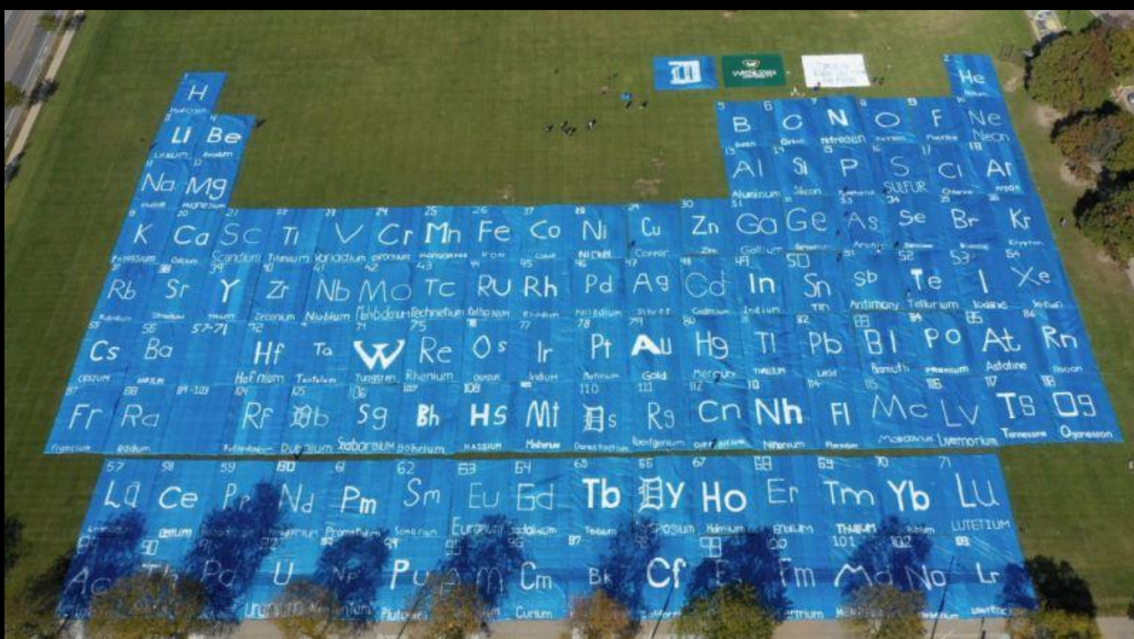
The Periodic Table



World's Largest: Wayne State, 10/23/2019

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The Periodic Table

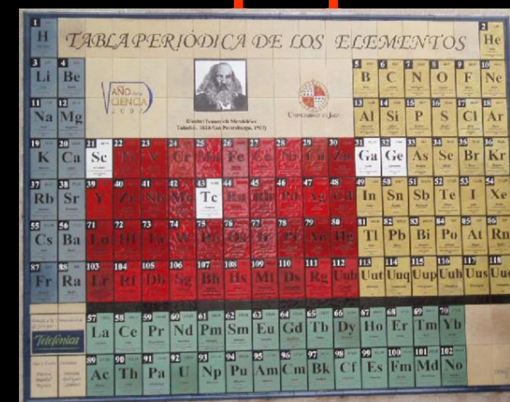
Periodic – having repeated cycles

First proposed by Mendeleyev, a Russian chemist in 1869

Arranged 69 known elements by weight and chemical properties

Had 4 empty spaces, 3 of which he predicted

- eka-Aluminum (Gallium)
- eka-Boron (Scandium)
- eka-Silicon (Germanium)



Eka = Samarian for "undiscovered"

The 4 th, technecium was not discovered until the 1920's

Ordered Te & I by chemical properties, not weight

Established state standards for alcohol content in Vodka

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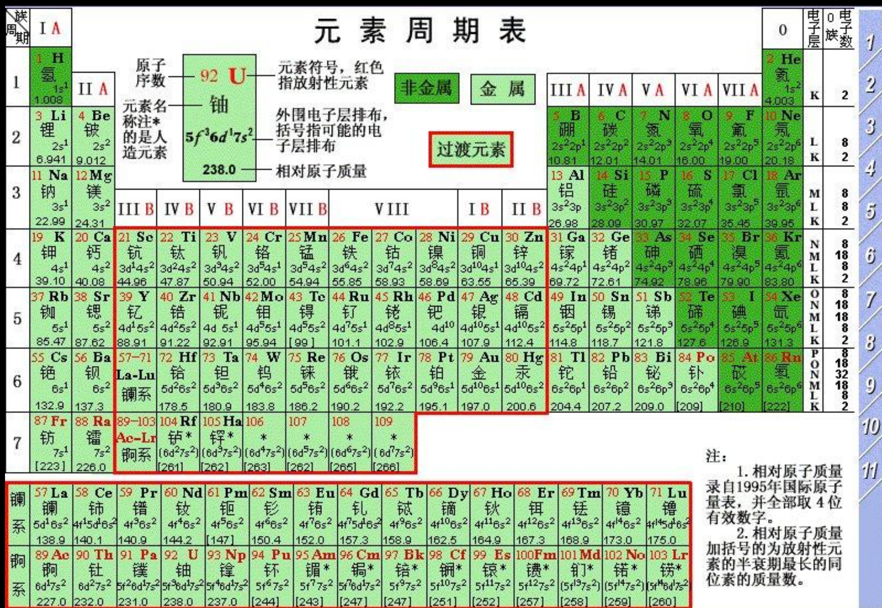
Chemistry Department Periodic Table

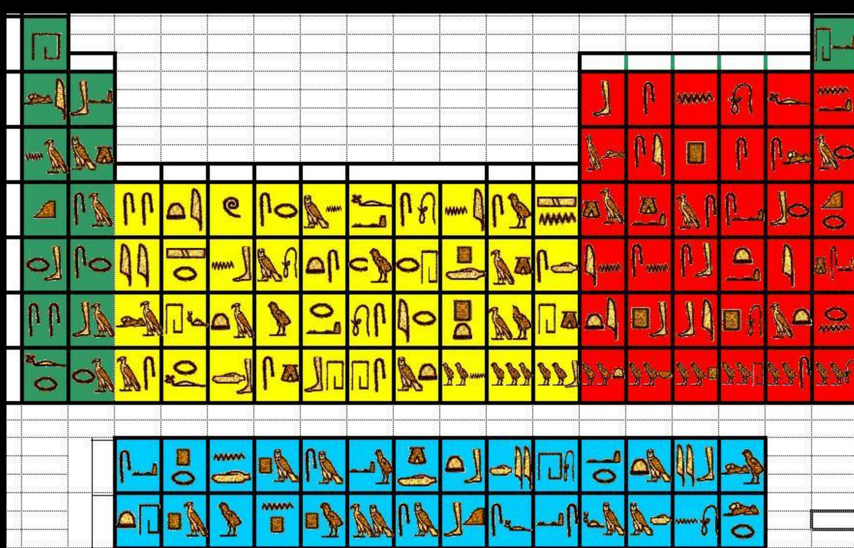
[1] 1A	[2] 2A	[3] 3B	[4] 4B	[5] 5B	[6] 6B	[7] 7B	[8]	[9] 8B	[10]	[11] 1B	[12] 2B	[13] 3A	[14] 4A	[15] 5A	[16] 6A	[17] 7A	[18] 8A
1 H 1.008																	2 He 4.003
3 Li 6.941	4 Be 9.012											5 B 10.81	6 C 12.01	7 N 14.01	8 O 16.00	9 F 19.00	10 Ne 20.18
11 Na 22.99	12 Mg 24.31											13 Al 26.98	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 44.96	22 Ti 47.87	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 65.41	31 Ga 69.72	32 Ge 72.59	33 As 74.92	34 Se 78.96	35 Br 79.91	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 98.00	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 183.9	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 (210)	85 At (210)	86 Rn (222)
87 Fr (223)	88 Ra (226)	89† Ac (227)	104 Rf (267)	105 Db (268)	106 Sg (271)	107 Bh (272)	108 Hs (270)	109 Mt (276)	110 Ds (280)	111 Rg (280)	112 Cn (285)	113 Nh (286)	114 Fl (289)	115 Mc (290)	116 Lv (293)	117 Ts (294)	118 Og (294)

*Lathanides	58 Ce 140.1	59 Pr 140.9	60 Nd 144.2	61 Pm (147)	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 231.0	92 U 238.0	93 Np (237)	94 Pu (242)	95 Am (243)	96 Cm (247)	97 Bk (249)	98 Cf (251)	99 Es (252)	100 Fm (257)	101 Md (258)	102 No (258)	103 Lr (262)

The Periodic Table Is Universal

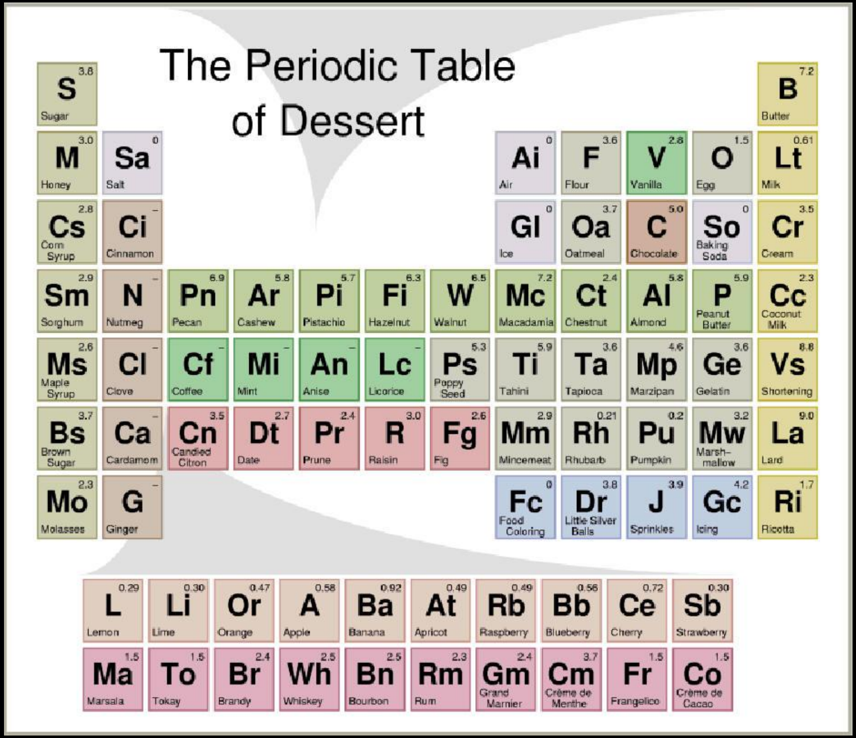


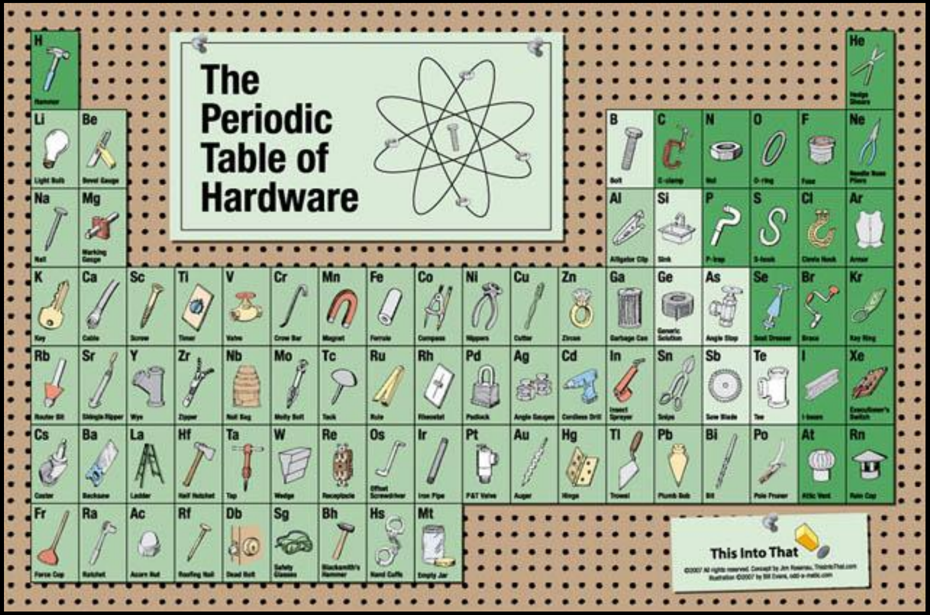
Implies Organized Knowledge



The Periodic Table

Format often used (incorrectly) for humor





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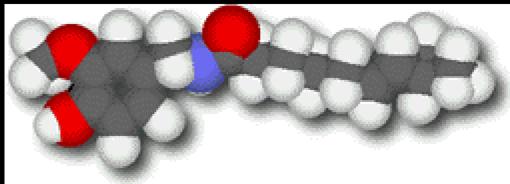


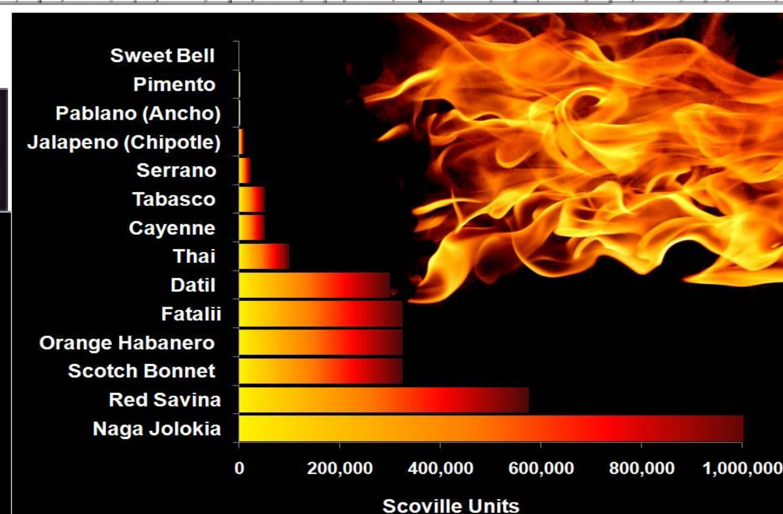
Periodic Table of Scoville Units™

Pepper Rank	Symbol	Pepper Name	Scoville Units
1	Bp	Sweet Bell	0
2	Pi	Pimento	0
3	Cy	Cherry	0 - 500
4	Pe	Pepperoncini	100 - 500
5	El	El-Paso	500 - 700
6	Sf	Santa Fe Grande	500 - 750
7	Co	Coronado	700 - 1,000
8	Es	Espanola	1,000 - 2,000
9	Po	Poblano	1,000 - 2,000
10	An	Ancho	1,000 - 2,000
11	Mu	Mulato	1,000 - 2,000
12	Pa	Pasilla	1,000 - 2,000
13	An	Anaheim	500 - 2,500
14	Sa	Sandia	500 - 2,500
15	Nu	NuMex big Jim	500 - 2,500
16	Ro	Rocotillo	1,500 - 2,500
17	Pu	Pulla	700 - 3,000
18	Mi	Mirasol	2,500 - 5,000
19	Gu	Guajilla	2,500 - 5,000
20	Ja	Jalapeno	2,500 - 8,000
21	Cp	Chipolte	5,000 - 8,000
22	Hw	Hot Wax	5,000 - 10,000
23	Py	Puya	5,000 - 10,000
24	Hi	Hidalgo	6,000 - 17,000
25	Se	Serrano	8,000 - 22,000
26	Ma	Manzano	12,000 - 30,000
27	Sh	Shipkas	12,000 - 30,000
28	Da	De Arbol	15,000 - 30,000
29	Jo	Jaloro	30,000 - 50,000
30	Aj	Aji	30,000 - 50,000
31	Ta	Tabasco	30,000 - 50,000
32	Ca	Cayenne	30,000 - 50,000
33	Sk	Santaka	40,000 - 50,000
34	Sc	Super Chile	40,000 - 50,000
35	Pq	Piquin	40,000 - 58,000
36	Ya	Yatsafusa	50,000 - 75,000
37	Hm	Haimen	70,000 - 80,000
38	Ci	Chiltecpin	60,000 - 85,000
39	Th	Thai	50,000 - 100,000
40	Tb	Tabiche	85,000 - 115,000
41	Ba	Bahamian	95,000 - 110,000
42	Cc	Carolina Cayenne	100,000 - 125,000
43	Ku	Kumataka	125,000 - 150,000
44	Jh	Jamaican Hot	100,000 - 200,000
45	Be	Birds Eye	100,000 - 225,000
46	Te	Tepin (Wild)	80,000 - 240,000
47	Dt	Devil Toung	125,000 - 325,000
48	Fa	Fatalii	125,000 - 325,000
49	Oh	Orange Habanero	150,000 - 325,000
50	Sb	Scotch Bonnet	150,000 - 325,000
51	Ch	Chocolate Habanero	200,000 - 385,000
52	Rs	Red Savina Habanero	350,000 - 577,000
53	Bj	Bhut Jolokia	1,041,427

Key: 1 — Pepper Rank; Bp — Symbol; Sweet Bell — Pepper Name; 0 — Scoville Units

Scoville Units Foods

thescienceofheat.com



SCOVILLE FOOD INSTITUTE •••EST. 2007•••

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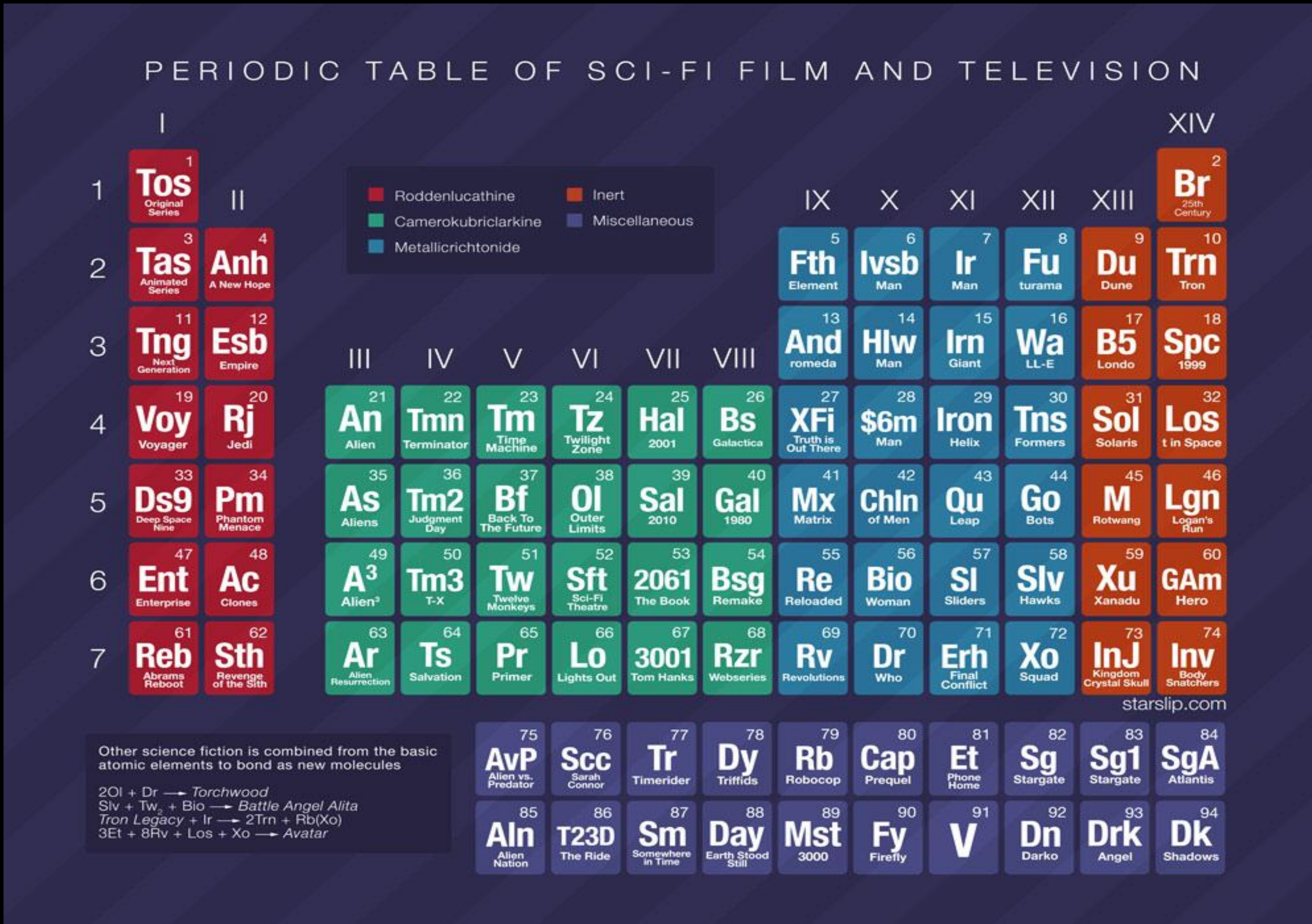
Science Fiction Periodic Chart



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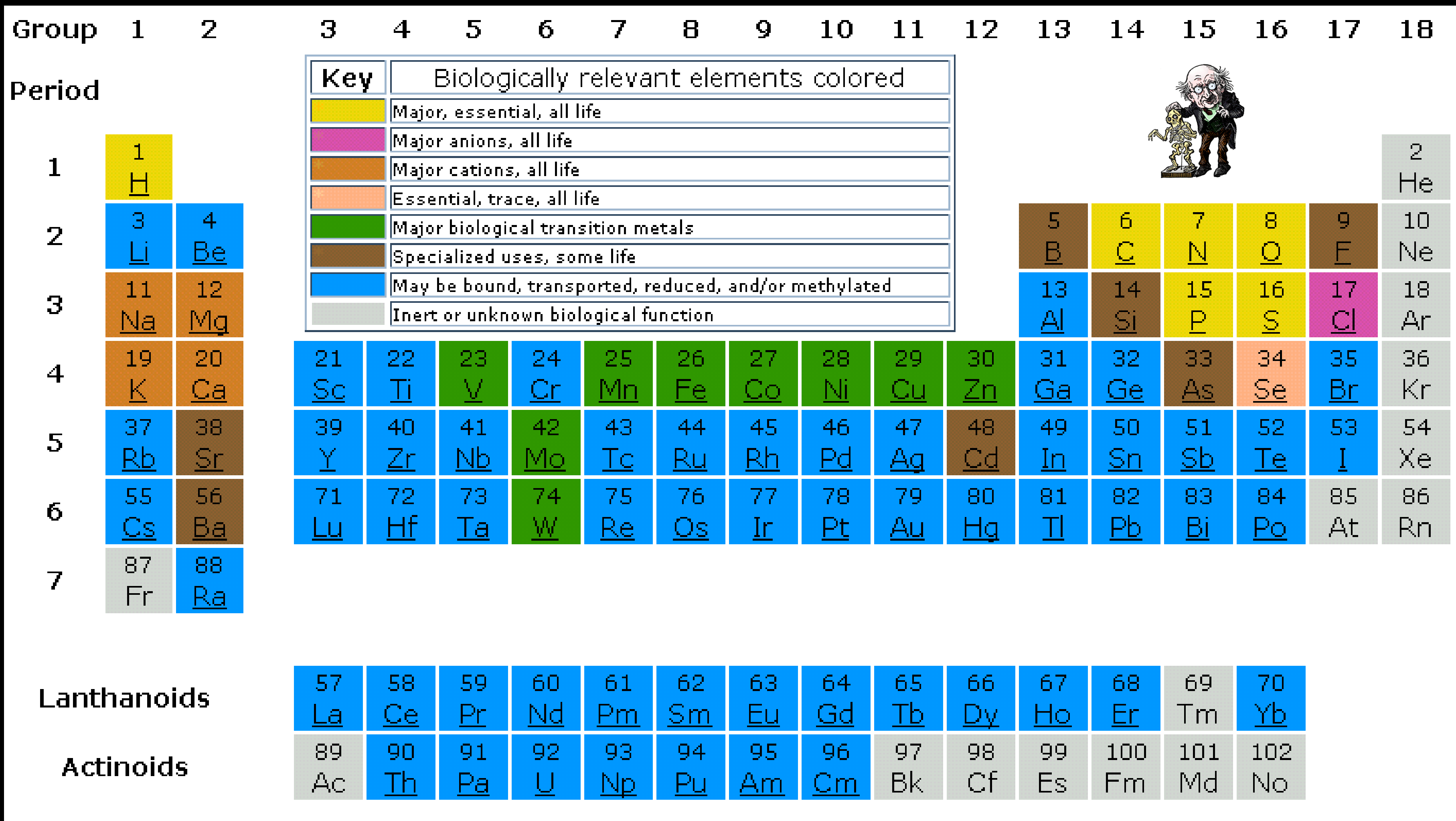
Biochemical Elements of Life



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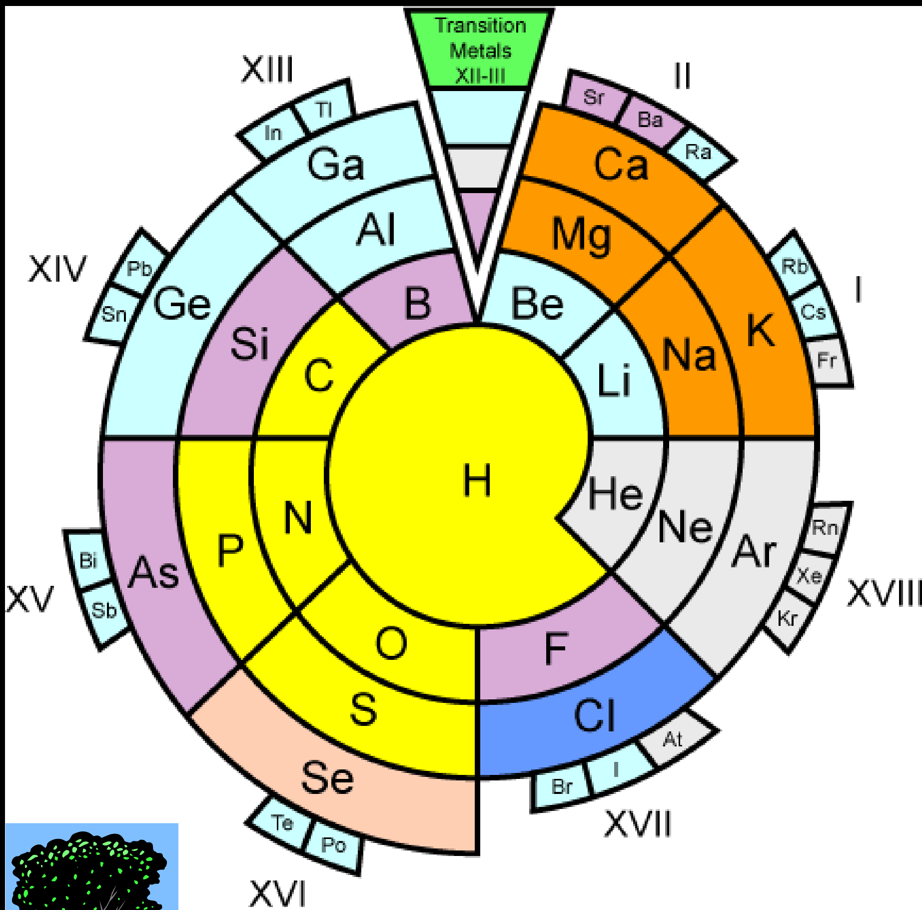
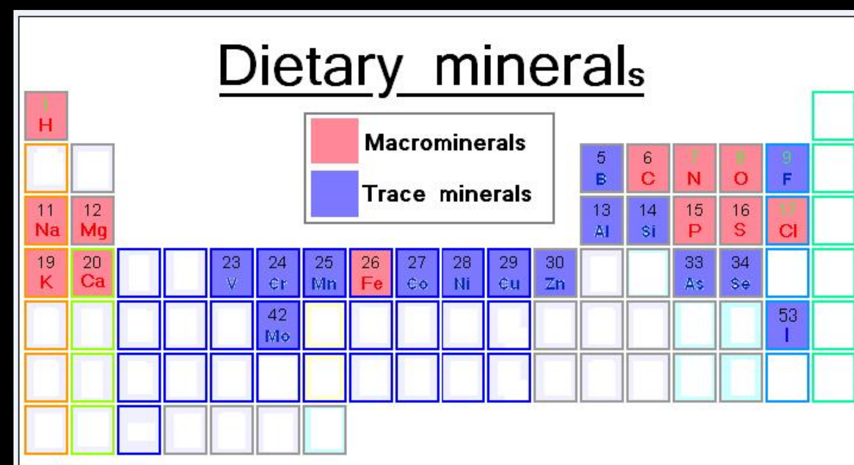
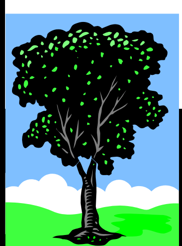
Biochemical Elements of Life



Key:

- Major, essential, all life
- Major cations, all life
- Major anions, all life
- Essential, trace, all life
- Specialized uses, some life
- May be bound, transported, reduced, and/or methylated
- Inert or unknown biological function





Essential Elements:

Some Homes Provide Needed Oreo Cookies

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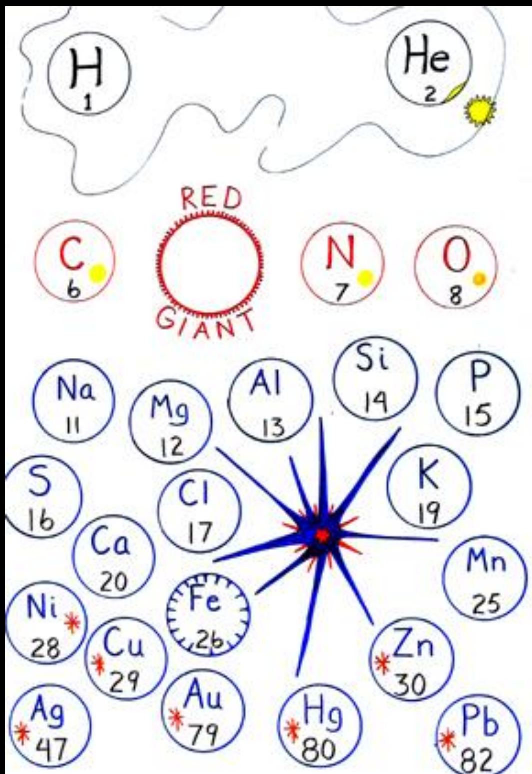
Elemental Stellar Origins

Elements > Fe Only From Supernova Events

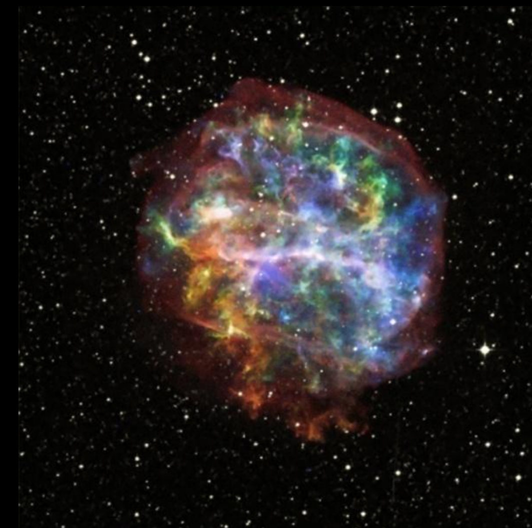


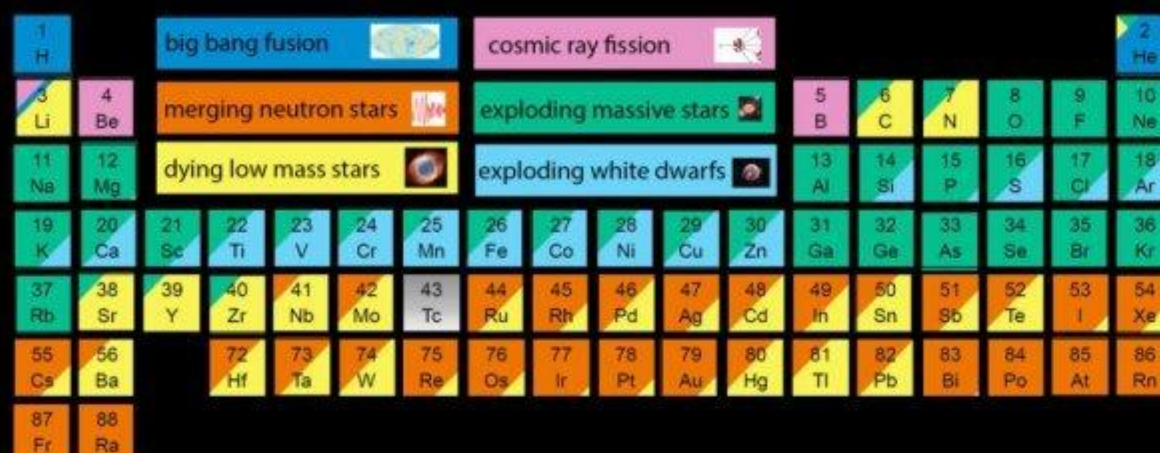
Primordial Gas

Red Giants

Hot Blue Stars

* Supernovas





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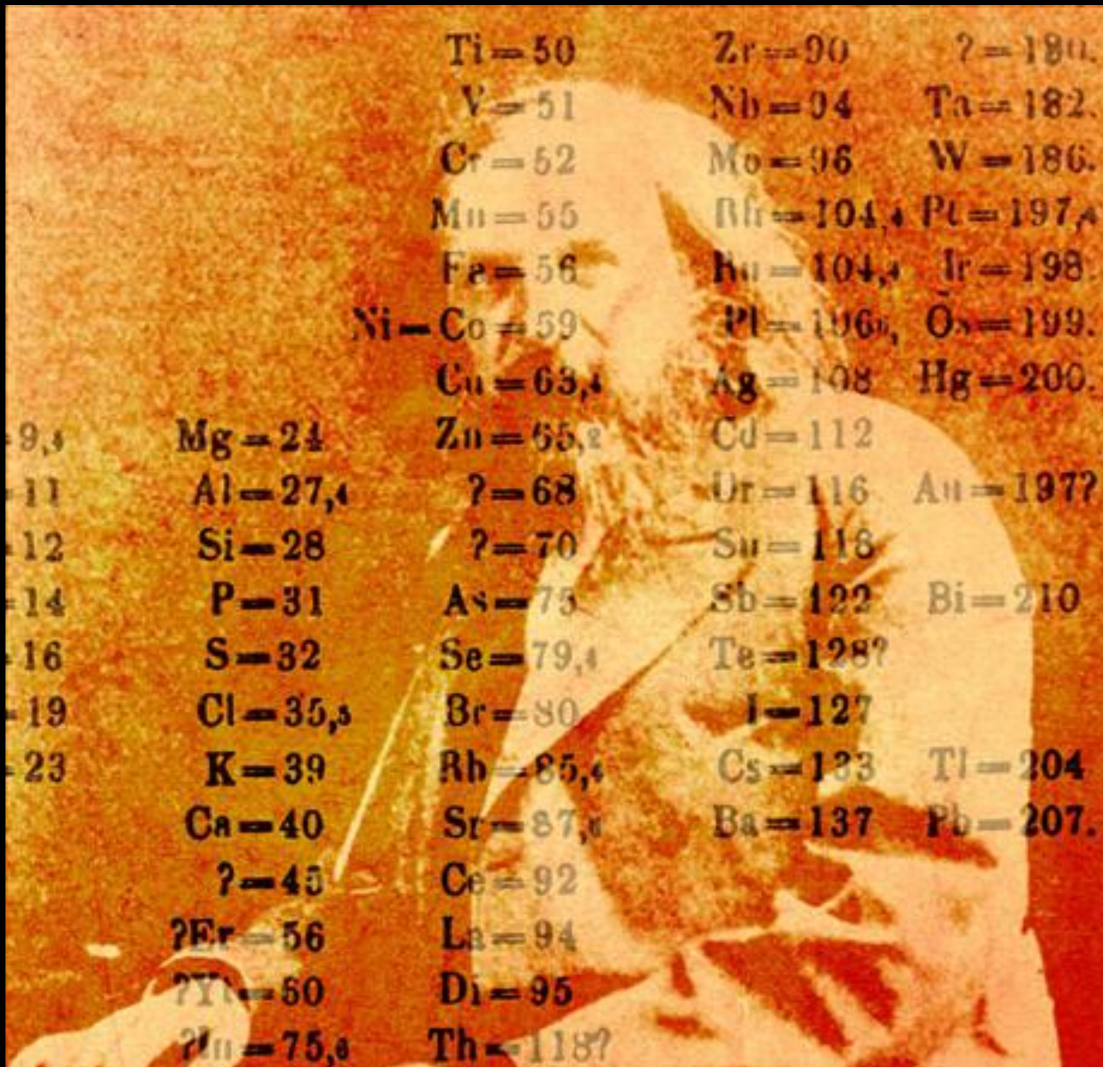
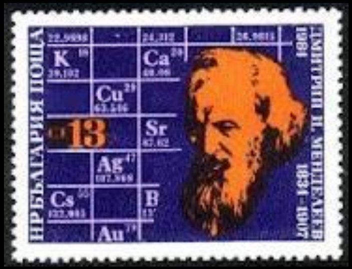
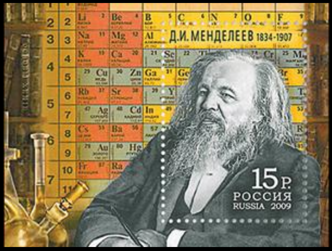
Mendeleev's Original "Table"



63 Known Elements
No Rare (Noble) Gases





Arranged by Atomic Weight

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The Periodic Table

Periodic = repeating
Elements ordered by Z show “repeating properties”
Period: rows ~ similar trends
Groups: columns ~ similar chemical properties
Groups = chemical families

Group → / ↓ Period	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
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		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		104 Rf	105 Db	106 Sg	107 Bh	108 Hs	109 Mt	110 Ds	111 Rg	112 UUb	113 Uut	114 Uuq	115 Uup	116 Uuh	117 Uus	118 Uuo
Lanthanides				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
Actinides				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

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Periodic Table exists in many forms

Depends upon Publisher's Choice:

Data Provided

Geometric Format

Elemental Special Properties

Student Learning

Unit Exam will not test different Formats

No matter what geometry is used
Elements show periodicity

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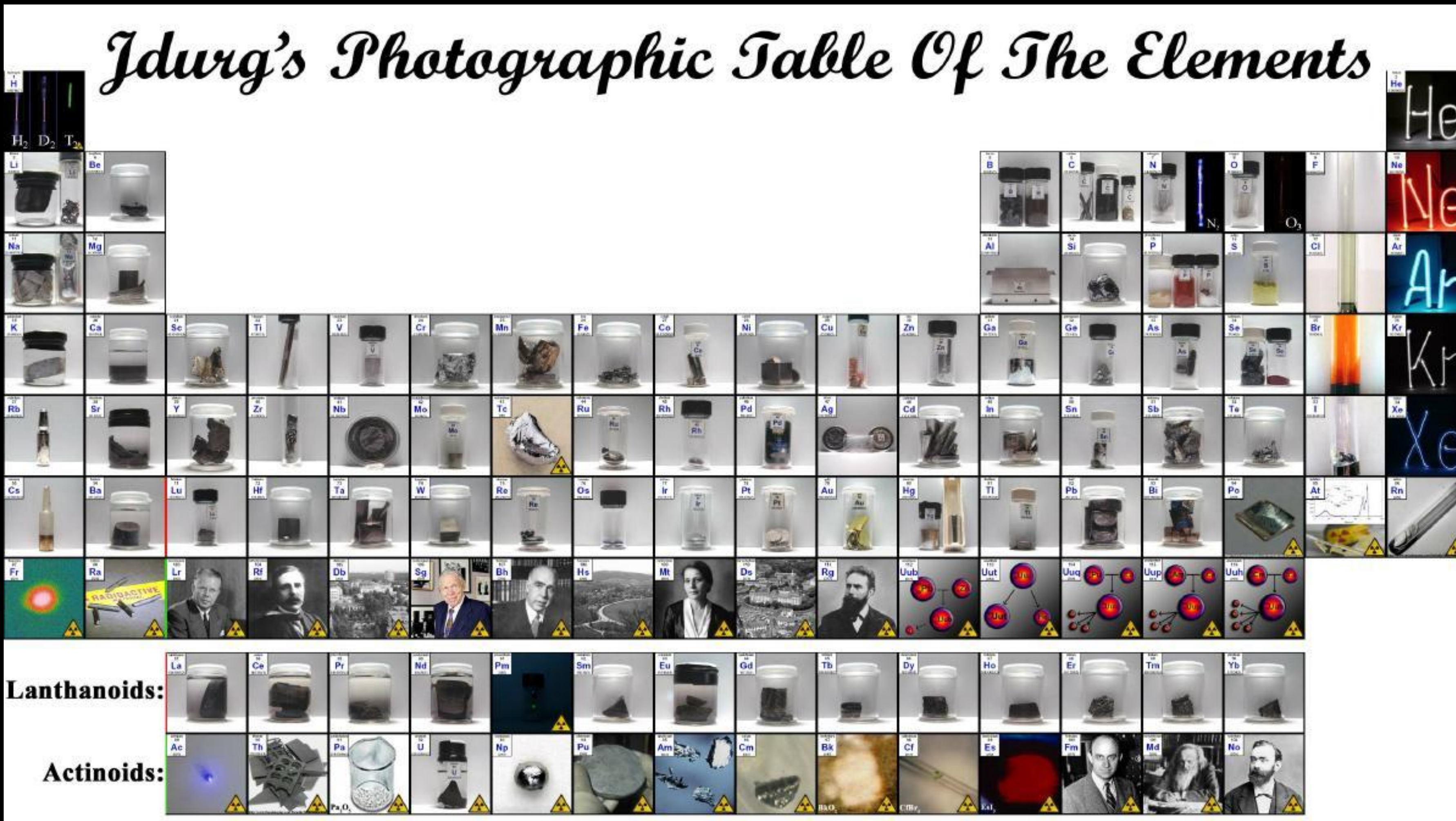
Periodic Table - Photographic



Periodic Table Emphasizing Physical State

Periodic Table of the Elements

Natural Form

Solid | Liquid | Gas

1A	2A	3B	4B	5B	6B	7B	8B	8B	8B	1B	2B	3A	4A	5A	6A	7A	8A
1 H_2 GAS																	2 He GAS
3 Li BCC	4 Be HEX											5 B RHOM	6 C HEX	7 N GAS	8 O GAS	9 F GAS	10 Ne GAS
11 Na BCC	12 Mg HEX											13 Al FCC	14 Si FCC	15 P CUBIC	16 S ORTHO	17 Cl GAS	18 Ar GAS
19 K BCC	20 Ca FCC	21 Sc HEX	22 Ti HEX	23 V BCC	24 Cr BCC	25 Mn BCC	26 Fe BCC	27 Co HEX	28 Ni FCC	29 Cu FCC	30 Zn HEX	31 Ga ORTHO	32 Ge FCC	33 As RHOM	34 Se HEX	35 Br LIQUID	36 Kr GAS
37 Rb BCC	38 Sr FCC	39 Y HEX	40 Zr HEX	41 Nb BCC	42 Mo BCC	43 Tc HEX	44 Ru HEX	45 Rh FCC	46 Pd FCC	47 Ag FCC	48 Cd HEX	49 In TETRA	50 Sn TETRA	51 Sb RHOM	52 Te HEX	53 I ORTHO	54 Xe GAS
55 Cs BCC	56 Ba BCC	57-71 Lanthanides	72 Hf HEX	73 Ta BCC	74 W BCC	75 Re HEX	76 Os HEX	77 Ir FCC	78 Pt FCC	79 Au FCC	80 Hg LIQUID	81 Tl HEX	82 Pb FCC	83 Bi RHOM	84 Po CUBIC	85 At UNK	86 Rn GAS
87 Fr UNK	88 Ra BCC	89-103 Actinides															

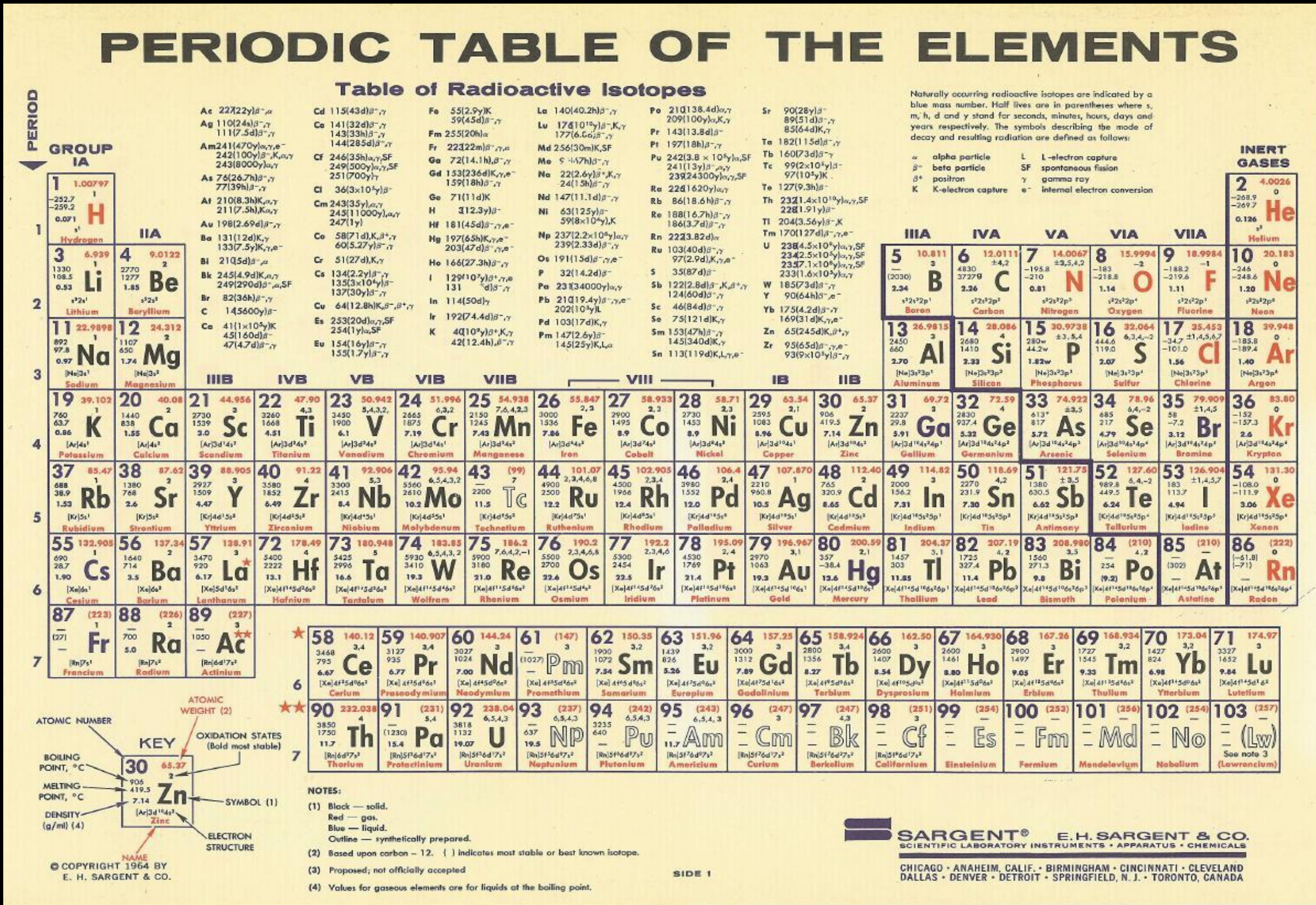
*** Elements > 104 exist only for very short half-lifes and the data is unknown.***

Lanthanides	57 La HEX	58 Ce FCC	59 Pr HEX	60 Nd HEX	61 Pm HEX	62 Sm RHOM	63 Eu BCC	64 Gd HEX	65 Tb HEX	66 Dy HEX	67 Ho HEX	68 Er HEX	69 Tm HEX	70 Yb FCC	71 Lu HEX
Actinides	89 Ac FCC	90 Th FCC	91 Pa TETRA	92 U ORTHO	93 Np ORTHO	94 Pu MONO	95 Am HEX	96 Cm HEX	97 Bk HEX	98 Cf HEX	99 Es HEX	100 Fm UNK	101 Md UNK	102 No UNK	103 Lr UNK

Most stable crystaline structure of solids

CUBIC	Simple Cubic	**FCC**	Face Centered Cubic	**ORTHO**	Orthorhombic	**TETRA**	Tetragonal	**UNK**	Unknown
BCC	Body Centered Cubic	**HEX**	Hexagonal	**RHOM**	Rhombohedral	**MONO**	Monoclinic		

Student Table From the 1960's



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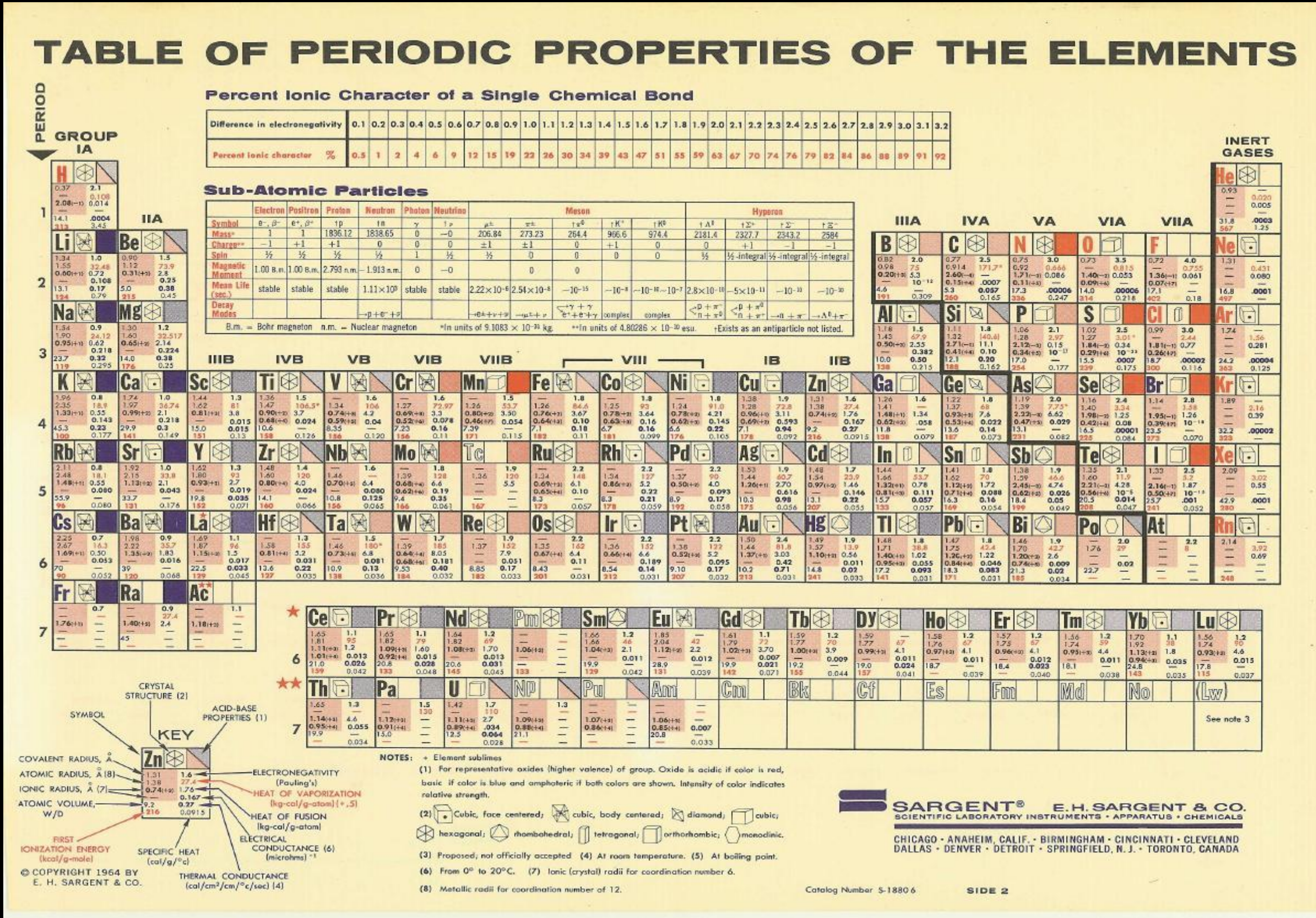
Student Table From the 1960's



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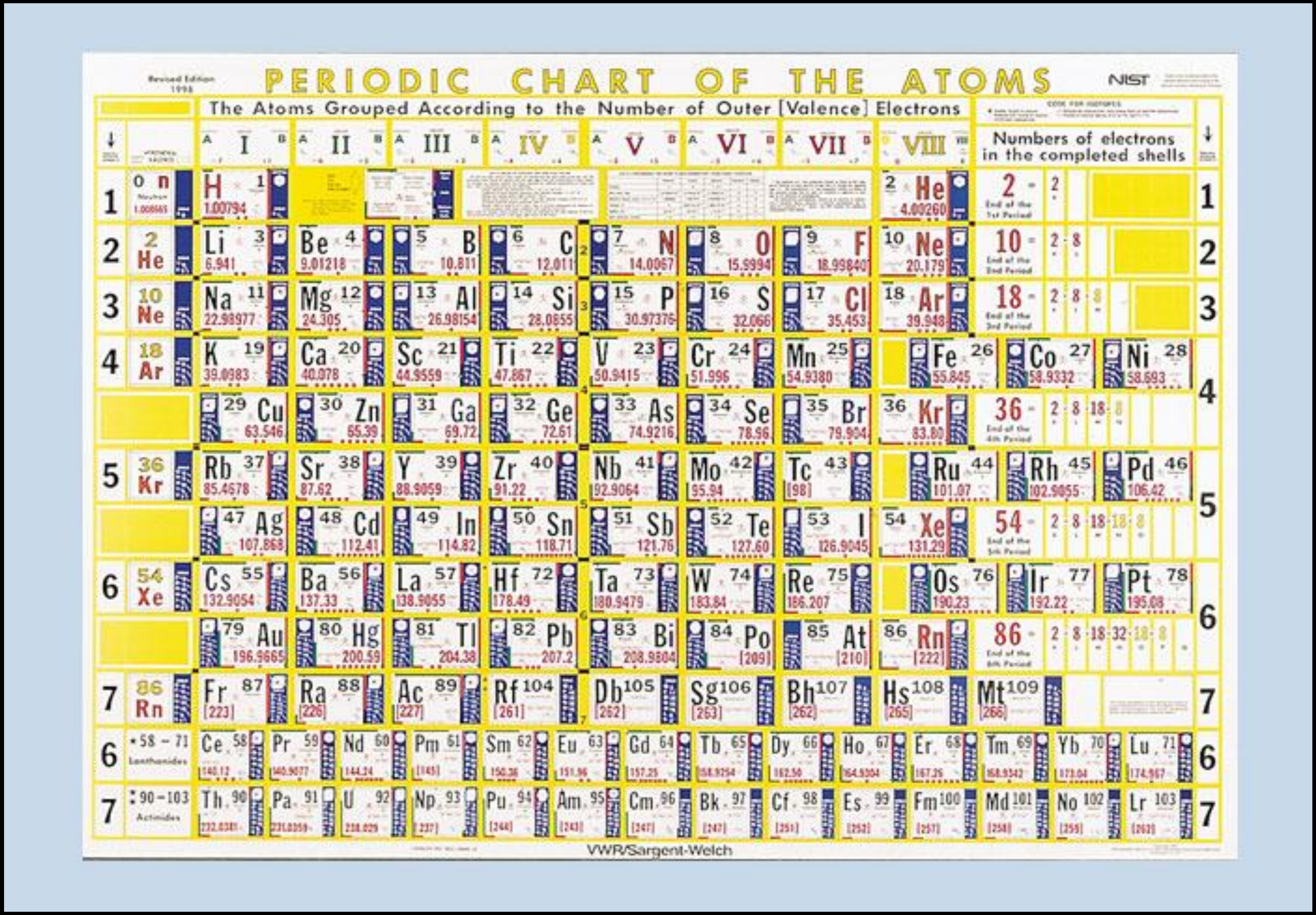
Welch – Standard for Decades



Set Dressing for Movies

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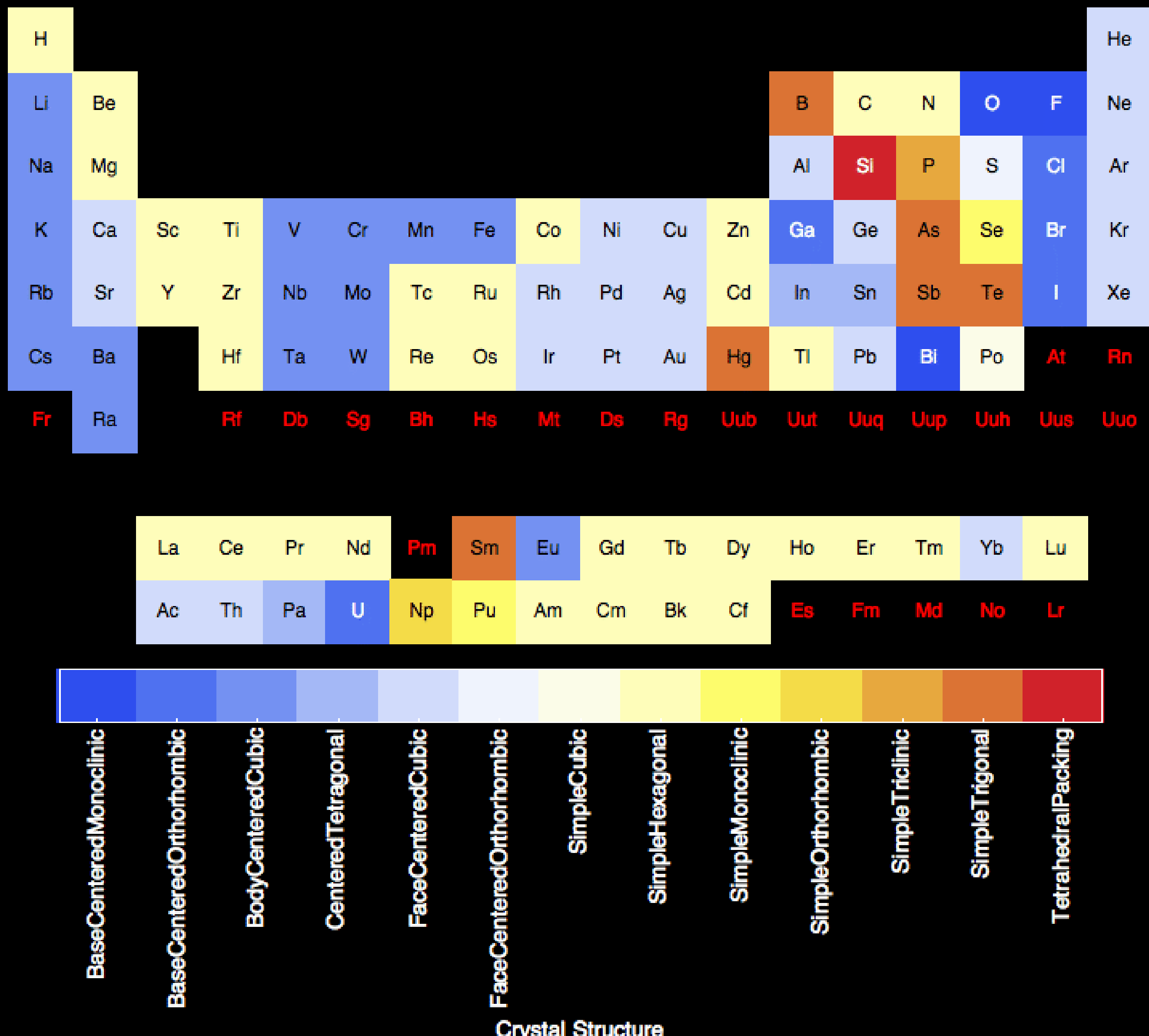
Crystal Structures of the Elements



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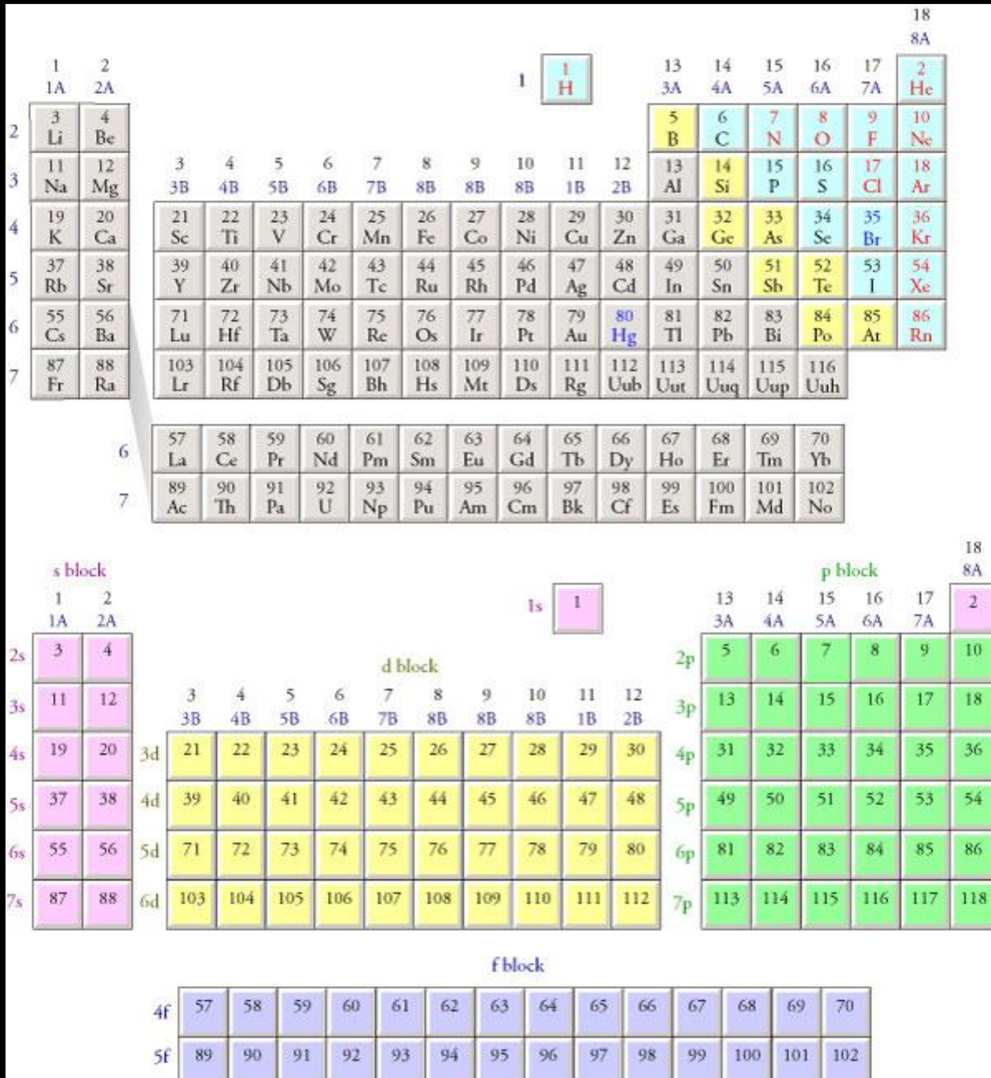
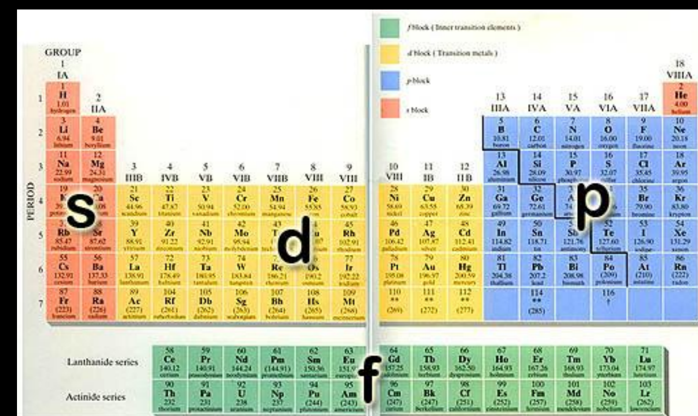
Periodic Table - Blocks



Column Labels:

A & B

Numerals



Emphasizes Filling Sub-Orbitals

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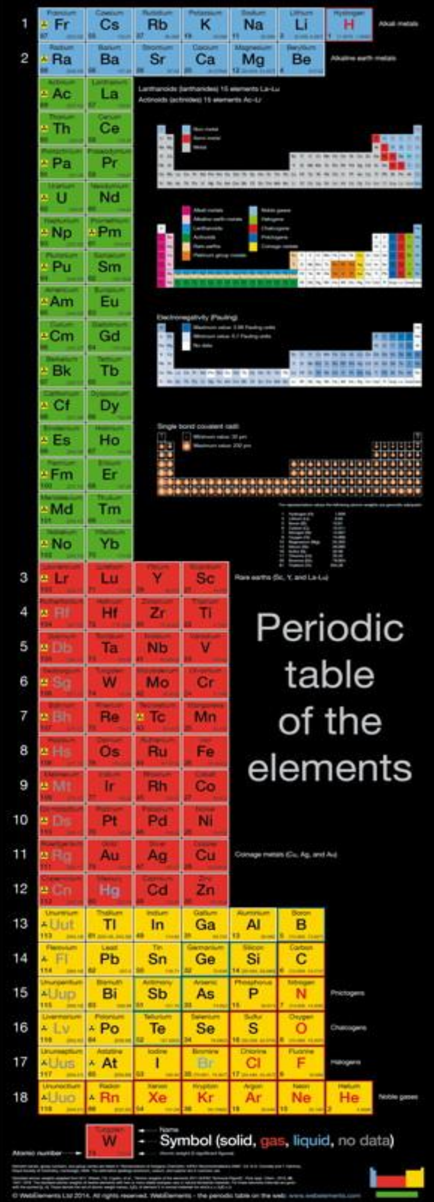
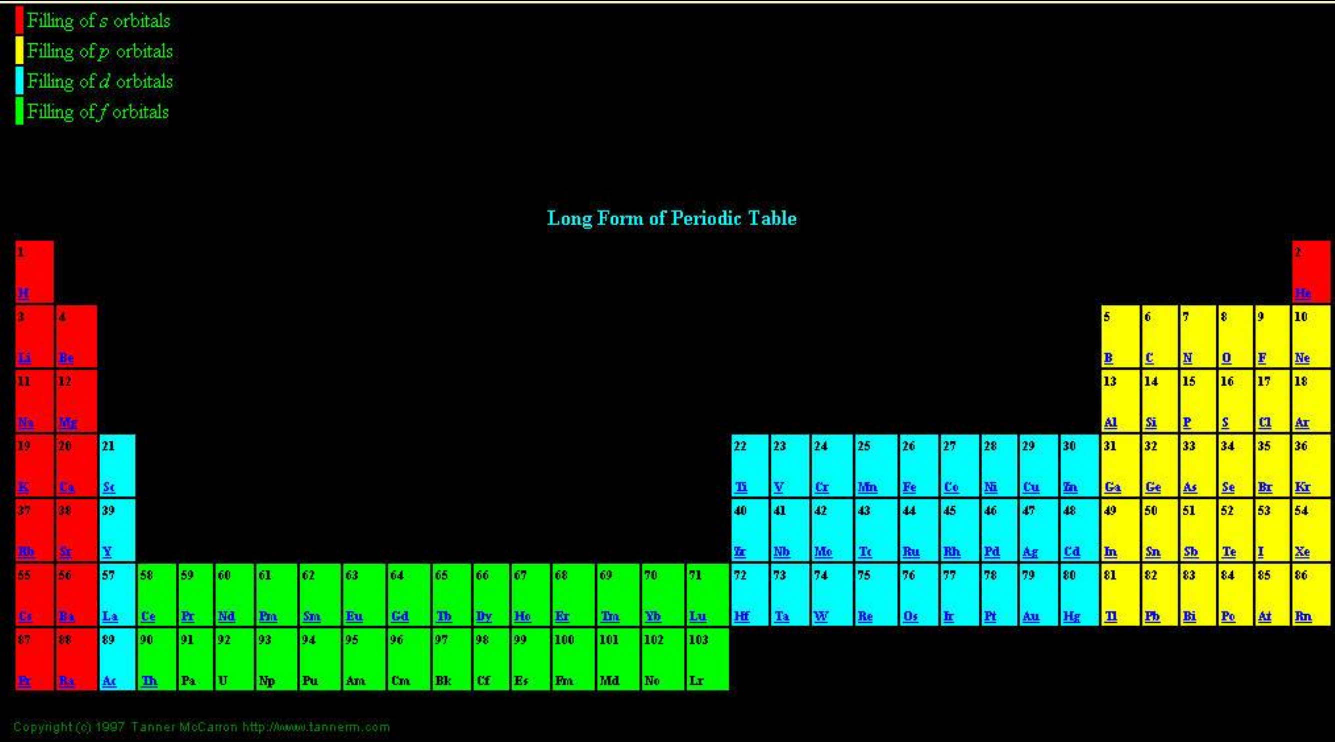
Periodic Table - Extended





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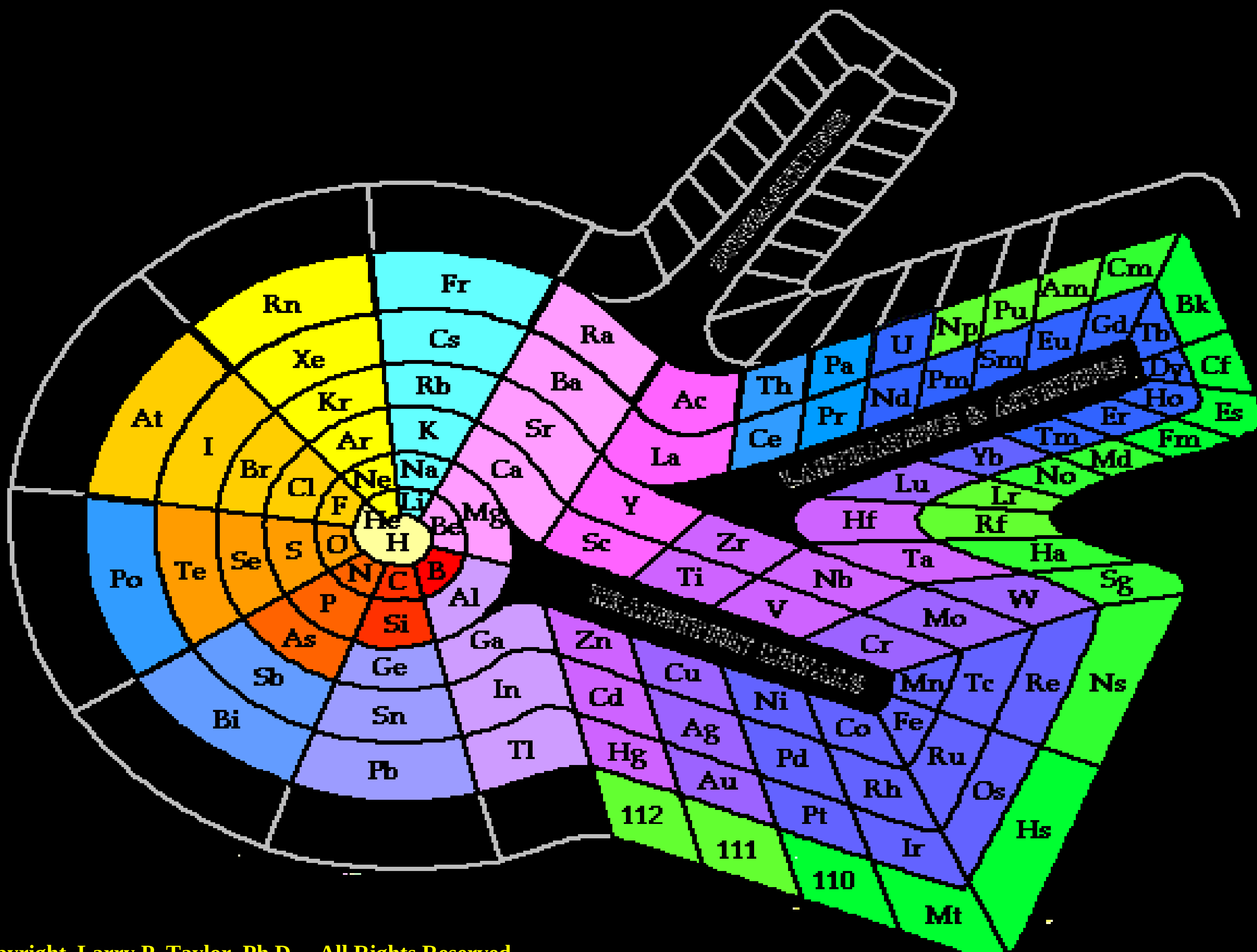
A Circular Periodic Table



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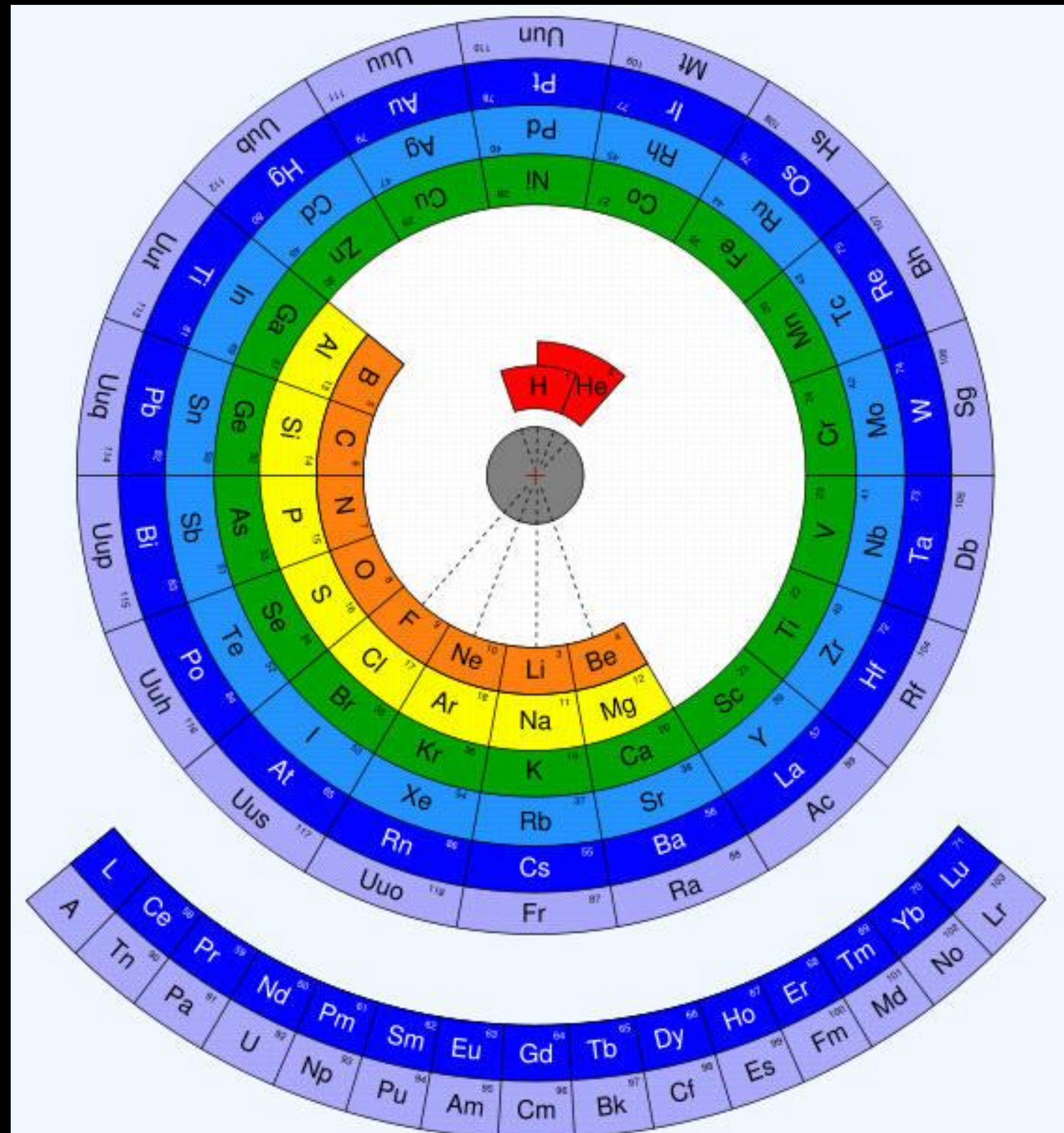
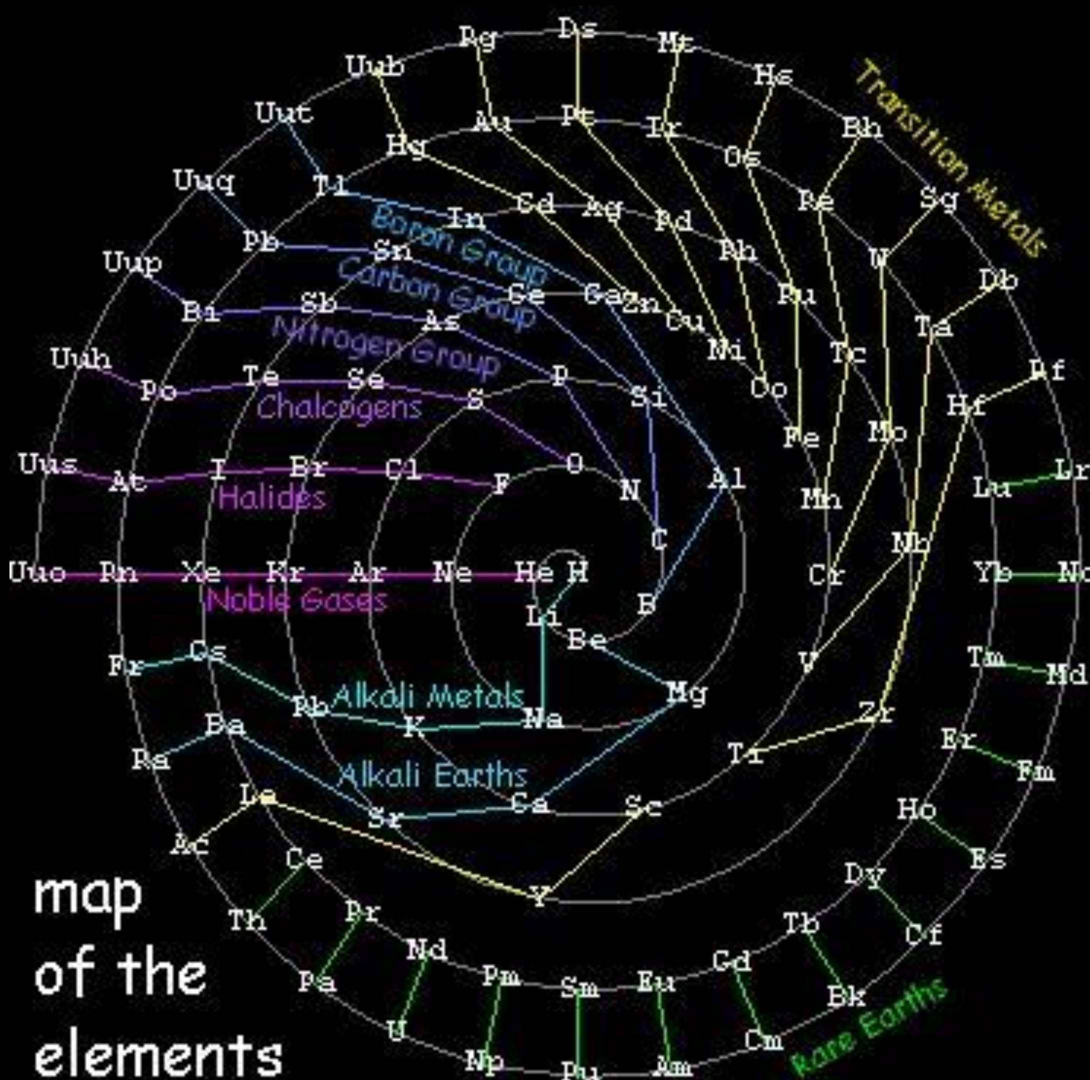
Another Circular Periodic Table



Elemental Spiral Map



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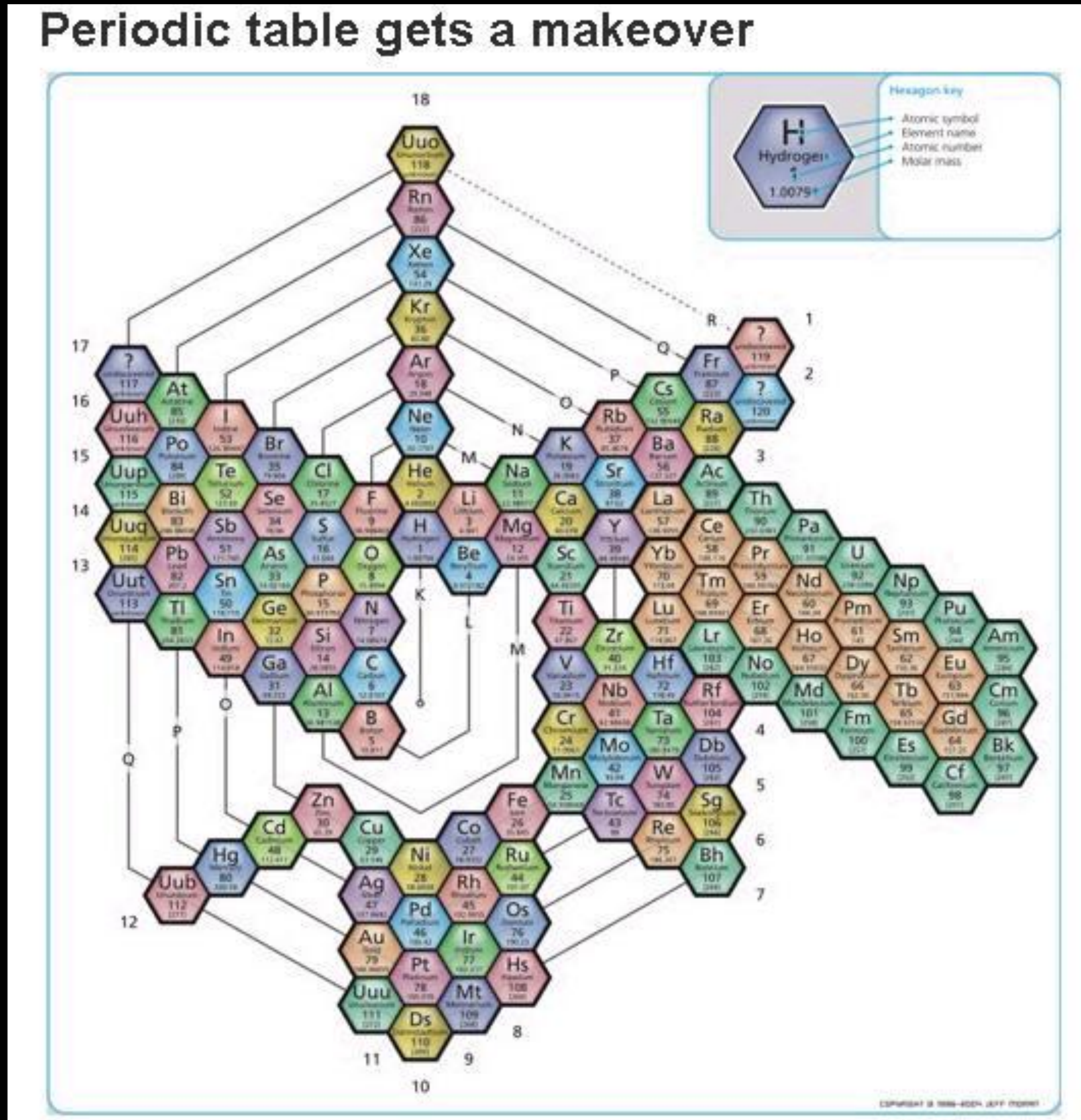
Periodic Table - Hexes



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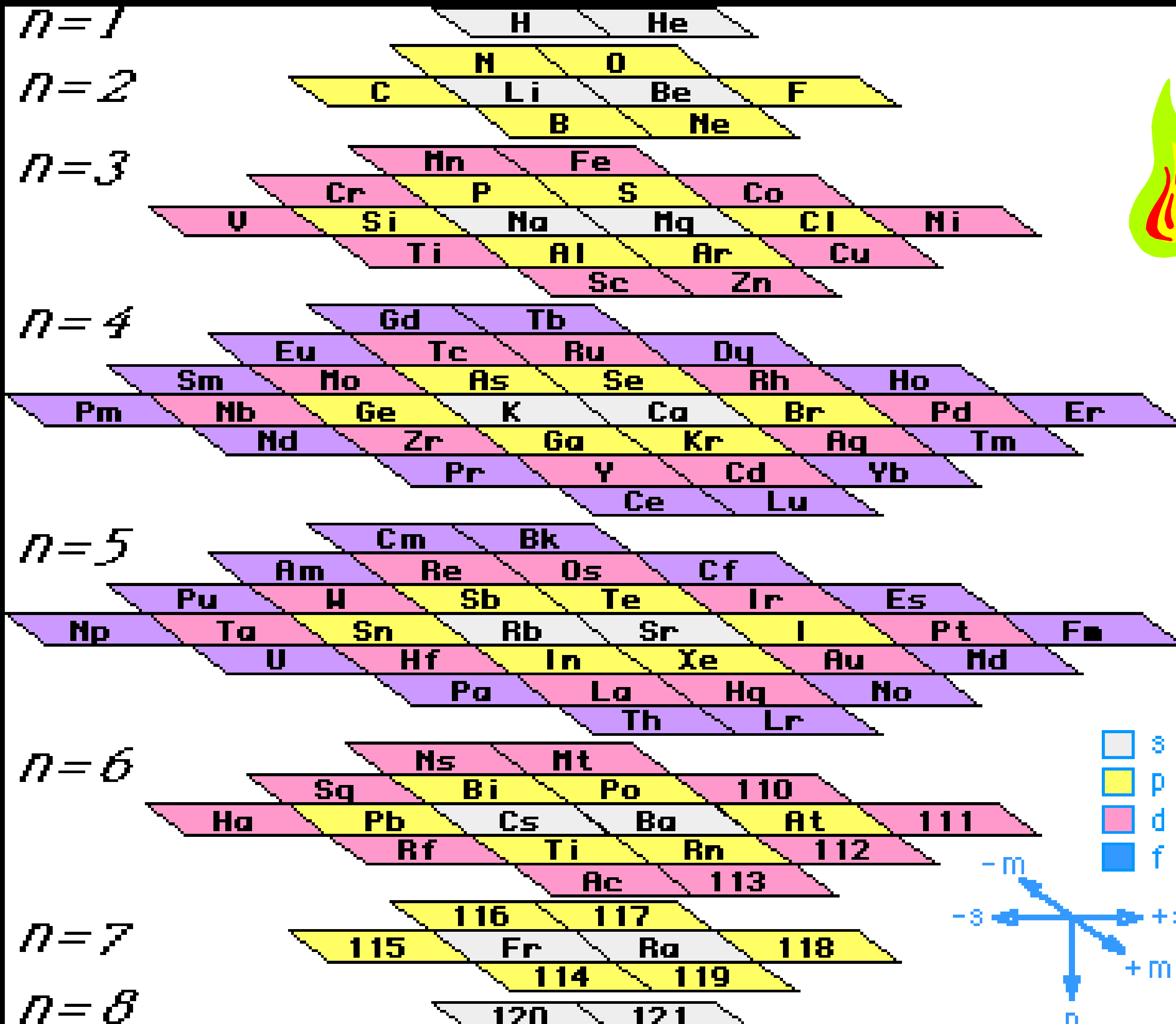
Periodic Table - Planar



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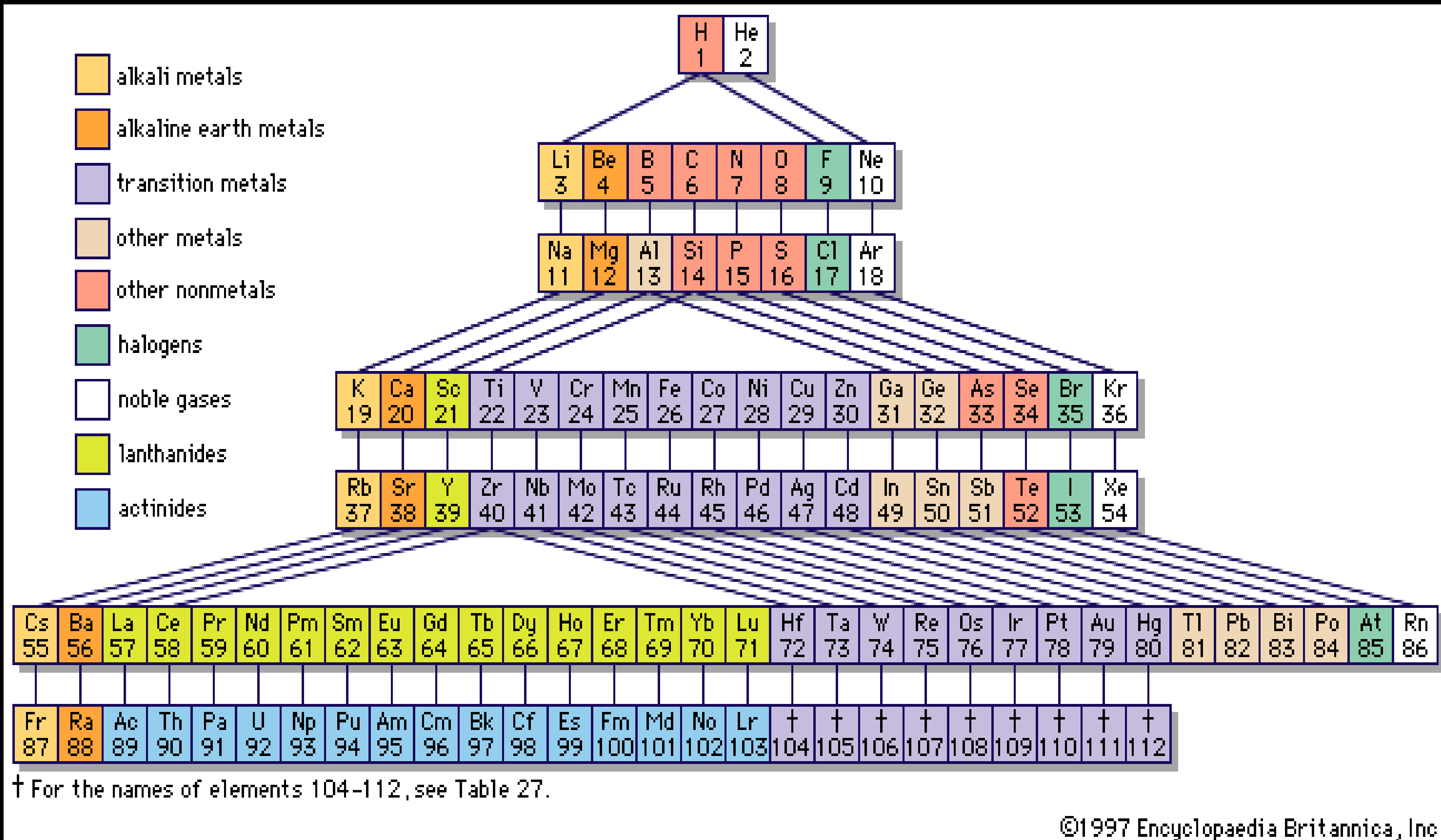
Periodic Table - Pyramid



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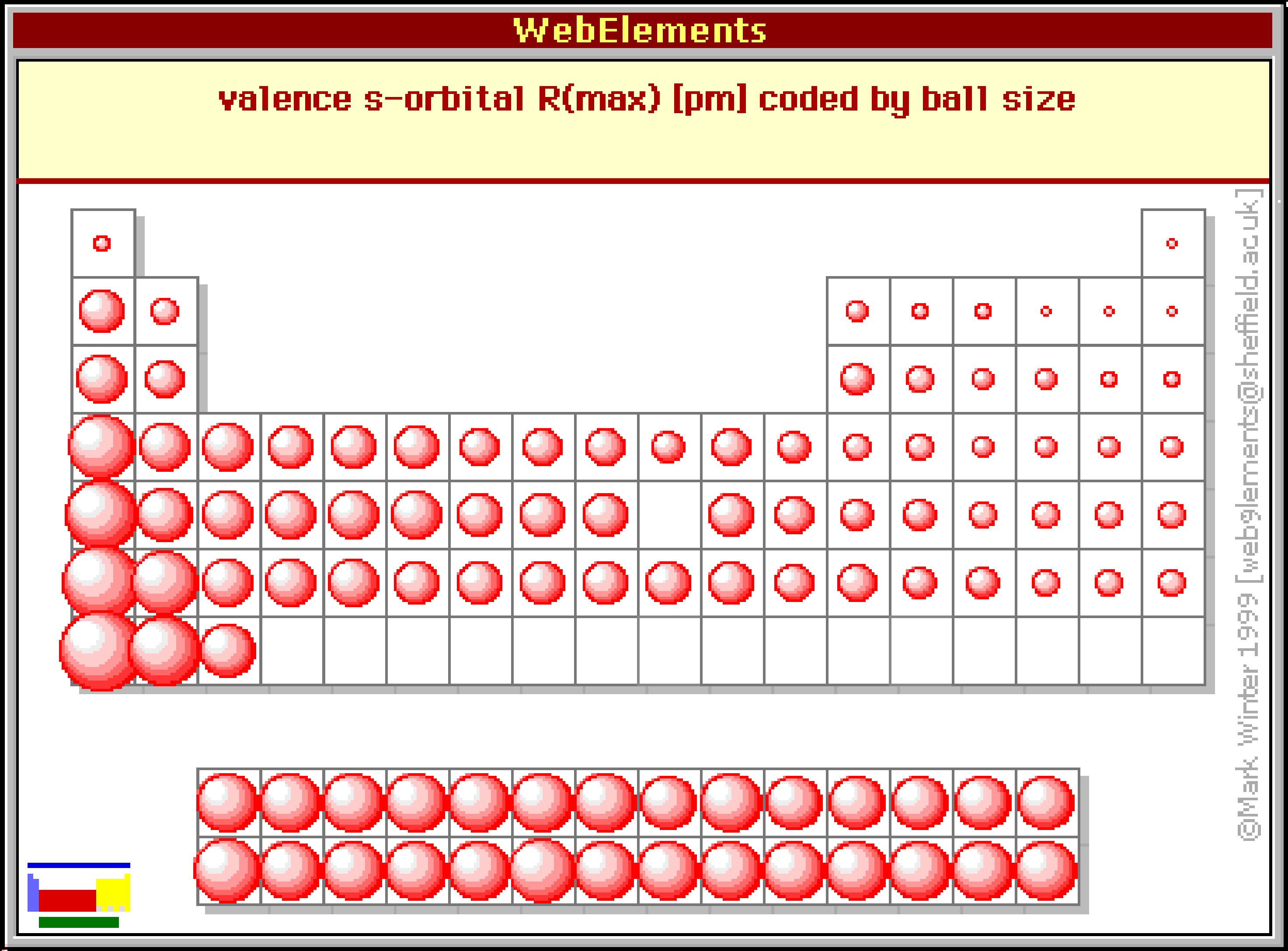
The Periodic Table- Atomic Size



Atomic size increases as you descend within a family

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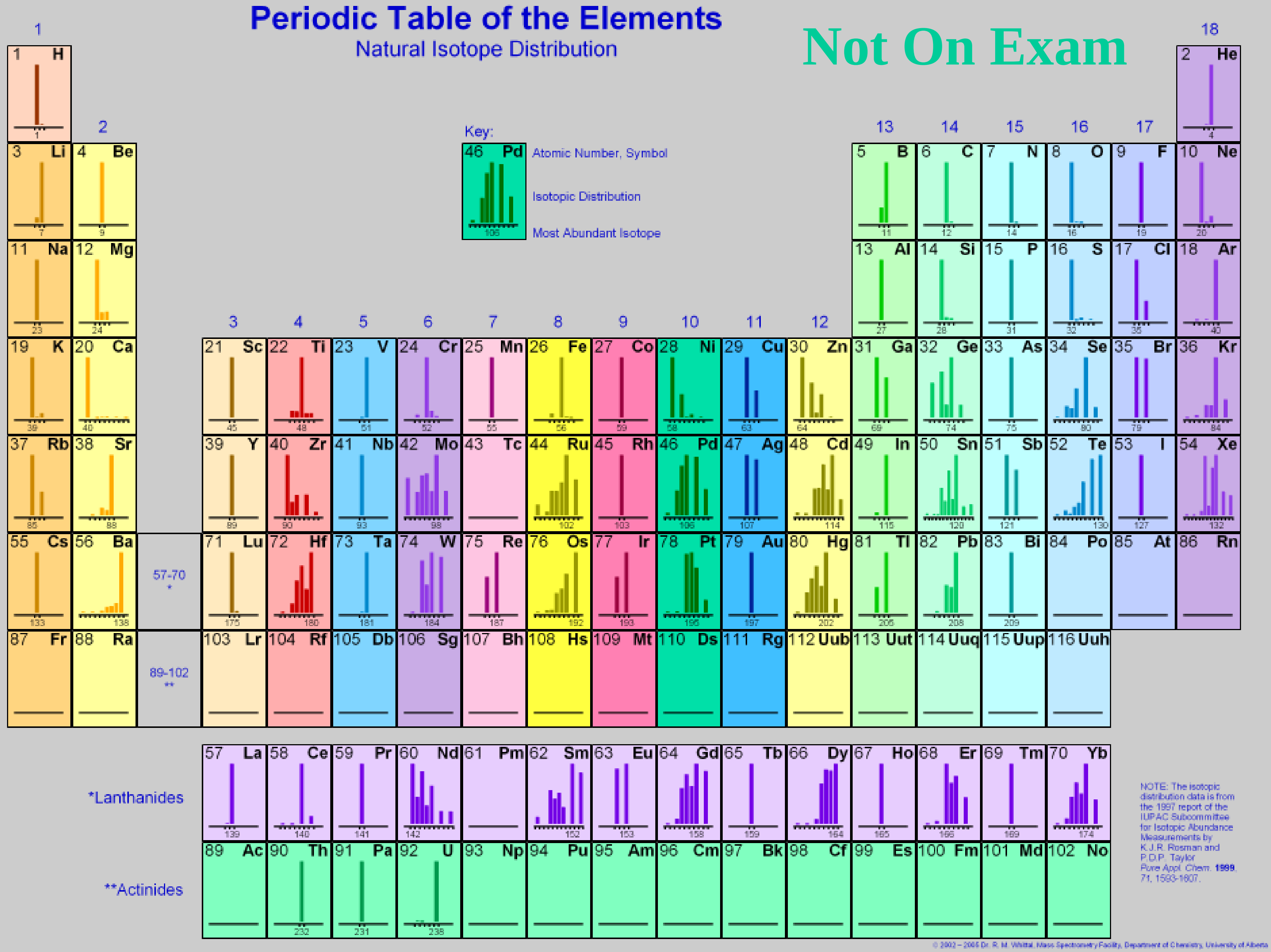
Not On Exam



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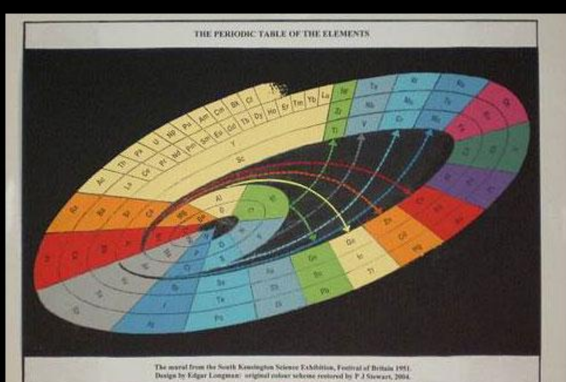
The Periodic Table Notation

Placement of data at publisher's option

Mass
Always greater

16	**Z**
S	**Symbol**
32.07	**AMU (weighted)**



Isotope information not given

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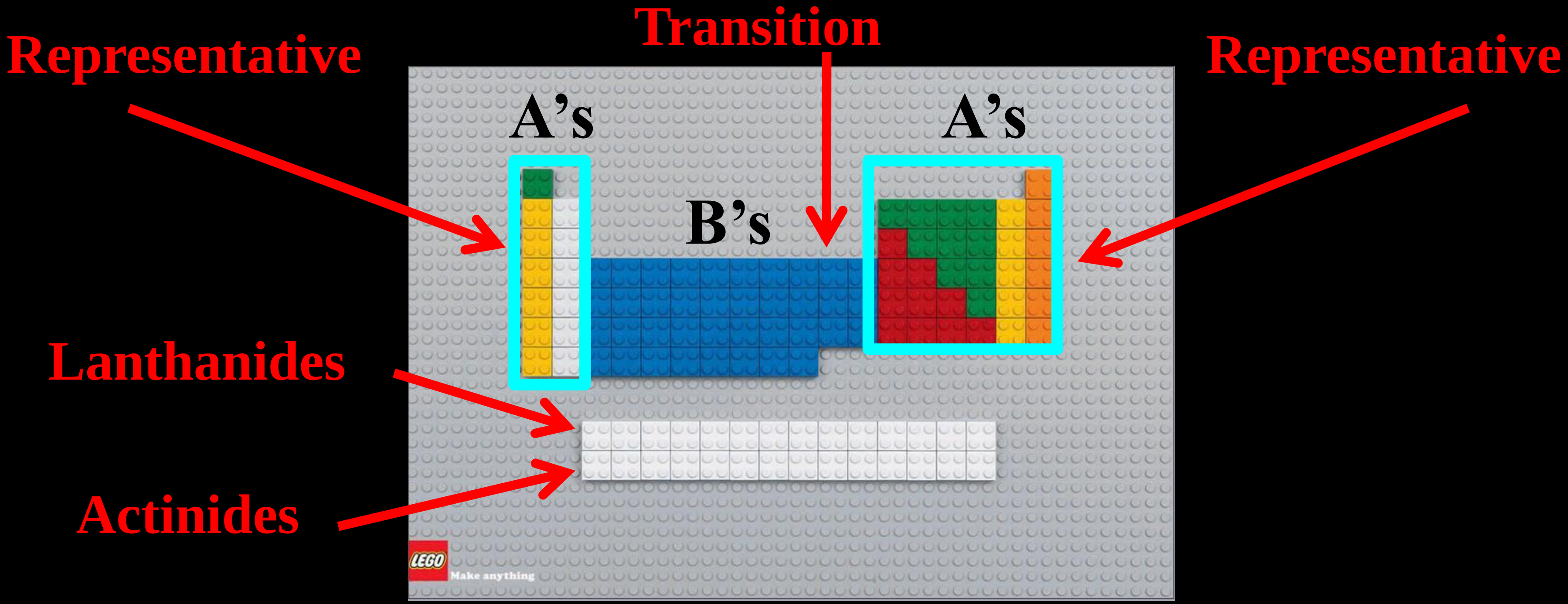
The Periodic Table

Representative Elements: “A” groups (Edges)
Transition Elements: “B” groups (Middle)
Lanthanides: #58 - #71 (Bottom - upper)
Actinides: #90 - #103 (Bottom - lower)



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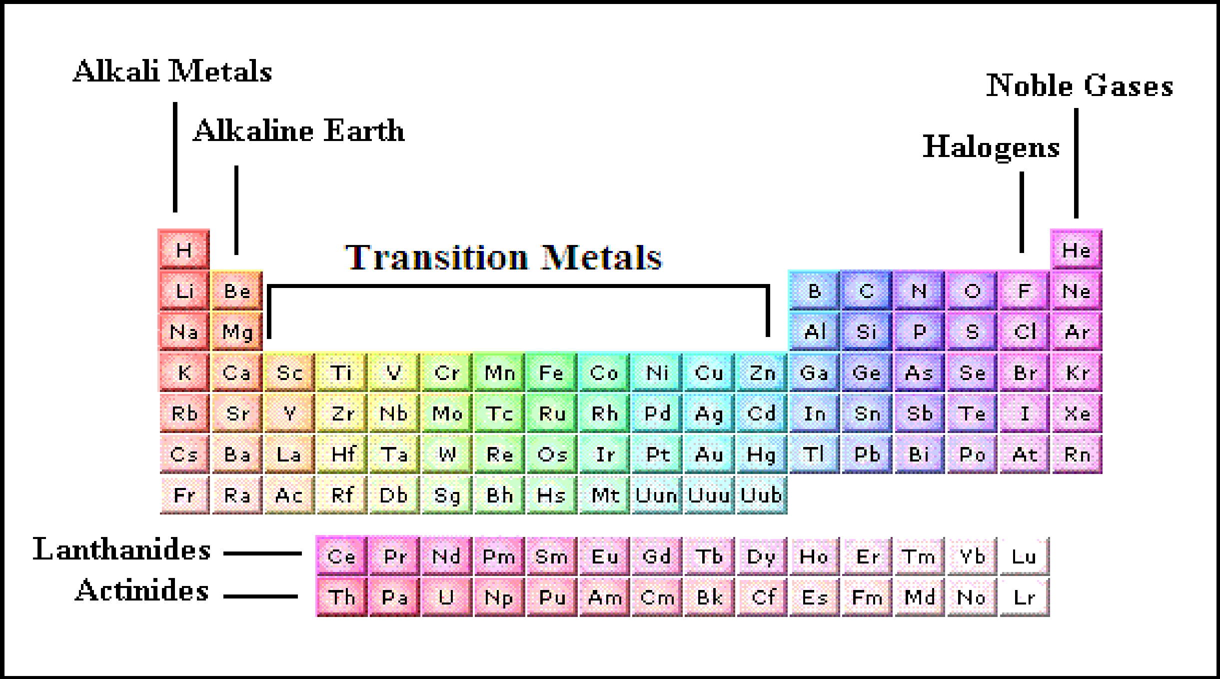
The Periodic Table - Families

Group 1A (1): Alkali Metals

Group 2A (2): Alkaline Earths

Group 7A (17): Halogens

Group 8A (18): Noble (Inert, Rare) Gases



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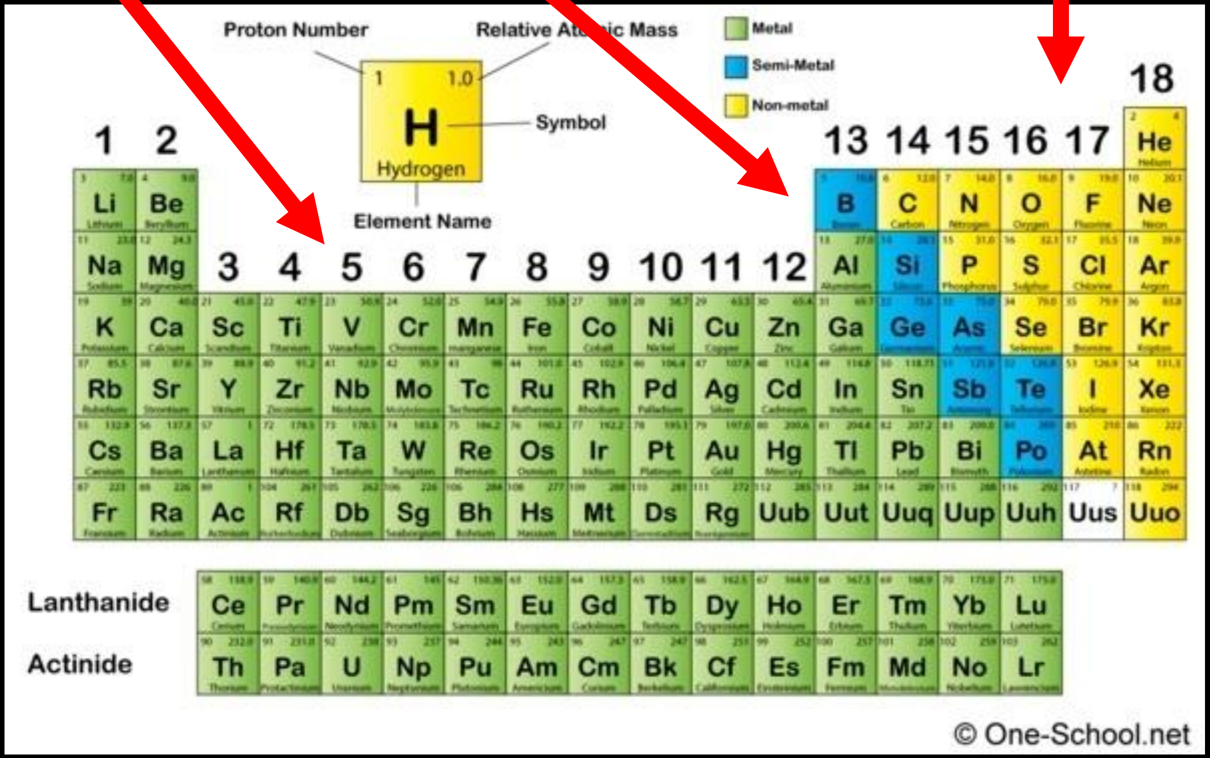
3 Categories: of Elements

Metals
(left of staircase)

Metalloids
(staircase)

Nonmetals
(right of staircase)



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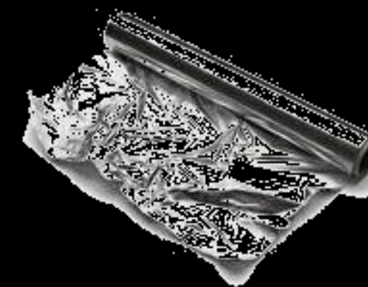
Metals - Left Side Periodic Table

Metallic shine or luster
Flexible
Solids (mostly) @ room temp
Ductile - can be drawn into wires
Malleable - can be pounded into thin sheets
Conduct heat & electricity

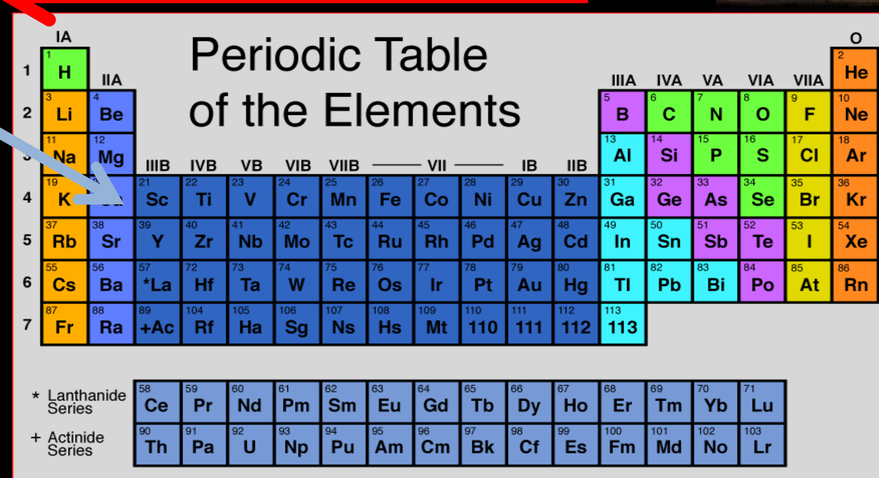


Metals

Most Elements (> 80)

Beyond Iron:
"Heavy Metals"

More Metallic



Periodic Table of the Elements

	IA	IIA	IIIB	IVB	VB	VIB	VIIB	VII	VII	VII	IB	IIB	IIIA	IVA	VA	VIA	VIIA	O
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	[illegible]	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 Ha	106 Sg	107 Ns	108 Hs	109 Mt	110 110	111 111	112 112	113 113					

* Lanthanide Series	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
+ Actinide Series	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

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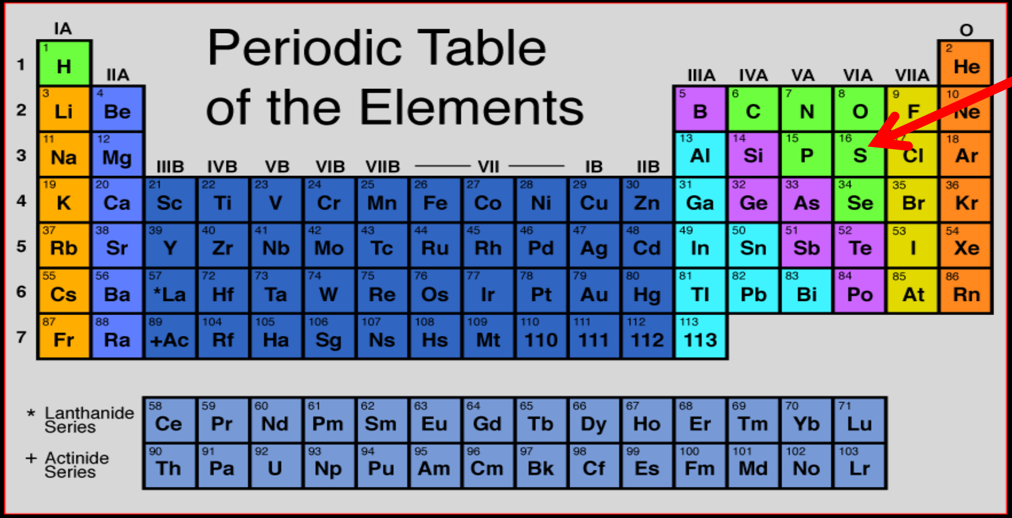
Nonmetals - Right Side Periodic Table

No shine ~ variable colors
Brittle, hard (when solid)
Mostly gases @ room temperature
Not malleable
Not ductile
Poor conductors

More Non-metallic



Non-Metals

17 or 18 Elements

At has some metallic, some metalloid, and mostly halide properties

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Metalloids (Semi-Metals) – “Staircase”

Properties (metallic or nonmetallic) depend on environment

Semi-conductors

good conductor at high T

poor conductor at low T

Staircase

B Boron

Si Silicon

Ge Germanium

As Arsenic

Sb Antimony

Te Tellurium

Po Polonium ?

At Astatine ??

Periodic Table of the Elements

	IA	IIA	IIIB	IVB	VB	VIB	VIIB	— VII —			IB	IIB	IIIA	IVA	VA	VIA	VIIA	O
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 Ha	106 Sg	107 Ns	108 Hs	109 Mt	110 110	111 111	112 112	113 113					

* Lanthanide Series	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
+ Actinide Series	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

6 , 7, or 8 Elements

At on some, Most consider At a halide

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Periodic Table – Summary of Families

Group 1A (1): alkali metals

Group 2A (2): alkaline earths

Group 7A (17): halogens

Group 8A (18): noble (inert, rare) gases

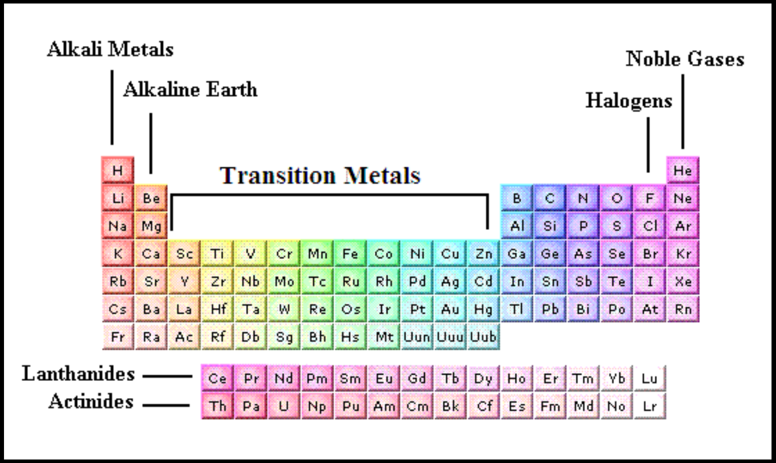
Representative (1-2;13-18) : The “A” Groups (the Edges)

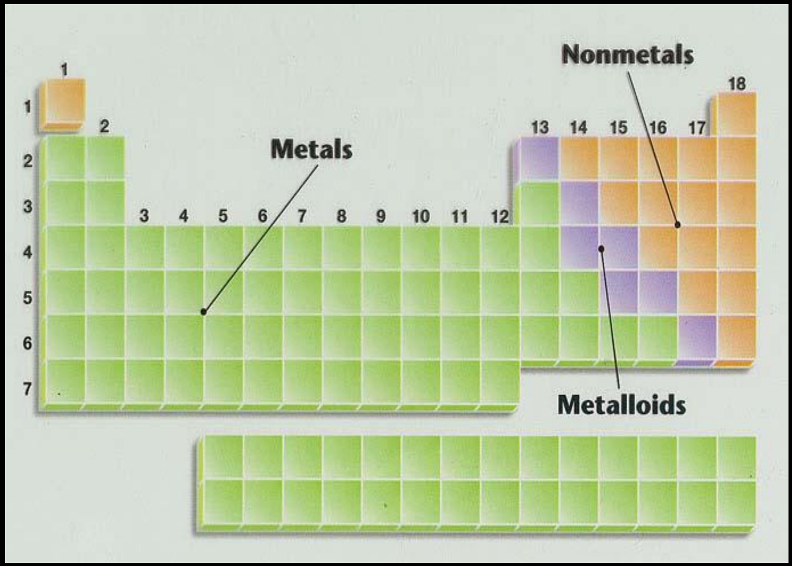
Transition Metals (3-12) : The “B” Groups (the Center)

Metalloids: “Staircase” ➔ B, Si, Ge, As, Sb, Te, Po

Lanthanides = upper, of lower rows

Actinides = lower, of lower row





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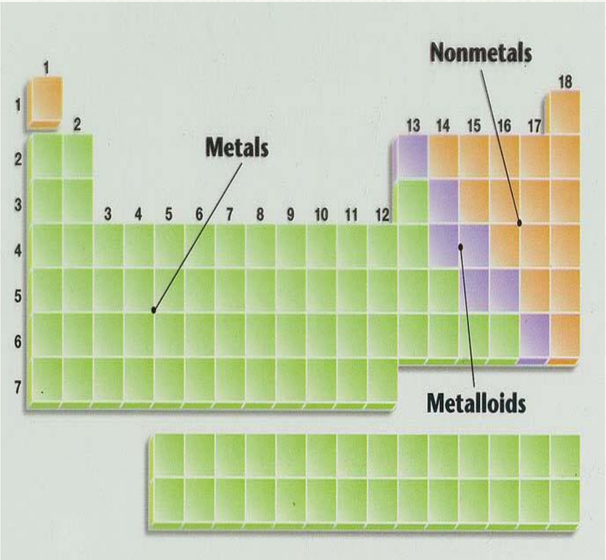
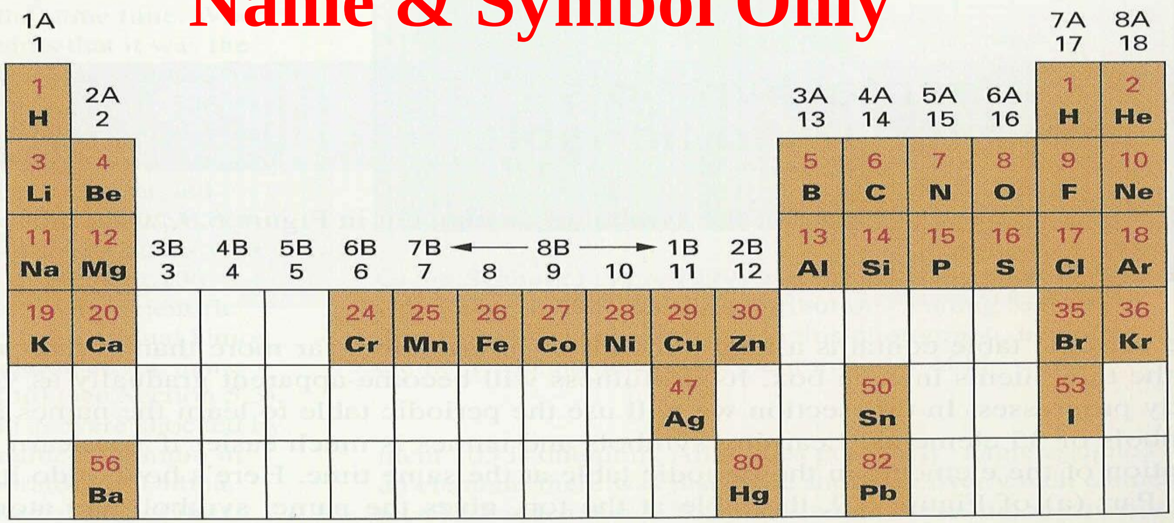
Common Elements – Need To Memorize

Common Elements

Atomic Number	Symbol	Element	Atomic Number	Symbol	Element	Atomic Number	Symbol	Element
1	H	Hydrogen	13	Al	Aluminum	28	Ni	Nickel
2	He	Helium	14	Si	Silicon	29	Cu	Copper
3	Li	Lithium	15	P	Phosphorus	30	Zn	Zinc
4	Be	Beryllium	16	S	Sulfur	35	Br	Bromine
5	B	Boron	17	Cl	Chlorine	36	Kr	Krypton
6	C	Carbon	18	Ar	Argon	47	Ag	Silver
7	N	Nitrogen	19	K	Potassium	50	Sn	Tin
8	O	Oxygen	20	Ca	Calcium	53	I	Iodine
9	F	Fluorine	24	Cr	Chromium	56	Ba	Barium
10	Ne	Neon	25	Mn	Manganese	80	Hg	Mercury
11	Na	Sodium	26	Fe	Iron	82	Pb	Lead
12	Mg	Magnesium	27	Co	Cobalt			



Name & Symbol Only



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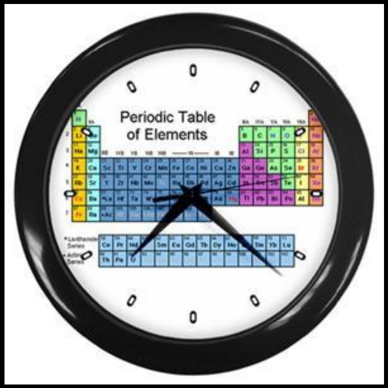
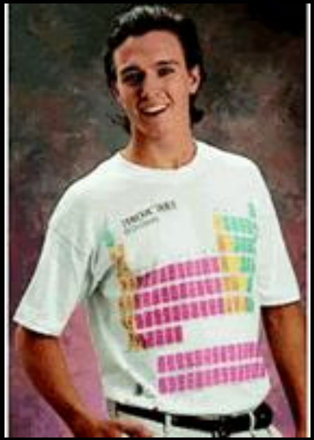
Memorizing Preferable to Alternatives





Slightly Extreme Learning Aids

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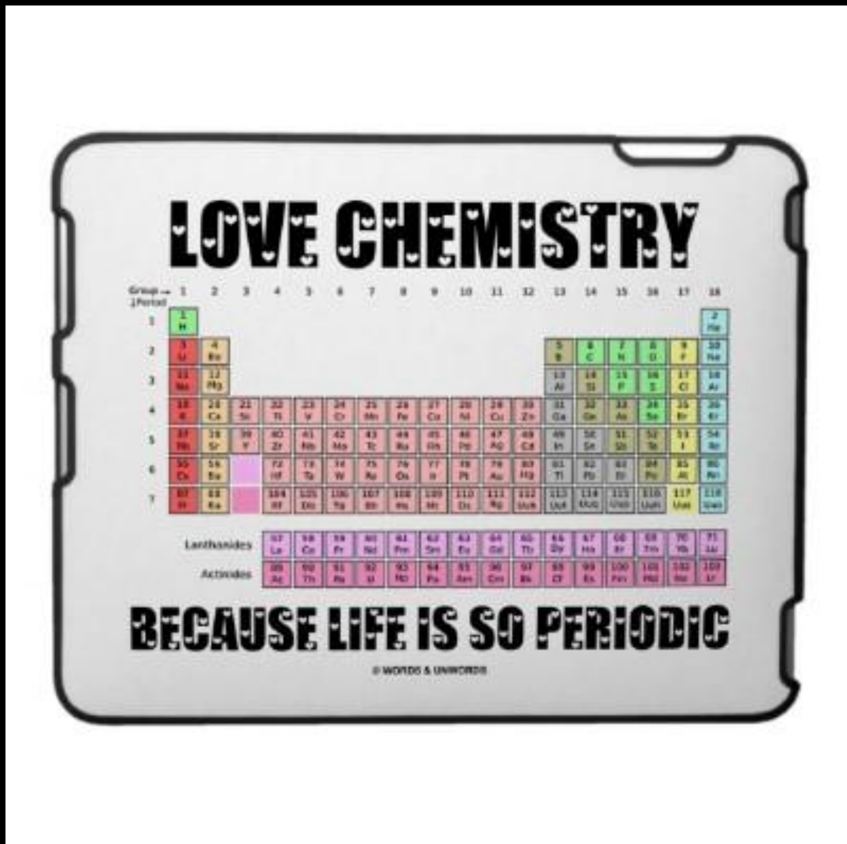
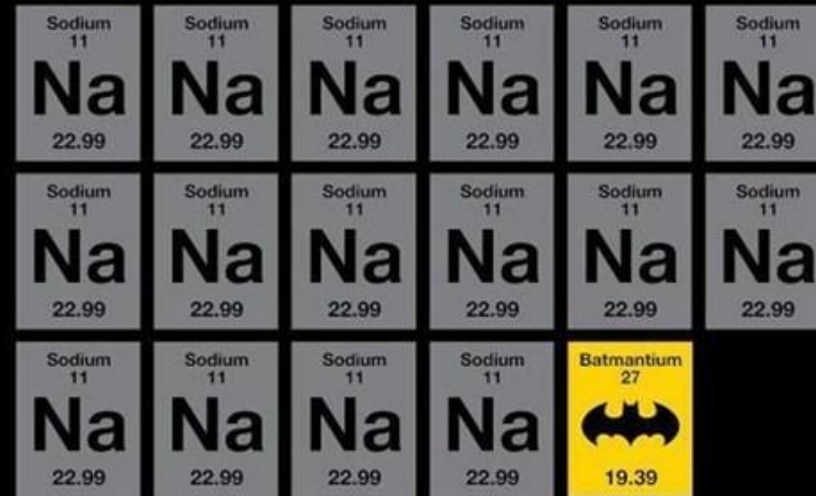

LOVE CHEMISTRY
Lanthanides
Actinides
BECAUSE LIFE IS SO PERIODIC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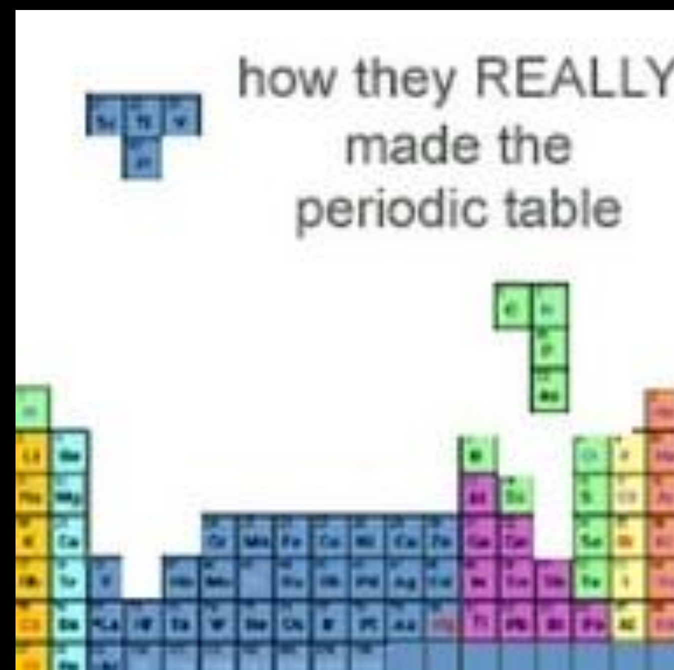
how they REALLY
made the
periodic table