Chemical Bonding

Part 1: Introduction, Electrons, Lewis Dot Diagrams, & Oxidation Numbers

What do aspirin, plastic wrap, & vinegar have in common?

Give up?

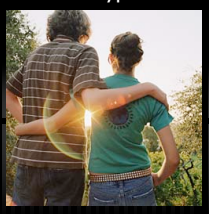
- They are all made of the **same 3 elements**:
  - Carbon
  - Hydrogen
  - Oxygen
- Only the elements are in different amounts & in different combinations
- However, when they are chemically combined and bonded in certain ways they form **compounds**, and are extremely useful!

"C" is for Compound

- A compound contains two or more elements that are **chemically bonded** together.
- Examples:
  - Water - H_2O
  - Salt - NaCl
  - Sugar - $C_6H_{12}O_6$
- Practically everything you eat is a compound.
- In fact, most matter is in the form of a compound.

What is a bond?

Or this type



Or this…

And definitely not this Bonds.

Not this type

A chemical bond!

- What does it mean to be "chemically combined" or bonded?
- A bond **holds** atoms together
- A chemical bond forms when atoms **transfer** or **share electrons**.
- This is actually a **force** of attraction, like gravity or magnetism, that holds the atoms together.
- A bond also involves **valence electrons**

Electrons & Bonds

- In order to understand WHY bonding occurs, we need to revisit electrons.
- We use a concept called "Happy Atoms."
- We figure most atoms want to be happy, just like you.
- The idea behind Happy Atoms is that atomic shells like to be full.
- That's it.

Electrons & Bonds

- If you are an atom and you have a shell, you want your shell to be full.
- Some atoms have too many electrons (one or two extra).
- These atoms like to give up their electrons.
- Some atoms are really close to having a full shell.
- Those atoms go around looking for other atoms who want to give up an electron.

Electrons & Bonds

- The only electrons that can do the bonding are the ones in the outermost shell - the farthest from the nucleus.
- We call these special guys **valence electrons**.
- Valence electrons are the electrons in an atom's outermost shell- the shell that is the furthest from the nucleus that holds electrons.

Valence Electrons

- They are the only electrons that are allowed to participate in a bond.
- Remember the secret for finding the number of valence electrons?
- It's the same as the **group** (column) **number** the element belongs in
- Think of it valence electrons as an atom's "skin".

You try it!

- Let's see how much you remember about determining the number of valence electrons. Use your periodic table & complete the chart below.

	Total Electrons	First Shell	Second Shell	Third Shell?	**Valence Electrons**
Hydrogen					
Helium					
Lithium					
Oxygen					
Sodium					

You try it!

	Total Electrons	First Shell	Second Shell	Third Shell?	**Valence Electrons**
Hydrogen	1	1	-	-	1
Helium					
Lithium					
Oxygen					
Neon					

You try it!

	Total Electrons	First Shell	Second Shell	Third Shell?	**Valence Electrons**
Hydrogen	1	1	-	-	1
Helium	2	2	-	-	2
Lithium					
Oxygen					
Sodium					

You try it!

	Total Electrons	First Shell	Second Shell	Third Shell?	**Valence Electrons**
Hydrogen	1	1	-	-	1
Helium	2	2	-	-	2
Lithium	3	2	1	-	1
Oxygen					
Sodium					

You try it!

	Total Electrons	First Shell	Second Shell	Third Shell?	**Valence Electrons**
Hydrogen	1	1	-	-	1
Helium	2	2	-	-	2
Lithium	3	2	1	-	1
Oxygen	8	2	6	-	6
Sodium					

You try it!

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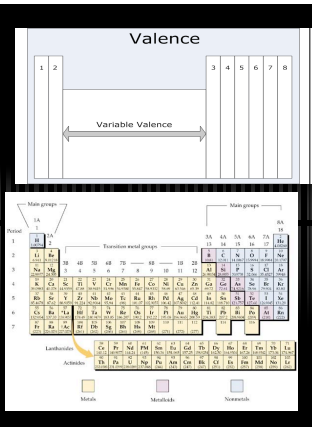
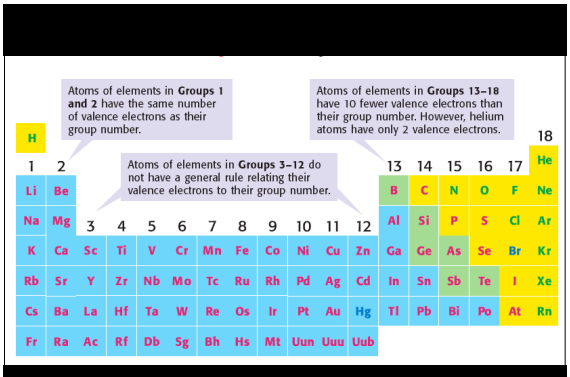
Hydrogen	1	1	-	-	1
Helium	2	2	-	-	2
Lithium	3	2	1	-	1
Oxygen	8	2	6	-	6
Sodium	11	2	8	1	1

Shhh! Secret rule!

- ✓ Remember, elements in a family on the periodic table have similar properties, including the # of valence electrons.
- ✓ The number of valence electrons is identical to the **family number** on the periodic table.





Lewis Dot Structure

- A Lewis Dot Structure, also called an Electron-Dot Diagram, is a drawing that shows the number of valence electrons in an atom.
- They're easy! Here's how you draw one:

1. Write the element symbol: O
2. Determine the # of valence electrons: 6
3. Draw that # of dots around the symbol! (remember to go all the way around first)

You Try it!

	Valence Electrons	Lewis Structure
Carbon		
Fluorine		
Calcium		
Krypton		

You Try it!

	Valence Electrons	Lewis Structure
Carbon	4	
Fluorine		
Calcium		
Krypton		

You Try it!

	Valence Electrons	Lewis Structure
Carbon	4	
Fluorine	7	
Calcium		
Krypton		

You Try it!

	Valence Electrons	Lewis Structure
Carbon	4	
Fluorine	7	
Calcium	2	
Krypton		

You Try it!

	Valence Electrons	Lewis Structure
Carbon	4	
Fluorine	7	
Calcium	2	
Krypton	8	

Happy atoms!

- Again, in order for an atom to be happy - it needs a **full outer** shell.
- We have a **2-8-8** rule.
  - The 1st shell is happy with **2** electrons.
  - The 2nd shell is happy with **8** electrons.
  - The 3rd shell is happy with **8** (or 18) electrons.
- Now that you're a pro at calculating the # of valence electrons in an element, let's take it 1 step further & determine how many more electrons an atom needs to become happy.

Happy atoms!

- Looking back at this table we did earlier… **add another column** & calculate HOW many more electrons each element needs to be happy.

	Total Electrons	First Shell	Second Shell	Third Shell?	**Valence Electrons**	Wants how many more?
Hydrogen	1	1	-	-	1	
Helium	2	2	-	-	2	
Lithium	3	2	1	-	1	
Oxygen	8	2	6	-	6	
Sodium	11	2	8	1	1	

Happy atoms!

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Happy atoms!

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Happy atoms!

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Happy atoms!

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Happy atoms!

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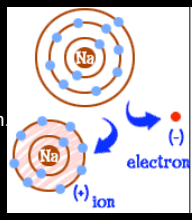
Hydrogen	1	1	-	-	1	1
Helium	2	2	-	-	2	none
Lithium	3	2	1	-	1	7
Oxygen	8	2	6	-	6	2
Sodium	11	2	8	1	1	7

Consider this…

- Look at Sodium & Oxygen.
- Which one is going to have a harder time finding enough electrons to make it happy?
- **Sodium**! Why?
- Because it needs 7 more! That's a lot!
- It's going to be impossible for it to find an atom that is willing to give it 7 whole electrons.
- Instead, Sodium will have a much better chance at being happy if it is willing to give its electron away.

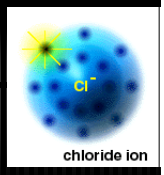
Generous "Giving" Sodium

- Some atoms are better off giving electrons away & some are better getting a couple.
- When electrons get passed around, it changes the overall charge of the atom.
- Look at Sodium again.
- It wants to give away one electron.
- When it gives the negative electron away, sodium becomes **positive**.
- When an atom becomes either negative or positive (it has an overall charge),
- we call it an **ion.**



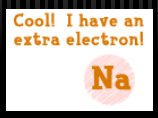
Greedy "Gimme" Chlorine

- Compare that to chlorine.
- Chorine (valence # = 7) wants 1 electron.
- By gaining a negative electron, the chlorine atom becomes a **chloride ion** with a charge of -1
- Yes, the names change when atoms become ions…but we'll talk about that later!



A match made in chemistry heaven

- Hmmmmm… Notice something?
- Greedy Chlorine is willing to take an electron.
- Generous Sodium is willing to give an electron away.
- No wonder these atoms like each other so much!!!
- Throw in a little bit of chemical magic and you get salt!
- Sodium chloride - NaCl!
- We'll talk more about this soon.



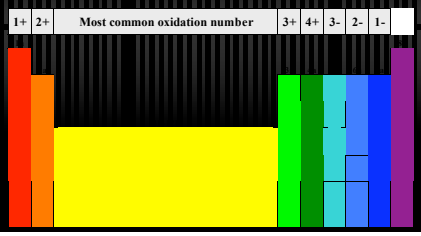
Giving vs. Getting

- Since sodium always ionizes to become Na+, with a positive charge of ~~+1~~, we can say it has has an **oxidation number** of 1+.
- An oxidation number indicates the charge on the atom when electrons are lost or gained.
- Typically, we write the charge **after** the number.

Atom	Electrons gained or lost	Oxidation #
K	Loses 1	1+
Mg	Loses 2	2+
Al	Loses 3	3+
P	Gains 3	3-
Se	Gains 2	2-
Br	Gains 1	1-
Ar	Loses 0	0

Giving vs. Getting

- Use this table to help and remember…
  - **Positive** Oxidation Number = **losing** electrons
  - **Negative** Oxidation Number = **gaining** electrons



What's up with Bonding??

- Let's see what Tim & Mobey have to say about chemical bonding: (take some notes!)
- Click here

Wrap it up

Here is what you should be able to do now:

- Define chemical bond
- Determine the # of valence electrons
- Draw Lewis Dot Structure (Electron Dot Diagrams)
- Calculate how many electrons that atoms need to have full outer shells
- Find out whether an atom becomes a positive or negative ion
- Determine the oxidation number of atoms

Let's continue with Lect 2 which focuses on bonding