

Jumpstart

- 1. Pick up one of each handout from table 8**
- 2. Get out glue stick, highlighter, colored pencils/markers**

The Periodic Table of Elements

	1																	18
1	1 H 1.008	2											13	14	15	16	17	2 He 4.003
2	3 Li 6.941	4 Be 9.012											5 B 10.811	6 C 12.001	7 N 14.007	8 O 15.999	9 F 18.998	10 Ne 20.180
3	11 Na 22.990	12 Mg 24.305	3	4	5	6	7	8	9	10	11	12	13 Al 26.982	14 Si 28.086	15 P 30.974	16 S 32.066	17 Cl 35.453	18 Ar 39.948
4	19 K 39.098	20 Ca 40.078	21 Sc 44.956	22 Ti 47.87	23 V 50.942	24 Cr 51.996	25 Mn 54.938	26 Fe 55.845	27 Co 58.933	28 Ni 58.69	29 Cu 63.546	30 Zn 65.39	31 Ga 69.723	32 Ge 72.61	33 As 74.922	34 Se 78.96	35 Br 79.904	36 Kr 83.80
5	37 Rb 85.468	38 Sr 87.62	39 Y 88.906	40 Zr 91.224	41 Nb 92.906	42 Mo 95.94	43 Tc (98)	44 Ru 101.07	45 Rh 102.906	46 Pd 106.42	47 Ag 107.868	48 Cd 112.4	49 In 114.818	50 Sn 118.710	51 Sb 121.760	52 Te 127.60	53 I 126.904	54 Xe 131.29
6	55 Cs 132.905	56 Ba 137.327	★ 71 Lu 174.967	72 Hf 178.49	73 Ta 180.95	74 W 183.84	75 Re 186.207	76 Os 190.23	77 Ir 192.217	78 Pt 195.078	79 Au 196.967	80 Hg 200.59	81 Tl 204.383	82 Pb 207.2	83 Bi 208.980	84 Po (209)	85 At (210)	86 Rn (222)
7	87 Fr (223)	88 Ra (226)	★ ★ 103 Lr (262)	104 Rf (261)	105 Db (262)	106 Sg (266)	107 Bh (264)	108 Hs (269)	109 Mt (268)	110 Ds (269)	111 Rg (272)	112 Uub (285)	113 Uut (284)	114 Uuq (289)	115 Uup (288)	116 Uuh (292)	117 Uus	118 Uuo

★ Lanthanides

★ ★ Actinides

57 La 138.906	58 Ce 140.116	59 Pr 140.908	60 Nd 144.24	61 Pm (145)	62 Sm 150.36	63 Eu 151.964	64 Gd 157.25	65 Tb 158.925	66 Dy 162.50	67 Ho 164.930	68 Er 167.26	69 Tm 168.934	70 Yb 173.04
89 Ac (227)	90 Th 232.038	91 Pa 231.036	92 U 238.029	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)

Periodic → *Periodic Law* → *Periodic Table*



- *Periodic* occurs at regular, predictable intervals
- *Periodic law* - physical and chemical properties of the elements are periodic -
By atomic number!
- *Periodic Table of Elements* - arranged by atomic number - shows patterns in properties

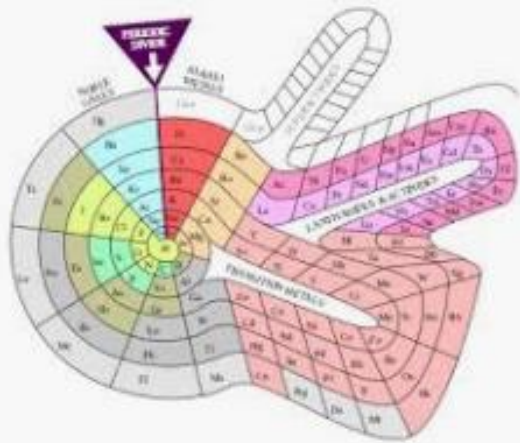
Element



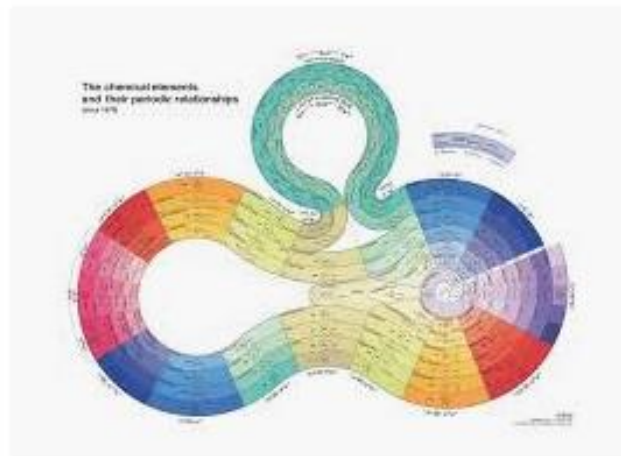
- A pure substance - one kind of atom
 - Cannot be broken down into simpler substances
- 90 occur naturally on earth
- 25 were synthesized (made) by scientists

There are tons of periodic tables out there!

- A periodic table is just a way to organize the elements to try and show various patterns
- The periodic table we are used to is just the most commonly used one, not the only one! Some are trying to show different patterns than we are usually using



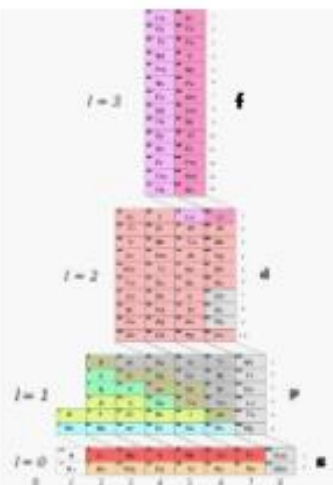
Alternative periodic tables - Wikipedia
en.wikipedia.org



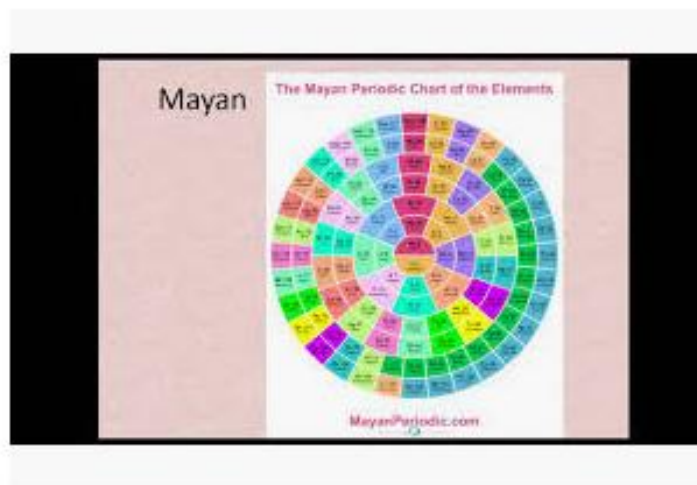
Alternative periodic tables ...
easternblot.net



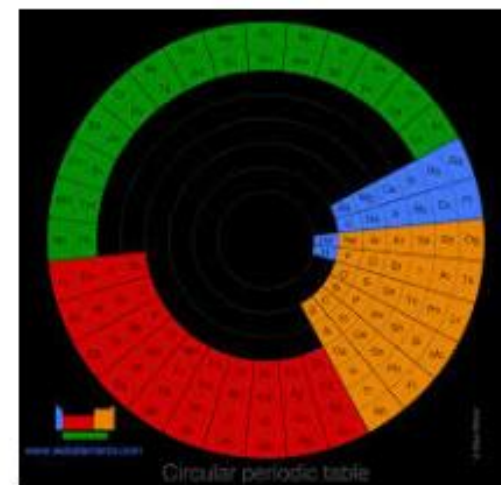
Alternative periodic tables - ...
wikiwand.com



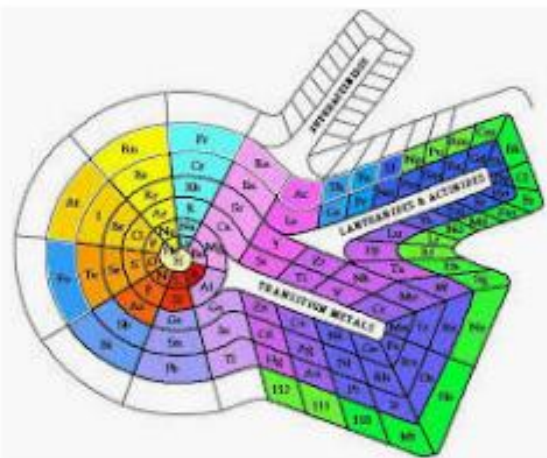
Alternative periodic tab...
en.wikipedia.org



Alternative Periodic Tables - YouTube
youtube.com



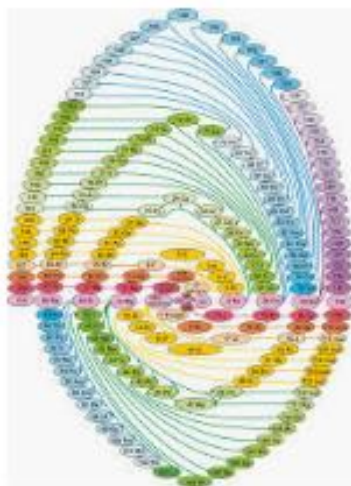
The periodic table of the elements ...
webelements.com



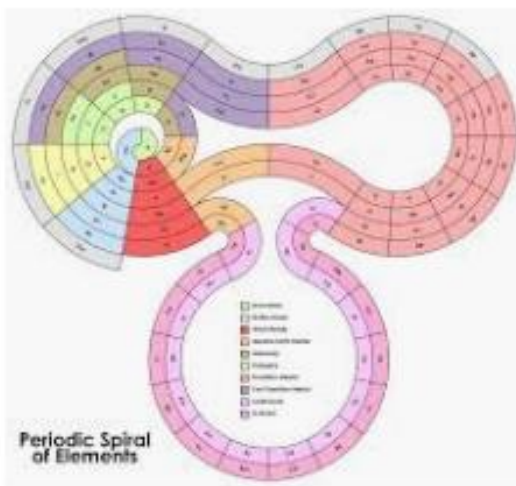
Alternative Periodic Tables (Updated ...
chemistry-blog.com



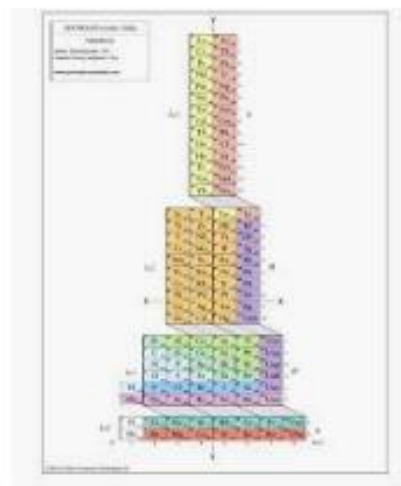
Alternative Periodic Tables (Updated ...
chemistry-blog.com



Makayev Alexander 1 s...
pinterest.com



Alternative Periodic Table » ChartGee...
chartgeek.com



Alternative Periodic Tables (...
chemistry-blog.com

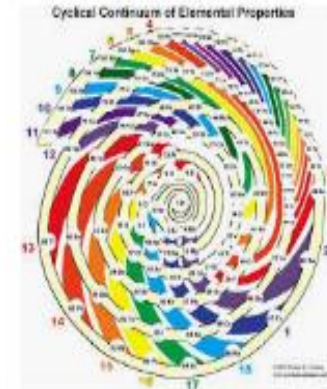


Alternative Periodic Tabl...
teepublic.com

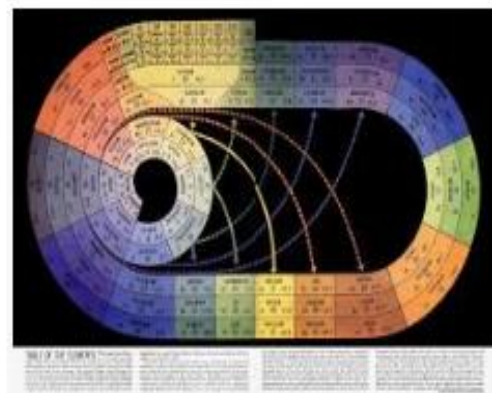
Alternative periodic tables ...
easternblot.net



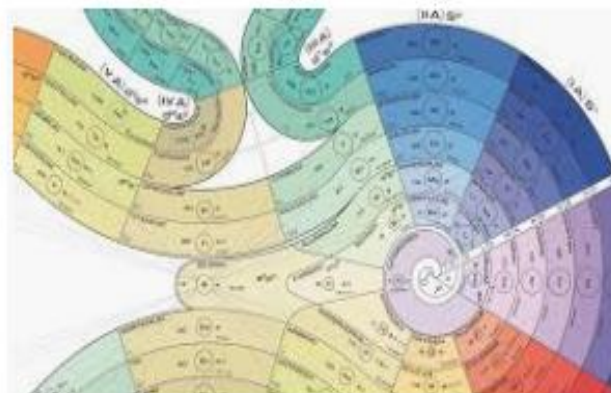
Alternative Periodic Ta...
usefulcharts.com



Alternative Periodic Tabl...
pinterest.com



beautiful alternative periodic table ...
teepublic.com



I love alternative periodic tables ...
easternblot.net



Alternative periodic tables ...
easternblot.net

Al...
easternblot.net

Dmitri Mendeleev



- 1860's
- Grouped elements according to **atomic masses and properties**

Image taken from:

<http://jscms.jrn.columbia.edu/cns/2006-04-18/fido-luxuriantflowinghair/mendeleev/>

Mendeleev's Published Periodic Table of Elements

Ueber die Beziehungen der Eigenschaften zu den Atomgewichten der Elemente. Von D. Mendelejeff. — Ordnet man Elemente nach zunehmenden Atomgewichten in verticale Reihen so, dass die Horizontalreihen analoge Elemente enthalten, wieder nach zunehmendem Atomgewicht geordnet, so erhält man folgende Zusammenstellung, aus der sich einige allgemeinere Folgerungen ableiten lassen.

			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	Ru = 104,4	Ir = 198
		Ni =	Co = 59	Pd = 106,6	Os = 199
			Cu = 63,4	Ag = 108	Hg = 200
H = 1			Zn = 65,2	Cd = 112	
	Be = 9,4	Mg = 24	? = 68	Ur = 116	Au = 197?
	B = 11	Al = 27,4	? = 70	Sn = 118	
	C = 12	Si = 28	As = 75	Sb = 122	Bi = 210?
	N = 14	P = 31	S = 79,4	Te = 128?	
	O = 16	S = 32	K = 80	J = 127	
	F = 19	Cl = 35,5	Rb = 85,4	Cs = 133	Tl = 204
Li = 7	Na = 23	K = 39	Sr = 87,6	Ba = 137	Pb = 207
		Ca = 40	Ce = 92		
		? = 45	La = 94		
		?Er = 56	D = 95		
		?Yt = 60	Th = 118?		
		?In = 75,6			

1. Die nach der Größe des Atomgewichts geordneten Elemente zeigen eine stufenweise Abänderung in den Eigenschaften.
2. Chemisch-analoge Elemente haben entweder übereinstimmende Atomgewichte (Pt, Ir, Os), oder letztere nehmen gleichviel zu (K, Rb, Cs).
3. Das Anordnen nach den Atomgewichten entspricht der *Werthigkeit* der Elemente und bis zu einem gewissen Grade der Verschiedenheit im chemischen Verhalten, z. B. Li, Be, B, C, N, O, F.

Why do you think there are question marks here?

Mendeleev's Predictions



- Mendeleev's Table had missing elements or gaps," BUT he was able to predict the characteristics of these missing elements because of Periodic Law.

	<u>"Ekasilicon"</u> Prediction		<u>Germanium</u> Actual
Date Predicted	1871	Date Discovered	1886
Atomic Mass	72	Atomic Mass	72.6
Density	5.5 g/cm ³	Density	5.47 g/cm ³
Bonding Power	4	Bonding Power	4
Color	Dark Gray	Color	Grayish White

Notice how Mendeleev's predictions (orange column) were very accurate when compared to Germanium's actual characteristics (green column)

Henry Moseley

- 1914
- Rearranged the elements by **atomic numbers**
- He determined # protons = atomic #
- The periodic table we use today!



Image taken from:
<http://dewey.library.upenn.edu/sceti/smith/>

Metals

Chemical Prop.	Physical Prop.
Few electrons in VALENCE shell (outer shell)	Ductile Malleable
Lose electrons easily	Good conductors
POSITIVE charge Ca^{2+}	Shiny
Make Cations	Solid at room temp



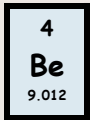
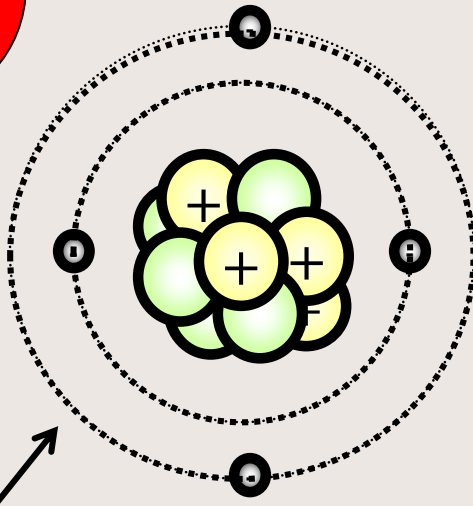
79
Au
196.967



11
Na
22.990

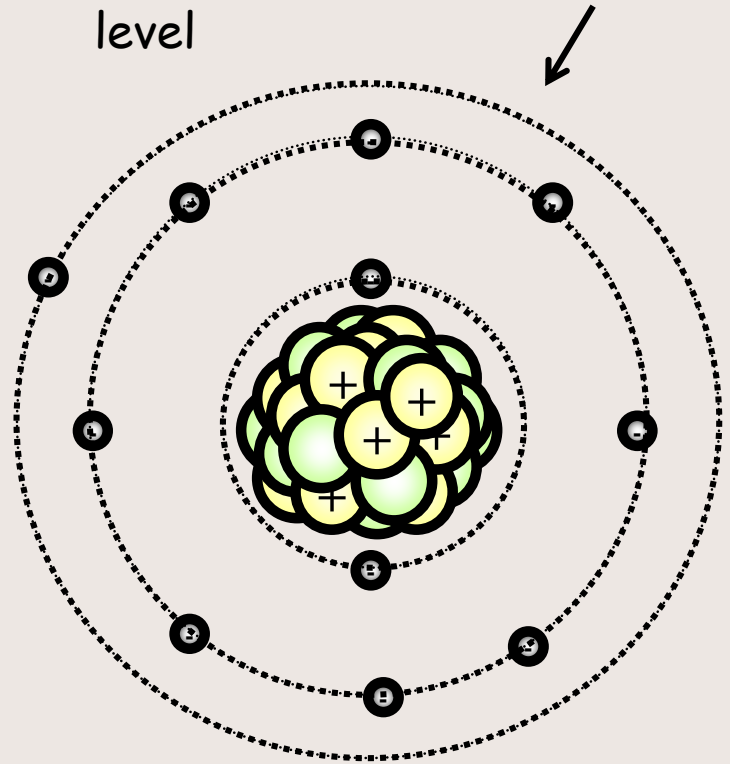
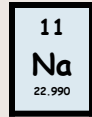
What metal
is not a solid
@ room
temperature?

Atoms with Few Electrons in their Outer Energy Level



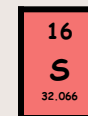
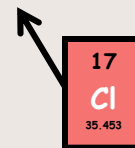
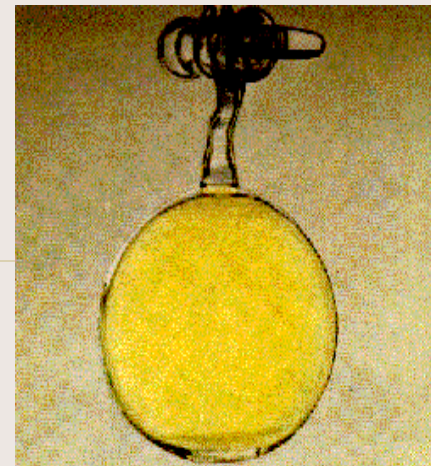
Notice: only 2 electrons in outer level

Notice: only 1 electron in outer level

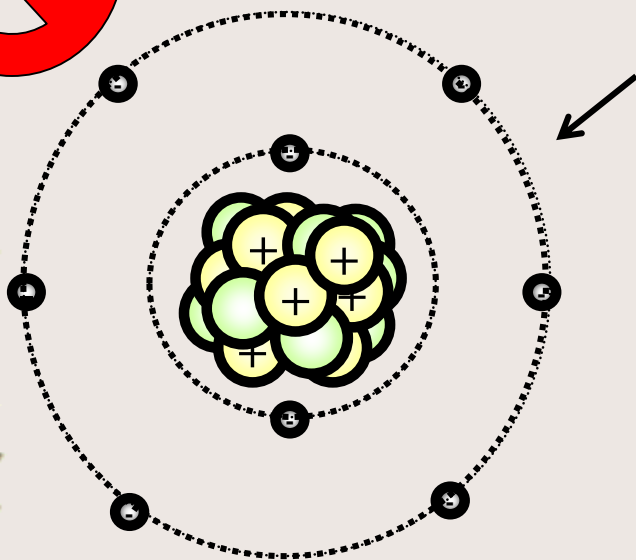


Non-Metals

Chemical Prop.	Physical Prop.
Almost full, or totally full valence shell	NOT Ductile NOT malleable
Tend to gain electrons	BAD conductors
NEGATIVE charge N^{3-}	Mostly solid
Make ANIONS	Some are gas at room temp

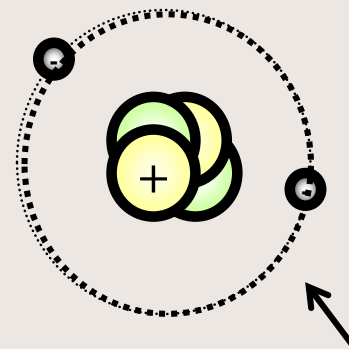


Atoms with Full or Almost Full Outer Energy Level



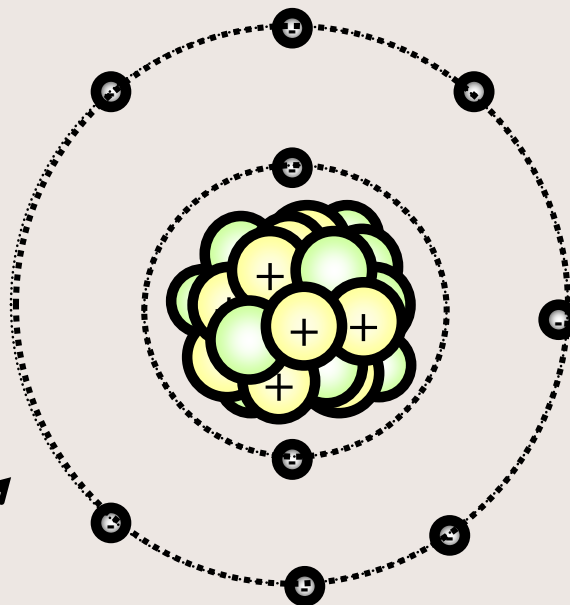
8
O
15.999

Notice: 2
electrons in
outer level -
FULL



2
He
4.003

Notice: 6
electrons in
outer level -
almost full

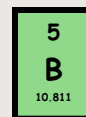
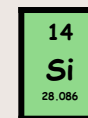


9
F
18.998

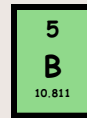
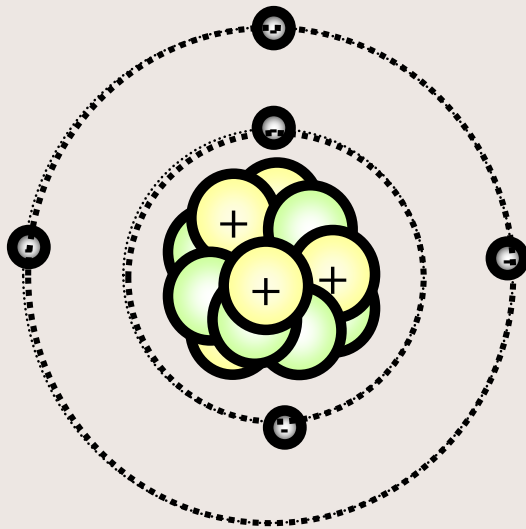
Notice: 7
electrons in
outer level -
almost full

Metalloids (Semi-metals)

Chemical Prop.	Physical Prop.
Most have half full valence shell	Have properties of metals AND non-metals
Make anions OR cations depending on their environment	No way to know which properties of each

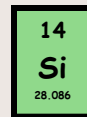
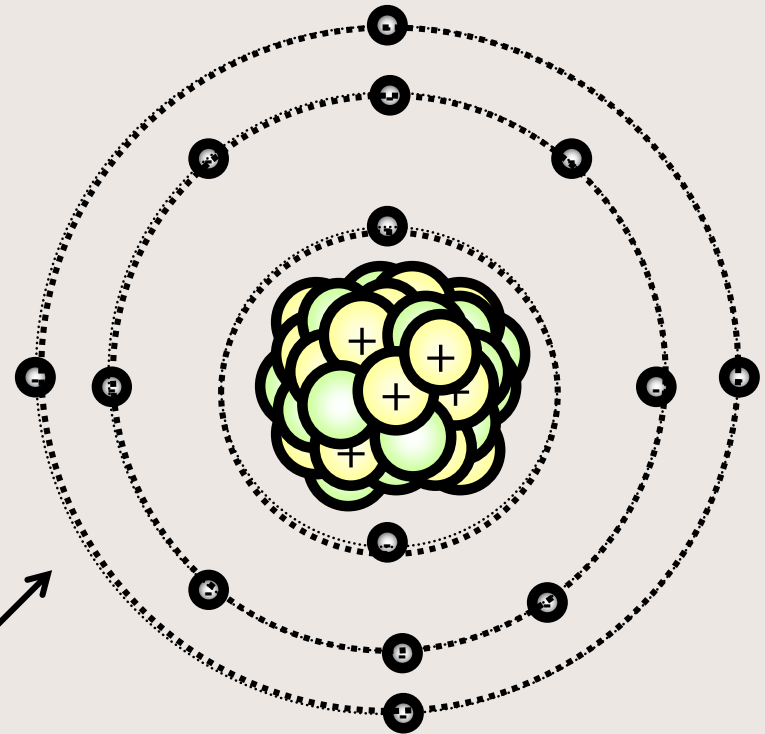


Atoms with $\sim\frac{1}{2}$ Complete Outer Energy Level



Notice: only 4 electrons in outer level

Notice: only 3 electrons in outer level



Important Features of the Periodic Table: Period (Row)



each horizontal row of elements on the periodic table

	1												18					
1	1 H 1.008	2										13 Al 26.982	14 Si 28.086	15 P 30.974	16 S 32.066	17 Cl 35.453	18 Ar 39.948	
2	3 Li 6.941	4 Be 9.012											5 B 10.811	6 C 12.001	7 N 14.007	8 O 15.999	9 F 18.998	10 Ne 20.180
3	11 Na 22.990	12 Mg 24.305	3 4 5 6 7 8 9 10 11 12										13 Al 26.982	14 Si 28.086	15 P 30.974	16 S 32.066	17 Cl 35.453	18 Ar 39.948
4	19 K 39.098	20 Ca 40.078	21 Sc 44.956	22 Ti 47.87	23 V 50.942	24 Cr 51.996	25 Mn 54.938	26 Fe 55.845	27 Co 58.933	28 Ni 58.69	29 Cu 63.546	30 Zn 65.39	31 Ga 69.723	32 Ge 72.61	33 As 74.922	34 Se 78.96	35 Br 79.904	36 Kr 83.80
5	37 Rb 85.468	38 Sr 87.62	39 Y 88.906	40 Zr 91.224	41 Nb 92.906	42 Mo 95.94	43 Tc (98)	44 Ru 101.07	45 Rh 102.906	46 Pd 106.42	47 Ag 107.868	48 Cd 112.4	49 In 114.818	50 Sn 118.710	51 Sb 121.760	52 Te 127.60	53 I 126.905	54 Xe 131.29
6	55 Cs 132.905	56 Ba 137.327	★ 71 Lu 174.967	72 Hf 178.49	73 Ta 180.95	74 W 183.84	75 Re 186.207	76 Os 190.23	77 Ir 192.227	78 Pt 195.078	79 Au 196.967	80 Hg 200.59	81 Tl 204.383	82 Pb 207.2	83 Bi 208.980	84 Po (209)	85 At (210)	86 Rn (222)
7	87 Fr (223)	88 Ra (226)	★★ 89 Ac (227)	104 Rf (261)	105 Db (262)	106 Sg (266)	107 Bh (264)	108 Hs (269)	109 Mt (268)	110 Ds (269)	111 Rg (272)	112 Uub (285)	113 Uut (284)	114 Uuq (289)	115 Uup (288)	116 Uuh (292)	117 Uus (288)	118 Uuo (289)

How many periods (rows) are on the Periodic Table Of Elements?

★ Lanthanides

★★ Actinides

57 La 138.905	58 Ce 140.116	59 Pr 140.908	60 Nd 144.24	61 Pm (145)	62 Sm 150.36	63 Eu 151.964	64 Gd 157.25	65 Tb 158.925	66 Dy 162.50	67 Ho 164.930	68 Er 167.26	69 Tm 168.934	70 Yb 173.04
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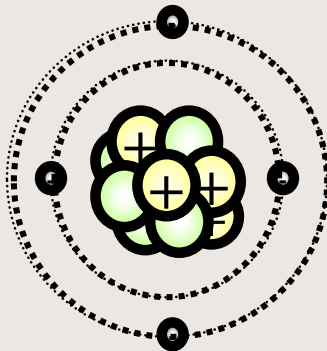
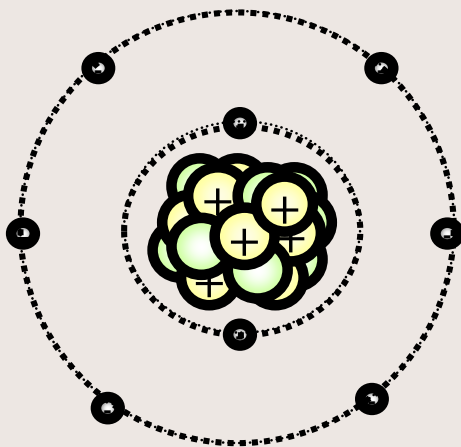


FROM LEFT TO RIGHT OR RIGHT TO LEFT

Period Properties

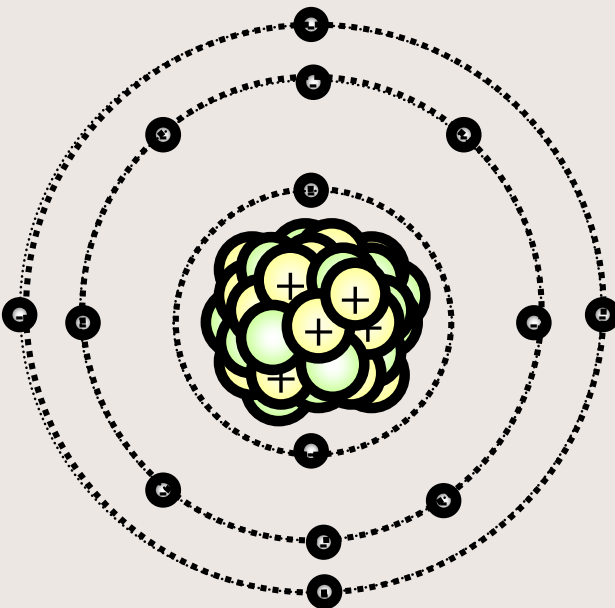
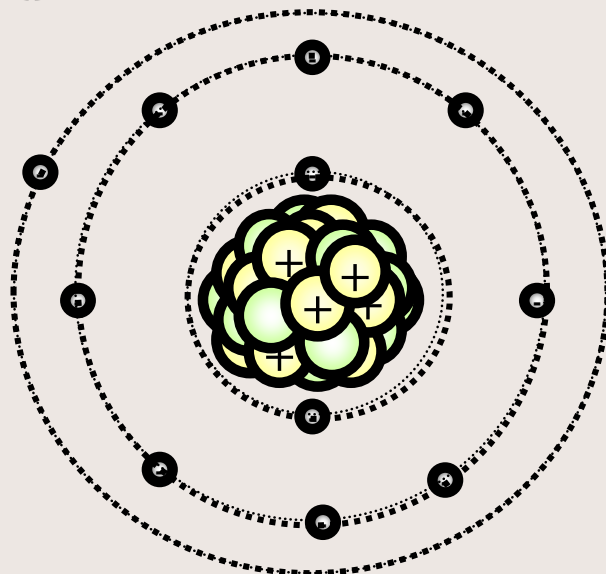
- Seven periods (numbered from the top down)
- Atomic #'s and masses increase as you move from the left to the right in a period
- All elements in the same period have the same number of energy levels
 - Period 1 = 1 energy level
 - Period 2 = 2 energy levels
 - Period 3 = 3 energy levels
 - Etc...

Examples of Period elements having the same number of energy levels in their atoms



In what period do you think these atoms reside?

In what period (row) do you think these atoms reside?





Important Features of the Periodic Table: Group (Family)

- each column of elements on the periodic table

How many groups (families) are on the Periodic Table Of 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 10.811	6 C 12.001	7 N 14.007	8 O 15.999	9 F 18.998	10 Ne 20.180	
11 Na 22.990	12 Mg 24.305											13 Al 26.982	14 Si 28.086	15 P 30.974	16 S 32.066	17 Cl 35.453	18 Ar 39.948	
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37 Rb 85.468	38 Sr 87.62	39 Y 88.906	40 Zr 91.224	41 Nb 92.906	42 Mo 95.94	43 Tc (98)	44 Ru 101.07	45 Rh 102.905	46 Pd 106.42	47 Ag 107.868	48 Cd 112.4	49 In 114.818	50 Sn 118.710	51 Sb 121.760	52 Te 127.60	53 I 126.905	54 Xe 131.29	
55 Cs 132.905	56 Ba 137.327	71 Lu 174.967	72 Hf 178.49	73 Ta 180.95	74 W 183.84	75 Re 186.207	76 Os 190.23	77 Ir 192.227	78 Pt 195.078	79 Au 196.967	80 Hg 200.59	81 Tl 204.383	82 Pb 207.2	83 Bi 208.980	84 Po (209)	85 At (210)	86 Rn (222)	
87 Fr (223)	88 Ra (226)	103 Lr (262)	104 Rf (261)	105 Db (262)	106 Sg (266)	107 Bh (264)	108 Hs (269)	109 Mt (268)	110 Ds (269)	111 Rg (272)	112 Uub (285)	113 Uut (284)	114 Uuq (289)	115 Uup (288)	116 Uuh (292)	117 Uus (288)	118 Uuo	



★ Lanthanides

★★ Actinides

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89 Ac (227)	90 Th 232.038	91 Pa 231.036	92 U 238.029	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)

FROM TOP TO BOTTOM OR BOTTOM TO THE TOP

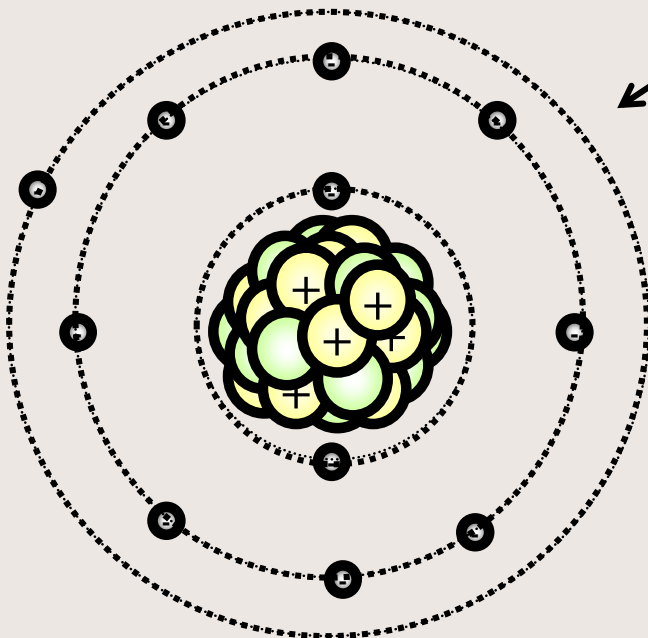
Group (Family) Properties

- 18 groups (numbered from left to right)
- Atomic # and masses increase from the top down
- Atoms in same group have same number of valence electrons
Exceptions: d block and f block
- similar physical and chemical properties
**BECAUSE THEY HAVE THE SAME
NUMBER OF VALENCE ELECTRONS**

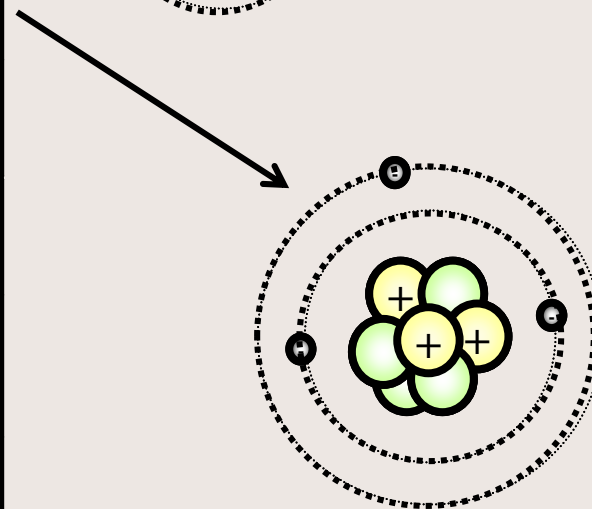
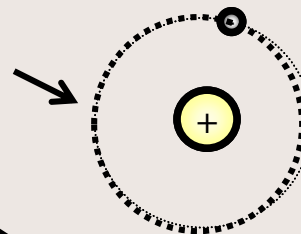
Examples of Group Elements with the same # of valence electrons



How many electrons do each of these atoms have in their outer orbital/level?



1
H
1.008
3
Li
6.941
11
Na
22.990
19
K
39.098
37
Rb
85.468
55
Cs
132.905
87
Fr
(223)



What group (family) do these elements reside in?



Identify the Element

	1																	18	
1	1 H 1.008	2																2 He 4.003	
2	3 Li 6.941	4 Be 9.012											5 B 10.811	6 C 12.001	7 N 14.007	8 O 15.999	9 F 18.998	10 Ne 20.180	
3	11 Na 22.990	12 Mg 24.305	3	4	5	6	7	8	9	10	11	12	13 Al 26.982	14 Si 28.086	15 P 30.974	16 S 32.066	17 Cl 35.453	18 Ar 39.948	
4	19 K 39.098	20 Ca 40.078	21 Sc 44.956	22 Ti 47.87	23 V 50.942	24 Cr 51.996	25 Mn 54.938	26 Fe 55.845	27 Co 58.933	28 Ni 58.69	29 Cu 63.546	30 Zn 65.39	31 Ga 69.723	32 Ge 72.61	33 As 74.922	34 Se 78.96	35 Br 79.904	36 Kr 83.80	
5	37 Rb 85.468	38 Sr 87.62	39 Y 88.906	40 Zr 91.224	41 Nb 92.906	42 Mo 95.94	43 Tc (98)	44 Ru 101.07	45 Rh 102.906	46 Pd 106.42	47 Ag 107.868	48 Cd 112.4	49 In 114.818	50 Sn 118.710	51 Sb 121.760	52 Te 127.60	53 I 126.904	54 Xe 131.29	
6	55 Cs 132.905	56 Ba 137.327	57 La 174.967	72 Hf 178.49	73 Ta 180.95	74 W 183.84	75 Re 186.207	76 Os 190.23	77 Ir 192.217	78 Pt 195.078	79 Au 196.967	80 Hg 200.59	81 Tl 204.383	82 Pb 207.2	83 Bi 208.980	84 Po (209)	85 At (210)	86 Rn (222)	
7	87 Fr (223)	88 Ra (226)	89 Ac (227)	103 Lr (262)	104 Rf (261)	105 Db (262)	106 Sg (266)	107 Bh (264)	108 Hs (269)	109 Mt (268)	110 Ds (269)	111 Rg (272)	112 Uub (285)	113 Uut (284)	114 Uuq (289)	115 Uup (288)	116 Uuh (292)	117 Uus (293)	118 Uuo (294)

★ Lanthanides

57 La 138.905	58 Ce 140.116	59 Pr 140.908	60 Nd 144.24	61 Pm (145)	62 Sm 150.36	63 Eu 151.964	64 Gd 157.25	65 Tb 158.925	66 Dy 162.50	67 Ho 164.930	68 Er 167.26	69 Tm 168.934	70 Yb 173.04
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★★ Actinides

89 Ac (227)	90 Th 232.038	91 Pa 231.036	92 U 238.029	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)
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Group 2 - Period 5 →

Strontium - Sr



Identify the Element

1	2											13	14	15	16	17	18	
1 H 1.008																	2 He 4.003	
2	3 Li 6.941	4 Be 9.012											5 B 10.811	6 C 12.001	7 N 14.007	8 O 15.999	9 F 18.998	10 Ne 20.180
3	11 Na 22.990	12 Mg 24.305	3	4	5	6	7	8	9	10	11	12	13 Al 26.982	14 Si 28.086	15 P 30.974	16 S 32.066	17 Cl 35.453	18 Ar 39.948
4	19 K 39.098	20 Ca 40.078	21 Sc 44.956	22 Ti 47.87	23 V 50.942	24 Cr 51.996	25 Mn 54.938	26 Fe 55.845	27 Co 58.933	28 Ni 58.69	29 Cu 63.546	30 Zn 65.39	31 Ga 69.723	32 Ge 72.61	33 As 74.922	34 Se 78.96	35 Br 79.904	36 Kr 83.80
5	37 Rb 85.468	38 Sr 87.62	39 Y 88.906	40 Zr 91.224	41 Nb 92.906	42 Mo 95.94	43 Tc (98)	44 Ru 101.07	45 Rh 102.906	46 Pd 106.42	47 Ag 107.868	48 Cd 112.4	49 In 114.818	50 Sn 118.710	51 Sb 121.760	52 Te 127.60	53 I 126.904	54 Xe 131.29
6	55 Cs 132.905	56 Ba 137.327	71 Lu 174.967	72 Hf 178.49	73 Ta 180.95	74 W 183.84	75 Re 186.207	76 Os 190.23	77 Ir 192.217	78 Pt 195.078	79 Au 196.967	80 Hg 200.59	81 Tl 204.383	82 Pb 207.2	83 Bi 208.980	84 Po (209)	85 At (210)	86 Rn (222)
7	87 Fr (223)	88 Ra (226)	103 Lr (262)	104 Rf (261)	105 Db (262)	106 Sg (266)	107 Bh (264)	108 Hs (269)	109 Mt (268)	110 Ds (269)	111 Rg (272)	112 Uub (285)	113 Uut (284)	114 Uuq (289)	115 Uup (288)	116 Uuh (292)	117 Uus (294)	118 Uuo (294)

★ Lanthanides

57 La 138.905	58 Ce 140.116	59 Pr 140.908	60 Nd 144.24	61 Pm (145)	62 Sm 150.36	63 Eu 151.964	64 Gd 157.25	65 Tb 158.925	66 Dy 162.50	67 Ho 164.930	68 Er 167.26	69 Tm 168.934	70 Yb 173.04
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★★ Actinides

89 Ac (227)	90 Th 232.038	91 Pa 231.036	92 U 238.029	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)
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Period 6 - Group 17 →

Astatine - At

Link to YouTube Video

- <https://youtu.be/kUWQxGiq1Q4>