

Periodic Trends

objectives:

I can determine parts (see vocab list) of the periodic table. (with stepline)

I can apply Coulomb's law to attraction of electrons to the nucleus.

I can analyze data or use the periodic table to predict periodic trends of given properties.

Vocabulary:

Coulomb's Law

(Coulombic Attraction)

Atomic radius

Ionization energy

Period/series

Group/Family

Energy Level

Valence electrons

Nuclear charge

(Representative elements)

Metal

Nonmetal

Metalloids

Halogen

Noble gases

Alkali metals

Alkaline earth metals

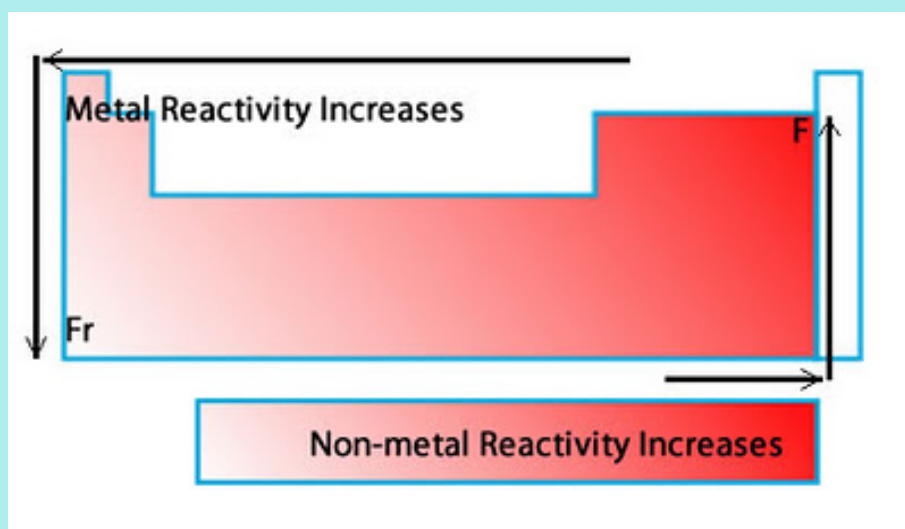
Transition elements

Inner transition (Lanthanides and Actinides)

Atomic Radius

Ionization Energy

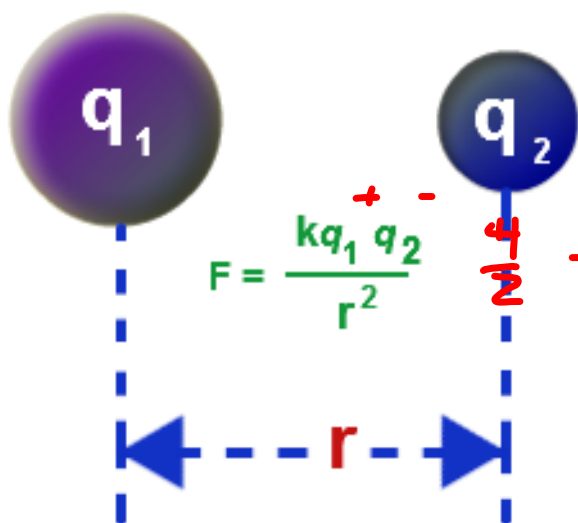
Reactivity



Coulomb's Law

basis -stability of atoms and ions
-periodic trends

2 variables: distance and charges



Coulomb's law

Distance:

The closer two charges are, the stronger the force between them



Charge:

The greater the charges are, the stronger the force of attraction

F = Force

q = charge of a particle, need + and - to attract

r = radius (distance)

k = constant

Determining Coulombic Attraction:

1. Compare Energy Levels - **distance**
2. Compare nuclear **charge** (# of p⁺)

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2. Compare nuclear **charge** (# of p^+)

Which has more Coulombic Attraction of all p^+ to 1 e^- in valence shell?

Na or K?

Coulomb's Law parameter	Na	K
Energy levels: (distance)		
Number of P^+ (charge)		

Na or Mg?

Coulomb's Law parameter	Na	Mg
Energy levels: (distance)		
Number of P^+ (charge)		

Determining Coulombic Attraction:

1. Compare Energy Levels - **distance**
2. Compare nuclear **charge** (# of p^+)

Which has more Coulombic Attraction of all p^+ to 1 e^- in valence shell?

Na or K?

Coulomb's Law parameter	Na	K
Energy levels: (distance)	3	4
Number of P^+ (charge)		

(Stop when you find a difference)

Na - less distance
more attraction

Na or Mg?

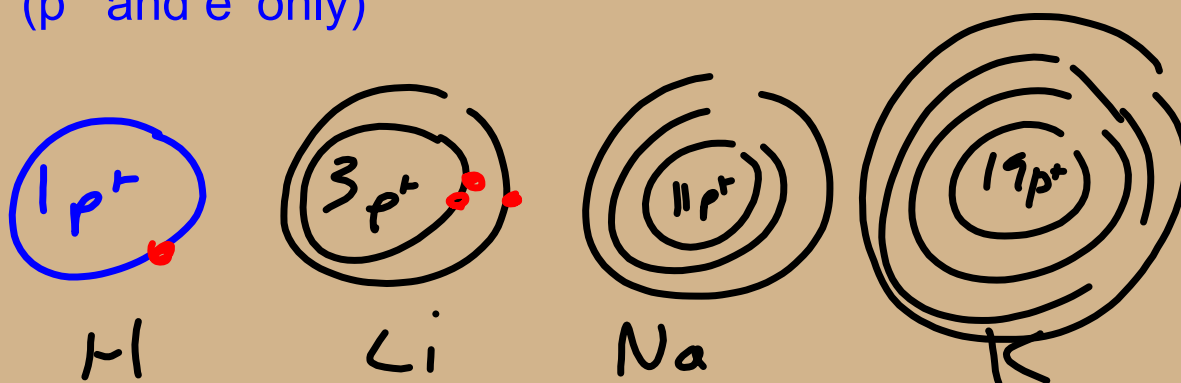
Coulomb's Law parameter	Na	Mg
Energy levels: (distance)	3	3
Number of P^+ (charge)	11	12

no difference in E level

Mg- greater charge
more attraction

Atomic Radii

Draw a Bohr Diagram of H, Li, Na, K
(p^+ and e^- only)



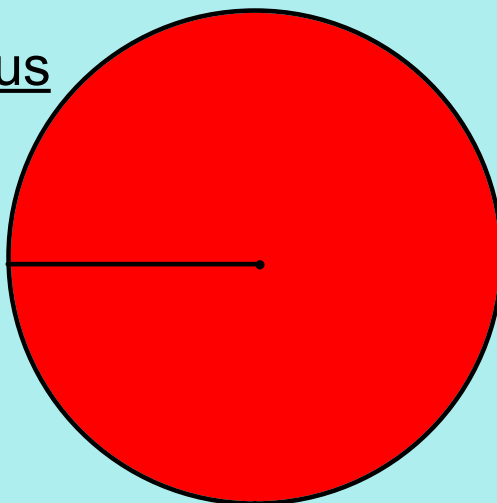
What can you infer about the size of each of these atoms?

Which is smallest and which is largest? Why?

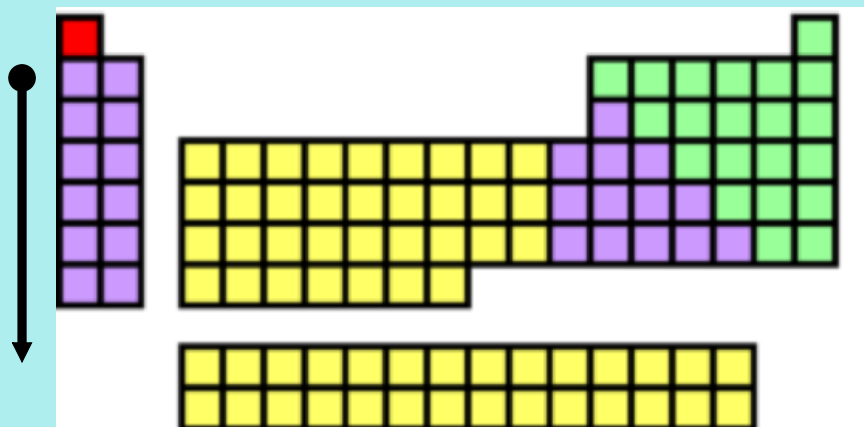
Is this due to distance or charge?

Atomic Radius

Distance from center
to outer electron



What do the radii of atoms compare as you move down the periodic table?



As you go down the PT,
every row adds an energy level,
so the radius will be larger

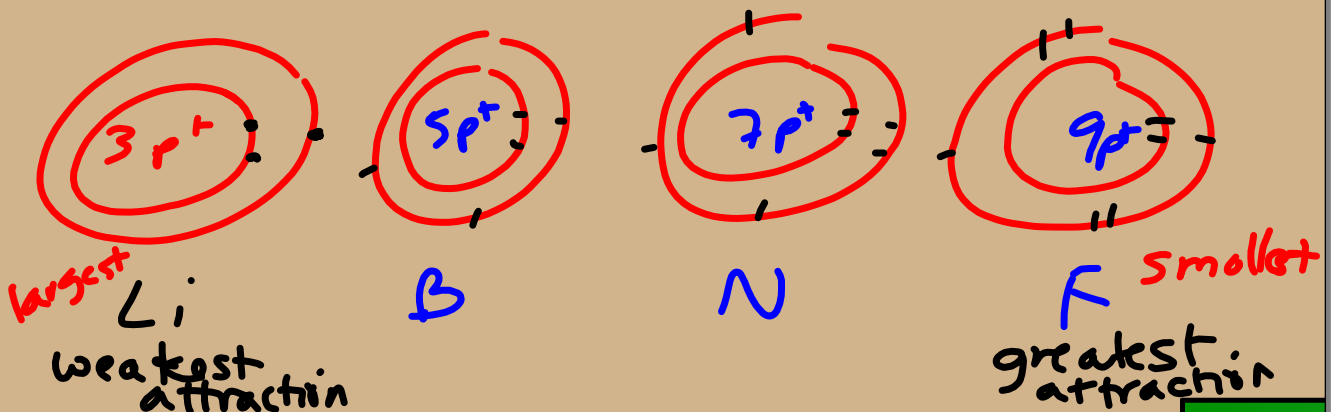
Which atom has largest radius? Why?

C(#6) Si(#14) Sn(#50)



Atomic Radii

Draw bohr diagrams Li, B, N, F



Protons are a "stationary beacon"
act on every e^- separately

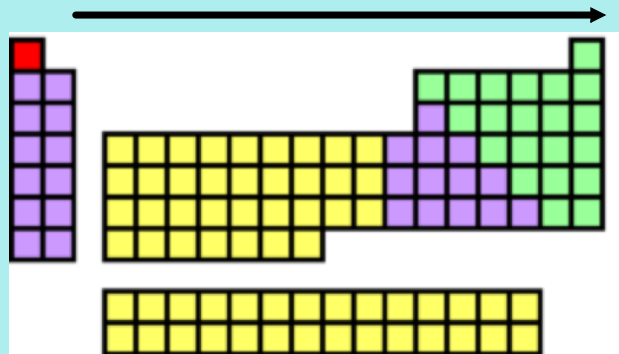
What can you infer about the attractive force of e^- to proton?

greater with more p^+

Which one has the strongest force on a valence e^- ? Weakest force?

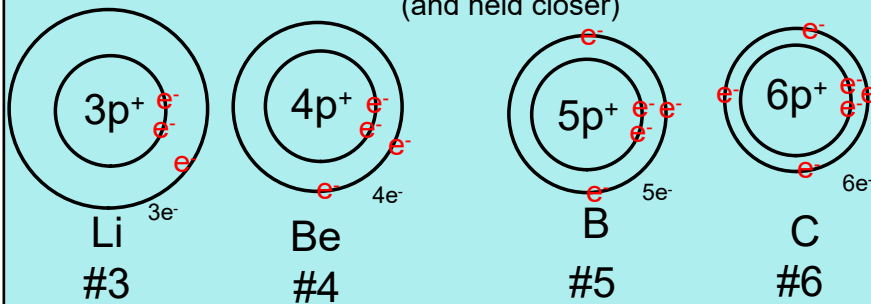
Is this due to distance or charge (Coulomb's Law)?

What happens to the radius as you add electrons across the row?



Across the PT - same valence shell, (left to right)
 More p^+ --increase attraction (pulling) in same valence shell, so
 the radii will decrease

Why? Coulomb's Law: charges increase,
 e^- have greater attraction
 (and held closer)



Which is bigger? Why?

S(#16) or Ar(#18)

E level? 3
 p^+ charge 16 larger
18 smaller

Which atom is the biggest on the PT?

Fr(#87)

Coulomb's Law:

Distance: most valence shells

Charges: 87 p^+ -- least amount in 7th level so less attraction than rest of level

Atomic Radii Trend:

increase as you go to the left

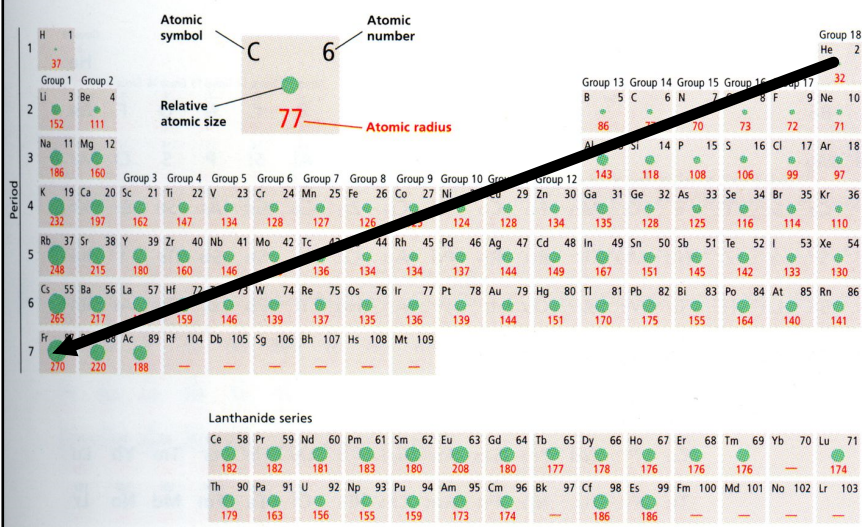
smallest atoms here

increase as you go down

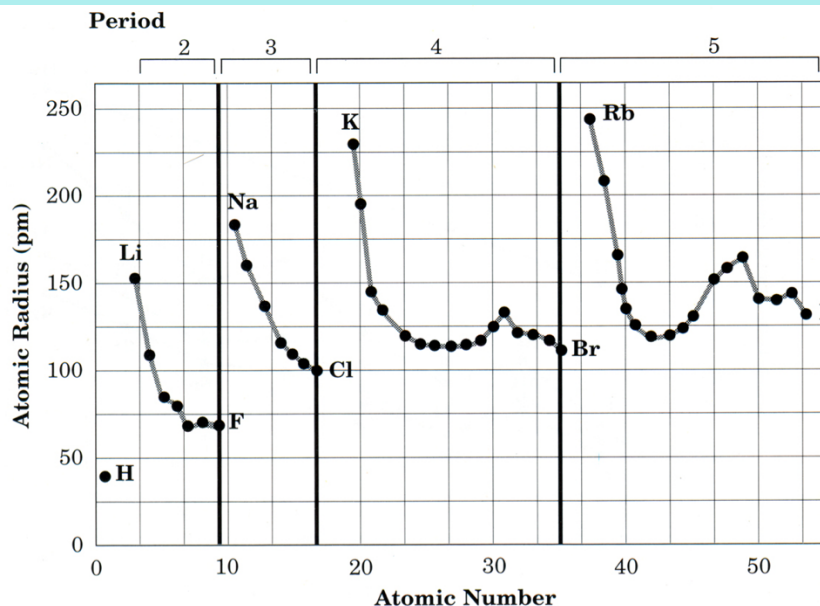
biggest atoms here



Atomic Radii



Graph --shows trends



Why does the radius increase from H, to Li, to Na, to K to Rb?

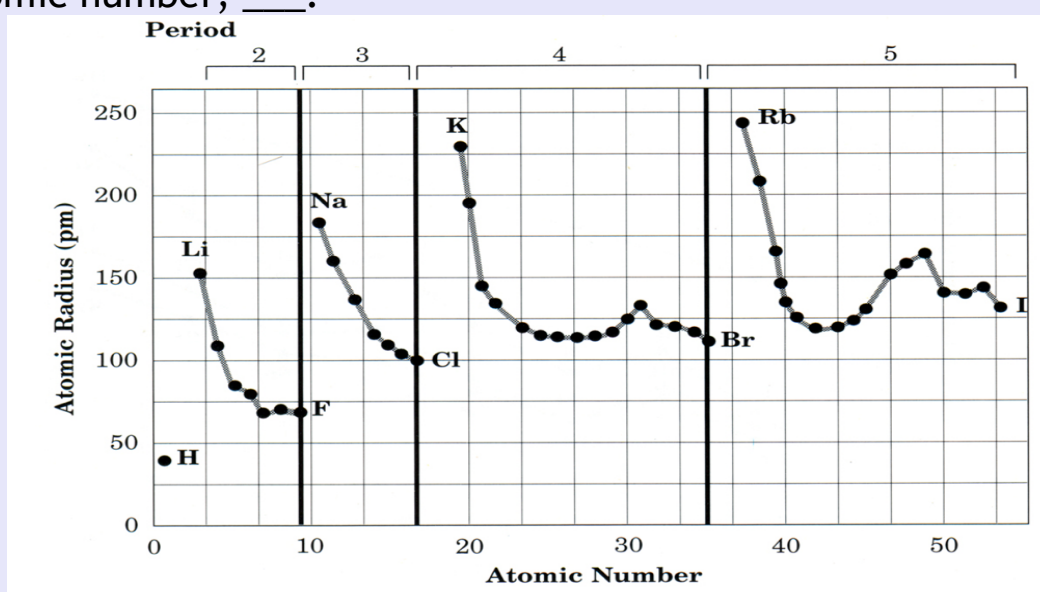
Why does the graph decrease after each alkali metal?

What is the atomic radius of the element with atomic number, ___?

3:

6:

11:



What is the trend going across a period?

What is the trend going down a group?

Determining Radius:

1. Compare Energy Levels - **distance**
2. Compare nuclear **charge** (# of p^+)

Which has a greater radius?

Na or K?

Coulomb's Law parameter	Na	K
Energy levels: (distance)		
Number of P^+ (charge)		

Na or Mg?

Coulomb's Law parameter	Na	Mg
Energy levels: (distance)		
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Determining Radius:

1. Compare Energy Levels - **distance**
2. Compare nuclear **charge** (# of p^+)

Which has a greater radius?

Na or K?

Coulomb's Law parameter	Na	K
Energy levels: (distance)	3	4
Number of P^+ (charge)		

K is larger
more energy levels

Na or Mg?

Coulomb's Law parameter	Na	Mg
Energy levels: (distance)	3	3
Number of P^+ (charge)	11	12

Na is larger
Mg has more nuclear charge and holds e^- closer

Ionization Energy

Easiest to remove e⁻

Metals (want to lose e⁻)

Atoms where e⁻ are the farthest away. (big)

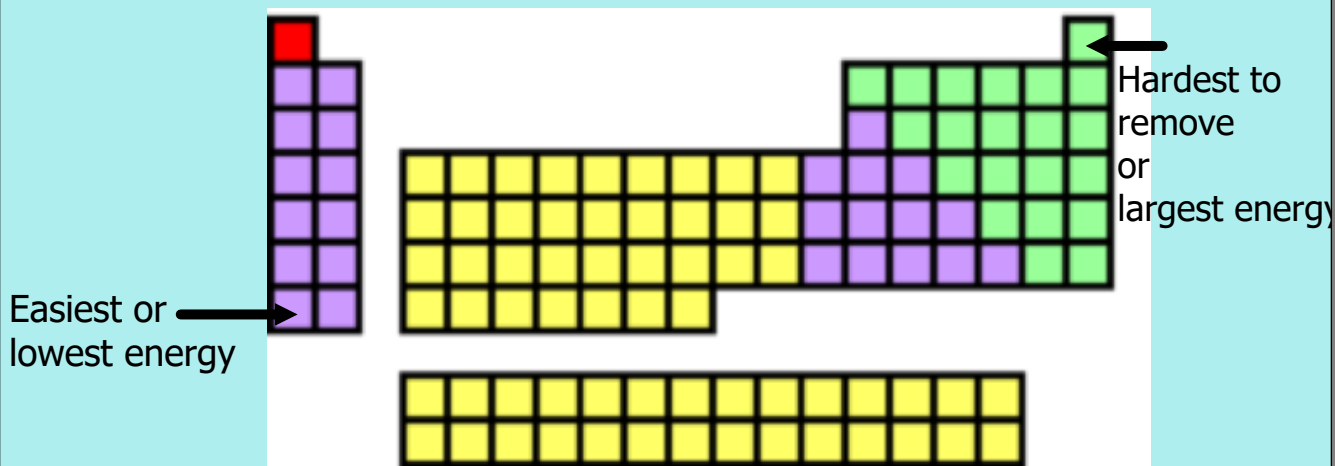
1st electron removed

Hardest to remove e⁻

Non-Metals (want to gain e⁻)

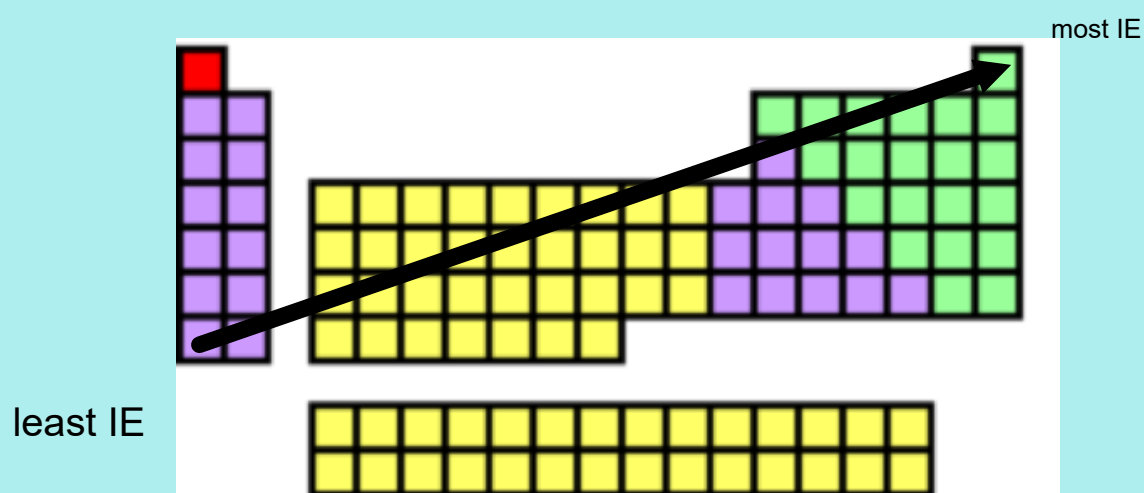
Noble Gas Group

Atoms where those e⁻ are the closest. (small)

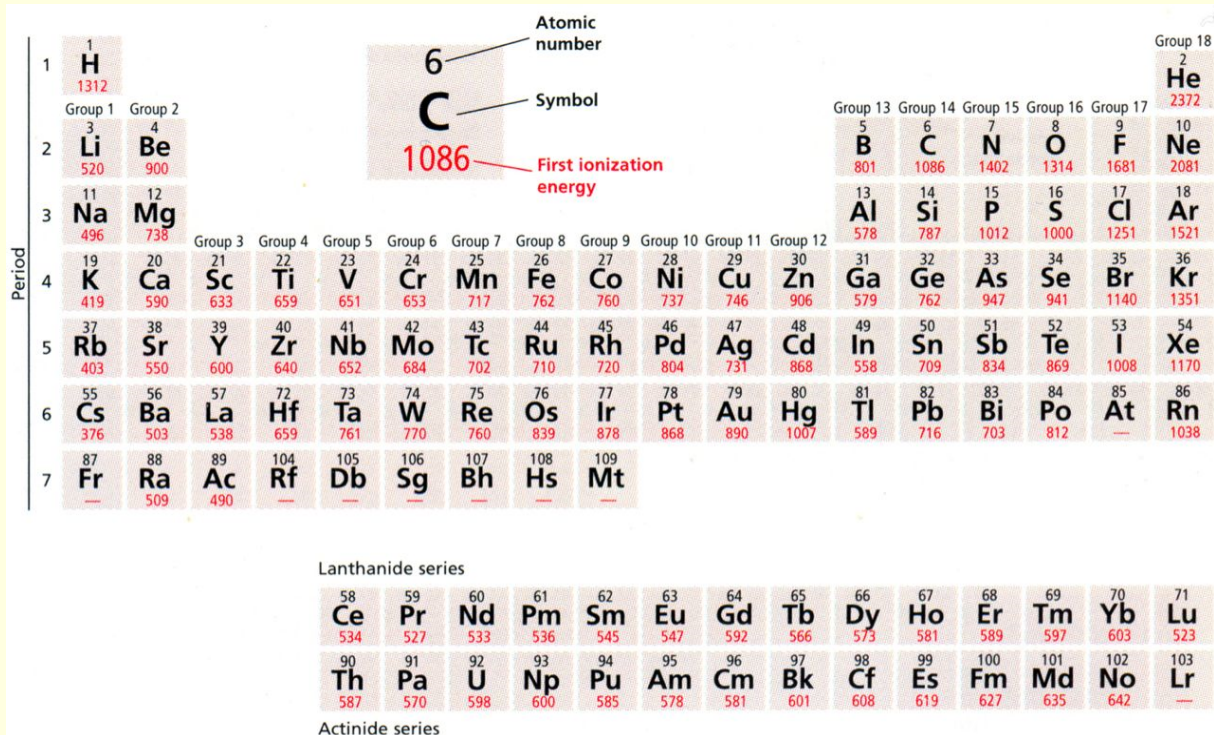


Ionization energy

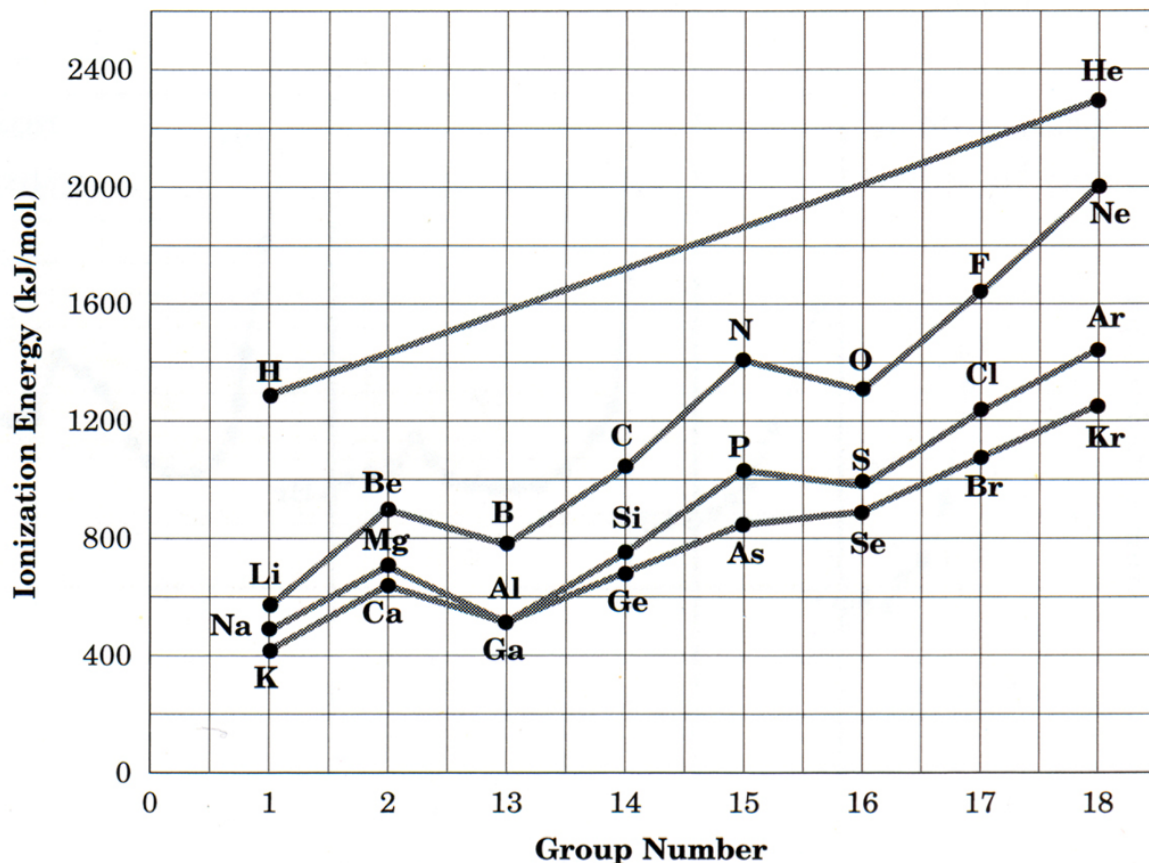
What is the trend?



First Ionization Energy



Graph



Determining Ionization Energy:

1. Compare Energy Levels - **distance**
2. Compare nuclear **charge** (# of p^+)

Which has a greater ionization energy?

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Determining Ionization Energy:

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Which has a greater ionization energy?

Na or K?

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Energy levels: (distance)	3	4
Number of P^+ (charge)		

Na has smaller distance so more Coulombic attraction, therefore, Na has greater IE

Na or Mg?

Coulomb's Law parameter	Na	Mg
Energy levels: (distance)	3	3
Number of P^+ (charge)	11	12

Mg has more nuclear charge so more Coulombic attraction, therefore Mg has greater IE

1. Metals tend to (gain/lose?) electrons
2. Which atom has the bigger radius? Why?
Mg (#12) or Cl (#17)
3. Which atom has the bigger radius? Why?
Mg(#12) or Ra (#88)
4. Which atom has the smaller ionization energy? Why?
 - a. K(#19) or Ca (20)
 - b. Mg (#12) or Cl (#17)
 - c. Mg(#12) or Ra (#88)

1. Metals tend to (gain/lose?) electrons
2. Nonmetals tend to (gain/lose?) electrons
3. Which atom has the bigger radius? Why?
 - a. Mg (#12) or Cl (#17)
 - b. Mg(#12) or Ra (#88)
4. Which atom is more reactive? Why?
 - a. K(#19) or Ca (20)
 - b. Mg(#12) or Ra (#88)
 - c. Cl (#17) or F(#9)
5. Which atom has the smaller ionization energy? Why?
 - a. K(#19) or Ca (20)
 - b. Mg (#12) or Cl (#17)
 - c. Mg(#12) or Ra (#88)

Review:

1. List in increasing order of radii:

a. Ne O F N

b. N As Sb P

2. List in increase order of ionization energy

a. Ne O F N

b. N As Sb P

Sample questions for quiz:

2 factors of Coulomb's law?

Which element is bigger?

Li or B?

O or S?

Which element has lower IE?

Li or B?

O or S?

Why does Cesium have a low ionization energy? (use Coulomb's law!)

Why does Neon have a high ionization energy? (use Coulomb's law!)

distance (radius) is small -- high attraction of outer e to nucleus, difficult to pull off e
charge is highest in period-- high attraction of outer e to nucleus

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Periodic Trends:

Radii

Reactivity

Ionization Energy

