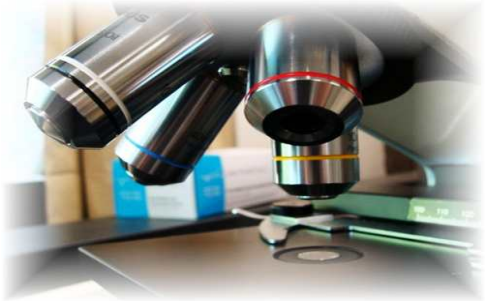

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• The SPO Virtual Classrooms offer many educational resources, including practice test questions, review questions, lecture PowerPoints, video tutorials, sample assignments and course syllabi. New materials are continually being developed, so check back frequently, or follow us on Facebook (Science Prof Online) or Twitter (ScienceProfSPO) for updates.

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• Several helpful links to fun and interactive learning tools are included throughout the PPT and on the Smart Links slide, near the end of each presentation. You must be in *slide show mode* to utilize hyperlinks and animations.

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Image: Compound microscope objectives, T. Port

Chemical Bonds, Reactions & Notation

Making
Molecules
& Compounds

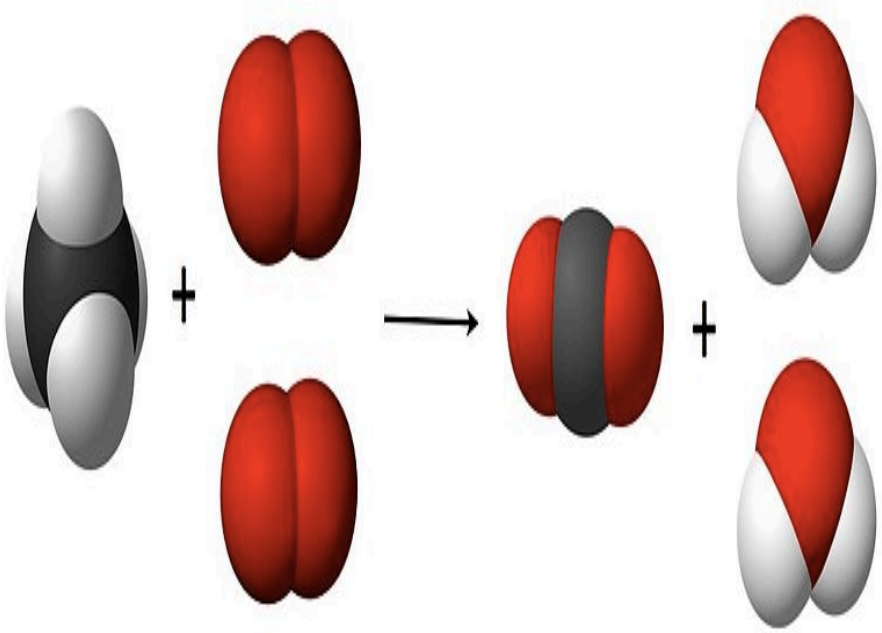
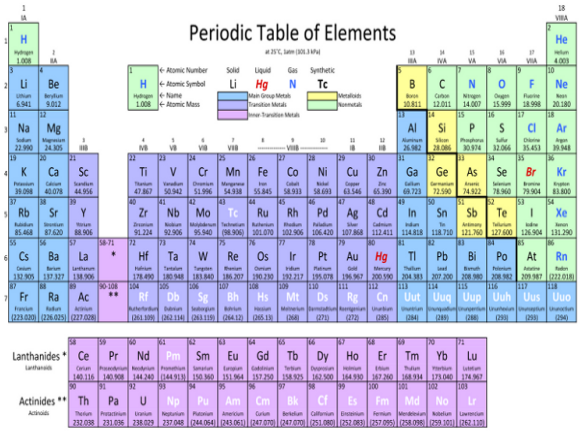


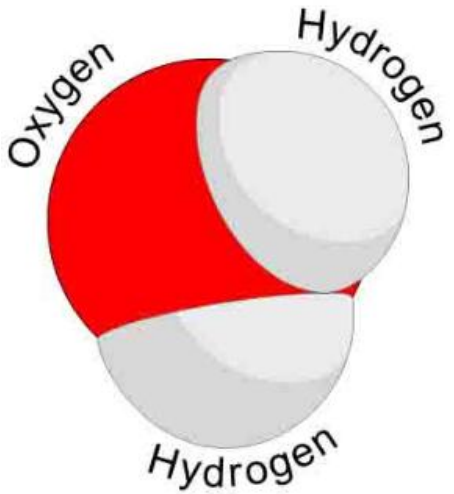
Image: Combustion Reaction of Methane, Wiki

Elements, Atoms, Molecules & Compounds

- **Elements** → Substances that can't be broken down any further.



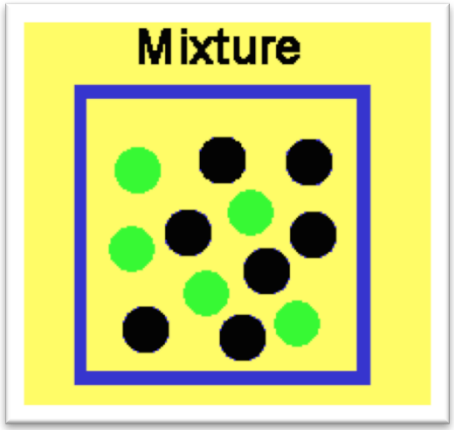
- **Atom** → The smallest unit of an element.
- Two or more atoms joined together chemically: **Molecule**
- Molecule containing at least two different
- Elements: **Compound**
- ***Examples of molecules:*** Carbon dioxide (CO_2) and methane (CH_4), molecular hydrogen (H_2), molecular oxygen (O_2) and molecular nitrogen (N_2).



- ***Examples of compounds***: Only molecules containing two or more elements, such as carbon dioxide (CO_2) and methane (CH_4).
- ***Q: Explain why all compounds are molecules but not all molecules are compounds.***

Image: Periodic Table of Elements; Water Molecule, Wiki

Mixtures & Compounds



mixture = **Physical** combination of two or more pure substances.

compound = **Chemical** combination of two or more pure substances in a fixed, definite proportion.

Example:

Mixture - Iron & Sulfur

Iron filings may be mixed with powdered sulfur in any proportion.
The two components are easily separated by means of a magnet,
The magnet will draw out the iron from the mixture.

The components of a mixture usually can be separated by physical means such as distillation, evaporation, etc.

Watch Video: Mixture vs Compound

Compound – Iron sulfide (Pyrite or Fools Gold)

However, if:

a. seven parts iron filings or powder are mixed with four parts powdered sulfur
b. mixture is heated to a red glow
c. iron and sulfur form a compound - iron sulfide; chemically combined, not readily separated.

Remind me why we care about these valence electrons…

The electrons in an atom are located in shells at different **energy levels**.

Electrons in the highest energy level are called **valence electrons**.

Number of valence electrons governs an atom's bonding behavior.

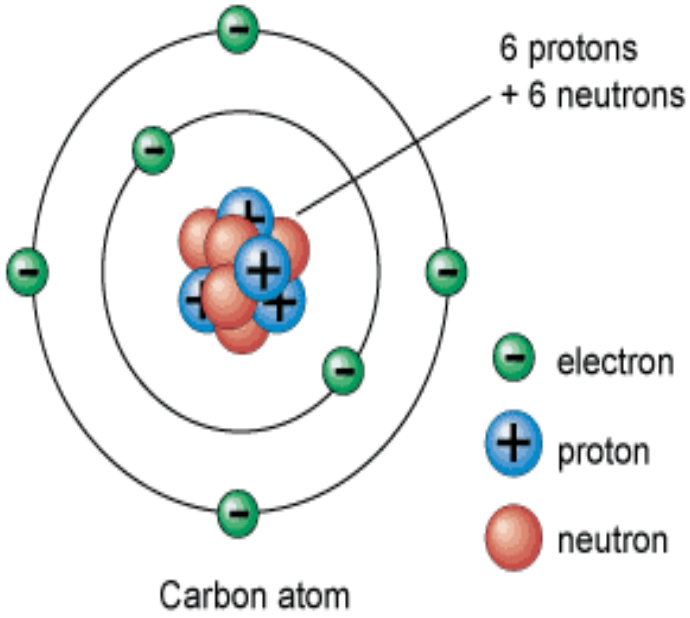
Q: What is the max number of valence electrons for a full valence shell?

Atoms are much more stable, or less reactive, with a full valence shell.

By moving electrons, the two atoms become linked. This is known as **chemical bonding**.

This stability can be achieved one of two ways:

- **Ionic** bond
- **Covalent** bond

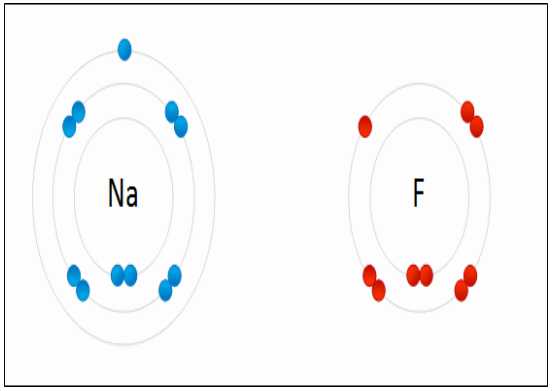


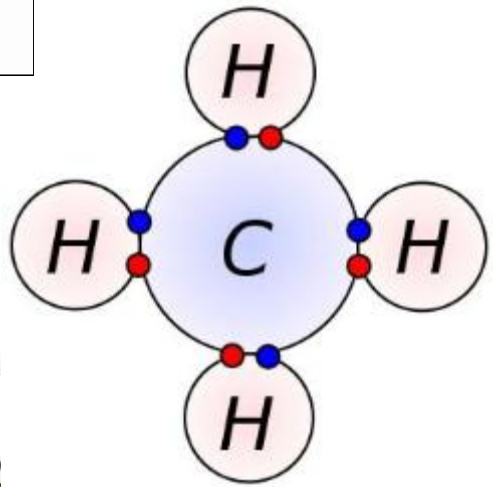
Images: Carbon, Universe Today Website

From the Virtual Cell Biology Classroom on ScienceProfOnline.com

Three Main Types of Chemical Bonds:

1. **Ionic**
2. Covalent
3. Hydrogen





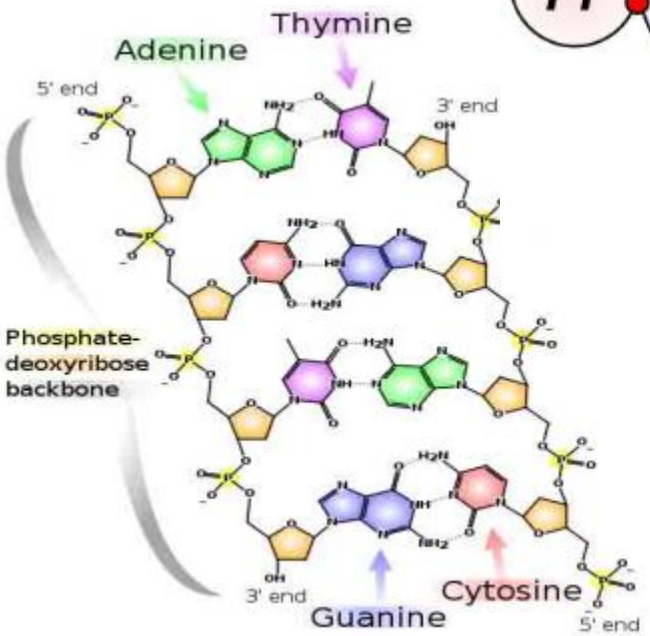
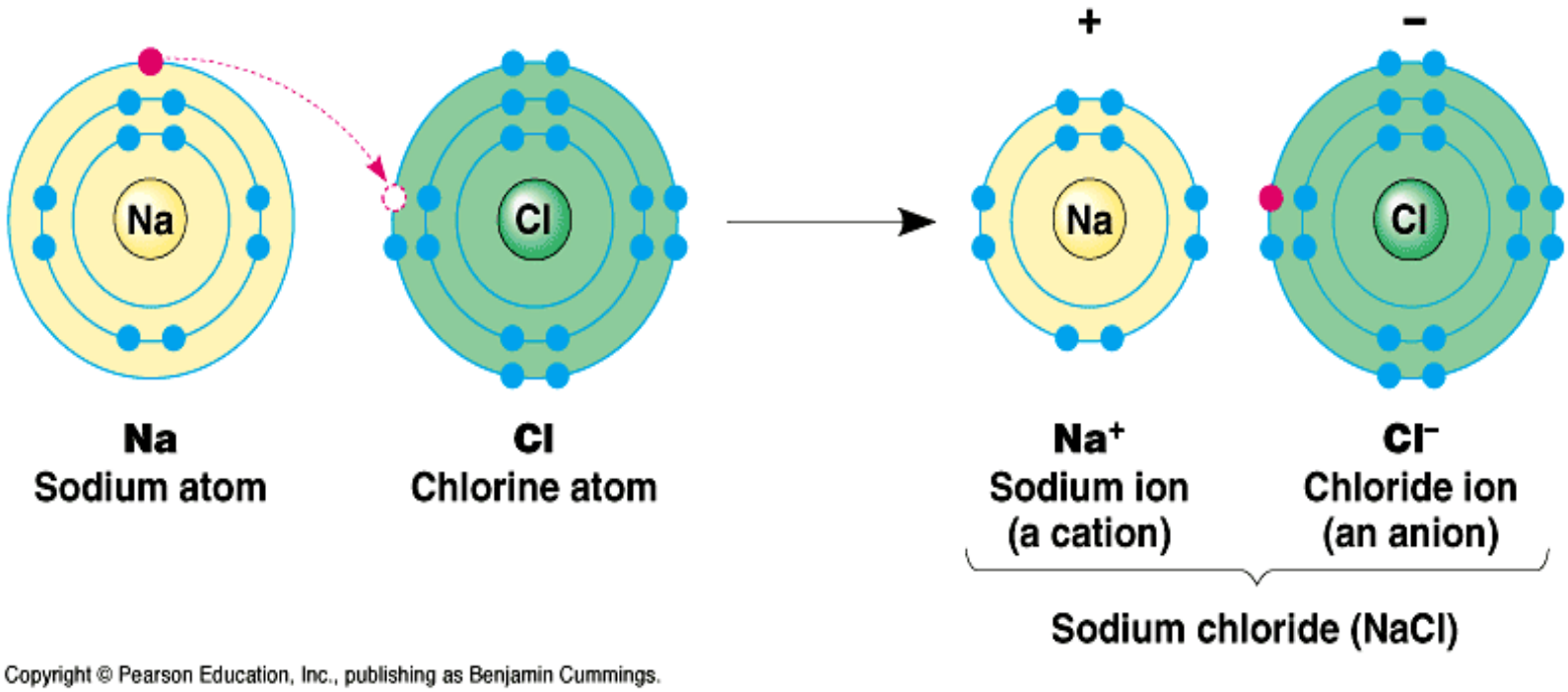


Image: Formation of ionic sodium fluoride, Wdcf; Methane Covalent Bonds, Dynablast, Wiki; DNA Chemical Structure, Madprime, Wiki

Ionic Bonds

Involves transfer of electrons between two atoms.

Found mainly … inorganic compounds.



Ion = an atom or group of atoms which have lost or gained one or more electrons, making them negatively or positively charged.

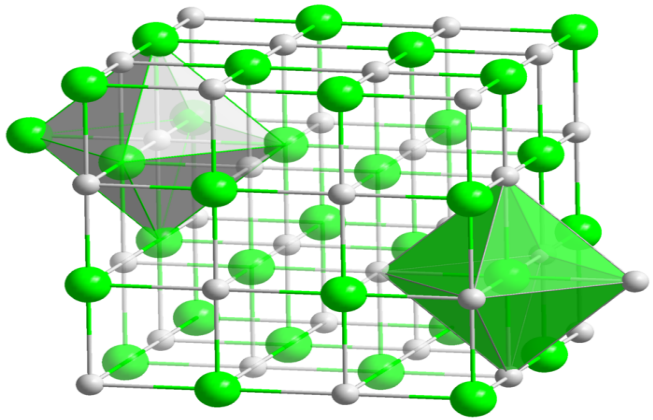
Q: What are positively charged ions (+) called?

Q: What are negatively charged ions (-) called?

Images: Sodium Chloride, University of Winnepeg

From the Virtual Cell Biology Classroom on ScienceProfOnline.com

Ionic compounds are made of oppositely charged ions



- Ionic Bonds are atoms held together by attraction between a **(+) and a (–) ion**
- **Compound is neutral overall,** but still charged on the inside.
- Makes solid crystals (salts).

Images: Halit crystal, Crystal structure of NaCl, Wiki

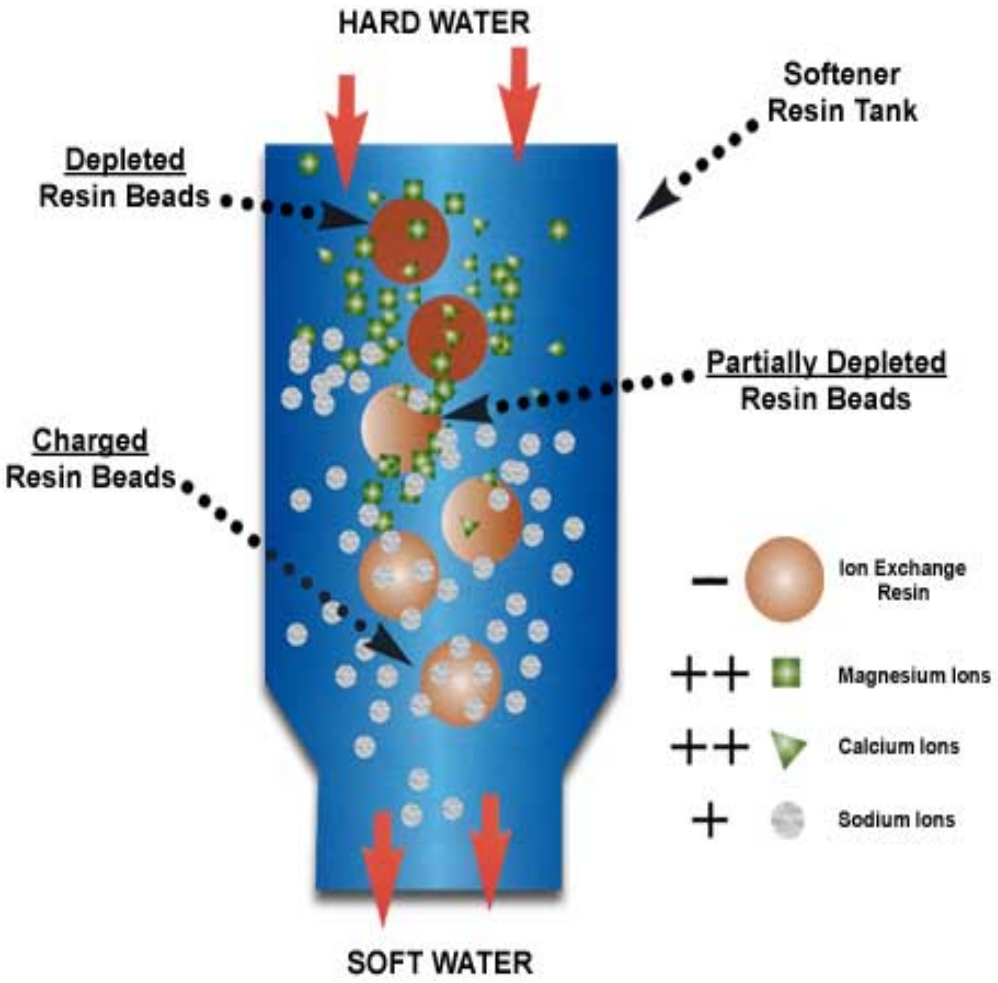
Reactions Involving Ions

Remember… **ion** = an atom which has lost or gained one or more electrons, so it's negatively or positively charged.

The Principle of

ion exchange

is a common water softening method.



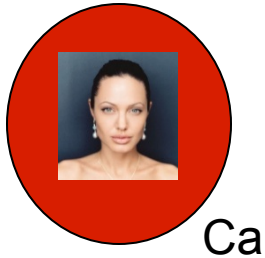
Lets use a **Branganalogy** to help us Understand the Concept of Ion Exchange…

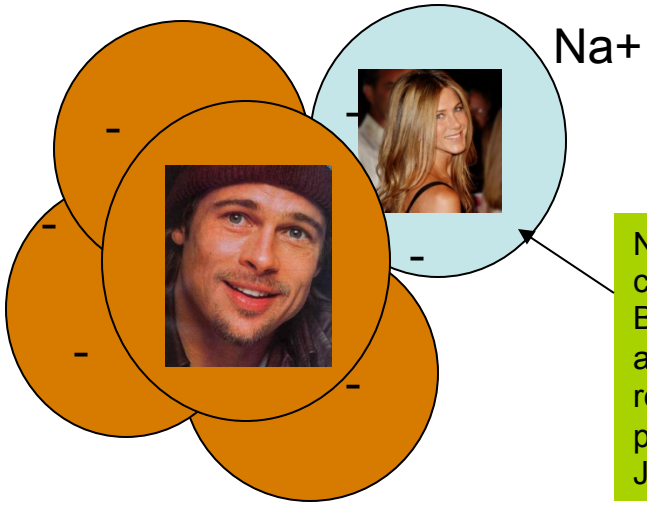
1. Brad Pitt is a negatively charged resin bead

2. Jennifer Anniston is a positively charged Sodium Ion

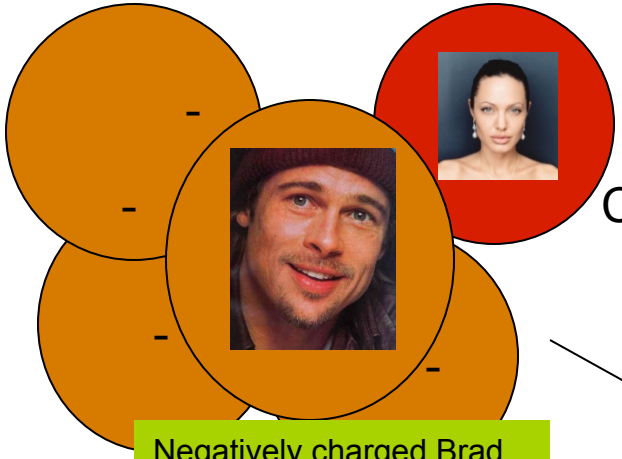
Now lets say that 'positiveness' equates with 'drop-dead gorgeousness'

3. Angelina Jolie is a positively charged Calcium Ion

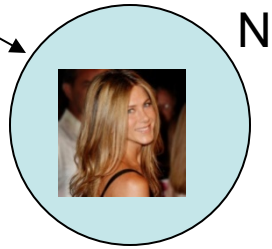




Negatively charged Brad is attracted to reasonably positive Jennifer.



Negatively charged Brad lets go of reasonably positive Jennifer in the presence of insanely positive Angelina.



Importance of Ions/Electrolytes in the Body:

K^+ ,Na^+, Cl^-

- Carry electrical impulses in the nervous system
- Maintain cellular function with the correct concentrations electrolytes
- **Watch This!**
  "Brawndo" Video Clip
  from movie Idiocracy.

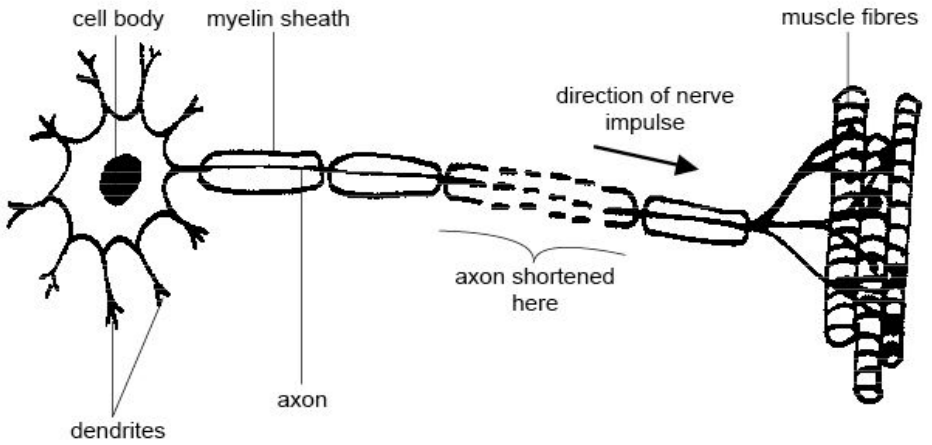
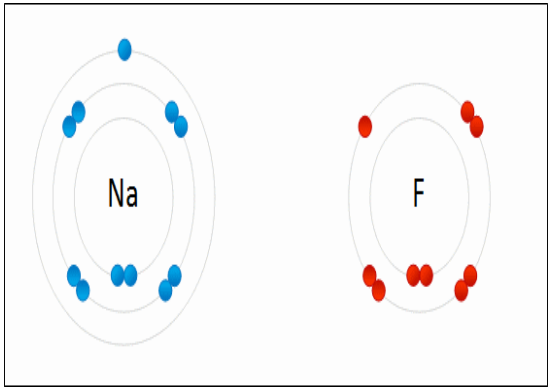
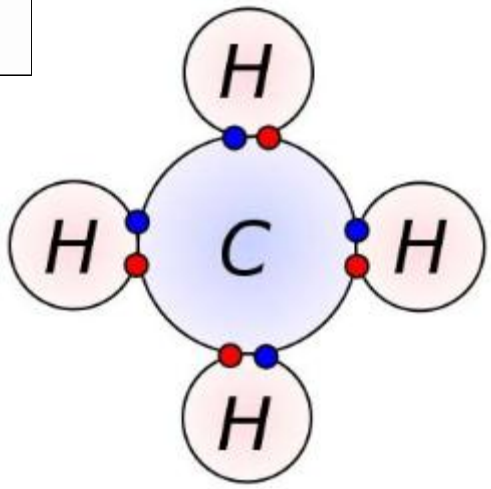


Image: Motor neuron, Wiki

Three Main Types of Chemical Bonds:

1. Ionic
2. **Covalent**
3. Hydrogen





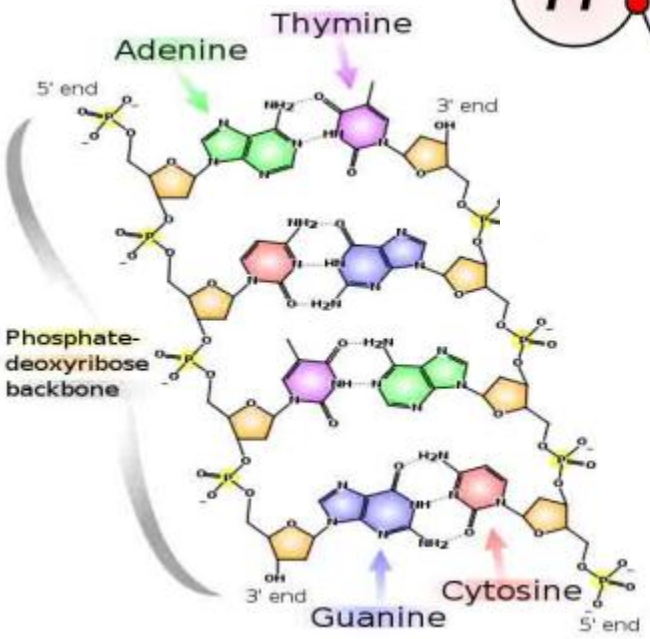


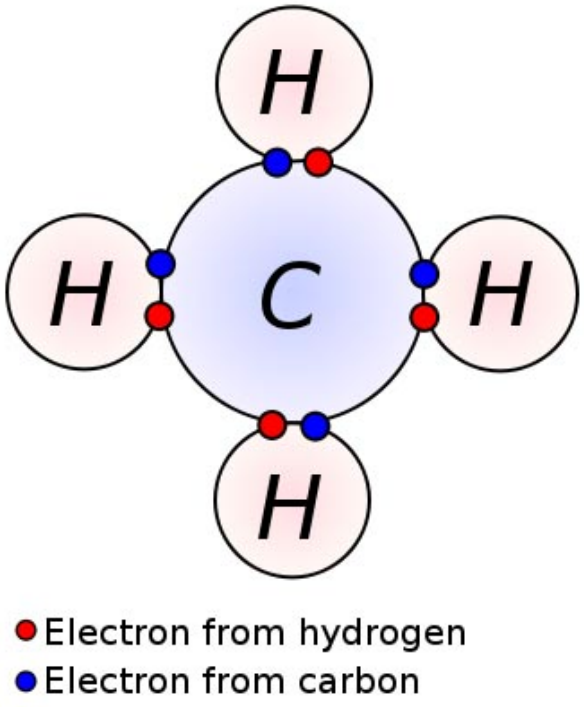
Image: Formation of ionic sodium fluoride, Wdcf; Methane Covalent Bonds, Dynablast, Wiki; DNA Chemical Structure,

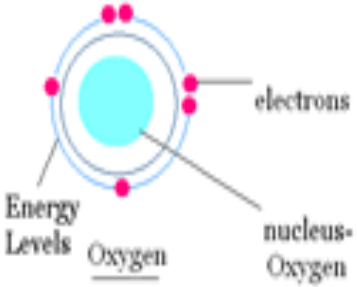
From the Virtual Cell Biology Classroom on ScienceProfOnline.com

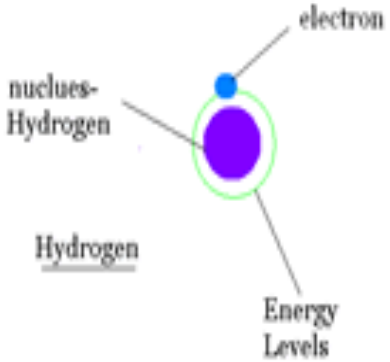
Covalent Bonds

Involves the sharing of a pair of electrons between atoms.
One covalent bond = 1 pair of shared electrons
Covalent Compounds can make single (2 electrons), double (4 electrons) or even triple bonds (6 electrons) depending on the number of electrons they share.

Found mainly … organic compounds







If combined you get...

...H_2O

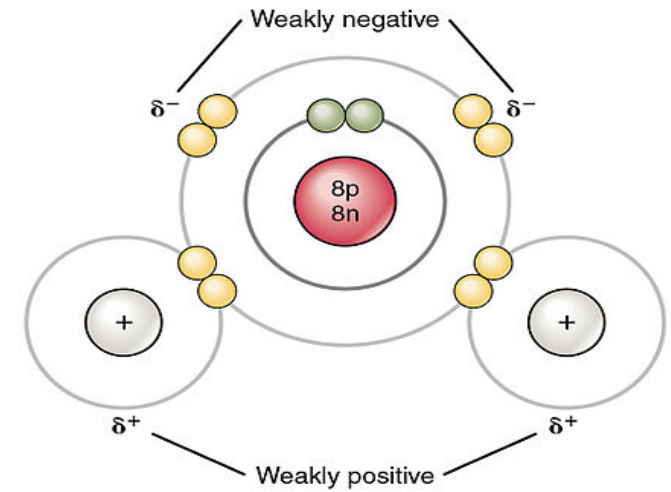
Because the Oxygen and Hydrogen are sharing two electrons. It has two have two Hydrogen Atoms , because Hydrogen only has one electron.

Image: Methane Covalent Bonds, Dynablast, Wiki

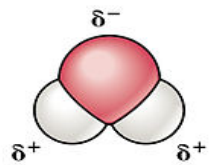
From the Virtual Cell Biology Classroom on ScienceProfOnline.com

Polar vs. Non-Polar Covalent Bonds

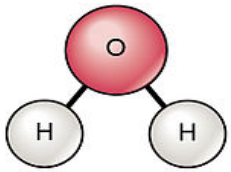
Polar molecules unequally share electrons between atoms, so have a slight positive charge at one end and a slight negative charge at the other.



(a) Planetary model of a water molecule



(b) Three-dimensional model of a water molecule



(c) Structural formula for water molecule

Non-polar molecules have electrons equally shared between their atoms.

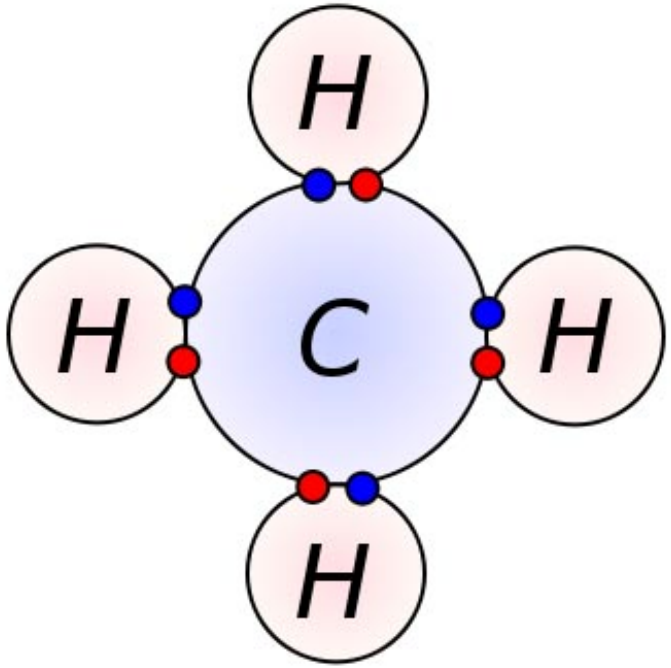


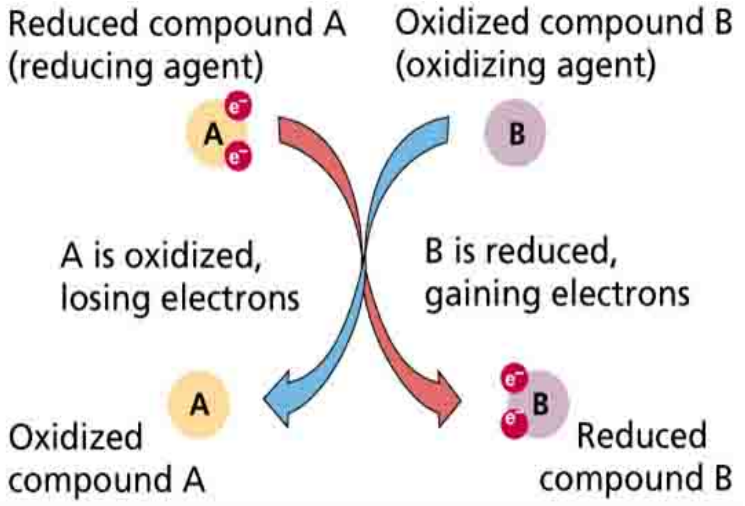
Image: Polar water molecule, Non-polar methane molecule, Wiki

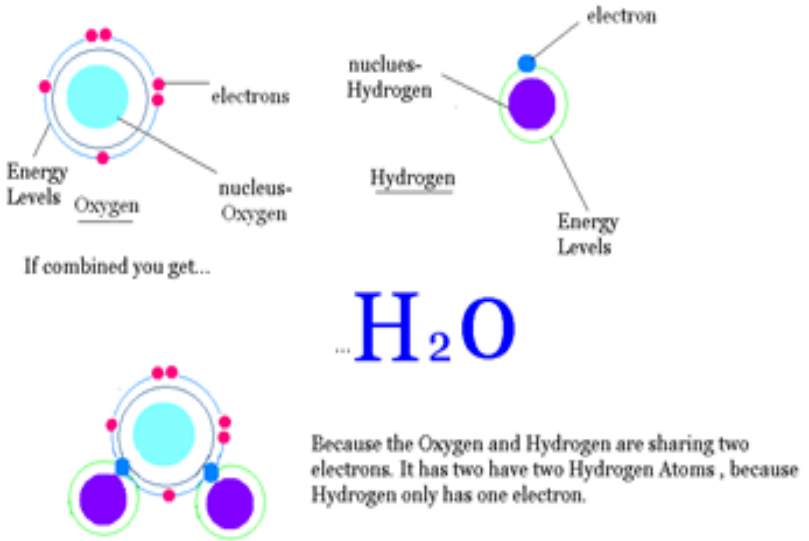
Oxidation - Reduction Reactions

- Or **Redox** reaction = chemical reactions in which electrons are ***gained, lost*** (*Q: What kind of bond?*) or ***shared*** (*Q: What kind of bond?*) in a chemical reaction.

- **oxidation**: ***loss*** of electrons by a molecule, atom or ion.

- **reduction**: ***gain*** of electrons by a molecule, atom or ion.





Oil Rig

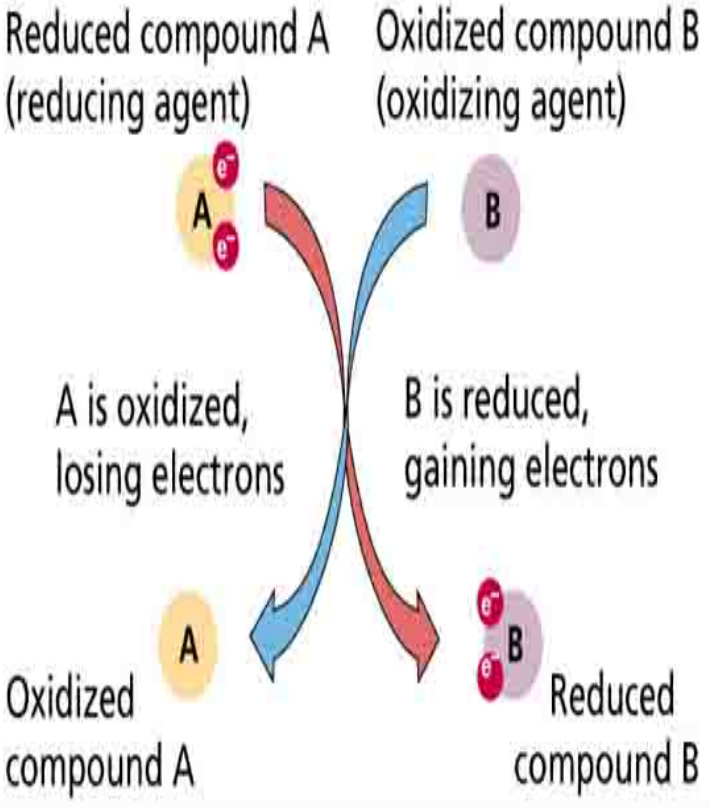
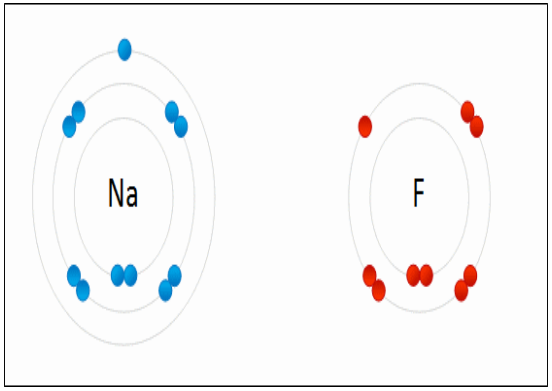


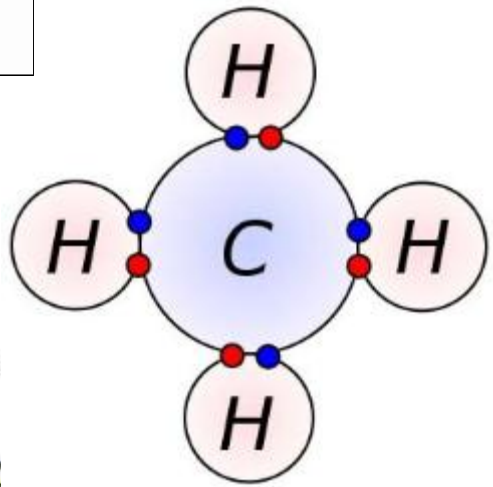
Image: Oil Rig Platform, Nasa

From the Virtual Cell Biology Classroom on ScienceProfOnline.com

Three Main Types of Chemical Bonds:

1. Ionic
2. Covalent
3. **Hydrogen**





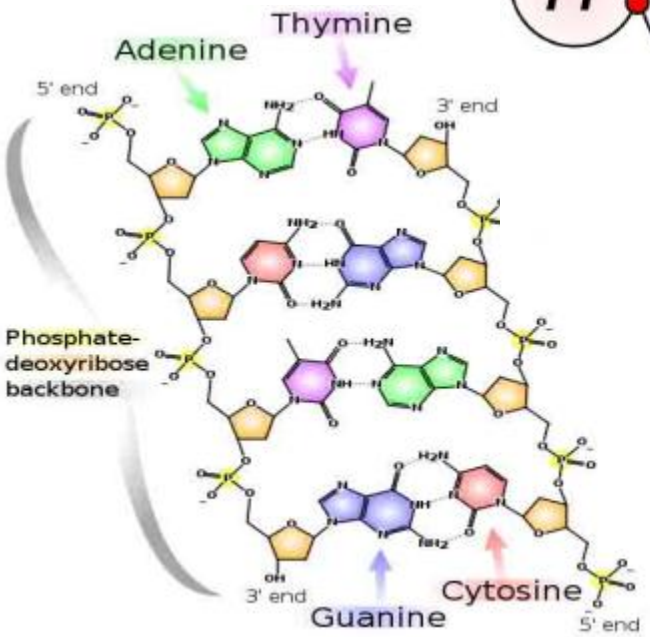


Image: Formation of ionic sodium fluoride, Wdcf; Methane Covalent Bonds, Dynablast, Wiki; DNA Chemical Structure, Madprime, Wiki

From the Virtual Cell Biology Classroom on ScienceProfOnline.com

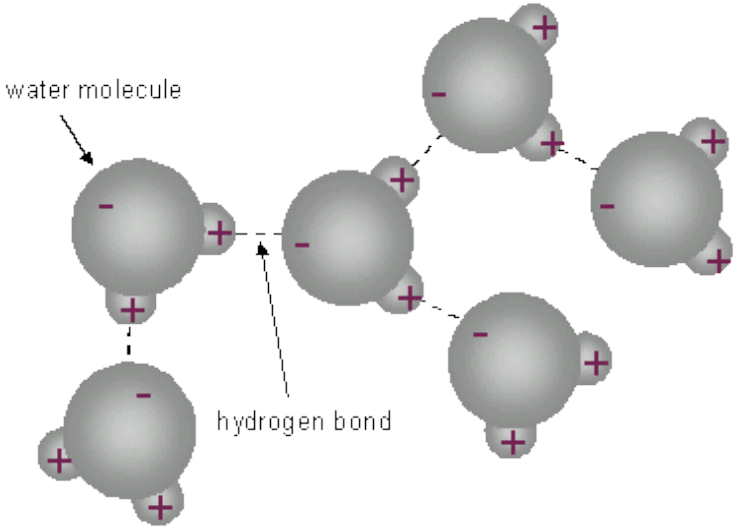
Hydrogen Bonds

Hydrogen Bonds: When an atom of hydrogen is attracted to another electronegative atom in addition to the one it is covalently bonded to.

In some covalent bonds electrons are shared *unequally* by the hydrogen and the atom that the hydrogen is bound to. When the electrons in a covalent bond are not equally shared, the molecule is **polar**.

See the **polar, covalent bonds** of *each individual water molecule* below.

See the **hydrogen bond attractions** *between the hydrogens and the oxygens of nearby, but separate water molecule below.*



Found in water, proteins & DNA

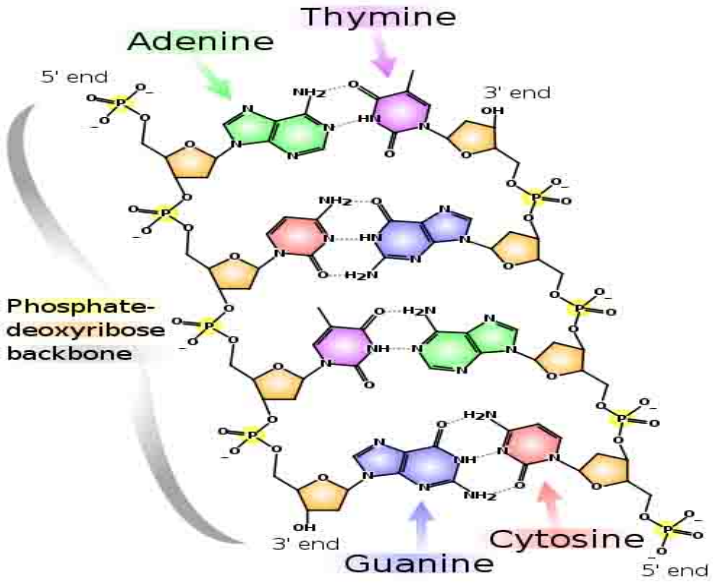
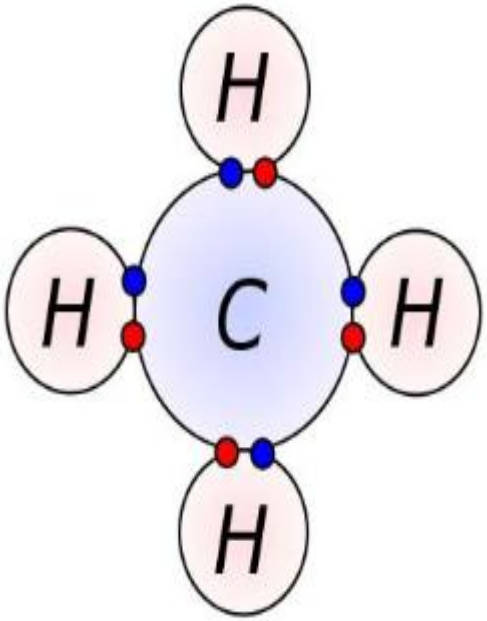
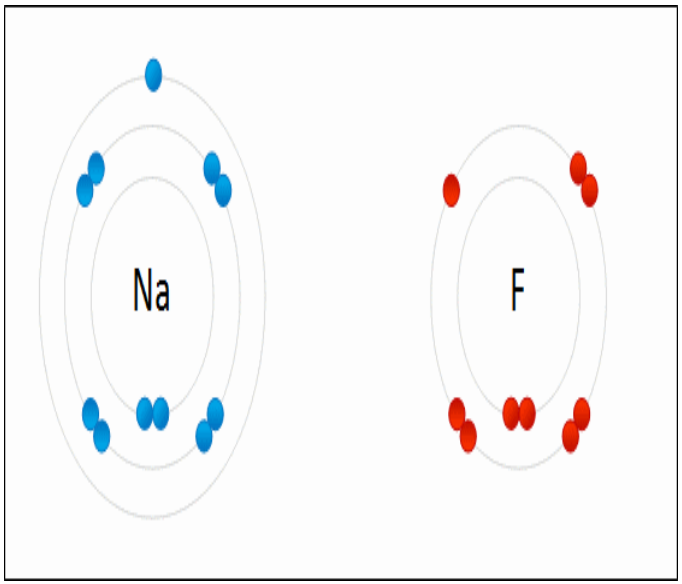


Image: DNA Chemical Structure, Madprime, Wiki; Water Striders, Markus Gayda, Wiki

REVIEW!

Animated lessons on
Chemical Bonding





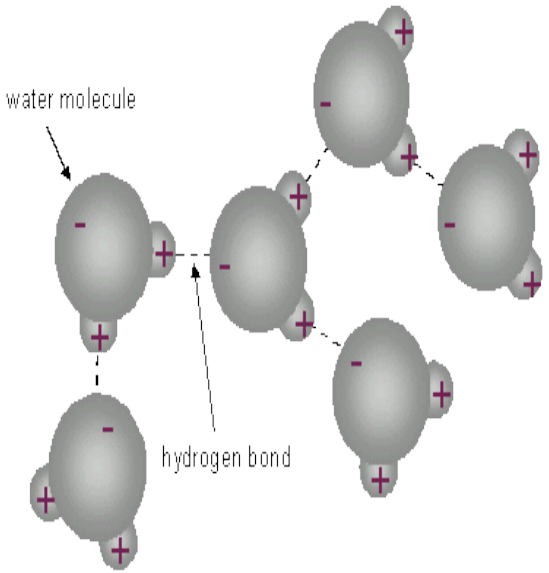
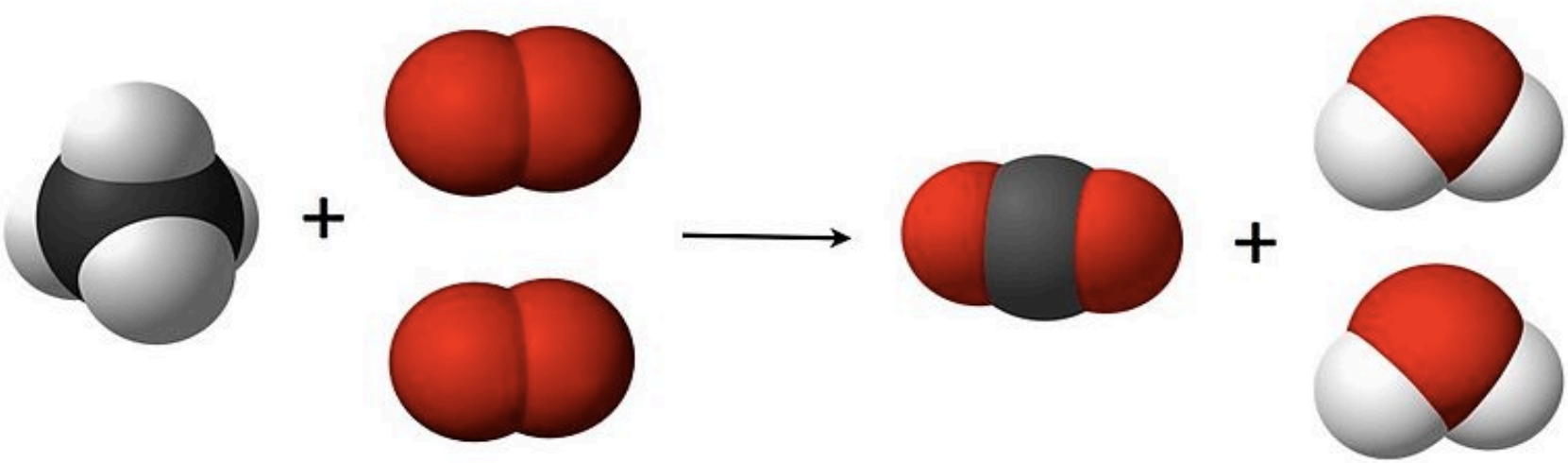


Image: Methane Covalent Bonds, Dynablast; Formation of ionic sodium fluoride,

Chemical Bonds hold molecules together, but can be broken during a chemical reaction



$$CH_4 + 2O_2 \longrightarrow CO_2 + 2H_2O$$

Reactants are the starting materials
Products are the end materials

Image: Combustion Reaction of Methane, Wiki

Formats for writing a chemical reaction.

_____ + _____ ----------> _____

_____ ----------> _____ _____

Synthesis, Decomposition & Exchange Reactions

Synthesis **Reaction** (a.k.a. Combination or Anabolic Reaction)

When two or more substances combine to form a single compound.

Requires energy in order to take place

The general form of a direct combination reaction is:

A + B → AB where A and B are elements or compounds, and AB is a compound consisting of A and B.

Examples of combination reactions include:

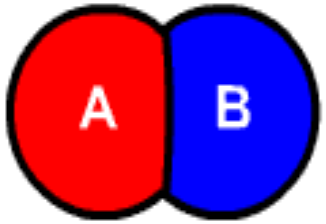
$2Na + Cl_2 \rightarrow 2\ NaCl$ (formation of table salt)

$4\ Fe + 3\ O_2 \rightarrow 2\ Fe_2O_3$ (iron rusting)

Decomposition **Reaction** (a.k.a. Catabolic Reaction)

The opposite of a composition reaction. A compound is broken down.

The generalized reaction formula for chemical decomposition is:
AB → A + B



Exchange **Reaction** (a.k.a. Transfer or Replacement Reaction)

Atoms are moved from one molecule to another.

A + BC → AB + C

Images: Animation decomposition reaction, Armando-Martin; Rust, Later Keiwos From the Virtual Cell Biology Classroom on ScienceProfOnline.com

What type of reaction is each of the following?

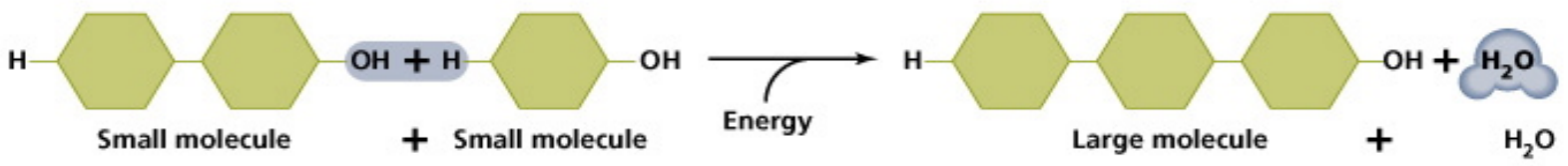
$$NiCl_2 \rightarrow Ni + Cl_2$$

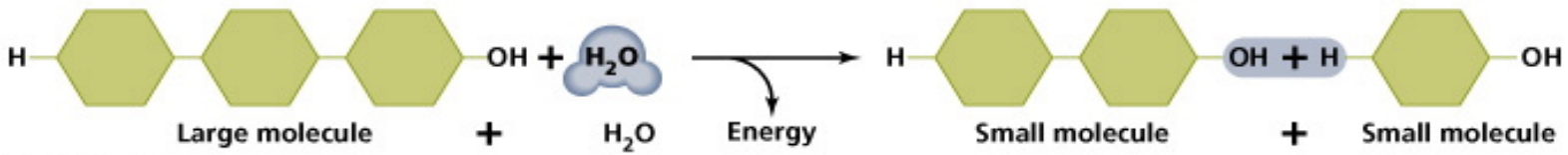
$$MgBr_2 + 2K \rightarrow Mg + 2KBr$$

$$4C + 6H_2 + O_2 \rightarrow 2C_2H_6O$$

Q: Based on the reaction types we just discussed, how would you categorize the reactions below?

What type is the top reaction?





What type is the bottom reaction?

Chemical reactions must be **balanced**, meaning they have the same number of each type of atom on both the reactant side and the product side of the reaction.

Is the following chemical reaction balanced?

$$Ca + 2H_2O \rightarrow Ca(OH)_2 + H_2$$

Confused?

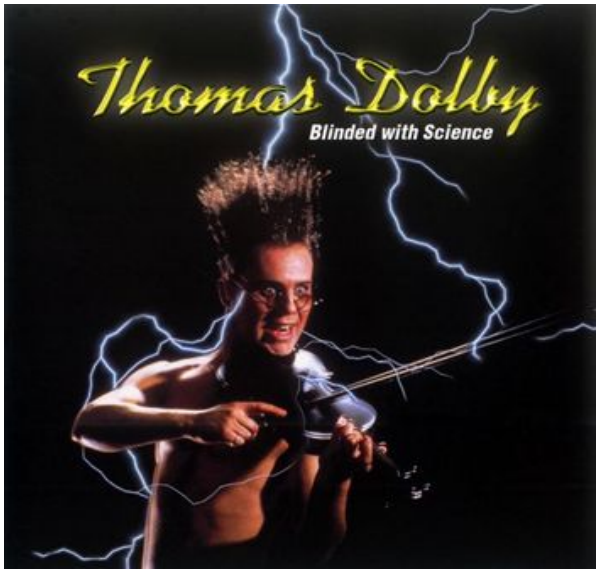
Here are some links to fun resources that further explain Chemistry:

- Inorganic Chemistry Main Page on the Virtual Cell Biology Classroom of Science Prof Online.
- "What Kind of Bonds Are These?" song and slide show by Mark Rosengarten.
- Chemical Bond Formation animated science tutorial.
- "Meet the Elements" music video by They Might Be Giants.
- Redox Reactions video lecture by Kahnacademy.
- Chem4Kids website by Rader.
- Neutron Dance …a so-bad-its-good '80s music video by The Pointer Sisters

(You must be in PPT slideshow view to click on links.)

Smart Links

Image: Daniel Radcliff by Joella Marano

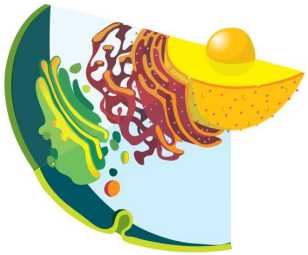


Are you feeling blinded by science?

Do yourself a favor. Use the…

Virtual Cell Biology Classroom *(VCBC)* !

The VCBC is full of resources to help you succeed, including:



- practice test questions
- review questions
- study guides and learning objectives
- PowerPoints on other topics

You can access the VCBC by going to the Science Prof Online website
www.ScienceProfOnline.com

Images: Blinded With Science album, Thomas Dolby; Endomembrane system, Mariana Ruiz, Wiki