

# **Chemical Reactions: An Introduction**

**Balancing Chemical Equations**

# Balancing Chemical Equations

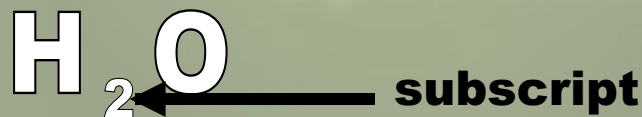


- An unbalanced chemical equation is not an accurate representation of the reaction that occurs.
- Whenever you see an equation for a reaction, you should ask yourself whether it is balanced.
- Atoms are conserved in a chemical reaction.
- Atoms are neither created nor destroyed.
  - They are just grouped differently.

# Balancing Chemical Equations

The identities (formulas) of the compounds must never be changed in balancing a chemical equation.

**NEVER TOUCH THE  
SUBSCRIPTS!**



- The subscripts in a formula cannot be changed, nor can atoms be added to or subtracted from a formula.

# Balancing Chemical Equations

- Most chemical equations can be balanced by trial and error.
  - Keep trying until you find the numbers of reactants and products that give the same number of each type of atom on both sides of the arrow.
  - It's okay to make a few wrong turns before you get to the right answer.

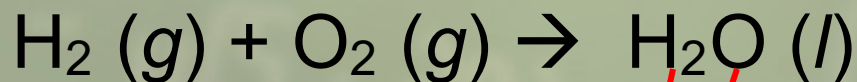
**DON'T**



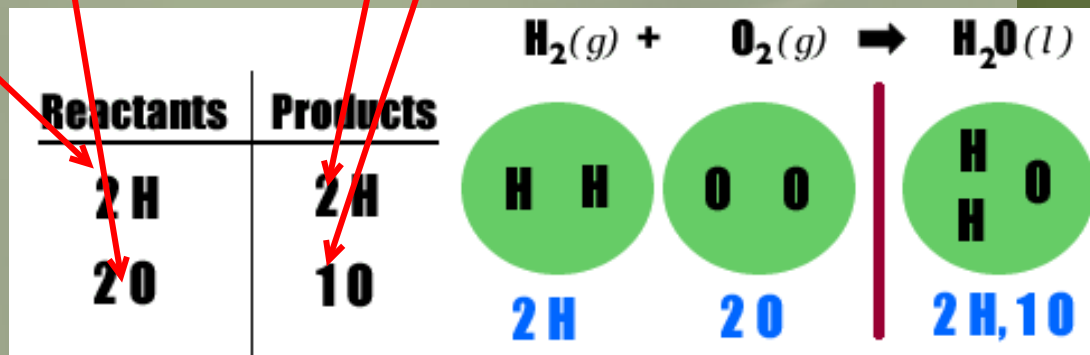
# Balancing Chemical Equations

## The Combustion of Hydrogen

- Consider the reaction of hydrogen gas and oxygen gas to form liquid water.
- First, we write the unbalanced equation from the description of the reaction.

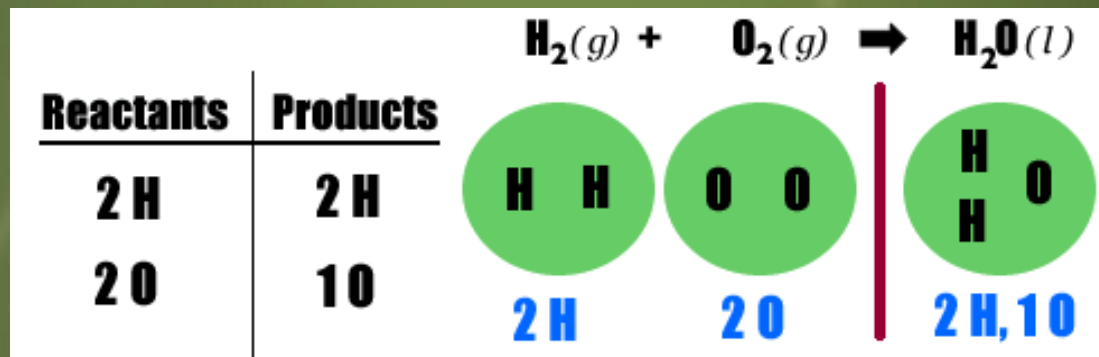


- We can see that this equation is unbalanced by counting the atoms on both sides of the arrow.





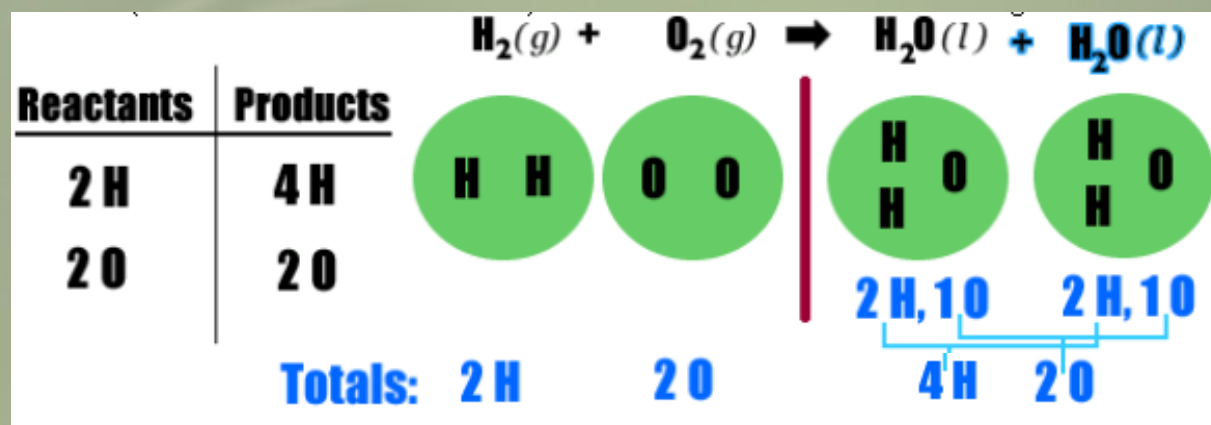
# Balancing Chemical Equations



- We have 1 more O atom in the reactants than in the products.
- Because we cannot create or destroy atoms and because we *cannot change the formulas* of the reactants or products, we must balance the equation by adding more molecules of reactants and/or products.

# Balancing Chemical Equations

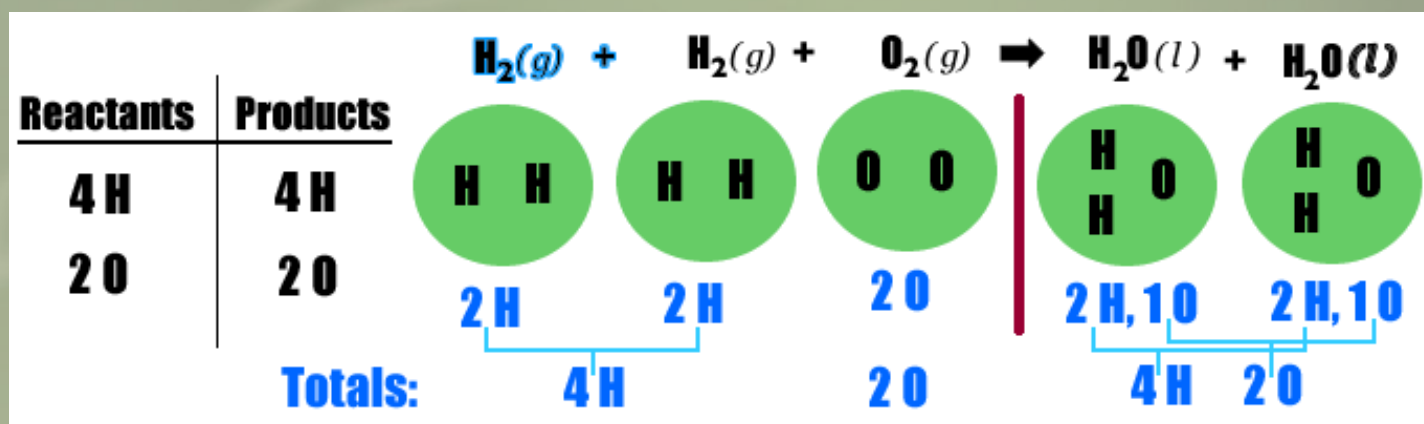
- In this case we need 1 more O atom on the right, so we add another water molecule (which contains one O atom).
- Then we count all of the atoms again.



- We have balanced the O atoms, but now the H atoms have become unbalanced.

# Balancing Chemical Equations

- There are more H atoms on the right than on the left.
- We can solve this problem by adding another hydrogen molecule ( $\text{H}_2$ ) to the reactant side.

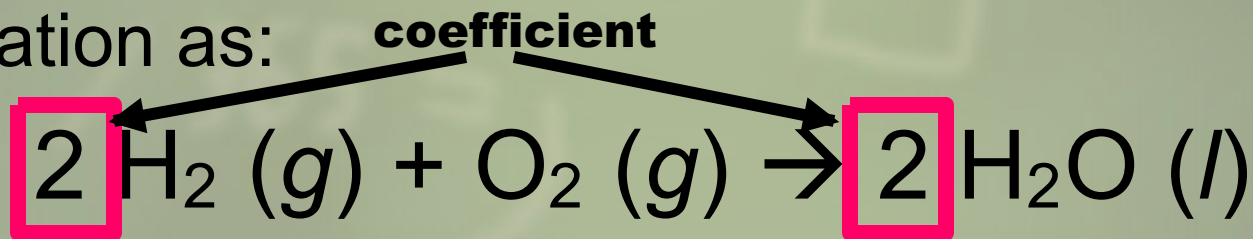


- The equation is now balanced!
- We have the same numbers of H and O atoms represented on both sides of the arrow



# Balancing Chemical Equations

- Collecting like molecules, we write the balanced equation as:



- This equation is balanced (count the atoms to verify this).
- The accepted convention is that the "best" balanced equation is the one with the *smallest whole numbers*.
  - These whole numbers are called the coefficients for the balanced equation.

# Balancing Chemical Equations

- **Coefficient** → number written in front of the chemical formulas in a balanced chemical equation.
  - Coefficients indicate the relative numbers of reactants and products in the reaction.

# Balancing Chemical Equations

- Therefore, for the reaction of hydrogen and oxygen to form water, the "correct" balanced equation is:



- The coefficients 2, 1 (never written), and 2, respectively, are the smallest *whole numbers* that give a balanced equation for this reaction.

# Balancing Chemical Equations

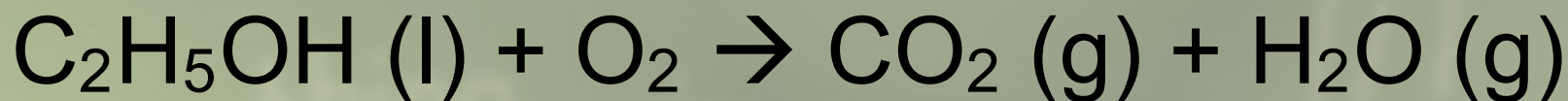
## Combustion of Ethanol

- We will balance the equation for the reaction of liquid ethanol,  $\text{C}_2\text{H}_5\text{OH}$ , with oxygen gas to form gaseous carbon dioxide and water.
  - This reaction, among many others, occurs in engines that burn a gasoline-ethanol mixture called gasohol.



# Balancing Chemical Equations

- The first step in obtaining the balanced equation for a reaction is always to identify the reactants and products from the description given for the reaction.
- In this case we are told that liquid ethanol,  $\text{C}_2\text{H}_5\text{OH (l)}$ , reacts with gaseous oxygen,  $\text{O}_2 \text{ (g)}$ , to produce gaseous carbon dioxide,  $\text{CO}_2 \text{ (g)}$ , and gaseous water,  $\text{H}_2\text{O (g)}$ .
- Therefore, the unbalanced equation is:



# Combustion of Ethanol

**Recorded Lesson-Click link below**

- <http://community.palcs.org/p46132763/>



# Balancing Chemical Equations

## How to Write and Balance Equations

**Step 1** Read the description of the chemical reaction.

- What are the reactants, the products, and their states?
- Write the appropriate formulas.

**Step 2** Write the unbalanced equation that summarizes the information from step 1.

# Balancing Chemical Equations

## How to Write and Balance Equations

### Step 3

Balance the equation by inspection, starting with the most complicated molecule.

- Go element by element to determine what coefficients are needed so the same number of each type of atom appears on both sides.
- Do not change the formulas of any of the reactants or products.

# Balancing Chemical Equations

## How to Write and Balance Equations

### Step 4

Check to see that the coefficients used give the same number of each type of atom on both sides of the arrow.

- Note that an "atom" may be present in an element, compound, or an ion.
- Check to see that the coefficients used are the smallest whole numbers that give the balanced equation. This can be done by determining whether all coefficients can be divided by the same whole numbers to give a set of smaller *whole number* coefficients.

- The End