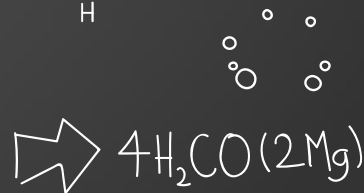
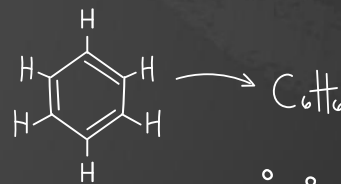
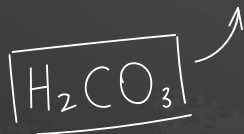
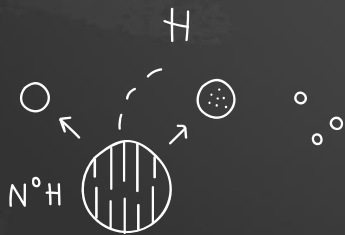
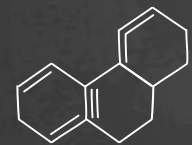




# Chemistry - 101

Let's continue the journey -  
December 19



# Atoms' electron configurations and the periodic law of elements

Periodic Table of Elements

Chemical properties of elements change periodically according to the charge of their nuclei

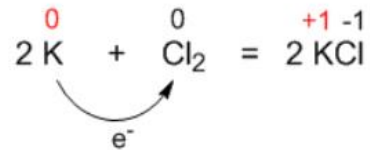
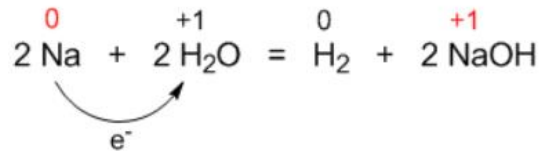
Element	Charge of the nuclei	Outer shell
H	1	...1s <sup>1</sup>
Li	3	...2s <sup>1</sup>
Na	11	...3s <sup>1</sup>
K	19	...4s <sup>1</sup>
Rb	37	...5s <sup>1</sup>
Cs	55	...6s <sup>1</sup>
Fr	87	...7s <sup>1</sup>

These elements have similar chemical properties:

Valence 1

Electron donors → reducers

Na (1s<sup>1</sup>2s<sup>2</sup>2p<sup>6</sup>3s<sup>1</sup>)-1 electron = Na<sup>+</sup> (1s<sup>1</sup>2s<sup>2</sup>2p<sup>6</sup> Ne electron configuration)



Oxidation state - I

Valence shell	$s^1$	$s^2$	$s^2p^1$	$s^2p^2$	$s^2p^3$	$s^2p^4$	$s^2p^5$	$s^2p^6$
Groups	I	II	III	IV	V	VI	VII	VIII
Electrons Element Atomic number	$1s^1$ H 1	$1s^2$ He 2	There are no "p" orbitals in the first shell					He should be here?
Electrons Element Atomic number	$2s^1$ Li 3	$2s^2$ Be 4	$2s^2p^1$ B 5	$2s^2p^2$ C 6	$2s^2p^3$ N 7	$2s^2p^4$ O 8	$2s^2p^5$ F 9	$2s^2p^6$ Ne 10
Electrons Element Atomic number	$3s^1$ Na 11	$3s^2$ Mg 12	$3s^2p^1$ Al 13	$3s^2p^2$ Si 14	$3s^2p^3$ P 15	$3s^2p^4$ S 16	$3s^2p^5$ Cl 17	$3s^2p^6$ Ar 18
Electrons Element Atomic number	$4s^1$ K 19	$4s^2$ Ca 20	And so on... But we need to put electrons on the inner 3d orbital first...					

The outer shells of elements have repeated configurations and the elements have repeated properties

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	

In any column (group), all the atoms have the same outer electron configuration.

In any line the properties of elements are changing as electrons fill the outer shell.

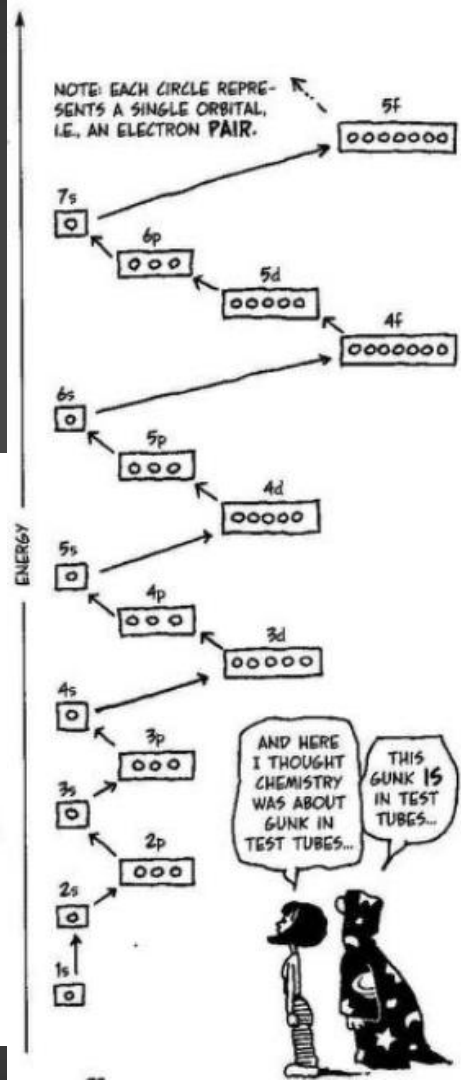
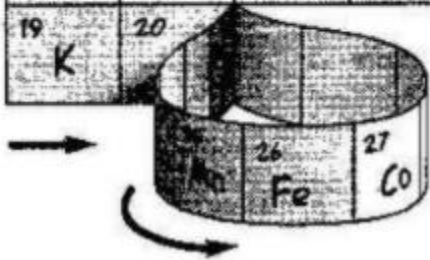
Each period starts with the active (alkali) metal and ends with an inert gas.

The group number corresponds to the number of valent electrons that can participate in the formation of chemical bonds.

Now we fill the 4<sup>th</sup> orbital, next, according to the energy levels electrons begin to occupy the 3d orbitals before we can continue in the fourth shell, ten electrons must go into there inner orbitals. We will write these ten elements on a loop.

1s, 2s, 2p, 3s, 3p, 4s, 3d, 4p, 5s, 4d, 5p, 6s, 4f, 5d, 6p, 7s, 5f, 6d, ...

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	





After those ten, we can resume putting electrons in the fourth shell, until all the 4s and 4p orbitals are full at element 36, krypton, Kr

1s, 2s, 2p, 3s, 3p, 4s, 3d, 4p, 5s, 4d, 5p, 6s, 4f, 5d, 6p, 7s, 5f, 6d, ...

1								2									
H								He									
3	4	5	6	7	8	9	10										
Li	Be	B	C	N	O	F	Ne										
11	12	13	14	15	16	17	18										
Na	Mg	Al	Si	P	S	Cl	Ar										
19	20		32	33	34	35	36										
K	Ca	Sc	Ti	V	Cr	Mn	Fe	Co	Ni	Cu	Zn	Ga	Ge	As	Se	Br	Kr

The fifth row fills up in exactly the same way as the fourth: first the outers, then inner d, then the outer p.

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

The elements that are "flat on the slide" are called main-group elements.  
Those in the loops are called transition metals.

The sixth row has a loop within a loop, as 4f orbitals will be before 5d. As there are 7 4f orbitals, this loop has 14 elements. It is called **lanthanide series**, after its first element, lanthanum.

1s, 2s, 2p, 3s, 3p, 4s, 3d, 4p, 5s, 4d, 5p, 6s, 4f, 5d, 6p, 7s, 5f, 6d, ...

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		21		22		23	As	34	Se	35	Br	36	Kr	
37	Rb	38		39		40		41	Sb	52	Te	53	I	54	Xe	
55									83	Bi	84	Po	85	At	86	Rn

Diagram illustrating the periodic table with the lanthanide and actinide series inserted into the gaps between the main table columns. The lanthanide series (elements 57-70) and actinide series (elements 89-102) are shown as separate loops, indicating their insertion points.

Lanthanide series elements: 57 Tb, 58 Dy, 59 Ho, 60 Er, 61 Tm, 62 Yb, 63 Lu, 64 Ce, 65 Pr, 66 Nd, 67 Pm, 68 Sm, 69 Eu, 70 Gd.

Actinide series elements: 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.

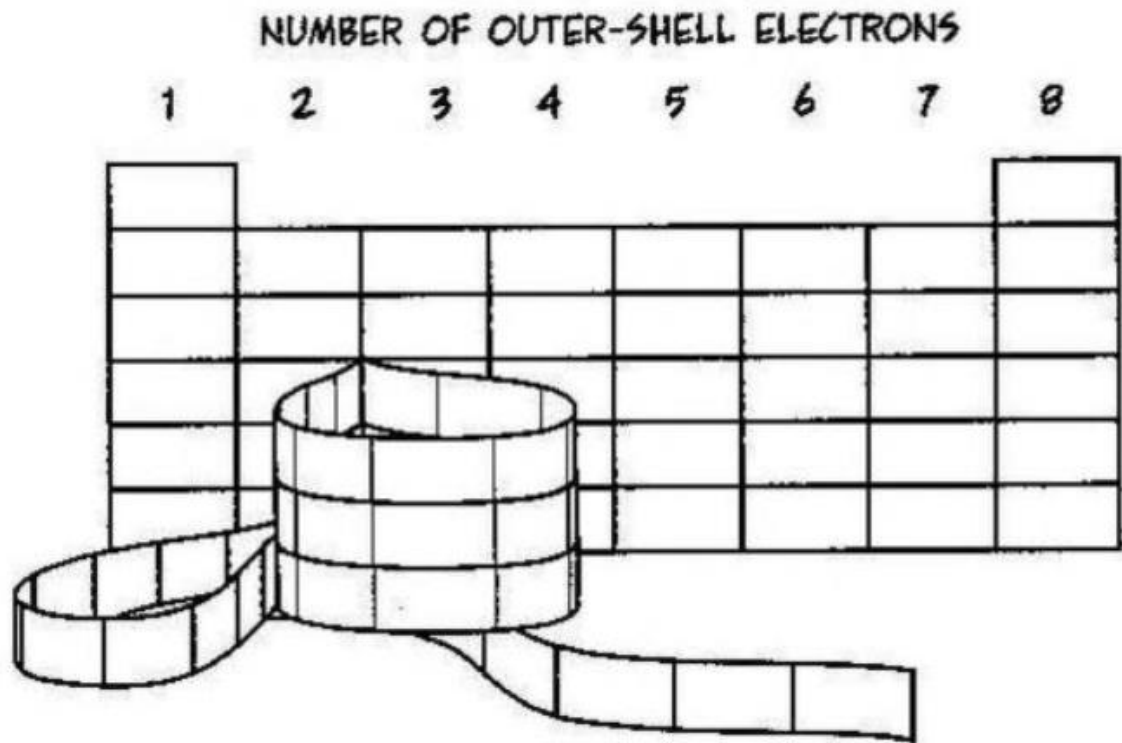
1 H							2 He
3 Li	4 Be	5 B	6 C	7 N	8 O	9 F	10 Ne
11 Na	12 Mg	13 Al	14 Si	15 P	16 S	17 Cl	18 Ar
19 K	20 Ca	21 Sc	22 Ti	23 V	24 Cr	25 Mn	26 Fe
27 Co	28 Ni	29 Cu	30 Zn	31 Ga	32 Ge	33 As	34 Se
35 Br	36 Kr	37 Rb	38 Sr	39 Y	40 Zr	41 Nb	42 Mo
43 Tc	44 Ru	45 Rh	46 Pd	47 Ag	48 Cd	49 In	50 Sn
51 Sb	52 Te	53 I	54 Xe	55 Ba	56 La	57 Ce	58 Pr
59 Nd	60 Pm	61 Sm	62 Eu	63 Gd	64 Tb	65 Dy	66 Ho
67 Er	68 Tm	69 Yb	70 Lu	71 Hf	72 Ta	73 W	74 Re
75 Os	76 Ir	77 Pt	78 Au	79 Hg	80 Tl	81 Pb	82 Bi
83 Po	84 At	85 Rn	86 Fr	87 Ra	88 Ac	89 Th	90 Pa
91 U	92 Np	93 Pu	94 Am	95 Cm	96 Bk	97 Cf	98 Es
99 Fm	100 Md	101 No	102 Lr	103 Rf	104 Db	105 Sg	106 Bh
107 Hs	108 Mt	109 Ds	110 Rg	111 Cn	112 Nh	113 Fl	114 Mc
115 Lv	116 Ts	117 Og	118 Uu	119 Uub	120 Uut	121 Uuq	122 Uuq

AND THAT IS THE END OF OUR TABLE!



# The Outermost Electrons

MOVING LEFT TO RIGHT ALONG A ROW OF MAIN-GROUP ELEMENTS, THE NUMBER OF OUTER ELECTRONS GOES UP STEADILY. GROUP 1 ELEMENTS ALL HAVE ONE OUTER ELECTRON, GROUP 2 ELEMENTS HAVE TWO, ETC., UNTIL THE LAST GROUP, WHICH ALL HAVE EIGHT. TRANSITION METALS HAVE EITHER ONE OR TWO OUTER ELECTRONS.\*

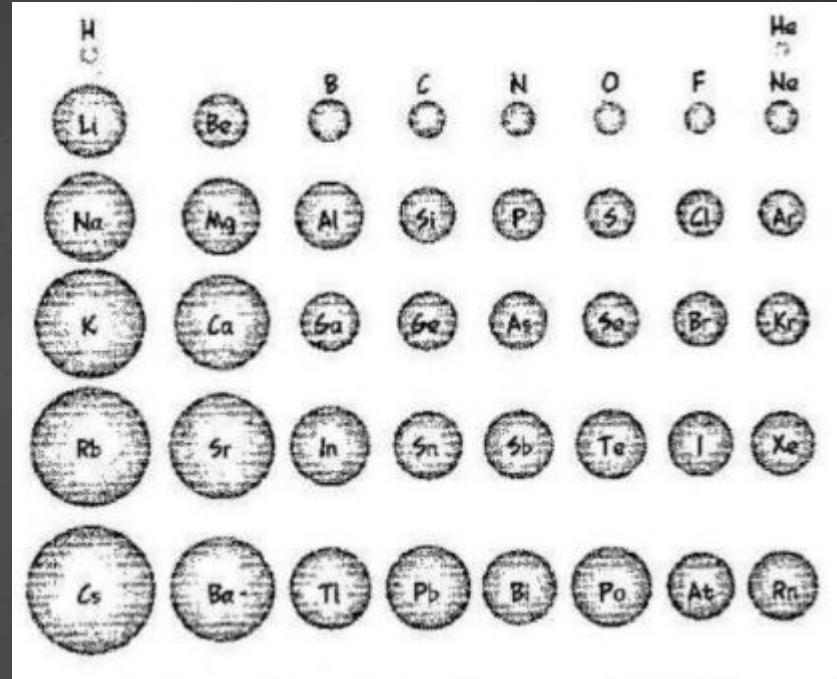


Group→	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	
↓Period																			
1	1 H																	2 He	
2	3 Li	4 Be											5 B	6 C	7 N	8 O	9 F	10 Ne	
3	11 Na	12 Mg											13 Al	14 Si	15 P	16 S	17 Cl	18 Ar	
4	19 K	20 Ca	21 Sc	22 Ti	23 V	24 Cr	25 Mn	26 Fe	27 Co	28 Ni	29 Cu	30 Zn	31 Ga	32 Ge	33 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	

Going along a row from left to right, atoms get smaller, and moving down a column, they get bigger.

Moving to the right, the bigger charge of the nucleus pulls electrons closer in.

Going down a column, the outer electrons are in higher shells, hence farther away from the nucleus.



# Periodic table of the elements

Oxidizing and non-metallic properties

Reducing and metallic properties

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
3	4											5	6	7	8	9	10
Li	Be											B	C	N	O	F	Ne
11	12											13	14	15	16	17	18
Na	Mg											Al	Si	P	S	Cl	Ar
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	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86
Cs	Ba	La	Hf	Ta	W	Re	Os	Ir	Pt	Au	Hg	Tl	Pb	Bi	Po	At	Rn
87	88	89	104	105	106	107	108	109	110	111	112	113	114	115	116	117	118
Fr	Ra	Ac	Rf	Db	Sg	Bh	Hs	Mt	Ds	Rg	Cn	Nh	Fl	Mc	Lv	Ts	Og

Reducing and metallic properties

Electronegativity

lanthanoid s	59	60	61	62	63	64	65	66	67	68	69	70	71		
	Pr	Nd	Pm	Sm	Eu	Gd	Tb	Dy	Ho	Er	Tm	Yb	Lu		
actinoid s	89	90	91	92	93	94	95	96	97	98	99	100	101	102	103
	Th	Pa	U	Np	Pu	Am	Cm	Bk	Cf	Es	Fm	Md	No	Lr	

\*Numbering system adopted by the International Union of Pure and Applied Chemistry (IUPAC). © Encyclopædia Britannica, Inc.



# Metallic and non-metallic properties

## Properties of metals

- High density
- High melting and boiling points
- Good electrical conductivity
  - Shiny
  - Malleable (easy to shape)
- Ductile (easy to stretch into wires)
  - Reactive with nonmetals

## Properties of nonmetals

- Often liquid or gaseous at room temperature
  - Brittle when Solid
  - Dull-looking
- Poor electrical conductivity
- Reactive with metals (except for the last group)

This class uses the materials from the following books:

Larry Gonick and Graig Criddle “The cartoon guide to chemistry”

Manyuilov and Rodionov “Chemistry for children and adults”

Kuzmenko, Eremin, Popkov “Beginnings of chemistry”