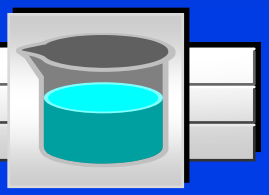
BALANCING EQUATION

How do you tell if it is a chemical reaction???????

- Color change
- Gas Produced
- Precipitate (a solid that falls –like rain—out of a solution)
- Temperature change (heat, cold)
- Light given off

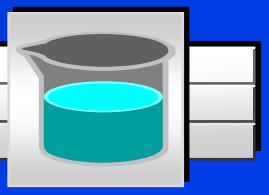


Physical or Chemical Change

- **Growth of a tree.** **Chemical**
- **Melting butter.** **Physical**
- **Fizzing soda** **Chemical**
- **Use of food by body** **Chemical**
- **Combustion of gas** **Chemical**
- **Separation of crude oil** **Physical**
- **Freezing pond** **Physical**
- Separation of water into Hydrogen and oxygen gas **Chemical**

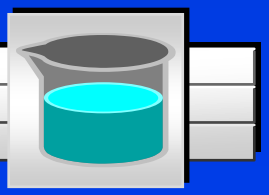
All chemical reactions

- have two parts
- **Reactants** - the substances you start with
- **Products**- the substances you end up with
- The reactants turn into the products.
- Reactants → Products



In a chemical reaction

- The way atoms are joined is changed
- Atoms aren't created or destroyed.
- Can be described several ways
- In a sentence
- Copper reacts with chlorine to form copper (II) chloride.
- In a **word equation**
- Copper + chlorine → copper (II) chloride



Symbols used in equations

- the arrow separates the reactants from the products
- Read “reacts to form”
- The plus sign = “and”
- (s) after the formula -solid
- (g) after the formula -gas
- (l) after the formula -liquid

Symbols used in equations

- **(aq) after the formula - dissolved in water, an aqueous solution.**
- **used after a product indicates a gas (same as (g))**
- **↓ used after a product indicates a solid (same as (s))**

Symbols used in equations

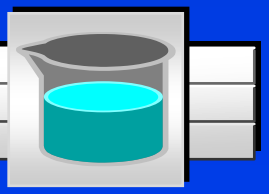
- $\rightleftharpoons$ indicates a reversible reaction (More later)
- $\xrightarrow{\Delta}$, $\xrightarrow{\text{heat}}$ shows that heat is supplied to the reaction
- $\xrightarrow{Pt}$ is used to indicate a catalyst used supplied, in this case, platinum.

What is a catalyst?

- **A substance that speeds up a reaction without being changed by the reaction.**
- **Enzymes are biological or protein catalysts.**

Skeleton Equation

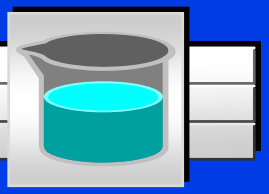
- Uses formulas and symbols to describe a reaction
- doesn’t indicate how many.
- All chemical equations are sentences that describe reactions.



Convert these to equations

- **Solid iron (III) sulfide reacts with aqueous hydrogen chloride to form iron (II) chloride and hydrogen sulfide gas.**

$$Fe_2S_{3\ (s)} + HCl_{(aq)} \rightarrow FeCl_2 + H_2S_{(g)}$$

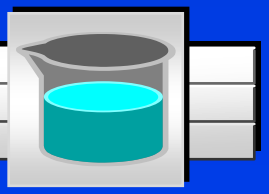


- **Nitric acid dissolved in water reacts with solid sodium carbonate to form liquid water and carbon dioxide gas and sodium nitrate dissolved in water.**

$$HNO_{3(aq)} + Na_2CO_3 \rightarrow H_2O_{(l)} + CO_{2(g)} + NaNO_{3(aq)}$$

The other way

- $Fe(g) + O_2(g) \rightarrow Fe_2O_3(s)$
- $Cu(s) + AgNO_3(aq) \rightarrow Ag(s) + Cu(NO_3)_2(aq)$
- $NO_2 \xrightarrow{Pt} N_2(g) + O_2(g)$



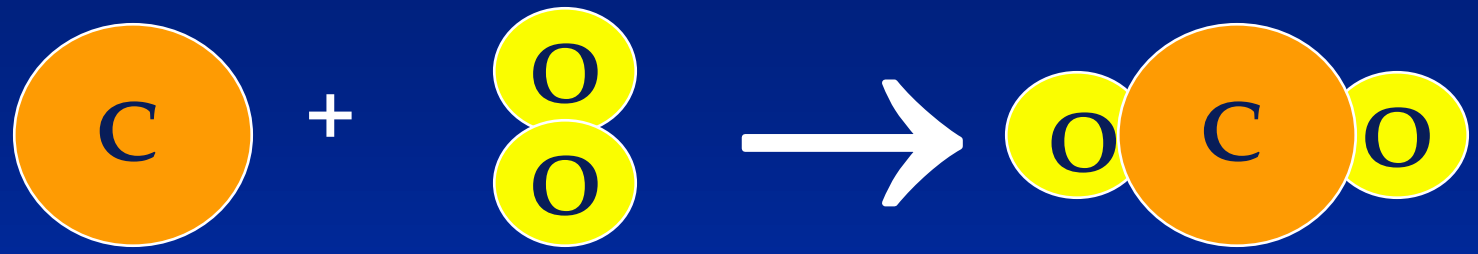
Reactions

- Come in 5 types.
- Can tell what type they are by the reactants.
- Single Replacement happens based on the activity series using activity series.
- Double Replacement happens if the product is a solid, water, or a gas.

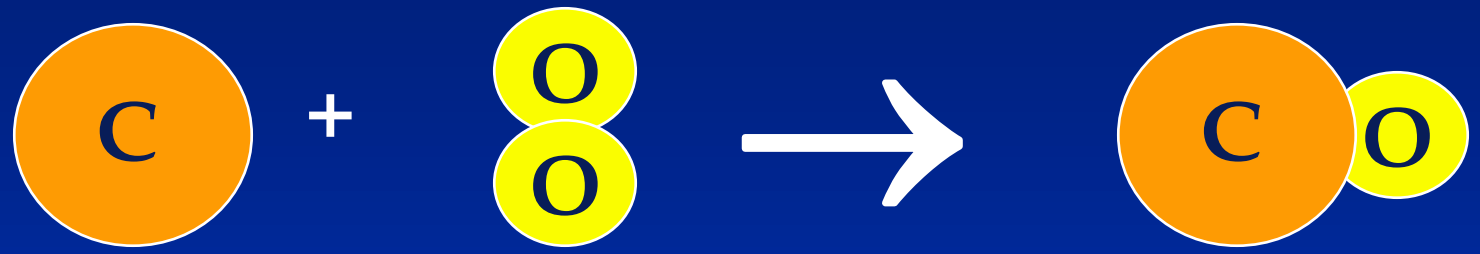
Balancing Chemical Equations

Balanced Equation

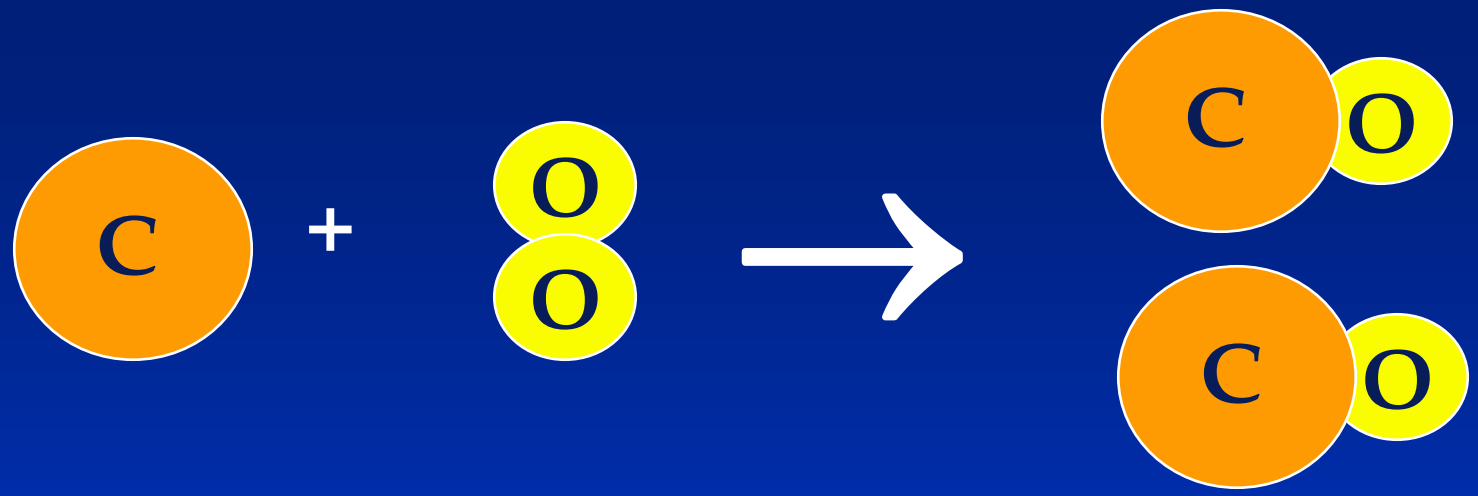
- Atoms can't be created or destroyed
- All the atoms we start with we must end up with
- A balanced equation has the same number of each element on both sides of the equation.



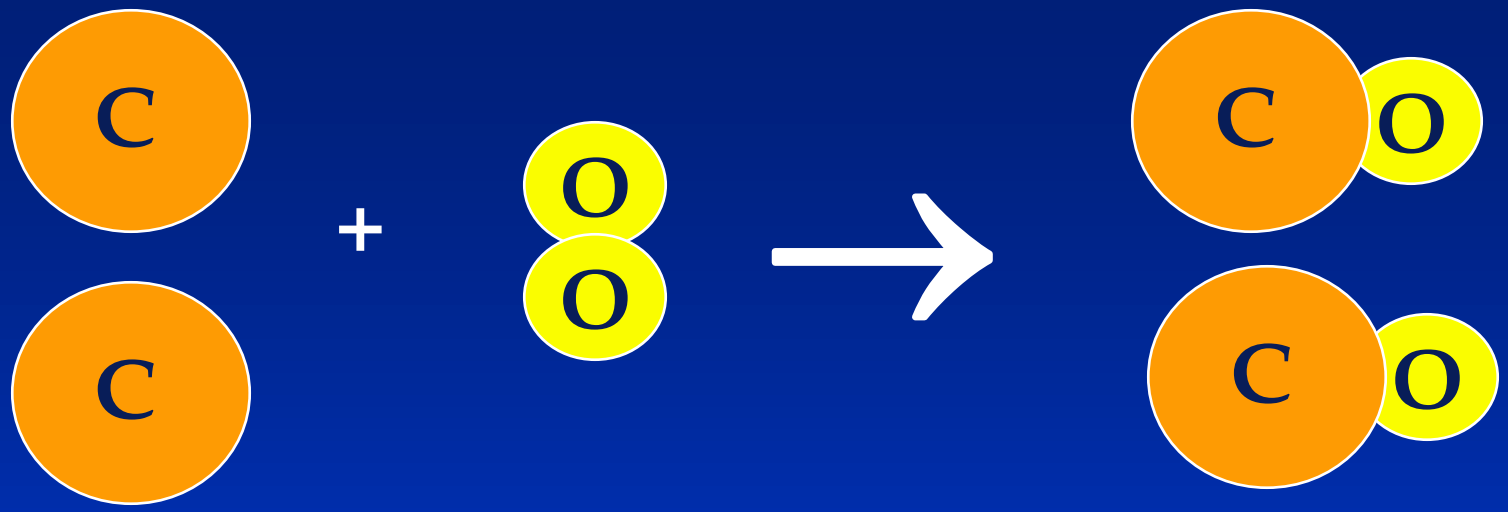
- $C + O_2 \rightarrow CO_2$
- This equation is already balanced
- What if it isn't already?



- $C + O_2 \rightarrow CO$
- We need one more oxygen in the products.
- Can't change the formula, because it describes what is



- Must be used to make another CO
- But where did the other C come from?



- Must have started with two C
- $2\ C + O_2 \rightarrow 2\ CO$

Rules for balancing

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). Start with the highest subscript . Save oxygen for last and hydrogen for next to last.**
4. **Check to make sure it is balanced.**

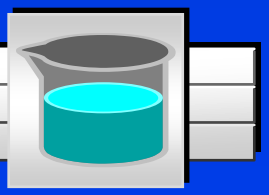
Never

- **Change a subscript to balance an equation.**
- **If you change the formula you are describing a different reaction.**
- **H_2O is a different compound than H_2O_2**
- **Never put a coefficient in the middle of a formula**
- **2 NaCl is okay, Na2Cl is not.**

Example

$$H_2 + O_2 \rightarrow H_2O$$

Make a table to keep track of where you are.



Example

$$H_2 + O_2 \rightarrow H_2O$$

R		P
2	H	2
2	O	1

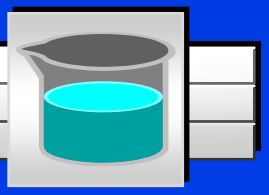
Need twice as much O in the product

Example

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

R		P
2	H	2
2	O	1

Changes the O



Example

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

R		P
2	H	2
2	O	~~1~~ 2

Also changes the H

Example

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

	R		P
2	H	~~2~~	4
2	O	~~1~~	2

Need twice as much H in the reactant

Example

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

R		P	
2	H	~~2~~	4
2	O	~~1~~	2

Recount

Example

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

R			P	
4	~~2~~	H	~~2~~	4
2		O	~~1~~	2

The equation is balanced, has the same number of each kind of atom on both sides

~~Example~~

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

	R		P
4	~~2~~	H	~~2~~ 4
2		O	~~1~~ 2

This is the answer

Not this

Examples

- $AgNO_3 + Cu \rightarrow Cu(NO_3)_2 + Ag$
- $Mg + N_2 \rightarrow Mg_3N_2$
- $P + O_2 \rightarrow P_4O_{10}$
- $Na + H_2O \rightarrow H_2 + NaOH$

Types of Reactions

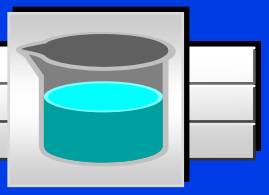
Predicting the Products

Types of Reactions

- There are millions of reactions.
- Can't remember them all
- Fall into several categories.
- We will learn 5 types.
- Will be able to predict the products.
- For some we will be able to predict whether they will happen at all.
- Will recognize them by the reactants

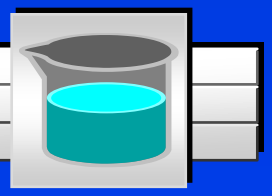
Types of Chemical Reactions

- Let's look in more detail.



#1 Combination Reactions or Synthesis

- **Combine - put together**
- **2 elements, or compounds combine to make one compound.**
- **$Ca + O_2 \rightarrow CaO$**
- **$SO_3 + H_2O \rightarrow H_2SO_4$**
- **We can predict the products if they are two elements.**
- **$Mg + N_2 \rightarrow$**



Write and balance

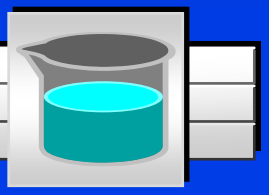
- $Ca + Cl_2 \rightarrow$
- $Fe + O_2 \rightarrow$ iron (II) oxide
- $Al + O_2 \rightarrow$
- Remember that the first step is to write the formula
- Then balance

More Practice

- Sodium burns in Oxygen
- Potassium combines with bromine
- Silver combines with nitrogen
- Magnesium burns in Oxygen

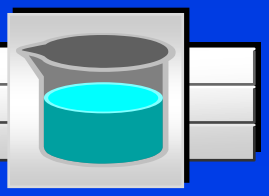
Check Answers

- $2Na + O_2 \rightarrow 2Na_2O$
- $2K + Br_2 \rightarrow 2KBr$
- $6Ag + N_2 \rightarrow 2Ag_3N$
- $2Mg + O_2 \rightarrow 2MgO$



#2 Decomposition Reactions

- **decompose = fall apart**
- **one reactant falls apart into two or more elements or compounds.**
- $NaCl \xrightarrow{\text{electricity}} Na + Cl_2$
- $CaCO_3 \xrightarrow{\Delta} CaO + CO_2$

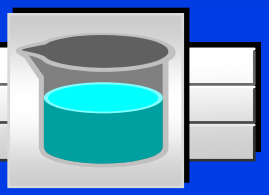


#2 Decomposition Reactions

- Can predict the products if it is a binary compound
- Made up of only two elements
- Falls apart into its elements
- $H_2O \xrightarrow{\text{electricity}}$
- $HgO \xrightarrow{\Delta}$

#2 Decomposition Reactions

- When the reactant has a polyatomic ion they break apart in a special way
- You have to know how 3 special polyatomic ions decompose
- Carbonates, chlorates and hydroxides

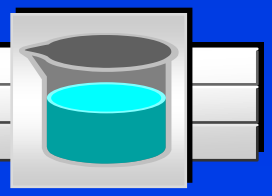


Special Decomposition Rxns

- **Carbonates**
  - –**break apart into metal oxide + CO_2**

$Na_2CO_3 \rightarrow Na_2O + CO_2$

$MgCO_3 \rightarrow MgO + CO_2$

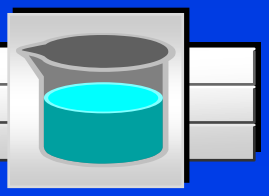


Special Decomposition Rxns

- **Chlorates**
  - **Break apart into metal chloride + O_2**

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

$Ca(ClO_3)_2 \rightarrow CaCl_2 + 3\ O_2$

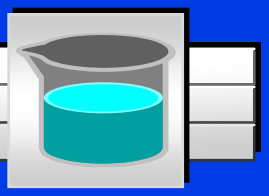


Special Decomposition Rxns

- **Hydroxides**
  - **Break apart into the metal oxide and H_2O**

$$Ca(OH)_2 \rightarrow CaO + H_2O$$

$$2\ LiOH \rightarrow Li_2O + H_2O$$



#3 Single Replacement

- One element replaces another
- Reactants must be an element and a compound.
- Products will be a different element and a different compound.
- $Na + KCl \rightarrow K + NaCl$
- $F_2 + LiCl \rightarrow LiF + Cl_2$

#3 Single Replacement

- **Metals replace metals (and hydrogen)**
- **K + AlN →**
- **Zn + HCl →**
- **Think of water as HOH**
- **Metals replace one of the H, combine with hydroxide.**
- **Na + HOH**

#3 Single Replacement

- We can tell **whether** a reaction will happen
- Some are more active than other
- More active replaces less active
- There is a list on your cruncher
- Higher on the list replaces lower.
- If the element by itself is higher, it happens, in lower it doesn’t

#3 Single Replacement

- Lithium
- Potassium
- Calcium
- Sodium
- Magnesium
- Aluminum
- Zinc
- Iron

- Nickel
- Tin
- Lead
- Hydrogen
- Copper
- Silver
- Gold

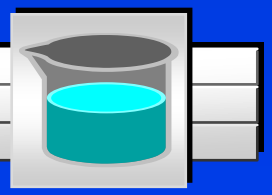
Only the first 5 (Li - Na) react with water.

#3 Single Replacement

- **Iron (II) + Copper (II) sulfate →**
- **Lead (II) + potassium chloride →**
- **Aluminum + Hydrochloric acid →**

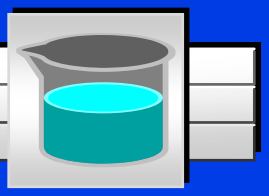
#3 Single Replacement

- What does it mean that Au And Ag are on the bottom of the list?
- Nonmetals can replace other nonmetals
- Limited to F_2 , Cl_2 , Br_2 , I_2
- The order of activity is that on the table.
- Higher replaces lower.
- $F_2 + HCl \rightarrow$
- $Br_2 + KCl \rightarrow$



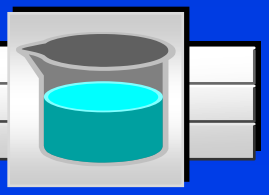
#4 Double Replacement

- Two things replace each other.
- Reactants must be two ionic compounds or acids.
- Usually in aqueous solution
- $NaOH + FeCl_3 \rightarrow$
- The positive ions change place.
- $NaOH + FeCl_3 \rightarrow Fe^{+3} OH^- + Na^{+1}Cl^{-1}$
- $NaOH + FeCl_3 \rightarrow Fe(OH)_3 + NaCl$



#4 Double Replacement

- **Will only happen if one of the products**
  - **doesn't dissolve in water and forms a solid**
  - **or is a gas that bubbles out.**
  - **or is a covalent compound, usually water.**

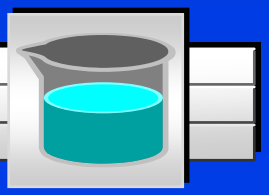


Complete and balance

- assume all of the reactions take place.
- Calcium chloride + sodium hydroxide →
- Copper (II) nitrate + potassium sulfide →

How to recognize which type

- Look at the reactants
- E + E Combination
- C Decomposition
- E + C Single replacement
- C + C Double replacement



Examples

- $H_2 + O_2 \rightarrow$
- $H_2O \rightarrow$
- $Zn + H_2SO_4 \rightarrow$
- $HgO \rightarrow$
- $KBr + Cl_2 \rightarrow$
- $AgNO_3 + NaCl \rightarrow$
- $Mg(OH)_2 + H_2SO_3 \rightarrow$

Last Type: Combustion

- A compound composed of only C H and maybe O is reacted with oxygen
- If the combustion is complete, the products will be CO_2 and H_2O.
- If the combustion is incomplete, the products will be CO and H_2O.

Examples

- $C_4H_{10} + O_2 \rightarrow$ (complete)
- $C_4H_{10} + O_2 \rightarrow$ (incomplete)
- $C_6H_{12}O_6 + O_2 \rightarrow$ (complete)
- $C_8H_8 + O_2 \rightarrow$ (incomplete)