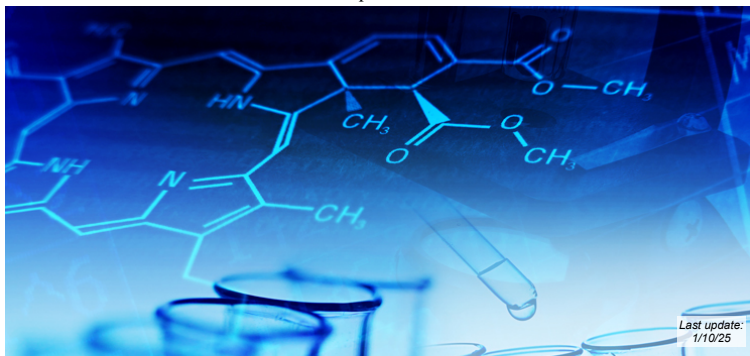


Chemistry 151: Basic Chemistry

Chapter 7 Section 7.1: The Chemical Reaction



Chemical Equations

Chemical equations are like recipes in cooking: They tell a chemist how to make something ("products") and what you'll need to make it ("reactants")

Having balanced amounts critical in cooking: too much flour can make a cake dry, and too little flour can prevent the cake from forming. Same in chemistry!

We will learn how to create a balanced chemical equation in this chapter, and in the next section, we will explore the quantities needed to actually make the products.



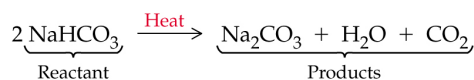
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Chemical Equations

Chemical equation: An expression in which symbols and formulas are used to represent a chemical reaction.

Reactant: A substance that **undergoes change** in a chemical reaction; written on **left side** of the reaction arrow

Product: A substance that is **formed** in a chemical reaction; written on **right side** of reaction arrow



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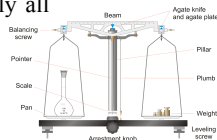
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The **Law of conservation of mass** states that matter cannot be created or destroyed in any chemical reaction

The **bonds** between atoms in the reactants are **rearranged** to form new compounds, but none of the atoms disappear, and no new atoms are formed.

So: **Chemical equations must be balanced**, meaning the numbers and kinds of atoms must be the same on both sides of the reaction arrow.

The numbers placed in front of formulas to balance equations are called **coefficients**, and they multiply all the atoms in the chemical formula.

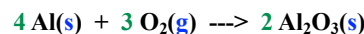


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Chemical Equations

Equations depict the **kind** of **reactants** and **products** and their relative amounts in a reaction.



The **numbers** in the front are called

stoichiometric coefficients

The letters **(s)**, **(g)**, **(l)** and **(aq)** are the physical states of compounds:

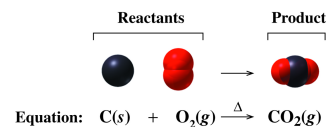
s = solid, **g** = gas, **l** = liquid,

aq = solution in water (aqueous)

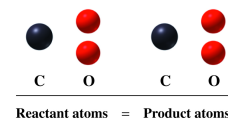
Chemical Equations are Balanced

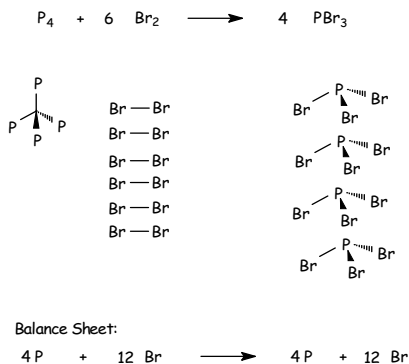
In a **balanced chemical reaction**:

- atoms are not gained or lost.



- the number of reactant atoms is equal to the number of product atoms.





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Balancing Chemical Equations

The following four steps can be used as a guide to balance chemical equations.

Example: Sulfuric acid reacts with sodium hydroxide to create sodium sulfate and water. Balance this chemical reaction.

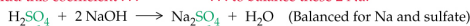
Step 1: Write an unbalanced equation, using correct formulas for all reactants and products.



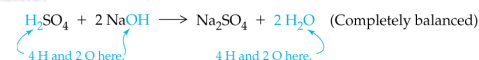
Step 2: Add appropriate coefficients to balance the numbers of atoms of each element.



Add this coefficient ... to balance these 2 Na.
 One sulfate here ... and one here.



Step 3: Check the equation to make sure the numbers and kinds of atoms on both sides of the equation are same.



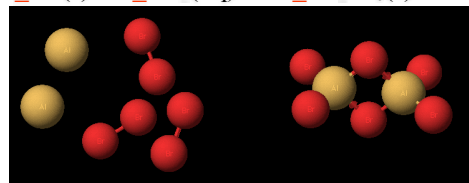
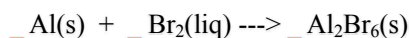
Step 4: Make sure the coefficients are reduced to their lowest whole-number value (ok here).

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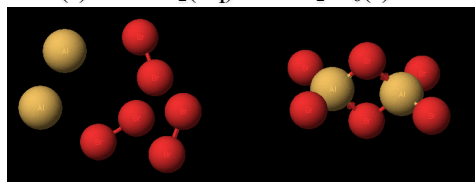
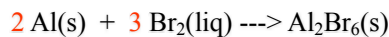
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Balancing Equations

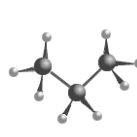


Balancing Equations

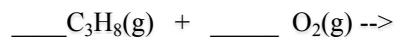


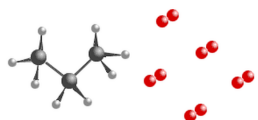
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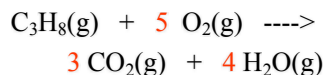


Balancing Equations





Balancing Equations



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Balancing Equations

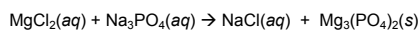
Balance the following:



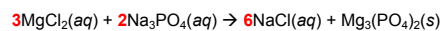
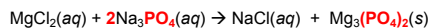
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Balancing with Polyatomic Ions

Magnesium chloride + sodium phosphate →
magnesium phosphate + sodium chloride



Leave polyatomic ions as "units", don't break up when balancing,
usually balance them first before other atoms

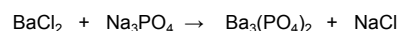


Balanced!

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Balancing Equations

Balance the following. To save time, balance polyatomic ions as units (not individual atoms):



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Balancing Equations - Hints

Balance those atoms which occur in only one compound on each side

Balance the remaining atoms

Reduce coefficients to smallest whole integers

Check your answer

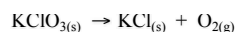
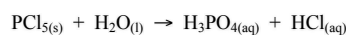
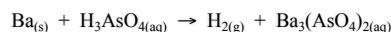
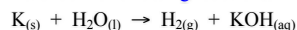
Remember the seven diatomics! HONCl

BrIF

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Test Yourself

Balance the following reactions:



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practice, practice, practice!

Types of Reactions

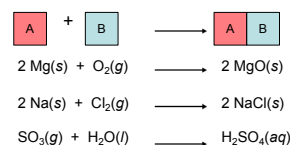
Most chemical reactions can be grouped into one of these six categories:

- Combination** $A + B \rightarrow AB$
- Decomposition** $AB \rightarrow A + B$
- Single Replacement** $AB + C \rightarrow CB + A$ or $MY + X \rightarrow MX + Y$
(Metals replace metals; nonmetals replace nonmetals)
- Combustion** $C_xH_y + O_2 \rightarrow CO_2 + H_2O$
- Acid-Base** $HX + MOH \rightarrow MX + H_2O$
- Precipitation** $AX + BY \rightarrow AY(s) + BX$

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Combination (Addition)

In a **combination reaction**, two or more reactants form one product or simple compounds combine to form one product.

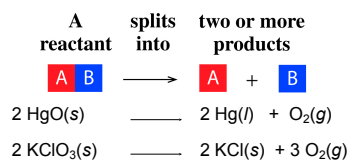


Combination reactions are also known as **addition reactions**.

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Decomposition

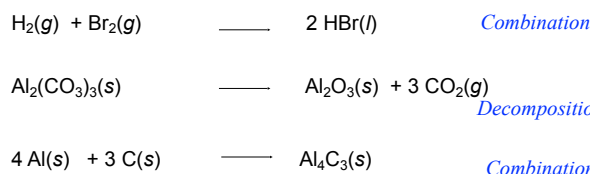
In a **decomposition reaction**, one substance splits into two or more simpler substances.



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Learning Check

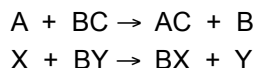
Classify the following reactions as combination or decomposition.



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Single Replacement Reactions

Single replacement reactions:



Metal (A and B) replace metals;
Non-metals (X and Y) replace non-metals

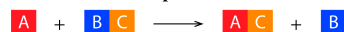
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Single Replacement

In a **single replacement reaction**, one element takes the place of a different element in a reacting compound.

Single replacement

One element replaces another element



Metals (Zn and Ag) replacing metals:



Nonmetals (Br and Cl) replacing nonmetals:



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Learning Check

Complete and balance the following single replacement equation:

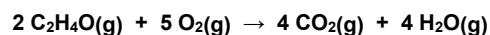
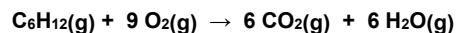
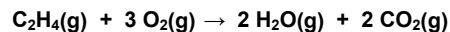
Metals replace metals:
zinc + silver nitrate →

Non-metals replace non-metals:
chlorine + sodium iodide →

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Combustion Reactions

In a combustion reaction, a hydrocarbon (containing C, H and/or O) reacts with oxygen (O₂) to make carbon dioxide and water. These are very common in organic chemistry (and in your combustion gasoline car!)

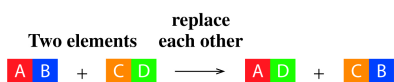


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Acid-Base Reactions

In an acid-base reaction, an acid (H listed first) reacts with a base (metal hydroxide) to create water and a "salt"

Double replacement

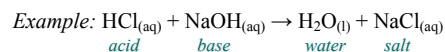


Acid-Base reactions are also a type of **double displacement** or **exchange reactions**

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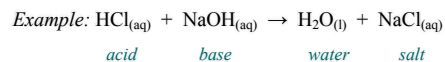
Acid-Base Reactions

When equal amounts (moles) of **acids** (H⁺) and **bases** (OH⁻) are mixed together, both acidic and basic properties disappear because of a **neutralization reaction**. The neutralization reaction produces **water** and a **salt**.



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Acid-Base Reactions

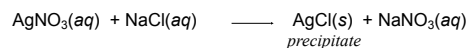
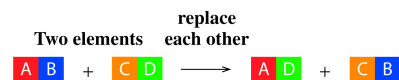


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Precipitation Reactions

In a precipitation reaction, reactants exchange cations, and at least one of the products is a solid (a *precipitate*)

Double replacement



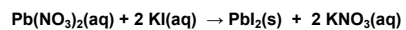
Precipitation reactions are also a type of **double displacement** or **exchange reactions**

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Precipitation Reactions

Solubility: The amount of a compound that will dissolve in a given amount of solvent at a given temperature.

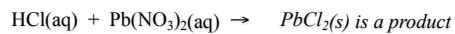
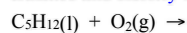
When solubility exceeded, **precipitates** form



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Test Yourself

Balance and classify the following reactions:



MAR

practice, practice, practice!

End of Chapter 7 Section 7.1

