metal found in most meteorites, silvery white takes a polish. Used in alloys and for coins. (German Nickel, Satan)
Uranium	A heavy, naturally occurring, radioactive, silver-white metal softer than steel. Used for nuclear power. (Planet Uranus)
Sulphur	A pale yellow, odorless, brittle solid, which is insoluble in water. Strong odor as Sulfer oxides. (Sanskrit, sulvere; L. sulphur, brimstone)



Dmitri Ivanovich Mendeleev

- *Russian chemist (1834-1907).*





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- *Showed periodic trends of the then-known elements based on their properties and atomic weights.*
- *Also predicted the properties of eight elements yet to be discovered.*



Dmitri Ivanovich Mendeleev



1 H Hydrogen	2 He Helium	3 Li Lithium	4 Be Beryllium	5 B Boron	6 C Carbon	7 N Nitrogen	8 O Oxygen	9 F Fluorine	10 Ne Neon	11 Na Sodium	12 Mg Magnesium	13 Al Aluminium	14 Si Silicon	15 P Phosphorus	16 S Sulphur	17 Cl Chlorine	18 Ar Argon	19 K Potassium	20 Ca Calcium	21 Sc Scandium	22 Ti Titanium	23 V Vanadium	24 Cr Chromium	25 Mn Manganese	26 Fe Iron	27 Co Cobalt	28 Ni Nickel	29 Cu Copper	30 Zn Zinc	31 Ga Gallium	32 Ge Germanium	33 As Arsenic	34 Se Selenium	35 Br Bromine	36 Kr Krypton	37 Rb Rubidium	38 Sr Strontium	39 Y Yttrium	40 Zr Zirconium	41 Nb Niobium	42 Mo Molybdenum	43 Tc Technetium	44 Ru Ruthenium	45 Rh Rhodium	46 Pd Palladium	47 Ag Silver	48 Cd Cadmium	49 In Indium	50 Sn Tin	51 Sb Antimony	52 Te Tellurium	53 I Iodine	54 Xe Xenon	55 Cs Cesium	56 Ba Barium	57 La Lanthanum	58 Ce Cerium	59 Pr Praseodymium	60 Nd Neodymium	61 Pm Promethium	62 Sm Samarium	63 Eu Europium	64 Gd Gadolinium	65 Tb Terbium	66 Dy Dysprosium	67 Ho Holmium	68 Er Erbium	69 Tm Thulium	70 Yb Ytterbium	71 Lu Lutetium	72 Hf Hafnium	73 Ta Tantalum	74 W Tungsten	75 Re Rhenium	76 Os Osmium	77 Ir Iridium	78 Pt Platinum	79 Au Gold	80 Hg Mercury	81 Tl Thallium	82 Pb Lead	83 Bi Bismuth	84 Po Polonium	85 At Astatine	86 Rn Radon	87 Fr Francium	88 Ra Radium	89 Ac Actinium	90 Th Thorium	91 Pa Protactinium	92 U Uranium	93 Np Neptunium	94 Pu Plutonium	95 Am Americium	96 Cm Curium	97 Bk Berkelium	98 Cf Californium	99 Es Einsteinium	100 Fm Fermium	101 Md Mendelevium	102 No Nobelium	103 Lr Lawrencium	104 Rf Rutherfordium	105 Db Dubnium	106 Sg Seaborgium	107 Bh Bohrium	108 Hs Hassium	109 Mt Meitnerium	110 Ds Darmstadtium	111 Rg Roentgenium	112 Cn Copernicium	113 Nh Nihonium	114 Fl Flerovium	115 Mc Moscovium	116 Lv Livermorium	117 Ts Tennessine	118 Og Oganesson
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Dmitri Ivanovich Mendeleev

Reihen	Gruppe I. — R'O	Gruppe II. — R'O	Gruppe III. — R'O ³	Gruppe IV. RH ⁴ RO ²	Gruppe V. RH ⁵ R'O ⁵	Gruppe VI. RH ⁶ RO ³	Gruppe VII. RH R'O ⁷	Gruppe VIII. — RO ⁴
1	H=1							
2	Li=7	Be=9,4	B=11	C=12	N=14	O=16	F=19	
3	Na=23	Mg=24	Al=27,3	Si=28	P=31	S=32	Cl=35,5	
4	K=39	Ca=40	—=44	Ti=48	V=51	Cr=52	Mn=55	Fe=56, Co=59, Ni=59, Cu=63.
5	(Cu=63)	Zn=65	—=68	—=72	As=75	Se=78	Br=80	
6	Rb=86	Sr=87	?Yt=88	Zr=90	Nb=94	Mo=96	—=100	Ru=104, Rh=104, Pd=106, Ag=108.
7	(Ag=108)	Cd=112	In=113	Sn=118	Sb=122	Te=125	J=127	
8	Cs=133	Ba=137	?Di=138	?Ce=140	—	—	—	— — — —
9	(—)	—	—	—	—	—	—	
10	—	—	?Er=178	?La=180	Ta=182	W=184	—	Os=195, Ir=197, Pt=198, Au=199.
11	(Au=199)	Hg=200	Tl=204	Pb=207	Bi=208	—	—	
12	—	—	—	Th=231	—	U=240	—	— — — —

Mendeleev's 1871 periodic table



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 = 197,1.
		Fe = 56	Ru = 104,4	Ir = 198.
		Co = 59	Pd = 106,8	Os = 199.
		Cu = 63,4	Ag = 108	Hg = 200.
H = 1	Be = 9,4	Mg = 24	Zn = 65,2	Cd = 112
	B = 11	Al = 27,1	? = 68	Ur = 116
	C = 12	Si = 28	? = 70	Sn = 118
	N = 14	P = 31	As = 75	Sb = 122
	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
		Ca = 40	Sr = 87,6	Ba = 137
		? = 45	Ce = 92	Pb = 207.
		?Er = 56	La = 94	
		?Yt = 60	Di = 95	
		?In = 75,6	Th = 118?	

- Mendeleev published his periodic table of all known elements (56 elements)

- And he predicted several new elements to complete the table (in 1871).

eka-aluminium

eka-silicon

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 = 197,1.
		Fe = 56	Ru = 104,4	Ir = 198.
		Co = 59	Pd = 106,8	Os = 199.
		Cu = 63,4	Ag = 108	Hg = 200.
H = 1	Be = 9,4	Mg = 24	Zn = 65,2	Cd = 112
	B = 11	Al = 27,1	? = 68	U = 116
	C = 12	Si = 28	? = 70	Sn = 118
	N = 14	P = 31	As = 75	Sb = 122
	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
		Ca = 40	Sr = 87,6	Ba = 137
		? = 45	Ce = 92	Pb = 207.
		?Er = 56	La = 94	
		?Yt = 60	Di = 95	
		?In = 75,5	Th = 118?	

- Mendeleev published his periodic table of all known elements (56 elements)

- And he predicted several new elements to complete the table (in 1871).

eka-aluminium – Gallium (discovered in 1875)

eka-silicon – Germanium (isolated in 1886)



Dmitri Ivanovich Mendeleev

The 40% standard strength of Vodka
approved by the royal government commission
headed by Mendeleev in 1894
as the highest quality of Russian vodka





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**"TRUST ME,
YOU CAN
DANCE."**

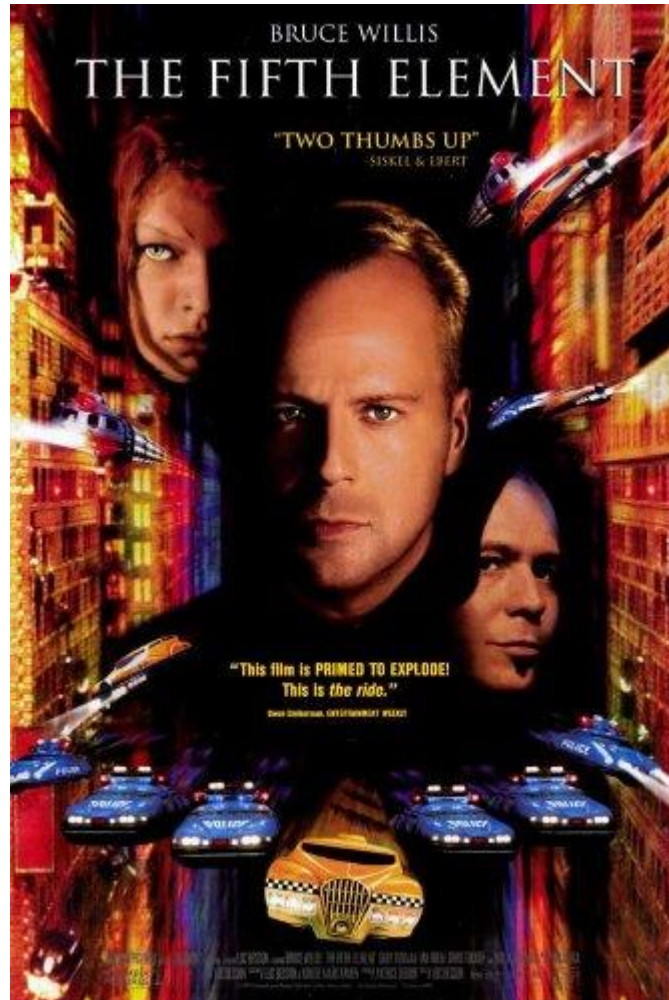
-VODKA






















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ELEMENTS		
	Hydrogen	1
	Azote	5
	Carbon	5
	Oxygen	7
	Phosphorus	9
	Sulphur	13
	Magnesia	20
	Lime	24
	Soda	28
	Potash	42
	Strontian	46
	Barytes	68
	Iron	50
	Zinc	56
	Copper	56
	Lead	90
	Silver	100
	Gold	190
	Platina	190
	Mercury	167

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[Dalton](#) (1806): listing the known elements by atomic weight

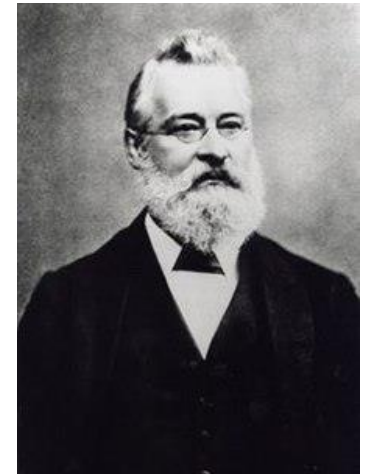
- Around 330 BCE, the [Greek philosopher Aristotle](#) proposed that everything is made up of a mixture of one or more *roots* that cannot be broken down into a simpler substance.

ELEMENTS			
○ Hydrogen. 1	⊕ Strontian 46		
⊖ Azote 5	⊗ Barytes 68		
● Carbon 54	⊖ Iron 50		
○ Oxygen 7	⊖ Zinc 56		
⊖ Phosphorus 9	⊖ Copper 56		
⊕ Sulphur 13	⊖ Lead 90		
⊖ Magnesia 20	⊖ Silver 190		
⊖ Lime 24	⊖ Gold 190		
⊖ Soda 28	⊖ Platina 190		
⊖ Potash 42	⊖ Mercury 167		

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- In 1864, the English chemist [John Newlands](#) classified the known elements into eight groups, based on their physical properties.

No.	No.	No.	No.	No.	No.	No.	No.
H 1	F 8	Cl 15	Co & Ni 22	Br 29	Pd 36	I 42	Pt & Ir 50
Li 2	Na 9	K 16	Cu 23	Rb 30	Ag 37	Cs 44	Os 51
G 3	Mg 10	Ca 17	Zn 24	Sr 31	Cd 38	Ba & V 45	Hg 52
Bo 4	Al 11	Cr 19	Y 25	Ce & La 33	U 40	Ta 46	Tl 53
C 5	Si 12	Ti 18	In 26	Zr 32	Sn 39	W 47	Pb 54
N 6	P 13	Mn 20	As 27	Di & Mo 34	Sb 41	Nb 48	Bi 55
O 7	S 14	Fe 21	Se 28	Ro & Ru 35	Te 43	Au 49	Th 56

[Newlands'](#) periodic table



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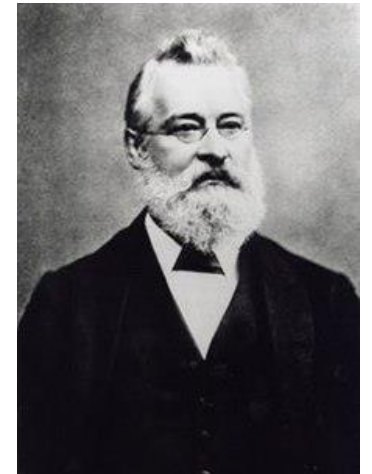
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○ Hydrogen. 1	⊕ Strontian 46		
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● Carbon 54	⊖ Iron 50		
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⊖ Phosphorus 9	⊖ Copper 56		
⊕ Sulphur 13	⊖ Lead 90		
⊖ Magnesia 20	⊖ Silver 190		
⊖ Lime 24	⊖ Gold 190		
⊖ Soda 28	⊖ Platina 190		
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H 1	F 8	Cl 15	Co & Ni 22	Br 29	Pd 36	I 42	Pt & Ir 50
Li 2	Na 9	K 16	Cu 23	Rb 30	Ag 37	Cs 44	Os 51
G 3	Mg 10	Ca 17	Zn 24	Sr 31	Cd 38	Ba & V 45	Hg 52
Bo 4	Al 11	Cr 19	Y 25	Ce & La 33	U 40	Ta 46	Tl 53
C 5	Si 12	Ti 18	In 26	Zr 32	Sn 39	W 47	Pb 54
N 6	P 13	Mn 20	As 27	Di & Mo 34	Sb 41	Nb 48	Bi 55
O 7	S 14	Fe 21	Se 28	Ro & Ru 35	Te 43	Au 49	Th 56

[Newlands'](#) periodic table



- In 1864, [Julius Lothar Meyer](#), a German chemist, noted groups of similar chemical and physical properties repeated at periodic intervals if each element is arranged in the order of their atomic weights.

- In 1869, a few months later than Mendeleev, Meyer published a revised and expanded version of his 1864 table independently, which was similar to that published by Mendeleev.

	4 werthig	3 werthig	2 werthig	1 werthig	1 werthig	2 werthig
	-	-	-	-	Li = 7,03	(Be = 9,3?)
Differenz =	-	-	-	-	16,02	(14,7)
	C = 12,0	N = 14,04	O = 16,00	Fl = 19,0	Na = 23,05	Mg = 24,0
Differenz =	16,5	16,96	16,07	16,46	16,08	16,0
	Si = 28,5	P = 31,0	S = 32,07	Cl = 35,46	K = 39,13	Ca = 40,0
Differenz =	89,1 / 2 = 44,55	44,0	46,7	44,51	46,3	47,6
	-	As = 75,0	Se = 78,8	Br = 79,97	Rb = 85,4	Sr = 87,6
Differenz =	89,1 / 2 = 44,55	45,6	49,5	46,8	47,6	49,5
	Sn = 117,6	Sb = 120,6	Te = 128,3	J = 126,8	Cs = 133,0	Ba = 137,1
Differenz =	89,4 = 2*44,7	87,4 = 2*43,7	-	-	(71 = 2*35,5)	-
	Pb = 207,0	Bi = 208,0	-	-	(Tl = 204?)	-

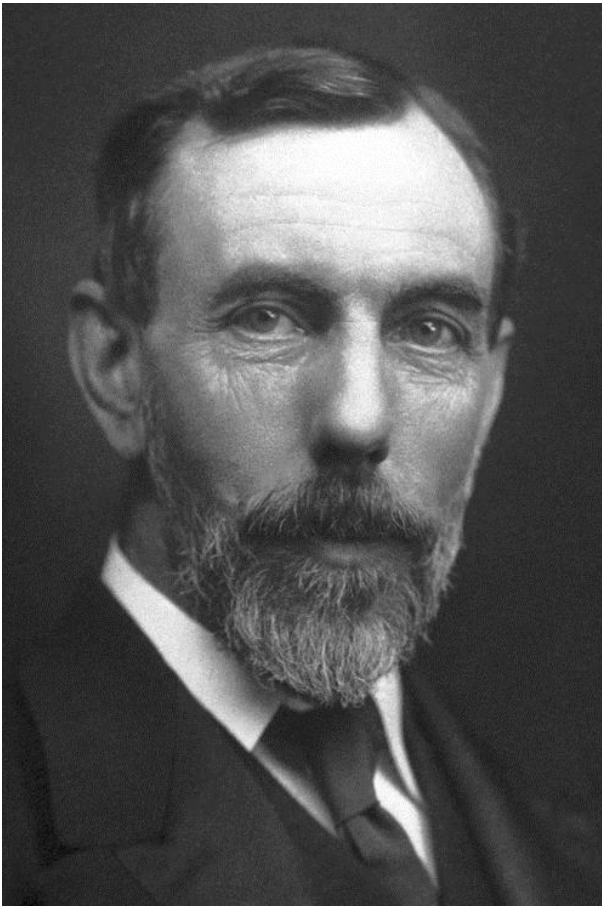


Julius Lothar Meyer's periodic table, published in "Die modernen Theorien der Chemie" (1864)

- In 1882, both Meyer and Mendeleev received the Davy Medal from the Royal Society in recognition of their work on the Periodic Law.

Sir William Ramsay - a Scottish chemist

- Discovered the [noble gases](#) and received the [Nobel Prize in Chemistry](#) in 1904 "in recognition of his services in the discovery of the inert gaseous elements in air"



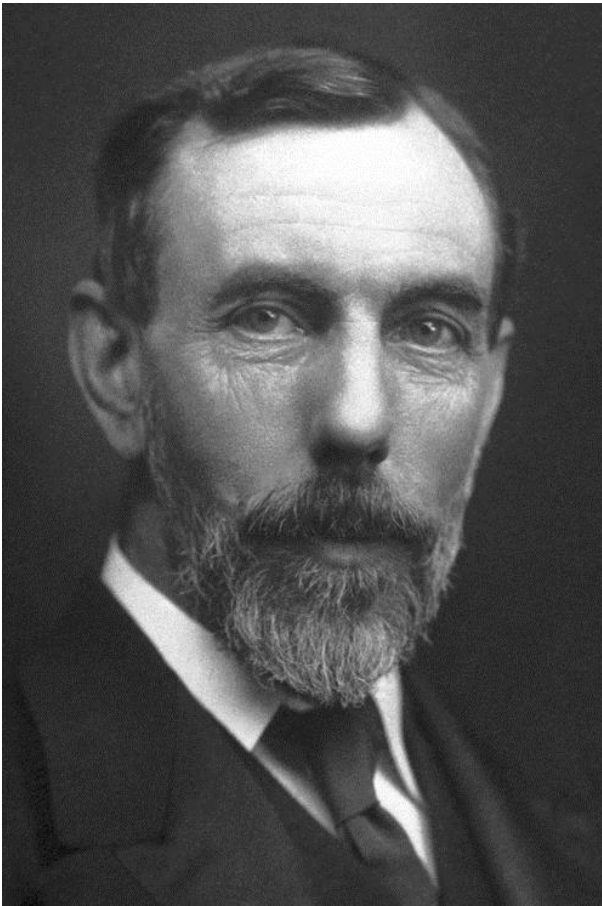
William Ramsay
Nobel Prize in
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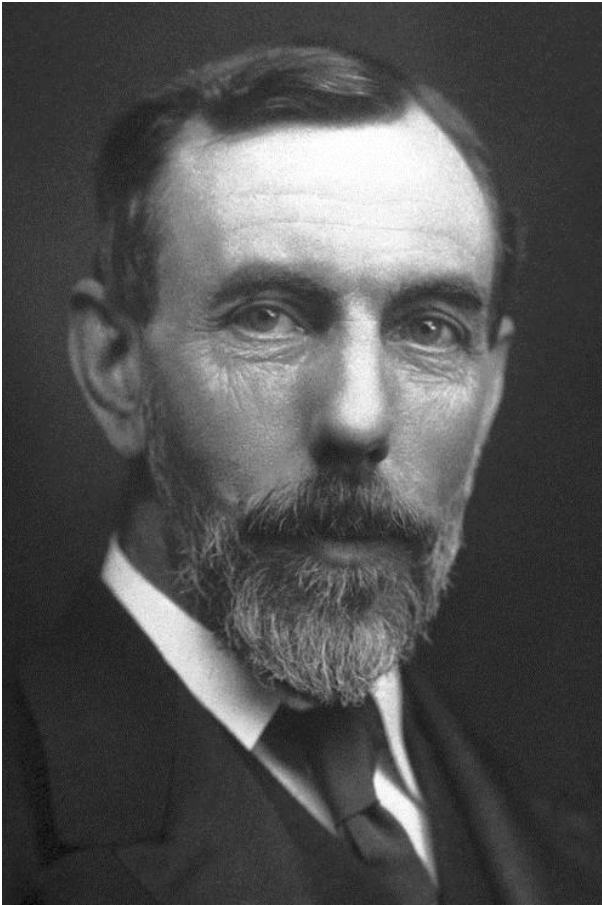


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- **When the entire group of [noble gases](#) was discovered, Ramsay added them to the table as [Group 0](#), without disturbing the basic concept of the periodic table.**



John William Strutt,
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Nobel Prize in
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- The English physicist [Henry Moseley](#) found a relationship between the [X-ray wavelength](#) of an element and its atomic number (1910-1914).
- He was then able to re-sequence the periodic table by [nuclear charge](#), rather than by atomic weight.



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- He died in World War I, at the age of 27.



The **GSI Helmholtz Centre for Heavy Ion Research** (German: *GSI Helmholtzzentrum für Schwerionenforschung*) is a research center in [Darmstadt](#), Germany

Elements discovered at GSI:
Element 107 [bohrium](#) (1981),
109 [meitnerium](#) (1982), 108 [hassium](#) (1984),
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1966 – element 102 ([nobelium](#))
1999-2005 – elements 105 (dubnium),
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Yuri Oganessian

He is a Russian nuclear physicist of Armenian origin who is considered the world's leading researcher in superheavy chemical elements.

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Co-discoverers of new superheavy elements

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94 (Plutonium), 95 (americium), 96 (curium), 97
(berkelium), 98 (californium), 99 (einsteinium), 100
(fermium), 101 (mendelevium), 102 (nobelium), 103
(lawrencium), 106 (seaborgium)

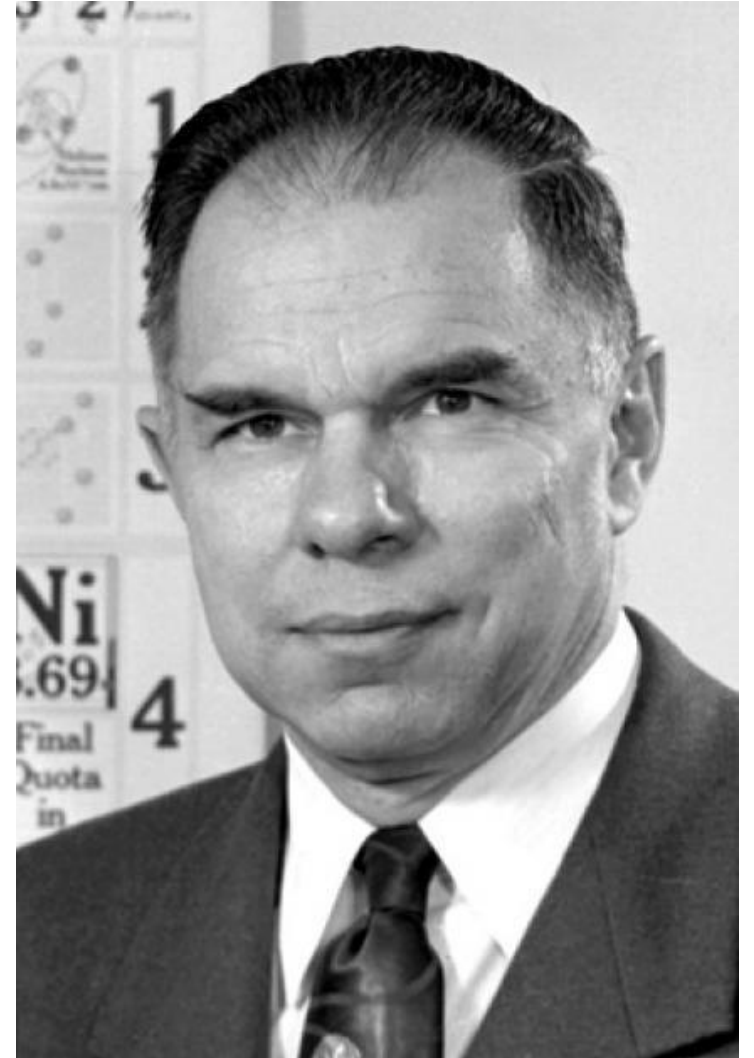
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Glenn T. Seaborg was an American chemist whose
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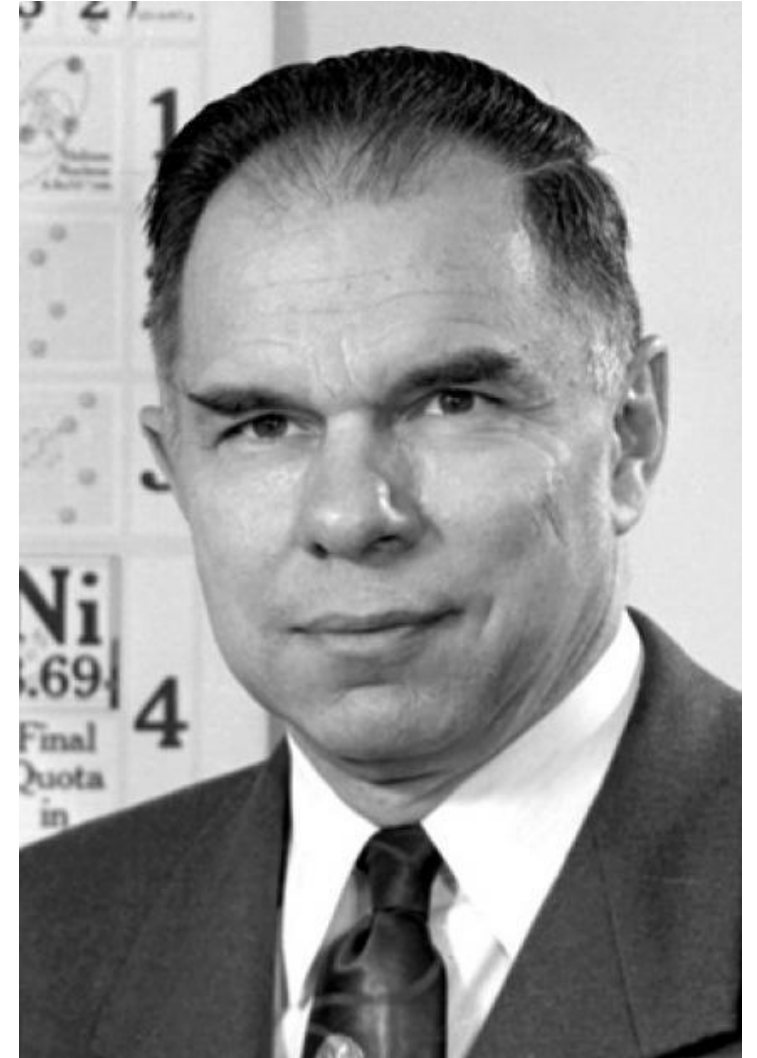
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**Seaborgium is the first element ever to have been officially
named after a living person. The second element to be so
named is oganesson, in 2016, after Yuri Oganessian**

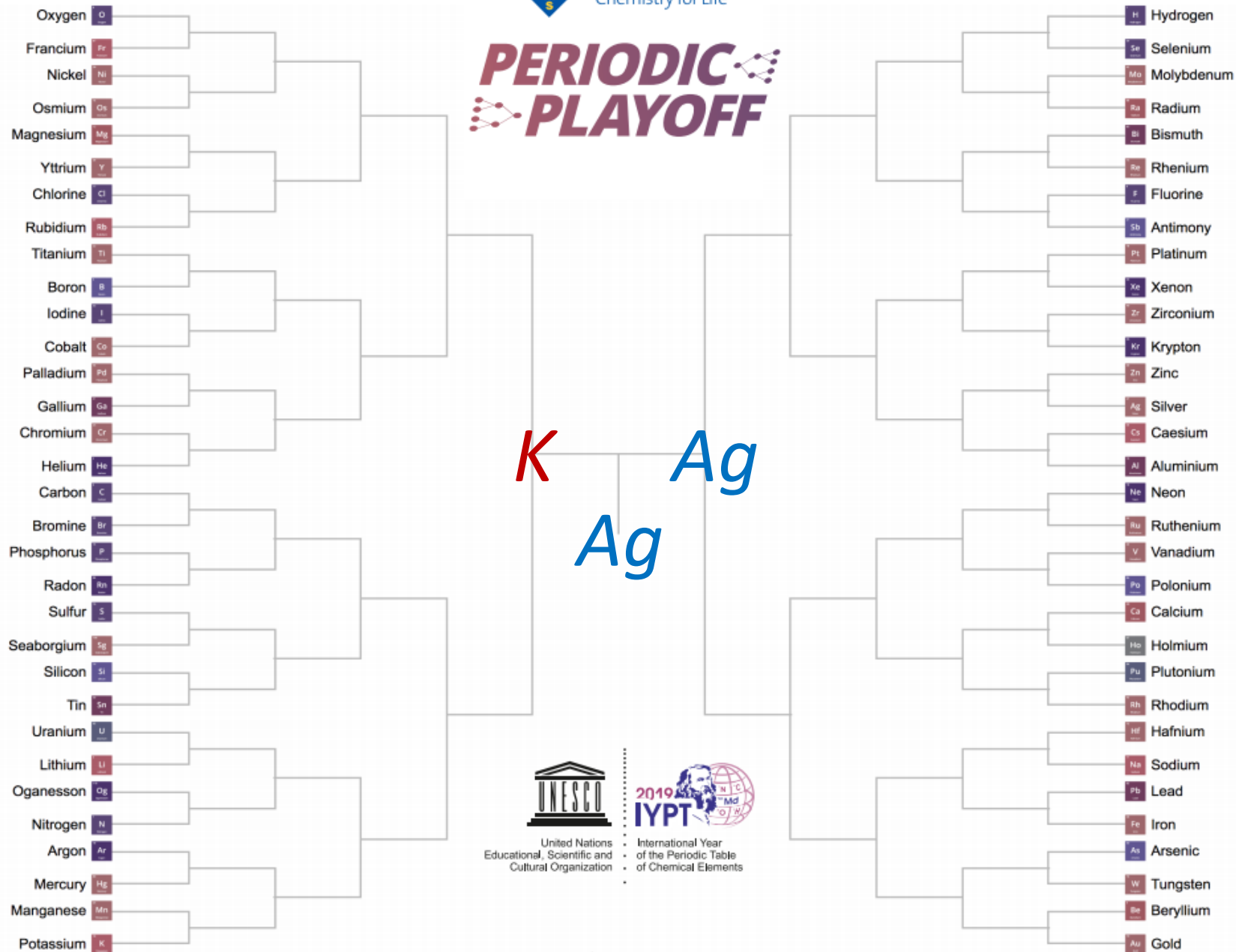




What's your favorite element?



PERIODIC PLAYOFF



Modern Periodic Table – From Hydrogen-1 to Oganesson-118

Group → 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18

Period ↓

1 1 H 2 He

2 3 Li 4 Be 5 B 6 C 7 N 8 O 9 F 10 Ne

3 11 Na 12 Mg 13 Al 14 Si 15 P 16 S 17 Cl 18 Ar

4 19 K 20 Ca 21 Sc 22 Ti 23 V 24 Cr 25 Mn 26 Fe 27 Co 28 Ni 29 Cu 30 Zn 31 Ga 32 Ge 33 As 34 Se 35 Br 36 Kr

5 37 Rb 38 Sr 39 Y 40 Zr 41 Nb 42 Mo 43 Tc 44 Ru 45 Rh 46 Pd 47 Ag 48 Cd 49 In 50 Sn 51 Sb 52 Te 53 I 54 Xe

6 55 Cs 56 Ba 57 La * 72 Hf 73 Ta 74 W 75 Re 76 Os 77 Ir 78 Pt 79 Au 80 Hg 81 Tl 82 Pb 83 Bi 84 Po 85 At 86 Rn

7 87 Fr 88 Ra 89 Ac * 104 Rf 105 Db 106 Sg 107 Bh 108 Hs 109 Mt 110 Ds 111 Rg 112 Cn 113 Nh 114 Fl 115 Mc 116 Lv 117 Ts 118 Og

* 58 Ce 59 Pr 60 Nd 61 Pm 62 Sm 63 Eu 64 Gd 65 Tb 66 Dy 67 Ho 68 Er 69 Tm 70 Yb 71 Lu

* 90 Th 91 Pa 92 U 93 Np 94 Pu 95 Am 96 Cm 97 Bk 98 Cf 99 Es 100 Fm 101 Md 102 No 103 Lr

Display of the chemical elements,
which are arranged by
atomic number

Modern Periodic Table – From Hydrogen-1 to Oganesson-118

Group →	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Period ↓	1 1 H																	2 He
2	3 Li	4 Be											5 B	6 C	7 N	8 O	9 F	10 Ne
3	11 Na	12 Mg											13 Al	14 Si	15 P	16 S	17 Cl	18 Ar
4	19 K	20 Ca	21 Sc	22 Ti	23 V	24 Cr	25 Mn	26 Fe	27 Co	28 Ni	29 Cu	30 Zn	31 Ga	32 Ge	33 As	34 Se	35 Br	36 Kr
5	37 Rb	38 Sr	39 Y	40 Zr	41 Nb	42 Mo	43 Tc	44 Ru	45 Rh	46 Pd	47 Ag	48 Cd	49 In	50 Sn	51 Sb	52 Te	53 I	54 Xe
6	55 Cs	56 Ba	57 La	* 72 Hf	73 Ta	74 W	75 Re	76 Os	77 Ir	78 Pt	79 Au	80 Hg	81 Tl	82 Pb	83 Bi	84 Po	85 At	86 Rn
7	87 Fr	88 Ra	89 Ac	* 104 Rf	105 Db	106 Sg	107 Bh	108 Hs	109 Mt	110 Ds	111 Rg	112 Cn	113 Nh	114 Fl	115 Mc	116 Lv	117 Ts	118 Og
				* 58 Ce	59 Pr	60 Nd	61 Pm	62 Sm	63 Eu	64 Gd	65 Tb	66 Dy	67 Ho	68 Er	69 Tm	70 Yb	71 Lu	
				* 90 Th	91 Pa	92 U	93 Np	94 Pu	95 Am	96 Cm	97 Bk	98 Cf	99 Es	100 Fm	101 Md	102 No	103 Lr	

The seven rows of the table,
called periods

Modern Periodic Table – From Hydrogen-1 to Oganesson-118

Group →	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Period ↓																		
1	1 H																	2 He
2	3 Li	4 Be											5 B	6 C	7 N	8 O	9 F	10 Ne
3	11 Na	12 Mg											13 Al	14 Si	15 P	16 S	17 Cl	18 Ar
4	19 K	20 Ca	21 Sc	22 Ti	23 V	24 Cr	25 Mn	26 Fe	27 Co	28 Ni	29 Cu	30 Zn	31 Ga	32 Ge	33 As	34 Se	35 Br	36 Kr
5	37 Rb	38 Sr	39 Y	40 Zr	41 Nb	42 Mo	43 Tc	44 Ru	45 Rh	46 Pd	47 Ag	48 Cd	49 In	50 Sn	51 Sb	52 Te	53 I	54 Xe
6	55 Cs	56 Ba	57 La	* 72 Hf	73 Ta	74 W	75 Re	76 Os	77 Ir	78 Pt	79 Au	80 Hg	81 Tl	82 Pb	83 Bi	84 Po	85 At	86 Rn
7	87 Fr	88 Ra	89 Ac	* 104 Rf	105 Db	106 Sg	107 Bh	108 Hs	109 Mt	110 Ds	111 Rg	112 Cn	113 Nh	114 Fl	115 Mc	116 Lv	117 Ts	118 Og
				* 58 Ce	59 Pr	60 Nd	61 Pm	62 Sm	63 Eu	64 Gd	65 Tb	66 Dy	67 Ho	68 Er	69 Tm	70 Yb	71 Lu	
				* 90 Th	91 Pa	92 U	93 Np	94 Pu	95 Am	96 Cm	97 Bk	98 Cf	99 Es	100 Fm	101 Md	102 No	103 Lr	

The columns, called groups, contain elements with similar chemical behaviors

Modern Periodic Table – From Hydrogen-1 to Oganesson-118

Group →	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Period ↓																		
1	1 H																	2 He
2	3 Li	4 Be											5 B	6 C	7 N	8 O	9 F	10 Ne
3	11 Na	12 Mg											13 Al	14 Si	15 P	16 S	17 Cl	18 Ar
4	19 K	20 Ca	21 Sc	22 Ti	23 V	24 Cr	25 Mn	26 Fe	27 Co	28 Ni	29 Cu	30 Zn	31 Ga	32 Ge	33 As	34 Se	35 Br	36 Kr
5	37 Rb	38 Sr	39 Y	40 Zr	41 Nb	42 Mo	43 Tc	44 Ru	45 Rh	46 Pd	47 Ag	48 Cd	49 In	50 Sn	51 Sb	52 Te	53 I	54 Xe
6	55 Cs	56 Ba	57 La *	72 Hf	73 Ta	74 W	75 Re	76 Os	77 Ir	78 Pt	79 Au	80 Hg	81 Tl	82 Pb	83 Bi	84 Po	85 At	86 Rn
7	87 Fr	88 Ra	89 Ac *	104 Rf *	105 Db	106 Sg	107 Bh	108 Hs	109 Mt	110 Ds	111 Rg	112 Cn	113 Nh	114 Fl	115 Mc	116 Lv	117 Ts	118 Og
				* 58 Ce	59 Pr	60 Nd	61 Pm	62 Sm	63 Eu	64 Gd	65 Tb	66 Dy	67 Ho	68 Er	69 Tm	70 Yb	71 Lu	
				* 90 Th	91 Pa	92 U	93 Np	94 Pu	95 Am	96 Cm	97 Bk	98 Cf	99 Es	100 Fm	101 Md	102 No	103 Lr	

The first 94 elements all occur naturally

The Ultra-long Periodic Table of the Elements

1	1 H																	2 He																
2	3 Li	4 Be																	5 B	6 C	7 N	8 O	9 F	10 Ne										
3	11 Na	12 Mg																	13 Al	14 Si	15 P	16 S	17 Cl	18 Ar										
4	19 K	20 Ca																	21 Sc	22 Ti	23 V	24 Cr	25 Mn	26 Fe	27 Co	28 Ni	29 Cu	30 Zn	31 Ga	32 Ge	33 As	34 Se	35 Br	36 Kr
5	37 Rb	38 Sr																	39 Y	40 Zr	41 Nb	42 Mo	43 Tc	44 Ru	45 Rh	46 Pd	47 Ag	48 Cd	49 In	50 Sn	51 Sb	52 Te	53 I	54 Xe
6	55 Cs	56 Ba	57 La	58 Ce	59 Pr	60 Nd	61 Pm	62 Sm	63 Eu	64 Gd	65 Tb	66 Dy	67 Ho	68 Er	69 Tm	70 Yb	71 Lu	72 Hf	73 Ta	74 W	75 Re	76 Os	77 Ir	78 Pt	79 Au	80 Hg	81 Tl	82 Pb	83 Bi	84 Po	85 At	86 Rn		
7	87 Fr	88 Ra	89 Ac	90 Th	91 Pa	92 U	93 Np	94 Pu	95 Am	96 Cm	97 Bk	98 Cf	99 Es	100 Fm	101 Md	102 No	103 Lr	104 Rf	105 Db	106 Sg	107 Bh	108 Hs	109 Mt	110 Ds	111 Rg	112 Cn	113 Uut	114 Uuq	115 Uup	116 Uuh	117 Uus	118 Uuo		

Alkali metals	Alkaline earth metals	Lanthanides	Actinides	Transition metals
Poor metals	Metalloids	Nonmetals	Halogens	Noble gases

State at standard tempurature and pressure

Atomic number in red: gas

Atomic number in blue: liquid

Atomic number in black: solid

solid border: at least one isotope is older than the Earth (Primordial elements)

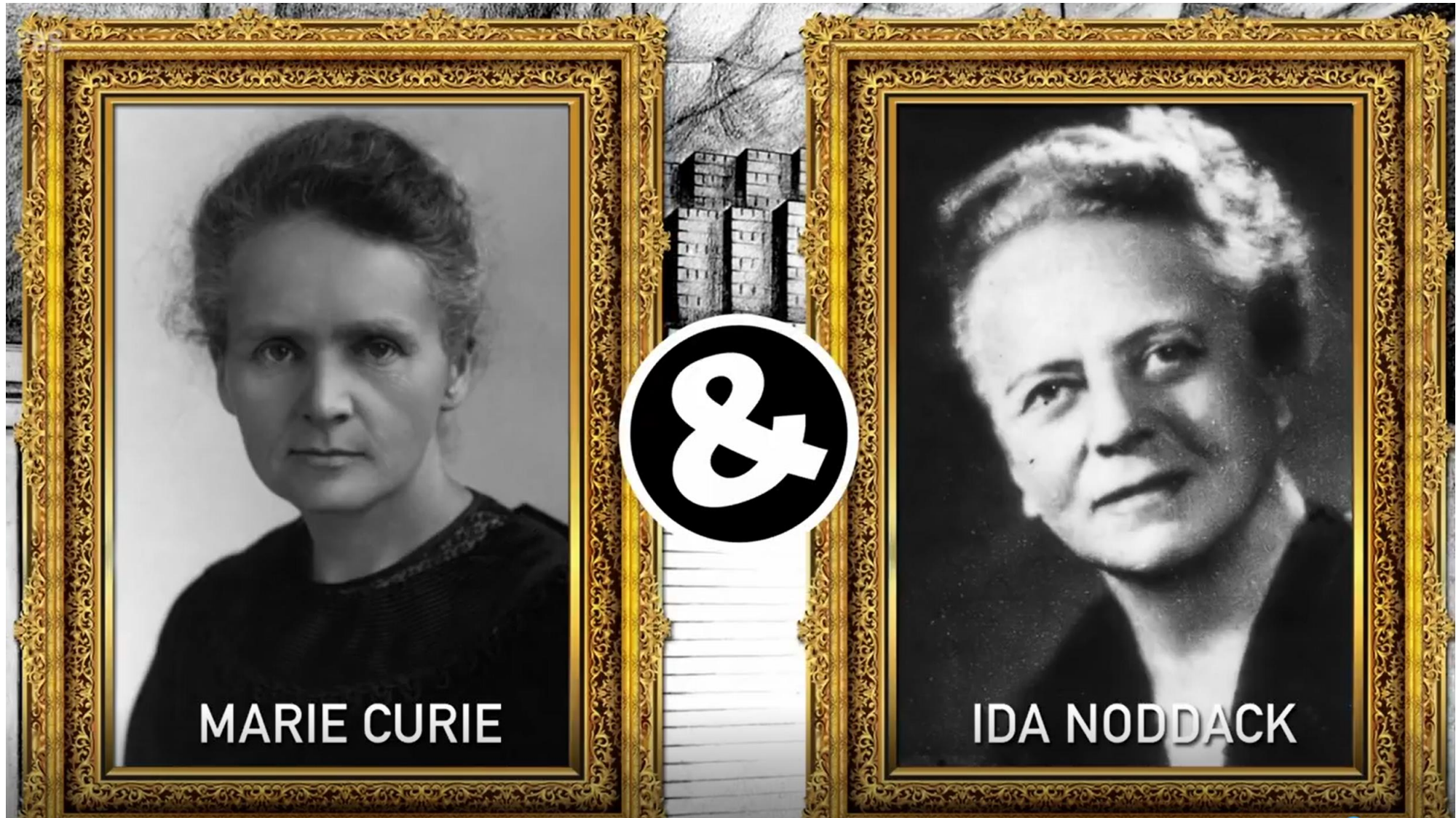
dashed border: at least one isotope naturally arise from decay of other chemical elements and no isotopes are older than the earth

: dotted border: only artificially made isotopes (synthetic elements)

no border: undiscovered



Women Scientists who contributed to the Periodic Table





**LISE
MEITNER**



**MARGUERITE
PEREY**



**DARLEANE
HOFFMAN**



Ida Noddack was a German [chemist](#) and [physicist](#). With her husband [Walter Noddack](#) she discovered element 75, [rhenium](#). She was nominated three times for the [Nobel Prize in Chemistry](#).

In 1925, they published a paper and called the new elements [rhenium](#) (75) and masurium (43). They named the elements rhenium in respect of Ida's birthplace, and masurium in honor of his.

They were unable to isolate element 43 (Technetium).



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Darleane Christian Hoffman is an [American nuclear chemist](#) who was among the researchers who confirmed the existence of [Seaborgium](#), [element](#) 106 (1974). She is a faculty senior scientist in the Nuclear Science Division of [Lawrence Berkeley National Laboratory](#) and a professor in the graduate school at [UC Berkeley](#).

Marie Curie was a [Polish and naturalized-French](#) [physicist](#) and [chemist](#) who conducted pioneering research on [radioactivity](#). She was the [first woman](#) to win a [Nobel Prize](#), the first person and only woman to [win twice](#), and the only person to win a Nobel Prize in two different sciences.



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Curie's achievements included the development of the theory of *radioactivity*, techniques for isolating radioactive [isotopes](#), and the discovery of two elements, [polonium](#) and [radium](#).

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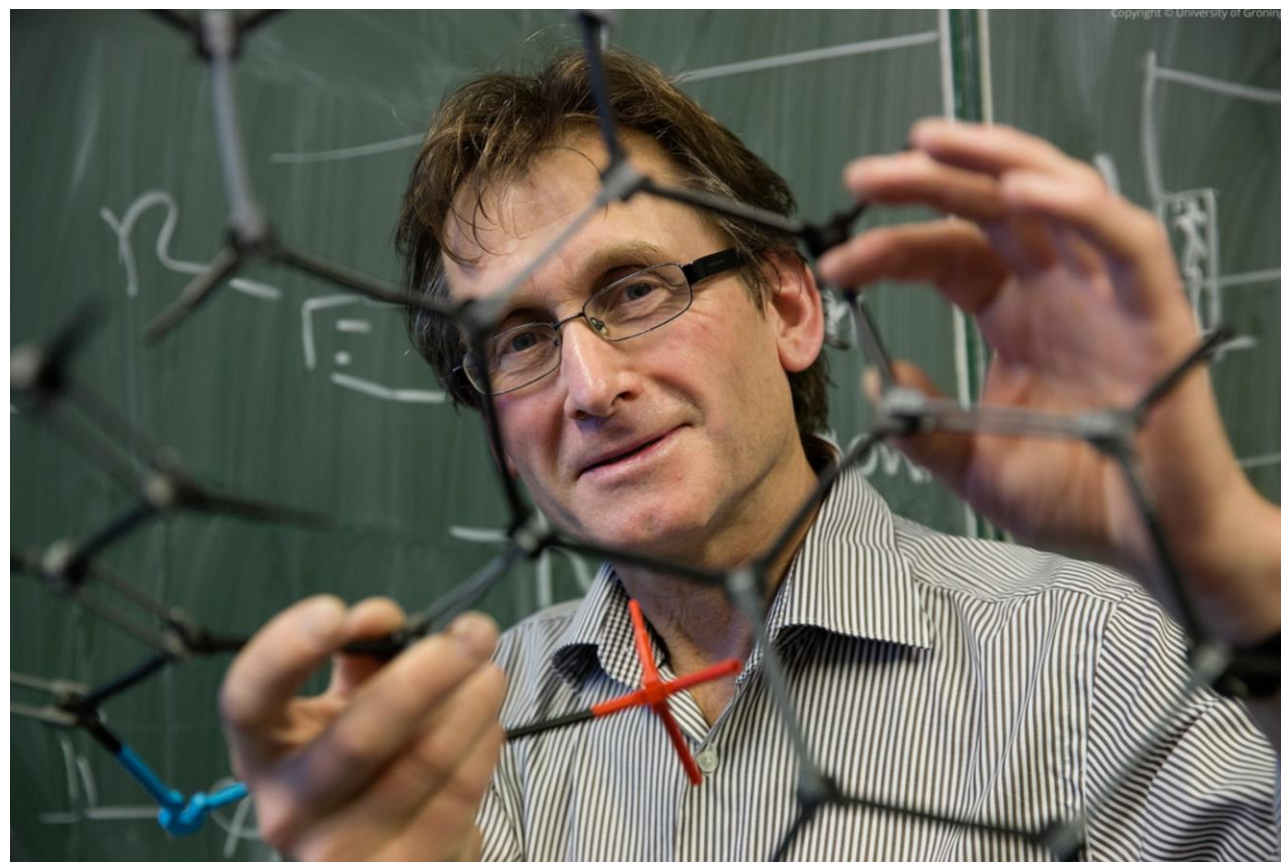


Lise Meitner

The [GSI Helmholtz Centre for Heavy Ion Research](#) near [Darmstadt](#), Germany, first created the element-109 (Meitnerium) in 1982. It is named after [Lise Meitner](#).

"When I draw a molecule in China or in Argentina, it is the same molecule. People understand immediately without knowing Spanish or Chinese. That is beautiful. Our common goal is not about power or borders of the country, it is about bringing forward human knowledge."

Ben Feringa
2016
Nobel Prize
in Chemistry





Elements Named After People

Many of the transuranic elements are named after recipients of the Nobel Prize (8), including:

- bohrium (Niels Bohr),
- curium (Marie and Pierre Curie),
- einsteinium (Albert Einstein),
- fermium (Enrico Fermi),
- lawrencium (Ernest Lawrence),
- roentgenium (Wilhelm Röntgen),
- rutherfordium (Ernest Rutherford),
- and seaborgium (Glenn T. Seaborg).

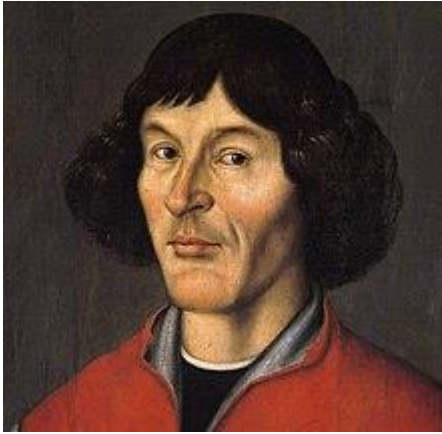
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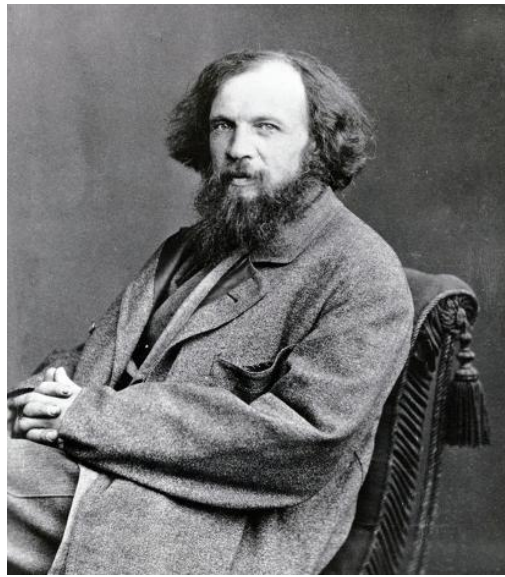
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- rutherfordium (Ernest Rutherford),
- and seaborgium (Glenn T. Seaborg).

Transuranic elements named in honor of scientists (6) who did not receive the prize include:

- copernicium (Nicolaus Copernicus),
- flerovium (Georgiy Flyorov),
- meitnerium (Lise Meitner),
- mendelevium (Dmitri Mendeleev),
- nobelium (Alfred Nobel),
- and oganesson (Yuri Oganessian).



Nicolaus Copernicus



Dmitri Mendeleev



Alfred Nobel



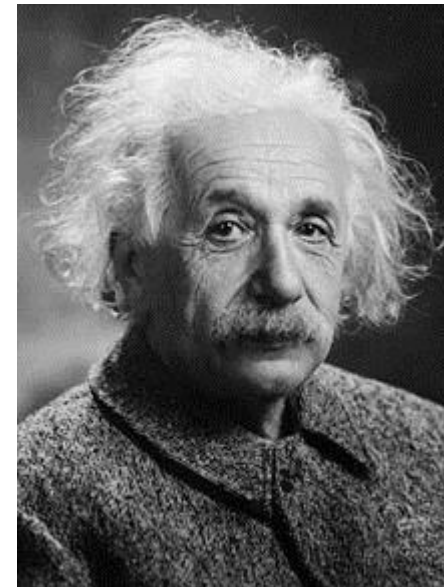
Niels Bohr



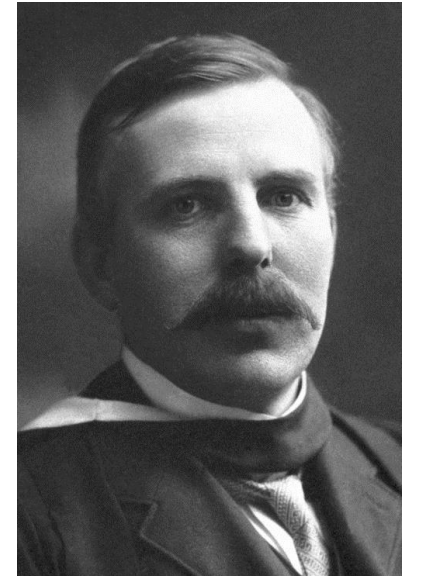
Wilhelm Röntgen



Marie and Pierre Curie



Albert Einstein



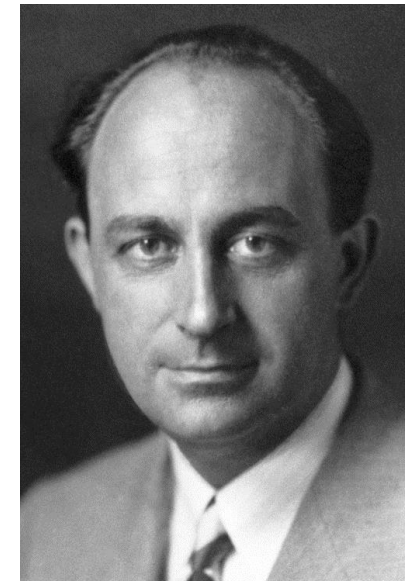
Ernest Rutherford



Lise Meitner



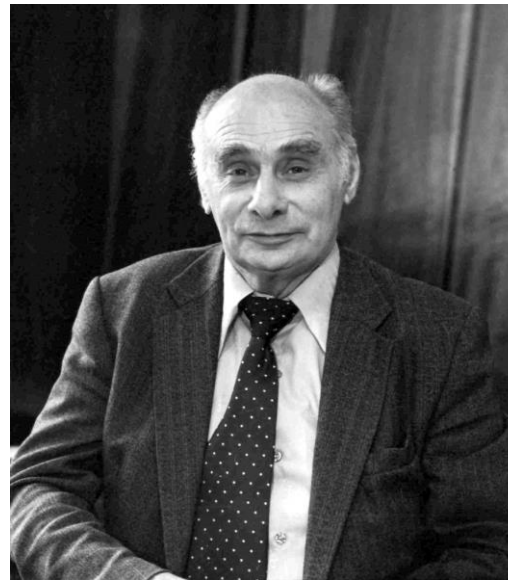
Yuri Oganessian



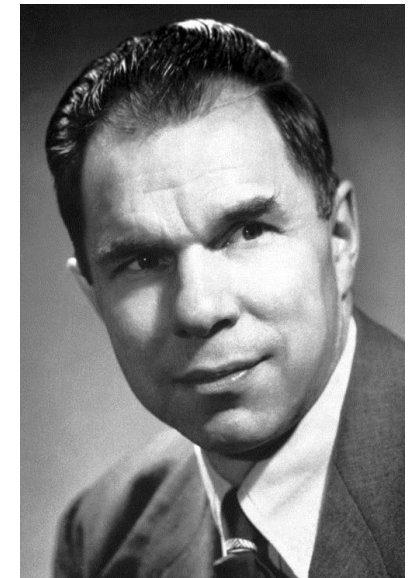
Enrico Fermi



Ernest Lawrence



Georgy Flyorov



Glenn T. Seaborg

96

CURIUM

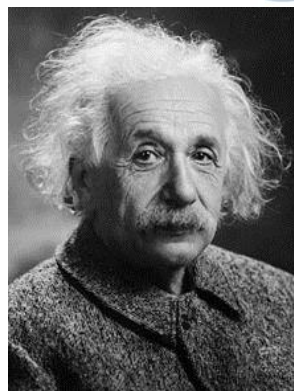


Curium is named after Marie Curie who discovered radium and polonium.

Cm

99

EINSTEINIUM



Einsteinium was named after the famous physicist Albert Einstein.

Es

100

FERMIUM

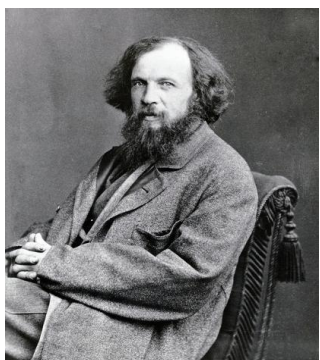


Fermium was named after Enrico Fermi, who did work on nuclear reactions.

Fm

101

MENDELEVIVM



Mendelevium was named for Dmitri Mendeleev, inventor of the periodic table.

Md

102

NOBELIVM



Nobelium is named for Alfred Nobel, for whom the Nobel Prize is also named.

No

103

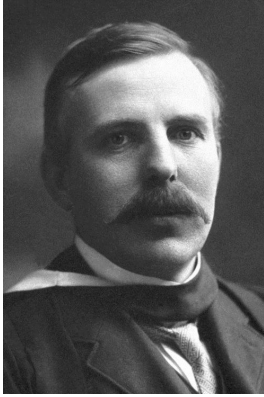
LAWRENCIVM



Lawrencium is named after Ernest O. Lawrence, the inventor of the cyclotron.

Lr

104 RUTHERFORDIUM



Rutherfordium is named for Ernest Rutherford, who discovered that elements have nuclei.

Rf

106 SEABORGIUM



Seaborgium is named for Glenn T. Seaborg, who helped discover many elements.

Sg

107 BOHRIUM



Bohrium is named for Niels Bohr, who did groundbreaking research on the atom.

Bh

109 MEITNERIUM



Meitnerium is named for Lise Meitner, who helped discover nuclear fission.

Mt

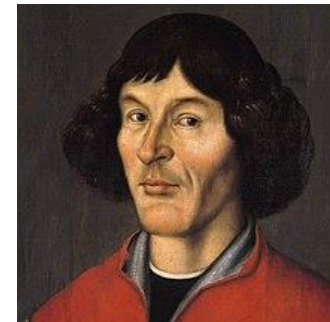
111 ROENTGENIUM



Roentgenium is named for Wilhelm Conrad Röntgen, inventor of the x-ray.

Rg

112 COPERNICIUM



Copernicium is named after Nicolaus Copernicus, the famous astronomer.

Cn

Which Elements Are Named for Places? Total 30

- Americium – America, the Americas
- Berkelium – University of California at Berkeley
- [Californium](#) – State of California and University of California at Berkeley
- Copper - probably named for Cyprus
- Darmstadtium – Darmstadt, Germany
- Dubnium – Dubna, Russia
- Erbium – Ytterby, a town in Sweden
- Europium – Europe
- Francium – France
- Gallium – Gallia, Latin for France. Also named for Lecoq de Boisbaudran, the element's discoverer (Lecoq in Latin is gallus)
- Germanium – Germany
- Hafnium – Hafnia, Latin for Copenhagen
- Hassium – Hesse, Germany
- [Holmium](#) – Holmia, Latin for Stockholm
- Lutetium – Lutecia, ancient name for Paris
- Magnesium – Magnesia prefecture in Thessaly, Greece
- [Polonium](#) – Poland
- Rhenium – Rhenus, Latin for Rhine, a German province
- Ruthenium – Ruthenia, Latin for Russia
- Scandium – Scandia, Latin for Scandinavia
- Strontium – Strontian, a town in Scotland
- Terbium – Ytterby, Sweden
- [Thulium](#) – Thule, a mythical island in the far north (Scandinavia?)
- Ytterbium – Ytterby, Sweden
- Yttrium – Ytterby, Sweden

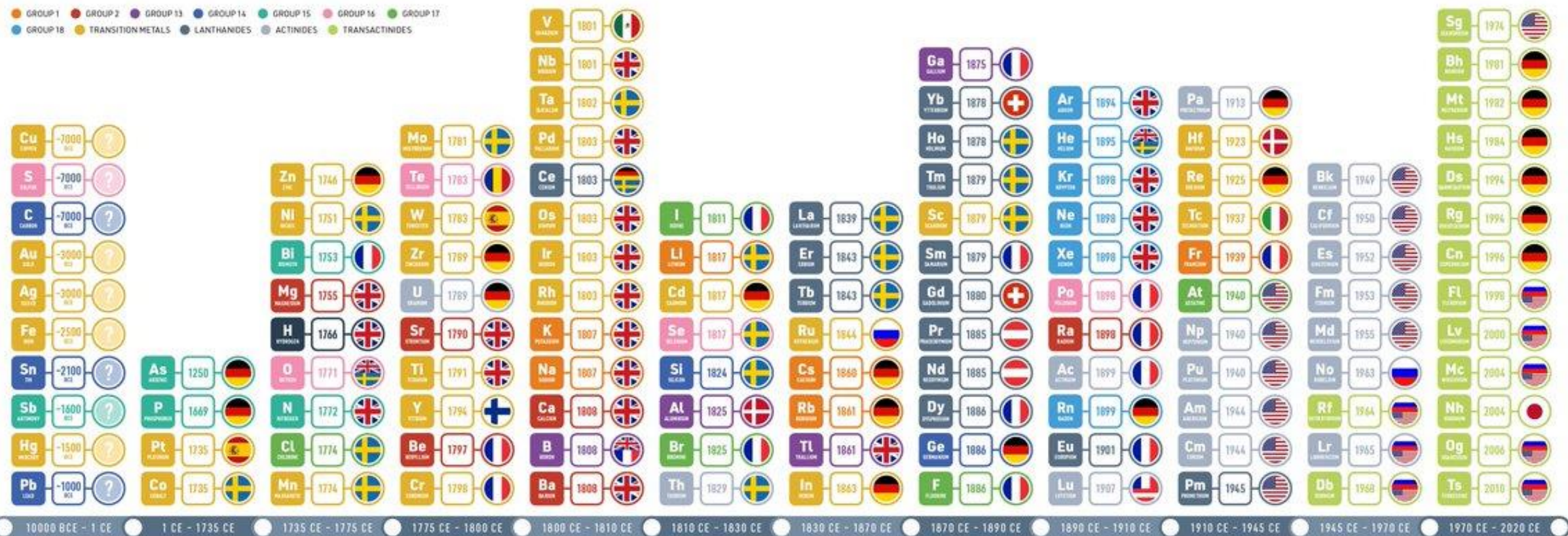
Nihonium

Livermorium

Moscovium

Tennessine

A TIMELINE OF THE DISCOVERIES OF THE CHEMICAL ELEMENTS



The years shown for element discoveries subsequent to those elements which were known since antiquity are those in which the element in question was isolated for the first time. The flags identify the country in which the discovery was made, rather than the nationality of the discoverer(s).



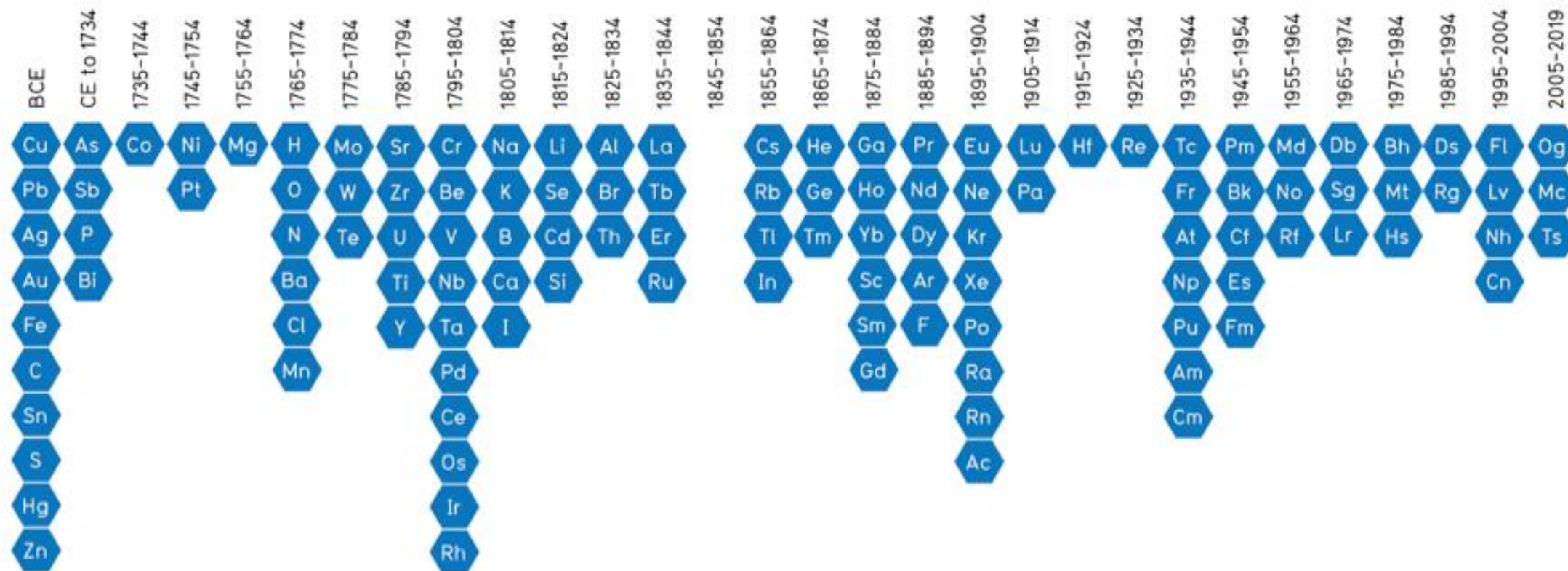
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Students
design tiles

2019 International Year of the Periodic Table

Timeline of Elements



Celebrating the discovery of elements

A collaborative University of Waterloo project

uwaterloo.ca/chemistry/timeline-of-elements



UNIVERSITY OF WATERLOO
FACULTY OF SCIENCE

with country and date of discovery

1838	1803	f	1885	f	1885	1942	f	1879	1896	f	1880	1942	1886	1878	1942	1879	1906
																	
La	Ce	Pr	Nd	Pm	Sm	Eu	Gd	Tb	Dy	Ho	Er	Tm	Yb	Lu			
Lanthanum	57 Cerium	58 Praseodymium	59 Neodymium	60 Promethium	61 Samarium	62 Europium	63 Gadolinium	64 Terbium	65 Dysprosium	66 Holmium	67 Erbium	68 Thulium	69 Ytterbium	70 Lutetium	71		
1902	1829	f	1913	f	1940	f	1940	f	1944	1944	1949	1950	1952	1952	1955	1966	1961
																	
Ac	Th	Pa	U	Np	Pu	Am	Cm	Bk	Cf	Es	Fm	Md	No	Lr			
Actinium	89 Thorium	90 Protactinium	91 Uranium	92 Neptunium	93 Plutonium	94 Americium	95 Curium	96 Berkelium	97 Californium	98 Einsteinium	99 Fermium	100 Mendelevium	101 Nobelium	102 Lawrencium	103		

/u/ʊdzu

Top Elements Mined in the U.S.
the origins of the top elements mined in our 50 states,
and the essential role they play in our daily lives.

1. **Copper:** building construction

The most substantial copper mines are located in Arizona, Utah, New Mexico, Nevada, and Montana

2. **Lithium** - most famous for its use in batteries - in Nevada

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5. **Iron Ore** - Without iron ore, we would have no steel
Michigan and Minnesota take the top spots for iron ore production.

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6. Lead - protecting against X-ray and gamma radiation, lead-acid batteries
primarily extracted from mines in Missouri

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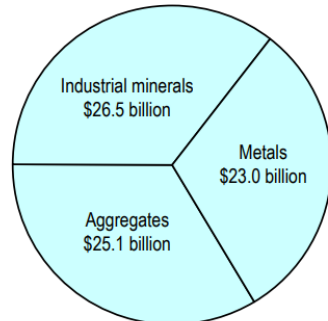
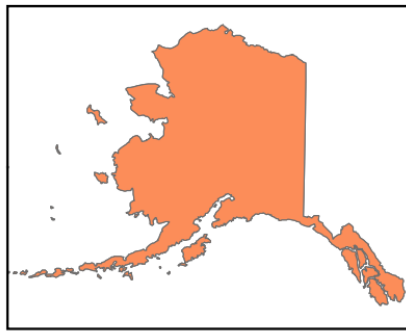
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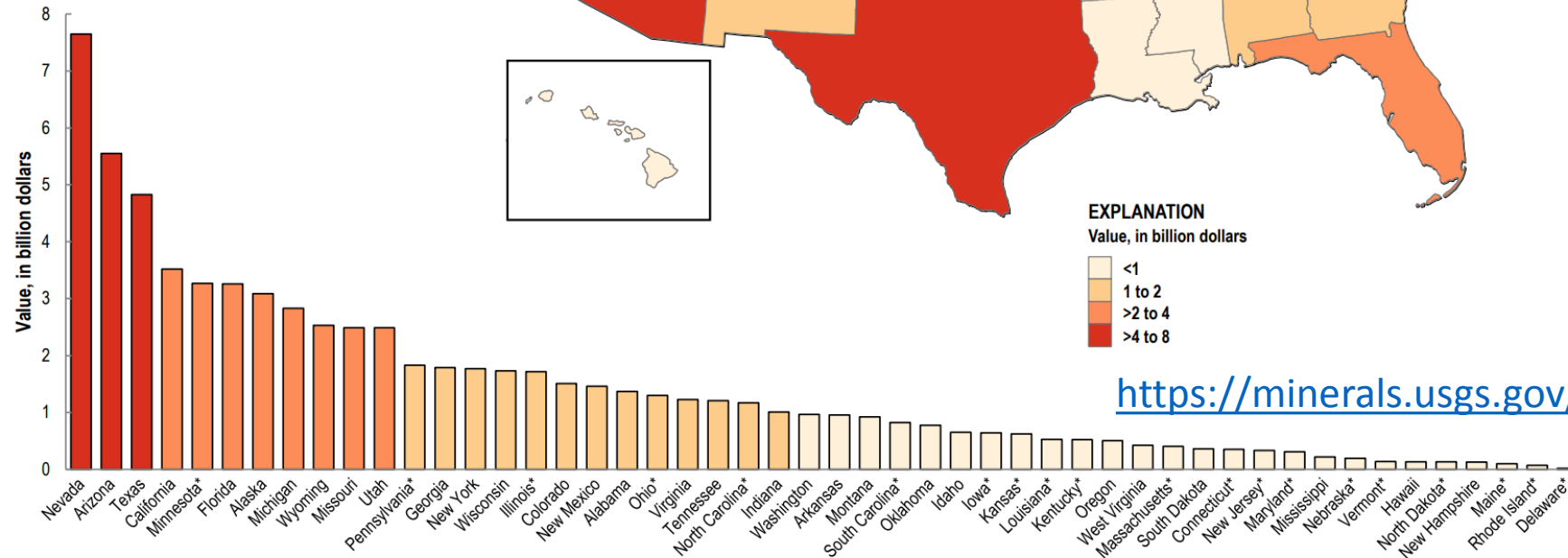
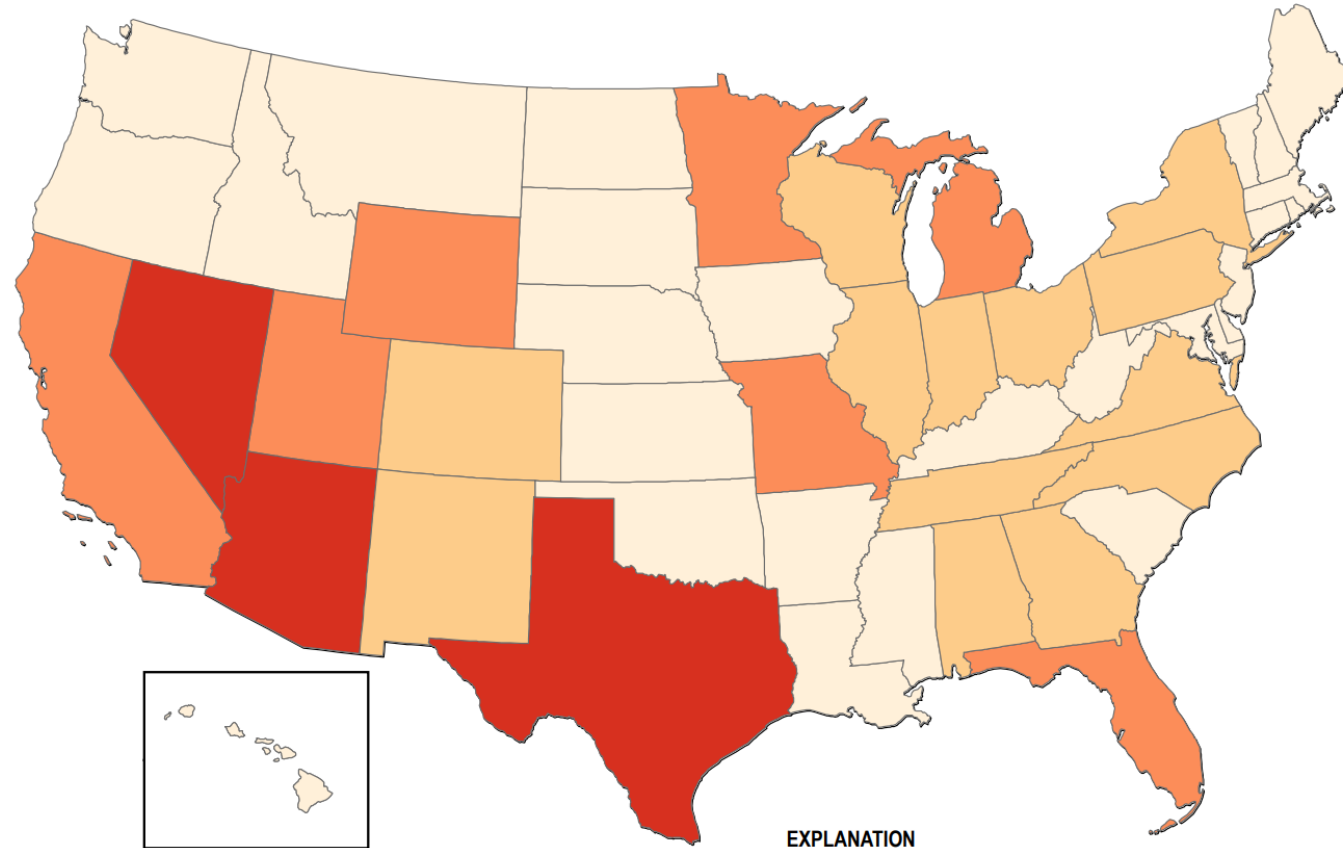
9. **Molybdenum** - found in many alloys - useful in nuclear power plants and aircraft engines
The highest-producing molybdenum mines are found in Colorado

10. **Boron** - found in California

VALUE OF NONFUEL MINERALS PRODUCED IN 2016, BY STATE



U.S. total: \$74.6 billion



EXPLANATION
Value, in billion dollars

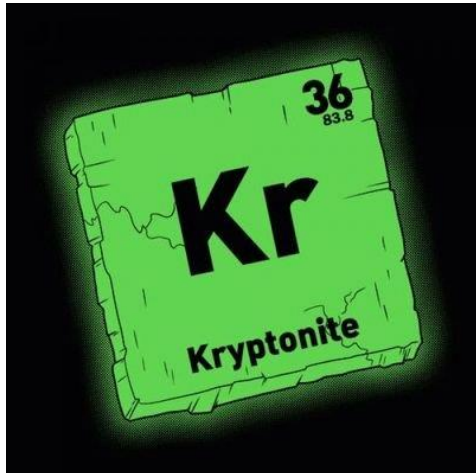
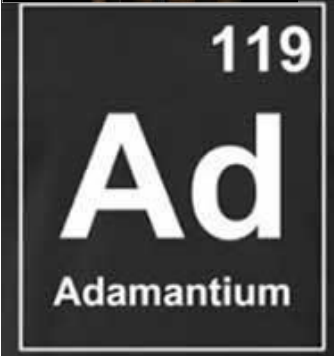
- <1
- 1 to 2
- >2 to 4
- >4 to 8

<https://minerals.usgs.gov/minerals/pubs/country/>

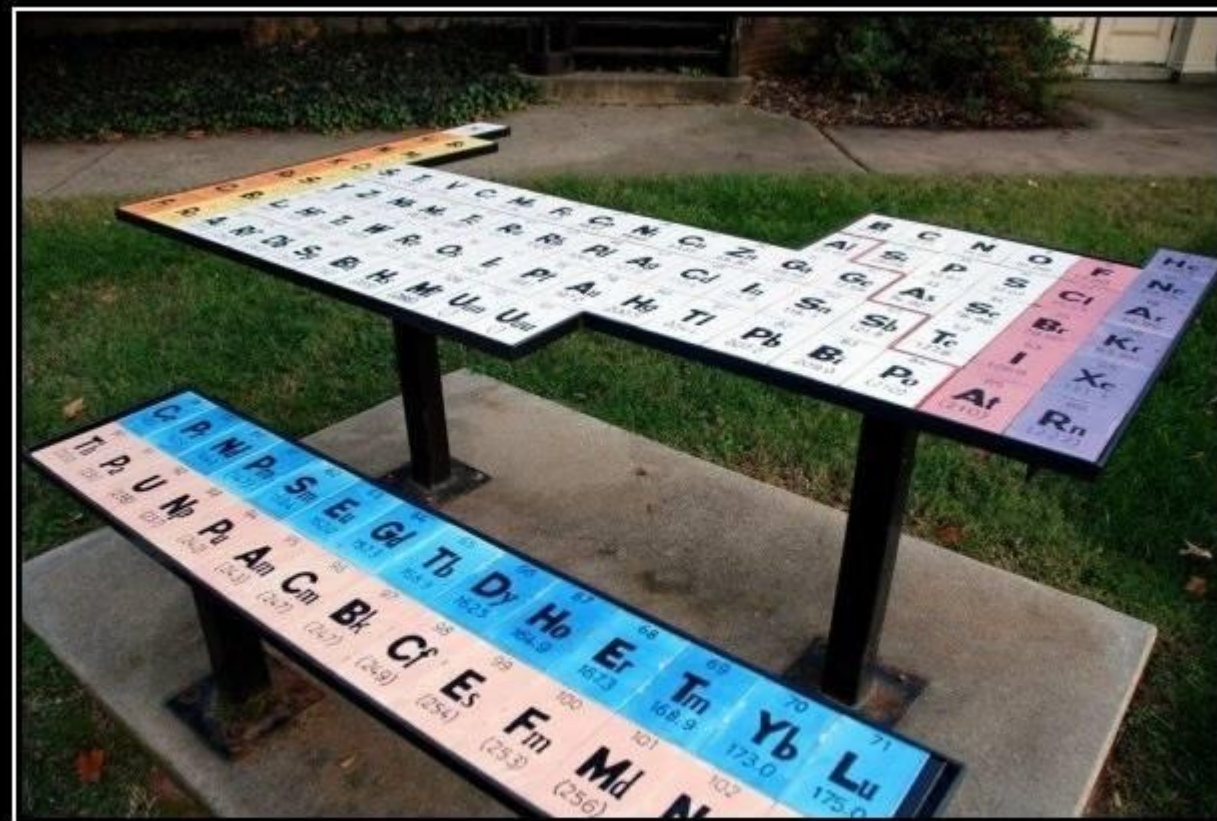
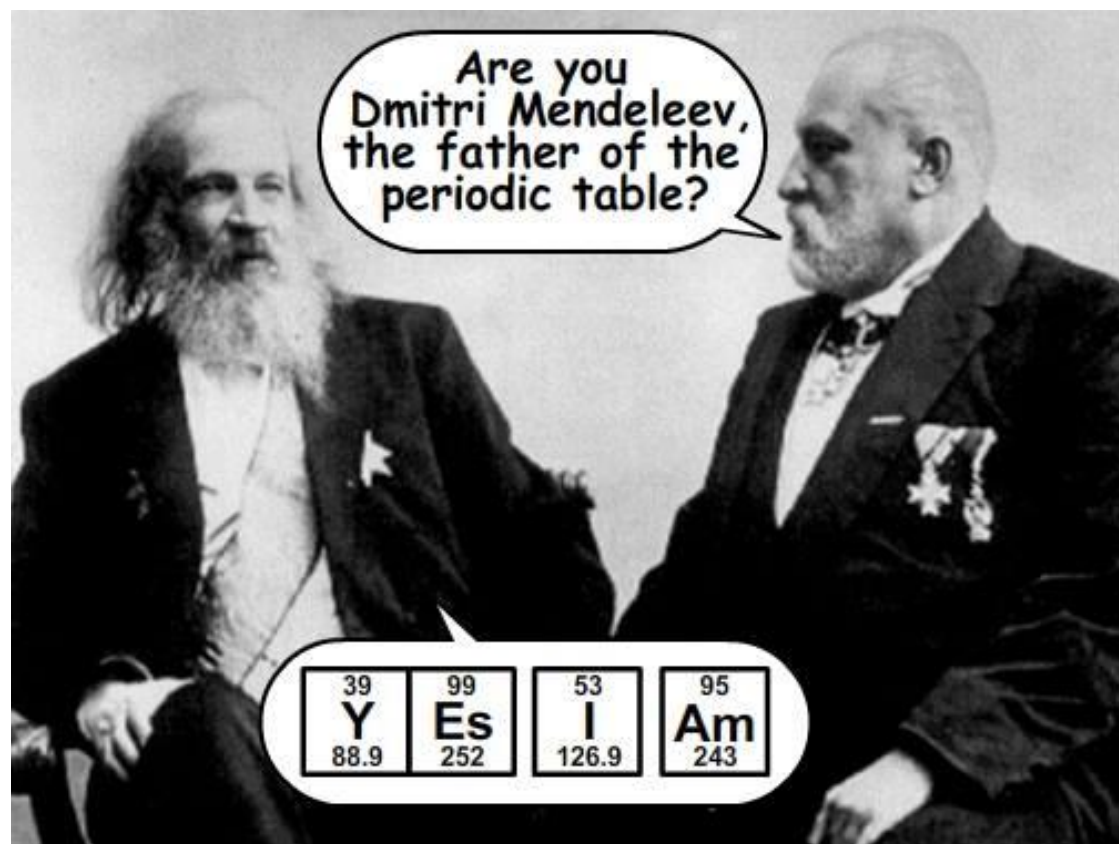
*Partial total; excludes values that must be withheld to avoid disclosing company proprietary data, which are included with "Undistributed" in table 3.



Fictional Elements in Comics



Periodic Table Table!!



PERIODIC TABLE

I bet that bench is really unstable.

Acknowledgements

Southern Arizona ACS Local Section



<https://sazacs.sites.acs.org/>

Email: info@sazacs.org

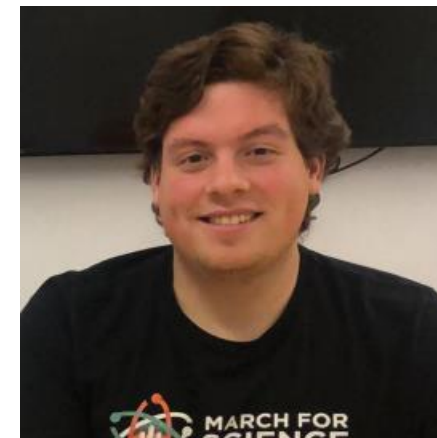


THE UNIVERSITY
OF ARIZONA

*Iman Daryaei
Ben Zarin
Laura Stratton
Chris Cabello
Steve Brown
Brooke Massani
Chuck Weidner
Grazyna Zreda
Trina Shartsis
Pedro Flores Gallardo*

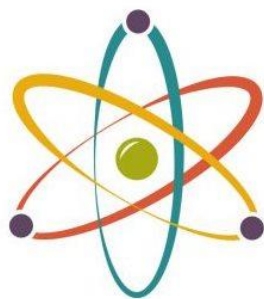


Kristen Watts

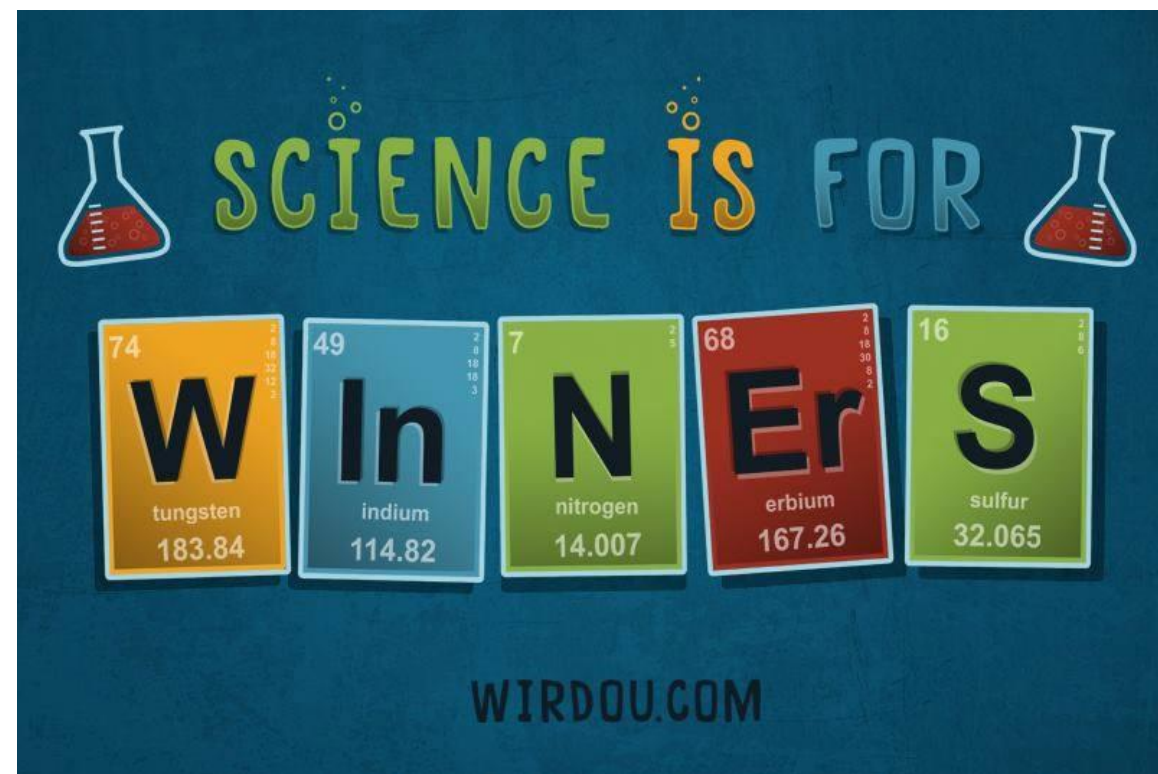
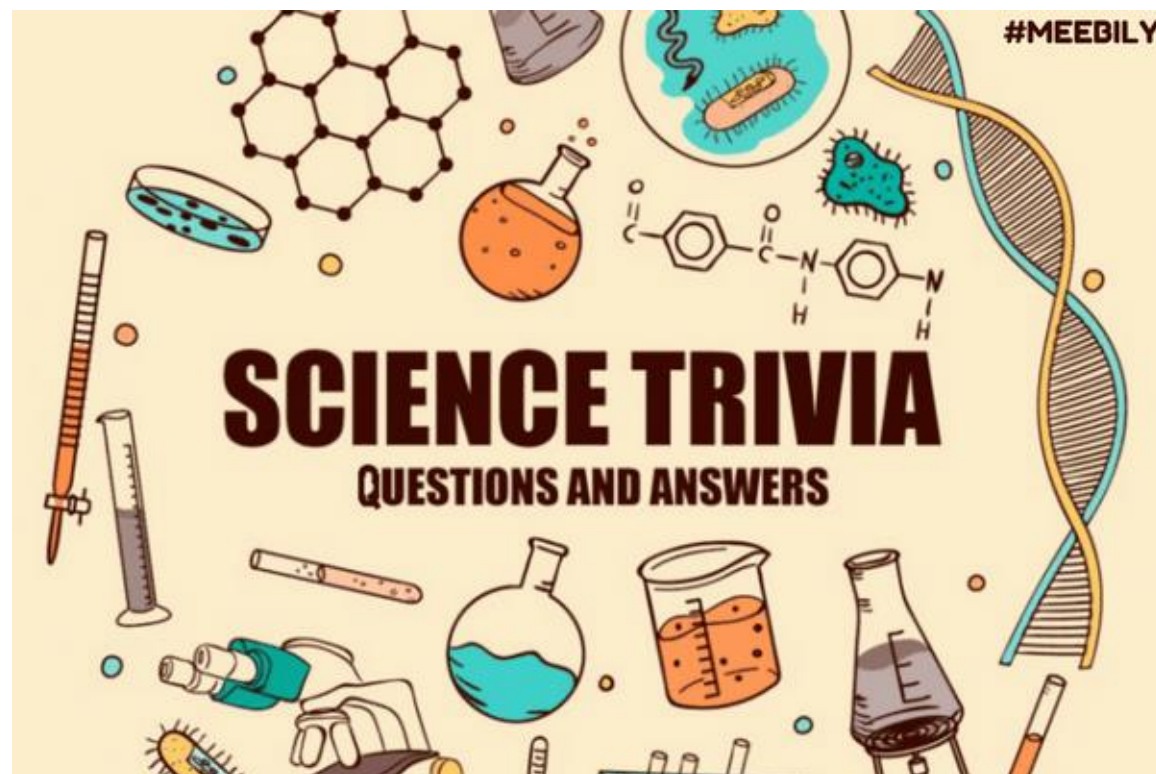
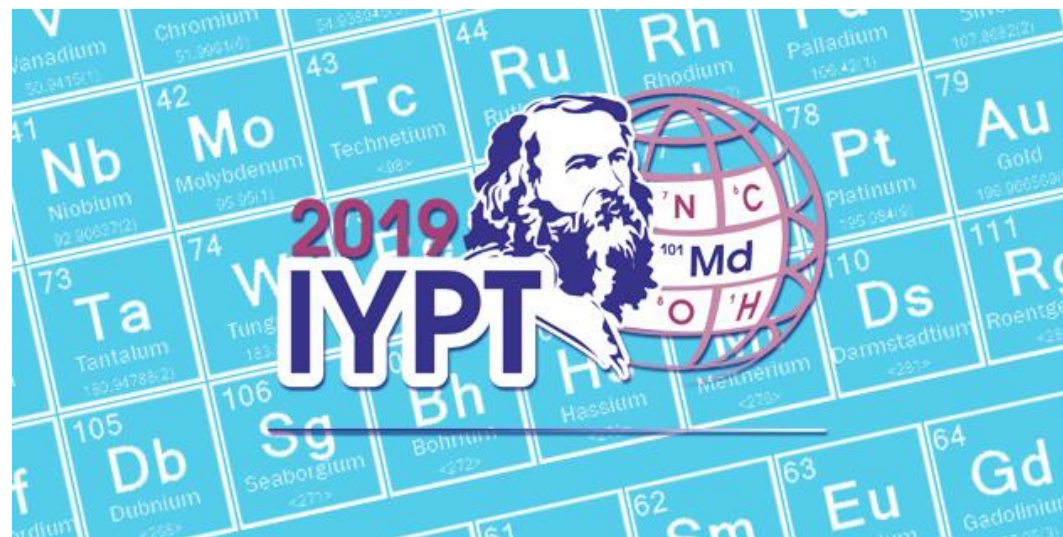


Josh Hoskinson





INTERNATIONAL
YEAR OF THE
PERIODIC TABLE
2019



Freddie Mercury vs. Lead (Led) Zeppelin

