OGUN DIGICLASS

CLASS: SENIOR SECONDARY SCHOOL

SUBJECT: CHEMISTRY

TOPIC: THE PERIODIC TABLE

The Periodic Table of Elements

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

At the end of the lesson, learners should be able to state:

- The periodic law
- Criteria for arranging elements on the periodic table
- Families of elements
- Periodicity of some properties

The Periodic Table of Elements

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Periodic → Periodic Law → Periodic Table

- ***Periodic law*** - The properties (physical and chemical) of the elements are periodic functions of their atomic numbers
- ***Periodic Table of Elements*** – a table of the elements, arranged by atomic number, that shows the patterns in their properties; based on the periodic law

Dmitri Mendeleev

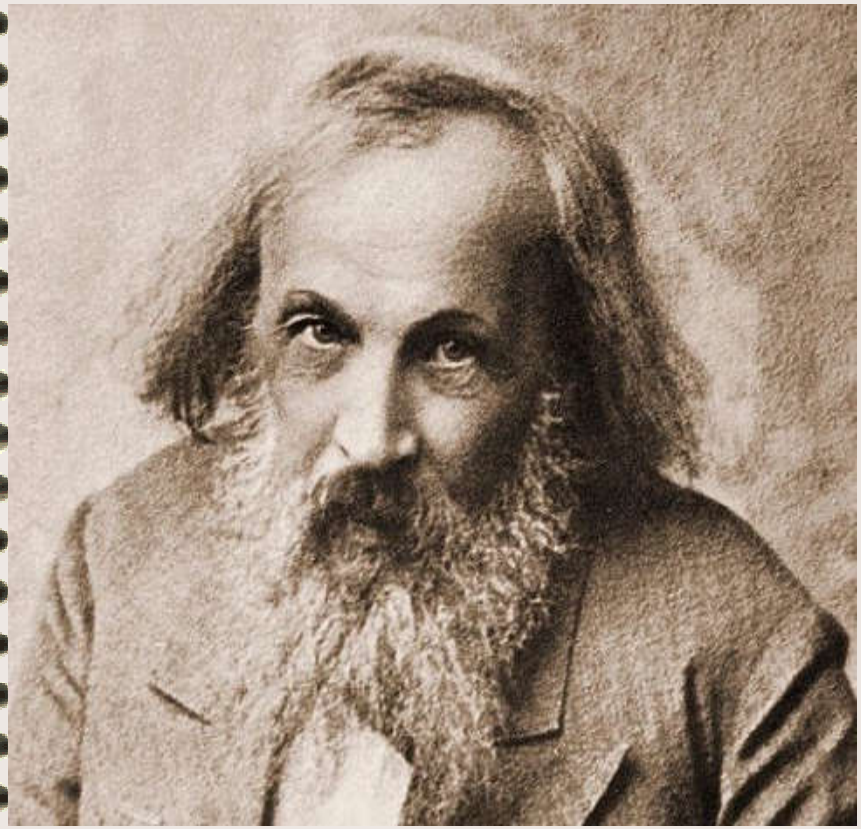

Image taken from:
http://jscms.jrn.columbia.edu/cns/2006-04-18/fido-luxuriantflowinghair/mendeleev/

- In the 1860's he devised a periodic table where the elements were ordered by their atomic masses
- He did this by grouping elements together according to their similarities

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
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	J = 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?		

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?

Image taken from: http://www.chemsoc.org/networks/learnnet/periodictable/post16/develop/mendeleev.htm

Mendeleev's Predictions

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

"Ekasilicon"		Germanium	
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

- In 1914, his work led to a revision of the periodic table by rearranging the elements by their atomic numbers
- He concluded that the number of protons in an atom is its atomic number
- Sample X-ray Spectra

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

3 Classes of Elements

Class	Color
Metal	
Non-Metal	
Metalloid	

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Metals

Location

- Found on the left of the zigzag line/staircase on the periodic table (exception → Hydrogen)

Chemical Properties

- Have few electrons in their outer energy level, thus lose electrons easily

Physical Properties

- ductile, good conductors, malleable, shiny, most are solid @ room temperature

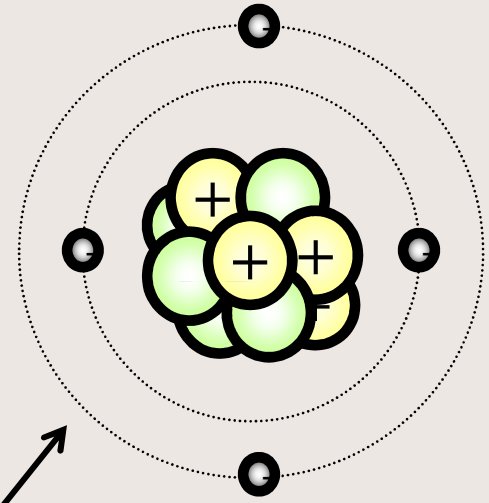
79
Au
196.967

11
Na
22.990

Image taken from:
http://chemistry.about.com/od/periodictableelements/ig/Element-Photo-Gallery.--98/Sodium.htm

What metal is <u>not</u> a solid @ room temperature?

Atoms with Few Electrons in their Outer Energy Level

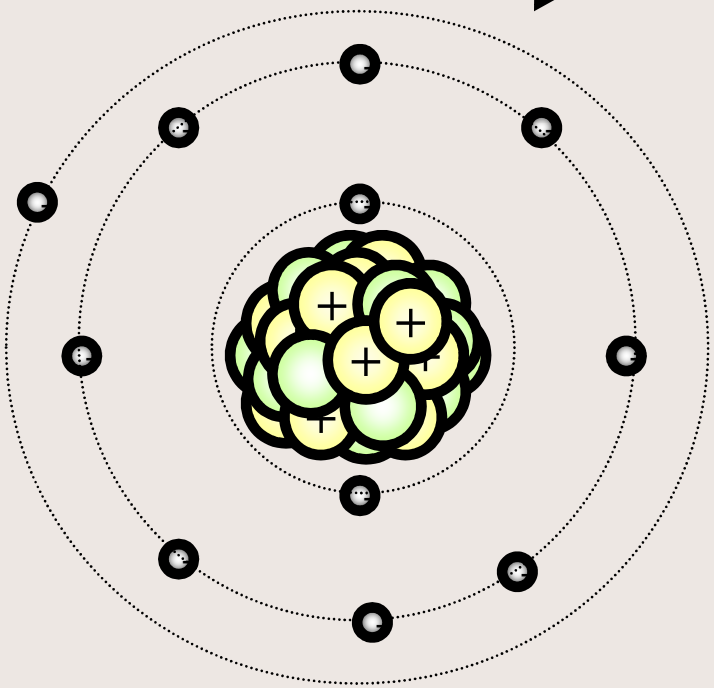


4
Be
9.012

Notice: only 2 electrons in outer level

Notice: only 1 electron in outer level

11
Na
22.990



Non-Metals

Location

- Most found to the right of the zigzag line/staircase on the periodic table

Chemical Properties

- Most have almost full outer energy levels, thus they tend to gain electrons; some have completely full outer level

Physical Properties

- not ductile or malleable, not shiny, poor conductors, most are solid, but some are gas at room temperature

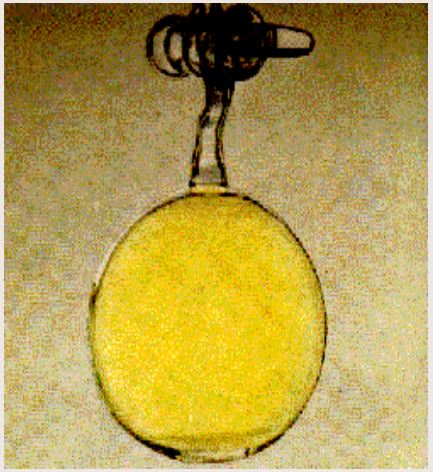


Image taken from:
http://nobel.scas.bcit.ca/resource/ptable/cl.htm

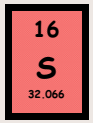
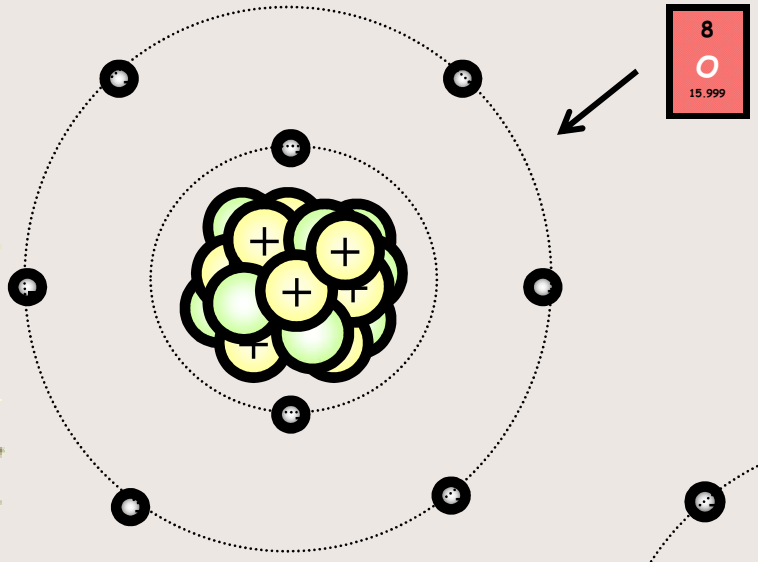


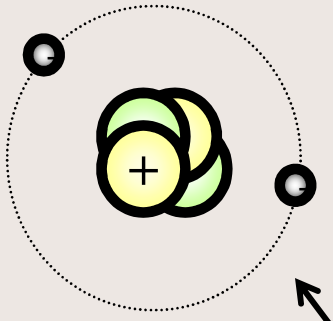
Image taken from:
https://www.dmr.nd.gov/ndgs/rockandmineral/sulfur.asp

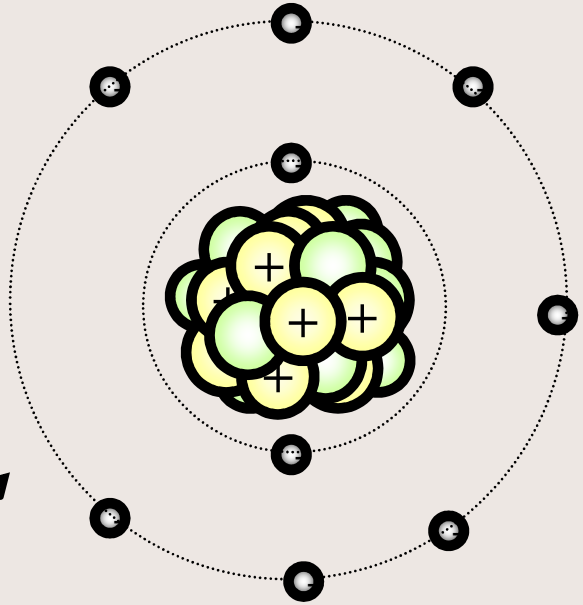
Atoms with Full or Almost Full Outer Energy Level



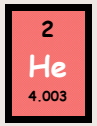
Notice: 6 electrons in outer level – almost full

Notice: 2 electrons in outer level – FULL





Notice: 7 electrons in outer level – almost full



Metalloids

Location

- Border the zigzag line/staircase on the periodic table

Chemical Properties

- Most atoms have $\frac{1}{2}$ (≈) complete set of electrons in outer level

Physical Properties

- have properties of both metals and non-metals

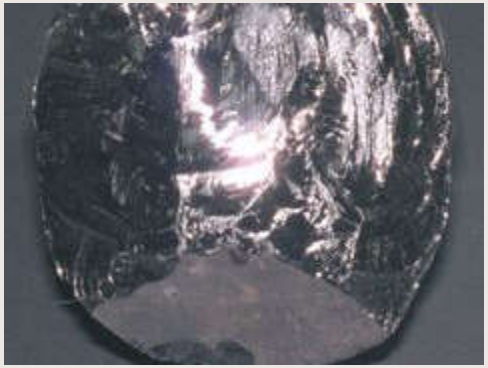


Image taken from:
http://library.thinkquest.org/C0113863/bios.shtml

← 14 Si 28.086

5 B 10.811 →

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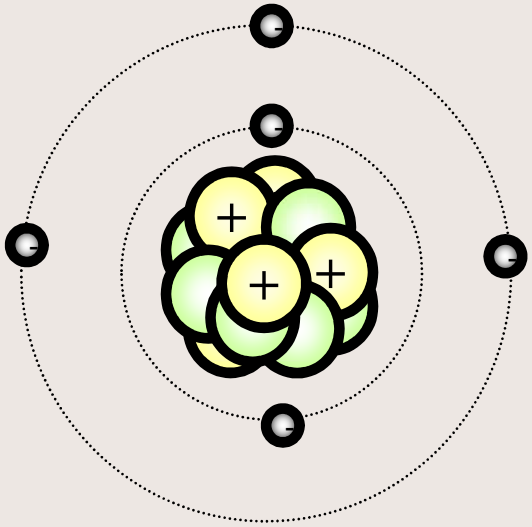
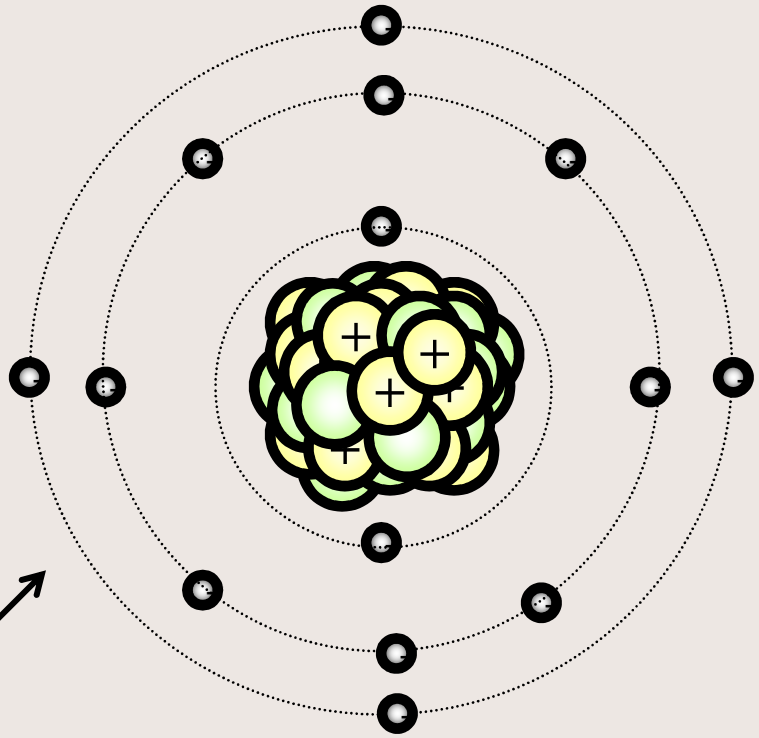
Atoms with $\frac{1}{2}$ (≈) Complete Outer Energy Level



5
B
10.811

Notice: only 3 electrons in outer level

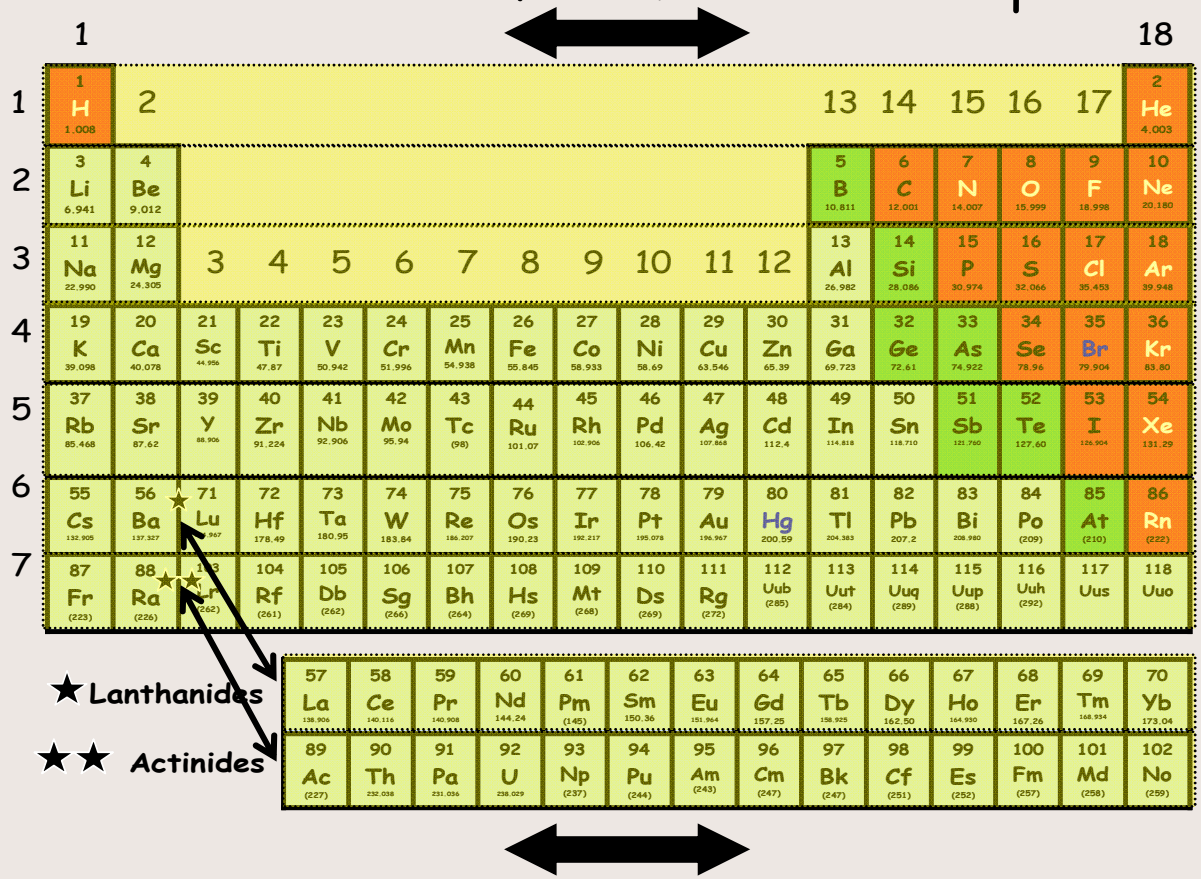
Notice: only 4 electrons in outer level



14
Si
28.086

Important Features of the Periodic Table: Period (Row)

- each horizontal row of elements on the periodic table



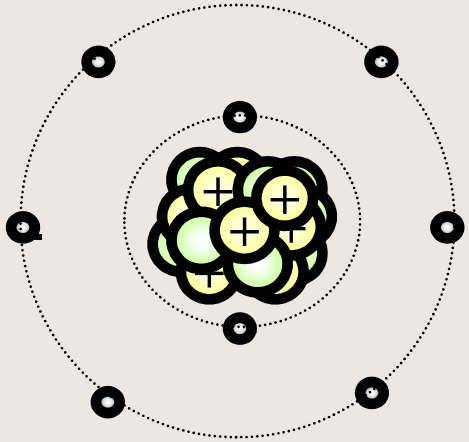
How many periods (rows) are on the Periodic Table Of Elements?

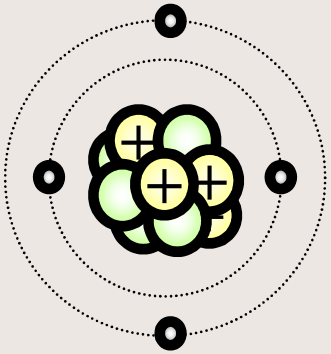
FROM LEFT TO RIGHT OR RIGHT TO LEFT

Period (Row) Properties

- Seven periods on a periodic table (numbered from the top down)
- Atomic numbers and atomic masses increase as you move from the left to the right in a period
- All atoms of the elements in the same period have the same number of electron shell
- All atoms of the elements in a specific period have that respective number of electron shells
  - Example
    - Period 1 = 1 shell
    - Period 2 = 2 shells
    - Period 3 = 3 shells
    - Etc…

Examples of Period (Row) elements having the same number of orbitals/levels in their atoms





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

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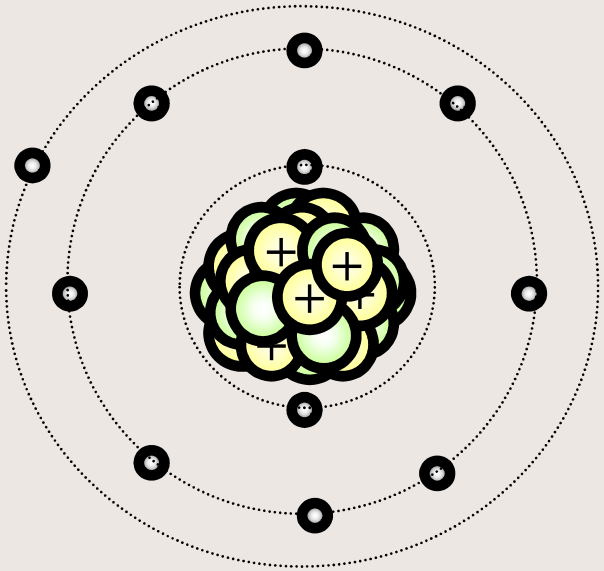

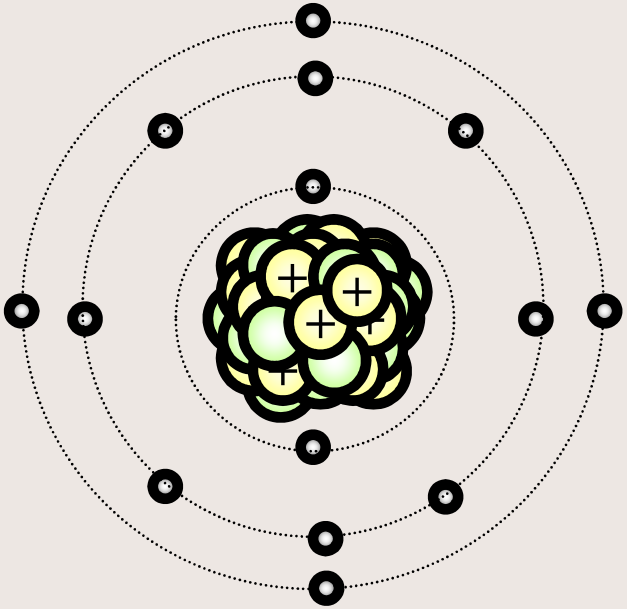

Important Features of the Periodic Table: <u>Group</u>

- each column of elements on the periodic table

How many groups are on the Periodic Table Of Elements?

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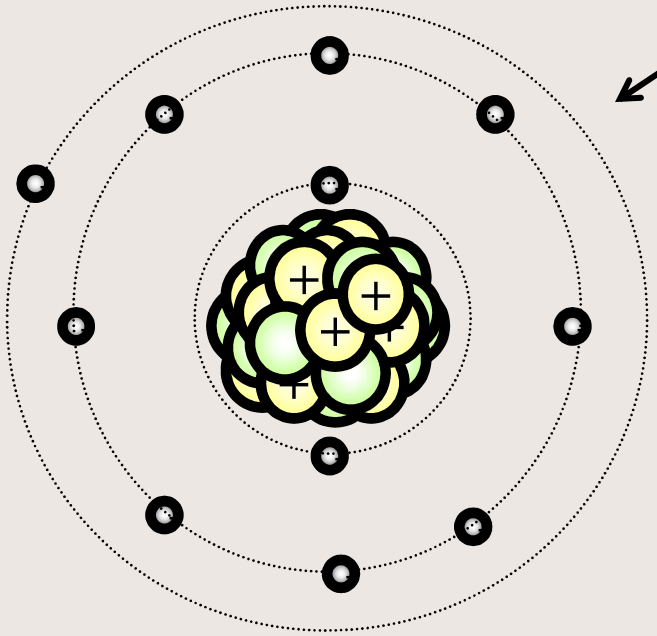
FROM TOP TO BOTTOM OR BOTTOM TO THE TOP

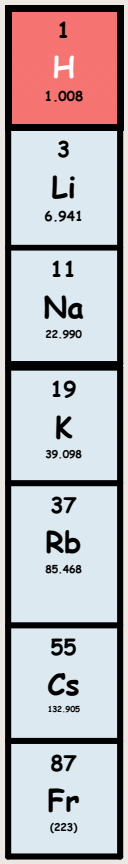
Group Properties

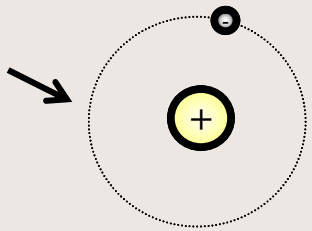
- Eighteen groups on the periodic table (numbered from left to right)
- Atomic numbers and atomic masses increase as you move from the top down in a group (family)
- Atoms of elements in the same group have the same number of electrons in the outer shell (known as valence electrons)
  - **Exceptions**:
    - Transition elements (3-12)
    - Hydrogen (could be 1 or 17)
    - Helium (actually has 2 valence electrons)
- Elements in groups usually have similar physical and chemical properties

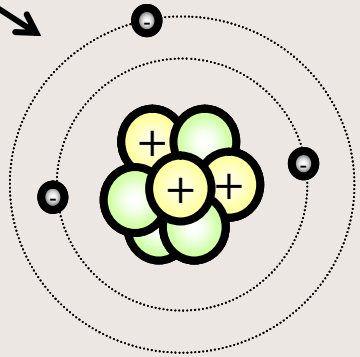
Examples of Group Elements with the same # of valence electrons

How many electrons do each of these atoms have in their outer shell?









What group do these elements reside in?

Family Names

Alkali Metals → 1

Alkaline Earth Metals → 2

Transition Metals → 3 4 5 6 7 8 9 10 11 12

Boron Group → 13

Carbon Group → 14

Nitrogen Group → 15

Oxygen Group → 16

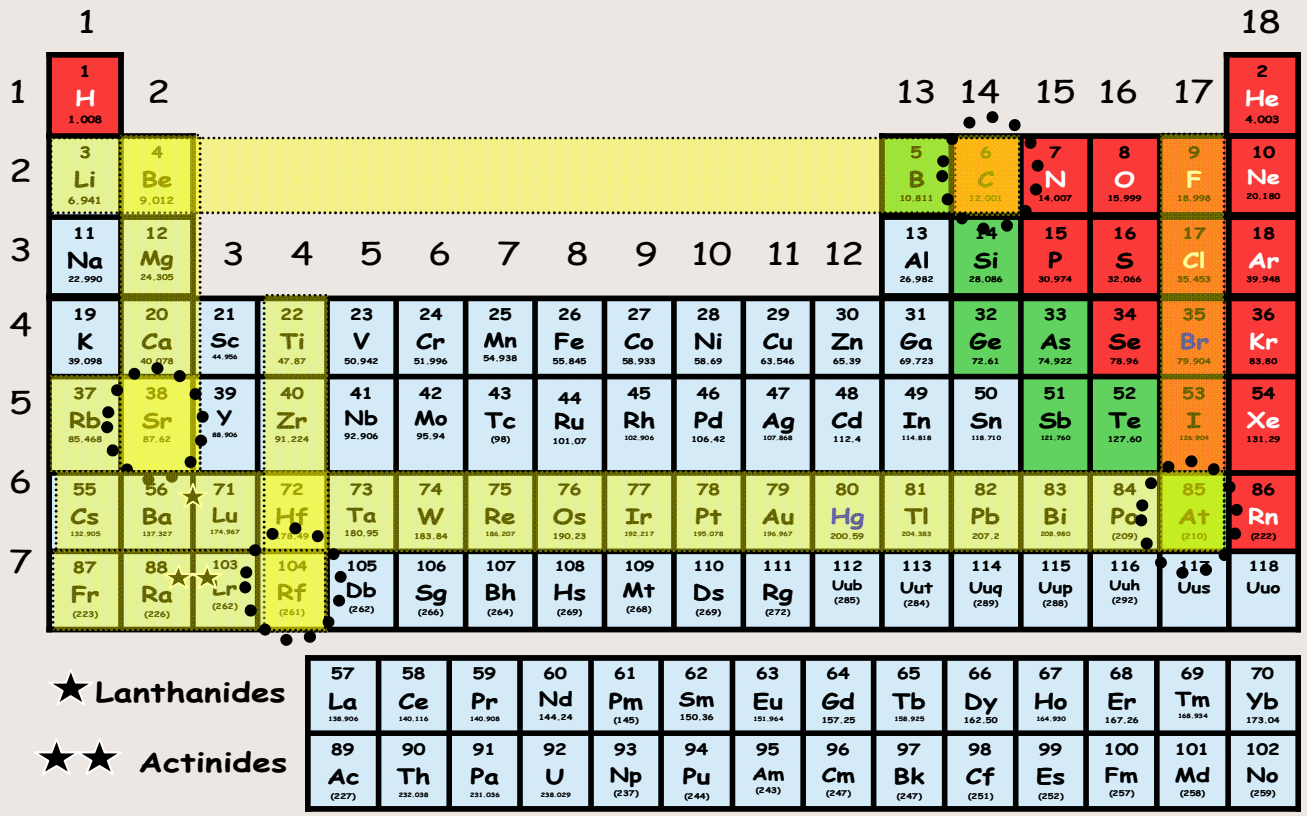
Halogens → 17

Noble Gases → 18

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

Identify the Element



Period 7 — Group 14 →

Rutherfordium - Rf

Block elements

- Periodic table can also be partition into four blocks on the basis of the type of sublevel accommodating the very last electron when feeding the available electrons into the sublevels. Groups 1 and 11 are s-block, 111 to 0 are p-block,the transition elements are d-block while the Lanthanides and Actinides are f-block elements

PERIODICITY OF PROPERTIES

The following properties vary among the elements in a particular period and group:

- Atomic radius
- Electropositivity
- Ionization energy
- Electron affinity
- electronegativity

ASSIGNMENT

- List the criteria for arranging element on the periodic table
- Given element Y with the electronic structure 1s22s22p63s2. to what group and period does Y belong on the periodic table
- State 2 properties each which increase (1) across the period (11) down the group