Chp14: Lect 1 Notes: **Name:**_____ **Pd**__ **Sci#**____ 2pts ec printing

Chemical Bonding: *Electrons, Lewis Dot Diagrams, & Oxidation Numbers*

What do aspirin, plastic wrap, & vinegar have in common? Give up? They are all _____ made from different combinations of the same 3 atoms: Carbon, Hydrogen, Oxygen. Individually, these 3 elements cannot reduce pain, keep food fresh, or season food. But when they are chemically combined in certain ways to form **compounds**, they are extremely useful!

"C" is for Compound A compound contains two or more elements that are _____ _____ 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? A chemical bond! What does it mean to be "chemically combined" or bonded? A chemical bond forms when atoms _____ or _____. This is actually a _____ of attraction, like gravity or magnetism, that holds the atoms together. A bond also involves _____

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. 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. 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** are the electrons in an atom's outermost shell- the shell that is the furthest from the nucleus that holds 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 _____**(column)** _____ the element belongs in. Think of valence electrons as an atom's "skin". **You try it!** Calculating the number of valence electrons. Use the Per Tbl & complete the chart bellow.

	Total Electrons	First Shell (2)	Second Shell (8)	Third Shell (18)	Valence Electrons	Wants how many more?
Hydrogen						
Helium						
Lithium						
Oxygen						
Sodium						

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 _____ _____ 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:
Write the element symbol (oxygen)
Determine the # of valence electrons
Draw that # of dots around the symbol!

Happy atoms!

Again, in order for an atom to be happy - it needs a _____ shell. We have a _____ rule.

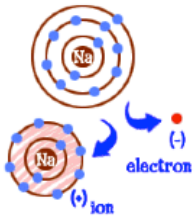
- The 1st shell is happy with _____ electrons.
- The 2nd shell is happy with _____ electrons.
- The 3rd shell is happy with _____ (or 18) electrons.

You Try It: Draw Lewis Dot Structures

	Valence Electrons	Lewis Dot Structure
Carbon		
Fluorine		
Calcium		
Krypton		

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

Ions ions ions An ion is a _____ or an atom that has either _____ or _____ an _____. In the case of NaCl, Sodium willingly gives away its lone valence electron. Chlorine very greedily takes that electron, in order to full its outer shell. Like we said, sodium & chloride are a match made in heaven. As sodium gives away its electron, it becomes a _____ ion called a _____. When chlorine receives the electron, it becomes a _____ ion. This is called an _____. After the electron moves, the positive sodium ion is then immediately attracted to the negative chloride ion. Why are they attracted to each other? **Because** _____



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

Generous "Giving" Sodium & Greedy "Gimme" Chlorine

Some atoms are better off giving electrons away & some are better getting a couple. When sodium gives the negative electron away, sodium becomes a _____ ion 1+. When Chlorine (valence # = 7) takes that electron it becomes a NEGATIVE _____ _____with a charge of 1-. Both sodium & chlorine have become **ions**: An ion is an atom that has _____or _____an **electron.** SInce sodium always ionizes to become Na+, with a positive charge of 1, we can say it has has an _____ of 1+. An **oxidation number** indicates the charge on the atom when electrons are lost or gained. Typically, we write the charge _____ the number

Use this table to help and remember…

_____ Oxidation Number = _____ electrons

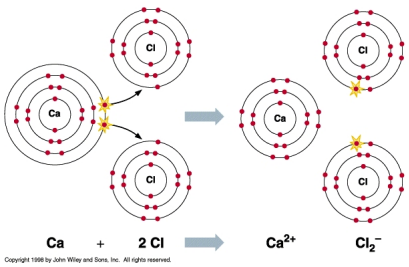
_____ Oxidation Number = _____ electrons

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

Ionic Bonds: The GIVING and TAKING of electrons… It's all about what I want! ☺

A _____ that is formed from one element _____and one element _____. These bonds are not limited to a single pair of atoms. In NaCl, each Na+ is attracted to all of the neighboring chloride ions. Likewise, each Cl- is attracted to all the neighboring sodium atoms. These ions form in a repeated 3-dimensional pattern called a _____ This means the positive and negative atoms are arranged in alternating patterns. This is why salt is formed in cubes.

Ionic Bond Examples



The prime example of an ionic bond is NaCl, but there are many more examples of ionic bonds. Look how it takes 1 calcium atom to bond with 2 chlorine atoms. Also, notice how calcium is now Ca^{2+}. Why? Well, because calcium _____ electrons, leaving it with an overall charge of 2+. Conversely, each chlorine _____ electron, leaving each with an overall charge of 1-. This new compound would be written as _____

Superscript & Subscripts

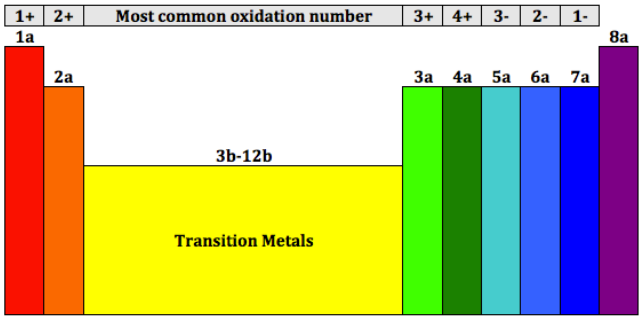
Two ions: H^{1+} and $(SO_4)^{2-}$

_____ (high #) represents the **charge** number.

Remember that the subscript (low #) refers to the number of atoms. How many hydrogens does it take to pair with the sulfate ion (SO_4)? _____ (see the 2 outside the parenthesis?)That shows I need 2 positive charges to match the 2- charge. So, 2 hydrogen are needed to fill that .The final compound would be _____ because the ion numbers have to be balanced.

You Try It!

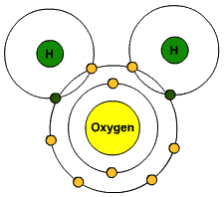
Cation	Anion	Compound
Li^{1+}	S^{2-}	
Mg^{2+}	Cl^{1-}	
Al^{3+}	$(PO_4)^{3-}$	



Chp 14 Lect 2: Chemical Bonding Continued…

Remember: Bond with me

A chemical bond forms when atoms _____ or _____. For example, in a water molecule, each hydrogen atom shares its single electron with the oxygen at the center. This way, all of the atoms are happy with full shells. Almost all elements form chemical bonds easily - which is why most matter is found in compounds.



Metallic Bonds: a metallic bond is the force of attraction between a _____ charged metal ion and the electrons in a metal. Metals atoms are so tightly packed, their electron shells overlap. This lets electrons move freely from one atom to another. THIS lets metal conduct electricity & change shape easily (ductility, malleability).

Covalent Bonds

A _____ is formed when atoms _____ electrons. The bonds between oxygen and hydrogen in a water molecule are covalent bonds. There are two covalent bonds in a water molecule, between the oxygen and each of the hydrogen atoms. Each bond represents one electron. In a covalent bond, electrons are _____ between atoms, not transferred.

"M" is for Molecule

A group of atoms held together by covalent bonds is called a _____. Water is a molecule, and so is sugar. Other examples of molecules are methane (CH_4), ammonia (NH_3), oxygen (O_2), nitrogen (N_2).

Single bond	Double bond	Triple bond
H–H	O=O	N≡N
H : H	·Ö::Ö·	Ṅ:::Ṅ

Fancy Bonding

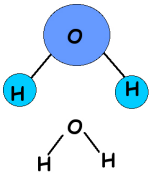
Sometimes, atoms share more than one electron. Occasionally, they can share 2 or even 3 electrons. These are called _____ and _____ bonds.

Chemical Formulas

Molecules are represented by a _____ _____. The chemical formula tells you the _____ of each kind of atom in the molecule. For example, the chemical formula for water is H_2O. The _____ 2 indicates there are two hydrogen atoms in the molecule. The chemical formula also tells you that water always contains twice as many hydrogen atoms as oxygen atoms.

Water is a simple molecule, so the formula is pretty easy. Let's look at a more complex molecule. Baking soda, or sodium bicarbonate, is $NaHCO_3$. That means it has: 1 Sodium (Na), 1 Hydrogen (H), 1 Carbon (C), 3 Oxygen (O)

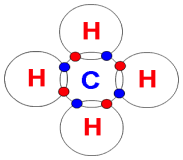
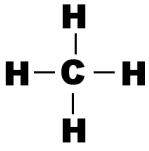
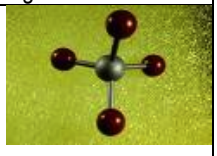
You Try It! Chemical Formulas	
Chemical Formula	**Elements - #**
C_6H_6	
NH_3	
$Al(OH)_3$	
$CO(NH_2)_2$	



Structural Diagrams

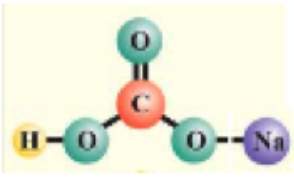
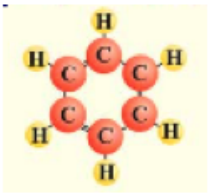
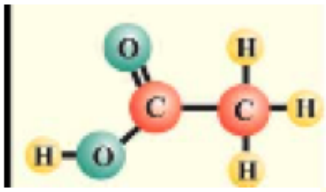
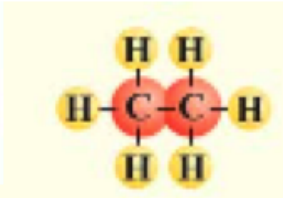
The shape of a molecule is also important to its function and properties. For this reason, molecules are represented by _____ which show the shape and arrangement of atoms. A single bond is represented by a bold short line.

Double and triple bonds are indicated by _____ and _____ lines. Of course, real molecules are _____ not flat as shown in a structural diagram. For example, methane - CH_4 - has the shape of a 4-sided pyramid called a tetrahedron

Chemical Formula	Diagram with electrons	Flat Structural Diagram	3D structural Diagram
CH_4			

You Try It! Match the structural diagram with its chemical formula.

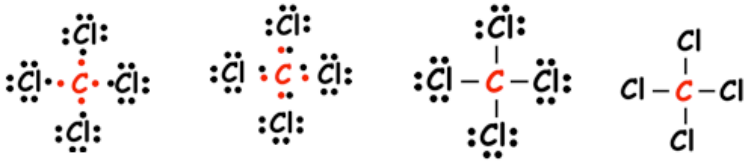
1. C_2H_6 _____ 2. $NaHCO_3$ _____ 3. $HC_2H_3O_2$ _____ 4. C_6H_6_____

Lewis Dot Molecules

We've already seen how you draw a Lewis dot structure. The dots represent the valence electrons of an atom. We can draw Lewis dot structures for molecules too. Each element forms bonds to reach one of the magic numbers of valence electrons: _____ or _____. In dot diagrams of a happy molecule, each element symbol has either 2 or 8 dots around it.

Notice that with this molecule, each atom has 8 electrons. The shells are all full!!! Each chlorine atom shares an electron with carbon. In return, carbon shares its electrons with chlorine.



You can see how the drawing changes & becomes simpler & simpler.

Review: Types of bonds There are a couple different types of bonds 1. _____ 2. _____ 3. _____	**Covalent**	**Ionic**
	_____ Electrons	_____ Electrons
	Creates _____	Creates _____
	Bond consists of 2 electrons	Bonds form with all oppositely charged neighbors

Counting Atoms

The formula for a compound indicates the elements that make up the compound and the number of atoms of each element present in the compound. These numbers of atoms are indicated by the use of small numbers called subscripts. Sometimes groups of atoms act as a single atom. Such a group of atoms is called a polyatomic ion. List each element in the compound & the number of atoms of each element present. The first example has been done for you. In addition, you are to also identify the elements atomic number and group/family, and what type of atom it is: metal, nonmetal, metalloid.

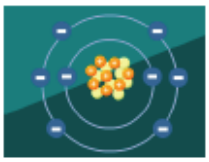
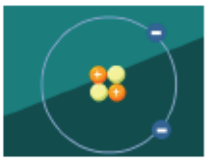
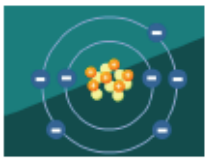
Name	**Use**	**Formula**	**Atoms in Formula**	**Element's atomic number**	**Element's group/family**	**Type of element**
Calcium Carbonate	Limestone	$CaCO_3$	Ca = Calcium : 1 C= Carbon: 1 O= Oxygen: 3	Ca=20 C= 6 O = 8	Alkaline EarthMetals Carbon Family Oxygen family	metal nonmetal nonmetal
Aspirin	Pain reliever	$C_9H_8O_4$	_____ _____ _____			
Magnesium hydroxide	Tummy tablets for gas pain	$Mg(OH)_2$	_____ _____ _____			
Paradichloro-benzene	Moth balls	$C_6H_4Cl_2$	_____ _____ _____			
Acetic acid	Vinegar	$C_2H_4O_2$	_____ _____ _____			
Trinitro-toluene (TNT)	explosive	$C_7H_5(NO_2)_3$	_____ _____ _____ _____			
Calcium dihydrogen phosphate	fertilizer	$Ca(H_2PO_4)_2$	_____ _____ _____ _____			

Chp 14 BrainPop: Chemical Bonds

1. If an atom has no charge, which of the following must be true?
a. It has more neutrons than protons or electrons
b. There are only neutrons inside the atom
c. Its number of protons is equal to its number of electrons

2. Based on what you know about atomic structure, what can you infer about the word "nuclear?"
a. It relates to protons and neutrons b. It relates to electrons
c. It relates to neutrons only d. It relates to ions only

3. Which of these is an ion?

a. 
b. 
c. 
d. 

4. Atom X has 10 electrons. Atom Y has eight electrons. Which of them is more likely to bond with another atom?
a. Atom X b. Atom Y c. Neither of them is likely to bond
d. They are equally likely to bond

5. Which of these atoms is most likely to bond with another atom?

a. 
b. 
c. 
d. 

6. An atom has 15 total electrons. How many electrons does it have in its outer shell?
a. Three b. Four c. Five d. Six

7. The relationship between the number of electrons in an atom's outer shell and the atom's tendency to bond is called the octet rule. What can you infer about the meaning of "octet?"
a. It refers to negative charges b. It refers to sets of eight
c. It refers to different states of matter

8. Atom A has 7 electrons in its outer shell. Atom B has 1 electron in its outer shell. They react and bond. Now both atoms have eight electrons in their outer shells. What kind of bond has formed?
a. Covalent b. Ionic c. Metallic d. Electron

9. Cations have positive charges. Anions have negative charges. What force draws the two together?
a. Magnetic attraction b. Ionic attraction
c. Electromagnetic attraction d. Electrostatic attraction

10. Substance M is a blue, brittle solid. Substance N is a colorless, flammable gas. What can we predict about the compound created when M and N form a covalent bond?
a. It will be a liquid, since M is a solid and N is a gas
b. It will be blue, since M is blue and N is colorless
c. It will probably be flammable, since N is flammable
d. There's no way to tell based on the information given

Chp 15 BrainPop: Chemical Equations

1. Which of the following is a chemical reaction?
a. Sodium and chlorine atoms bond to form salt molecules
b. Ice melts to form water
c. Carbon dioxide freezes to form dry ice
d. Salt and water mix to form salt water

2. In the equation $2H_2 + O_2 \rightarrow 2H_2O$, what are the reactants?
a. Hydrogen atoms b. Hydrogen and oxygen molecules
c. Water molecules d. Ice crystals

3. Sulfuric acid is made of two hydrogen atoms (H), one sulfur atom (S), and four oxygen atoms (O). What is its molecular formula?
a. $2H_4SO$ b. $H4S_2O$ c. H_2SO4 d. $H_2S_2O_4$

4. What is the best synonym for the word "stoichiometry?"
a. Combining atoms
b. Balancing chemical equations
c. Discovering new chemical formulas
d. Breaking the chemical bonds that hold molecules together

5. The chemical symbol "Ni" most likely represents:
a. Carbon b. Antimony c. Lead d. Nickel

6. How do the products of chemical reactions compare to their reactants?
a. The products usually weigh more than the reactants
b. The products often have completely different properties than the reactants
c. The products usually have more atoms than the reactants
d. The products are usually more toxic than the reactants

7. What's the problem with this chemical equation: $H_2 + O_2 = H_2O$?
a. There's a missing hydrogen in the reactants
b. There's a missing oxygen in the product
c. There's an additional oxygen in the product
d. There's an additional hydrogen in the reactants

8. What's the easiest way to balance a chemical equation?
a. Trial and error b. Using the periodic table
c. Complex algebra d. Calculus

9. **Which reactant is missing from the following equation? X + PO4 ¬ H3PO4**
a. One hydrogen atom b. One phosphorus atom
c. Three hydrogen atoms d. One oxygen atom

10. What is the product of the following equation? $2Na + S_2O_3 \rightarrow$
a. NaS_2O_3 b. NaS_4O_3 c. $Na_2S_2O_5$ d. $Na_2S_2O_3$

Chp 14: Brainpop: Ions

1. Which of the following is a true statement about atomic nuclei? [Atomic nucleus]
a. They are made up of protons, neutrons, and electrons
b. They have a net positive charge
c. Every atomic nucleus has the same number of particles
d. The atomic nucleus has no relation to an atom's mass

2. How do the inner electron shells of an atom differ from the outer electron shells?
a. The electrons in the outer shells orbit the nucleus at slower speeds
b. The electrons in the outer shells have negative charges; the electrons in the inner shells have positive charges
c. Electrons in the inner shells are gained and lost more frequently than electrons in the outer shells
d. The outer shells can hold more electrons than the inner shells

3. An atom with one electron in its valence shell will tend to: [Atom with one electron in valence shell]
a. Become positively charged b. Become negatively charged
c. Accept electrons from other atoms d. Accept protons from other atoms

4. Cations tend to have:
a.High valence b.Neutral valence c.Positive valence d.Negative valence

5. Fluorine is an element located on the right side of the periodic table of elements. What can you conclude about fluorine from this fact?
a. Its valence shell is nearly full
b. It tends to donate electrons to other atoms
c. It tends to form cations d. It tends to have a positive valence

6. What can you infer about elements located in the middle of the periodic table?
a. They tend to have very large atomic masses
b. They tend to have completely full valence shells
c. They tend to have positive charges
d. They tend to form ions less frequently than elements on the edges of the table

7. Which of the following is a true statement about ions?
a. Removing an electron from an atom requires energy
b. When an atom gains an electron, it loses energy
c. No energy is transferred when an atom gains or loses an electron
d. Gaining and losing protons requires less energy than gaining and losing electrons

8. Which statement best describes why sodium and chlorine form bonds so frequently?
a. A closed system can neither gain nor lose energy
b. Opposites attract
c. Objects in motion tend to remain in motion
d. What goes up must come down

9. Water is sometimes described as the "universal solvent." From the information presented in the movie, what can you infer about this nickname?
a. It means that water can make dangerous substances harmless
b. It means that water dissolves electrons
c. It means that water usually has a neutral charge
d. It means that water can break the bonds that hold many substances together

10. How is table salt (sodium chloride) different than the ions that make it up?
a. It has a net negative charge b. It has a net positive charge
c. It has a neutral charge d. It contains no electrons

Chp 15: BrainPop: Conservation of Mass

1. In science, a law is:
a. A rule governing what you are permitted to do
b. A generalization about how the physical universe works
c. A legal document that describes a rule of conduct
d. A statute enacted by a legislative body

2. What is true of a substance with a lot of mass?
a. It contains a lot of matter b. It has a large volume
c. It has a high density d. It has a low frequency

3. The law of conservation of mass says substances can neither be _____ nor _____.
a. Built; torn down b. Blended together; separated
c. Created; destroyed d. Condensed; extracted

4. How is weight different from mass?
a. Weight changes depending on gravity; mass stays constant throughout the universe
b. Weight is measured in grams; mass is measured in newtons
c. Weight can be converted to energy; mass cannot

5. Sodium and chlorine combine to form sodium chloride, or table salt. Sodium and chlorine are:
a. Producers b. Products c. Reactionaries d. Reactants

6. When sodium and chlorine combine to form sodium chloride, sodium chloride is the:
a. Originator b. Reactant c. Product d. Produce

7. 4 gm of hydrogen & 32 gm of oxygen will combine to form:
a. 36 grams of water b. 28 grams of hydroxide
c. 32 grams of oxygen d. 36 grams of deuterium

8. In a chemical reaction, 4 gm of sodium must combine with how many grams of chlorine to produce 10 gm of table salt?
a. 4 grams b. 6 grams c. 8 grams d. 10 grams

9. What was Antoine Lavoisier's contribution to the law of conservation of mass? [Lavoisier]
a. He was the first person to think of it
b. He was the first person to propose it in a scientific way
c. He came up with a widely-read, precise description
d. He was the first person to perform a chemical reaction

10. Which of the following describes a chemical reaction?
a. Oxygen interacts with iron to form rust
b. Ice melts into water
c. Carbon dioxide freezes to make dry ice
d. Rocks split apart over many years due to weathering