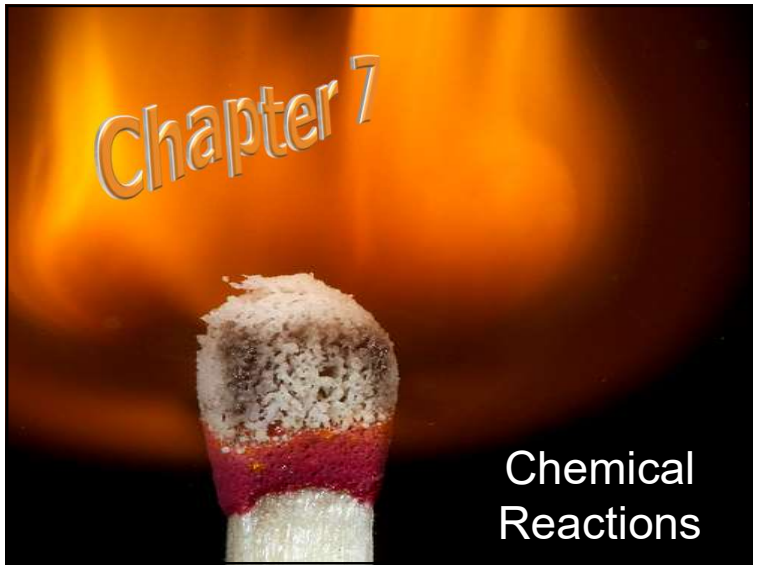


Seedlings in a Jar

A. The total mass of the original jar with seeds will be *more* than the total mass of the jar with the seedlings.

B. The total mass of the original jar with seeds will be *less* than the total mass of the jar with seedlings.

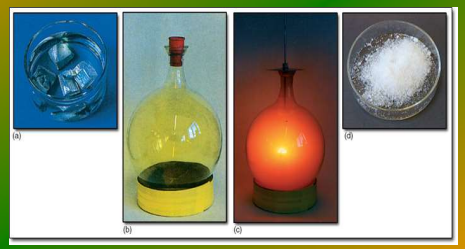
C. There will be *no change* in the total mass of the jar with seedlings

The Law of Conservation of Matter:
Matter cannot be created nor destroyed.

So… Whatever atoms a chemical reaction begins with, then the chemical reaction must end with the *exact atoms in the same amounts.*

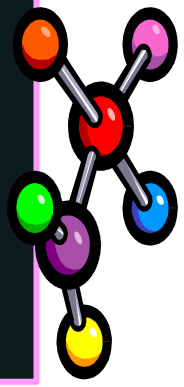
Chemical Reactions

- **It is a change in matter that produces one or more *NEW SUBSTANCES* with different properties**



Chemical Reactions

- A chemical reaction is another name for a chemical change
- New properties are formed
- No new atoms are made, but atoms are rearranged
- New compounds can be made
- Old bonds are broken and new bonds are formed
- Always involves changes in energy



Chemical Reactions

- What forms of evidence show that a chemical reaction took place?
  - Color Change.
  - New phase is made
    - Precipitation
    - Gas or solid formation.
  - Changes in Temperature.
  - Changes in Properties.
  - Energy change

Heat is given off

ENERGY

Chemical Reactions

Parts To A Chemical Reaction

1. Reactants: starting materials of a chemical reaction
2. Products: substances formed at the end

Reactants

$C + O_2$

Yields

Products

CO_2

Chemical Reaction 2

Products

$2Na + Cl_2 \rightarrow 2NaCl$

Reactants

What Do You Notice About All The Atoms?

Energy and Reactions

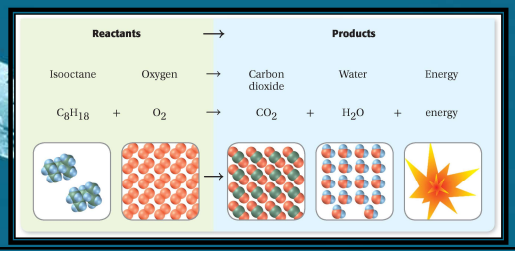
- Chemical reaction occurs when chemical bonds break and new bonds form.
  - Always takes a little energy
- Chemical reactions usually absorb heat or liberate (release) heat.

- Different forms of energy can be used:
  - » Heat
  - » Electricity
  - » Light

Energy and Reactions

Every Reaction Involves Energy

1. During a reaction… bonds absorb energy and break
2. New bonds form…energy released



Energy and Reactions

- Forming bonds releases energy
- Energy is conserved
  - Chemical Energy is energy stored in the bonds of the chemicals

Energy and Reactions

Exothermic Reaction

- If breaking bonds takes less energy than making them- it releases energy (exothermic)
  - *Exo-* outside
  - *therm-* heat
- Exothermic reactions release energy
  - Get hot/warm
  - Give off light
  - Or release electricity

Energy and Reactions

Exothermic Reactions

$2\ Na + Cl_2 \rightarrow 2\ NaCl + Energy$

Energy is in the products in an Exothermic Reaction

Exothermic

Chemical Energy

reactants

Heat Released

products

Reactants → Products

Energy and Reactions

Endothermic Reaction

- A chemical reaction in which energy is taken in.
  - "absorb" heat
  - Feels cool!
  - Require heat or energy or they stop

Figure 6 The reaction in the flask absorbs energy and causes water between the bottom of the flask and the wood to freeze.

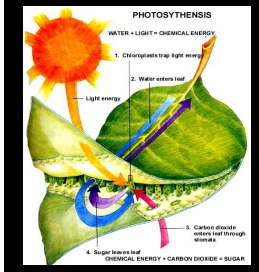
Endo-into Therm-heat

Energy and Reactions

Endothermic Reactions

Example: Photosynthesis

$6\ CO_2 + 6\ H_2O + Energy \rightarrow C_6H_{12}O_6 + 6\ 0_2$



Energy is in the reactants in an Endothermic Reaction

ENDOTHERMIC

Chemical Energy

products

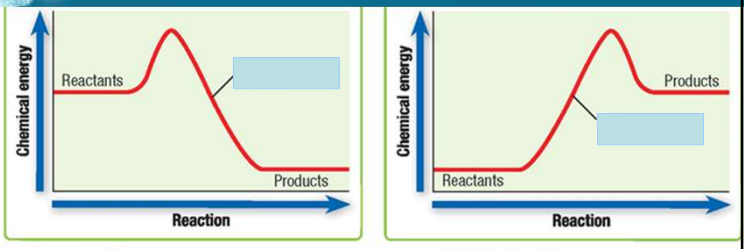
Heat is absorbed

reactants

Reactants → Products

Energy and Reactions

Exothermic vs. Endothermic



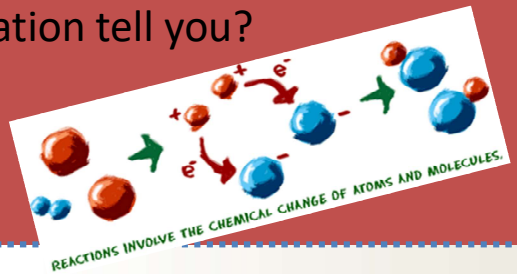
Exo and Endo Clip

What is the law of the conservation of mass?

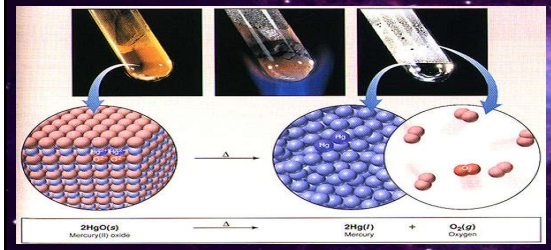
- During a chemical reaction, matter is neither created nor destroyed.
- Atoms in = atoms out

Section7.2 Balancing Chemical Equations

- What is a chemical equation?
- What can a balanced chemical equation tell you?

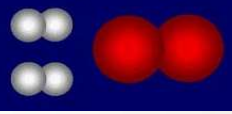


Describing Reactions



Chemical Equations are simple.

$2H_2 + O_2 \rightarrow 2H_2O$



Describing Reactions

Chemical Equation

- A symbolic representation of a chemical reaction
- Putting chemical changes into words
- The plus mean "and"
- The arrow means "yield" or "make"

$$2Na + Cl_2 \rightarrow 2\,NaCl$$

Describing Reactions

Chemical Formulas

- **Shows the elements & number of atoms of each element in a molecule**

H_2SO_4

Hydrogen: 2 atoms
Sulfur: 1 atom
Oxygen: 4 atoms

7 atoms total

Subscript

Describing Reactions

Coefficients

- **A formula may begin with a number.**
  - This number is called the ***coefficient***.
  - – Represents the number of molecules of that compound or atom needed in the reaction.
  - – **For example:**
    - **$2H_2SO_4$ – 2 molecules of Sulfuric Acid**
- **Never put a coefficient in the middle of a formula (2 NaCl is okay, Na2Cl is not)**
- **If there is no number, then "1" is understood to be in front of the formula.**

Coefficients

$2H_2SO_4$

2 molecules of Sulfuric Acid

– A coefficient is distributed to ALL elements in a compound

2 – H_2 (for a total of 4 H atoms)
2 – S (for a total of 2 S atoms)
2 – O_4 (for a total of 8 O atoms)

Counting Atoms

$3\ H_2O$

Coefficient: Tells us how many of that entire molecule we have

Subscript: Tells us how many of that one single atom we have

How Many of Each Atom?

Write these down on a piece of paper?
Figure out how many atoms you have for each example.

1) $4\ MgCl_2$
   Mg_____ Cl_____

2) $Be(NO_3)_2$
   Be_____ O_____ N_____

3) $4\ Be(NO_3)_2$
   Be_____ O_____ N_____

4) $MgCl_2 + Li_2CO_3$
   Mg_____ Cl_____ Li____ C_____ O____

5) $C_6H_{12}O_6 + 9\ O_2$
   C___ O____ H_____

6) $6\ CO_2 + 6\ H_2O$
   C___ O____ H_____

7) $Pb + FeSO_4$
   Pb___ O____ S_____ Fe_____

How Many of Each Atom?

1) $2\ P_2O_3$
   P____ O_____

2) $2\ RbNO_3 + BeF_2$
   Rb____ O_____ N_____ Be_____ F_____

3) $Be(NO_3)_2 + 2\ RbF$
   Rb____ O_____ N_____ Be_____ F_____

4) $2\ AgNO_3 + Cu$
   Ag____ O_____ N_____ Cu_____

5) $Cu(NO_3)_2 + 2\ Ag$
   Ag____ O_____ N_____ Cu_____

6) $C_3H_6O + 4\ O_2$
   C____ O_____ H_____

7) $3\ CO_2 + 3\ H_2O$
   C____ O_____ H_____

8) $2\ C_5H_5 + H_2O$
   C____ O_____ H_____

9) $Fe(C_5H_5)_2$
   Fe____ C_____ H_____

Describing Reactions

Reading Chemical Equations

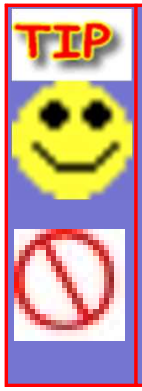
- **The two sides of the equation are separated by an arrow.**
  - **REACTANTS: The combination of chemicals *before* the reaction are on the left side of the arrow**
  - **PRODUCTS: The right side indicates the combination of chemicals *after* the reaction.**

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

Balanced Chemical Equations

- A balanced chemical equation follows the law of conservation of mass.
- It can tell you the amount of reactants you will need, and the amount of products you will get from the reaction.
- For example,
  - Methane + oxygen → carbon dioxide + water
  - $CH_4 + O_2 \rightarrow CO_2 + H_2O$
    - Does not tell you how much of each compound you will need.
  - $CH_4 + 2\,O_2 \rightarrow CO_2 + 2\,H_2O$
    - This balanced equation does.

Balancing Chemical Equations



Balance equations by changing **coefficients**

$2Na + Cl_2 \rightarrow 2\,NaCl$

… never by changing formula **subscripts**

Parts of a chemical Equation

Coefficient the number of Molecules in an equation

Subscript the number of atoms in a formula

$2Na + Cl_2 \rightarrow 2\,NaCl$

Reactants Everything to the left

"yields"

Products Everything to the right

Rules for balancing

Make a T-chart

1. Write the correct formulas for all the reactants and products
2. Count the number of atoms of each type appearing on both sides
3. Balance the elements one at a time by adding coefficients (the numbers in front ONLY)
4. Check to make sure it is balanced.

*****REMEMBER: IF YOU CHANGE A COEFFICIENT, ALL ELEMENTS IN THAT COMPOUND ARE AFFECTED.

Rules of the Game

- 1. Matter cannot be created or destroyed.
- 2. Subscripts cannot be added, removed, or changed.
- 3. You can only change coefficients.
- 4. Coefficients can only go in front of chem. formulas…NEVER in the middle of a formula.
- A few extra tips:
  - Try balancing big formulas first; save free elements for last.
  - If the same polyatomic ion appears on both sides of the equation, it's usually okay to treat it as one unit.
  - There is no one particular way to balance equations. Some equations are harder to balance than others and might require some creativity to solve.

Photosynthesis Reaction

- Carbon dioxide + water → Glucose (sugar) + oxygen

$$6CO_2 + 6\,H_2O \rightarrow C_6H_{12}O_6 + 6O_2$$

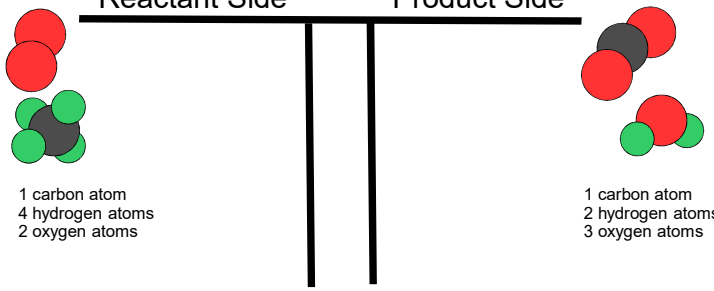
- Count the atoms on each side of the equation.

C : 6	C : 6
O : 18	O : 18
H : 12	H : 12

An Unbalanced Equation

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

Reactant Side | Product Side



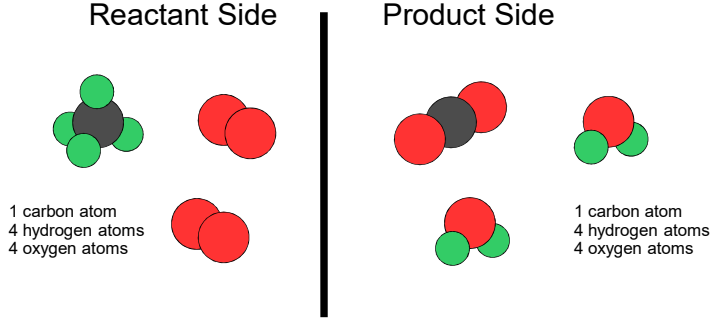
1 carbon atom
4 hydrogen atoms
2 oxygen atoms

1 carbon atom
2 hydrogen atoms
3 oxygen atoms

A Balanced Equation

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

Reactant Side | Product Side



1 carbon atom
4 hydrogen atoms
4 oxygen atoms

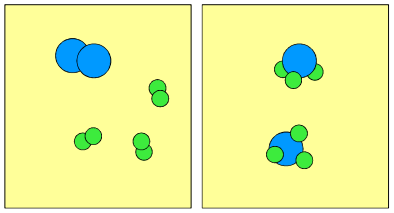
1 carbon atom
4 hydrogen atoms
4 oxygen atoms

Balancing Equations

- Balance the following equation by adjusting coefficients.

$N_2 + 3\,H_2 \rightarrow 2NH_3$

	reactants	products
N	2	2
H	6	6

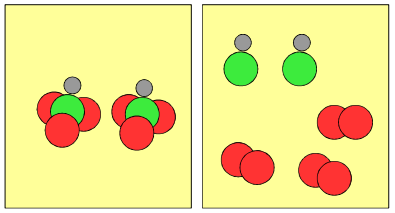


Balancing Equations

- **Balance the following equation by adjusting coefficients.**

$2KClO_3 \rightarrow 2\,KCl + 3O_2$

	reactants	products
K	2	2
Cl	2	2
O	6	6



Balancing Equations

1) Determine number of atoms for each element.

2) Pick an element that is not equal on both sides of the equation.

3) Add a coefficient in front of the formula with that element and adjust your counts.

4) Continue adding coefficients to get the same number of atoms of each element on each side.

$\square Mg + \square O_2 \rightarrow \square MgO$

Mg
O

Try these:

$\square Ca + \square O_2 \rightarrow \square CaO$

Ca
O

$\square N_2 + \square H_2 \rightarrow \square NH_3$

N
H

$\square Cu_2O + \square C \rightarrow \square Cu + \square CO_2$

Cu
O
C

$\square H_2O_2 \rightarrow \square H_2O + \square O_2$

H
O

1. $Na + MgF_2 \rightarrow NaF + Mg$

2. $Mg + HCl \rightarrow MgCl_2 + H_2$

3. $Cl_2 + KI \rightarrow KCl + I_2$

4. $NaCl \rightarrow Na + Cl_2$

5. $Na + O_2 \rightarrow Na_2O$

6. $Na + HCl \rightarrow H_2 + NaCl$

7. $K + Cl_2 \rightarrow KCl$

Challenge: This one is tough!

$C_2H_6 + O_2 \rightarrow CO_2 + H_2O$

1) $\_\_HCl + \_\_O_2 \rightarrow \_\_Cl_2 + \_\_H_2O$

2) $\_\_Fe + \_\_H_2O \rightarrow \_\_Fe_3O_4 + \_\_H_2$

3) $\_\_B_2H_6 + \_\_H_2O \rightarrow \_\_H_3BO_3 + \_\_H_2$

4) $\_\_NH_3 + \_\_N_2O \rightarrow \_\_N_2 + \_\_H_2O$

5.) $\_\_NO_2 + \_\_H_2O \rightarrow \_\_HNO_3 + \_\_NO$

6.) $\_\_NaCl + \_\_BeF_2 \rightarrow \_\_NaF + \_\_BeCl_2$

7.) $\_\_FeCl_3 + \_\_Be_3(PO_4)_2 \rightarrow \_\_BeCl_2 + \_\_FePO_4$

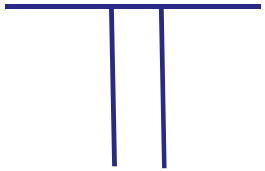
8.) $\_\_AgNO_3 + \_\_LiOH \rightarrow \_\_AgOH + \_\_LiNO_3$

9.) $\_\_CH_4 + \_\_O_2 \rightarrow \_\_CO_2 + \_\_H_2O$

10.) $\_\_Mg + \_\_Mn_2O_3 \rightarrow \_\_MgO + \_\_Mn$

Balancing Equations Practice

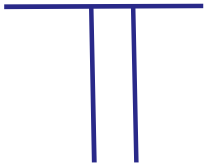
1. $Mg + N_2 \rightarrow Mg_3N_2$
2. $P + O_2 \rightarrow P_4O_{10}$
3. $Na + H_2O \rightarrow H_2 + NaOH$
4. $CH_4 + O_2 \rightarrow CO_2 + H_2O$



More Balancing Equations Practice

a) $MnO_2 + HCl \rightarrow MnCl_2 + H_2O + Cl_2$

b) $C_3H_6 + O_2 \rightarrow CO_2 + H_2O$

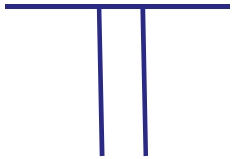


More Balancing Equations Practice

e) $CO + Fe_2O_3 \rightarrow Fe + CO_2$

f) $CS_2 + Cl_2 \rightarrow CCl_4 + S_2Cl_2$

g) $CH_4 + Br_2 \rightarrow CH_3Br + HBr$



BrINClHOF Brothers!

Bromine, Iodine, Nitrogen, Chlorine, Hydrogen, Oxygen, Fluorine are *always* going to be diatomic.

Br_2 I_2 N_2 Cl_2 H_2 O_2 F_2

Magnesium + Oxygen (g) ⟶ Magnesium Oxide

Write and Balance the following equation

Hydrogen plus oxygen yield water.

Write and Balance the following equation

Aluminum bromide plus chlorine yield aluminum chloride and bromine.

Write and Balance the following equation

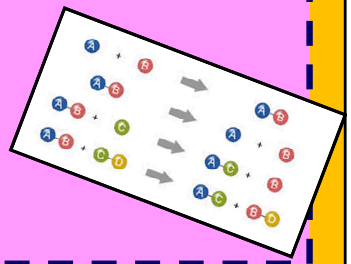
- Nitrogen gas plus oxygen gas react and form dinitrogen pentoxide.

More Balancing Equations Practice

A. Potassium iodide reacts with bromine forming potassium bromide plus iodine.

Classifying Reactions

- Helps to identify the kinds of chemical reactions and to predict the products of the chemical reactions.
- Five general kinds of reactions:
  - Synthesis
  - Decomposition
  - Single Displacement
  - Double Displacement
  - Combustion Reaction



Types of reactions

Synthesis A+ B → AB

Decomposition AB → A + B

Single displacement AC +B →BC + A

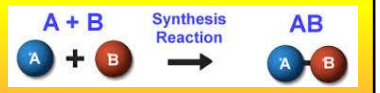
Double displacement AC + BD → AD + BC

Combustion Ex: $CH_4 + 2O_2 \rightarrow CO_2 + 2H_2O$

Synthesis Reaction

- **Two or more substances (reactants)**
- **Combine to form only one (new) substance (product)**
- **Also known as Addition**

$K + Cl_2 \rightarrow KCl$



$Mg + O_2 \rightarrow MgO$

$Fe + O_2 \rightarrow Fe_2O_3$

Addition (Synthesis)

Synthesis (combination)

A + B → AB

Decomposition Reaction

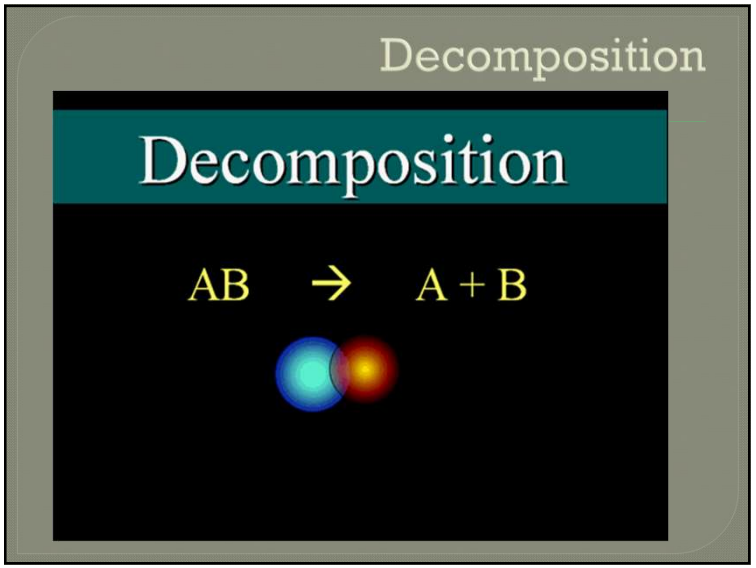
- One substance (reactant) combine forms 2 or more substances (products)

$$AB \longrightarrow A + B$$

- Compounds are broken down into two or more smaller compounds

$$H_2CO_3 \rightarrow H_2O + CO_2$$

$$MClO_3 \rightarrow MCl + O_2$$

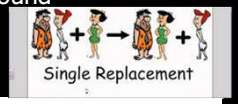


Single displacement

- One element and one compound (in reactants)
- Produces one element and one compound (in Products)

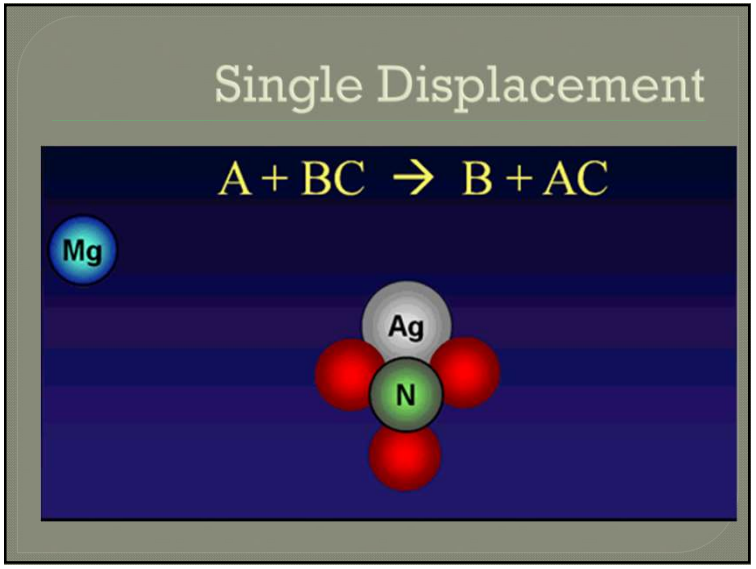
One element replaces another in a compound

$$AC + B \rightarrow BC + A$$



$$Zn + CuSO_4 \text{ --> } Cu + ZnSO_4$$

$$F_2 + 2KI \rightarrow I_2 + 2KF$$



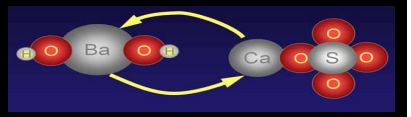
Single Displacement

Iron + Copper Sulfate: The iron replaces the copper in the solution, turning copper sulfate into iron sulfate (FeSO4). Pure copper collects on the iron.

Double displacement

- 2 compounds (in reactants) produce
- 2 compounds (in products)

- Elements switch places

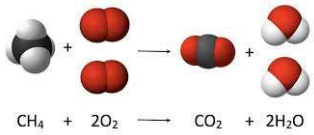


$AgNO_3 + NaCl \rightarrow AgCl + NaNO_3$

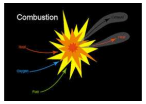
$Na_2CO_3 + CaCl_2$ ------> $CaCO_3 + 2NaCl$

Combustion Reaction

- A reaction in which a carbon compound and oxygen burn.
- Water, carbon dioxide and energy are common product



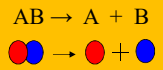
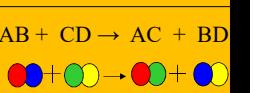
- Carbon cmpd + O_2 → CO_2 + H_20 + energy!
- $C_2H_6 + 7\ O_2 \rightarrow 4\ CO_2 + 6\ H_20$
  - But don't forget that ENERY is a product too (heat, light, etc)…



Combustion

- Dynamite combusting…

A = Red B = Blue C = Green D = Yellow

Type of Reaction	Definition	★ Equation
Synthesis (Addition)	Two or more elements or compounds combine to make a more complex substance	A + B → AB 
Decomposition	Compounds break down into simpler substances	AB → A + B 
Single – Displacement Or Replacement	Occurs when one element replaces another one in a compound	AB + C → AC + B 
Double – Displacement or Replacement	Occurs when different atoms in two different compounds trade places	AB + CD → AC + BD 

Let's Recap

- **Addition**
  End with only 1 compound
- **Decomposition**
  Start with only 1 compound
- **Single Displacement**
  Each side has a single element and a compound
- **Double Displacement**
  Each side has 2 compounds
- **Combustion**
  Products will always be $CO_2 + H_2O$ and ENERGY
- **Acid-Base Reaction**
  Products will always be H_2O and a salt of some form

Classifying Reaction Practice

A. $S_8 + 8O_2 \rightarrow 8SO_2 + \text{energy}$

Synthesis

B. $6CO_2 + 6H_20 \rightarrow C_6H_{12}O_6 + 6O_2$

Synthesis

C. $2NaHCO_3 \rightarrow Na_2CO3 + H_2O + CO_2$

Decomposition

D. $Zn + 2HCl \rightarrow ZnCl_2 + H_2$

Single-displacement