TOPIC 4.1

DEVELOPMENT/ORGANIZATION OF THE PERIODIC TABLE

How are the elements organized on the periodic table?

The Periodic Table exists to provide some element of order to all 118 elements we currently know of/have discovered. Primarily, we will talk about order in one of 3 ways:

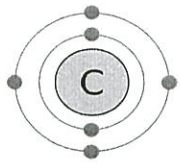
Atomic number: how the elements are arranged from left to right

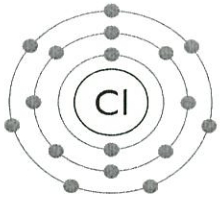
Periods: rows

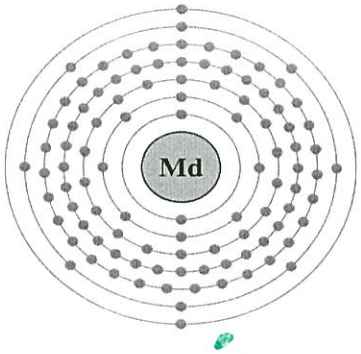
Groups/families: columns

As you might imagine, when we start sorting and ordering elements systematically, certain patterns emerge. We'll be looking at those patterns over the course of this unit. All of these patterns are a result of atom structure.

Remember Bohr? His diagrams will be useful when thinking about patterns in the Periodic Table. However, drawing all those circles and dots can get a bit ridiculous:







The electrons in the outermost shell (farthest away from the nucleus) are called **valence electrons**.

Valence electrons: involved in chemical reactions; responsible for an element's reactivity

chemica properti

We are usually most interested in valence electrons when talking about chemical reactions, so chemists developed a simplified diagram to show just the element symbol and its valence electrons: a **Lewis Dot Diagram** (also called an **electron dot diagram**). To draw a Lewis Dot Diagram for an atom, just follow three simple steps:

1. Write the element symbol
2. Pretend there is a square around the element symbol. Place one dot for every **valence electron** around the element symbol on the "edges" of the invisible square.
3. Partner up the dots one by one if there are more than 4 **valence** electrons. You will only ever have to deal with a maximum of 8 valence electrons.

elements with the same # of valence e⁻ share similar chemical properties

TOPIC 4.2

IONS & THE OCTET RULE

Why do some elements tend to gain or lose electrons?

➢ So far in class we've focused on the number of protons equaling the number of electrons in an atom, which explains why atoms are electrically neutral.

➢ However, certain elements tend to gain or lose electrons. The driving force behind this is: STABILITY

THE OCTET RULE: atoms "like" to have 8 valence electrons, so they will gain, lose, or share electrons in order to achieve this

EXCEPTIONS: H, He, Li, and Be are complete/stable/happy with 2 valence electrons

- When an atom gains or loses electrons, it is no longer considered an "atom," but rather, an ION.
  - There are two types of **ions**

lose electrons → **Cation**

gain electrons → **Anion**

cation
★positively charged

★no dots in diagram

Cation
cat•i•on
Pronunciation: [kat-ahy-uh n, -on]
-noun, *Chemistry*
1. An ion with a paws-itive charge.
2. The cutest ion ever.

an N ion
★negatively charged

★ 8 dots in diagram

ANIONS (ONIONS) ARE BAD (NEGATIVE)

- **Lewis Dot Diagrams** (or Electron Dot Diagrams) look different for **ions** than they do for **atoms**

FLUORINE ATOM # of protons 9 # of electrons 9 Net charge 0	$\cdot\ddot{F}:$
FLUORINE ION # of protons 9 # of electrons 10 Net charge −1	$[:\ddot{F}:]^{-1}$
LITHIUM ATOM # of protons 3 # of electrons 3 Net charge 0	$\cdot Li$
LITHIUM ION # of protons 3 # of electrons 2 Net charge +1	$[Li]^{+1}$

★ must show brackets & charge

TOPIC 4.3

PERIODIC TRENDS: ATOMIC & IONIC RADIUS

What happens to the radius of an atom that gains or loses electrons to become an ion?

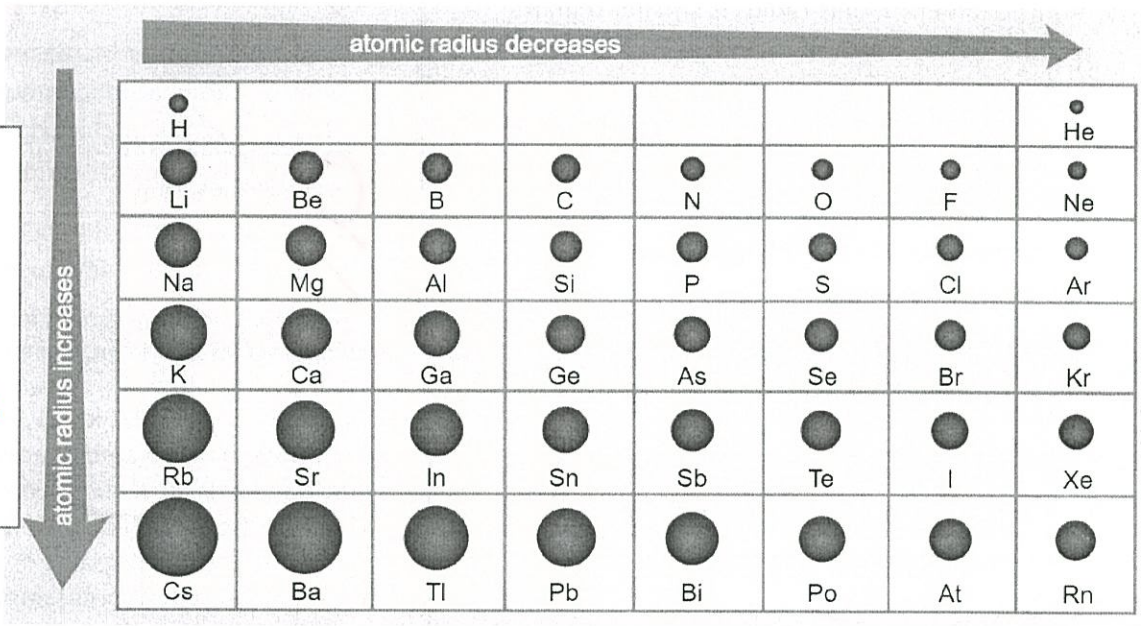
Gaining or losing electrons changes an **atom** into an **ion**, which also changes the size (**radius**) of the element.

1: Trends in Atomic Radius

★Table S

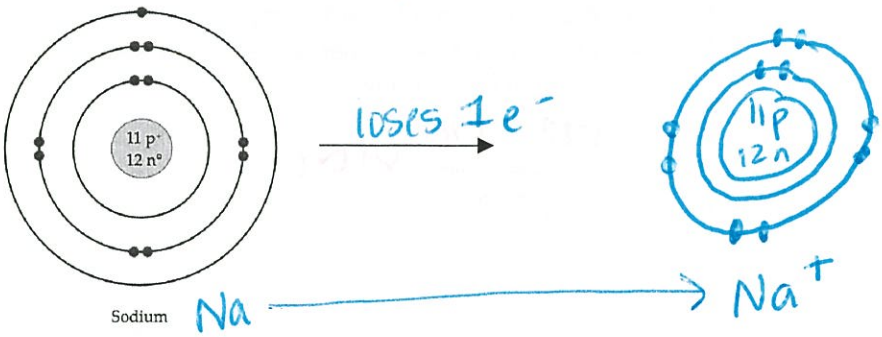
From left to right across a period, atomic radius decreases because nuclear charge increases and pulls electrons closer to the nucleus.

From top to bottom down a group, atomic radius increases because the number of electron shells increases.

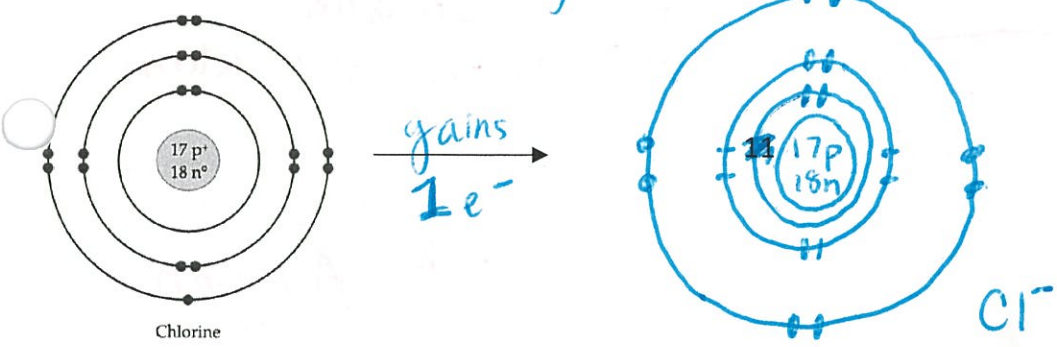


2: Trends in Ionic Radius

LOSING ELECTRONS: A positive **ion is created with a** smaller **radius.**



GAINING ELECTRONS: A negative **ion is created with a** Larger **radius.**



TOPIC 4.4

PERIODIC TRENDS: FIRST IONIZATION ENERGY

How much energy is required to remove an electron?

There is no free lunch. Even though some elements "want" to lose electrons, it doesn't mean this happens at no cost. There is energy associated with this change.

~~Free~~ First ionization energy: energy required to remove valence electron

Why might it be *hard* to steal away an electron from an element?

1. need to overcome attraction between (+) nucleus & (−) electron

2. if an element is stable (8 valence electrons)

Summarize the general trend in first ionization energy seen in the Periodic Table as you move across a period and down a group:

Across a period: ionization energy increases

Down a group: ionization energy decreases

																(17)	
																1681	
																1251	
(4)	419	590	633	659	651	653	717	762	760	737	745	906	579	762	944	941	1140	1351
																1008	

TOPIC 4.5

PERIODIC TRENDS: ELECRONEGATIVITY

How badly do some atoms want electrons?

Electronegativity: the relative ability of an element to attract electrons in a chemical bond

Why might an element want to attract electrons?

1. to achieve a full valence shell (8 electrons)

2. positive protons in the nucleus are attracted to negative electrons

Summarize the general trend in electronegativity seen in the Periodic Table as you move across a period and down a group:

Across a period: electronegativity increases

Down a group: electronegativity decreases

*Fluorine has the highest

																(17)	
																4.0	
																3.2	
(4)	0.8	1.0	1.4	1.5	1.6	1.7	1.6	1.8	1.9	1.9	1.9	1.7	1.8	2.0	2.2	2.6	3.0	
																	2.7	
																	2.2	

TOPIC 4.6

PERIODIC TRENDS: METALLIC CHARACTER

What are the properties of metals?

You may have noticed that elements on the left- and right-hand sides of the Periodic Table seem to have some similar **chemical properties**, given the patterns you've found with +/- ion formation, first ionization energy, and electronegativity. Chemistry has taken those similarities and used them to describe a new property:

Metallic character: low electronegativity & low first ionization energy leads to positive ion formation

Knowing what makes something defined as "metallic," where can you find the **metals** on the Periodic Table?

(To the left) / to the right

Things that are "non-metallic" tend to behave in opposite ways. Where can you find the **non-metals** on the Periodic Table?

To the left / (to the right)

Where do you draw the line as to what's "left" and what's "right"? Create "stairs" above **Al and Po.**

Anything that uses the staircase line as a border, besides Alpo, is classified as a **metalloid** (used to be called "semi-metals").

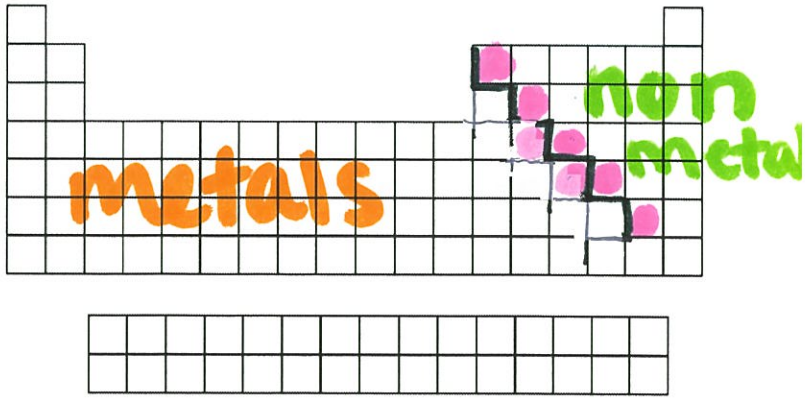
Metalloid: have physical & chemical properties of both metals & nonmetals

★ B, Si, Ge, As, Sb, Te, At ★

Summarize the (general) trend in metallic character seen in the Periodic Table as you move across a period and down a group:

Across a period: metallic character decreases

Down a group: metallic character increases



TOPIC 4.7

PERIODIC TRENDS: REACTIVITY

How can we predict the chemical properties of an atom?

Elements only bother reacting with stuff if it's worth it. What makes it worth it? **Stability**. The octet rule tells us that elements will try as hard as they can to gain a "full" valence shell (8 valence electrons). As is the case with people, some elements are more motivated than others.

What does it mean to **react**? How is reacting different than the **physical changes** we looked at in Units 1 and 2?

a new substance is formed!

Compare the chemical properties of the sodium atom, Na, and the sodium ion, Na^+.

Na is highly reactive (explodes in contact w/ water)

Na^+ is stable / unreactive (in table salt!)

What are good indicators of how reactive an element may be?

1. # of valence electrons
   - ★Noble Gases are unreactive/inert
2. location on P.T.
   - Fr - most reactive metal
   - F - most reactive nonmetal

Summarize the trends in reactivity seen in the Periodic Table as you move across a period and down a group for...

Metals: reactivity increases down a group and decreases across a period

Nonmetals: reactivity decreases down a group and increases across a period