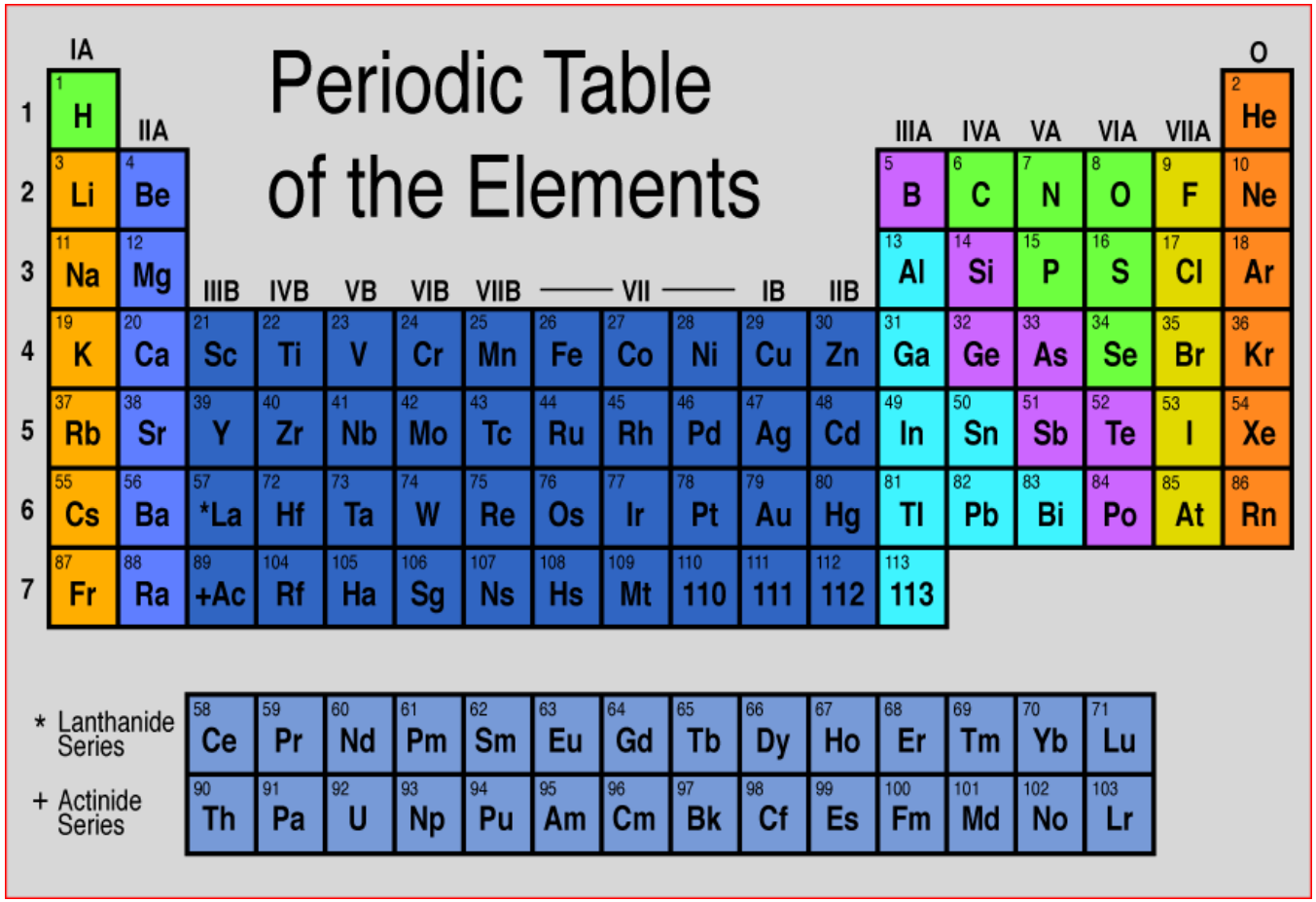
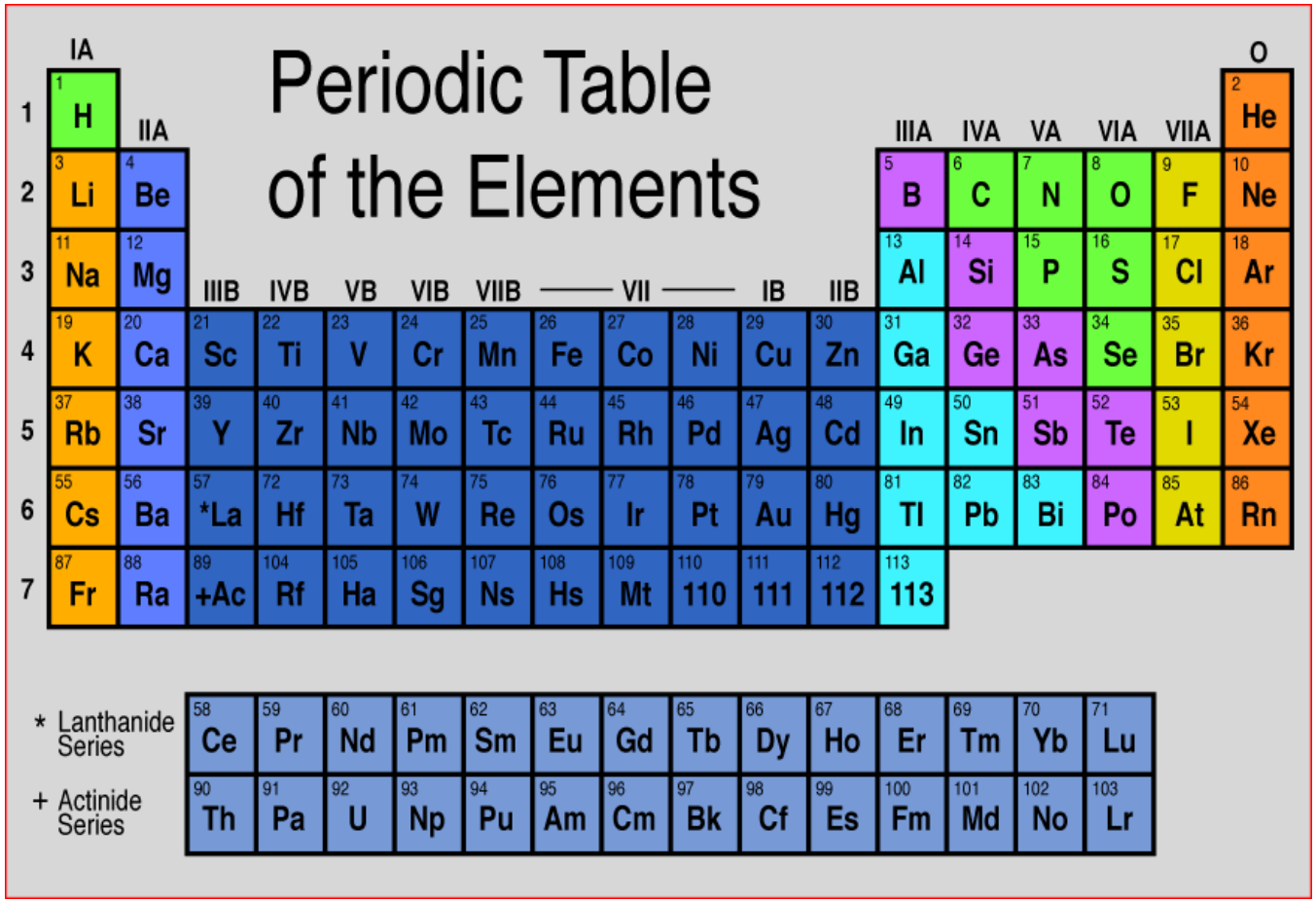
CHAPTER 6 NOTES: The Periodic Table



NOTES: 6.1-6.2

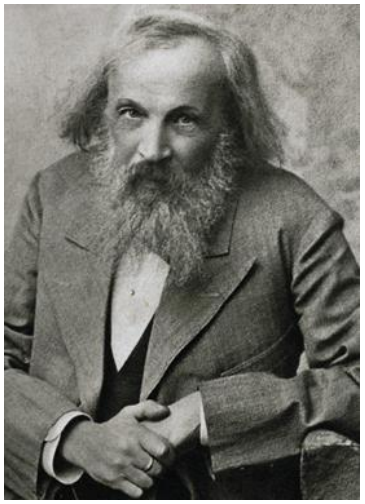
The Periodic Table – Organizing the Elements



PERIODIC TABLE:

- **Dmitri Mendeleev – mid 1800's**

  -proposed a table for 70 elements based on increasing mass and similar properties



- **Henry Moseley – 1913**

  -determined the atomic number of elements and arranged the table in order of increasing atomic number

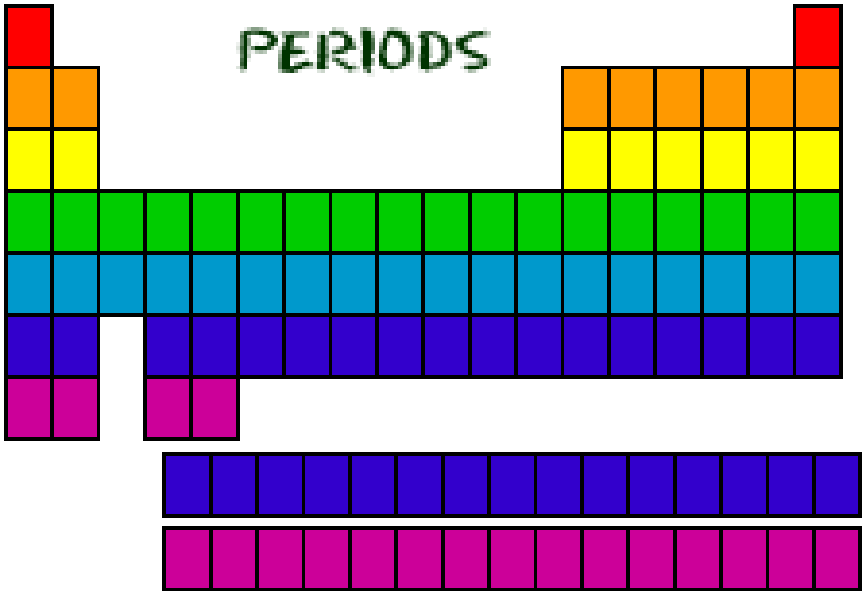
Periodic Table

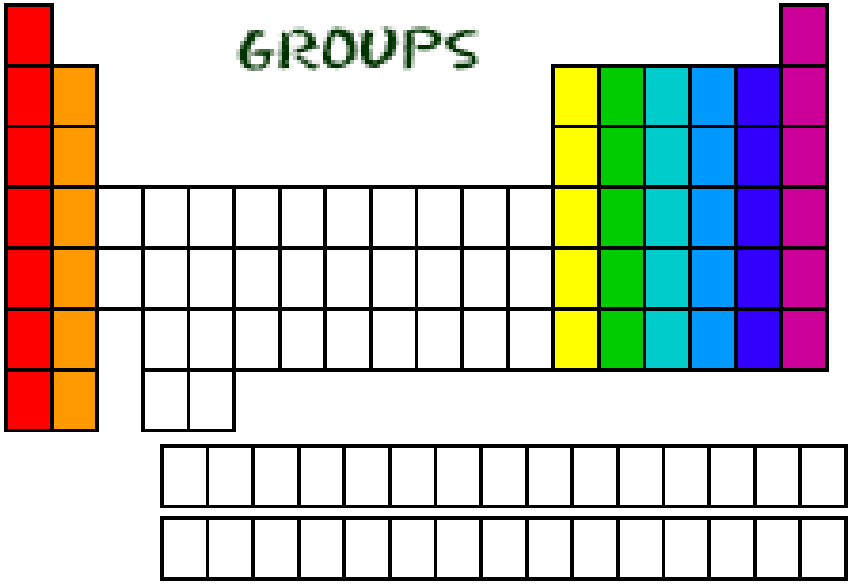
- **Periodicity:** (a.k.a. "**PERIODIC LAW**")

  -regular variations (or patterns) of properties with increasing atomic weight; both chemical and physical properties vary in a "periodic" way (repeating pattern).

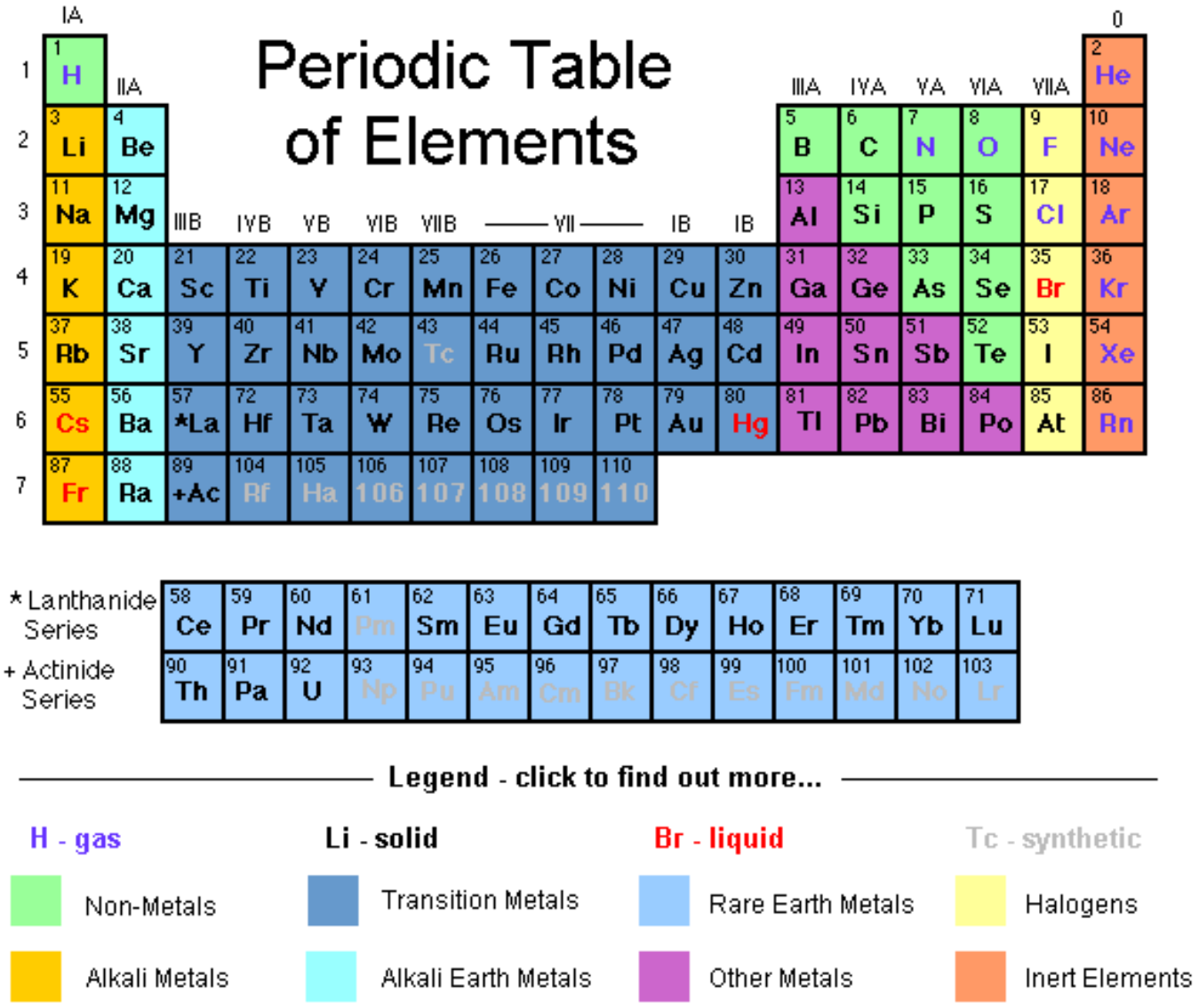
- **Group:** vertical column of elements ("family")

- **Period:** horizontal row of elements


PERIODS


GROUPS

Periodic Groups and Trends



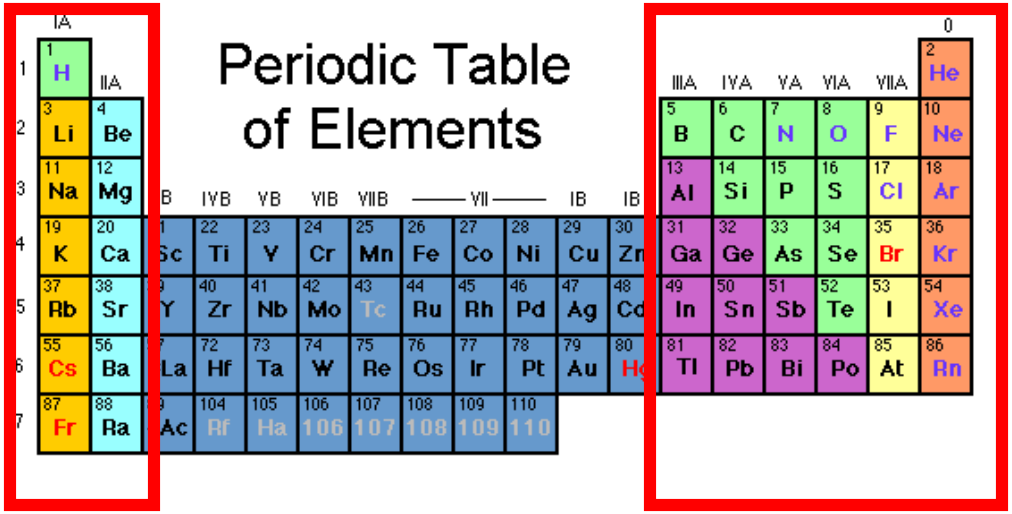
Groupings to know on the Periodic Table

- **<u>Representative Elements</u>**: "Group A" elements; columns 1A-8A; they include:

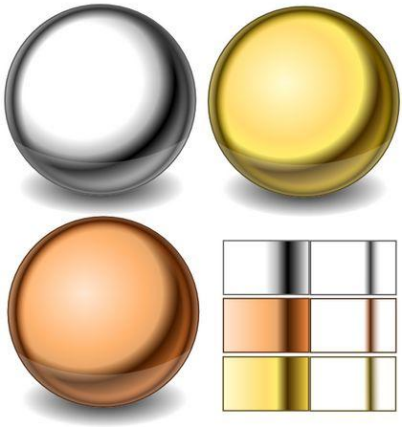
  -<u>metals</u>

  -<u>nonmetals</u>

  -<u>metalloids</u>

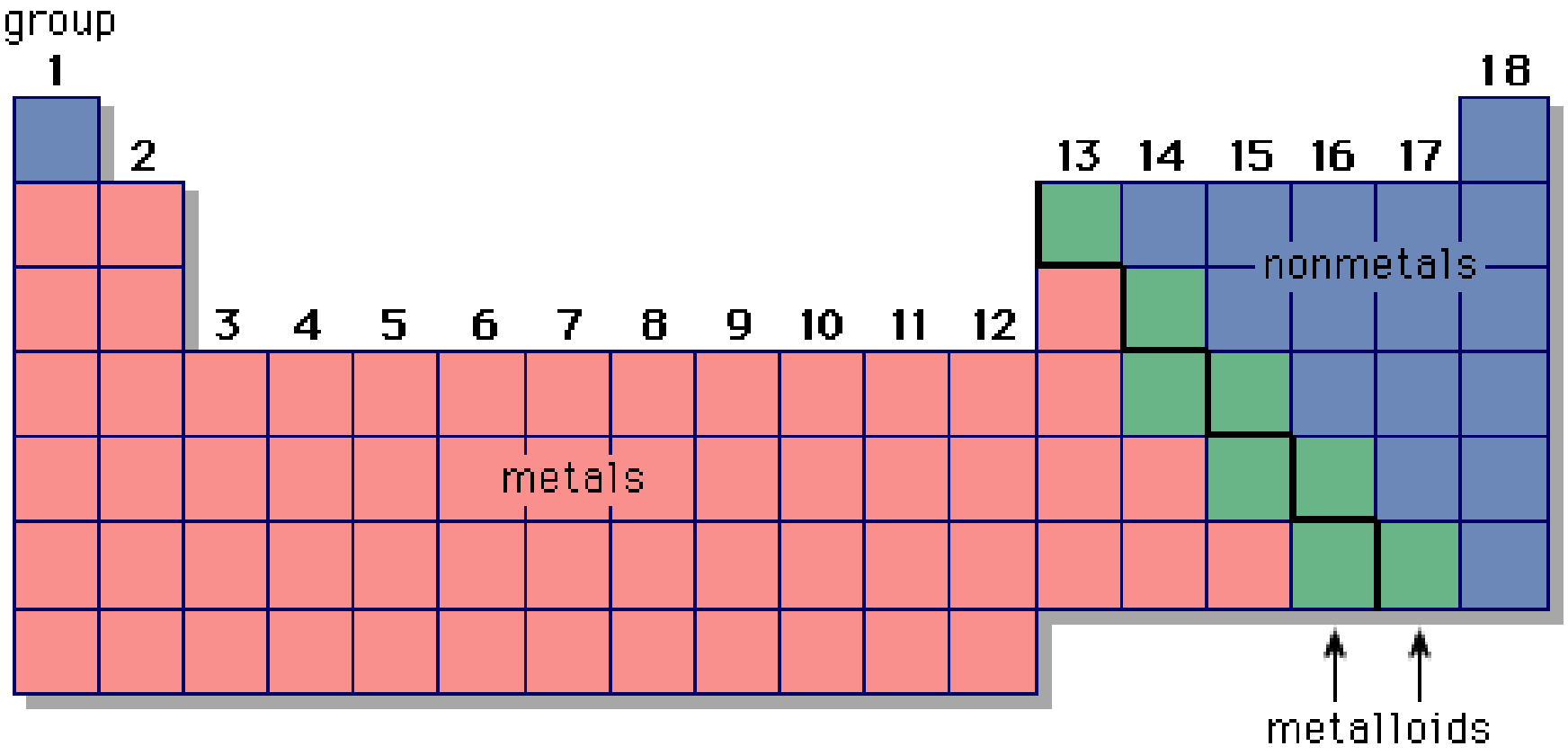


METALS:



Characteristics:

- high electrical conductivity
- high luster
- ductile & malleable
- on the left side of the periodic table (except hydrogen)


group
1
2
3
4
5
6
7
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11
12
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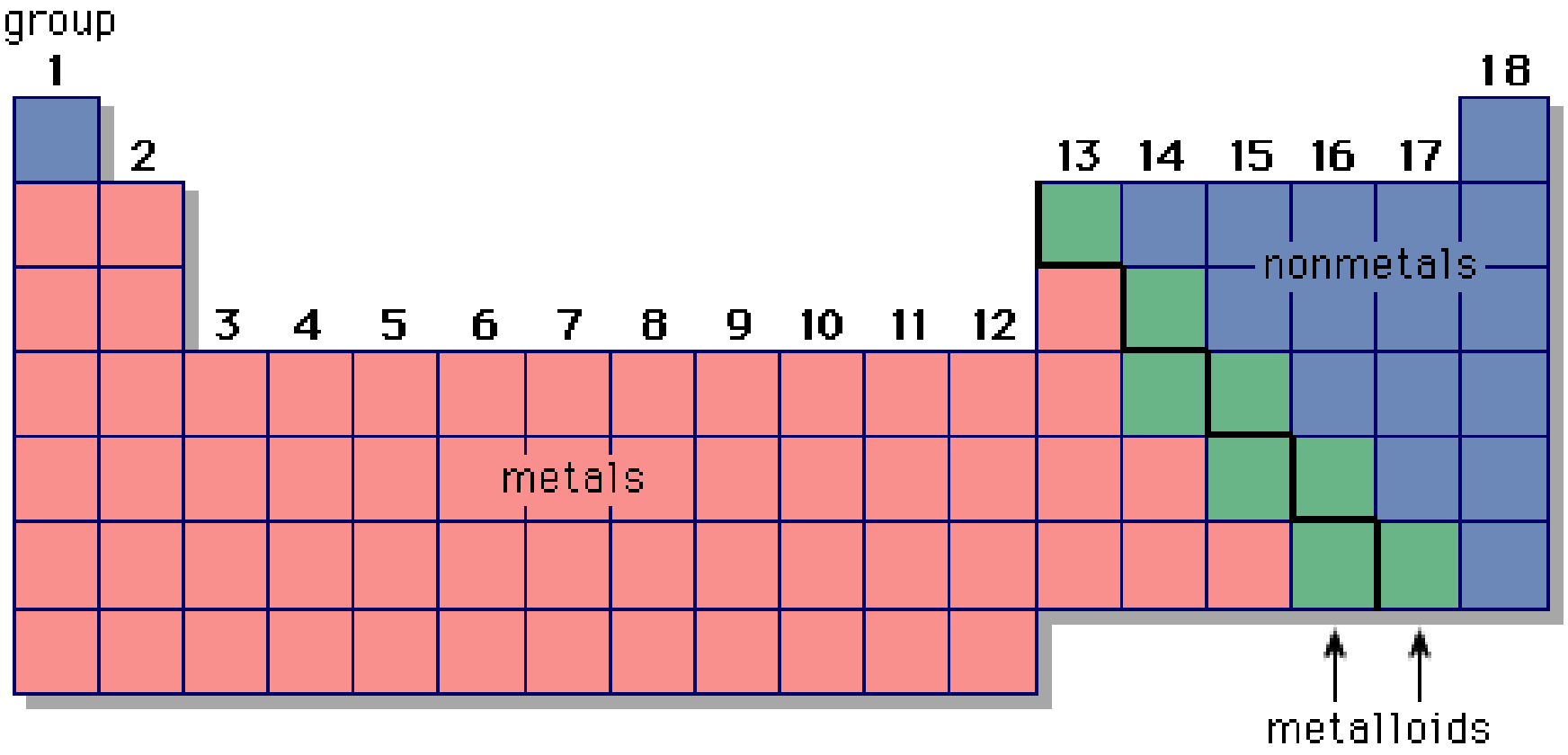
14
15
16
17
18
metals
nonmetals
metalloids

NONMETALS:

Characteristics:

- in the upper-right corner of the periodic table
- nonlustrous
- poor conductors of electricity
- some (O, Cl) are gases at room temp.
- others (S) are brittle solids


group
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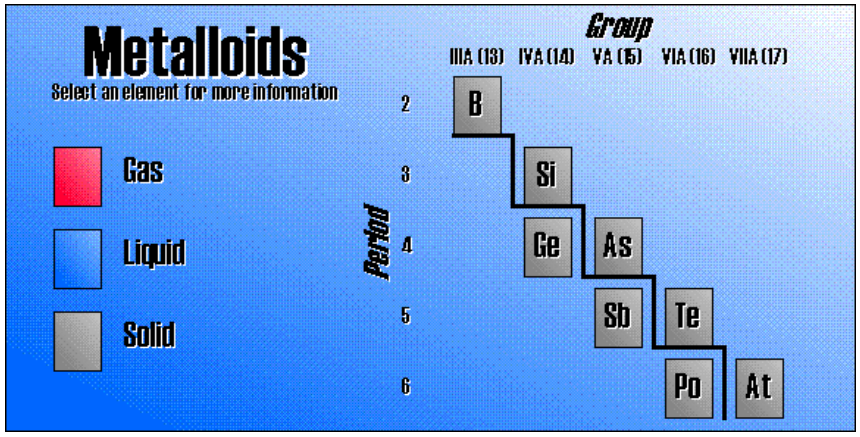
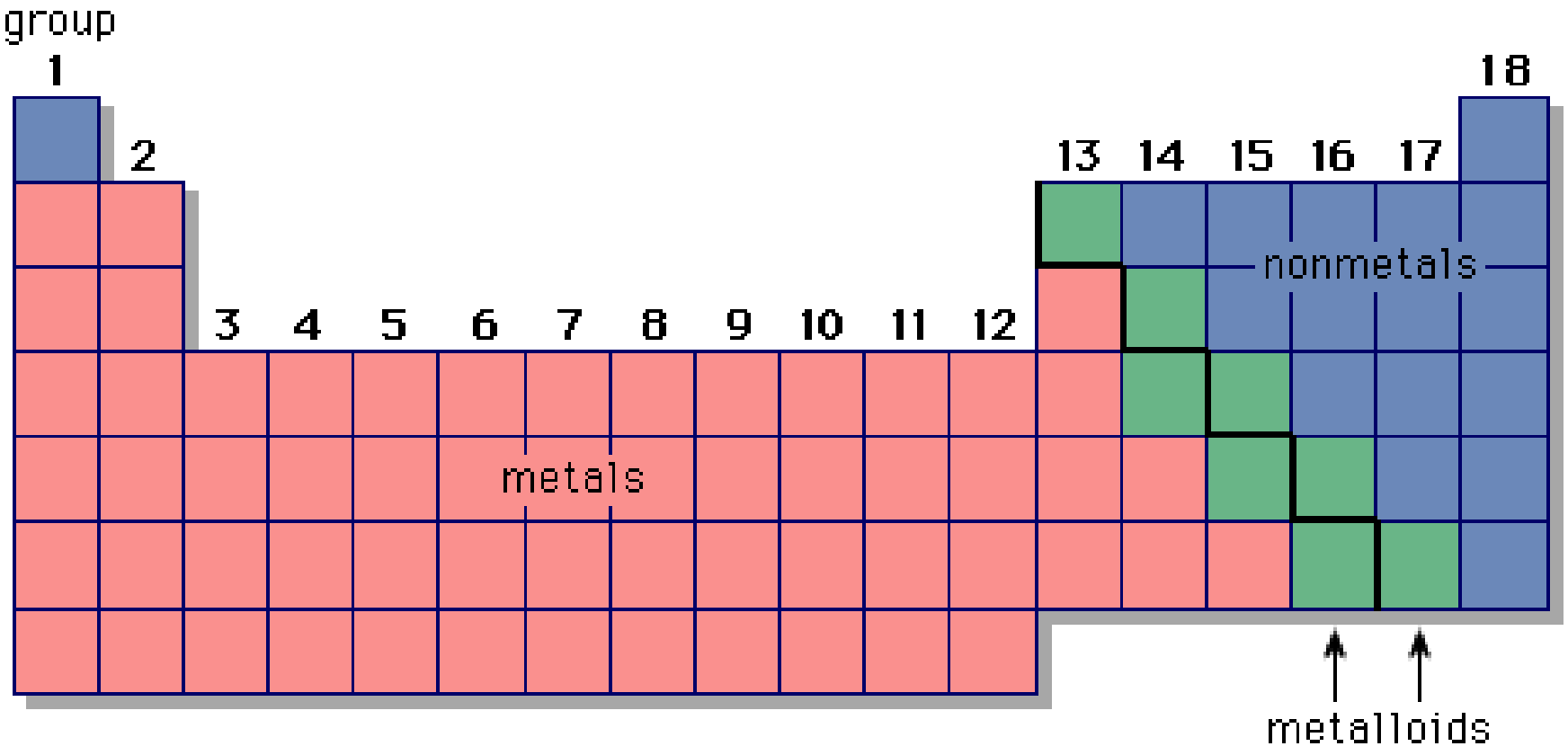
15
16
17
18
metals
nonmetals
metalloids

METALLOIDS:

Characteristics:

- on the stair-step line that divides the metals from the nonmetals
- exhibit properties that are intermediate between those of metals and nonmetals
- important metalloids: **silicon, germanium**




group
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metals
nonmetals
metalloids

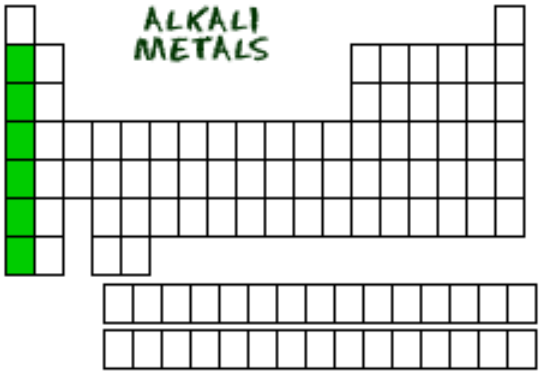
PERIODIC GROUPS

- alkali metals
- alkaline earth metals
- transition metals
- lanthanides
- actinides
- halogens
- noble gases

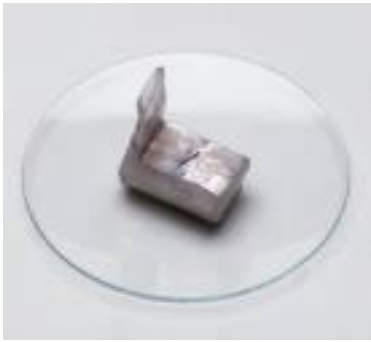
} “inner” transition metals

THE METALS!!

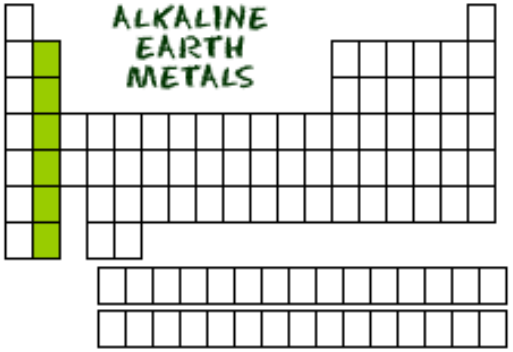
Alkali Metals



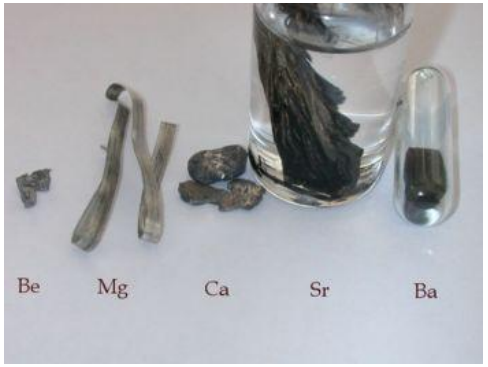
- Group 1 on periodic table
- Very reactive
- Soft solids
- Readily combine with halogens
- Tendency to lose one electron
- examples: sodium, potassium, cesium



Alkaline Earth Metals

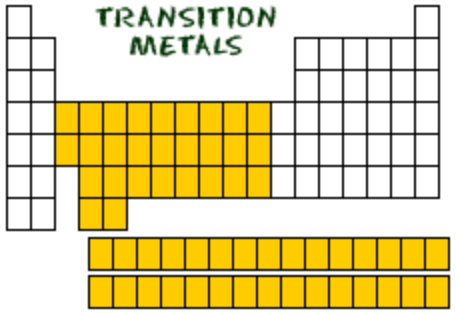


- Group 2 on periodic table
- Abundant metals in the earth
- Not as reactive as alkali metals
- examples: magnesium, strontium

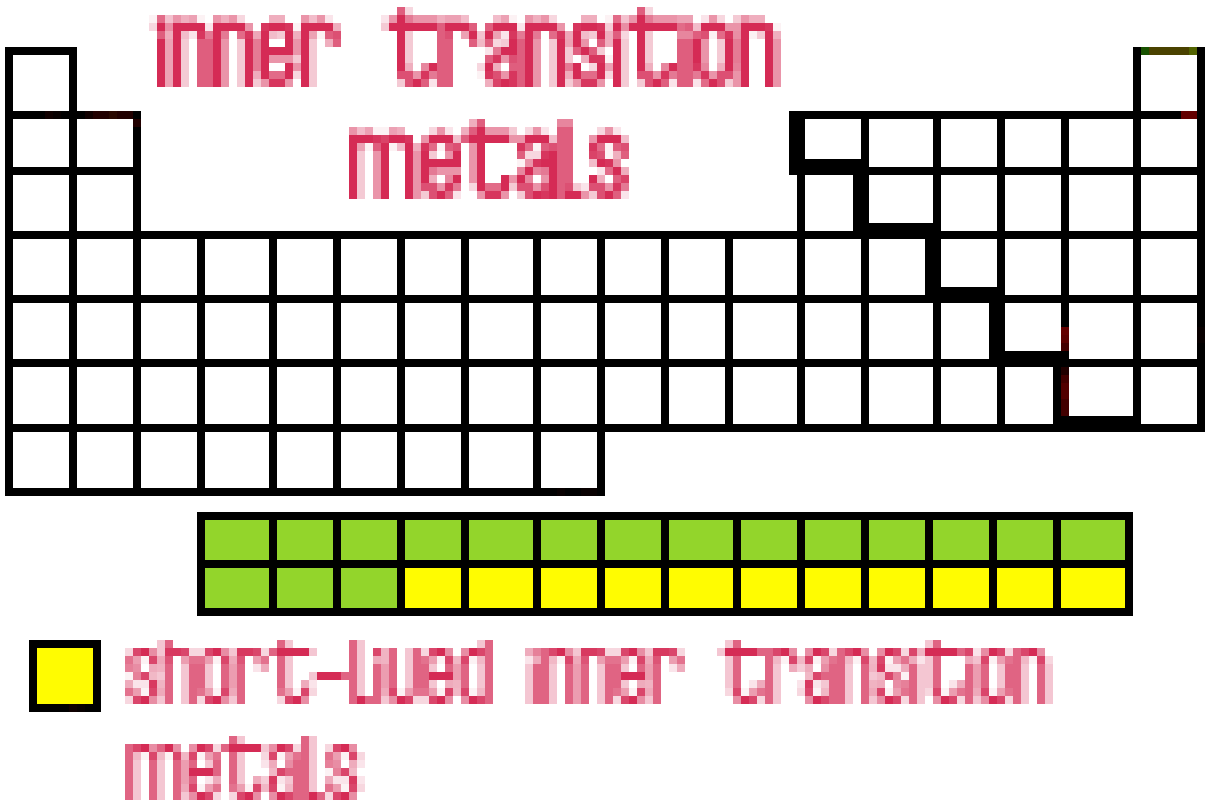


Transition Metals

- Groups 3 - 12 on periodic table
- Important for living organisms (i.e. as minerals)
- examples: iron, zinc, manganese

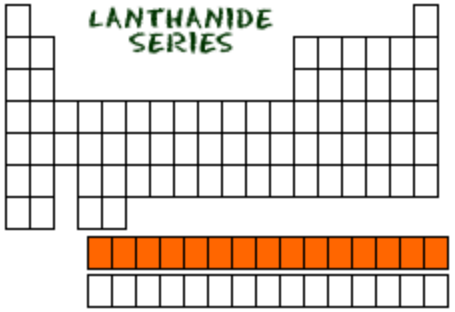


Inner Transition Metals!!



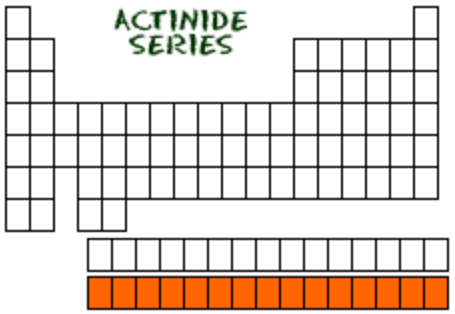
Lanthanides

- Part of the “inner transition metals”
- Soft silvery metals
- elements # 57 - 70
- examples: cerium, europium, ytterbium

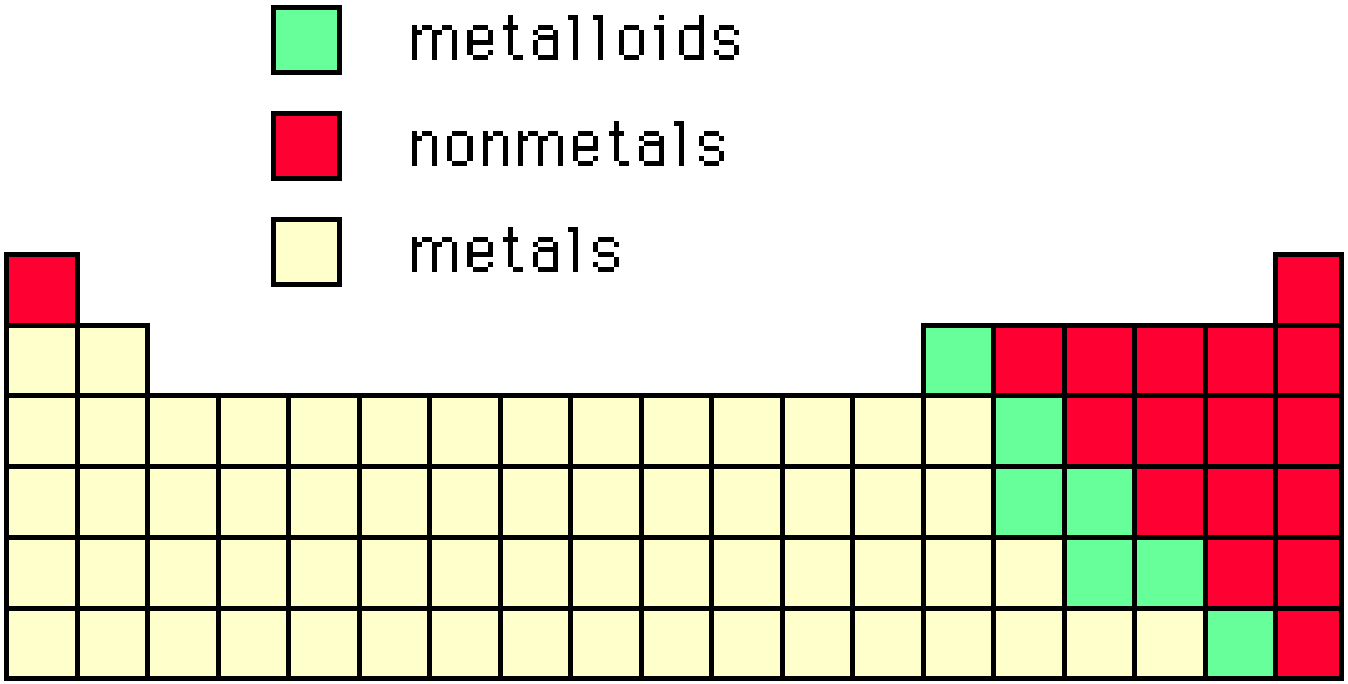


Actinides

- Radioactive elements
- Part of the “inner transition metals”
- elements # 89 – 102
- examples: uranium, plutonium, berkelium

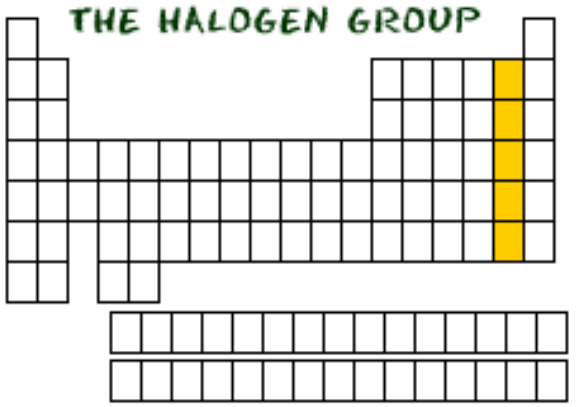


THE NONMETALS!!



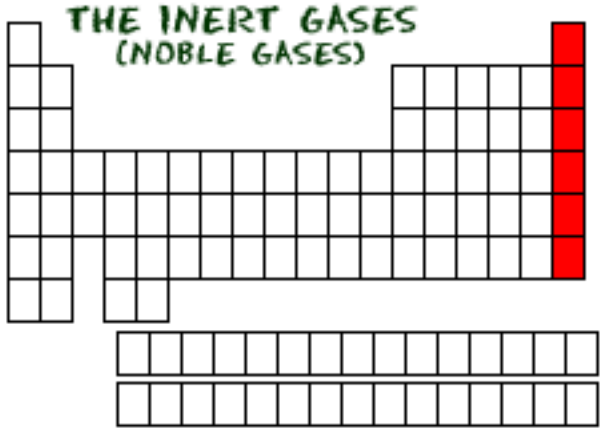
Halogens

- Group 17 on periodic table
- “Salt former” – combines with groups 1 and 2 to form salts (ionic bonds)
- examples: fluorine, bromine, iodine



Noble Gases

- Group 18 on periodic table
- Relatively **inert**, or nonreactive
- Gases at room temperature
- examples: helium, argon, radon



Activity: *use a black and white copy of the periodic table.*

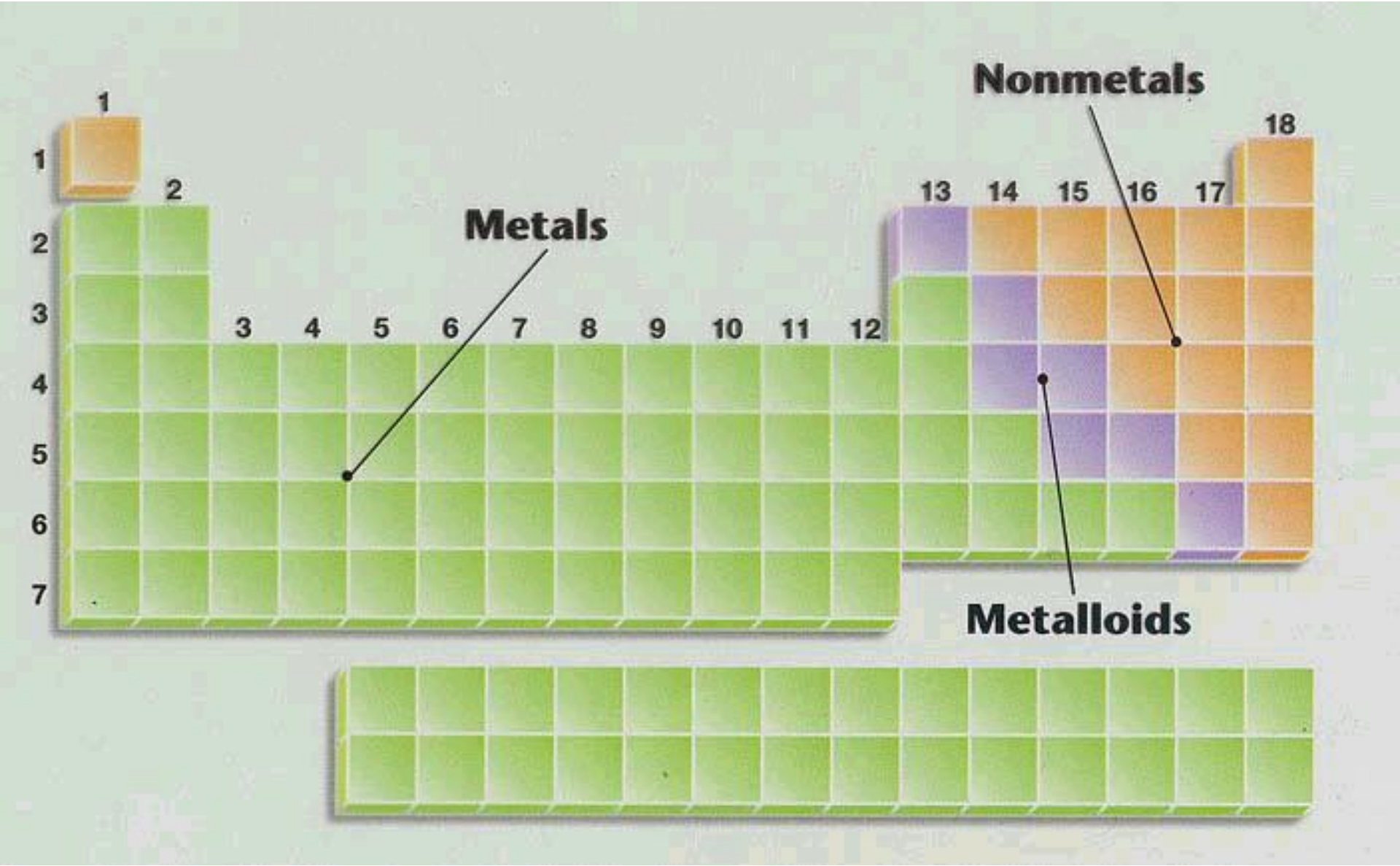
THE PERIODIC TABLE

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
1	1 H 1.0079																	2 He 4.0026
2	3 Li 6.941	4 Be 9.0122											5 B 10.811	6 C 12.011	7 N 14.007	8 O 15.999	9 F 18.998	10 Ne 20.18
3	11 Na 22.99	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 47.88	23 V 50.942	24 Cr 51.996	25 Mn 54.938	26 Fe 55.847	27 Co 58.933	28 Ni 58.693	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 83.8
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 (97.91)	44 Ru 101.07	45 Rh 102.91	46 Pd 106.42	47 Ag 107.87	48 Cd 112.41	49 In 114.82	50 Sn 118.71	51 Sb 121.76	52 Te 127.6	53 I 126.9	54 Xe 131.29
6	55 Cs 132.91	56 Ba 137.33	57 La 138.91	72 Hf 178.49	73 Ta 180.95	74 W 183.84	75 Re 186.21	76 Os 190.23	77 Ir 192.22	78 Pt 195.08	79 Au 196.97	80 Hg 200.59	81 Tl 204.38	82 Pb 207.2	83 Bi 208.98	84 Po (209)	85 At (210)	86 Rn (222)
7	87 Fr (223)	88 Ra (226)	89 Ac (227)	104 Rf (261.1)	105 Ha (262.1)	106 Sg (263.1)	107 Ns (262.1)	108 Hs (265.1)	109 Mt (266.1)	110 Unn (268)	111 Unu (269)							

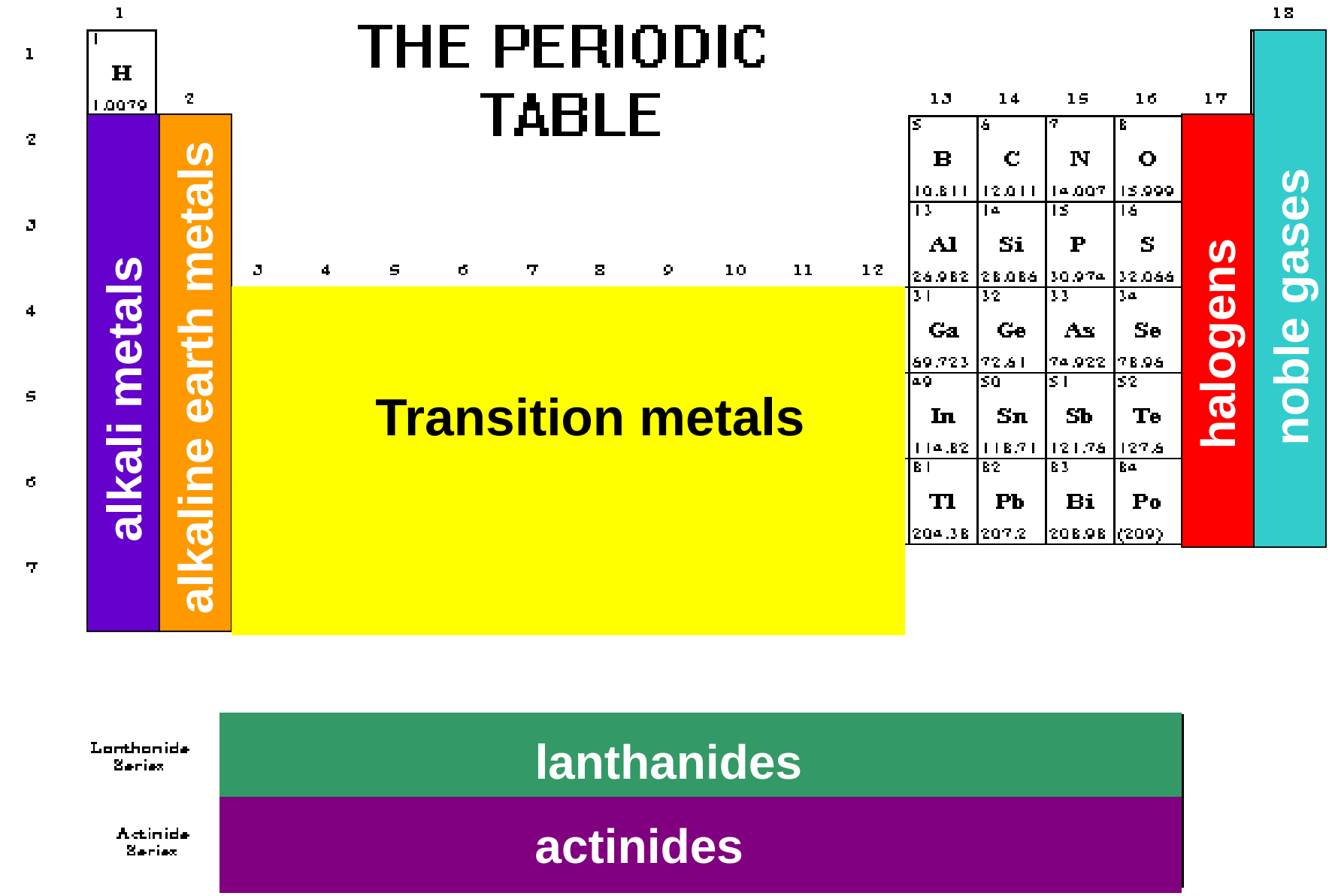
Lanthanide Series	58 Ce 140.12	59 Pr 140.91	60 Nd 144.24	61 Pm (144.9)	62 Sm 150.36	63 Eu 151.97	64 Gd 157.25	65 Tb 158.93	66 Dy 162.5	67 Ho 164.93	68 Er 167.26	69 Tm 168.93	70 Yb 173.04	71 Lu 174.97
Actinide Series	90 Th 232.04	91 Pa 231.04	92 U 238.03	93 Np (237)	94 Pu (244.1)	95 Am (243.1)	96 Cm (247.1)	97 Bk (247.1)	98 Cf (251.1)	99 Es (252.1)	100 Fm (257.1)	101 Md (258.1)	102 No (259.1)	103 Lr (262.1)

On one side, color and label the metals, nonmetals, and metalloids.

Another name for "metalloid" is "semi-metal".



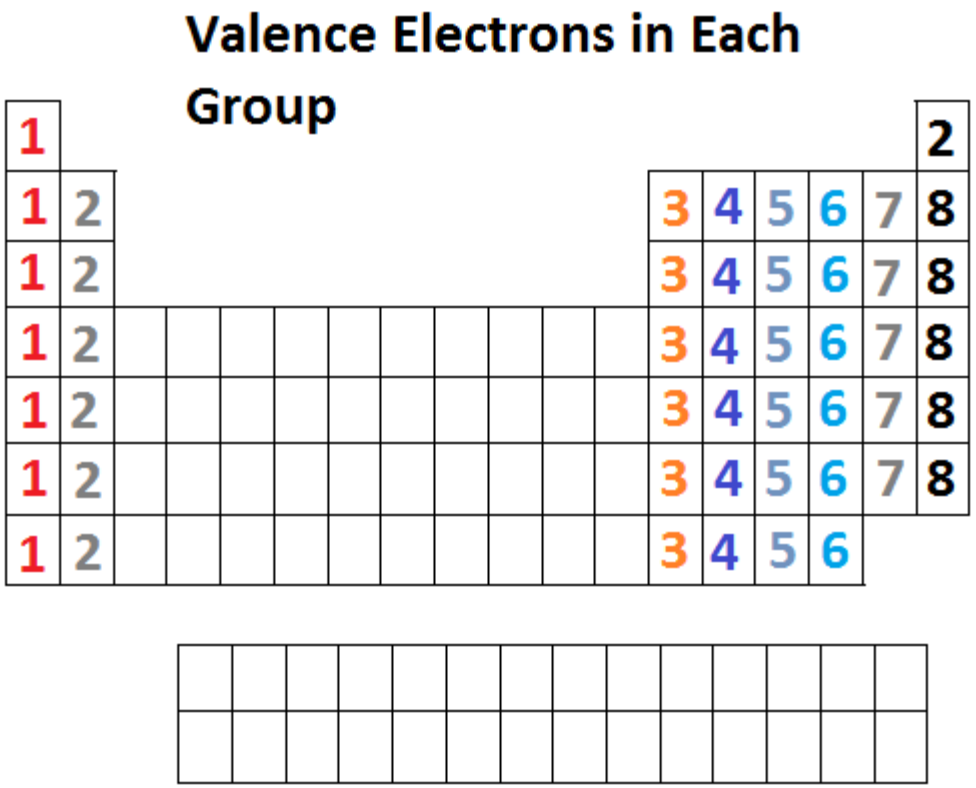
Color and label the groups/families of elements on the other side of your paper. Remember to create a legend.



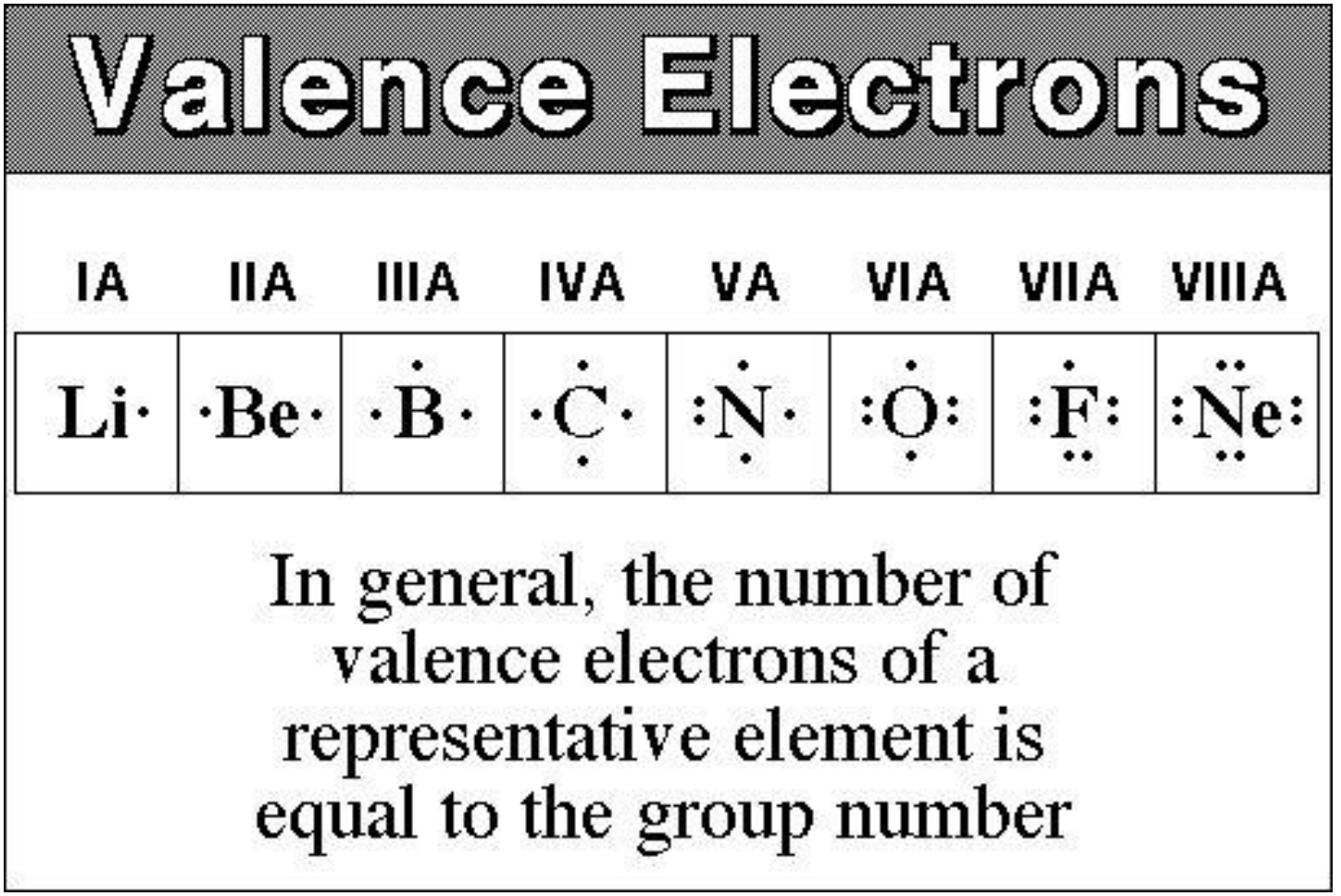
Chemical Properties & Families

- Chemical properties of elements are based on their "**VALENCE ELECTRONS**"
- Families are groups of elements that have similar VALENCE ELECTRONS
- **VALENCE ELECTRONS** = outermost electrons in an atom

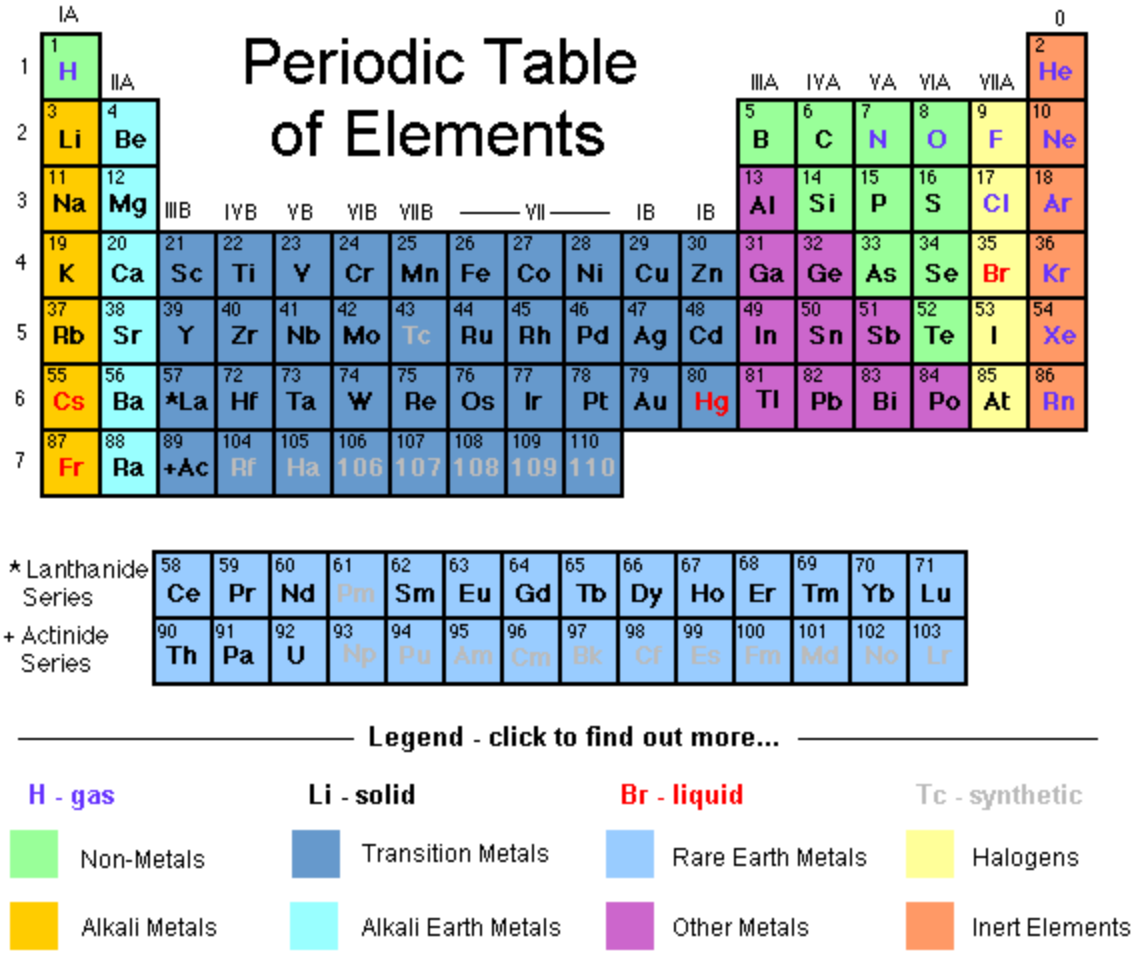
VALENCE ELECTRONS:



VALENCE ELECTRONS:



NOTES: 6.3 – Periodic Trends



PERIODIC TABLE:

RECALL…

- **Periodicity:** regular variations (or patterns) of properties with increasing atomic weight; both chemical and physical properties vary in a periodic (repeating pattern).

- **Group:** vertical column of elements (“family”)

- **Period:** horizontal row of elements

PERIODIC PROPERTIES:

- Atomic radius
- Ionization energy
- Ionic size / radius
- Electronegativity

ATOMIC RADIUS:

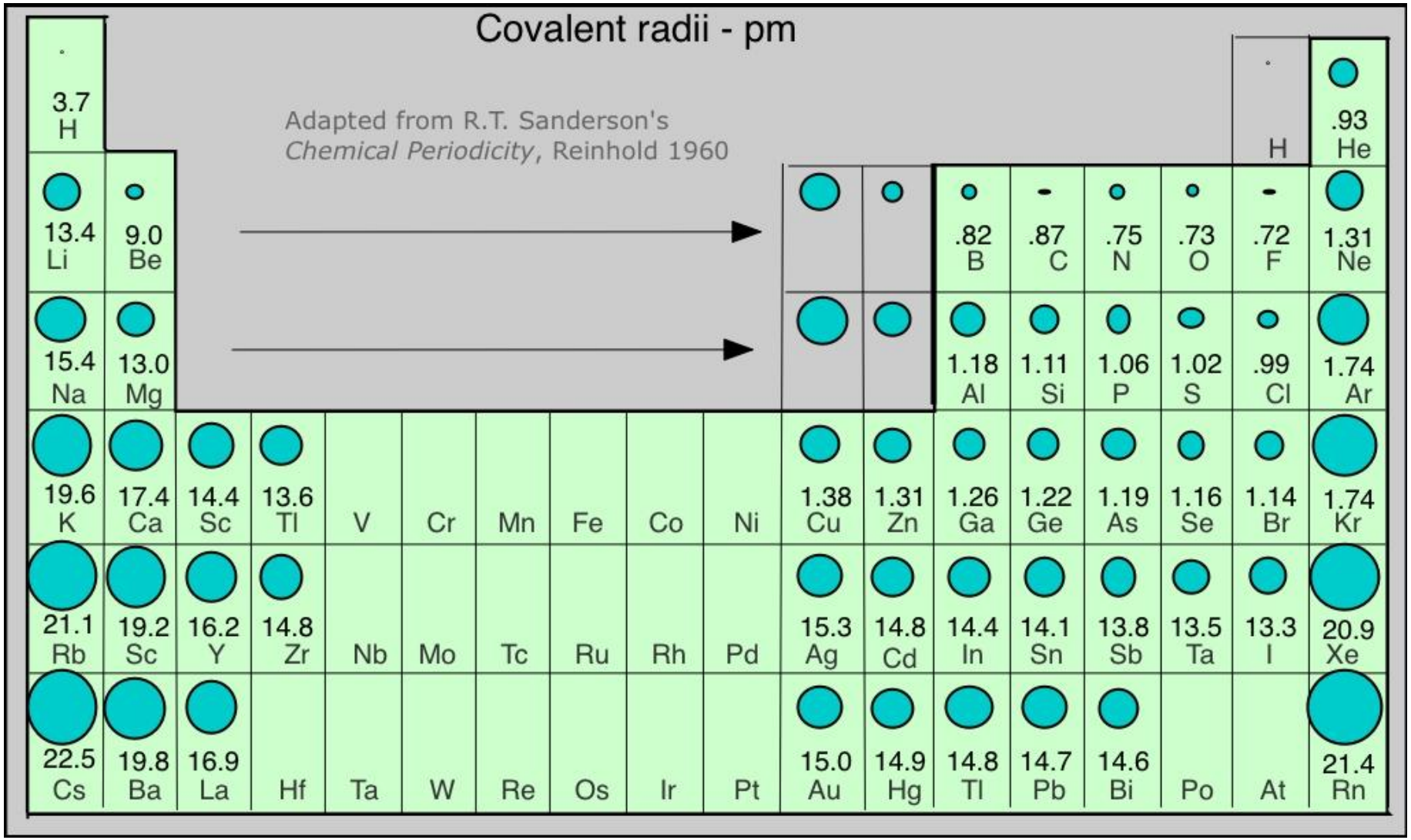
- **GROUP TREND**: increases as you move down a group
- ***WHY???***

  -electrons are added to higher energy levels (farther away from the nucleus).

ATOMIC RADIUS:

- **PERIODIC TREND**: decreases as you move L to R across a period
- ***WHY???***

  -As the # of protons in the nucleus increases, the positive charge increases and as a result, the "pull" on the electrons increases.

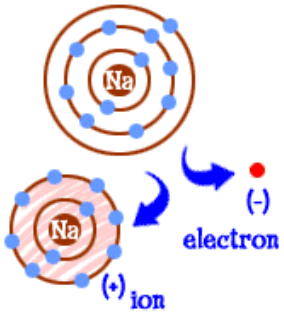

Covalent radii - pm
Adapted from R.T. Sanderson's
Chemical Periodicity, Reinhold 1960
3.7 H
H
.93 He
13.4 Li
9.0 Be
.82 B
.87 C
.75 N
.73 O
.72 F
1.31 Ne
15.4 Na
13.0 Mg
1.18 Al
1.11 Si
1.06 P
1.02 S
.99 Cl
1.74 Ar
19.6 K
17.4 Ca
14.4 Sc
13.6 Tl
V
Cr
Mn
Fe
Co
Ni
1.38 Cu
1.31 Zn
1.26 Ga
1.22 Ge
1.19 As
1.16 Se
1.14 Br
1.74 Kr
21.1 Rb
19.2 Sc
16.2 Y
14.8 Zr
Nb
Mo
Tc
Ru
Rh
Pd
15.3 Ag
14.8 Cd
14.4 In
14.1 Sn
13.8 Sb
13.5 Ta
13.3 I
20.9 Xe
22.5 Cs
19.8 Ba
16.9 La
Hf
Ta
W
Re
Os
Ir
Pt
15.0 Au
14.9 Hg
14.8 Tl
14.7 Pb
14.6 Bi
Po
At
21.4 Rn

IONS:

- **ION**: an atom or group or atoms that has a positive or negative charge
- recall…an **atom** is electrically neutral because it has equal # of protons (+) & # of electrons (-)
- positive & negative ions form when electrons are transferred between atoms!

IONS:

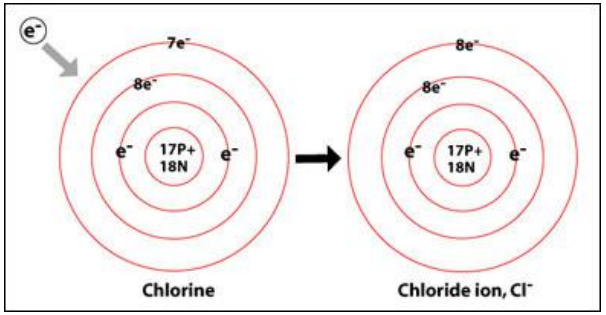
- atoms of **METALS** tend to form positive ions by losing 1 or more e^- from their valence (outermost) shell
- an ion with a positive charge is called a **CATION**.
- example: **SODIUM (Na → Na^+)**



IONS:

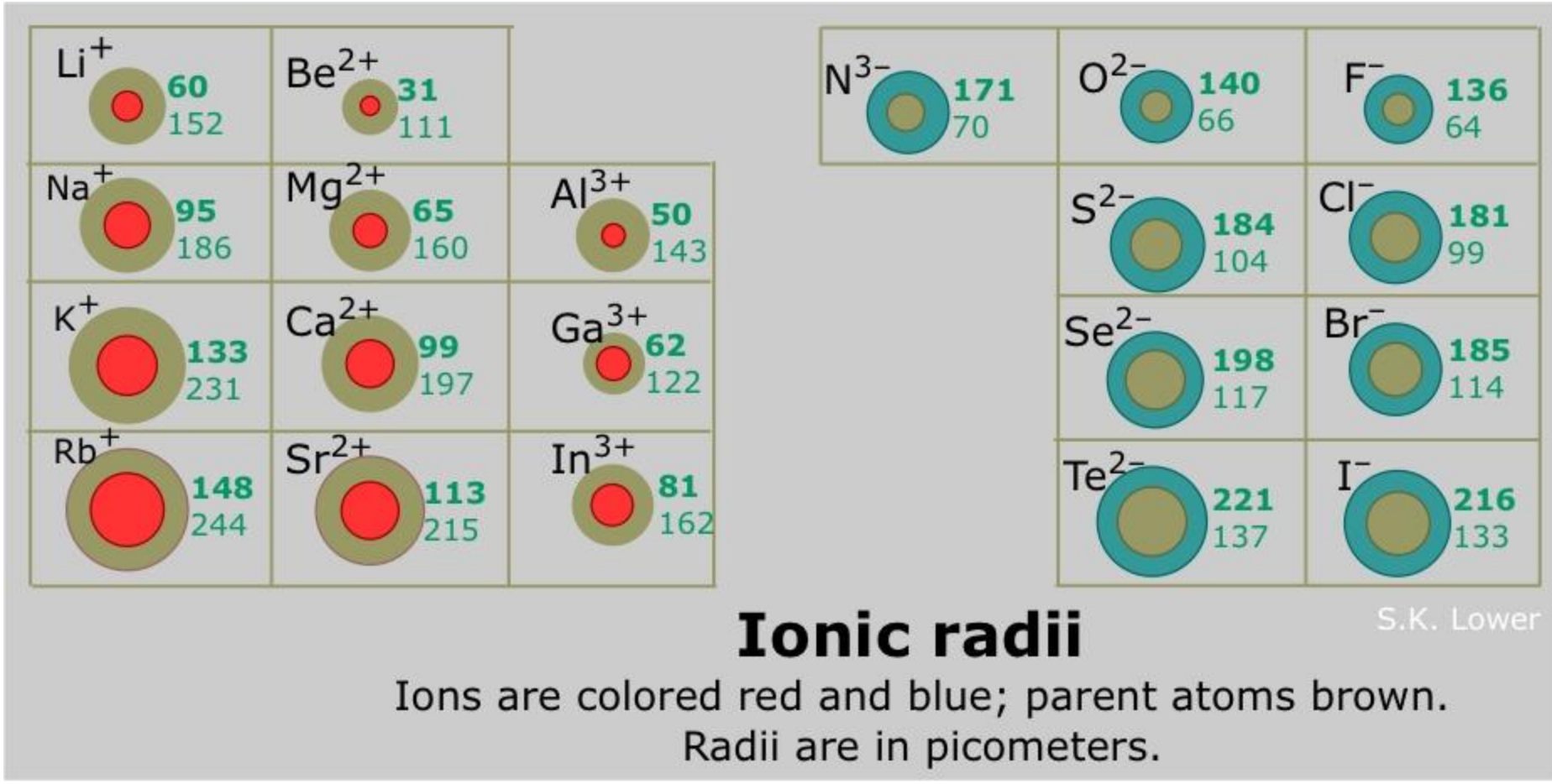
- atoms of **NONMETALS** tend to form negative ions by gaining 1 or more e^- (& thus filling their outermost energy level)
- an ion with a negative charge is called an **ANION**.
- example:

CHLORINE ($Cl \rightarrow Cl^-$)



IONIC RADIUS:

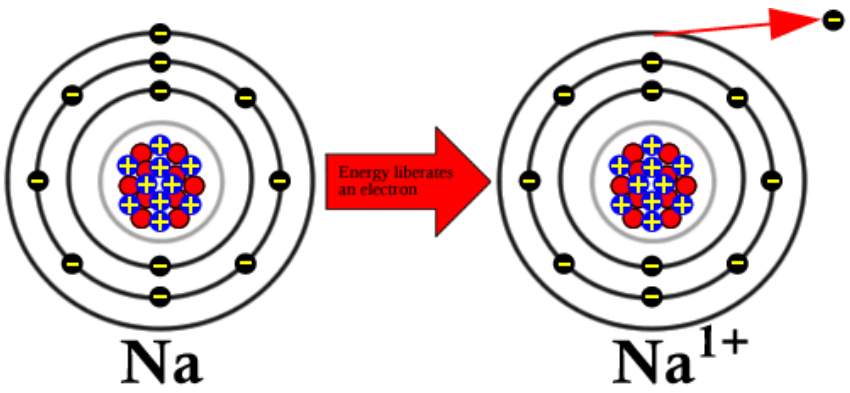
- **ANIONS** (negative ions) have full valence shells: **they are LARGER than their neutral ATOM.**
- **CATIONS** (positive ions) have empty valence shells: **they are SMALLER than their neutral ATOM.**
- BUT, the size of one ion compared to the next is the same pattern as ATOMIC RADIUS.


Li+ 60 152
Be2+ 31 111
Na+ 95 186
Mg2+ 65 160
Al3+ 50 143
K+ 133 231
Ca2+ 99 197
Ga3+ 62 122
Rb+ 148 244
Sr2+ 113 215
In3+ 81 162
N3− 171 70
O2− 140 66
F− 136 64
S2− 184 104
Cl− 181 99
Se2− 198 117
Br− 185 114
Te2− 221 137
I− 216 133
S.K. Lower
Ionic radii
Ions are colored red and blue; parent atoms brown.
Radii are in picometers.

IONIZATION ENERGY:

- Definition: energy required to remove outer electrons

  ➔ results in the formation of a positive ion!



IONIZATION ENERGY:

- **GROUP TREND**: decreases as you move down a group

- ***WHY???***

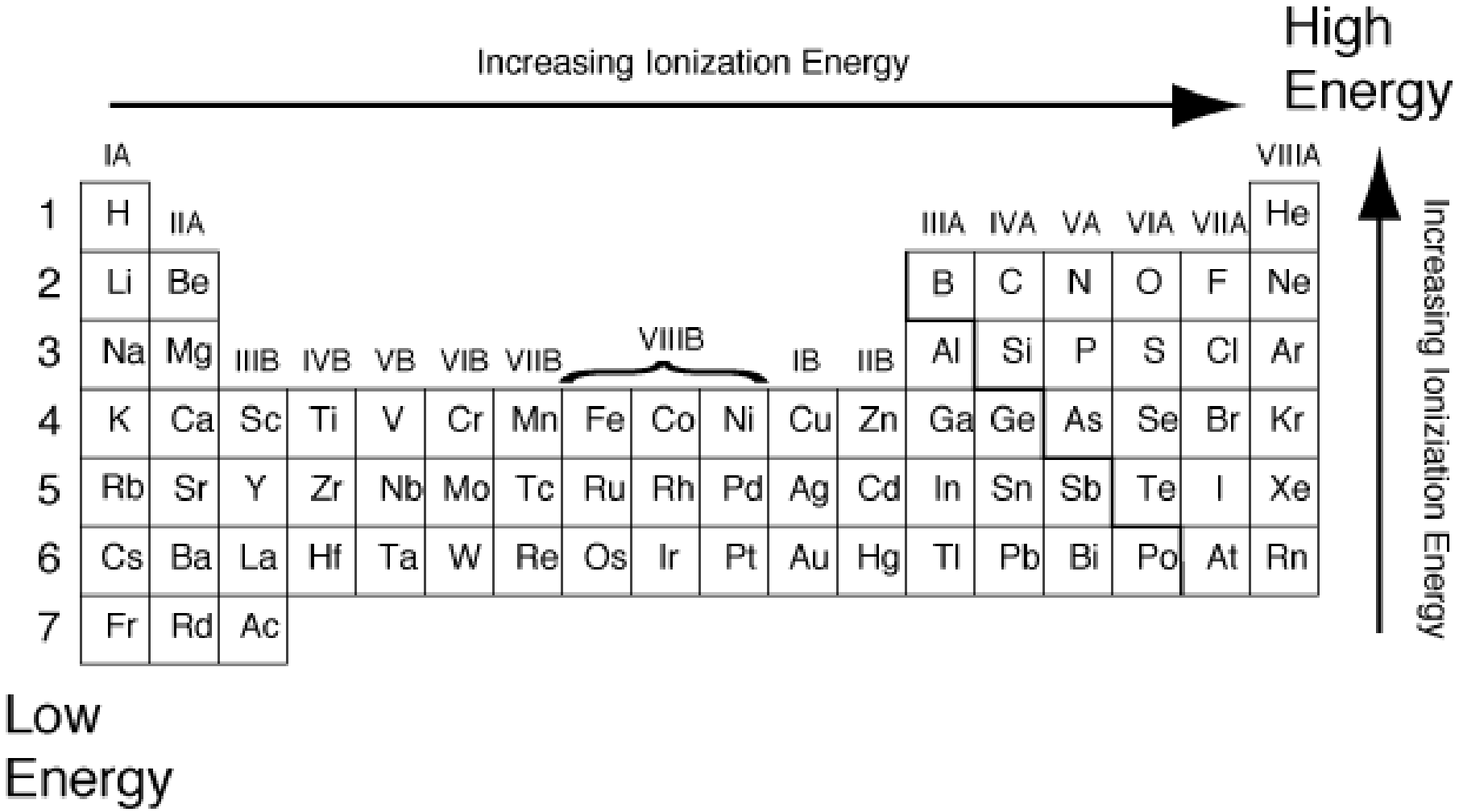
  -Electrons are in higher energy levels as you move down a group; they are farther away from the positive “pull” of the nucleus and therefore easier to remove.

IONIZATION ENERGY:

- **PERIODIC TREND**: increases as you move from L to R across a period

- ***WHY???***

  -The increasing charge in the nucleus as you move across a period exerts greater "pull" on the electrons; it requires more energy to remove an electron.


Increasing Ionization Energy
High Energy
Increasing Ionization Energy
Low Energy
IA
IIA
IIIB
IVB
VB
VIB
VIIB
VIIIB
IB
IIB
IIIA
IVA
VA
VIA
VIIA
VIIIA
1 H He
2 Li Be B C N O F Ne
3 Na Mg Al Si P S Cl Ar
4 K Ca Sc Ti V Cr Mn Fe Co Ni Cu Zn Ga Ge As Se Br Kr
5 Rb Sr Y Zr Nb Mo Tc Ru Rh Pd Ag Cd In Sn Sb Te I Xe
6 Cs Ba La Hf Ta W Re Os Ir Pt Au Hg Tl Pb Bi Po At Rn
7 Fr Rd Ac

ELECTRONEGATIVITY:

- Definition: the tendency of an atom to attract electrons of another atom

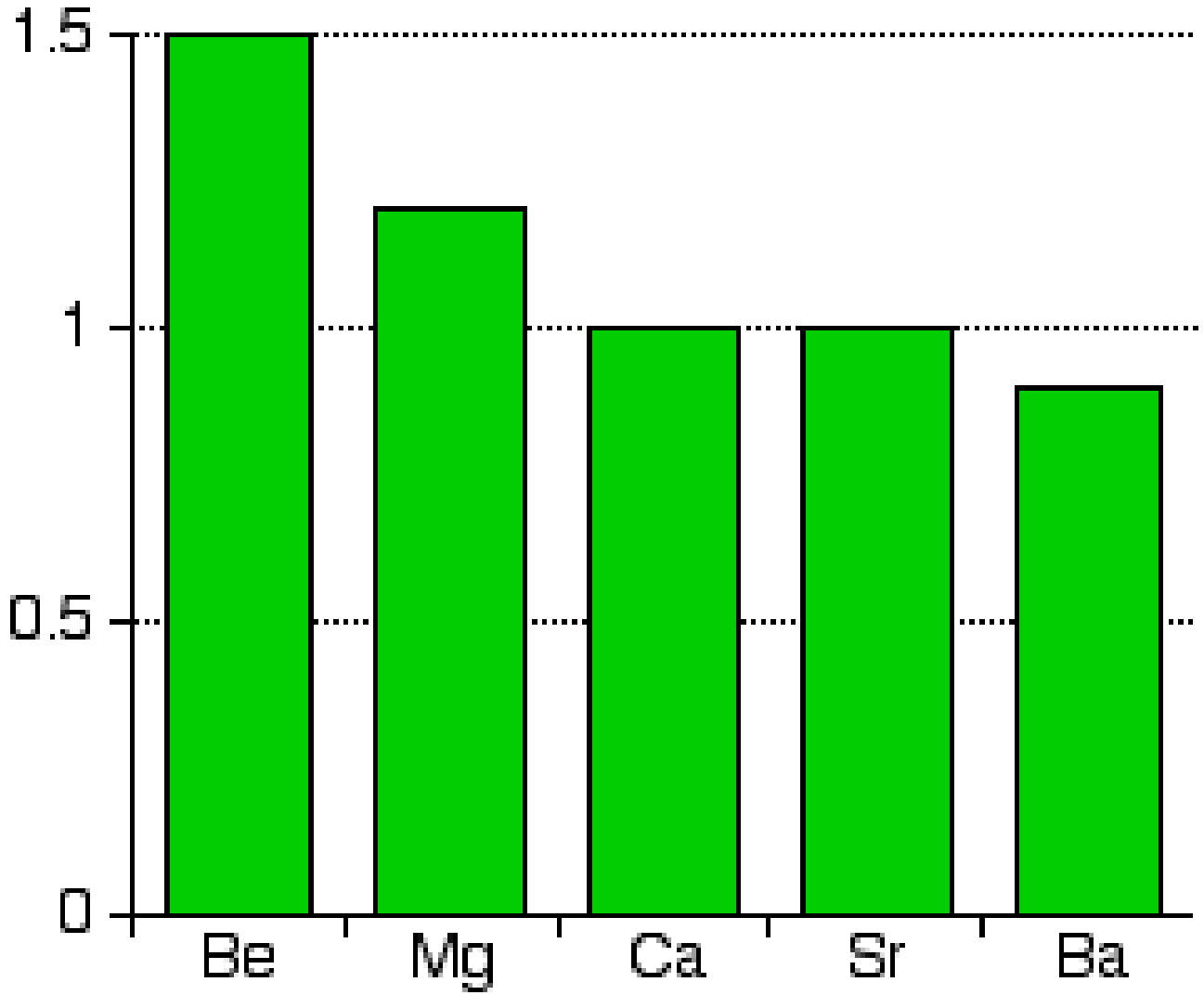
ELECTRONEGATIVITY:

- **GROUP TREND**: decreases as you move down a group
- ***WHY???***

  -higher energy levels means the electrons are farther away from the nucleus;

  -greater distance = decreased attraction

Electronegativity of the Group 2 elements

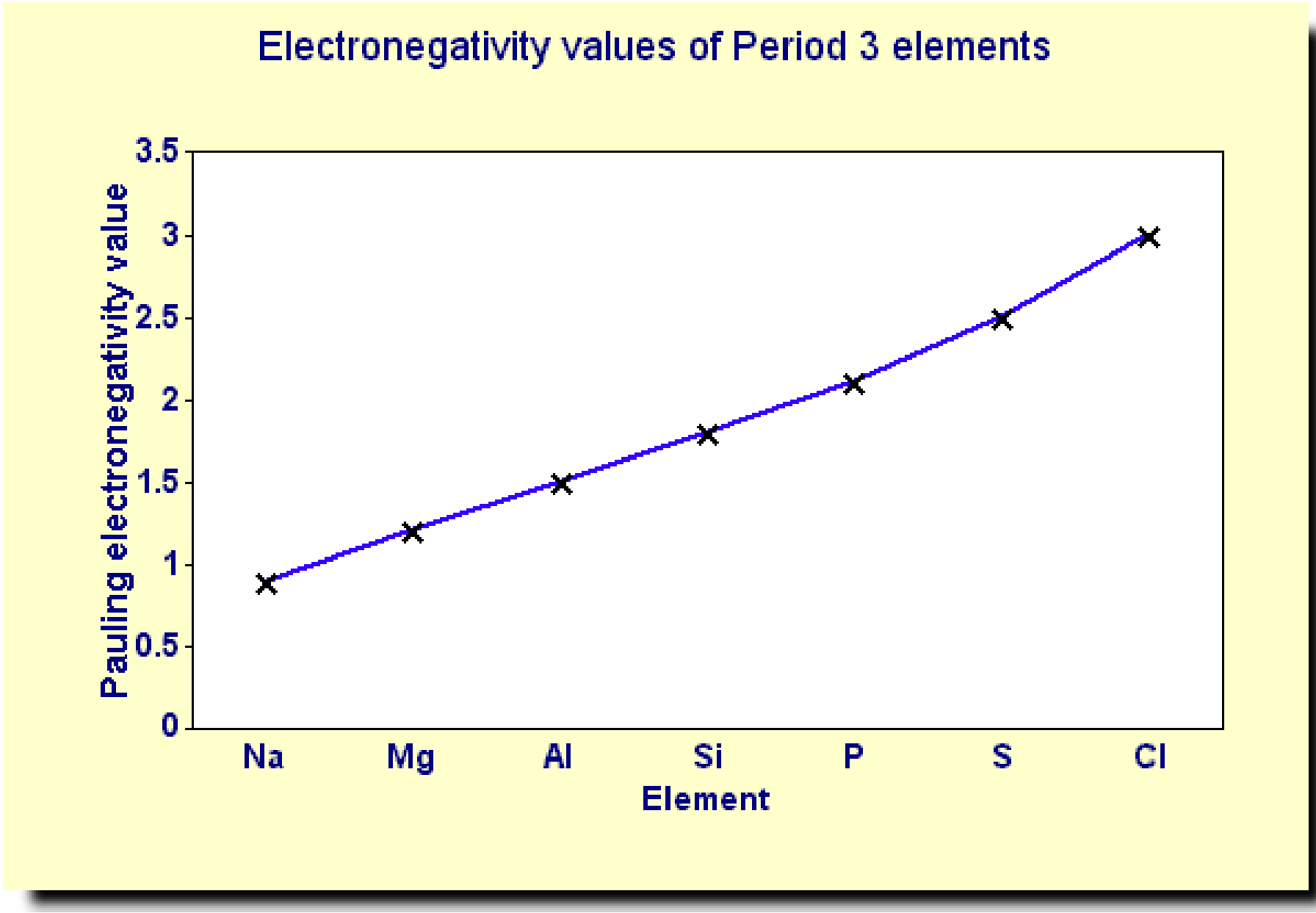


ELECTRONEGATIVITY:

- **PERIODIC TREND**: increases as you move across a period (noble gases excluded!)
- ***WHY???***

  -nuclear charge is increasing;

  -atomic radius is decreasing


Electronegativity values of Period 3 elements
Pauling electronegativity value
3.5
3
2.5
2
1.5
1
0.5
0
Na
Mg
Al
Si
P
S
Cl
Element

ELECTRONEGATIVITY TREND

ELECTRONEGATIVITY:

- Most electronegative element:

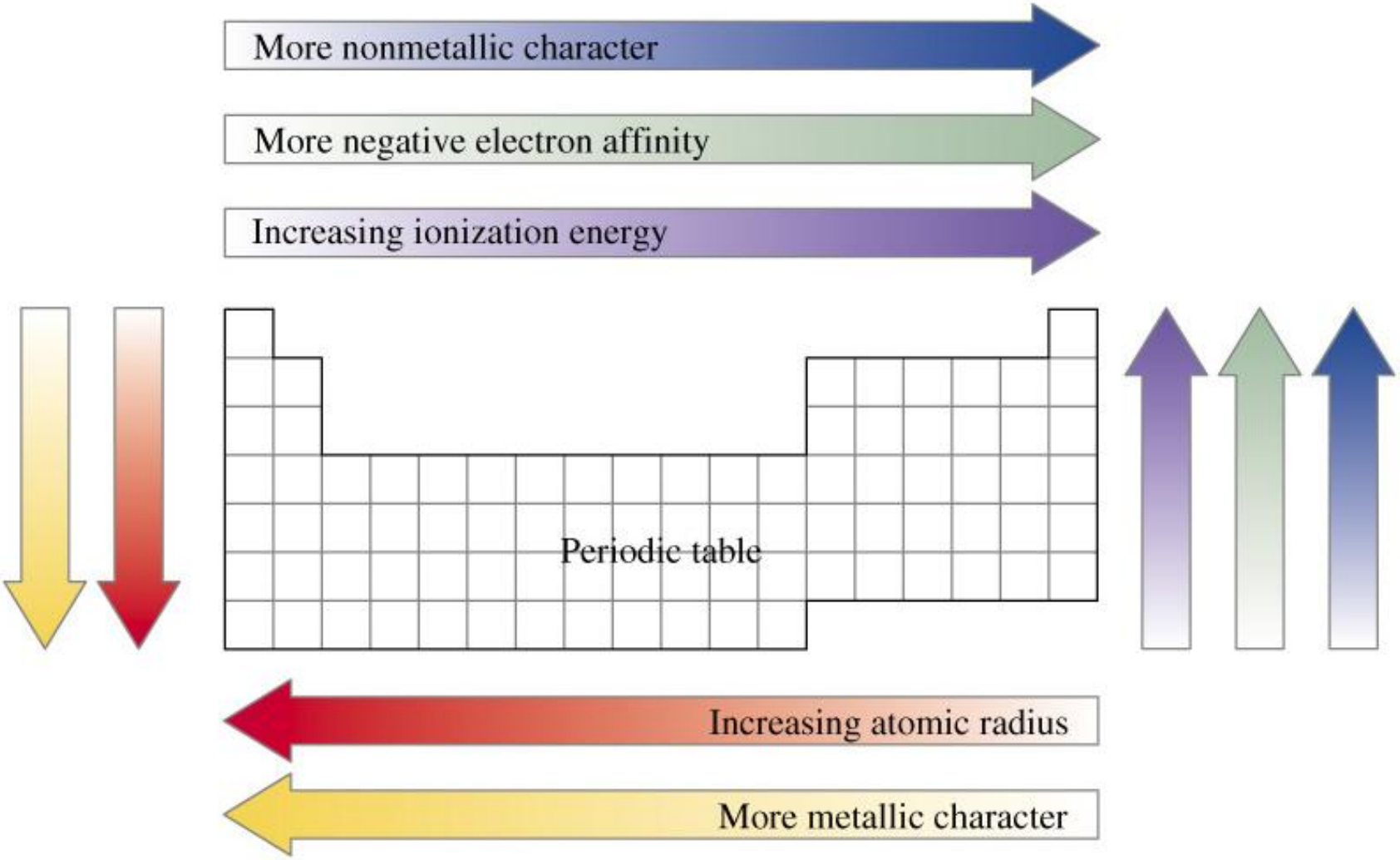
  FLUORINE (4.0)

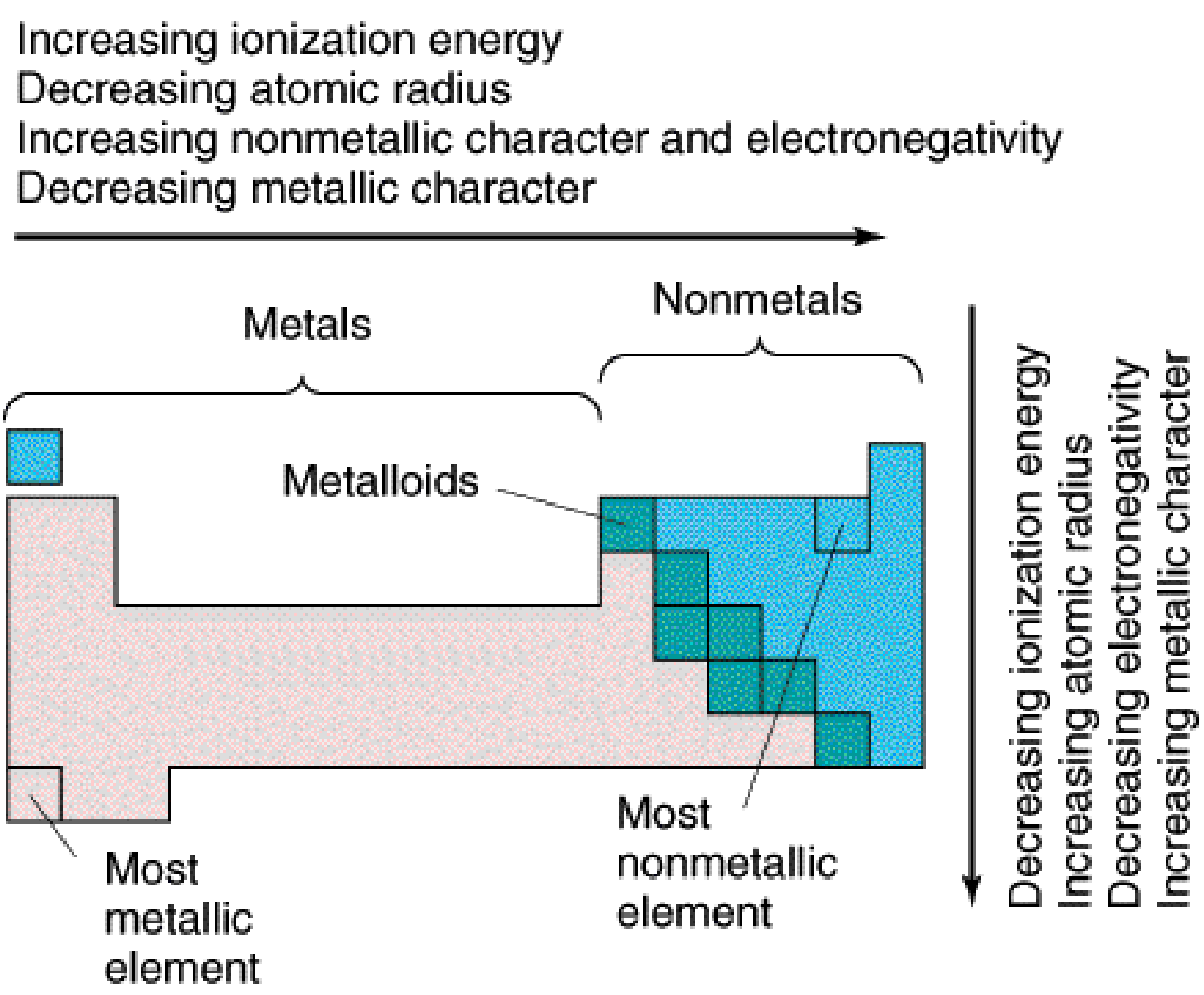
- Least electronegative element:

  CESIUM (0.7)

see table 6.2 on page 181 for all values!

Summing Up Periodic Trends




Increasing ionization energy
Decreasing atomic radius
Increasing nonmetallic character and electronegativity
Decreasing metallic character
Metals
Nonmetals
Metalloids
Most metallic element
Most nonmetallic element
Decreasing ionization energy
Increasing atomic radius
Decreasing electronegativity
Increasing metallic character