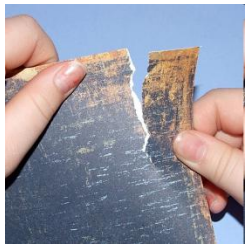
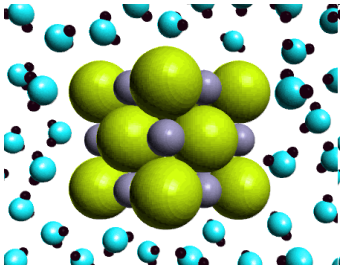
Physical Science

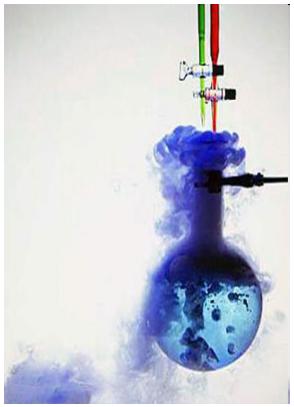
Chapter 17
Chemical Reactions

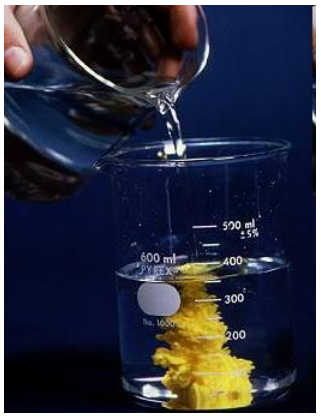
Changes in Matter

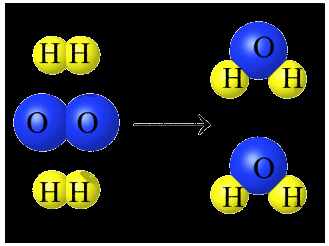
- **Physical Change -**A change that alters the form of a substance but not the chemical makeup of the substance, a change of state
  - Words like: *crush, smash, tear, evaporate, slice, breakdown, dissolve, absorb, swell, burst*
- **Chemical Change -** One or more substances combine or decompose to form a chemically different substance
  - Words like: *react, burns, forms, decomposed, rusting, sours, rotting, digesting, cooked, molecular change*











Matter & Its Changes

- **Physical Changes – Alters form or appearance but doesn't change it into another** substance ie. Water evaporates into water vapor, a rock is broken into pieces
- It's like printing a word in a different font, it's the same word just looks different!

stampedes → stampedes

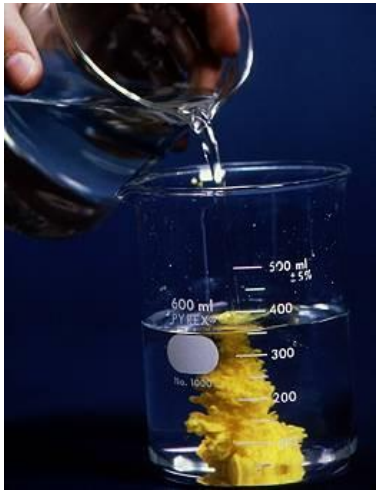
Matter & Its Changes

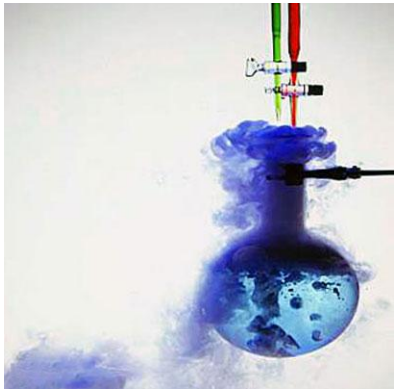
- **Chemical change-** changes the material into a new substance i.e. hydrogen and oxygen combine to form water.
  - Chemical reactions take place when chemical bonds are either formed or broken.
  - Strong chemical bonds resist change: glass
  - Weak chemical bonds breakdown easily: wood
- A chemical change is like scrambling letters to form new words

stampedes → made + steps

Observing Chemical Reactions

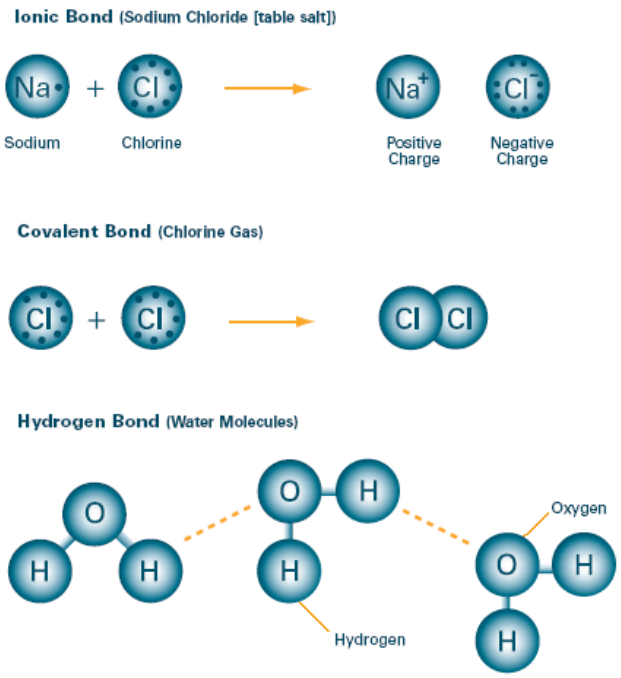
- Chemical reactions produce new substances that can usually be detected by observing the evidence:
  - Color change
  - Precipitation
  - Temperature change
  - Property change
  - Gas produced

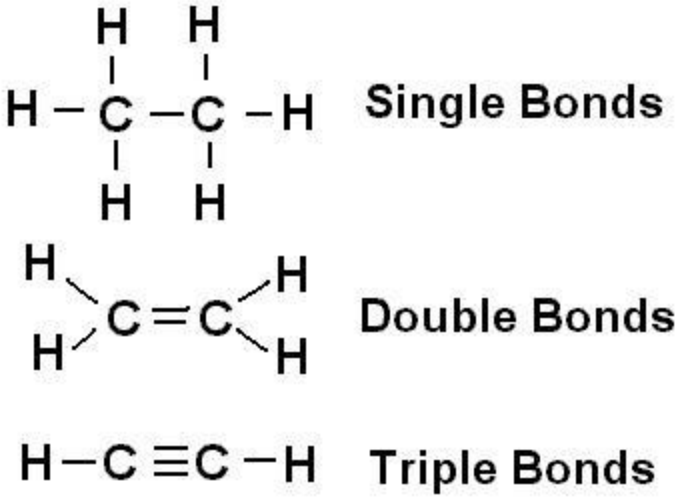




Chemical Reactions

- Chemical reactions occur when chemical bonds are formed or broken
  - Strong chemical bonds resist change: glass
  - Weak chemical bonds breakdown easily: wood

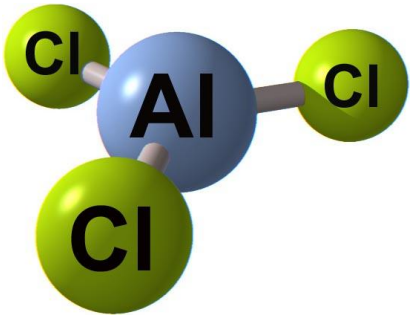


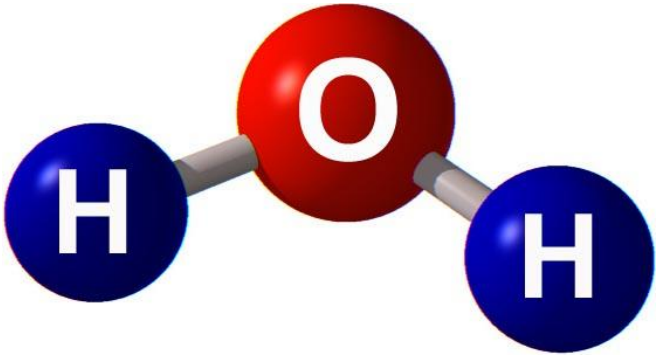


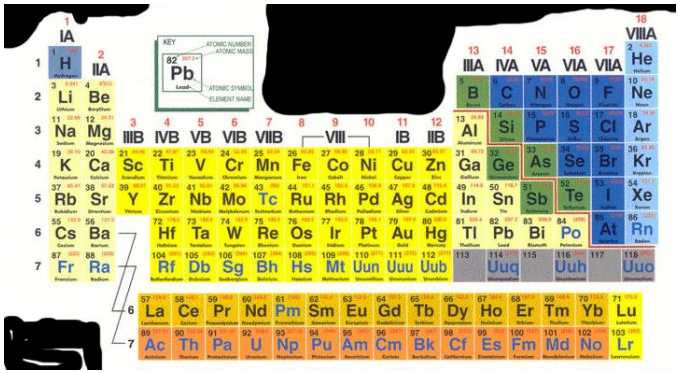
Writing Chemical Reactions

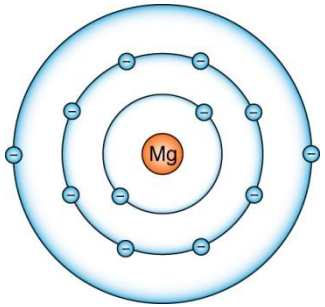
- Elements are represented by a one or two letter symbol
  - a. When symbol is a single letter: always capitalize: Hydrogen=H
  - b. When symbol is two letters, capitalize first letter & lower case second letter: Sodium = Na

H hydrogen
O oxygen
C carbon
N nitrogen
Ca calcium
Cl chlorine
Na sodium





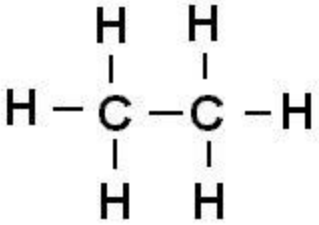




Writing Chemical Reactions

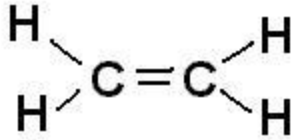
- Chemical formulas show the ratio of elements found in molecules and compounds
  - a. Subscript numbers designate how many atoms of each element are present: H_2O_2 ; 2 Hydrogen atoms and 2 Oxygen atoms are present in this molecule
  - b. When no subscript number is shown: it is understood that there is only one atom present: H_2O = 2 Hydrogen atoms and only one Oxygen atom are present in this molecule

C_2H_6



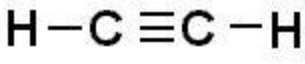
Single Bonds

C_2H_4



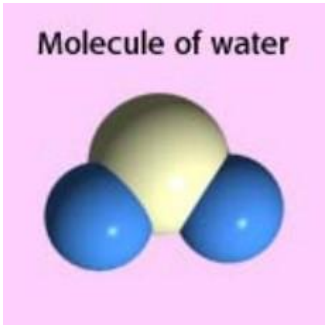
Double Bonds

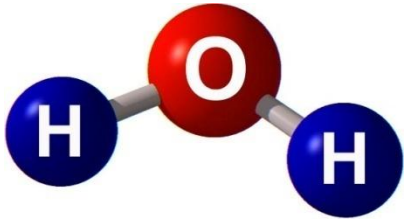
C_2H_2



Triple Bonds

H_2O

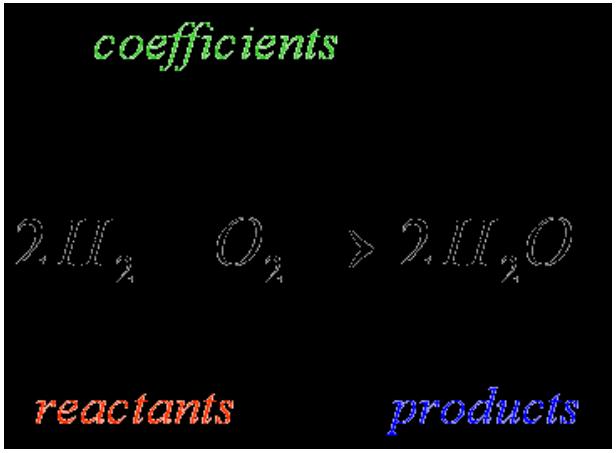




Structure of an Chemical Equation:

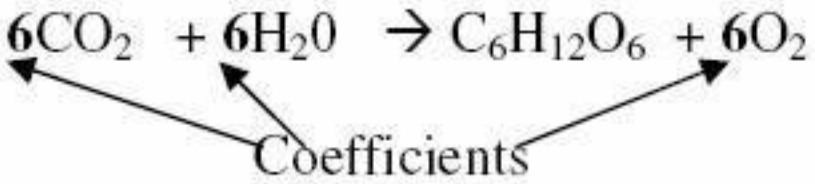
- Conservation of Mass - Matter cannot be created nor destroyed so there must be the same number of atoms on each side of the equation
- Beginning materials are reactants
- Ending materials are products
- Example of Chemical reaction:

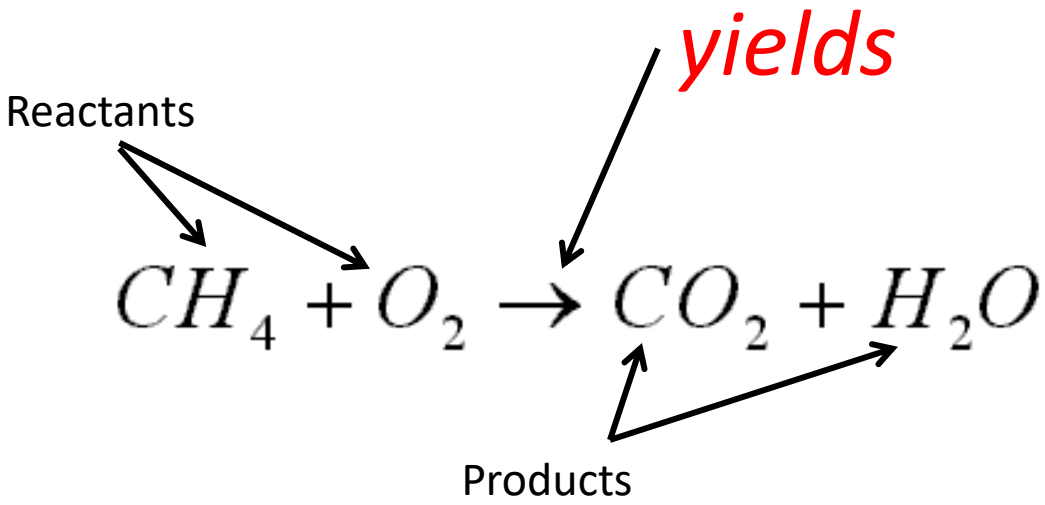
Reactant + Reactant → Product + Product



Structure of an Equation:

Coefficient: a whole number in front of an element or molecule in a chemical reaction: Tells how many of each compound or element is present





Counting Atoms in an Equation

- If no subscript present it is assumed to be 1 atom
- If elements in brackets or parenthesis, treat same as in math.
- Coefficients multiple the entire molecule atoms
- You must add all reactant molecules together & compare w/ all molecules in the products

$CaCl_2$

Ca=1

Cl=2

$Ca_3(PO_4)_2$

Ca=3

P=2

O=8

$2Ca_3(PO_4)_2$

Ca=6

P=4

O=16

$$2H_2 + O_2 \rightarrow 2H_2O$$

$$4H, \quad 2O \quad = \quad 4H, 2O$$

It's best to list the # of atoms under the molecules as we are doing in these examples

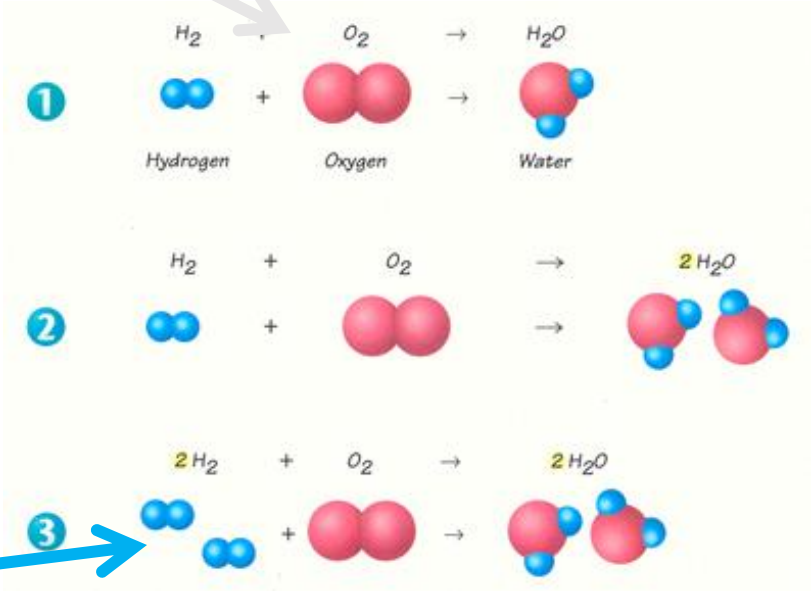
Balancing Equations

- Remember matter cannot be created or destroyed
  - Therefore the # of reactant atoms must equal the # of product atoms

This reaction IS NOT balanced

$$2H_2 + O_2 \rightarrow 2H_2O$$

$$4H, \quad 2O \quad = \quad 4H, 2O$$



4 Reactant Hydrogens = 4 Product Hydrogens
2 Reactant Oxygens = 2 Product Oxygens
This reaction is balanced!

Balance this…

$$CH_4 + O_2 \rightarrow CO_2 + H_2O$$

Step 1: Count the atoms on both sides of the equation & compare

$$CH_4 + O_2 \rightarrow CO_2 + H_2O$$

C=1		C=1
H=4	≠	H=2
O=2		O=3

** you can only add or change whole # coefficients to balance equations. Never change subscripts

Step 2: apply a coefficient to a molecule to balance an "easy" atom (in this case, we can add a 2 coefficient to the product water to balance the H's)

Step 3: Recount $CH_4 + O_2 \rightarrow CO_2 + 2H_2O$

C=1		C=1
H=4	≠	H=4
O=2		O=4

Balance this… (continued)

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

C=1		C=1
H=4	≠	H=4
O=2		O=4

Step 4: apply a coefficient to a molecule to balance the next off balanced atom (in this case, the oxygens are not yet balanced. We can add a coefficient of 2 in front of the reactant oxygen to correct this)

Step 5: Recount

Step 6: Continue doing this until all atoms are balanced

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

C=1		C=1
H=4	=	H=4
O=4		O=4

BALANCED!!

Classifying Chemical Reactions

- **Synthesis**: When two or more substances combine to form a more complex substance

$$2H_2 + O_2 \rightarrow 2H_2O$$

- **Decomposition**: When a complex substance is broken into two or more simpler substances:

$$2H_2O \rightarrow 2H_2 + O_2$$

- **Replacement:** When one element replaces another or when two elements in different compounds change places:

$$2CuO + C \rightarrow 2Cu + CO_2$$

Synthesis Reactions

Combination or Synthesis

$$A + B \longrightarrow AB$$

$$2H_2 + O_2 \longrightarrow 2H_2O$$

Decomposition Reactions

Decomposition

$AB \longrightarrow A + B$

$2HgO \longrightarrow 2Hg + O_2$

Replacement Reactions

- 2 types:
  - Single Replacement
  - Double Replacement

Single Replacement

$A + BC \rightarrow B + AC$

$Zn + 2HCl \rightarrow H_2 + ZnCl_2$

Double Replacement

$AB + CD \rightarrow CB + AD$

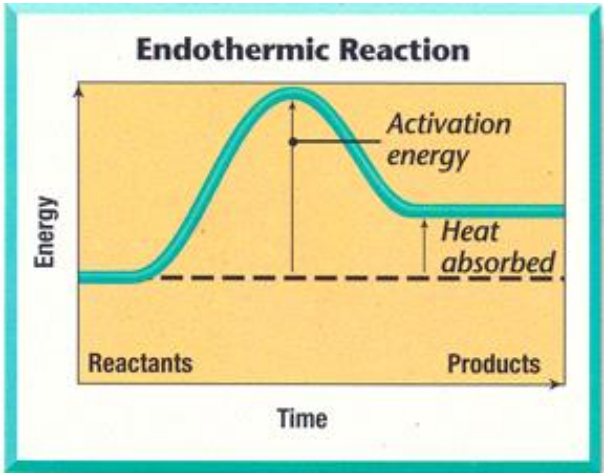
$2HCl + ZnS \rightarrow ZnCl_2 + H_2S$

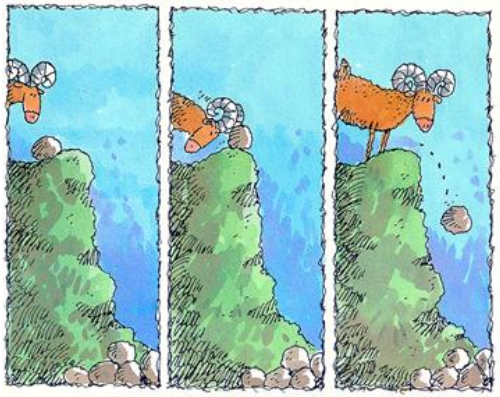
Controlling Chemical Reactions

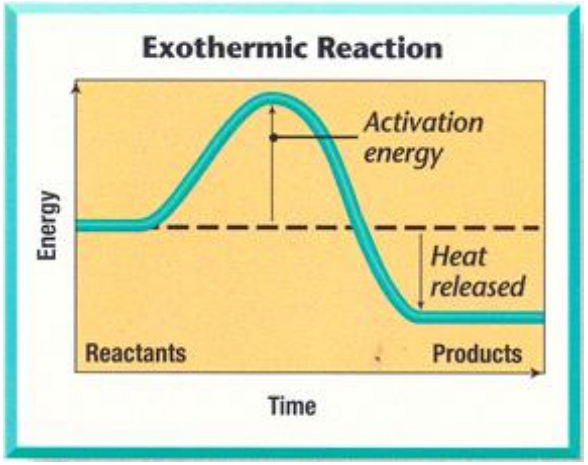
- Every chemical reaction involves a change in energy.
  - Some reactions release energy in the form of heat (**exothermic**)
  - Some reactions absorb energy & the container holding the reaction gets colder to the touch (**endothermic**)

Getting Reactions Started

- The **activation energy** is the energy needed by a system to initiate the reaction. It is the minimum energy needed for a specific chemical reaction to occur. Once achieved, the reaction continues until reactants are extinguished.







Enough is enough….
Stop already!!

OK