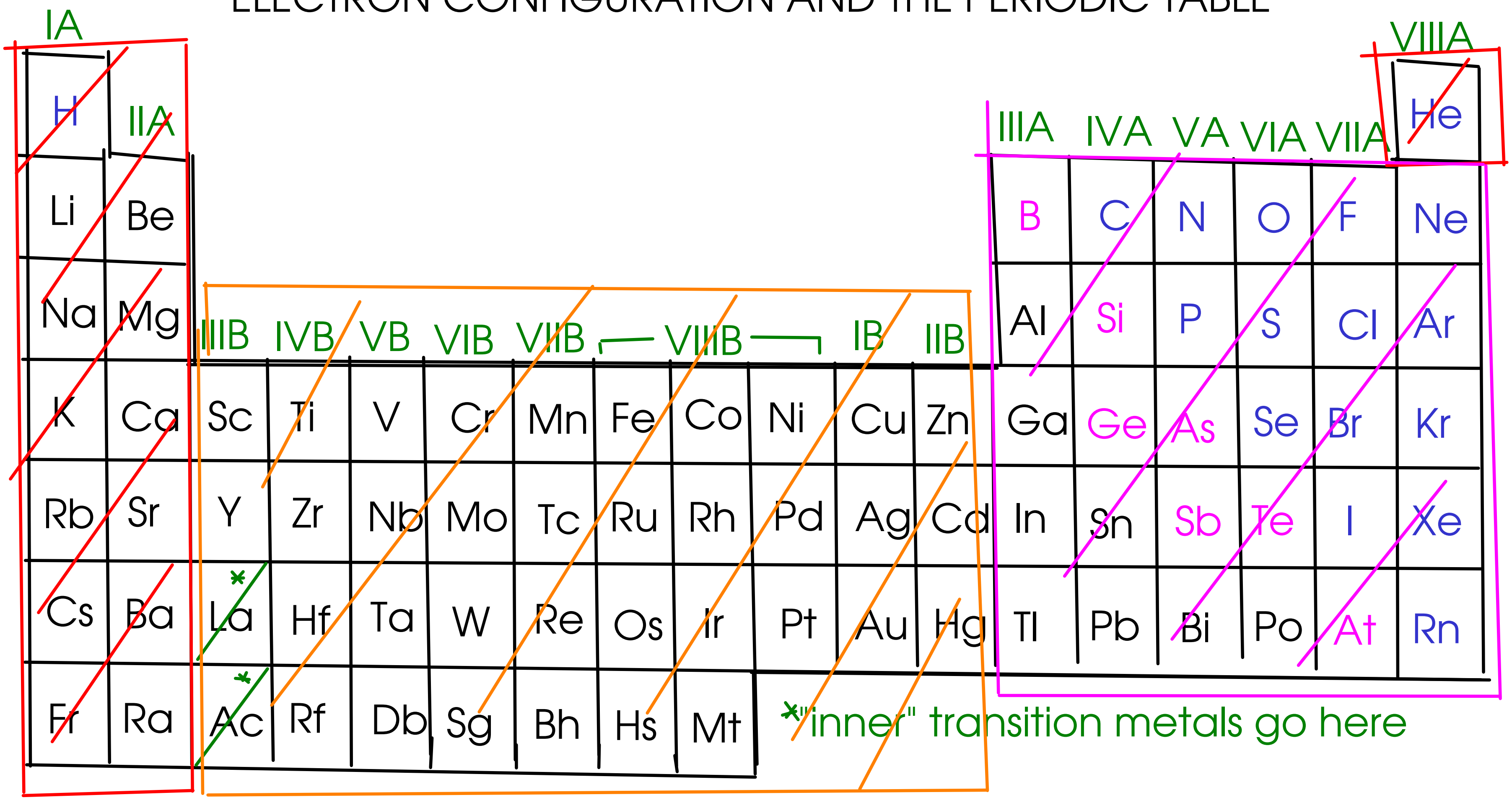
ELECTRON CONFIGURATION AND THE PERIODIC TABLE

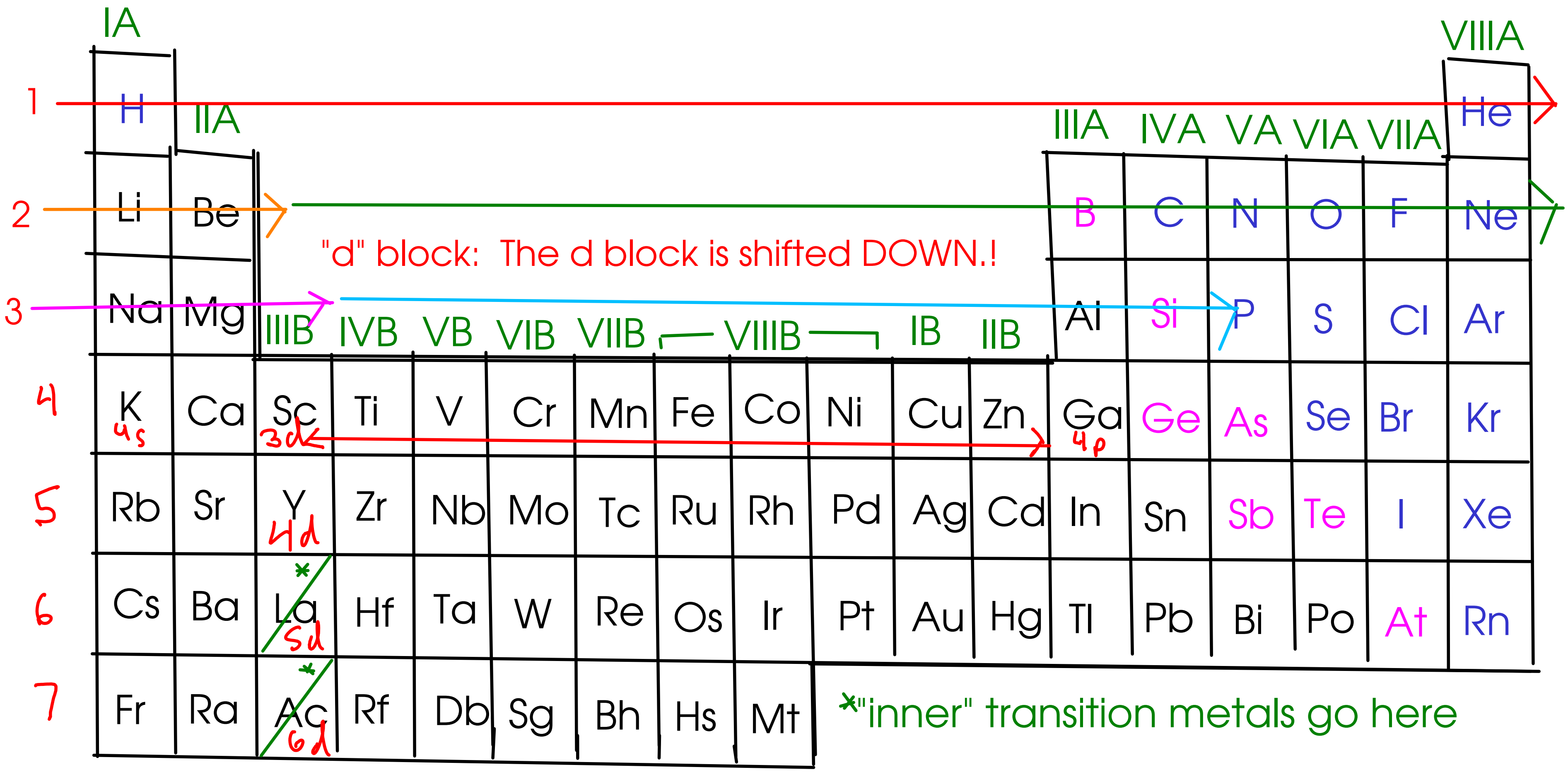


"s" block: last electron in these atoms is in an "s" orbital!

"p" block: last electron in these atoms is in a "p" orbital!

"d" block: last electron in these atoms is in a "d" orbital

- To write an electron configuration using the periodic table, start at hydrogen, and count up the electrons until you reach your element!



Example: Phosphorus (P):

Noble gas core notation for P:

EXAMPLES:

F $1s^2 2s^2 2p^5$

Remember - valence electrons are ALL of the electrons in the outermost SHELL (n)! More that one subshell (l) may be included in the valence electrons

S $1s^2 2s^2 2p^6 3s^2 3p^4$

TITANIUM is a transition metal that commonly forms either +2 or +4 cations. The 4s electrons are lost when the +2 ion forms, while the 4s AND 3d electrons are lost to form the +4!

Cl $1s^2 2s^2 2p^6 3s^2 3p^5$

[Ne] $3s^2 3p^5$

You can order the subshells in numeric order OR in filling order

Ti $1s^2 2s^2 2p^6 3s^2 3p^6 3d^2 4s^2$ or $1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^2$

or [Ar] $3d^2 4s^2$ or [Ar] $4s^2 3d^2$

Se $1s^2 2s^2 2p^6 3s^2 3p^6 3d^{10} 4s^2 4p^4$

or [Ar] $3d^{10} 4s^2 4p^4$

Noble gas core notation. Use the previous noble gas on the table, then add the electrons that it doesn't have to the end.

Kr [Ar] $3d^{10} 4s^2 4p^6$

~~[Kr]~~

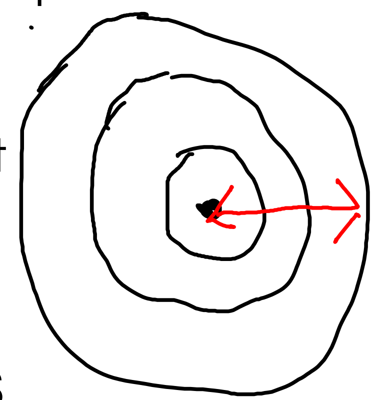
Sample f-block element

Ce: [Xe] $6s^2 5d^1 4f^1$

PERIODIC TRENDS

- Some properties of elements can be related to their positions on the periodic table.

ATOMIC RADIUS

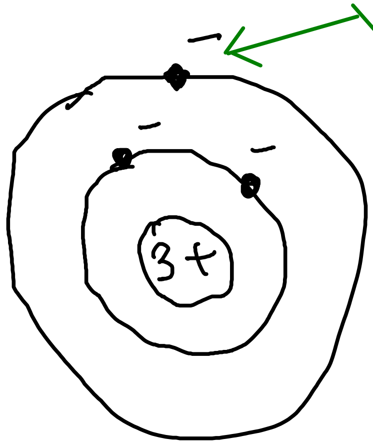


- The distance between the nucleus of the atoms and the outermost shell of the electron cloud.
- Relates to the size of the atom.
- As you go DOWN A GROUP (↓), the atomic radius INCREASES.

  - Why? As you go down a period, you are ADDING SHELLS!

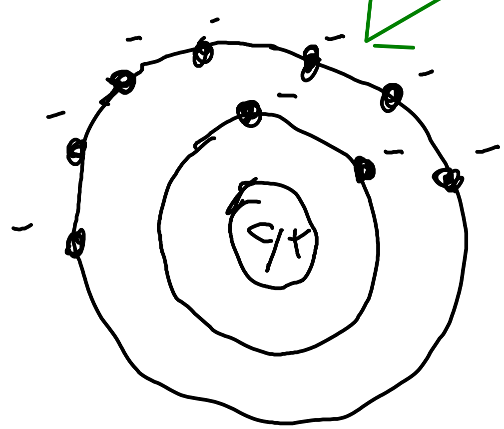
- As you go ACROSS A PERIOD (⟶), the atomic radius DECREASES

  Why? Let's look at some sample atoms.



Outer electron sees an effective +1 charge (shielded from +3 nucleus by 2 electrons)

lithium $1s^2 2s^1$



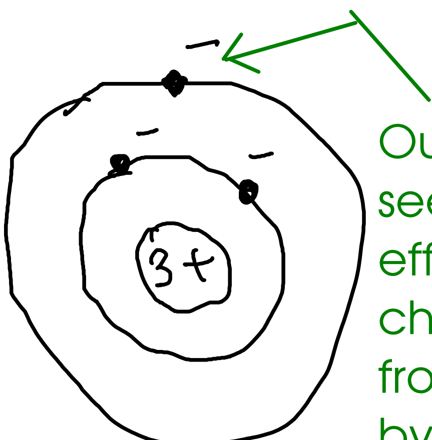
Outer electrons see an effective +7 charge (shielded from +9 nucleus by 2 electrons)

fluorine $1s^2 2s^2 2p^5$

... so fluorine's outer shell is pulled closer to the nucleus than lithium's!

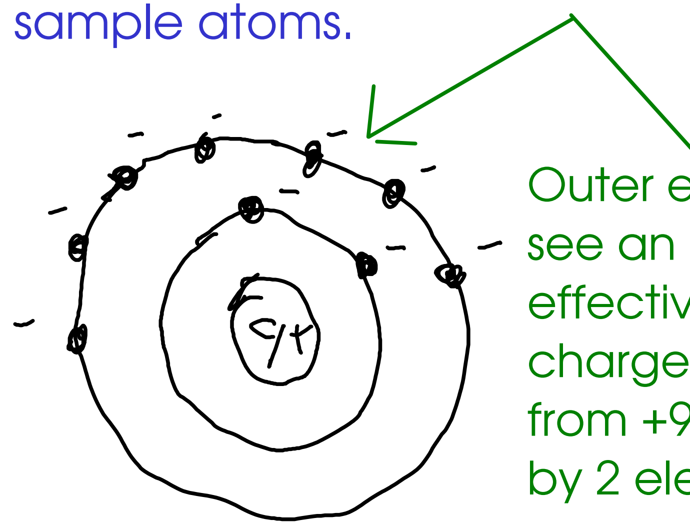
(FIRST) IONIZATION ENERGY

- The amount of energy required to remove a single electron from the outer shell of an atom.
- Relates to reactivity for metals. The easier it is to remove an electron, the more reactive the metal.
- As you go DOWN A GROUP ($\downarrow$), the ionization energy DECREASES.
    - Why? As you go down a period, you are ADDING SHELLS. Since the outer electrons are farther from the nucleus and charge attraction lessens with distance, this makes electrons easier to remove as the atoms get bigger!
- As you go ACROSS A PERIOD ($\longrightarrow$), the ionization energy INCREASES.
    - Why? Let's look at some sample atoms.



Outer electron sees an effective +1 charge (shielded from +3 nucleus by 2 electrons)

lithium

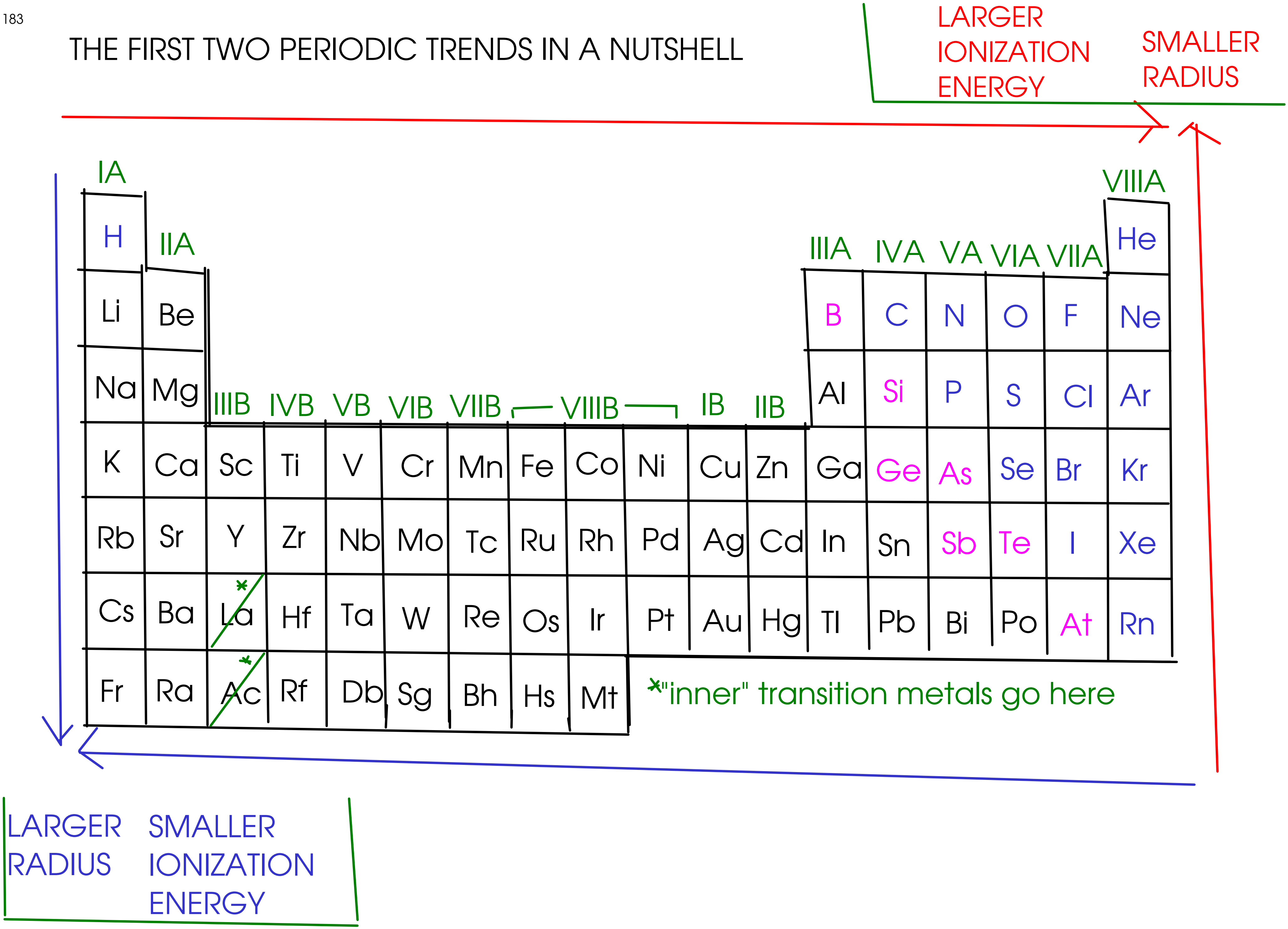


Outer electrons see an effective +7 charge (shielded from +9 nucleus by 2 electrons)

fluorine

... since fluorine's outer electrons are held on by a larger effective charge, they are more difficult to remove than lithium's.

THE FIRST TWO PERIODIC TRENDS IN A NUTSHELL



ELECTRON AFFINITY

- the electron affinity is the ENERGY CHANGE on adding a single electron to an atom.
    - Atoms with a positive electron affinity cannot form anions.
    - The more negative the electron affinity, the more stable the anion formed!

- General trend: As you move to the right on the periodic table, the electron affinity becomes more negative.

EXCEPTIONS

- Group IIA does not form anions (positive electron affinity)!

ns^2 — valence electrons for Group IIA!

n — period number

- To add an electron, the atom must put it into a higher-energy (p) subshell.

- Group VA: can form anions, but has a more POSITIVE electron affinity than IVA

ns^2np^3 — valence electrons for Group VA!

np^3 — Half-full "p" subshell! To add an electron, must start pairing!

- Group VIIIA (noble gases) does not form anions

ns^2np^6 — full "s" and "p" subshells!

"MAIN" or "REPRESENTATIVE" GROUPS OF THE PERIODIC TABLE

Period	IA	IIA
1	H	
2	Li	Be
3	Na	Mg
4	K	Ca
5	Rb	Sr
6	Cs	Ba
7	Fr	Ra

IA: Alkali metals

IIA: Alkaline earth metals

Read about these in Section 8.7 of the Ebbing textbook!

IIIA	IVA	VA	VIA	VIIA	VIIIA
					He
B	C	N	O	F	Ne
Al	Si	P	S	Cl	Ar
Ga	Ge	As	Se	Br	Kr
In	Sn	Sb	Te	I	Xe
Tl	Pb	Bi	Po	At	Rn

VIA: Chalcogens

VIIA: Halogens

VIIIA: Noble/Inert gases

The representative (main) groups

GROUP IA - the alkali metals

valence electrons:

ns^1

- React with water to form HYDROXIDES

$$2M + 2H_2O \rightarrow 2MOH + H_2$$

alkali metals form BASES when put into water!

- Alkali metal OXIDES also form bases when put into water. (This is related to METALLIC character. The more metallic something is, the more basic its oxide. Nonmetals have ACIDIC oxides!) M_2O

- Physical properties: All of these elements are soft metals with relatively low melting points.

GROUP IIA - the alkaline earth metals

valence electrons:

ns^2

- May react with water in a reaction similar to the alkali metals, producing hydroxides and hydrogen gas. For some of the alkaline earth metals, this reaction takes place at a significant rate only at high temperatures..

- Form basic oxides, formula: MO

- These elements are soft and low-melting ... but harder and higher melting than alkali metals.

- The name "alkaline earth" comes from the observation that the "earths" (oxides) of these metals are basic.

GROUP IIIA

valence electrons:

ns^2np^1

- most of the elements in this group are metals, but there is also a semiconductor (boron).

- The oxides of these elements are of the form M_2O_3

  - oxides of boron are acidic (metalloids tend to behave more like nonmetals in the acidity of their oxides).

  - Aluminum and gallium have AMPHOTERIC oxides (react as acids or bases), and the larger Group IIIA oxides are basic

- These elements do not react directly with water to make hydroxides, unlike Groups IA and IIA.

GROUP IVA

valence electrons

ns^2np^2

-contains some elements of each type: nonmetal, metalloid, and metal.

- oxides range from acidic to amphoteric, with formulas MO_2 or MO (C, Pb form both!)

- don't react with water to make hydroxides

GROUP VA

valence electrons

ns^2np^3

-range from nonmetal to metallic, but with only one metal (bismuth).

- Oxides of group VA nonmetals are acidic, while the group VA metalloids have amphoteric oxides. Bismuth's oxide is basic

- Formulas of these oxides vary considerably, but the most common variants are: RO_2, RO_3

GROUP VIA - the chalcogens

valence electrons

ns^2np^4

- Like Group VA, formulas of oxides of these elements vary. Common ones are: RO_2, RO_3

- mostly nonmetals/metalloids, plus one metal (polonium). Oxides range from acidic to amphoteric.

- This group's name means - "ore producers" Many metal ores contain oxygen and/or sulfur!

GROUP VIIA - the halogens

electron configuration:

ns^2np^5

- react with water, but form ACIDS when they do so! (ex: chlorine and water make HCl and HOCl).
- Oxides of the halogens are not very stable, but they are acidic.
- nonmetals, exist primarily as DIATOMIC MOLECULES.
- halogens are very similar in their chemical reactions, even though their physical appearance varies considerably!
- This group's name means "salt formers" (think sodium chloride)

GROUP VIIIA - the noble or inert gases

electron configuration:

ns^2np^6

- characterized by their lack of chemical reactivity. The lighter noble gases have no known compounds, while the heavier ones sometimes form molecules with reactive elements like oxygen and fluorine.
- exist primarily as single (uncombined) atoms - NOT diatomic molecules like the halogens.