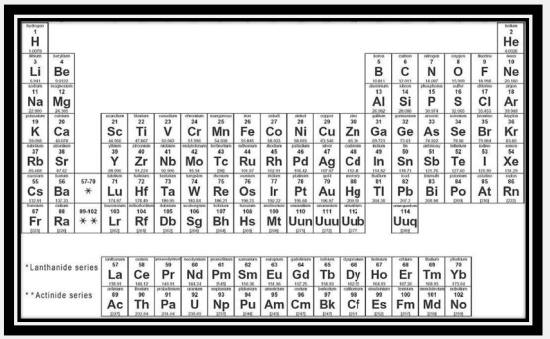
N15 - Periodic Trends

Target:
I can describe periodic trends and the reasons behind them.

Warning...

- Don't over think this stuff.
- You can talk yourself into backwards answers.
- Focus on the fact that there are only a set number of trends to learn.
- Practice explaining each trend until you can do it in your sleep!
- There will ALWAYS be exceptions. Don't worry about that – focus on the pattern and answer questions based on the patterns.

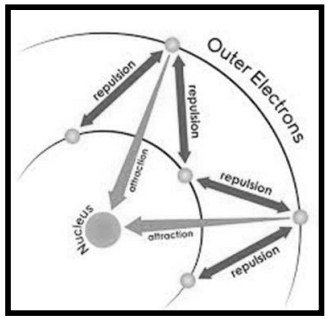
Periodic Trends



Factors that contribute to trends we see on the periodic table

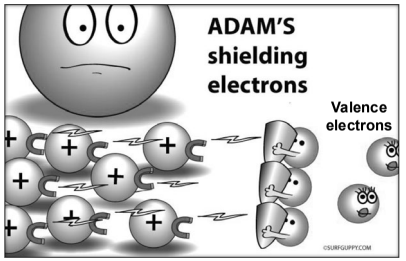
EVERYTHING is about...

- Attractions
- Repulsions



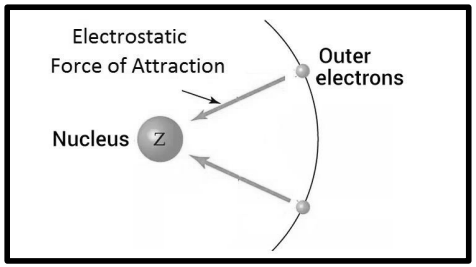
Shielding Effect

- Inner shell electrons repel the outer valence electrons
- Keeps valence e- from feeling the full attractive force of the nucleus.



Effective Nuclear Charge (Z_{eff})

- The *relative* attraction the valence electrons have for the protons in the nucleus



R-19

Effective Nuclear Charge (Z_{eff})

Adding a proton has a larger effect than adding an electron

Effective Nuclear Charge (Z_{eff})

- The relative attraction the valence electrons have for the protons in the nucleus

$$Z_{eff} = Z - S$$

Z = nuclear attraction = # protons
S = the core/inner e- shielding the valence e-'s
= the total number of e- minus the e- in the highest occupied s and p energy levels

Calculating Effective Nuclear Charge

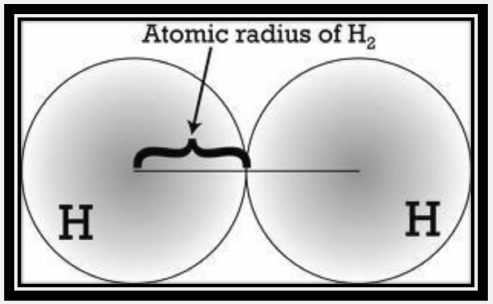
$Z_{eff} = Z - S$

Magnesium
Z = 12 protons
S = Previous noble gas
= Neon = 10 electrons
Zeff = 12 - 10 = 2

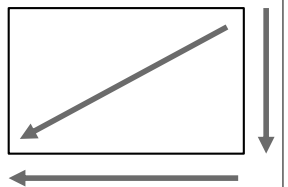
Aluminum
Z = 13 protons
S = Previous noble gas
= Neon = 10 electrons
Zeff = 13 – 10 = 3

Aluminum is smaller – valence electrons are pulled in harder by the nucleus

Radius



ATOMIC RADIUS

What	How
• ½ the distance between two bonded nuclei • Cant measure to the edge b/c orbitals aren't tangible!	

ATOMIC RADIUS

Why

INCREASES DOWN because...

Circle one:

Increased Shielding or Increased Nuclear Charge

- More energy levels
- Further from nucleus
- More shielding
- **Less attraction**

ATOMIC RADIUS

Why

DECREASES TO RIGHT because...

Circle one:

Increased Shielding or Increased Nuclear Charge

- More protons
- Same # of energy levels so no increase in shielding
- **Stronger nuclear attraction**

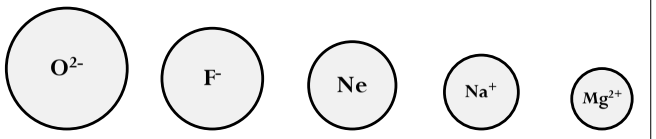
IONIC RADIUS

Cation	Anion
• Lost electrons • Always smaller	• Gained electrons • Always bigger
• Reduced e- repulsions • May drop down an energy level	• Extra valence e- = more repulsions = bigger

Isoelectric Species

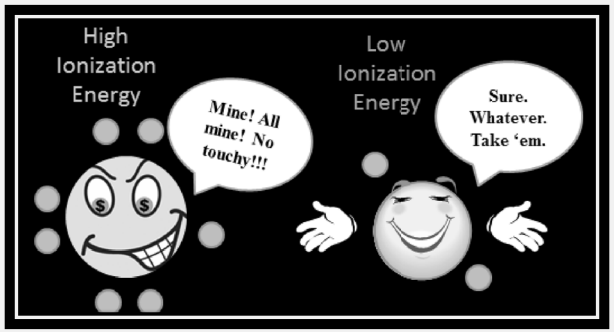
Atoms/Ions that have the same number of e-

All these examples are $1s^2 2s^2 2p^6$

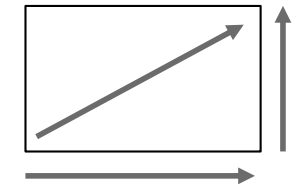


- Increased protons pull harder on valence electrons - *"Greater effective nuclear charge"*
- Radius ends up smaller

Ionization Energy



IONIZATION ENERGY

What	How
The energy required to remove one electron from a neutral atom of an element	 Noble Gases are HIGHEST! **They REALLY don't want to let go of an e-**

IONIZATION ENERGY

Why

DECREASES DOWN because...

Circle one:

Increased Shielding or Increased Nuclear Charge

- More energy levels
- Further from nucleus
- More shielding
- Less attraction → **easier to take electron away!**

IONIZATION ENERGY

Why

INCREASES TO RIGHT because...

Circle one:

Increased Shielding or Increased Nuclear Charge

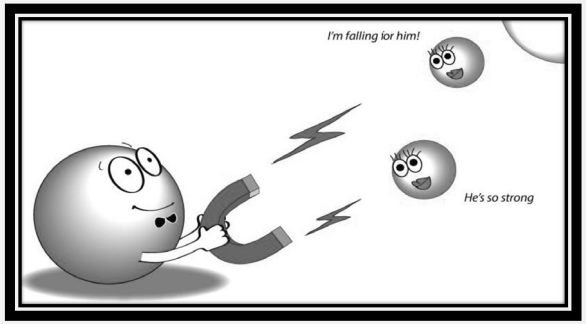
- More protons
- Same # of energy levels so no increase in shielding
- Stronger nuclear attraction → **Harder to take e- away!**

Subsequent Ionizations

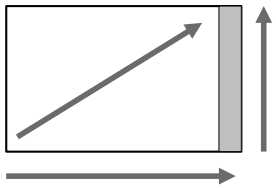
- Each time e- removed →harder to take next one.
- **Radius is getting smaller → increased attraction**
- HUGE LEAP in I.E. once it's achieved noble gas configuration
  – why would it want to lose another one?!

Element	IE_1	IE_2	IE_3	IE_4
Na	496	4560		
Mg	738	1450	7730	
Al	578	1820	2750	11,600

Electronegatvity



ELECTRONEGATIVITY

What	*How*
A measure of the ability of an atom in a chemical compound to attract electrons from another atom in the compound	
How strongly can one atom pull on the electrons being shared in a bond.	Noble Gases are LOWEST! **They DON'T CARE about attracting electrons!**

ELECTRONEGATIVITY

Why

DECREASES DOWN because...

Circle one:

Increased Shielding or Increased Nuclear Charge

- More energy levels
- Further from nucleus
- More shielding
- **Less attraction**

ELECTRONEGATIVITY

Why

INCREASE TO RIGHT because...

Circle one:

Increased Shielding or Increased Nuclear Charge

- More protons
- Same # of energy levels so no increase in shielding
- **Stronger nuclear attraction**

Reactivity

REACTIVITY

What	*How*
Elements in the same group have *similar* types of behaviors **because they have the same # of valence e- !** BUT The MAGNITUDE of their reactions changes!	 **Metals and Non-metals are opposite trends!** **Noble gases are "INERT" or non-reactive**

REACTIVITY

Why

METALS INCREASE DOWN because...

Circle one:

Remember – metals want to LOSE electrons

Increased Shielding or Increased Nuclear Charge

- More energy levels
- Further from nucleus
- More shielding
- Less attraction → **easier to LOSE an electron!**

REACTIVITY

Why

NON-METALS INCREASE UP because...

Circle one:

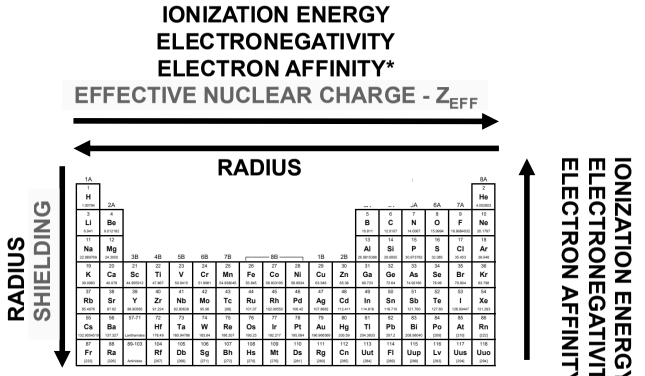
Remember – nonmetals want to GAIN electrons

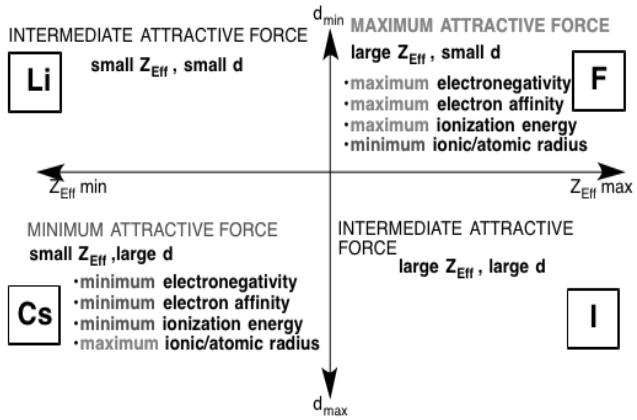
Decreased ~~Increased~~ Shielding or Increased Nuclear Charge

Ha! TRICKY!!!!!!

- FEWER energy levels
- CLOSER to nucleus
- LESS shielding
- MORE attraction → **easier to GAIN an electron!**

Summary





Brainiac Video – *note: they augmented the reactions, but it is such a fun, silly, memorable video I think it is still worth watching* ☺

Disposal of Sodium – *old footage from WWII. Neat to see such old footage and how they actually disposed of the sodium after the war!*

Crash Course – *Periodic Table episode*

Quick summary. Also has a quick but good explanation of some exceptions to the trends

https://www.youtube.com/watch?v=hePb00CqvP0

YouTube Link to this Presentation

(these are based on an old version of this lecture – same info just not laid out the same way we did in class)

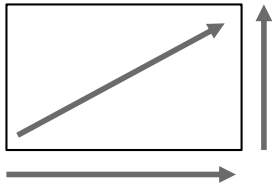
Part 1: https://youtu.be/jmy5tlVlFTs

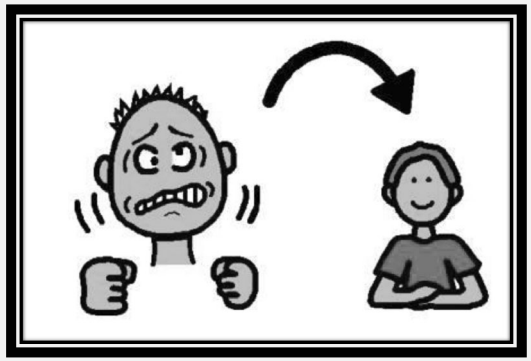
Part 2: https://youtu.be/1TGOnu_WJ5I

Things past this slide are not being taught this year

Electron Affinity

ELECTRON AFFINITY

What	How
How much energy is released when the atom gains an electron to make a negative ion. *How much stability does it gain once it is an anion. More energy released – more stable.*	 Noble Gases are LOWEST! They DON'T CARE about attracting electrons!



ELECTRON AFFINITY

Why

DECREASES DOWN	INCREASES TO RIGHT
• Electrons are further from nucleus in higher energy levels • Increased shielding from core e-'s causes the nucleus to not pull as hard on valence e-'s • So atom doesn't notice as much if it gains an electron – doesn't gain much stability	• Closer to filling valence shell – noble gas configuration is most stable