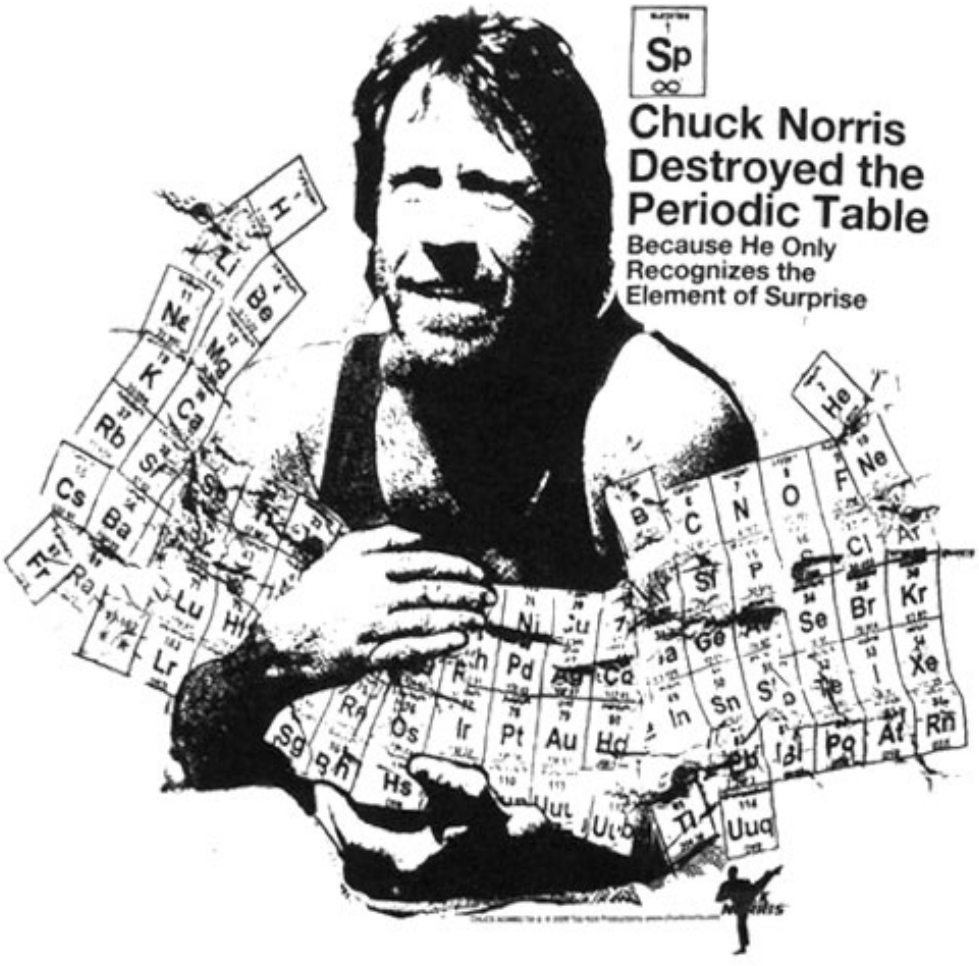
STUDENT

Unit 3 - The Periodic Table

STUDENT

VOCABULARY:

Ionization energy	Metalloids	Octet
Electronegativity	Alkali metals	States of matter
Atomic Radius	Alkaline Earth metals	Solids
Ionic Radius	Halogens	Liquids
Chemical Reactivity	Noble Gases	Gases
Metallic Character	Transition metals	Diatomic elements
Nonmetallic character	Periodic	Allotrope
Metals	Periodic Law	Isoelectronic
Metalloids	Periods	Families
Nonmetals	Groups	

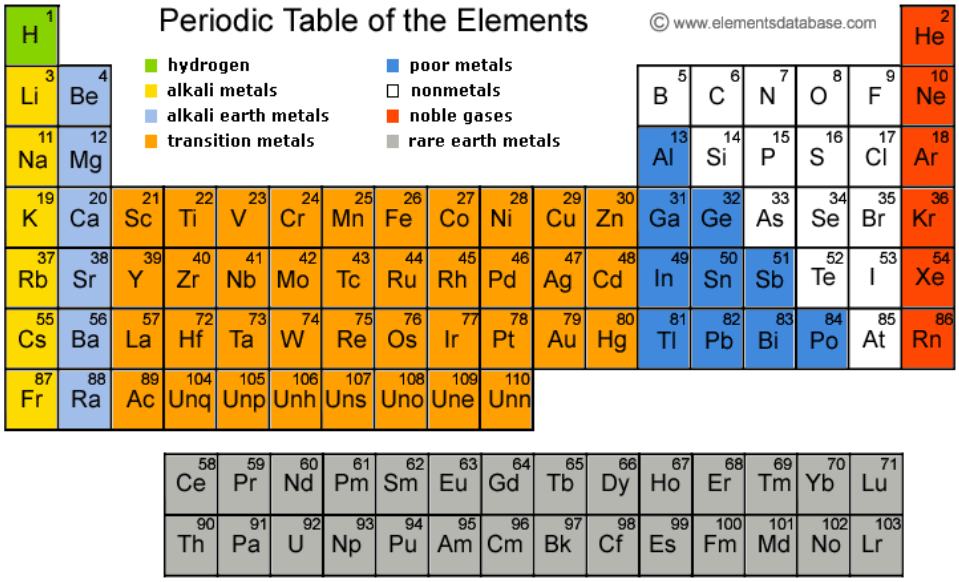


Chemical Periodicity/History of the Table:

- **Dmitri Mendeleev (Russia)**
  - 1st chemist to arrange newly found elements into a table form/usable manner
  - Elements arranged according to _____
  - Resulted in _____ or periodic intervals being _____

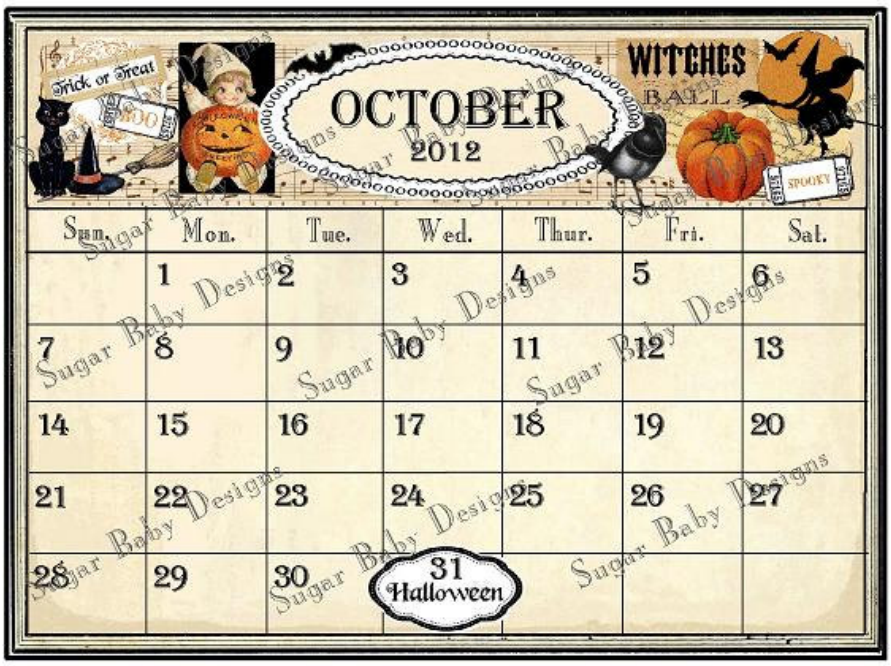
I	II	III	IV	V	VI	VII	VIII		
H 1.01									
Li 6.94	Be 9.01	B 10.8	C 12.0	N 14.0	O 16.0	F 19.0			
Na 23.0	Mg 24.3	Al 27.0	Si 28.1	P 31.0	S 32.1	Cl 35.5			
K 39.1	Ca 40.1		Ti 47.9	V 50.9	Cr 52.0	Mn 54.9	Fe 55.9	Co 58.9	Ni 58.7
Cu 63.5	Zn 65.4			As 74.9	Se 79.0	Br 79.9			
Rb 85.5	Sr 87.6	Y 88.9	Zr 91.2	Nb 92.9	Mo 95.9		Ru 101	Rh 103	Pd 106
Ag 108	Cd 112	In 115	Sn 119	Sb 122	Te 128	I 127			
Ce 133	Ba 137	La 139		Ta 181	W 184		Os 194	Ir 192	Pt 195
Au 197	Hg 201	Ti 204	Pb 207	Bi 209					
			Th 232		U 238				

- ***Henry Moseley (England)**
  http://en.wikipedia.org/wiki/Henry_Moseley
  - Used X-ray spectra to prove the existence of the _____
  - Arranged table by _____ (or # of protons) which proved to be much more effective
  - How the modern day periodic table is arranged
  - No more gaps!



Periodic Law = elements in periodic table are _____ functions of their _____

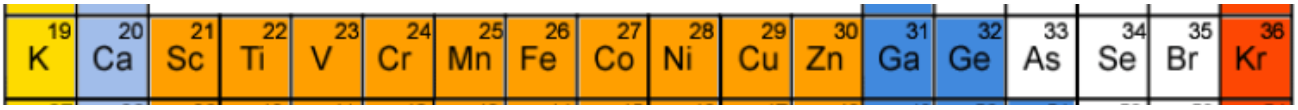
1) As you move across a **ROW** or **PERIOD**, you add **1 PROTON** to the nucleus, and **1 ELECTRON** to the **VALENCE SHELL**
2) The **MAXIMUM** number of **VALENCE ELECTRONS** any element can have is **EIGHT**, therefore any element with 8 valence electrons marks the **END** of a **ROW** or **PERIOD**. The next element will be the first of a new row and will restart the pattern with **1 VALENCE ELECTRON**.
   **Think of the way Sunday marks the start of a new row on a calendar and restarts the weekly pattern.*
3) The number of **VALENCE ELECTRONS** dictates the number of **BONDS** an atom of an element can form
4) The number of **BONDS** an element can form dictates that element's **CHEMICAL PROPERTIES**
5) As you move down a **GROUP** or **COLUMN**, you add **1 PRINCIPAL ENERGY LEVEL** or **ELECTRON SHELL**
6) All elements in the **SAME COLUMN** or **GROUP** have the **SAME NUMBER OF VALENCE ELECTRONS**, therefore elements in the **SAME COLUMN** or group tend to have **SIMILAR CHEMICAL PROPERTIES**.
   **Think of how you feel on every Monday or every Friday. That pattern repeats itself in weekly periods.*



Arrangement of the Periodic Table:

The Periodic Table is made up of **PERIODS** and **GROUPS**:

- **PERIODS** = _____ (run left to right)

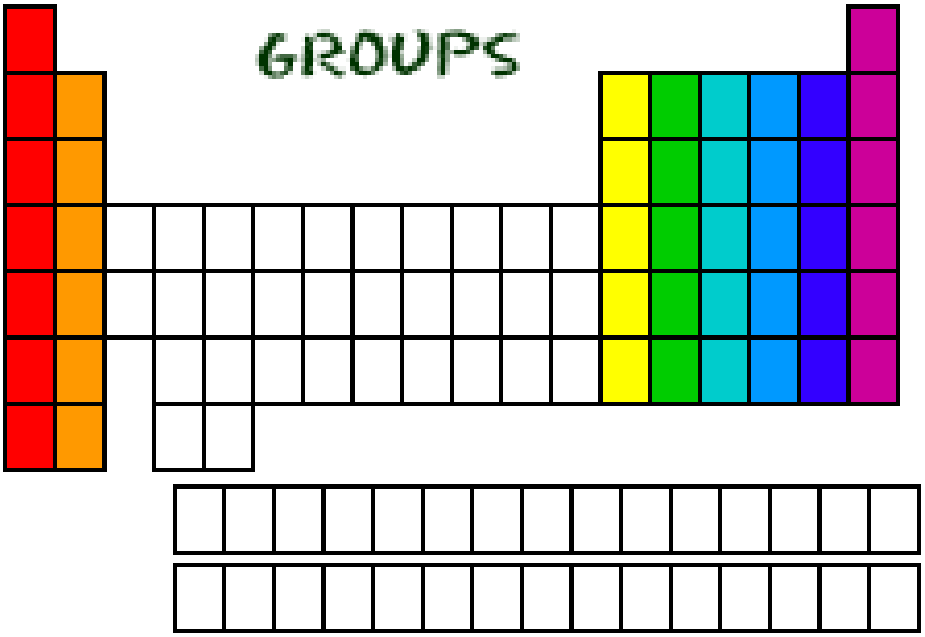


Element Symbol	Element Name	Group #	Electron configuration	Lewis diagram
K				
Ca				
Ga				
Ge				
As				
Se				
Br				
Kr				

*OCTET = full _____ (8 electrons, except for _____ elements, for whom _____ marks a full valence shell)

Remember…_____

- **GROUPS** = _____ (run up & down)



Use the Periodic Table in your CRT's to complete the table below for the Group I elements pictured next to it:

	Element Name	Electron configuration	Lewis diagram
1 H			
3 Li			
11 Na			
19 K			
37 Rb			
55 Cs			
87 Fr			

PRACTICE:

1. Mendeleev arranged the original periodic table according to what? What was the problem with this arrangement?

   _____

2. Henry Mosely proved the existence of what subatomic particle? How did he then arrange the periodic table?

   _____

3. How many electrons does the last element in every row or period have in its valence shell? _____
4. What happens to the number of energy levels as you move across a period? _____
5. What happens to the number of energy levels as you move down a group? _____
6. The chemical properties of an element are based on what?

   _____

7. Periods are similar to what on a calendar? _____
8. Groups are similar to what on a calendar? _____
9. Use the calendar analogy to explain whether it's more likely to find similar characteristics among elements in the same group or elements in the same period.

   _____

   _____

   _____

10. What happens to the number of valence electrons as you move across a period? _____
11. What happens to the number of valence electrons as you move down a group? _____
12. Use the concept of valence electrons to explain whether it's more likely to find similar characteristics among elements in the same group or elements in the same period.

    _____

    _____

    _____

The Groups (a more in-depth look…)

Group 1 → **ALKALAI METALS** (FAMILY)
http://www.youtube.com/watch?v=uixxJtJPVXk

- All have ____ valence electron
- Easily _____ their one electron to become ____ ions
- _____ reactive → never found alone in nature
- Contains the _____ reactive metal: Probably _____, but it's so rare, we've got to go w/ _____

Group 2 → **ALKALINE EARTH METALS** (FAMILY)
http://www.youtube.com/watch?v=DFQPnHkQlZM

- All have ____ valence electrons
- Prefer to _____ their two electrons to become ____ ions
- _____ reactive → never found alone in nature

Groups 3-12 →**TRANSITION METALS**

- Found in the _____ of the periodic table (the D block)
- Form _____ in solution (ex: Cu is bright blue when dissolved in water)
  - This concept is **ALWAYS** on the **REGENTS EXAM!!!**
- Tend to be _____ → will lose electrons or gain them depending on what other _____ are present
- _____ reactive group of metals

Groups 13-16 → **BCNO** groups (not a single group)

- _____ groups
- Metals, nonmetals, & metalloids found along the staircase (many different properties)

Group 17 → **HALOGENS** (FAMILIY)

- ____ valence electrons
- Like to gain ____ electron to become ions with ____ charge (Remember, _____)
- Form _____ called _____
- Contains the most _____ nonmetal: _____
- All _____ making up the group
- Three states of matter found in group: _____ _____
- Ex: _____

Group 18 → **NOBLE GASES** (FAMILY)

- _____ or _____
- Have _____ (___ e- in valence shell/outer energy level)
- Most _____ group; exist _____ in nature
- Exception to the _____ is _____ (only has ___ valence e-)
- EVERYONE WANTS TO BE A NOBLE GAS & HAVE 8 ELECTRONS! 8 IS GREAT!
- Ex: _____

Hydrogen → Not officially part of a group

- Both a _____ and a _____
- Can be seen as _____

The Lanthanide/Actinide Series – two rows on bottom of table (detached) – Elements 58 – 71 & 90 - 103

- Actually belong to the _____

PRACTICE:

1. Which of the groups are considered families? Give the group numbers and the names of the families. _____

   _____

2. Which group contains elements that do not typically react with other elements? Give the group number and the name.

   _____

3. Explain why elements in the group named above is not reactive.

   _____

4. Which group contains the most active metals? Give the group number and the name. _____

5. Which group contains the most active nonmetals? Give the group number and the name. _____

6. Which element is part of Group I, but is not an Alkali Metal?

   _____

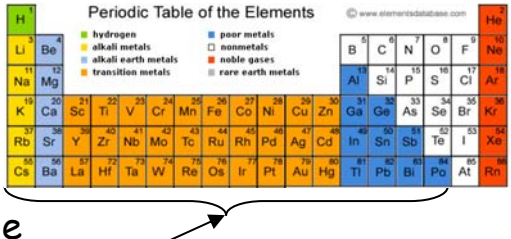
7. Which groups form colored ions in solution? Give both the group numbers and the name. _____

8. Which group contains the second most active metals? Give both the group number and the name. _____

9. Which groups contain the most unpredictable metals? Give both the group numbers and the name. _____

The Periodic Table can be "**KEYED**" for many things

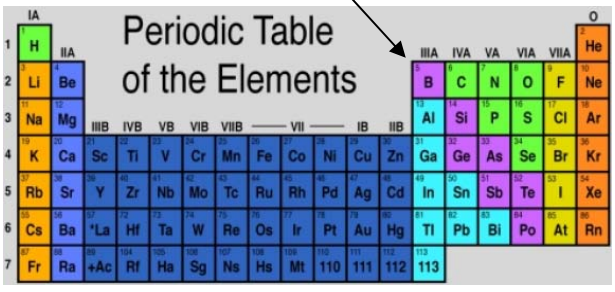
The Staircase →



1. **metals:**
   - make up _____ of table
   - _____ of or _____ "staircase"—except _____
   - all _____ (except _____)
   - Must have _____ properties of a metal:
     1. _____ (can be hammered/molded into sheets)
     2. _____ (can be drawn/pulled into wire)
     3. have _____ (are shiny when polished)
     4. good _____ (allow heat & electricity to flow through them)
        - ➢ due to "sea of _____ valence electrons"
   - like to _____ to form _____ ions

2. **nonmetals:**
   - _____ of or _____ staircase
   - mostly _____ and _____ @ STP—except _____
   - _____ malleable/ductile; _____ (shatter easily)
   - _____ luster (_____)
   - _____ or _____ conductors
   - like to _____ to form _____ ions
   - May have _____ or _____ properties of a metal

3. **metalloids** (AKA semi-metals):
   - Have _____ properties of a metal
   - _____ staircase (between _____ & _____ (except ____)



PRACTICE

1. Which type of element is located below or to the left of the staircase? What is the exception?

   _____

2. Which type of element is located above or to the right of the staircase?

   _____

3. Which type of element is located on the staircase? What are the exceptions?

   _____

4. Which of the following is NOT a property of a metal?
   a.) Shiny; has luster
   b.) Malleable
   c.) Ductile
   d.) Brittle
   e.) Good conductor

5. A sample of an element is shiny, is a good electrical conductor, and does not shatter when hit with a hammer. What type of element is it? (Circle one)

   METAL/NONMETAL/METALLOID

6. A sample of an element is dull, does not conduct electricity, and shatters upon being hit with a hammer. What type of element is it? (Circle one)

   METAL/NONMETAL/METALLOID

7. A sample of an element is shiny, does conduct electricity, and shatters upon being hit with a hammer. What type of element is it? (Circle one)

   METAL/NONMETAL/METALLOID

8. What do metals have that allows them to conduct heat and electricity so well?

   _____

STATES OF MATTER (at STP)

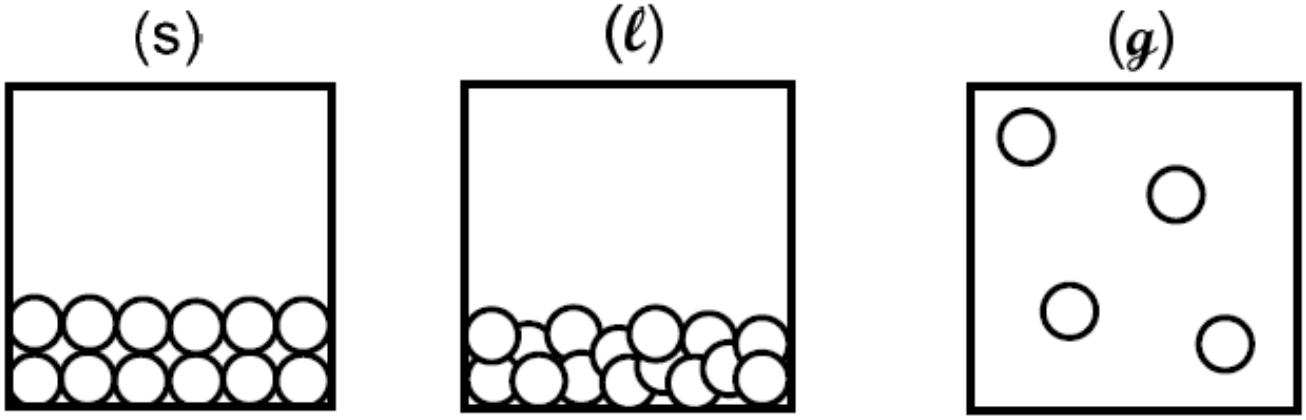
Table A
Standard Temperature and Pressure

Name	Value	Unit
Standard Pressure	101.3 kPa 1 atm	kilopascal atmosphere
Standard Temperature	273 K 0°C	kelvin degree Celsius

1. **solids(s)** – most elements are solids at STP; ex: _____
   a. Definite _____
   b. Definite _____

2. **liquids (ℓ)** – only TWO elements at STP (Br & Hg); ex: _____
   a. Definite _____
   b. Takes the _____of the container

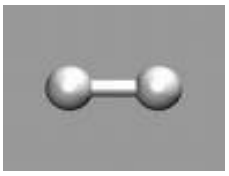
3. **gases (g)** – H, N, O, F, Cl, & all of group 18 (noble gases); ex: _____
   a. No definite _____
   b. _____their container

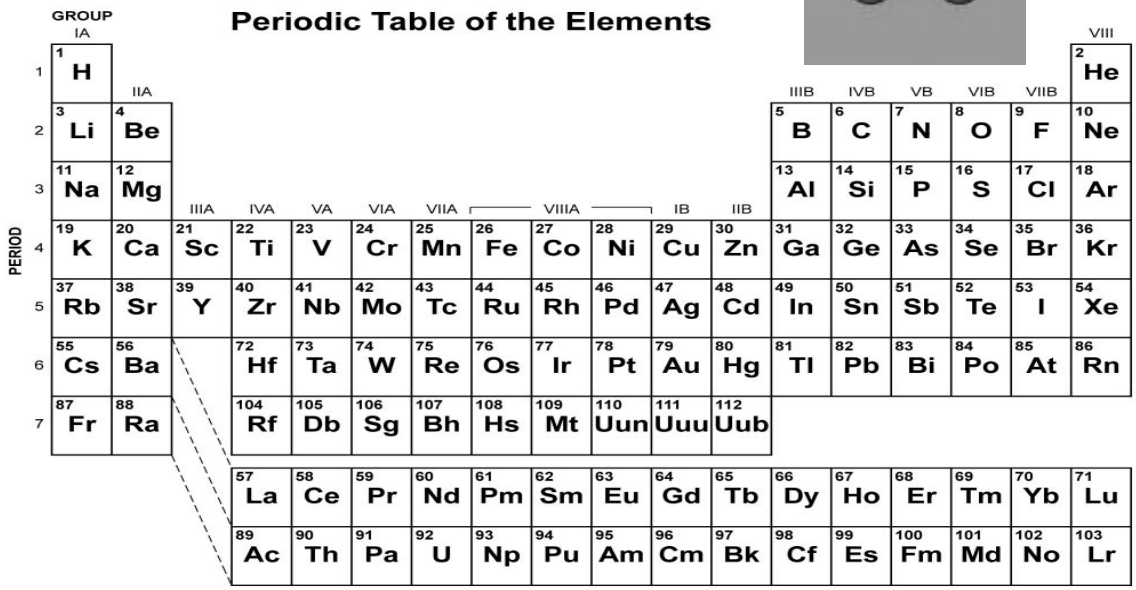


Diatomic Elements (7UP) – "Siamese Twins"

- Elements that are _____ in nature
- _____ in order to fill their _____
  - Both need the same number of electrons to fill valence shell
  - Perfect sharing
  - Look at Lewis structure for 2 oxygen atoms:

- Contain 2 _____ atoms
- 7 of them—must memorize! Use 7-UP trick (see below)
- Include the following elements:
  - _____ (make the shape of a ____)
  - _____





Allotrope = 1 of 2 or more different _____ of an element (nonmetal) in the same _____, but with different _____ and different _____ properties

Ex: allotropes of oxygen → _____ vs. _____
Ex: allotropes of carbon → _____ (in pencils) vs. _____

PRACTICE

1. Which phase of matter has the ***most*** definite shape?

   _____

2. Which phase of matter has the ***least*** definite shape?

   _____

3. The ***volume*** of which phase of matter changes based on the volume of its container?

   _____

4. The ***shape*** of which phase changes based on its container?

   _____

5. Give the chemical symbol for each of the diatomic elements.

   _____

6. Why can't any of the diatomic elements exist alone or unpaired?

   _____

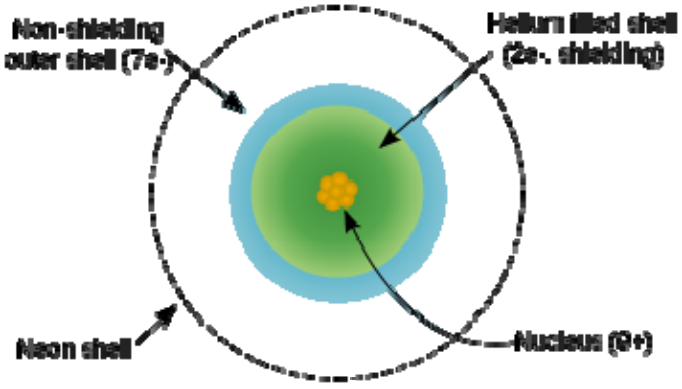
7. Why is it beneficial for one atom of a diatomic element to pair up with another atom of that same element?

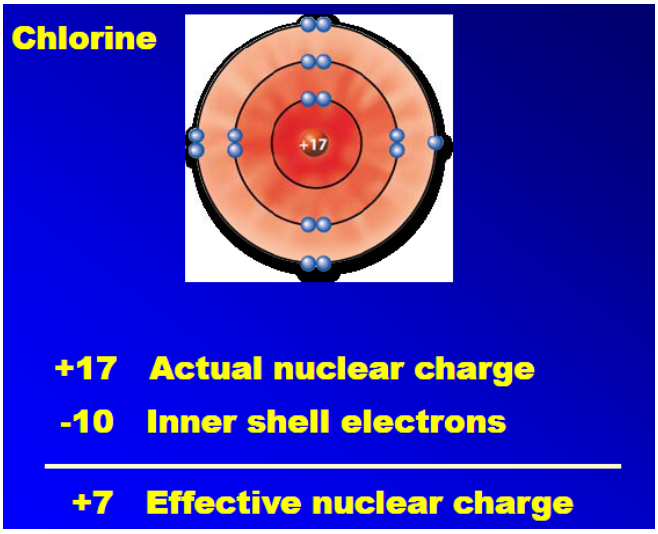
   _____

WHY the Periodic Table is PERIODIC…

As you move _____

1. _____
   a. Additional proton (massive and +) wins the tug-of-war with additional electron (tiny and -)
   b. Pulls the electron cloud in more tightly (*magnet/cart demo*)
2. _____
   a. Kernel electrons interfere with attraction between the protons in the nucleus and the valence electrons
   b. Every element in the same period/row has the same number of kernel electrons.





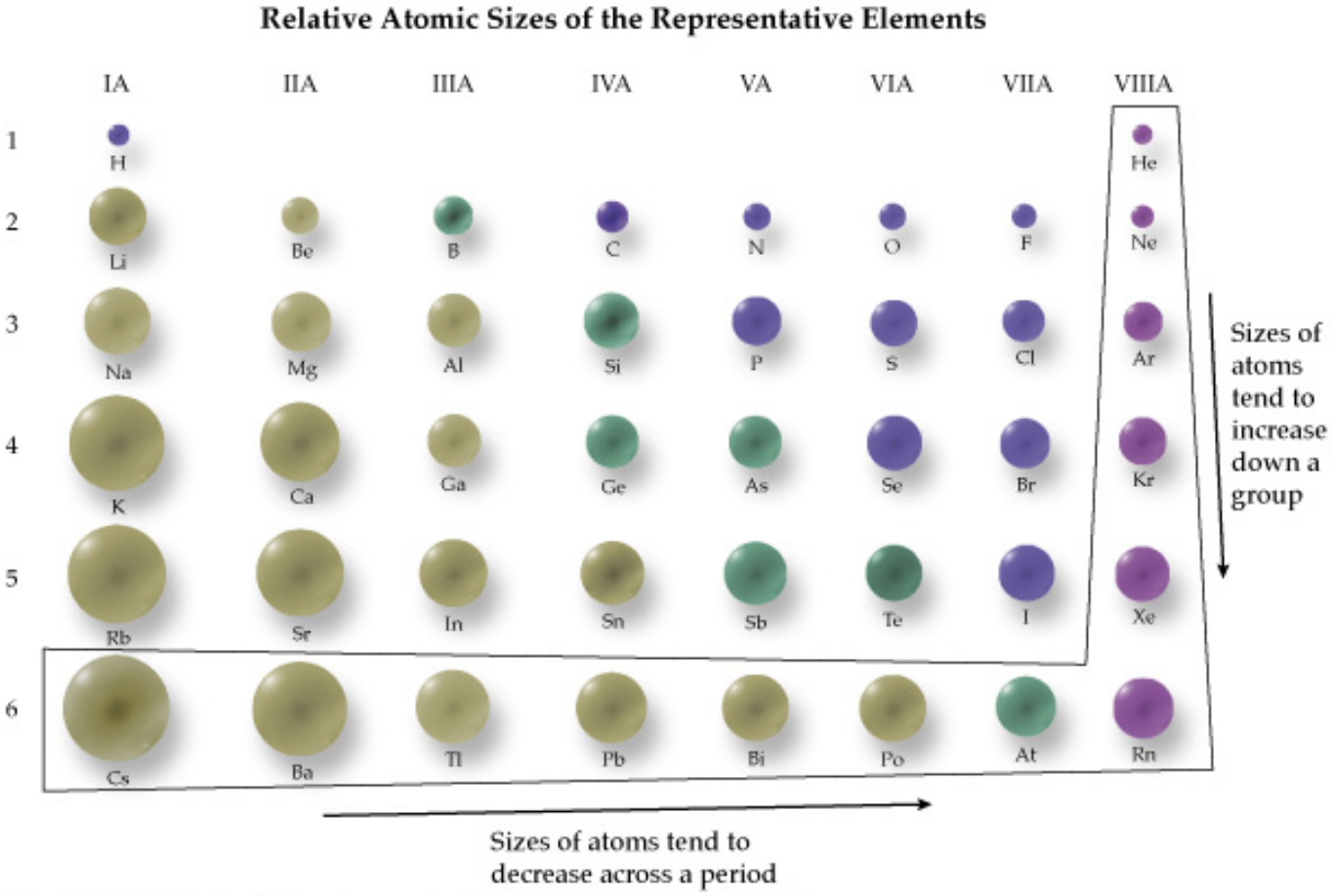
As you move _____

1. _____…BUT…
2. _____
   a. Additional orbital/energy level means more kernel electrons (-) to interfere with the attraction between the protons (+) and the valence electrons (-)
   b. Valence electrons able to drift farther from the nucleus

*****IF SHIELDING INCREASES, THAT TRUMPS EVERYTHING*****

The Periodic Trends

1. **Atomic Radius** = ½ the distance between neighboring nuclei of a given element



Going down a group, atomic radius INCREASES

- **Reasons:**
  - Adding _____ to the outside of the atom take up _____

Going across a period, atomic radius DECREASES

- **Reasons:**
  - _____ is _____
  - Same # of energy levels, no increase in shielding

*****Ionic Radius*** (Just like atomic radius, but for ions)**

- _____ → _____
  - **Reason:** _____ pulling on _____
    - Electrons outnumber Protons
    - Electrons drift farther away from nucleus

- _____ → _____
  - **Reason:** _____ pulling on _____
    - Protons outnumber Electrons
    - Electrons pulled closer to nucleus

*****<u>Isoelectronic Series</u>:** atoms and ions that have the _____ number of _____

- Elements gain or lose electrons in order to attain the electron configuration of the nearest noble gas
- All members of an ISOELECTRONIC SERIES have the same NOBLE GAS CONFIGURATION

Ex: N^{3-}, O^{2-}, F^{-}, Na^{+}, and Mg^{2+}

- all have _____ electrons
- all have the same electron configuration as the noble gas _____

Click on the link below to see an excellent animation/tutorial on Atomic Radius, Ionic Radius, and Isoelectronic Series

http://www.mhhe.com/physsci/chemistry/essentialchemistry/flash/atomic4.swf

PRACTICE:

1. Shielding increases as the number of _____ increases.
2. Who wins the "tug of war" between protons and electrons and why? _____
3. What happens to atomic radius as you move across a period (from left to right)? _____
4. Explain your answer to #2 in terms of nuclear charge and number of principal energy levels.

   _____

   _____
5. What happens to atomic radius as you move down a group?

   _____
6. Explain your answer to #4 in terms of nuclear charge and number of principal energy levels.

   _____

   _____
7. Is the ionic radius of a metal larger or smaller than its atomic radius? _____
8. Explain your answer to #6 in terms of protons and electrons.

   _____
9. Is the ionic radius of a nonmetal larger or smaller than its atomic radius? _____
10. Explain your answer to #8 in terms of protons and electrons.

    _____
11. Which ion has the same electron configuration as an atom of He?

    a. Ca^{2+} b. H^{-} c. O^{2-} d. Na^{+}
12. Which of the following does not have a noble gas configuration?

    a. Ar b. Na^{+} c. Mg^{2+} d. S

2. **Electronegativity:**
   - _____ to _____
   - _____ of an atom/ion for e^- like _____

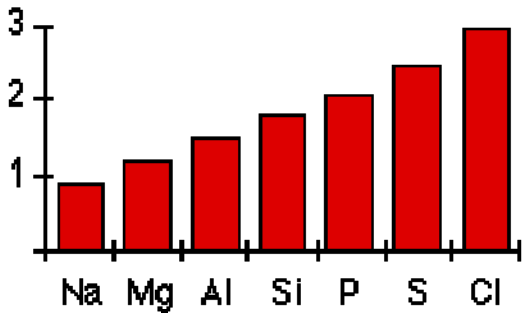
_____ → _____ to achieve full _____ → _____
_____ → _____ to achieve full _____ → _____

   - Values range from _____ (Table S in CRT)
     - _____ electronegative element = _____
     - _____ electronegative elements = _____
       or _____

Going _____, electronegativity _____

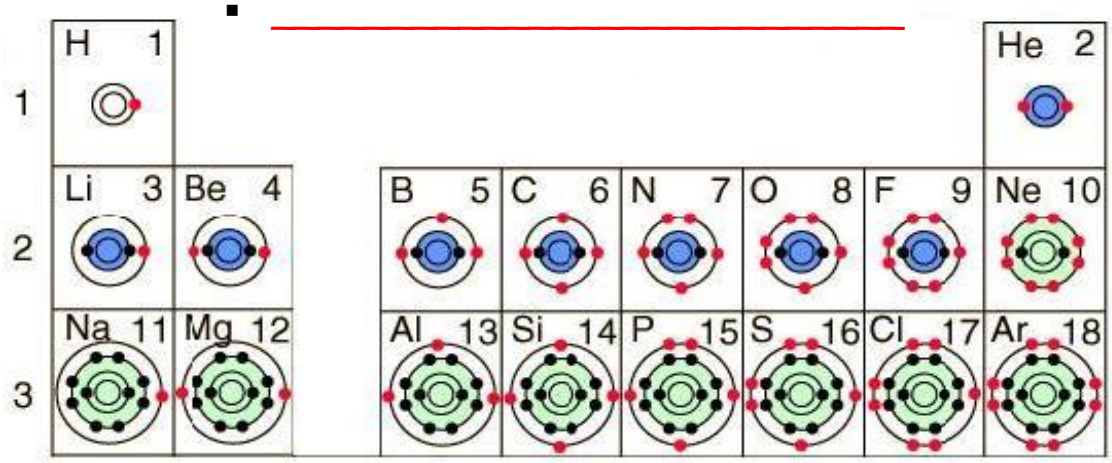
- **Reasons:**
  - _____
  - _____ does _____

Electronegativity of the Period 3 Elements



Going _____, electronegativity _____

- **Reasons:**
  - _____



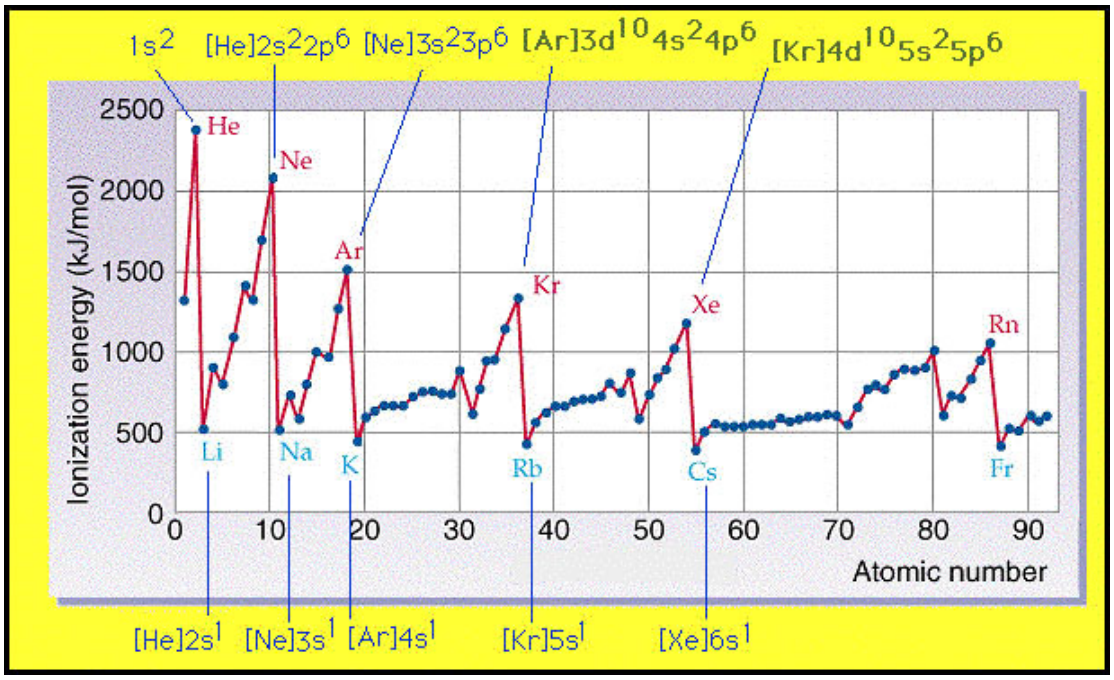
3. **<u>Ionization Energy</u>** = amount of ENERGY needed to REMOVE the most loosely bound e^- from and atom/ion (in the GAS phase) (values for each element listed in Table S)

(_____ with electrons, like _____)

X + energy → _____

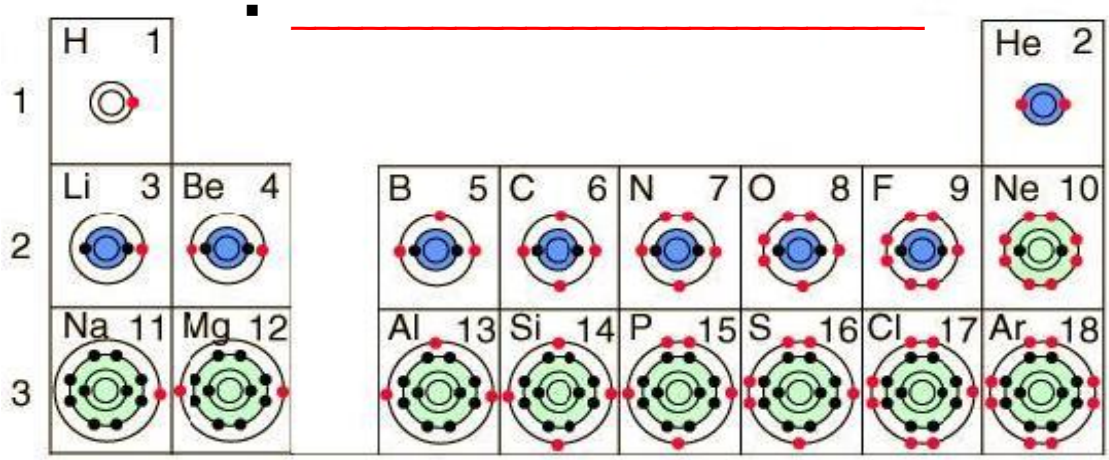
Going across a period, ionization energy _____

- **Reasons:**
  - _____
  - _____ does _____



Going down a group, ionization energy _____

- **Reason:**
  - _____



4. **Reactivity** = _____ or _____ of an element to go through a _____ change (or _____ with another element)

*_____ are _____, when it comes to electrons
**_____ are _____, when it comes to electrons

*****CAN'T COMPARE METALS TO NONMETALS!!!**
(Sorry for all the negative electron terminology…Get it?)

METALS: (recall: the most reactive metal is _____)

- **Going across a period**, reactivity _____
  - **Reasons**:
    - _____
    - _____ does _____
- **Going down a group**, reactivity _____
  - **Reason**:
    - _____

Click on the link below to see an AWESOME video of Group I Metals reacting in water…

http://www.youtube.com/watch?feature=player_embedded&v=uixxJtJPVXk&safe=active

NONMETALS: (recall: the most reactive nonmetal is _____)

- **Going across a period**, reactivity _____ (until you get to the _____ → unreactive)
  - **Reasons**:
    - _____
    - _____ does _____
- **Going down a group**, reactivity _____
  - **Reason**:
    - _____

You should now be able to…

- ✓ Describe the origin of the periodic table
- ✓ State the modern periodic law
- ✓ "Key" the periodic table according to metals vs. nonmetals and all 3 phases
- ✓ Explain how an element's electron configuration is related to the element's placement within a period and a group on the periodic table'
- ✓ Identify and state the properties of the following groups in the periodic table:
  - ❖ Alkali metals
  - ❖ Alkaline earth metals
  - ❖ Halogens
  - ❖ Noble Gases
  - ❖ Transition metals
- ✓ State the trends of the following properties within periods and groups of elements including:
  - ❖ Ionization energy
  - ❖ Electronegativity
  - ❖ Atomic Radius
  - ❖ Chemical Reactivity
  - ❖ Metallic/Nonmetallic character