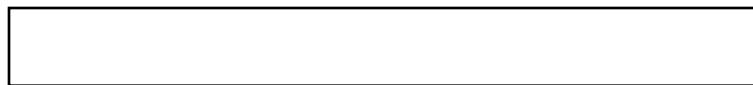


CHEMICAL REACTIONS



Chemical Equations

Their Job: 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), and (l) are the physical states of compounds.

Introduction

- **Chemical reactions occur when bonds between the outermost parts of atoms are formed or broken**
- **Chemical reactions involve changes in matter, the making of new materials with new properties, and energy changes.**
- **Symbols represent elements, formulas describe compounds, chemical equations describe a chemical reaction**

Parts of a Reaction Equation

- Chemical equations show the conversion of **reactants** (the molecules shown on the left of the arrow) into **products** (the molecules shown on the right of the arrow).
 - **A + sign separates molecules on the same side**
 - **The arrow is read as “yields”**
 - **Example**
$$\text{C} + \text{O}_2 \rightarrow \text{CO}_2$$
 - **This reads “carbon plus oxygen react to yield carbon dioxide”**



- The charcoal used in a grill is basically carbon. The carbon reacts with oxygen to yield carbon dioxide. The chemical equation for this reaction, $C + O_2 \rightarrow CO_2$, contains the same information as the English sentence but has quantitative meaning as well.

Chemical Equations

Because of the principle of the conservation of matter,

an equation must be balanced.

It must have the same number of atoms of the same kind on both sides.



Lavoisier, 1788






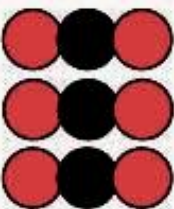
Symbols Used in Equations

- Solid (s)
- Liquid (l)
- Gas (g)
- Aqueous solution (aq)
- Catalyst $\xrightarrow{\text{H}_2\text{SO}_4}$
- Escaping gas (\uparrow)
- Change of temperature (Δ)

Balancing Equations

- When balancing a chemical reaction you may add coefficients in front of the compounds to balance the reaction, but you may **not** change the subscripts.
 - Changing the subscripts changes the compound. Subscripts are determined by the valence electrons (charges for ionic or sharing for covalent)

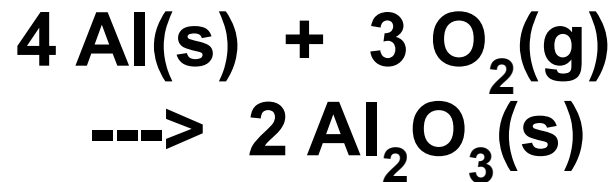
Subscripts vs. Coefficients

C	means		One atom of carbon
O	means		One atom of oxygen
O ₂	means		One molecule of oxygen consisting of two atoms of oxygen
CO	means		One molecule of carbon monoxide consisting of one atom of carbon attached to one atom of oxygen
CO ₂	means		One molecule of carbon dioxide consisting of one atom of carbon attached to two atoms of oxygen
3 CO ₂	means		Three molecules of carbon dioxide, each consisting of one atom of carbon attached to two atoms of oxygen

The subscripts tell you how many atoms of a particular element are in a compound.

The coefficient tells you about the quantity, or number, of molecules of the compound.

Chemical Equations



This equation means

4 Al atoms + 3 O₂ molecules
---produces--->
2 molecules of Al₂O₃

AND/OR

4 moles of Al + 3 moles of O₂
---produces--->
2 moles of Al₂O₃



Steps to Balancing Equations

There are four basic steps to balancing a chemical equation.

1. Write the correct formula for the reactants and the products. **DO NOT TRY TO BALANCE IT YET!** You must write the correct formulas first. And most importantly, once you write them correctly **DO NOT CHANGE THE FORMULAS!**
2. Find the number of atoms for each element on the left side. Compare those against the number of the atoms of the same element on the right side.
3. Determine where to place coefficients in front of formulas so that the left side has the same number of atoms as the right side for **EACH** element in order to balance the equation.
4. Check your answer to see if:
 - The numbers of atoms on both sides of the equation are now balanced.
 - The coefficients are in the lowest possible whole number ratios. (reduced)

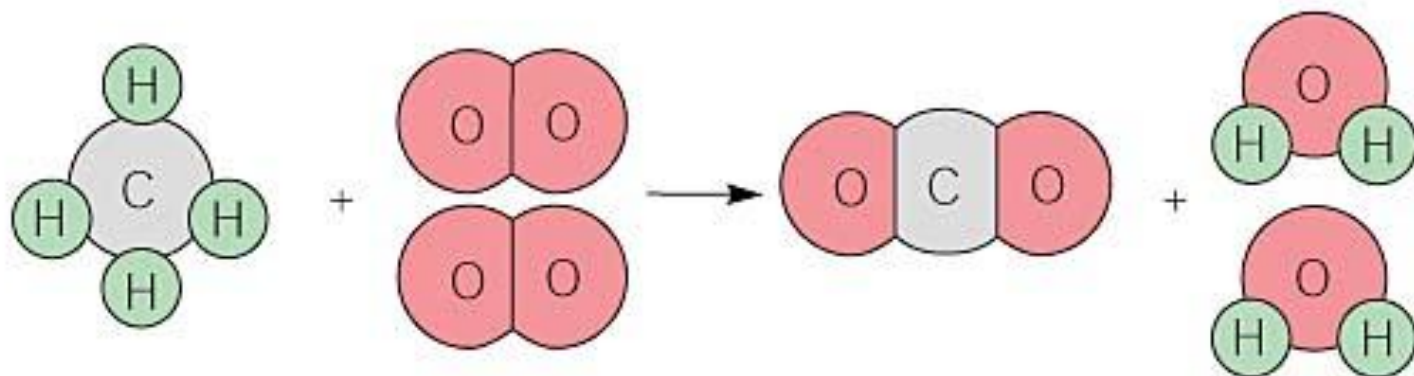
Some Suggestions to Help You

- Take one element at a time, working left to right except for H and O. Save H for next to last, and O until last.
- IF everything balances except for O, and there is no way to balance O with a whole number, double all the coefficients and try again. (Because O is diatomic as an element)
- (Shortcut) Polyatomic ions that appear on both sides of the equation should be balanced as independent units

Reaction: Methane reacts with oxygen to yield carbon dioxide and water

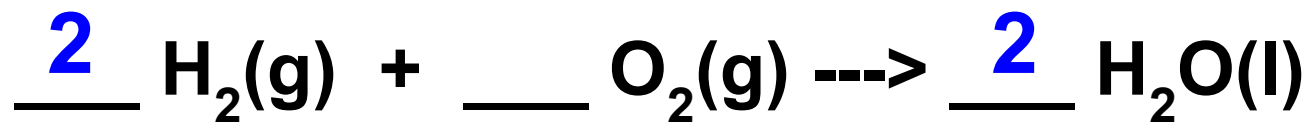
Balanced equation: $\text{CH}_4 + 2 \text{O}_2 \longrightarrow \text{CO}_2 + 2 \text{H}_2\text{O}$

Sketches representing molecules:



Meaning: 1 molecule of methane + 2 molecules of oxygen \longrightarrow 1 molecule of carbon dioxide + 2 molecules of water

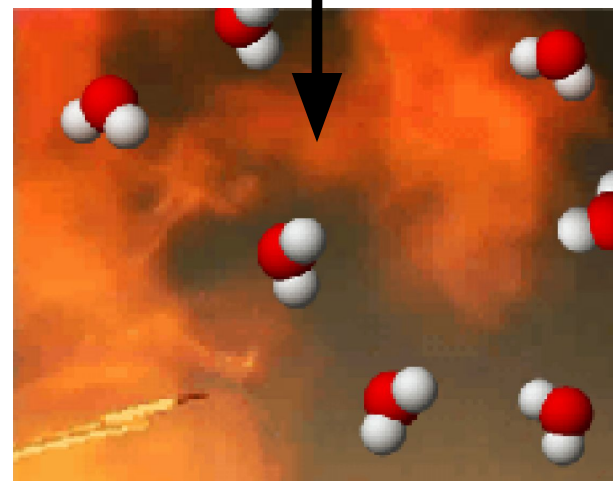
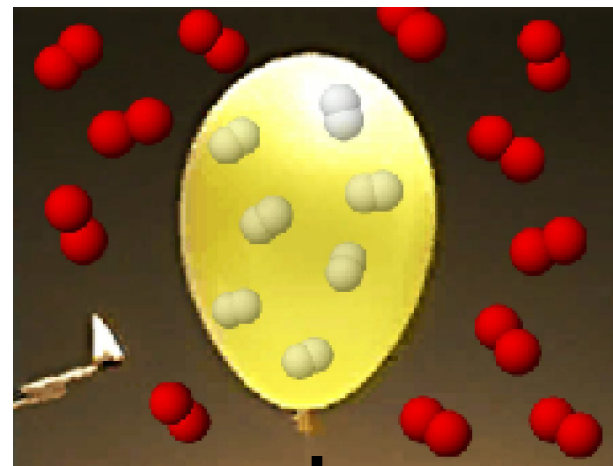
Balancing Equations



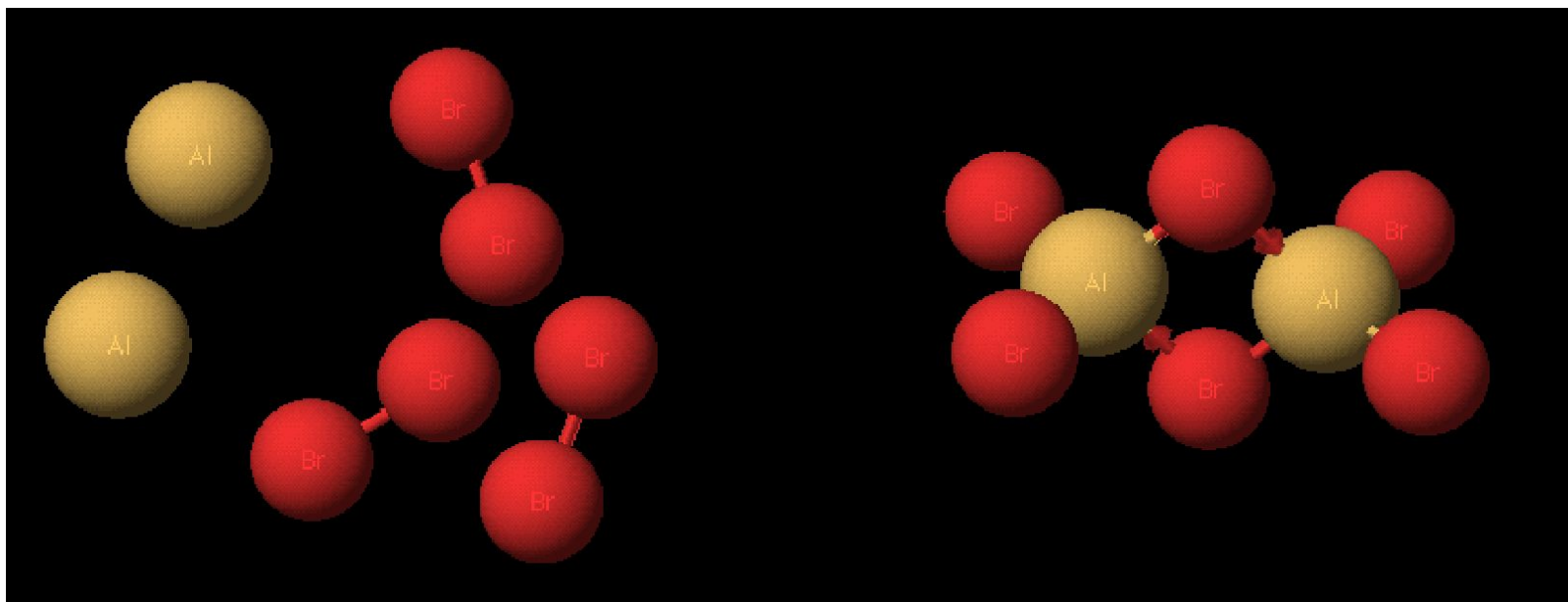
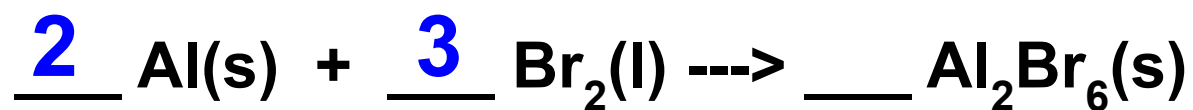
What Happened to the Other Oxygen Atom?????

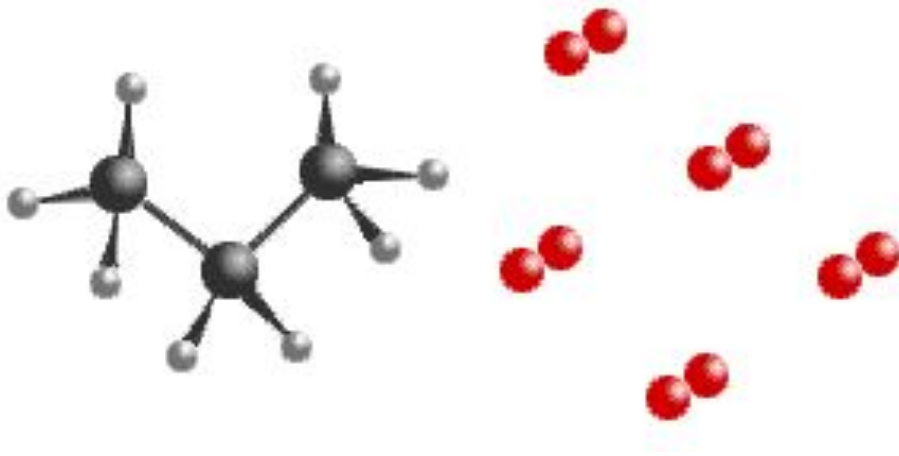
This equation is not balanced!

Two hydrogen atoms from a hydrogen molecule (H_2) combines with one of the oxygen atoms from an oxygen molecule (O_2) to form H_2O . Then, the remaining oxygen atom combines with two more hydrogen atoms (from another H_2 molecule) to make a **second** H_2O molecule.

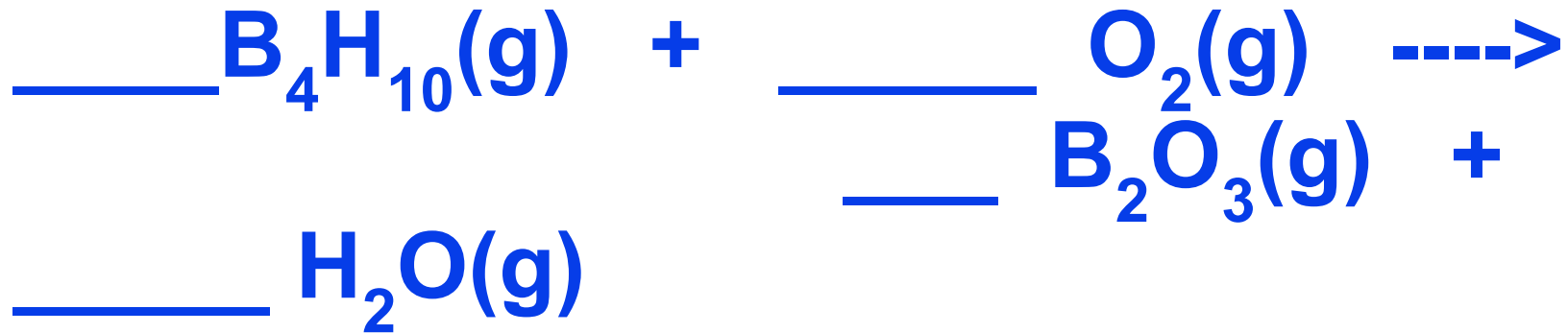
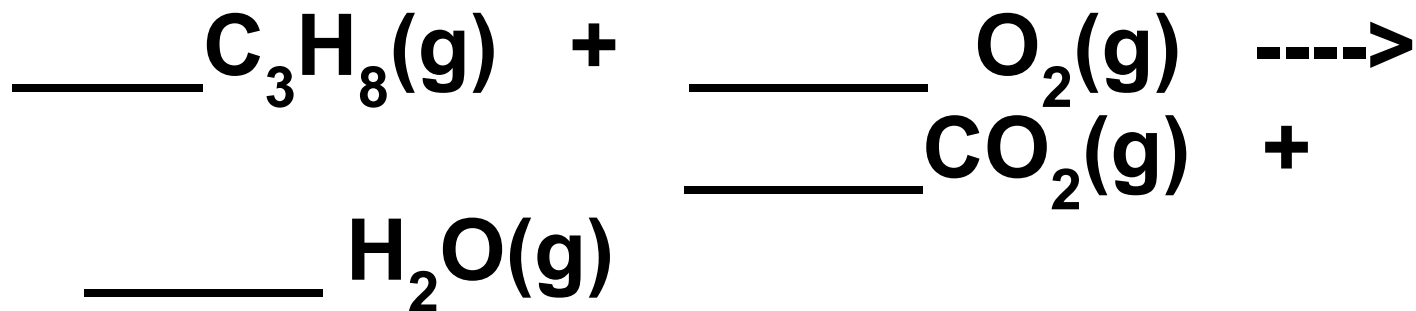


Balancing Equations





Balancing Equations



Balancing Equations

Sodium phosphate + iron (III) oxide \square
sodium oxide + iron (III) phosphate

