

Warm - Up

1. Write the electron configurations for F, Cl, and Br.
2. Draw the Lewis dot structure.
3. How many valence electrons in each?
4. If you were wondering if your favorite actor was in a new movie, how would you figure it out?

Today's Agenda

- QOTD: How is the periodic table organized?
- The scientists that developed the periodic table and how they did it!
- Types of elements
- Characterizations of elements by valence electrons

History of the Periodic Table

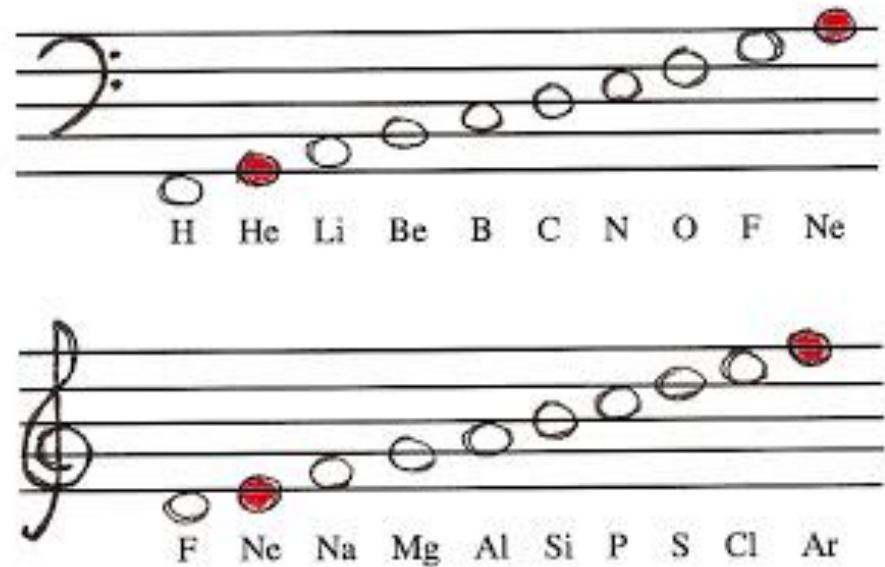
- Antoine Lavoisier's list of elements

	Simple Substances
Gases	Light, heat, dephlogisticated air, phlogisticated gas, inflammable air
Metals	Antimony, silver, arsenic, bismuth, cobalt, copper, tin, iron, manganese, mercury, molybdena, nickel, gold, platina, lead, tungsten, zinc
Nonmetals	Sulphur, phosphorous, pure charcoal, radical muriatique, radical fluorique, radical boracique
Earths	Chalk, magnesia, barote, clay, siliceous earth

- By 1870 there was 70 known elements

Organizing the Elements

- John Newlands – 1864 organized elements by atomic MASS.
 - Properties repeated every 8th element
 - Law of octaves
(like music patterns)



Is the table still organized by mass?

- Meyer and Medeleev
 - Atomic mass is related to properties
 - Mendeleev published the first periodic table.

Sc, Ga, Ge
predicted!

THE PERIODIC LAW
Mendelejeff's First Periodic Table (March, 1869)

				Ti 50	Zr 90	? 100
				V 51	Nb 94	Ta 182
				Cr 52	Mo 96	W 186
				Mn 55	Rh 104.4	Pt 197.4
				Fe 56	Ru 104.4	Ir 198
			Ni-Co 59	Pd 106.6	Os 199	
			Cu 63.4	Ag 108	Hg 200	
			Zn 65.2	Cd 112		
			? 68	U 116	Au 197?	
			? 70	Sn 118		
			As 75	Sb 122	Bi 210?	
			Se 79.4	Te 128?		
			F 19	Cl 35.5	Br 80	I 127
Li 7	Na 23	K 39		Rb 85.4	Cs 133	Tl 204
		Ca 40		Sr 87.6	Ba 137	Pb 207
		? 45		Ce 92		
		Er? 56		La 94		
		Yt? 60		Di 95		
		In 75.6?		Th 118?		

Feuding Scientists (Table 6.2)

- Arranging by MASS = problematic
- Moseley – 1913
 - Stated atomic # as # of protons
 - Arranging by atomic NUMBER solved problems.
- Periodic Law – Periodic repetition of chemical and physical properties of elements when they are arranged by increasing atomic number

Groups (families) = columns

Periods = rows

Representative Elements

Transition Elements

Periodic Table of the Elements

1	2											3	4	5	6	7	8	9	10										
H												B	C	N	O	F	Ne												
3	4											13	14	15	16	17	18												
Li	Be											Al	Si	P	S	Cl	Ar												
11	12	III B	IV B	V B	VI B	VII B	VIII B			IB	II B	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36
Na	Mg	Sc	Ti	V	Cr	Mn	Fe	Co	Ni	Cu	Zn	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	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	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	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	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	87	88	89	104	105	106	107	108	109	110	111	112	113					
Fr	Ra	+ Ac	Rf	Ha	Sg	Bh	Hs	Mt	Ds	Uuu	Uub	Fr	Ra	+ Ac	Rf	Ha	Sg	Bh	Hs	Mt	Ds	Uuu	Uub	Uut					

* Lanthanide Series

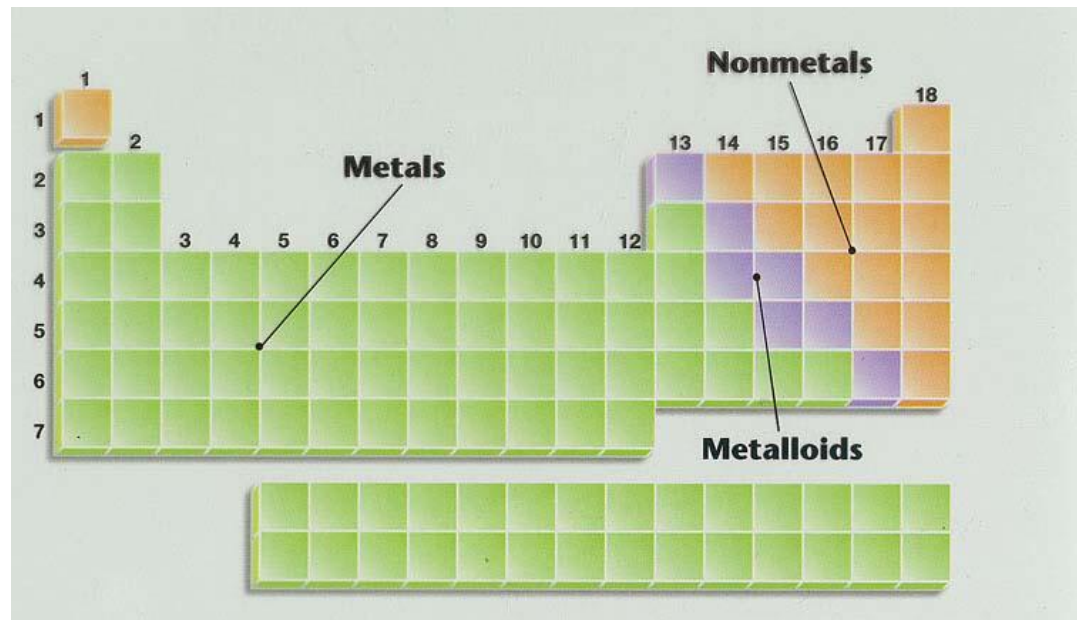
58	59	60	61	62	63	64	65	66	67	68	69	70	71
Ce	Pr	Nd	Pm	Sm	Eu	Gd	Tb	Dy	Ho	Er	Tm	Yb	Lu

+ Actinide Series

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

Metals

- Shiny, smooth, solid at room temp, good conductors of electricity, malleable and ductile (can be bent and reshaped).



Forming Ions

- All representative elements want a ~~_____ Noble~~ _____ **Gas** Configuration.
- Elements will lose/gain electrons in order to have a full s and p shell and be in a **stable** electron configuration (8 valence) → **OCTET RULE!**
- **Metals LOSE / Nonmetals GAIN electrons**
- **What ion does Na form?**
 - If Na loses 1 electron its got an NGC! Na is always a +1 cation.

Warm Up

- What is the octet rule?
- Where are the metals and where are the nonmetals on the periodic table?
- What do groups (or families) have in common?

Today's Agenda

- QOTD: What are the groups and what are their properties?
- Review
- Groups/properties
- Periodic Trends
- HW: pg 198 #'s 26,29,30-35,37,42, 45,46,48,51,54

Review

1. Elements were initially arranged according to their _____. They were later reorganized by _____ because their properties were consistent with their placement on the table.
2. Representative or transition element??
Iodine, Chromium, Uranium, Cesium
3. What are the names for group 1 and 2 metals?
4. What do atoms try to achieve when forming ions?

Predict the Ions!

• Mg will form an _____ ion.

A) +1

C) +3

B) +2

D) -1

• Cl will form an _____ ion.

A) +1

C) -1

B) +2

D) -2

What about Oxygen? Al?

Alkali and Alkaline Earth Metals

- Alkali metals – group 1 except for H (very reactive)
- Alkaline earth metals – group 2 (also reactive)

Group →

Periodic Table of the Elements

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	
	IA																		0
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 Ha	106 Sg	107 Bh	108 Hs	109 Mt	110 Ds	111 Uuu	112 Uub	113 Uut						

* Lanthanide Series

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
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+ Actinide Series

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
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Transition Metals = d & f block

3 4 5 6 7 8 9 10 11 12
Group →

Periodic Table
of the Elements

IIIB	IVB	VB	VIB	VIB	—VIII—	IB	II B		
21 Sc	22 Ti	23 V	24 Cr	25 Mn	26 Fe	27 Co	28 Ni	29 Cu	30 Zn
39 Y	40 Zr	41 Nb	42 Mo	43 Tc	44 Ru	45 Rh	46 Pd	47 Ag	48 Cd
57 *La	72 Hf	73 Ta	74 W	75 Re	76 Os	77 Ir	78 Pt	79 Au	80 Hg
89 +Ac	104 Rf	105 Ha	106 Sg	107 Bh	108 Hs	109 Mt	110 Ds	111 Uuu	112 Uub

Can form ions of many charges
and complex ions.

ALWAYS CATIONS!!!!

METALS ARE LOSERS!!

* Lanthanide
Series

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

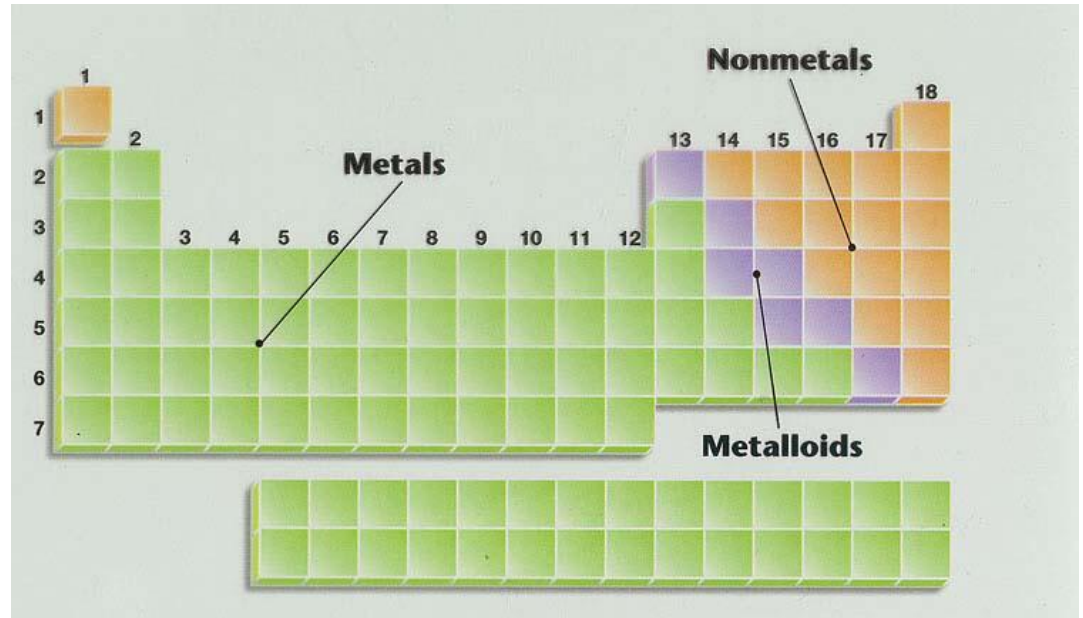
+ Actinide
Series

Nonmetals

- Usually gases or dull brittle solids. Poor conductors of heat or electricity.

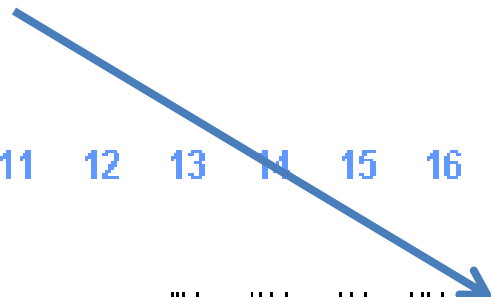


One of the only liquids at RT



Halogens

Also highly reactive
Form ANIONS easily



Group →

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18

IA IIA IIIA IVA VA VIA VIIA 0

**Periodic Table
of the Elements**

1	H																	2
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	Ra	+Ac	Rf	Ha	Sg	Bh	Hs	Mt	Ds	Uuu	Uub	Uut					

* Lanthanide Series

+ Actinide Series

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Noble Gases

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18
 IA Group → 0

Periodic Table
of the Elements

1	H											2	He																						
3	Li	4	Be											5	B	6	C	7	N	8	O	9	F	10	Ne										
11	Na	12	Mg	III B	IV B	V B	VI B	VII B	VIII B		IB	II B	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	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
87	Fr	88	Ra	89	+Ac	104	Rf	105	Ha	106	Sg	107	Bh	108	Hs	109	Mt	110	Ds	111	Uuu	112	Uub	113	Uut										

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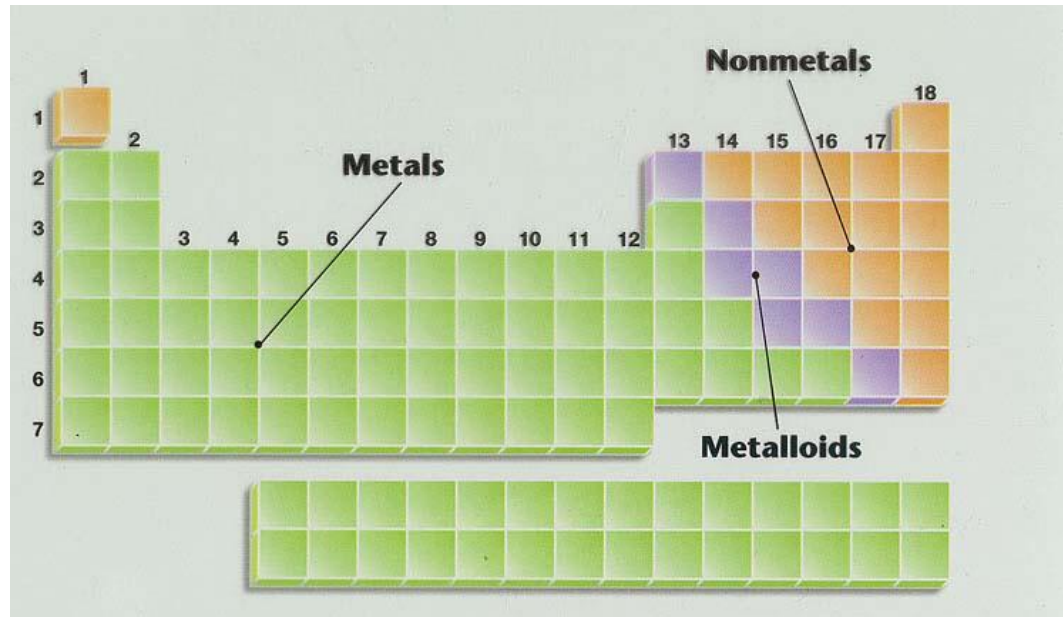
UNreactive

Don't form IONS

Important when considering ions and how they form

Metalloids

- Have properties of both metals and nonmetals.
- Silicon and germanium used extensively in solar cells and computer chips .



Warm Up!

- Sketch a periodic table. Identify:

Metals (all 3 types)

Halogens

Nonmetals

Noble gases

Metalloids

- What are some general characteristics of metals and nonmetals?
- Li, F, Se, Kr, predict the ions

Today's Agenda

- QOTD: How can we predict chemical behavior?
- Classification of elements by valence electrons
- Periodic Trends
- Atomic Radii
- HW due tomorrow

Predicting Trends! (Copy down questions and wait for data)

- Make predictions about Fr!
 1. From the data, devise a plan to predict mp, bp, and radius of Fr. Why can we do this?
 2. Is Fr a solid, liquid, or gas at RT?
 3. Which column do you think introduces the most error (mp, bp, or radius)?

These are called Periodic Trends and are seen all over the table!

Alkali Metals Data

Element	Melting Point (°C)	Boiling Point (°C)	Radius (pm)
Lithium	180.5	1347	152
Sodium	97.8	897	186
Potassium	63.3	766	227
Rubidium	39.31	688	248
Cesium	28.4	674.8	248
Francium	?	?	?

Classification of Elements

- Valence electrons - All electrons in the highest principle energy level (outermost electrons).

How many valence electrons in Na, Li, K, Rb?

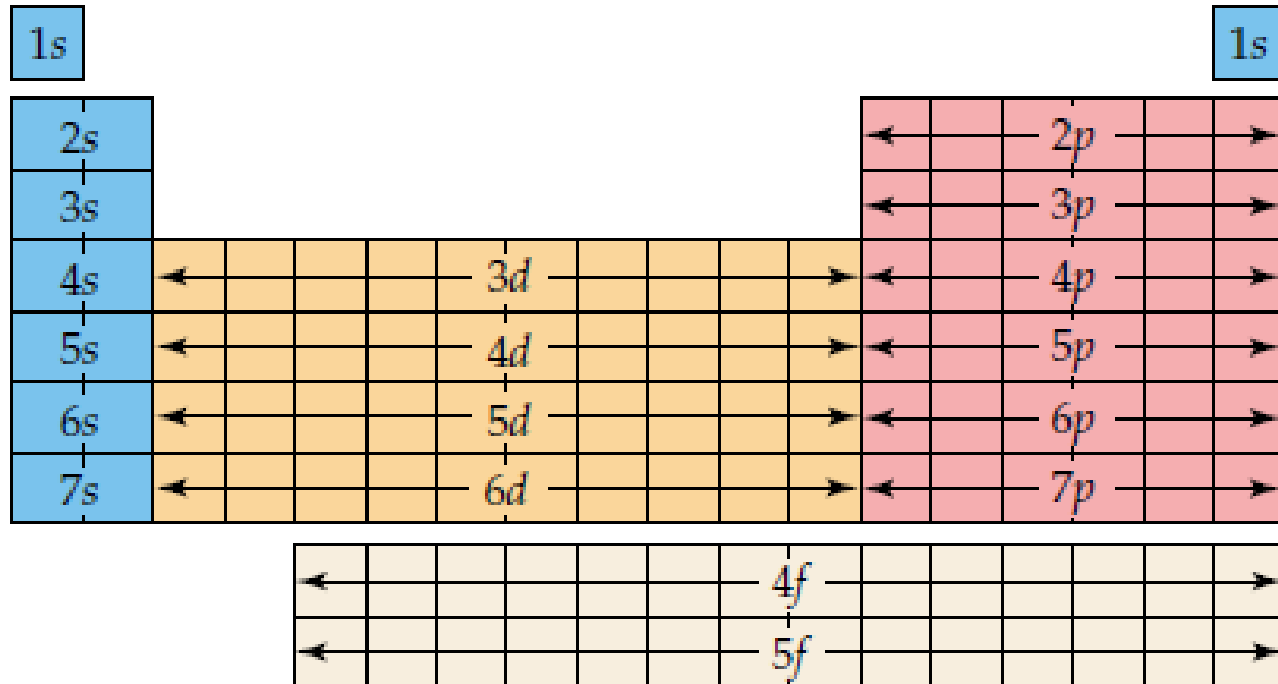
All members in each GROUP have the same number of valence electrons.


Where the valence electrons are indicates the PERIOD.

Valence Electrons and Groups


- Determine the valence electrons for groups 1, 2, 13-18.
- The group will indicate the number of valence electrons.
- ONE exception : He
 - Helium is a noble gas but only has 2 valence electrons.

Remember...



 Representative *s*-block elements

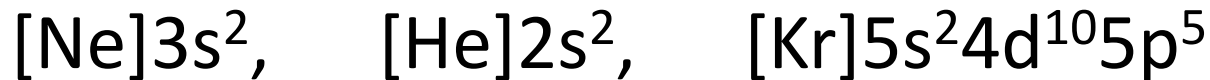
 Transition metals

 Representative *p*-block elements

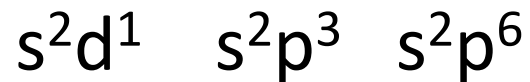
 *f*-Block metals

Try these:

- **Without using the table**, determine the group, period, and block of these elements:



- What are the symbols for the elements with the following valence electron configurations?



- Write the electron configs:

group 2 element in 4th period

noble gas in 5th period

group 12 element in the fourth period

group 16 element in the second period

Warm Up

- Write the electron configs:
group 2 element in 4th period
noble gas in 5th period
Prefers -2 charge in the second period
- Name the atom
- Forms +3 ion Period 3
- Two valence electrons Period 2
- $n = 4$ with 6 valence electrons

Warm Up – Welcome back

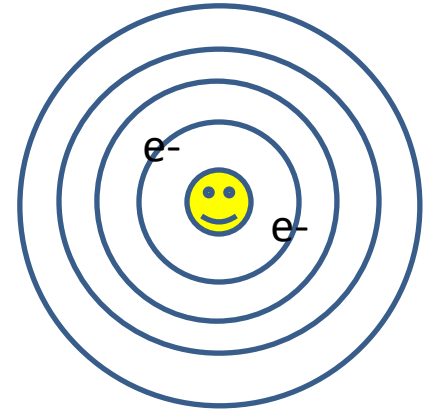
- List the alkali metals in order of increasing reactivity in water.
- Why do the alkali metals all react similarly?
- Name the element:
- An alkaline earth in period 5
- $n = 4$ in the group of the LEAST reactive elements

Agenda

- What is Z_{eff} ? How does it affect all the other periodic trends?
- Z_{eff}
- Atomic radii/Ionic radii
- Ionization energy
- HW: pg 199 # 56 – 59, 62-66, 69, 70

Effective Nuclear Charge

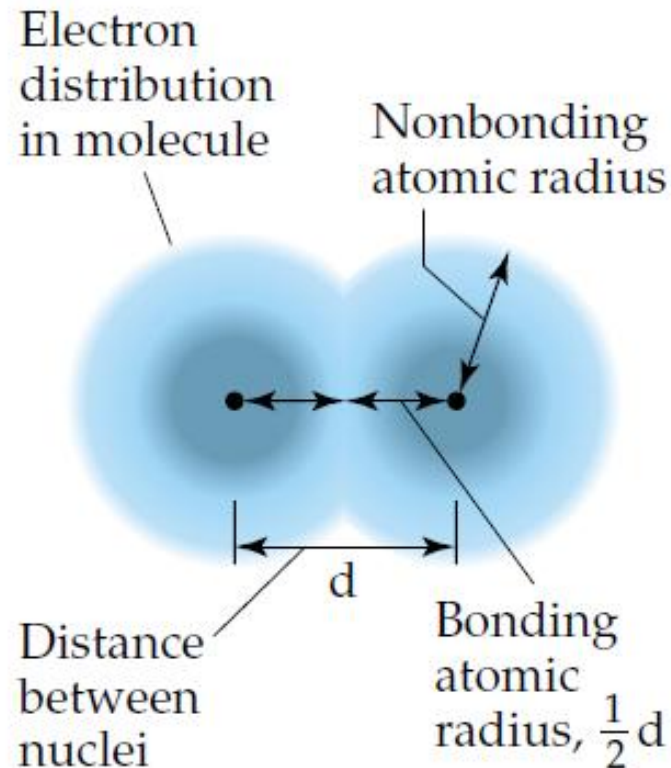
- Electrons are pulled toward nucleus like a magnet. The stronger the force that the electrons feel the more the “rings” will contract.



- $Z - S = Z_{\text{eff}}$
- Down a group – no change
- Across a period – Z_{eff} stronger! (more “pull”)

Trends - Atomic Radius

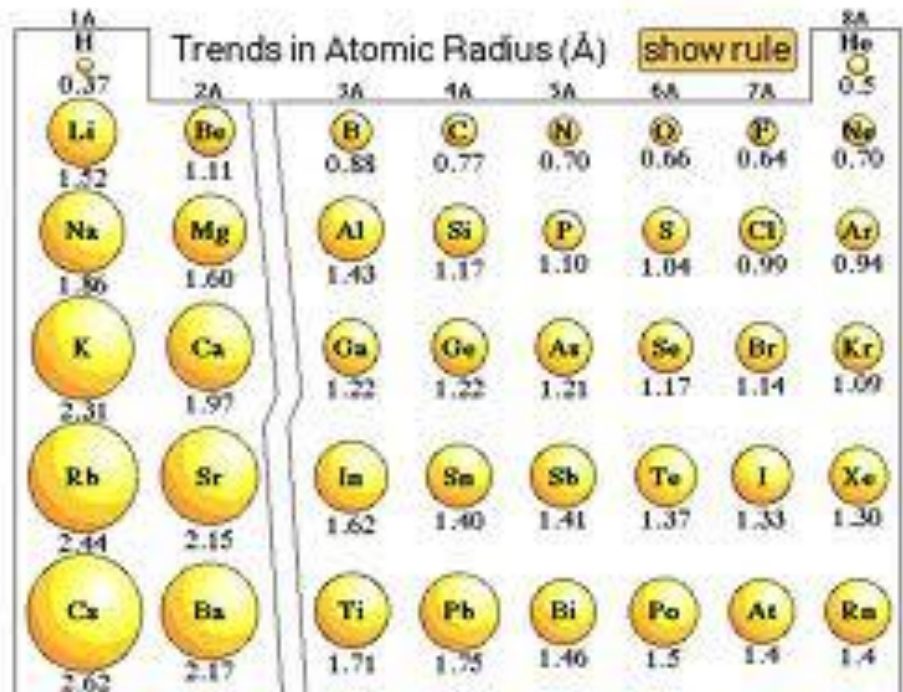
- Atomic radius – half the distance between adjacent nuclei in a crystal of the element.



Periodic Trends– Atomic Radii

- Atomic Radii decreases across a period.

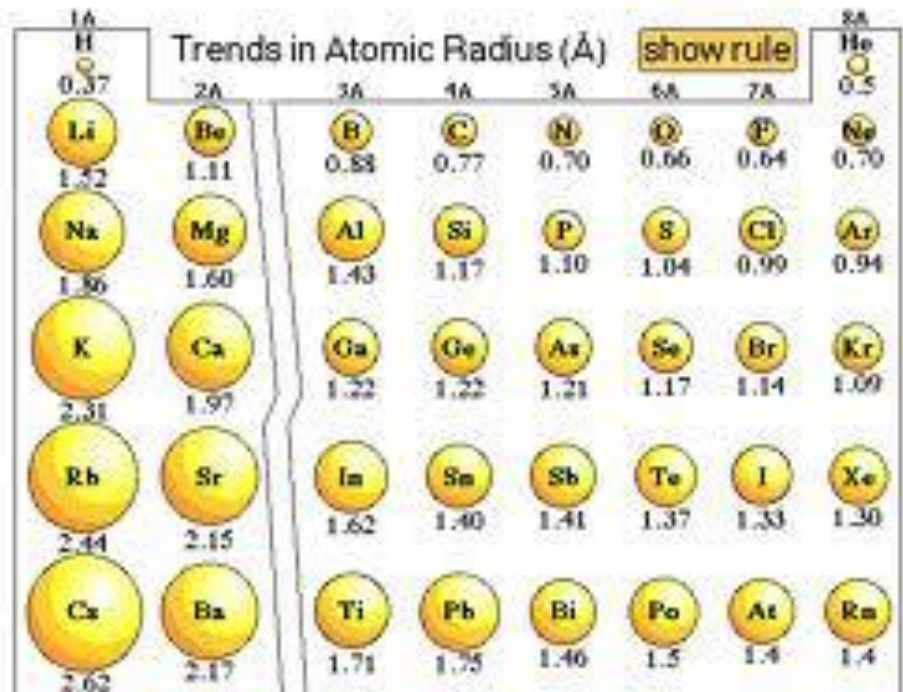
Add electrons to same energy level → more attracted to the nucleus. Electrons squeeze in and radii get smaller.



Periodic Trends– Atomic Radii

- Atomic radii increase down a group.

Add energy levels and electrons, with more “stuff” comes bigger atoms.



What about Ions?

- Ions have positive or negative charges.
- Cations have positive charges and have a SMALLER atomic radii than their atoms.
 - Lose electrons to form cations – less stuff = smaller radii
- Anions have negative charges and have a LARGER atomic radii than their atoms.
 - Gain electrons to form anions – more stuff = larger radii

Draw:

- A metal atom and its ion (consider relative sizes)
- A nonmetal atom and its ion (consider relative sizes)

Circle the Largest atom or ion

- a) Cl or Cl⁻
- b) Mg or Sr
- c) Mg or Si
- d) Mg or Mg⁺
- e) Se²⁻ or Br⁻

Warm - Up

- What happens to atomic radii (size) across a period? Why does this happen?
- What happens to atomic size down a group? Why does this happen
- Why are cations smaller than their atoms and anions larger?

Today's Agenda

- QOTD: How do periodic trends relate to the arrangement of electrons and ENERGY?
- Ionization energy – definition and trends
- Electronegativity – definition and trends
- HW due tomorrow, quiz Friday, lab due today!

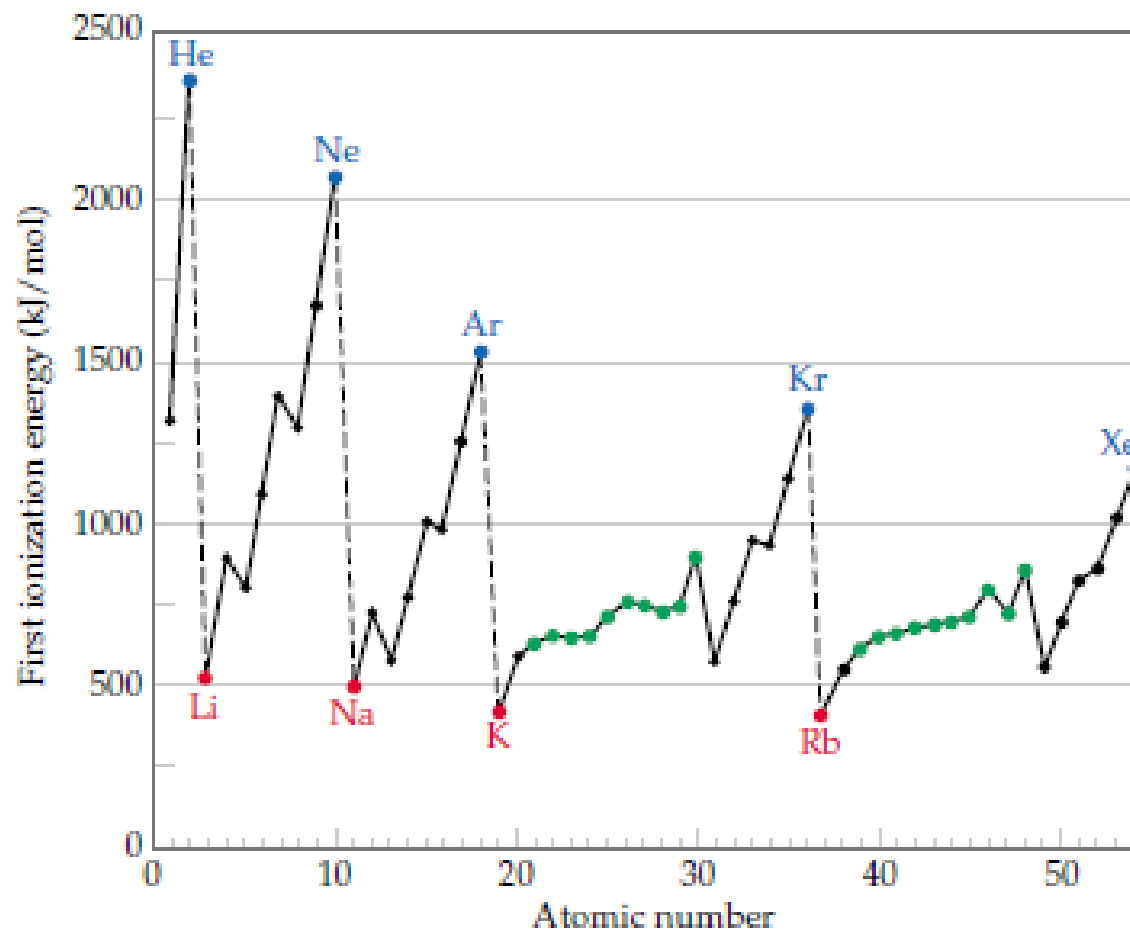
Ionization Energy

- The energy required to remove an electron from an atom.
- How strongly an atom holds on to its valence electrons.
 - Is it easier to remove an electron from a metal or a nonmetal?
- Metals have LOW ionization energy because they are LOSERS and give up electrons easily.

Trends in Ionization Energy

- Remember, across a period:
 Z_{eff} increases, size decreases... is it easy to remove an electron??
- Down a group, Z_{eff} constant, size increases... is it easy to remove an electron??

Trends in Ionization Energies



Removing More than 1 Electron

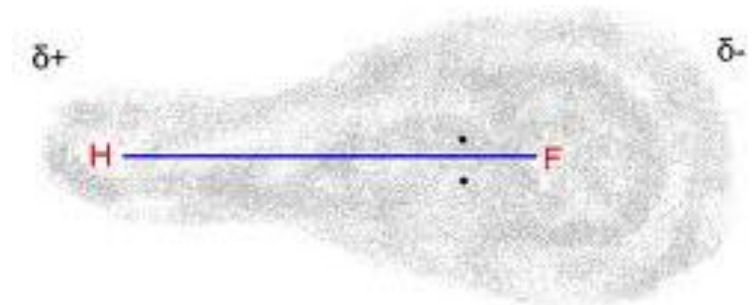
- Second and Third ionization energies...
Get's harder to remove as you remove more.

TABLE 7.2 Successive Values of Ionization Energies, I , for the Elements Sodium Through Argon (kJ/mol)

Element	I_1	I_2	I_3	I_4	I_5	I_6	I_7
Na	495	4562					(inner-shell electrons)
Mg	738	1451	7733				
Al	578	1817	2745	11,577			
Si	786	1577	3232	4356	16,091		
P	1012	1907	2914	4964	6274	21,267	
S	1000	2252	3357	4556	7004	8496	27,107
Cl	1251	2298	3822	5159	6542	9362	11,018
Ar	1521	2666	3931	5771	7238	8781	11,995

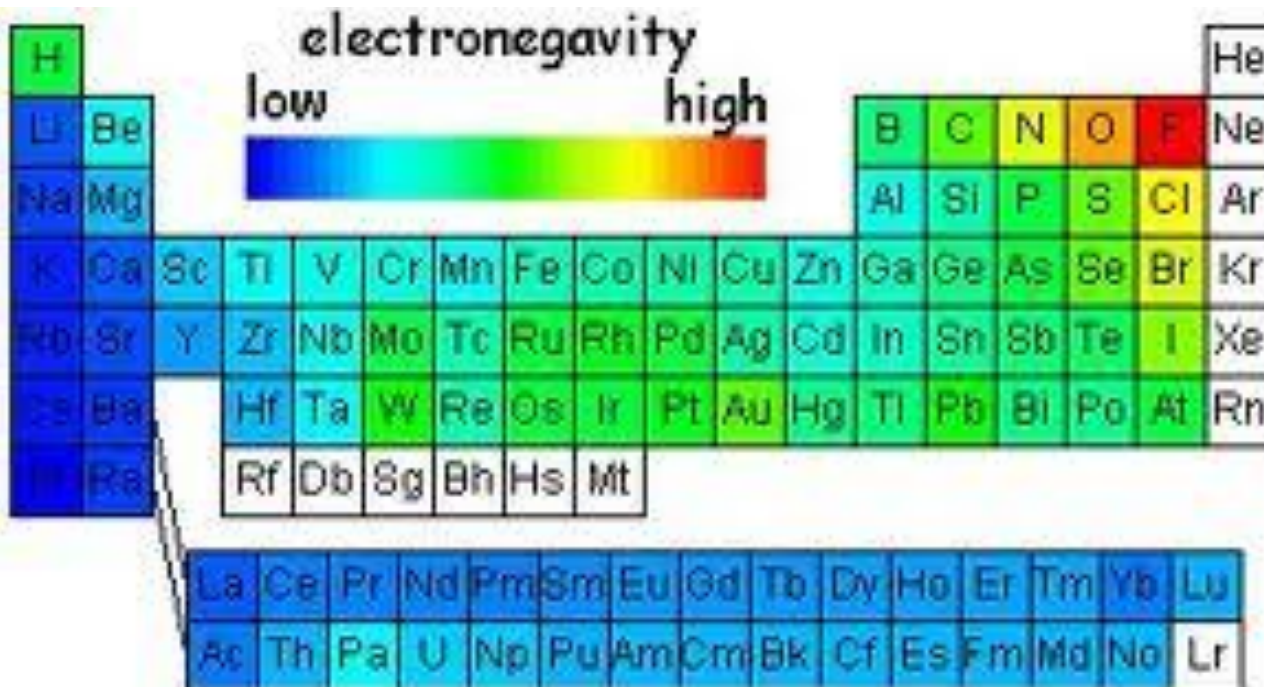
Electronegativity

- *Relative ability of an element to attract electrons in a chemical bond.*
- Some elements are **greedier** than others with electrons! In a bond, they **steal most of the electron density!**
- Fluorine is small and selfish!

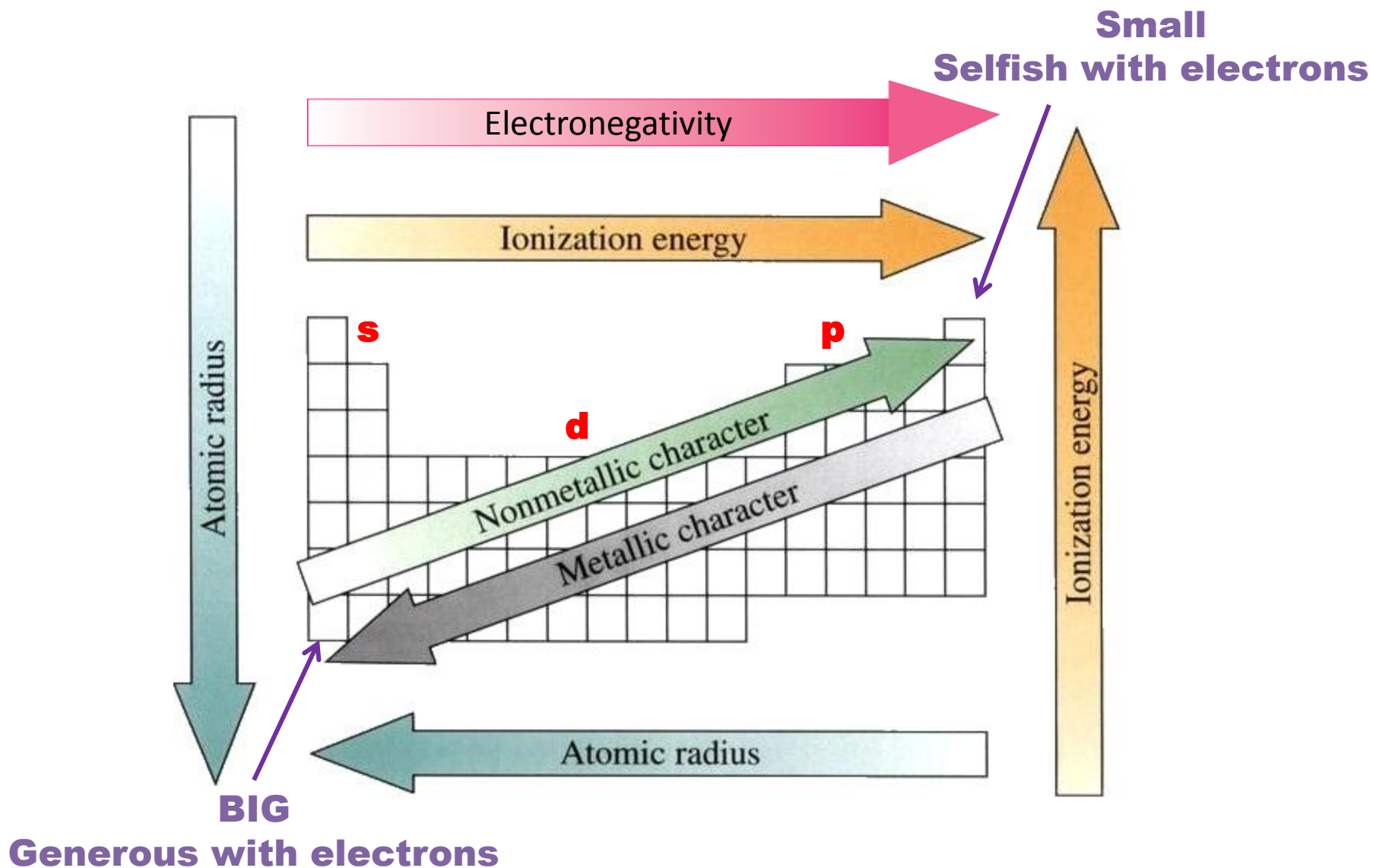


Electronegativity Trends

- Electronegativity INCREASES across a period.
and DECREASES down a group!



Periodic Trend Summary



Identify

- Trends in atomic radii – Sizes of atoms decrease across a period and increase down a group.
- Trends in ionic radii - Sizes of cations are smaller than their atoms, sizes of anions are larger than their atoms
- Trends in ionization energy -
How much energy does it take to remove an electron? Metals require less ionization energy

Identify

- Electronegativity –

In bonds, one element can pull all the electron cloud towards itself depending on how badly that atom wants an electron.

- Noble gas configurations and octet rule-

Lowest in energy! All elements want to be more stable and have lower energy, so they IONIZE to look like the noble gases. 8 valence electrons!

Today's Agenda

- QOTD: How do periodic trends relate to the arrangement of electrons and ENERGY?
- Review trends in radii and ionization energy
- Electronegativity – definition and trends
- Practice Worksheet

Warm Up!

- Using the periodic table, rank each group in order of increasing size
 - Calcium, magnesium, and strontium
 - Oxygen, lithium, and fluorine
 - Selenium, chlorine, and tellurium
- Write electron configs, draw Lewis diagrams and predict the ion
 - F
 - S
 - Ba

Warm Up!

- Using the periodic table, rank each group of in order of increasing size
 - Calcium, magnesium, and strontium
 - Oxygen, lithium, and fluorine
 - Selenium, chlorine, and tellurium
- Write electron configs, draw Lewis diagrams and predict the ion
 - F
 - S
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Warm Up

1. Rank these in order of increasing atomic size:

P, Al, Na, Ar, S

P, Bi, N, Sb

Justify your answer...(why is that the trend)

2. Rank the following in order of increasing ionization energy and justify your answer.

P, Al, Na, Ar, S

P, Bi, N, Sb

3. Define electronegativity. What is the most electronegative atom.

Today's Agenda

- QOTD: How does electronegativity affect bonding?
- Trends Practice
- Polar vs non-polar activity
- Review sheet
- Ch 6 Quiz on Friday! Review sheet due Friday.

Practice

- Why is it hard to remove a second electron from Li?
- If the ionization energy increases drastically after you remove 2 electrons, in which group is the element most likely?
- Is it easier to remove an electron from Mg or from Cl? Why?
- Rate these with increasing IE then with increasing electronegativity
 - Ca, Se, Ge, Kr
 - Te, S, Se, O