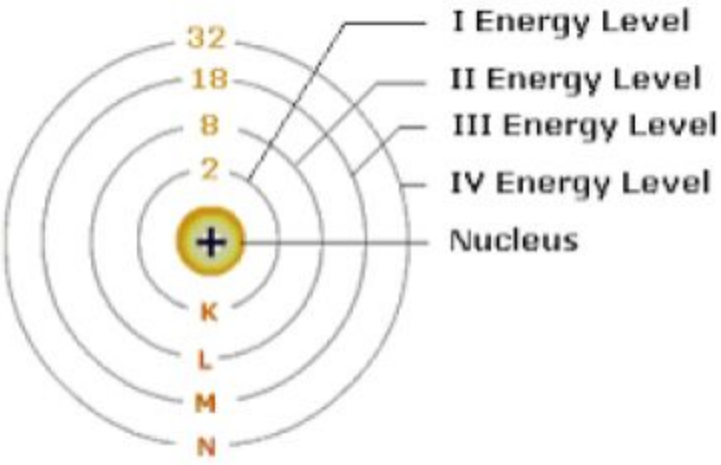
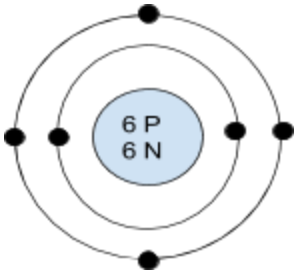
Ch. 4 Atoms and Bonding Outline

Lesson 1

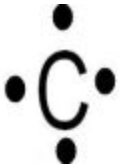
A. Atoms bond to form compounds. This happens due to the behavior of the electrons of the atoms.
   1. Electrons are found on different energy levels outside of an atom's nucleus.
      a. *Valence electrons* are found in the outermost energy level of an atom.
         i. Valence electrons have the highest energy.
         ii. Valence electrons are involved in chemical bonding
         iii. Valence electrons help determine the chemical properties of that element.
      b. Different atoms have a different number of electrons, but many follow this arrangement of electrons per energy level.



         i. Electron Dot diagrams help show the number of valence electrons an element has.
            1. Each dot stands for the number of valence electrons (NOT THE TOTAL NUMBER OF ELECTRONS!)



Carbon's atomic number is 6
It has 2 electrons on the first energy level and has 4 on its outermost energy level--***4 dots.***



B. Atoms want to be “stable”

1. This means most atoms want to have 8 valence electrons.
2. Once they have 8 they are no longer reactive.
    a. Helium (He) is stable with 2 electrons. It is non-reactive because it is stable. Because it has 2 electrons already it is stable and doesn’t like to bond.
    b. Hydrogen (H) only has 1 electron, but becomes stable with 2. It is highly reactive until it bonds.

3. Atoms share electrons with each other to form chemical bonds
    *** **chemical bond** is the force of attraction that holds atoms together as a result of the rearrangement of electrons between them

C. The Periodic Table shows a pattern of valence electrons.

1. The number of valence electrons increases from left to right.
2. Groups (Columns) have the same number of valence electrons
    a. Group 1 has 1 valence electron--they share the property of being highly reactive
    b. Group 2 has 2 valence electrons--they share similar properties
    c. Group 13 has 3
    d. Group 14 has 4
    e. Group 15 has 5
    f. Group 16 has 6
    g. Group 17 has 7

    still reactive but less and less

    h. Group 18 has 8--These are the Noble Gases. *They have all the electrons they need in their outer valence so they are non reactive*.
    i. Groups 3-13 follow a different pattern.

3. Metals on the periodic table react when they *losing their valence electrons.*

4. Non metals on the periodic table react by *gaining or sharing* enough electrons to make 8 valence electrons.
    a. Combine with metals--*gain* an electron
    b. Combine with other nonmetals, metalloids--*sharing* electrons

5. Halogens- react easily with other elements by *gaining* an electron

6. Metalloids- react by either *losing or sharing* electrons
7. Hydrogen- reacts by *sharing* an electron

Lesson 2

A. Ions- an atom or a group of atoms that has an electric charge.
   a. This happens when a neutral atom
      i. loses an electron giving it a charge + making it a positive ion
         1. Metals are likely to lose an electron--making them positively charged
      ii. gains an electron giving it a charge - making it a negative ion
         1. Non metals are likely to gain electrons making them positively charged.

   **a polyatomic ion is an ion composed of more than one of the same type of atom.

B. **Ionic bonds** form between 2 ions to form ionic compounds

   ****Usually formed when a metal combines with a non metal****

   Ionic compounds are made from bonded ions NOT FROM MOLECULES

   a. Happens when one +charged ion is attracted to a -charged ion
   b. In an ionic compound the charges even each other out

   c. Ionic compound Formulas
      i. Show the ratio of each ion in the compound

$MgCl_2$

Magnesium has a Positive charge of 2 Mg^{2+}

Chloride has a negative charge of 1 Cl^-

The subscript shows that the ionic compound is stable when 2 Cl- bond with 1Mg^{2+}

It takes 2 negative Cl ions to balance out the positive charge of 1 Mg^{2+} ion.

ii. When writing ionic compound formulas, the positive is written first, the negative is second. Then write in the subscripts to show the charges balance out.

Iii, Negative ions of a single element--end of name changes to ***ide***
Oxygen becomes oxide

Iv. Negative polyatomic ions--end of name changes to ***ate*** or ***ite***
Nitrogen becomes nitrate

C. Properties of Ionic Compounds
   1. Hard and brittle
      a. Each ion is attracted to the ions around it with the opposite charge. This makes ionic compounds hard.

   2. Form crystals
      a. Ions line up in a repeating pattern in a 3 dimensional formation

   3. High melting points
      a. Because of charge attraction, the bond is strong and resists separating even when temperatures increase. It takes a lot of heat (energy) to melt an ionic compound.

   4. Electrical conductivity when in melted or dissolved in liquid
      a. Electrical conductivity is the flow of charged particles.
         i. Ions are usually very strongly bonded and solid. The ions cannot move and can't conduct electricity.
         ii. When melted or dissolved in water, ions have more room to move freely so the current can form.

Lesson 3

A. Covalent Bonds

1. Formed when 2 atoms share electrons

Sharing electrons enables all atoms "sharing" to fill available space in their highest energy level

Oxygen has 8 electrons total

6 valence electrons

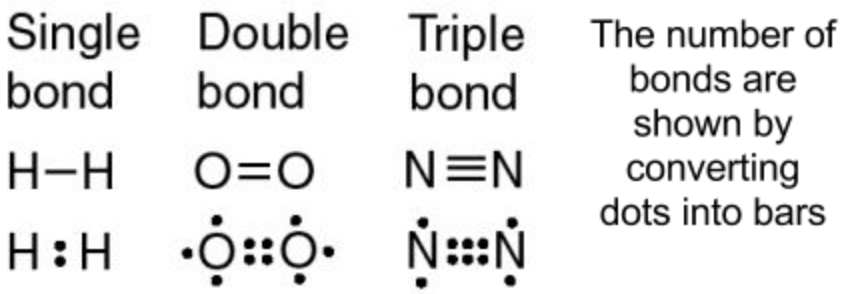
2 oxygen atoms form an oxygen molecule by sharing 2 valence electrons.

Oxygen Molecule (O_2)

2. Usually formed between two or more non metal atoms

3. Make molecules--a neutral group of atoms joined by covalent bonds
   ****Neutral because all 8 valence electrons are present

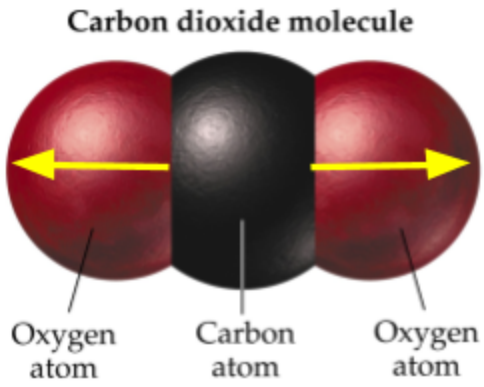
4. Types of bonds



   a. If a single electron is shared-- single bond (single bar)
   b. If two electrons are shared-- double bond (double bar)
   c. If three electrons are shared---triple bond (triple bar)

B. Properties of Molecular Compounds
   a. Molecular compounds are compounds made of molecules BONDED COVALENTLY
   b. Poor conductivity
      i. Molecular compounds DO NOT CONTAIN charged particles so there is no current.
   c. Low melting points and boiling points
      i. The forces that hold molecules together in a molecular solid are weak compared to the forces that hold ionic compounds together.
         1. It takes much less energy (heat) to break the covalent bonds, so molecular solids melt and boil at lower temperatures

C. Becoming Charged
   a. **Non polar bond** - two of the same atom pull equally on shared electrons and neither becomes charged

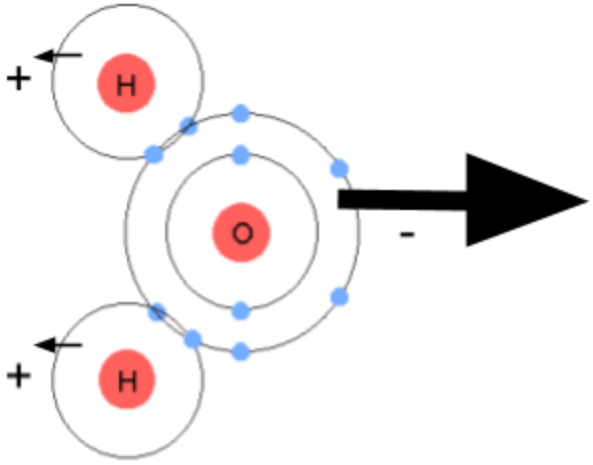


Non polar

Straight line shape

Pulling in opposite directions with equal force cancels each other out.

b. **Polar bond** - a covalent bond in which electrons are shared unequally--like a tug of war.
   i. The atom that pulls the most becomes slightly negatively charged.



Unequal sharing

Bent Shape

O atom has a very strong pull

H can't compete even though there are 2

Water molecule is polar

   ii. Van der Waals Forces
      1. The negative end of a polar molecule is attracted to the positive end of another polar molecule--opposites attract
         a. Allows molecules to want to hang on to each other
            i. Allows for surface tension

   iii. Properties
      1. Differ between polar and nonpolar compounds because of the differences of attraction between molecules.
      2. Polar molecules require more energy to break than non polar molecules.

a. Polar molecules have higher melting and boiling points than nonpolar ones.

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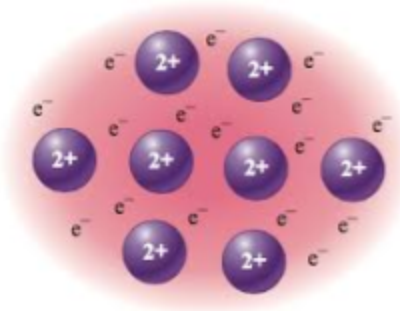
Lesson 4:

Bonding in Metals

1. Atoms of metals combine chemically with atoms of other elements and LOSE electrons from their valences--turning them into positively charged metal ions

    a. **Metallic bond**--when positively charged metal ions are attracted to the electrons surrounding it.



Positively charged metal ions

Attracted to the electrons in the cloud of the ion

2. Properties of Metals
    a. Luster
        i. Shiny and reflective because valence electrons absorb and reflect light as it hits them

    b. Malleability and Ductility
        i. Metal can be pounded into sheets or stretched into wire because the ions are more attracted to their valence electrons than other metal ions. They want to change position to become closer to the oppositely charged particle.

    c. Thermal Conductivity
        i. Valence electrons of metals are free to move easily. Electrons in the warmer part of a metal can transfer energy (heat) to cooler parts of the metal.

    d. Electrical Conductivity

        i. Valence electrons are free to move easily. This allows a charge to jump from one ion to another in a straight line. This is a current.

3. Alloys--mixtures of several elements and one or more metals.
    a. Stronger than pure metals
    b. Less reactive than pure metals
        i. Makes them more useful for industry--Iron alloy steel is much stronger and less reactive