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.

Warning…

There is about to be a lot of notes because it takes a lot of words to explain – you don't need EVERY word written down to understand it. Focus on listening and understanding. You can add to your notes at home. Capture enough to pay attention, leave space to come back and add/annotate.

Warning…

Make sure you capture:

What

How

Why

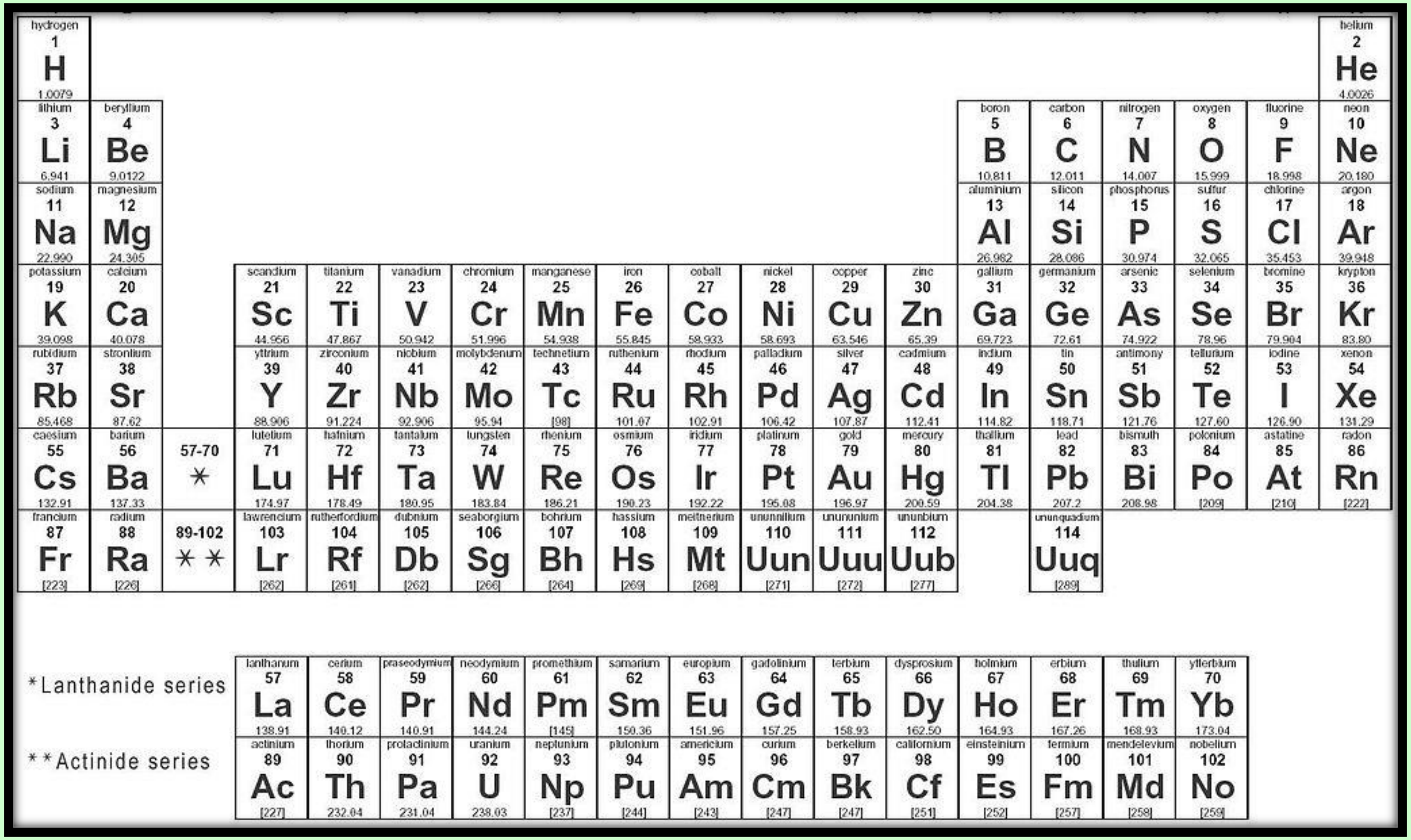
Make sure you can tell me:

What

How

Why

Periodic Trends

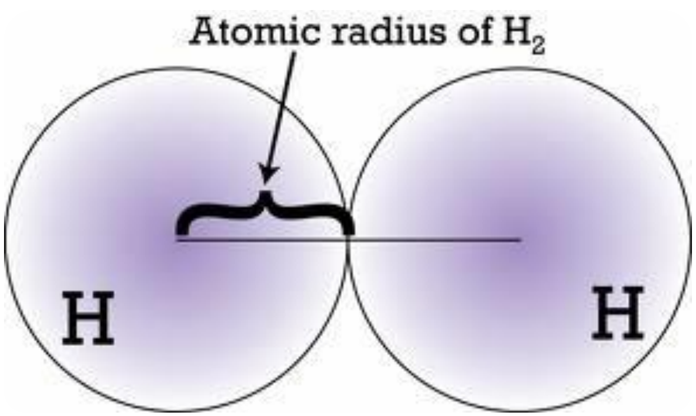
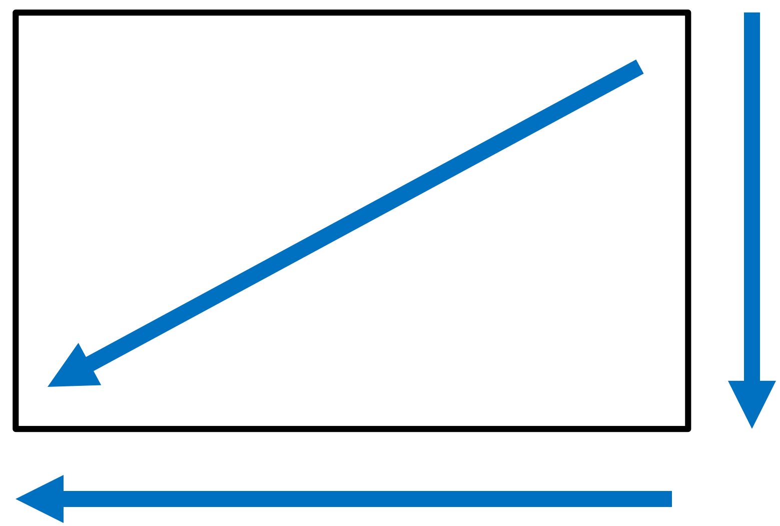


hydrogen 1 H 1.0079																		helium 2 He 4.0026
lithium 3 Li 6.941	beryllium 4 Be 9.0122												boron 5 B 10.811	carbon 6 C 12.011	nitrogen 7 N 14.007	oxygen 8 O 15.999	fluorine 9 F 18.998	neon 10 Ne 20.180
sodium 11 Na 22.990	magnesium 12 Mg 24.305												aluminium 13 Al 26.982	silicon 14 Si 28.086	phosphorus 15 P 30.974	sulfur 16 S 32.065	chlorine 17 Cl 35.453	argon 18 Ar 39.948
potassium 19 K 39.098	calcium 20 Ca 40.078		scandium 21 Sc 44.956	titanium 22 Ti 47.867	vanadium 23 V 50.942	chromium 24 Cr 51.996	manganese 25 Mn 54.938	iron 26 Fe 55.845	cobalt 27 Co 58.933	nickel 28 Ni 58.693	copper 29 Cu 63.546	zinc 30 Zn 65.39	gallium 31 Ga 69.723	germanium 32 Ge 72.61	arsenic 33 As 74.922	selenium 34 Se 78.96	bromine 35 Br 79.904	krypton 36 Kr 83.80
rubidium 37 Rb 85.468	strontium 38 Sr 87.62		yttrium 39 Y 88.906	zirconium 40 Zr 91.224	niobium 41 Nb 92.906	molybdenum 42 Mo 95.94	technetium 43 Tc [98]	ruthenium 44 Ru 101.07	rhodium 45 Rh 102.91	palladium 46 Pd 106.42	silver 47 Ag 107.87	cadmium 48 Cd 112.41	indium 49 In 114.82	tin 50 Sn 118.71	antimony 51 Sb 121.76	tellurium 52 Te 127.60	iodine 53 I 126.90	xenon 54 Xe 131.29
caesium 55 Cs 132.91	barium 56 Ba 137.33	57-70 *	lutetium 71 Lu 174.97	hafnium 72 Hf 178.49	tantalum 73 Ta 180.95	tungsten 74 W 183.84	rhenium 75 Re 186.21	osmium 76 Os 190.23	iridium 77 Ir 192.22	platinum 78 Pt 195.08	gold 79 Au 196.97	mercury 80 Hg 200.59	thallium 81 Tl 204.38	lead 82 Pb 207.2	bismuth 83 Bi 208.98	polonium 84 Po [209]	astatine 85 At [210]	radon 86 Rn [222]
francium 87 Fr [223]	radium 88 Ra [226]	89-102 * *	lawrencium 103 Lr [262]	rutherfordium 104 Rf [261]	dubnium 105 Db [262]	seaborgium 106 Sg [266]	bohrium 107 Bh [264]	hassium 108 Hs [269]	meitnerium 109 Mt [268]	ununnilium 110 Uun [271]	unununium 111 Uuu [272]	ununbium 112 Uub [277]		ununquadium 114 Uuq [289]				

*Lanthanide series	lanthanum 57 La 138.91	cerium 58 Ce 140.12	praseodymium 59 Pr 140.91	neodymium 60 Nd 144.24	promethium 61 Pm [145]	samarium 62 Sm 150.36	europium 63 Eu 151.96	gadolinium 64 Gd 157.25	terbium 65 Tb 158.93	dysprosium 66 Dy 162.50	holmium 67 Ho 164.93	erbium 68 Er 167.26	thulium 69 Tm 168.93	ytterbium 70 Yb 173.04
* *Actinide series	actinium 89 Ac [227]	thorium 90 Th 232.04	protactinium 91 Pa 231.04	uranium 92 U 238.03	neptunium 93 Np [237]	plutonium 94 Pu [244]	americium 95 Am [243]	curium 96 Cm [247]	berkelium 97 Bk [247]	californium 98 Cf [251]	einsteinium 99 Es [252]	fermium 100 Fm [257]	mendelevium 101 Md [258]	nobelium 102 No [259]

Atomic Radius

ATOMIC RADIUS

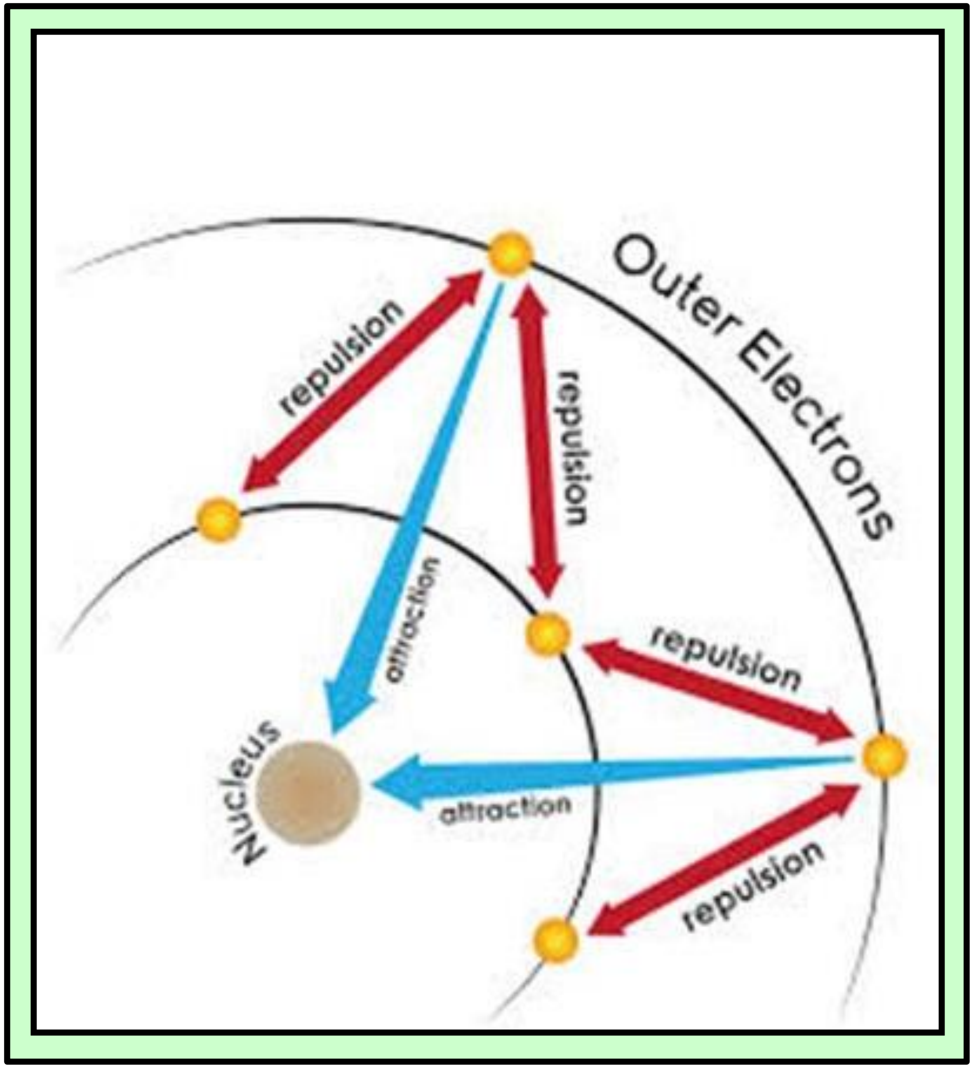
What	How
½ the distance between two bonded nuclei – cant measure to the edge because orbitals aren't tangible!  	

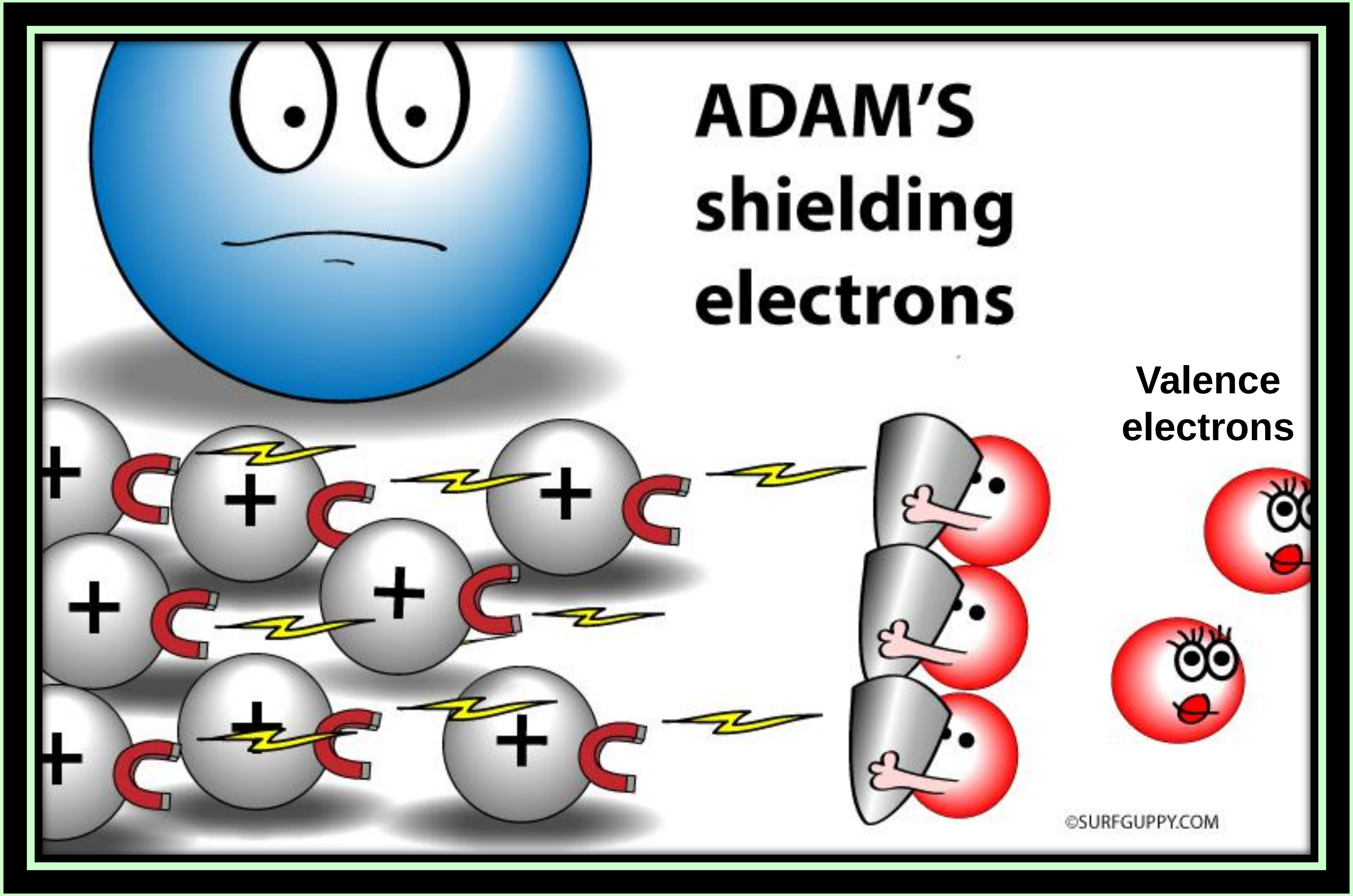
ATOMIC RADIUS

Why	
INCREASES DOWN	**DECREASES TO RIGHT**

Effective Nuclear Charge (Z_{eff})

Shielding Effect




ADAM'S
shielding
electrons
Valence
electrons
©SURFGUPPY.COM

Calculating Effective Nuclear Charge

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 electrons shielding the valence e-'s

= (# of e- in previous noble gas + any d or f e-'s)

Calculating Effective Nuclear Charge

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

Magnesium

Z =

S =

=

Zeff =

Aluminum

Z =

S =

=

Zeff =

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

IONIC RADIUS

What	How
The radius of an ion Cation – lost electrons Anion – gained electrons	Cation – always smaller Anion – always bigger

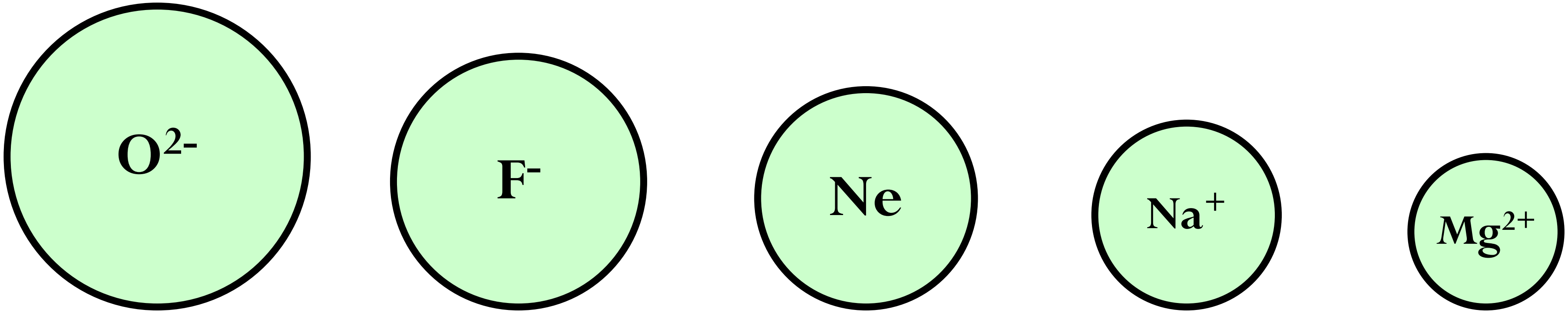
IONIC RADIUS

Why	
CATION SMALLER	**ANION LARGER**
• •	

Isoelectric Species

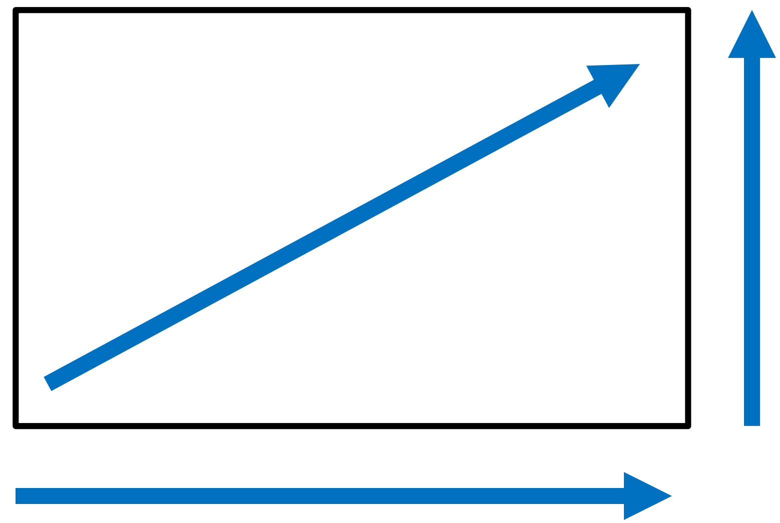
Atoms/Ions that have the same number of e-

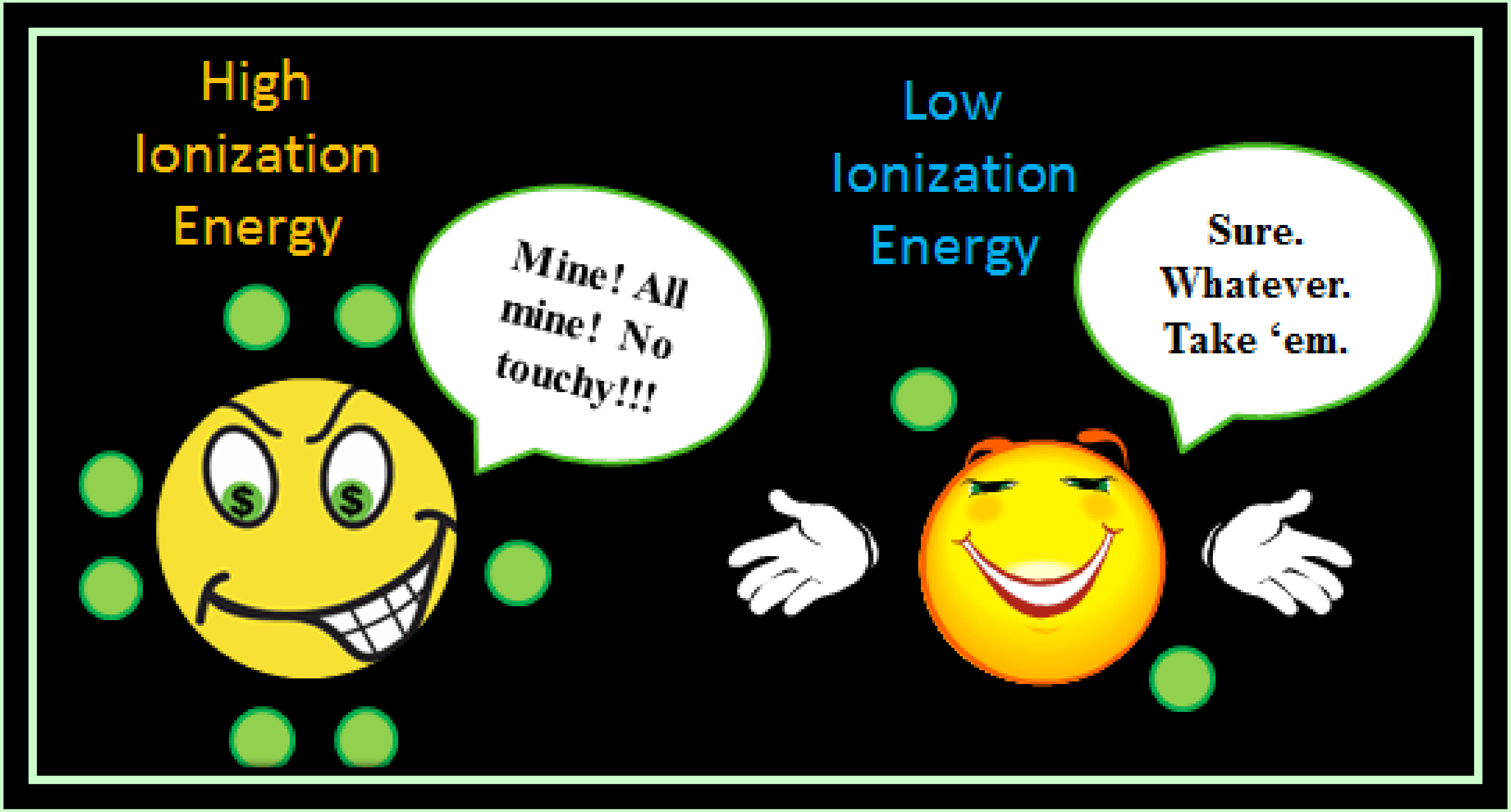
All these examples are $1s^2 2s^2 2p^6$



Ionization Energy

IONIZATION ENERGY

What	How
The energy required to remove on electron from a neutral atom of an element	


High Ionization Energy
Mine! All mine! No touchy!!!
Low Ionization Energy
Sure. Whatever. Take ‘em.

IONIZATION ENERGY

Why	
DECREASES DOWN	**INCREASES TO RIGHT**

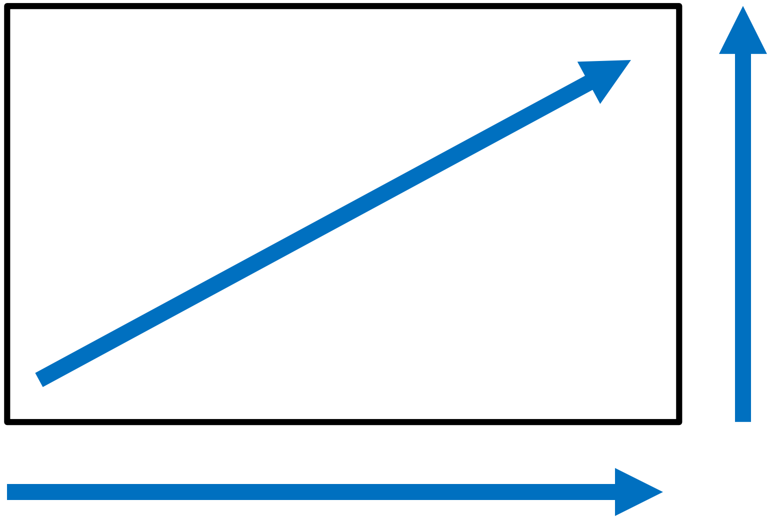
Subsequent Ionizations

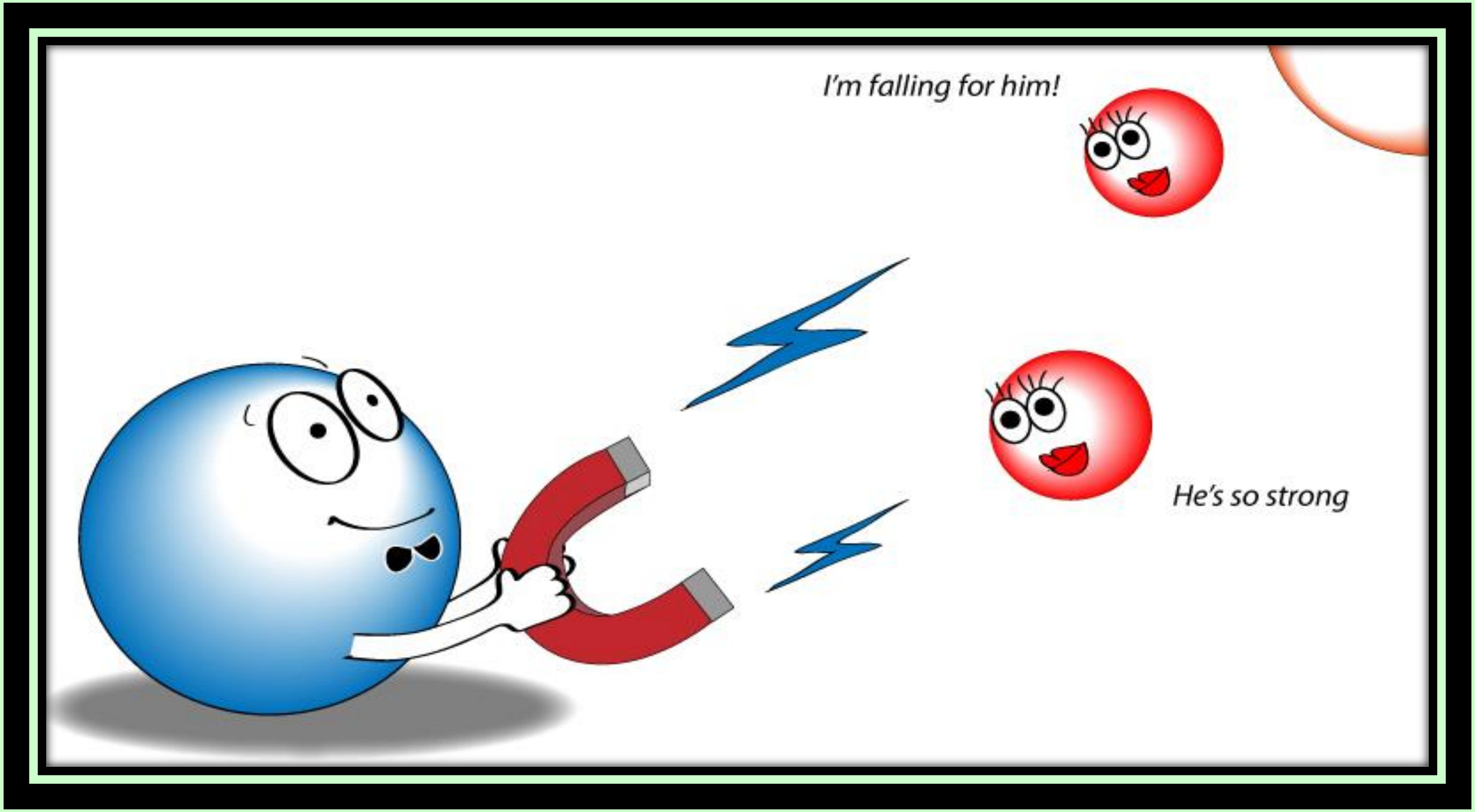
Every time you take an electron away it gets harder to take the next one. Radius is getting smaller, so nucleus can pull harder on the valence - harder to remove the next one. HUGE LEAP in I.E. once it's achieved noble gas configuration – why would it want to lose another one?!

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
	

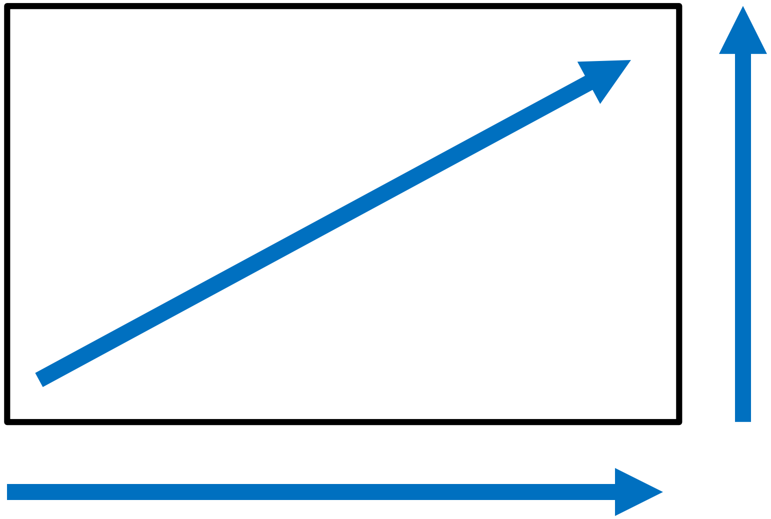

I'm falling for him!
He's so strong

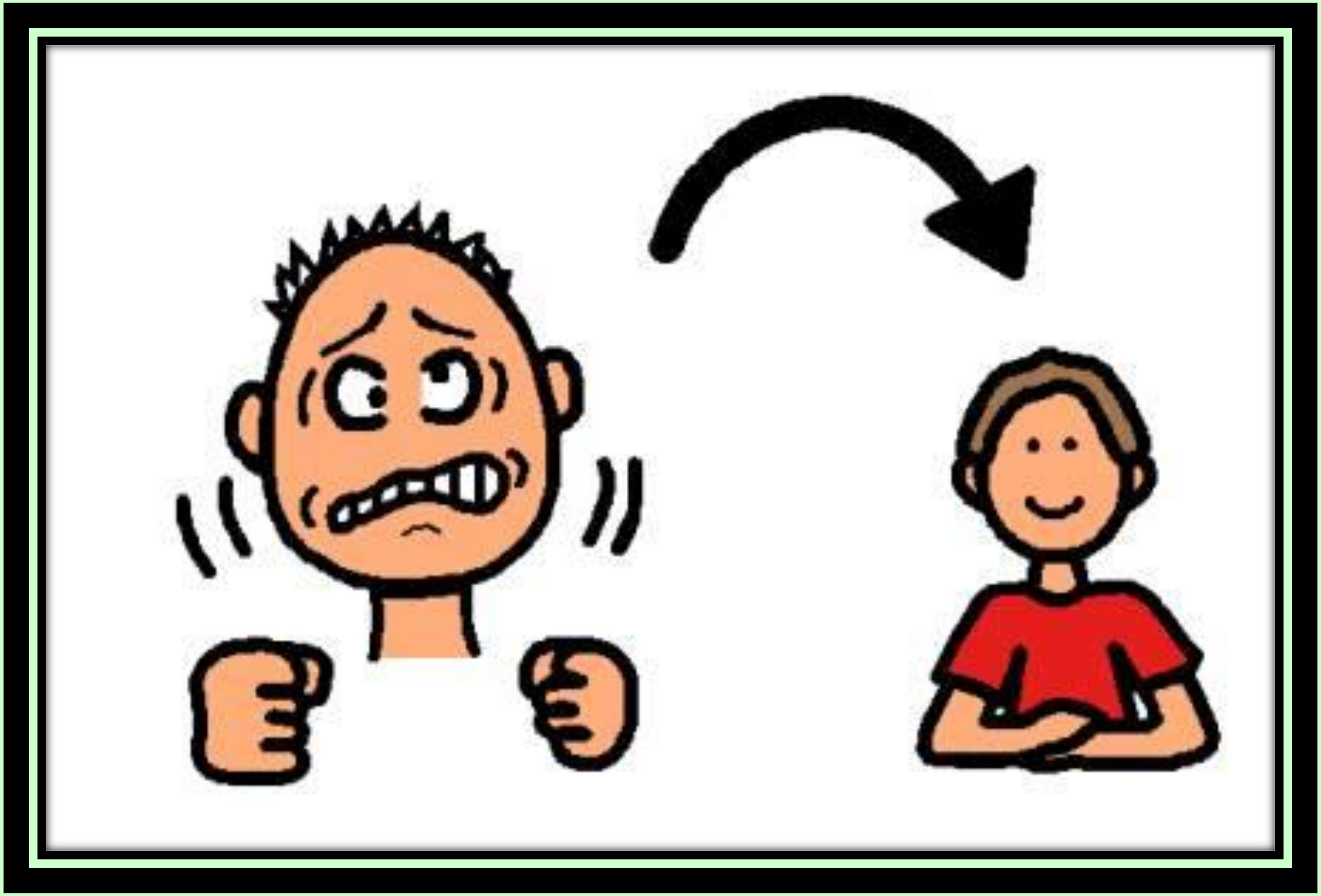
ELECTRONEGATIVITY

Why	
DECREASES DOWN	**INCREASES TO RIGHT**

Electron Affinity

ELECTRON AFFINITY

What	How
	

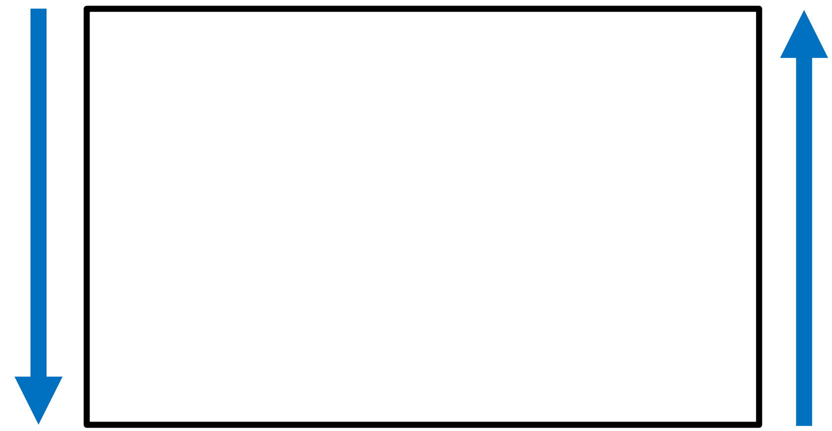


ELECTRON AFFINITY

Why	
DECREASES DOWN	**INCREASES TO RIGHT**

Reactivity

REACTIVITY

What	How
Elements in the same group have similar types of behaviors because they have the same number of valence electrons BUT The MAGNITUDE of their reactions changes!	

REACTIVITY

Why	
METALS INCREASE DOWN	**NON-METALS INCREASE UP**

Summary

IONIZATION ENERGY
ELECTRONEGATIVITY
ELECTRON AFFINITY
EFFECTIVE NUCLEAR CHARGE - Z_{EFF}

→

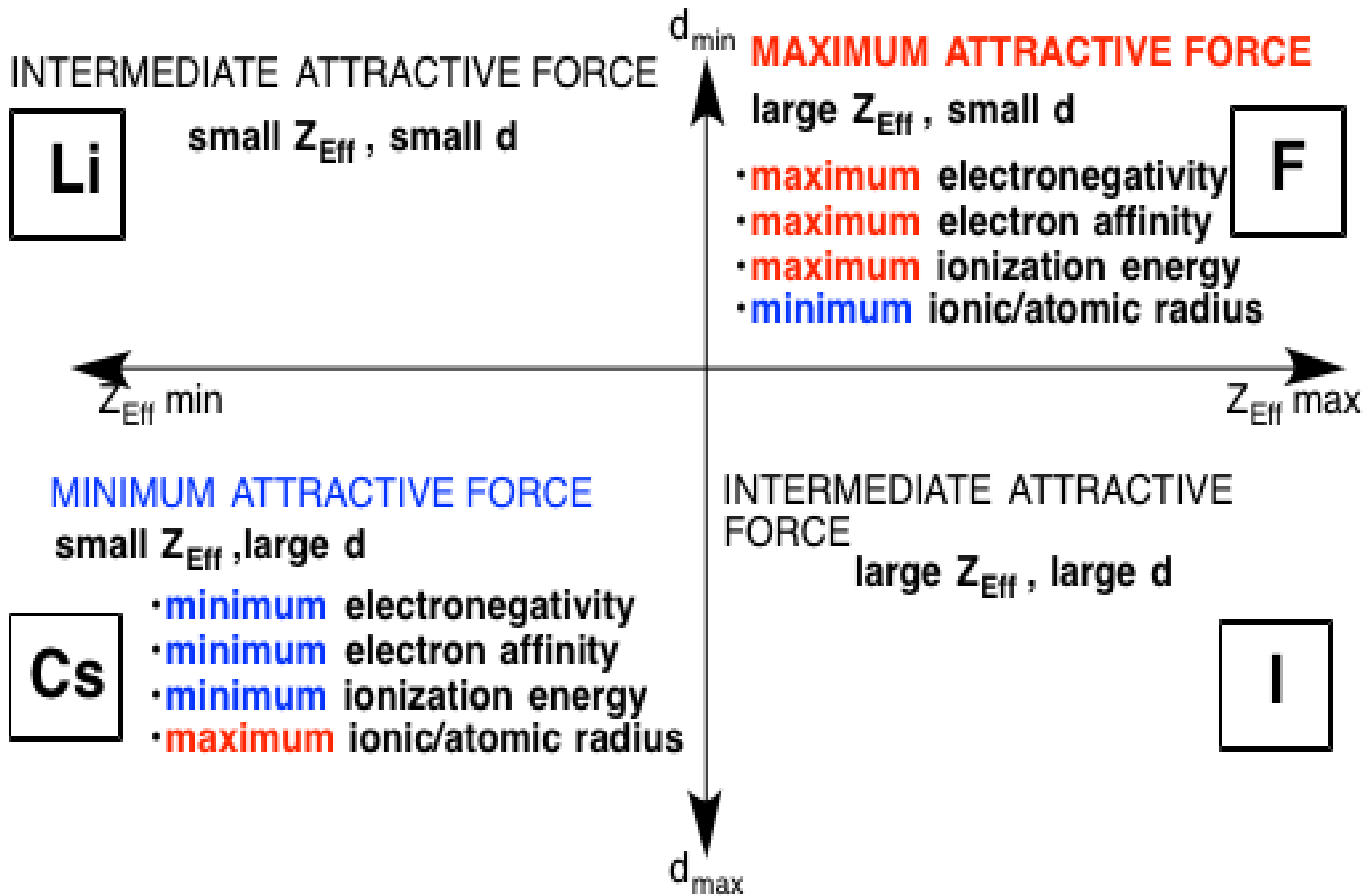
←

RADIUS

RADIUS
SHIELDING
↓

1A	2A	3B	4B	5B	6B	7B	8B			1B	2B	3A	4A	5A	6A	7A	8A
1 H 1.00794																	2 He 4.002602
3 Li 6.941	4 Be 9.012182											5 B 10.811	6 C 12.0107	7 N 14.0067	8 O 15.9994	9 F 18.9984032	10 Ne 20.1797
11 Na 22.989769	12 Mg 24.3050											13 Al 26.9815386	14 Si 28.0855	15 P 30.973762	16 S 32.065	17 Cl 35.453	18 Ar 39.948
19 K 39.0983	20 Ca 40.078	21 Sc 44.955912	22 Ti 47.867	23 V 50.9415	24 Cr 51.9961	25 Mn 54.938045	26 Fe 55.845	27 Co 58.933195	28 Ni 58.6934	29 Cu 63.546	30 Zn 65.38	31 Ga 69.723	32 Ge 72.64	33 As 74.92160	34 Se 78.96	35 Br 79.904	36 Kr 83.798
37 Rb 85.4678	38 Sr 87.62	39 Y 88.90585	40 Zr 91.224	41 Nb 92.90638	42 Mo 95.96	43 Tc [98]	44 Ru 101.07	45 Rh 102.90550	46 Pd 106.42	47 Ag 107.8682	48 Cd 112.411	49 In 114.818	50 Sn 118.710	51 Sb 121.760	52 Te 127.60	53 I 126.90447	54 Xe 131.293
55 Cs 132.9054519	56 Ba 137.327	57-71 Lanthanides	72 Hf 178.49	73 Ta 180.94788	74 W 183.84	75 Re 186.207	76 Os 190.23	77 Ir 192.217	78 Pt 195.084	79 Au 196.966569	80 Hg 200.59	81 Tl 204.3833	82 Pb 207.2	83 Bi 208.98040	84 Po [209]	85 At [210]	86 Rn [222]
87 Fr [223]	88 Ra [226]	89-103 Actinides	104 Rf [267]	105 Db [268]	106 Sg [271]	107 Bh [272]	108 Hs [270]	109 Mt [276]	110 Ds [281]	111 Rg [280]	112 Cn [285]	113 Uut [284]	114 Fl [289]	115 Uup [288]	116 Lv [293]	117 Uus [294]	118 Uuo [294]

↑
IONIZATION ENERGY
ELECTRONEGATIVITY
ELECTRON AFFINITY



INTERMEDIATE ATTRACTIVE FORCE
Li
small Z_{Eff} , small d
d_{min}
MAXIMUM ATTRACTIVE FORCE
large Z_{Eff} , small d
F
•maximum electronegativity
•maximum electron affinity
•maximum ionization energy
•minimum ionic/atomic radius
Z_{Eff} min
Z_{Eff} max
MINIMUM ATTRACTIVE FORCE
small Z_{Eff} ,large d
Cs
•minimum electronegativity
•minimum electron affinity
•minimum ionization energy
•maximum ionic/atomic radius
INTERMEDIATE ATTRACTIVE FORCE
large Z_{Eff} , large d
I
d_{max}

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!*

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

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