

Chapter 6

Groups (families) = columns

Periods = rows

Representative Elements

Transition Elements

Periodic Table of the Elements

1A	1	H	IIA	2	He															
2	3	Li	4	Be	5	6	7	8	9	10										
3	11	Na	12	Mg	III B	IV B	V B	VI B	VII B	VIII B	IB	IIB	13	14	15	16	17	18		
4	19	K	20	Ca	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36
5	37	Rb	38	Sr	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54
6	55	Cs	56	Ba	*La	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86
7	87	Fr	88	Ra	+Ac	104	105	106	107	108	109	110	111	112	113					

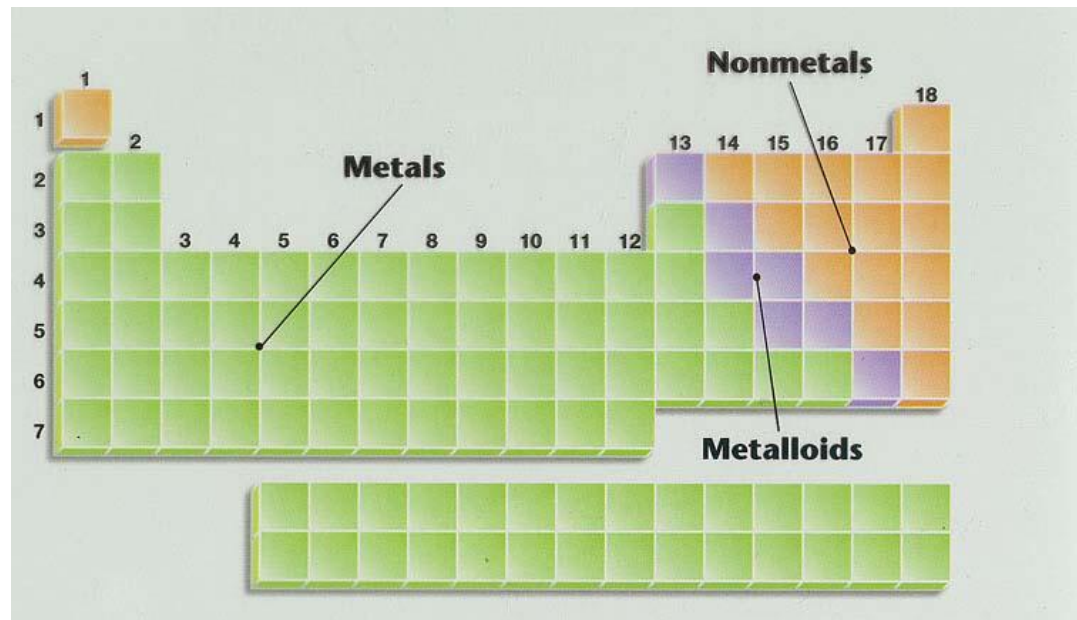
* Lanthanide Series

+ Actinide 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
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).



Alkali and Alkaline Earth Metals

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

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
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	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

Transition Metals

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

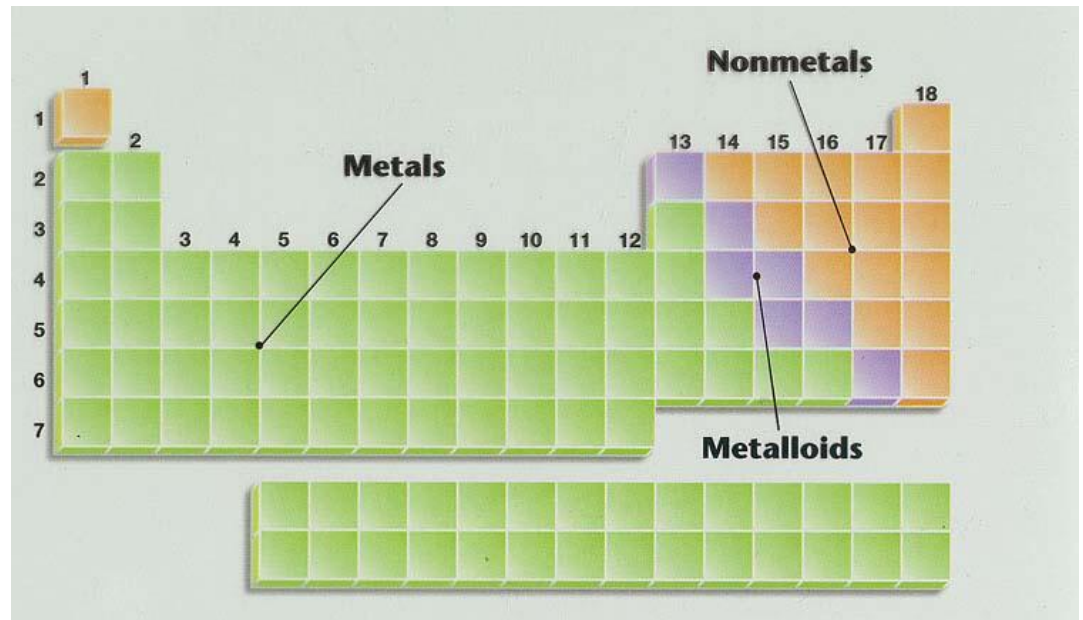
+ Actinide
Series

Nonmetals

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

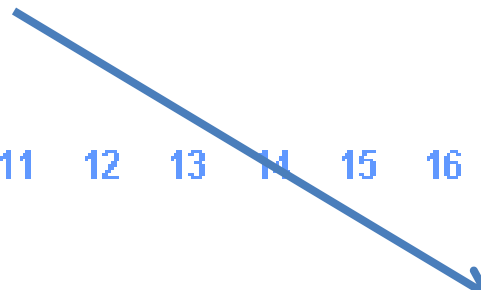


One of the only liquids at RT



Halogens

Also highly reactive
Form ANIONS easily



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	VIB	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	*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	+Ac	104 Rf	105 Ha	106 Sg	107 Bh	108 Hs	109 Mt	110 Ds	111 Uuu	112 Uub	113 Uut					

* Lanthanide Series

+ Actinide 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

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	2											3	4	5	6	7	8	9	10
1	IIA											IIIA	IVA	VA	VIA	VIIA	0	2	
1	H											5	6	7	8	9	10		
2	3	4											13	14	15	16	17	18	
2	Li	Be											B	C	N	O	F	Ne	
3	11	12	III B	IV B	V B	VI B	VII B	VIII B		IB	II B	13	14	15	16	17	18		
3	Na	Mg											Al	Si	P	S	Cl	Ar	
4	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	
4	K	Ca	Sc	Ti	V	Cr	Mn	Fe	Co	Ni	Cu	Zn	Ga	Ge	As	Se	Br	Kr	
5	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	
5	Rb	Sr	Y	Zr	Nb	Mo	Tc	Ru	Rh	Pd	Ag	Cd	In	Sn	Sb	Te	I	Xe	
6	55	56	57	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86	
6	Cs	Ba	*La	Hf	Ta	W	Re	Os	Ir	Pt	Au	Hg	Tl	Pb	Bi	Po	At	Rn	
7	87	88	89	104	105	106	107	108	109	110	111	112	113						
7	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

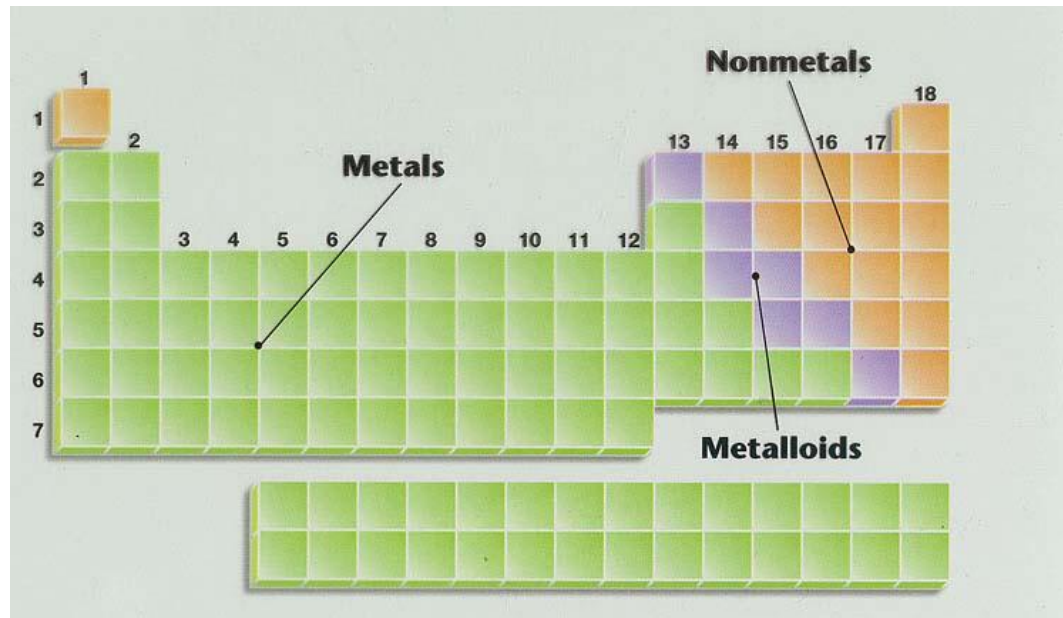
UNreactive

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 .



Review Questions!

- Who were the major players in the development of the periodic table?

- Sketch a periodic table. Identify:

Metals (all 3 types)

Halogens

Nonmetals

Noble gases

Metalloids

- What are some general characteristics of metals and nonmetals?
- Characterize each: Li, F, C, Kr, Ge, Mg

Warm Up!

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

Today's Agenda

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

Metals 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!

Classification of Elements

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

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

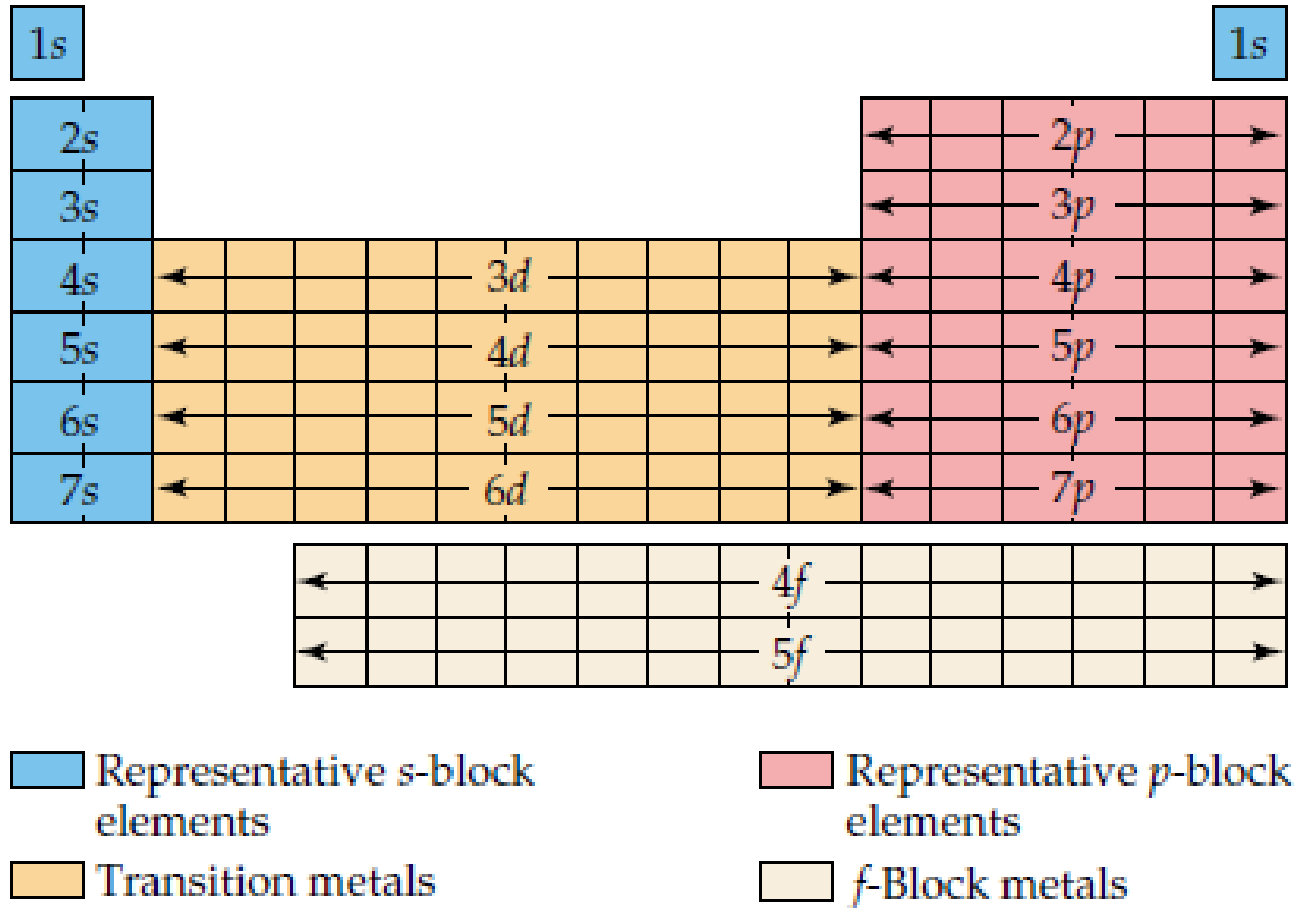
All members in each GROUP have the same number of valence electrons.

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.

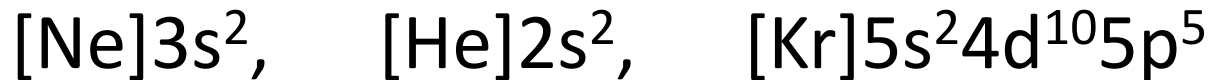
Remember...



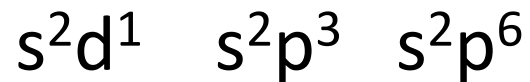
- Read over this section in the book pg 183-184 about spdf blocks

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

- Find the atom
- Group 13 Period 4
- Two valence electrons Period 2
- $N = 4$ with 6 valence electrons
- All atoms with 4 valence electrons...classify as metals, nonmetals and metalloids.

Today's agenda

- QOTD: Why are noble gases so important?
- Radii of atoms and ions
- Octet rule and Ionization energies
- Electronegativity
- Homework Due Friday: Read 6.3 #'s 58-9, 61-62, 64, 66, 69, 70, 72, 79, 81, 86

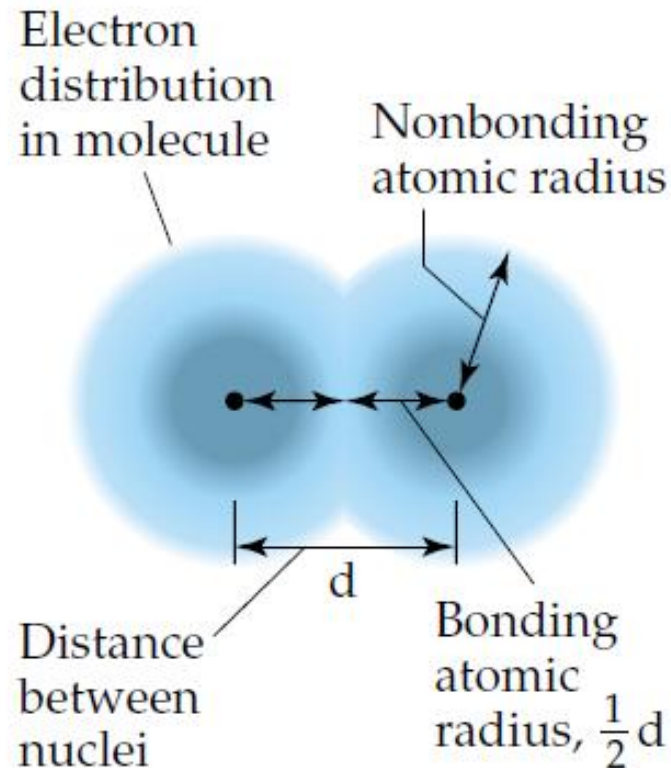
Metals Data

- 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!

Trends - Atomic Radius

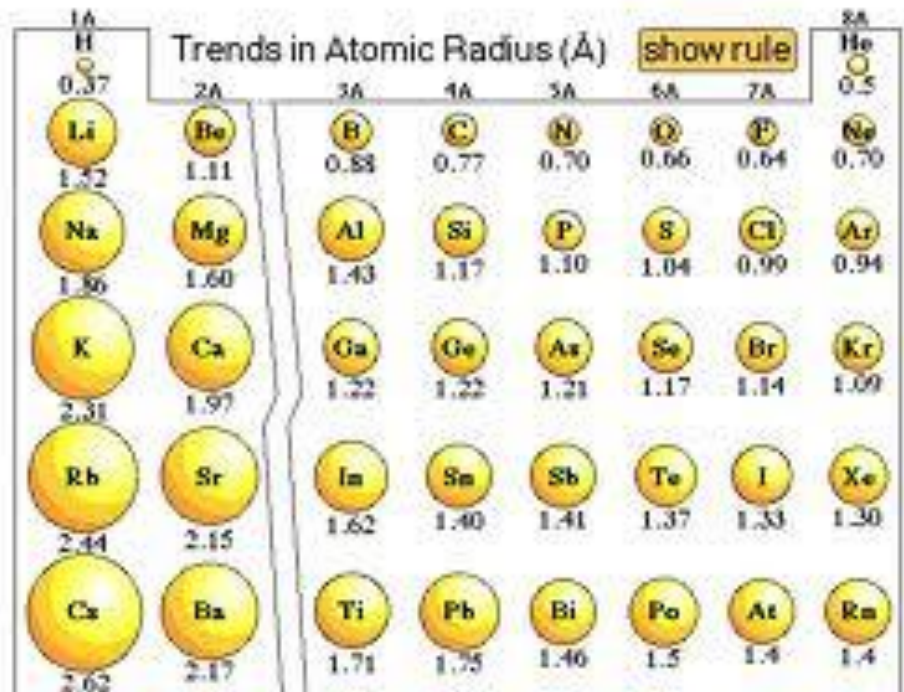
- Atomic radius – half the distance between adjacent nuclei in a crystal of the element.



Periodic Trends– Atomic Radii

- Atomic Radii decreases across a period.

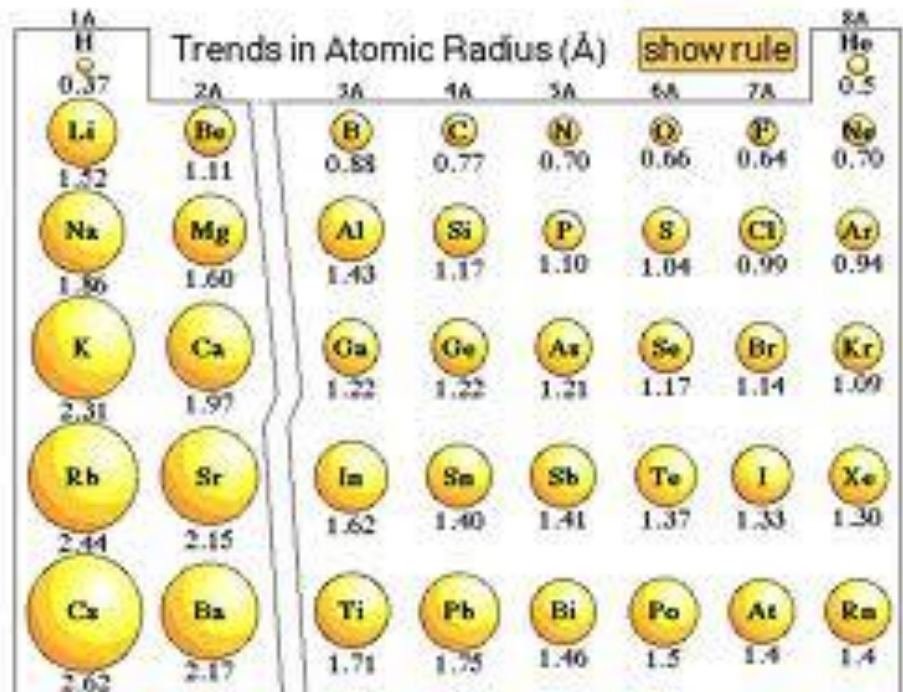
Add electrons to same energy level → more attracted to the nucleus. Electrons squeeze in and radii get smaller.



Periodic Trends– Atomic Radii

- Atomic radii increase down a group.

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



Warm Up!

- Identify the elements:
- I am in period 3 and have 4 valence electrons.
- I am in period 2 and have the smallest radii.
- I am smaller than Rb and bigger than Na but we are in the same family.
- I am a metalloid in group 13 and have no d orbitals.

Today's agenda

- QOTD: Why are noble gases so important to other elements?
- Radii of ions
- Octet rule and Ionization energies
- Electronegativity
- Homework Due Friday: Read 6.3 #'s 58-9, 61-62, 64, 66, 69, 70, 72, 79, 81, 86

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)

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!** Attain a **NGC!**
- What ion does Na form?
 - If Na loses 1 electron its got an NGC! Na is always a +1 cation.

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? K?

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

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

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.

Which is bigger?

List these atoms with increasing radii.

- a. Carbon, fluorine, beryllium, or lithium?
- b. Magnesium, silicon, sulfur, sodium

Describe ionic radius as you go across period 3

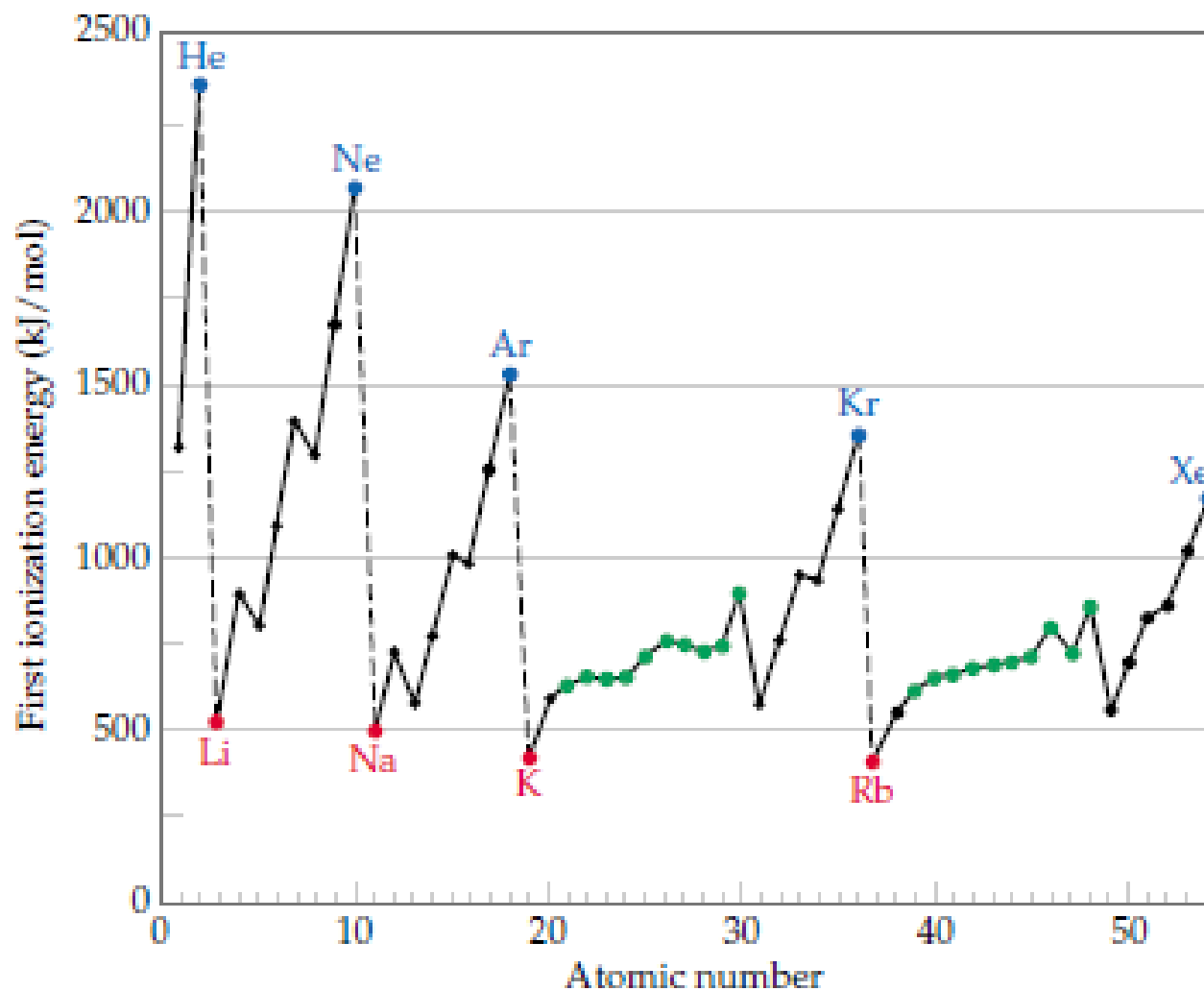
Identify the elements:

- I am in period 2 and have the smallest atomic radii (leave out Ne).
- I am smaller than Rb and bigger than Na but we are in the same family.

Agenda

- What is electronegativity?
- Exams
- Finish periodic trends
- Problem Set due Thursday

Trends in Ionization Energies



Octet Rule

- Elements will **lose/gain or share** electrons in order to have a full s and p shell and a **stable electron configuration (8 valence)** (like NOBLE GASES!)

Removing More than 1 Electron

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					
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

Warm Up!

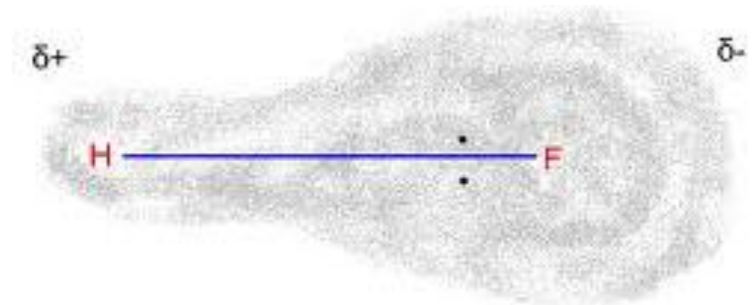
- Why is it hard to remove a second electron from Li?
- Is it easier to remove an electron from Mg or from Cl? Why? (Provide 2 reasons)

Agenda

- What are the overall trends and what do they have to do with one another?
- Electronegativity
- Overall trends scheme
- Worksheet from Friday!
- Problem Set due Thursday

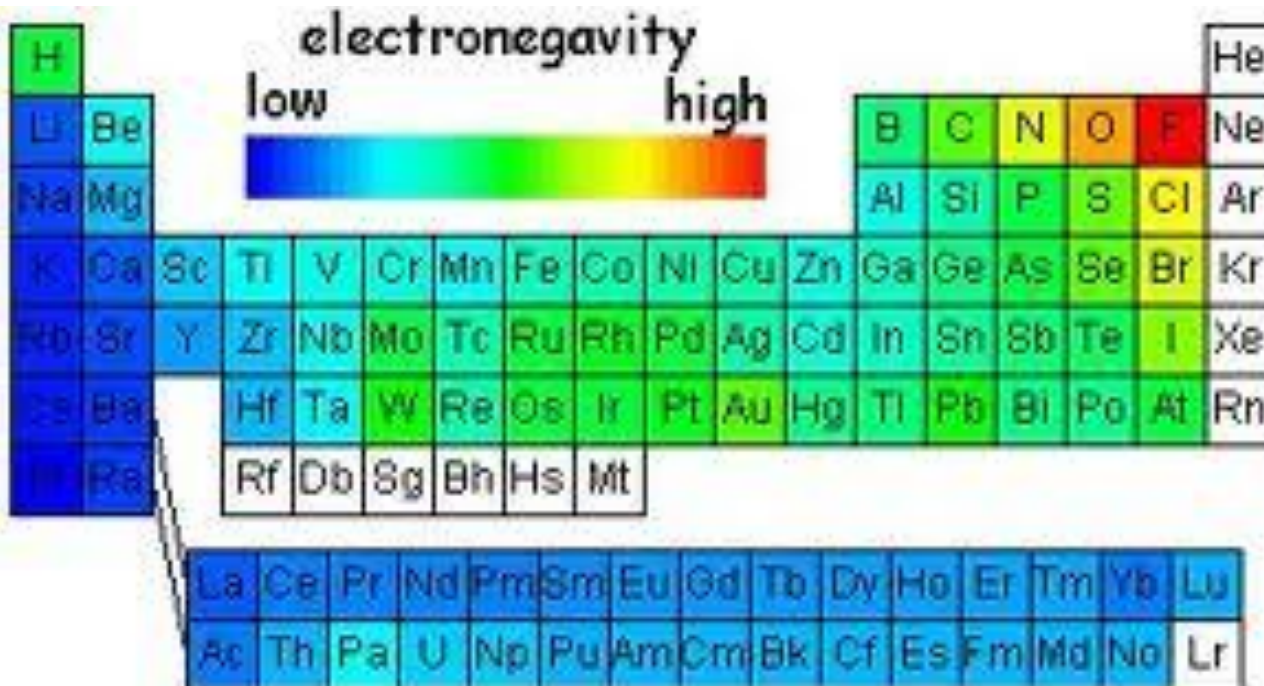
Electronegativity

- *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!

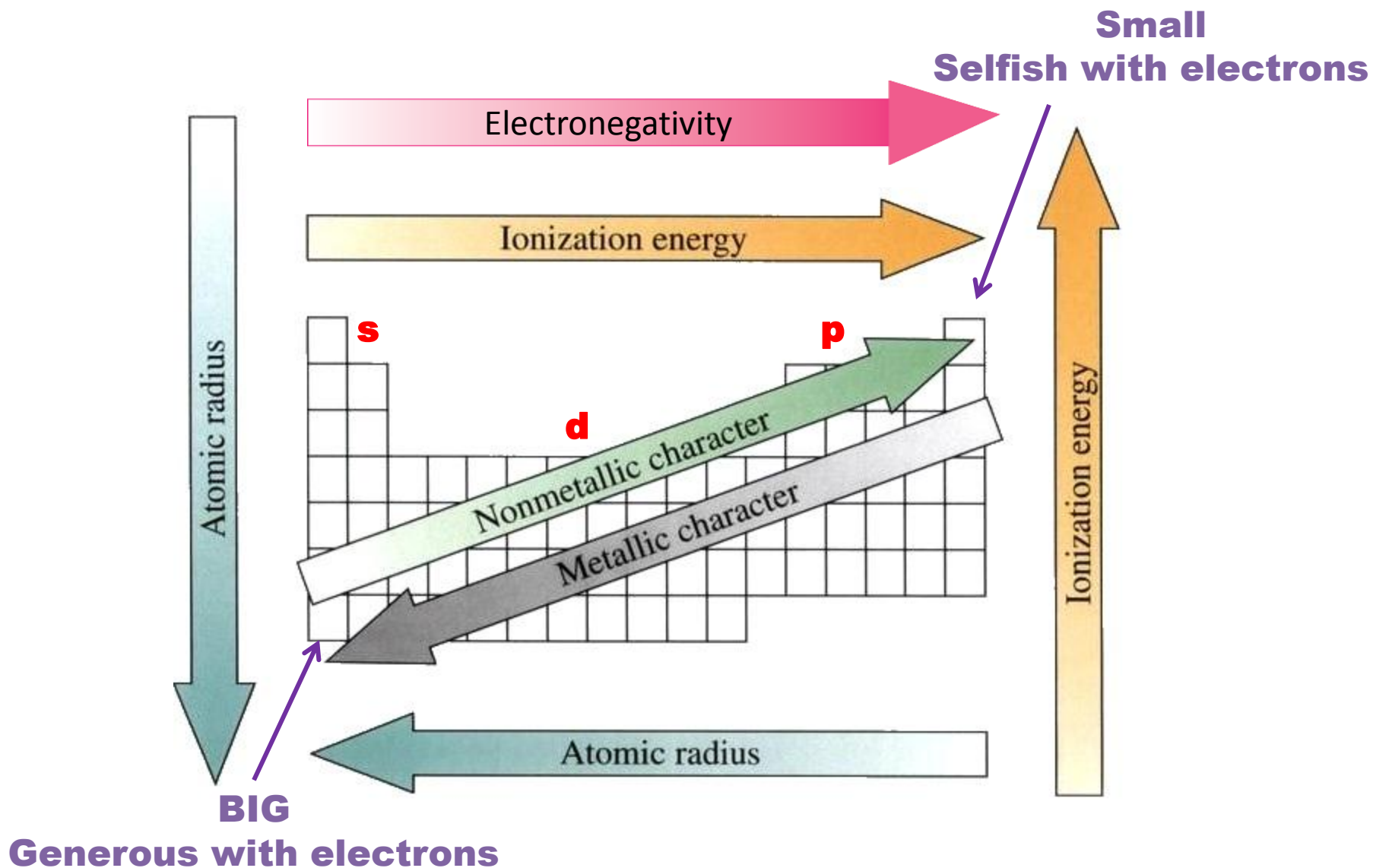


Electronegativity Trends

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



Periodic Trend Summary



	First Ionization Energy (kJ mol ⁻¹)	Second Ionization Energy (kJ mol ⁻¹)	Third Ionization Energy (kJ mol ⁻¹)
Element 1	1,251	2,300	3,820
Element 2	496	4,560	6,910
Element 3	738	1,450	7,730
Element 4	1,000	2,250	3,360

The table above shows the first three ionization energies for atoms of **four elements from the third period of the periodic table**. The elements are numbered randomly. Use the information in the table to answer the following questions.

- Which element is most metallic in character? Explain your reasoning.
- Identify element 3. Explain your reasoning.
- Write the complete electron configuration for an atom of element 3.
- What is the expected oxidation state for the most common ion of element 2?
- What is the chemical symbol for element 2?
- A neutral atom of which of the four elements has the smallest radius?
Explain your reasoning.