Honors UNIT 5: Chemical Reactions

Section 1: Types of Reactions

Section 2: Balancing Chemical Equations

Section 3: Ions in Water

Section 4: Oxidation – Reduction Reactions

UNIT 5 Synapsis

In this Unit we will explore chemical change by looking at the one of the most important models of chemical change; chemical equations.

In the first section we will learn how to identify 5 different types of reactions.

In the second section we will look at how all chemical change (or any type of change in the universe) must follow the law of conservation of matter & energy

In section three we will look at how ions are formed in water.

Finally, in section 4 we will introduce oxidation – reduction reactions.

Section 1: Types of Reactions

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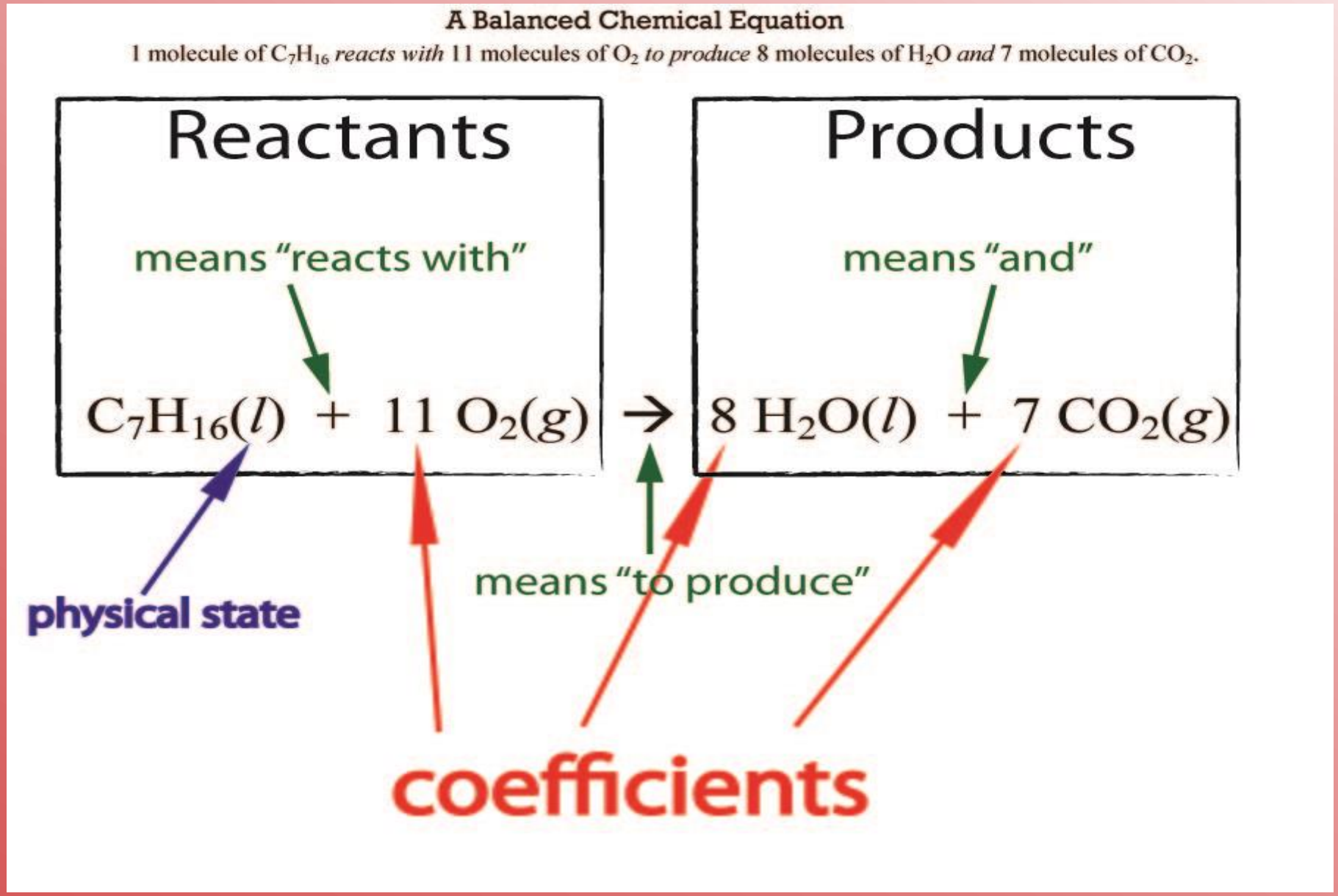
Section 1: Types of Reactions / Objectives

- Students Will Be Able too…
  - …*label* the parts of a **chemical equation."**
  - …*Identify* a chemical equation as representing a combustion reaction, single replacement reaction, double replacement reaction synthesis reaction, or decomposition reaction.

Chemical Equations

- One of the most important models in chemistry are **chemical equations**. Chemical equations provide information about the reactants and the products.
- Here are a few chemical equations for chemical reactions you might be familiar with:
- Octane or gasoline reacts with air:
  - $2\ C_8H_{18}(l) + 25\ O_2(g) \rightarrow 16\ CO_2(g) + 18\ H_2O(l)$
- A plant uses photosynthesis to turn carbon dioxide and water into oxygen and sugar:
  - $6\ CO_2(g) + 6\ H_2O(l) \rightarrow C_6H_{12}O_6(s) + 6\ O_2(g)$
- A piece of Iron rusts:
  - $4\ Fe(s) + 3\ O_2(g) \rightarrow 2\ Fe_2O_3\ (s)$
- Note that the same elements are in the products and reactants, they are just combined in different ways.
- On the next slide, all of the parts of a chemical equation are identified and labeled.

Parts of a Chemical Equation



#1: Synthesis Reactions (a.k.a. combination reactions)

- In a synthesis reaction, two or more elements or compounds combine to form a larger, more complex compound.

- <u>Sample Chemical Equations:</u>
  - $3\ H_2 + N_2 \rightarrow 2\ NH_3$
  - $2\ H_2 + O_2 \rightarrow 2\ H_2O$
  - $Mg + O_2 \rightarrow MgO$
  - $CaO + H_2O \rightarrow Ca(OH)_2$

- <u>Generic Chemical Equation:</u>
  - **A + B → C**

- ***How to identify***: *There should only be 1 product in the equation.*

Practice Problems: Identifying Types of Reactions

*Directions: Circle the **Synthesis Reactions.***

1) $4\ Al + 3\ O_2 \rightarrow 2\ Al_2O_3$
2) $2\ H_2O_2(aq) \rightarrow 2\ H_2O(l) + O_2(g)$
3) $Na_2O + 2\ CO_2 + H_2O \rightarrow 2\ NaHCO_3$
4) $CaCl_2 + Rb_2SO_4 \rightarrow CaSO_4 + 2\ RbCl$
5) $Cl_2 + NaBr \rightarrow NaCl + Br_2$
6) $3\ Mg + N_2 \rightarrow Mg_3N_2$
7) $Cu + 2\ AgNO_3 \rightarrow 2\ Ag + Cu(NO_3)_2$
8) $C_7H_{16}(l) + 11\ O_2(g) \rightarrow 8\ H_2O + 7\ CO_2$
9) $N_2H_4O_3(s) \rightarrow N_2O(g) + 2\ H_2O(g)$
10) $F_2 + NaI \rightarrow NaF + I_2$
11) $2\ AgF + CaCl_2 \rightarrow 2\ AgCl + CaF_2$
12) $SeCl_6 + O_2 \rightarrow SeO_2 + 3\ Cl_2$
13) $3\ Ca + 2\ AlCl_3 \rightarrow 3\ CaCl_2 + 2\ Al$
14) $2\ Pb(NO_3)_2 \rightarrow 2\ PbO + 4\ NO_2 + O_2$
15) $Fe + 2\ CuNO_3 \rightarrow 2\ Cu + Fe(NO_3)_2$
16) $2\ C_8H_{18}(l) + 25\ O_2(g) \rightarrow 18\ H_2O + 16\ CO_2$
17) $Pb(NO_3)_2 + 2\ CsCl \rightarrow 2\ CsNO_3 + PbCl_2$
18) $2\ Na + CaF_2 \rightarrow Ca + 2\ NaF$
19) $2\ Fe + 3\ H_2SO_4 \rightarrow Fe_2(SO_4)_3 + 2\ H_2$
20) $CuCl_2 + NaOH \rightarrow Cu(OH)_2 + NaCl$

#2: Decomposition Reactions

- In a decomposition reaction, A compound breaks down into two or more elements or compounds. This often occurs through heating but not always.
- In decomposition equations the arrow actually means "breaks down to produce" or "decomposes to produce."

- <u>Sample Chemical Equations:</u>
  - $2\ H_2O_2 \rightarrow 2\ H_2O + O_2$
  - $CuCO_{3(s)} \rightarrow CuO_{(s)} + CO_{2(g)}$
  - $C_3H_5(NO_3)_{3(l)} \rightarrow 6\ N_{2(g)} + 12\ CO_{2(g)} + 10\ H_2O_{(g)} + O_{2(g)}$

- <u>Generic Chemical Equation:</u>
  - **A → B + C**

- ***How to identify:*** *There will only be 1 reactant in the equation*

Practice Problems: Identifying Types of Reactions

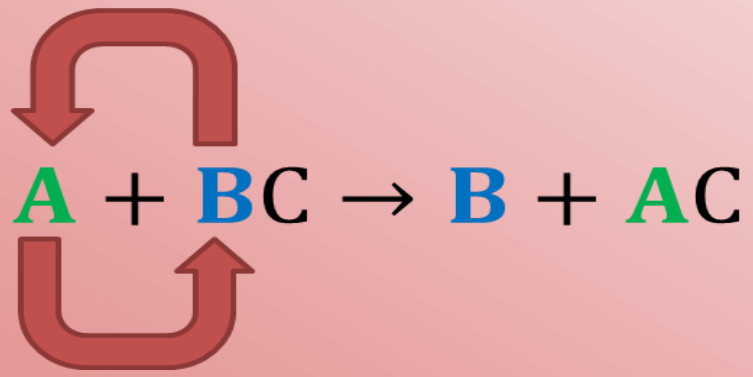
*Directions: Circle the **Decomposition Reactions.***

1) $4\ Al + 3\ O_2 \rightarrow 2\ Al_2O_3$
2) $2\ H_2O_2(aq) \rightarrow 2\ H_2O(l) + O_2(g)$
3) $Na_2O + 2\ CO_2 + H_2O \rightarrow 2\ NaHCO_3$
4) $CaCl_2 + Rb_2SO_4 \rightarrow CaSO_4 + 2\ RbCl$
5) $Cl_2 + NaBr \rightarrow NaCl + Br_2$
6) $3\ Mg + N_2 \rightarrow Mg_3N_2$
7) $Cu + 2\ AgNO_3 \rightarrow 2\ Ag + Cu(NO_3)_2$
8) $C_7H_{16}(l) + 11\ O_2(g) \rightarrow 8\ H_2O + 7\ CO_2$
9) $N_2H_4O_3(s) \rightarrow N_2O(g) + 2\ H_2O(g)$
10) $F_2 + NaI \rightarrow NaF + I_2$
11) $2\ AgF + CaCl_2 \rightarrow 2\ AgCl + CaF_2$
12) $SeCl_6 + O_2 \rightarrow SeO_2 + 3\ Cl_2$
13) $3\ Ca + 2\ AlCl_3 \rightarrow 3\ CaCl_2 + 2\ Al$
14) $2\ Pb(NO_3)_2 \rightarrow 2\ PbO + 4\ NO_2 + O_2$
15) $Fe + 2\ CuNO_3 \rightarrow 2\ Cu + Fe(NO_3)_2$
16) $2\ C_8H_{18}(l) + 25\ O_2(g) \rightarrow 18\ H_2O + 16\ CO_2$
17) $Pb(NO_3)_2 + 2\ CsCl \rightarrow 2\ CsNO_3 + PbCl_2$
18) $2\ Na + CaF_2 \rightarrow Ca + 2\ NaF$
19) $2\ Fe + 3\ H_2SO_4 \rightarrow Fe_2(SO_4)_3 + 2\ H_2$
20) $CuCl_2 + NaOH \rightarrow Cu(OH)_2 + NaCl$

#3: Single Replacement Reactions

- In a single replacement reaction two elements replace one another. In most cases, the substances are a pure metal and a compound that is dissolved in water.

- <u>Sample Chemical Equations:</u>
  - $2\ Al_{(s)} + 3\ CuCl_{2(aq)} \rightarrow 3\ Cu_{(s)} + 2\ AlCl_{3(aq)}$
  - $Fe_{(s)} + \ CuSO_{4(aq)} \rightarrow Cu_{(s)} + FeSO_{4(aq)}$
  - $Fe_{(s)} + Pb(NO_3)_{2(aq)} \rightarrow Pb_{(s)} + \ Fe(NO_3)_{2(aq)}$



- <u>Generic Chemical Equation:</u>
  - **A + BC → B + AC**

- ***How to identify:*** *Look for a pure element and a compound in the reactants. In the products the pure element should have switched places with one of the elements in the compound.*

Practice Problems: Identifying Types of Reactions

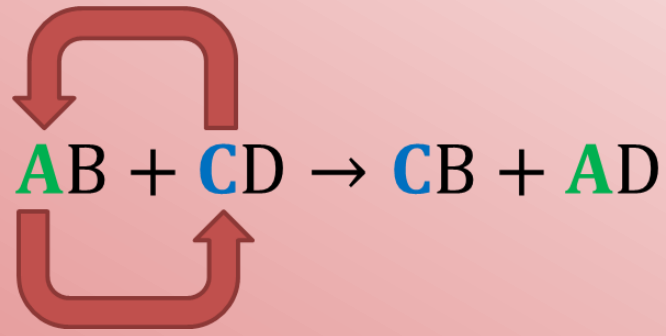
*Directions: Circle the **Single Replacement Reactions.***

1) $4\ Al + 3\ O_2 \rightarrow 2\ Al_2O_3$
2) $2\ H_2O_2(aq) \rightarrow 2\ H_2O(l) + O_2(g)$
3) $Na_2O + 2\ CO_2 + H_2O \rightarrow 2\ NaHCO_3$
4) $CaCl_2 + Rb_2SO_4 \rightarrow CaSO_4 + 2\ RbCl$
5) $Cl_2 + NaBr \rightarrow NaCl + Br_2$
6) $3\ Mg + N_2 \rightarrow Mg_3N_2$
7) $Cu + 2\ AgNO_3 \rightarrow 2\ Ag + Cu(NO_3)_2$
8) $C_7H_{16}(l) + 11\ O_2(g) \rightarrow 8\ H_2O + 7\ CO_2$
9) $N_2H_4O_3(s) \rightarrow N_2O(g) + 2\ H_2O(g)$
10) $F_2 + NaI \rightarrow NaF + I_2$
11) $2\ AgF + CaCl_2 \rightarrow 2\ AgCl + CaF_2$
12) $SeCl_6 + O_2 \rightarrow SeO_2 + 3\ Cl_2$
13) $3\ Ca + 2\ AlCl_3 \rightarrow 3\ CaCl_2 + 2\ Al$
14) $2\ Pb(NO_3)_2 \rightarrow 2\ PbO + 4\ NO_2 + O_2$
15) $Fe + 2\ CuNO_3 \rightarrow 2\ Cu + Fe(NO_3)_2$
16) $2\ C_8H_{18}(l) + 25\ O_2(g) \rightarrow 18\ H_2O + 16\ CO_2$
17) $Pb(NO_3)_2 + 2\ CsCl \rightarrow 2\ CsNO_3 + PbCl_2$
18) $2\ Na + CaF_2 \rightarrow Ca + 2\ NaF$
19) $2\ Fe + 3\ H_2SO_4 \rightarrow Fe_2(SO_4)_3 + 2\ H_2$
20) $CuCl_2 + NaOH \rightarrow Cu(OH)_2 + NaCl$

#4: Double Replacement Reactions

- In a **double replacement reaction**, two metals switch places. This almost always occurs when both reactants are in dissolved in water but not always.

- <u>Sample Chemical Equations (Solid Precipitation)</u>
  - $3\ CaCl_{2(aq)} + 2\ Na_3PO_{4(aq)} \rightarrow 6\ NaCl_{(aq)} + Ca_3(PO_4)_{2(s)}$
  - $2\ NaOH_{(aq)} + CuBr_{2(aq)} \rightarrow\ Cu(OH)_{2(s)} + 2\ \ NaBr_{(aq)}$
  - $Li_2CO_{3(aq)} + Mg(NO_3)_{2(aq)} \rightarrow MgCO_{3(s)} + 2\ LiNO_{3(aq)}$
  - $HCl_{(g)} + NaOH_{(aq)} \rightarrow H_2O + NaCl_{(aq)}$



- <u>Generic Chemical Equation</u>
  - **AB + CD → CB + AD**

- ***How to identify?***: *Look for two compounds in the reactants. The products should contain two compounds as well but two elements should have switched places.*

Practice Problems: Identifying Types of Reactions

*Directions: Circle the **Double Replacement Reactions.***

1) $4\ Al + 3\ O_2 \rightarrow 2\ Al_2O_3$
2) $2\ H_2O_2(aq) \rightarrow 2\ H_2O(l) + O_2(g)$
3) $Na_2O + 2\ CO_2 + H_2O \rightarrow 2\ NaHCO_3$
4) $CaCl_2 + Rb_2SO_4 \rightarrow CaSO_4 + 2\ RbCl$
5) $Cl_2 + NaBr \rightarrow NaCl + Br_2$
6) $3\ Mg + N_2 \rightarrow Mg_3N_2$
7) $Cu + 2\ AgNO_3 \rightarrow 2\ Ag + Cu(NO_3)_2$
8) $C_7H_{16}(l) + 11\ O_2(g) \rightarrow 8\ H_2O + 7\ CO_2$
9) $N_2H_4O_3(s) \rightarrow N_2O(g) + 2\ H_2O(g)$
10) $F_2 + NaI \rightarrow NaF + I_2$
11) $2\ AgF + CaCl_2 \rightarrow 2\ AgCl + CaF_2$
12) $SeCl_6 + O_2 \rightarrow SeO_2 + 3\ Cl_2$
13) $3\ Ca + 2\ AlCl_3 \rightarrow 3\ CaCl_2 + 2\ Al$
14) $2\ Pb(NO_3)_2 \rightarrow 2\ PbO + 4\ NO_2 + O_2$
15) $Fe + 2\ CuNO_3 \rightarrow 2\ Cu + Fe(NO_3)_2$
16) $2\ C_8H_{18}(l) + 25\ O_2(g) \rightarrow 18\ H_2O + 16\ CO_2$
17) $Pb(NO_3)_2 + 2\ CsCl \rightarrow 2\ CsNO_3 + PbCl_2$
18) $2\ Na + CaF_2 \rightarrow Ca + 2\ NaF$
19) $2\ Fe + 3\ H_2SO_4 \rightarrow Fe_2(SO_4)_3 + 2\ H_2$
20) $CuCl_2 + NaOH \rightarrow Cu(OH)_2 + NaCl$

#5: Combustion Reactions

- As you might have already realized, combustion reactions are when carbon compounds burn or explode.
- With one notable exception, which is the combustion of hydrogen gas, this produces carbon dioxide and water.
- Combustion reactions produce light and heat and occasionally you will see "heat" written as a product.

- <u>Sample Chemical Equations:</u>
  - $CH_4 + 2\ O_2 \rightarrow CO_2 + 2\ H_2O$
  - $2\ C_8H_{18} + 25\ O_2 \rightarrow 16\ CO_2 + 18\ H_2O$
  - $2\ C_2H_6O + 7\ O_2 \rightarrow 4\ CO_2 + 6\ H_2O$

- <u>Generic Chemical Equation:</u>
  - *Organic Compound* + $O_2 \rightarrow CO_2 + H_2O$

- ***How to identify:*** *Look for Carbon Dioxide and Water in the products. Oxygen should be a reactant.*

Practice Problems: Identifying Types of Reactions

*Directions: Circle the **Combustion Reactions.***

1) $4\ Al + 3\ O_2 \rightarrow 2\ Al_2O_3$
2) $2\ H_2O_2(aq) \rightarrow 2\ H_2O(l) + O_2(g)$
3) $Na_2O + 2\ CO_2 + H_2O \rightarrow 2\ NaHCO_3$
4) $CaCl_2 + Rb_2SO_4 \rightarrow CaSO_4 + 2\ RbCl$
5) $Cl_2 + NaBr \rightarrow NaCl + Br_2$
6) $3\ Mg + N_2 \rightarrow Mg_3N_2$
7) $Cu + 2\ AgNO_3 \rightarrow 2\ Ag + Cu(NO_3)_2$
8) $C_7H_{16}(l) + 11\ O_2(g) \rightarrow 8\ H_2O + 7\ CO_2$
9) $N_2H_4O_3(s) \rightarrow N_2O(g) + 2\ H_2O(g)$
10) $F_2 + NaI \rightarrow NaF + I_2$
11) $2\ AgF + CaCl_2 \rightarrow 2\ AgCl + CaF_2$
12) $SeCl_6 + O_2 \rightarrow SeO_2 + 3\ Cl_2$
13) $3\ Ca + 2\ AlCl_3 \rightarrow 3\ CaCl_2 + 2\ Al$
14) $2\ Pb(NO_3)_2 \rightarrow 2\ PbO + 4\ NO_2 + O_2$
15) $Fe + 2\ CuNO_3 \rightarrow 2\ Cu + Fe(NO_3)_2$
16) $2\ C_8H_{18}(l) + 25\ O_2(g) \rightarrow 18\ H_2O + 16\ CO_2$
17) $Pb(NO_3)_2 + 2\ CsCl \rightarrow 2\ CsNO_3 + PbCl_2$
18) $2\ Na + CaF_2 \rightarrow Ca + 2\ NaF$
19) $2\ Fe + 3\ H_2SO_4 \rightarrow Fe_2(SO_4)_3 + 2\ H_2$
20) $CuCl_2 + NaOH \rightarrow Cu(OH)_2 + NaCl$

Other Types of Reactions

- Not all reactions fit neatly into the five classifications listed previously. Here are some examples of those equations:
  - $Cu_2S + 12\ HNO_3 \rightarrow Cu(NO_3)_2 + CuSO_4 + 10\ NO_2 + 6\ H_2O$
  - $2\ K_2MnF_6 + 4\ SbF_5 \rightarrow 4\ KSbF_6 + 2\ MnF_3 + F_2$
- It's not in our objectives that your able to place every single chemical reaction into a specific category, just that you are able to clearly identify the five mentioned on the previous slides.
- There are also reactions that are in a "gray area" between two different classifications.
- Hydrogen gas, for example, will explode and produce nothing but water: $2\ H_2 + O_2 \rightarrow 2\ H_2O$
- This could be classified as combination. Even though carbon dioxide is not a product, it could also be classified as combustion because it produces a flame, has water as a product, and oxygen gas as a reactant.

Identifying Types of Chemical Reactions Summary

- **Combustion:** *Look for Carbon Dioxide and Water in the products. Oxygen should be a reactant.*
- **Single Replacement:** *Look for a pure element and a compound in the reactants. In the products the pure element should have switched places with one of the elements in the compound.*
- **Double Replacement**: *Look for two compounds in the reactants. The products should contain two compounds as well but two elements should have switched places.*
- **Decomposition:** *Look for 1 reactant and 2 or more Products*
- **Synthesis/Combination**: *Look for 1 product*

Section 1 Additional Resources & Links…

- Some Random Teacher's Video: "Parts of a Chemical Equation"
- Tyler Dewitt's Video on Types of Chemical Reactions

Section 2: Balancing Chemical Equations

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Section 2: Balancing Chemical Equations / Objectives

- Students Will Be Able too…
  - …*recite* the **law of conservation of mass** and *explain* how it applies to chemical equations."
  - …*balance* a chemical equation."

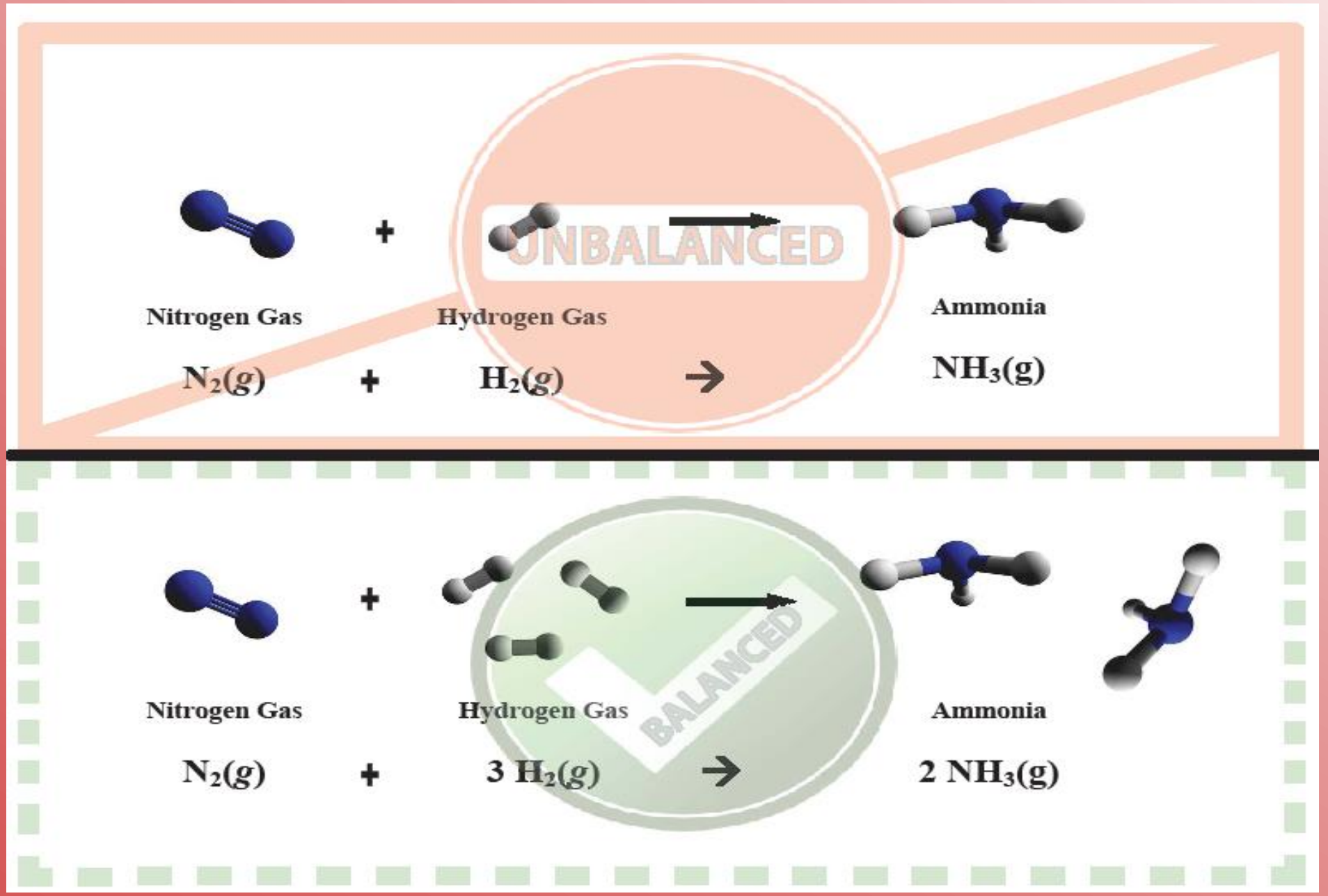
The Law of Conservation of Mass

- The **law of conservation of mass** states that in any type of change, matter cannot be created or destroyed. Another way of saying this is that the total amount of matter in the universe is constant.
- One of the things this means is that chemical equations must be balanced.
- A balanced chemical equation has the same number of atoms going into and out of the equation.
- If an equation is presented in it's unbalanced form, it can be balanced by inserting **coefficients** in front of the chemical formulas. If a chemical formula does not have a coefficient in front of it, the coefficient is 1.
- The coefficients technically represent the number of moles (A concept we will learn about in UNIT 4) but thinking of them as just the number of molecules makes things easier.
- When balancing, you must NEVER alter the chemical formulas. You can only change or add coefficients in front of the chemical formulas.

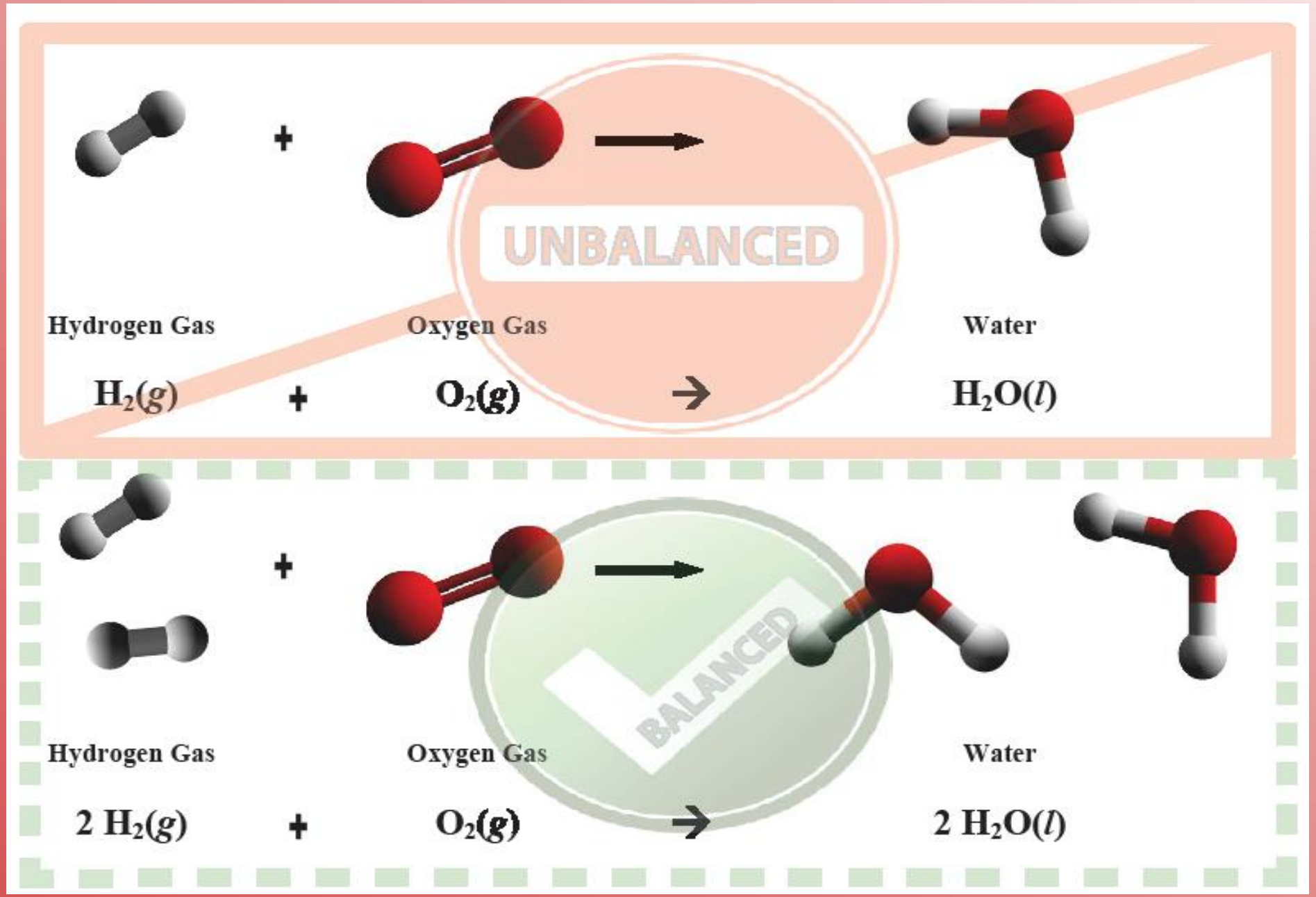
Video Time !!!

- TedED Video: “The Law of Conservation of Mass”

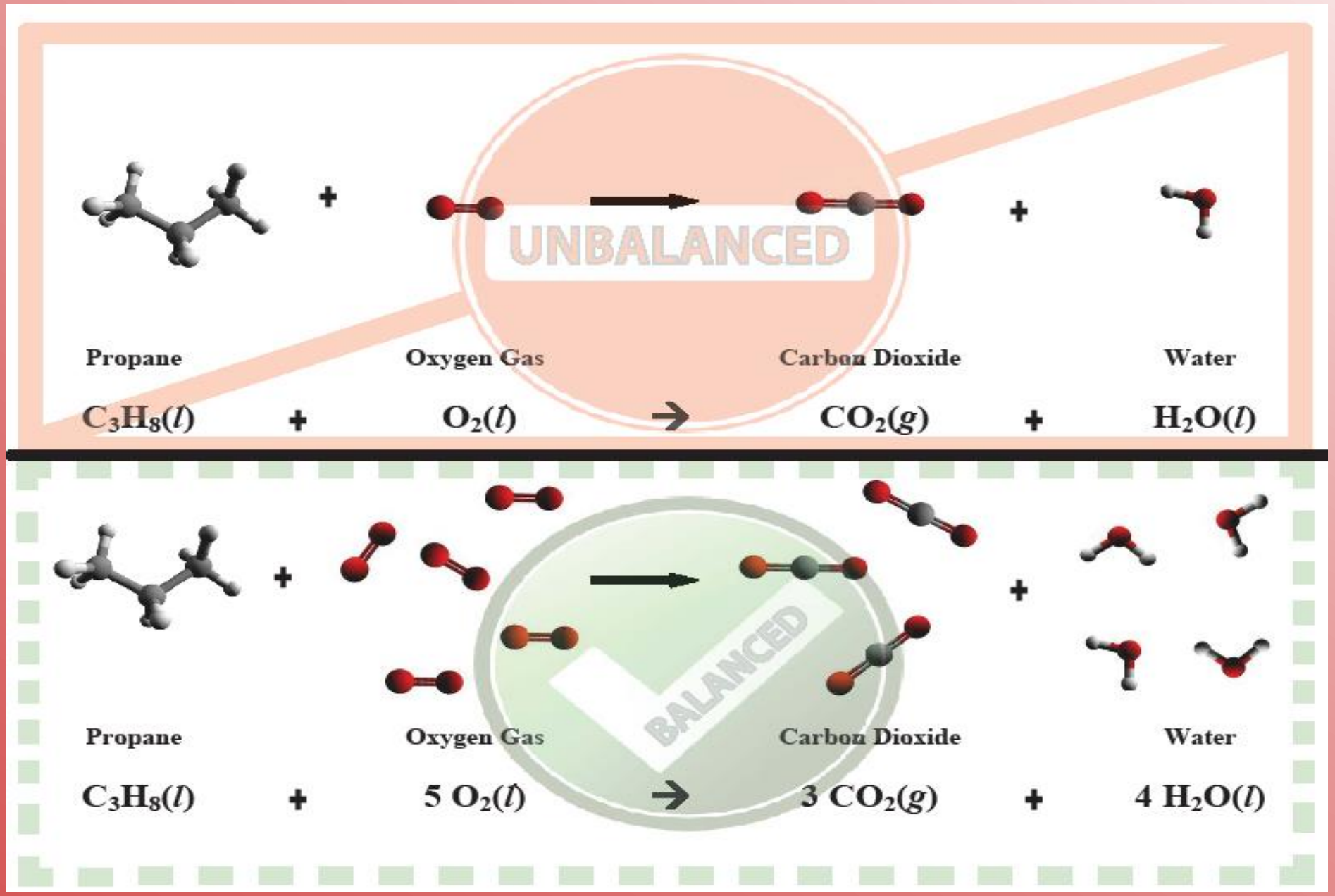
Examples of a Chemical Equation in it's Unbalanced and Balanced Forms (#1)



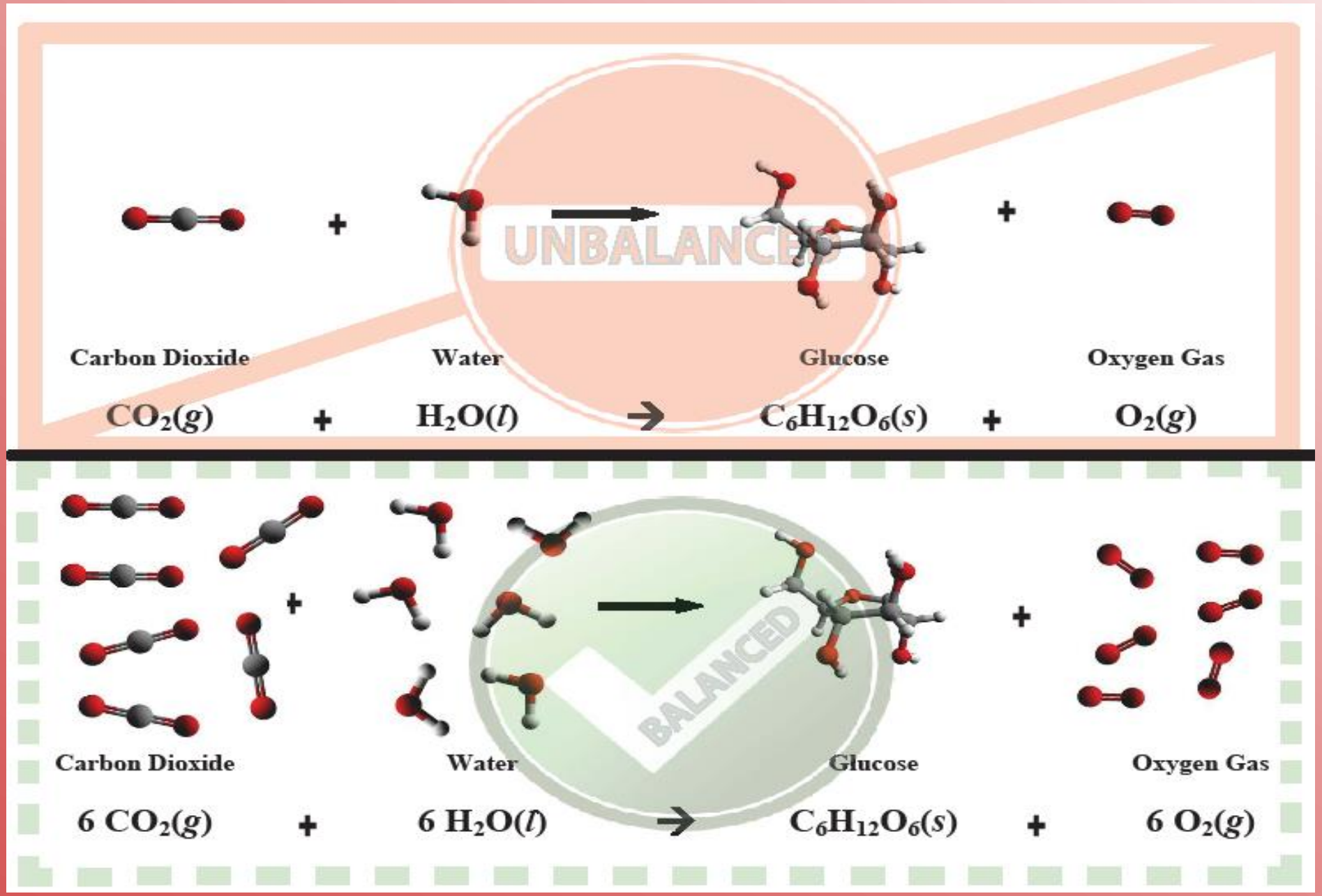
Examples of a Chemical Equation in it's Unbalanced and Balanced Forms (#2)



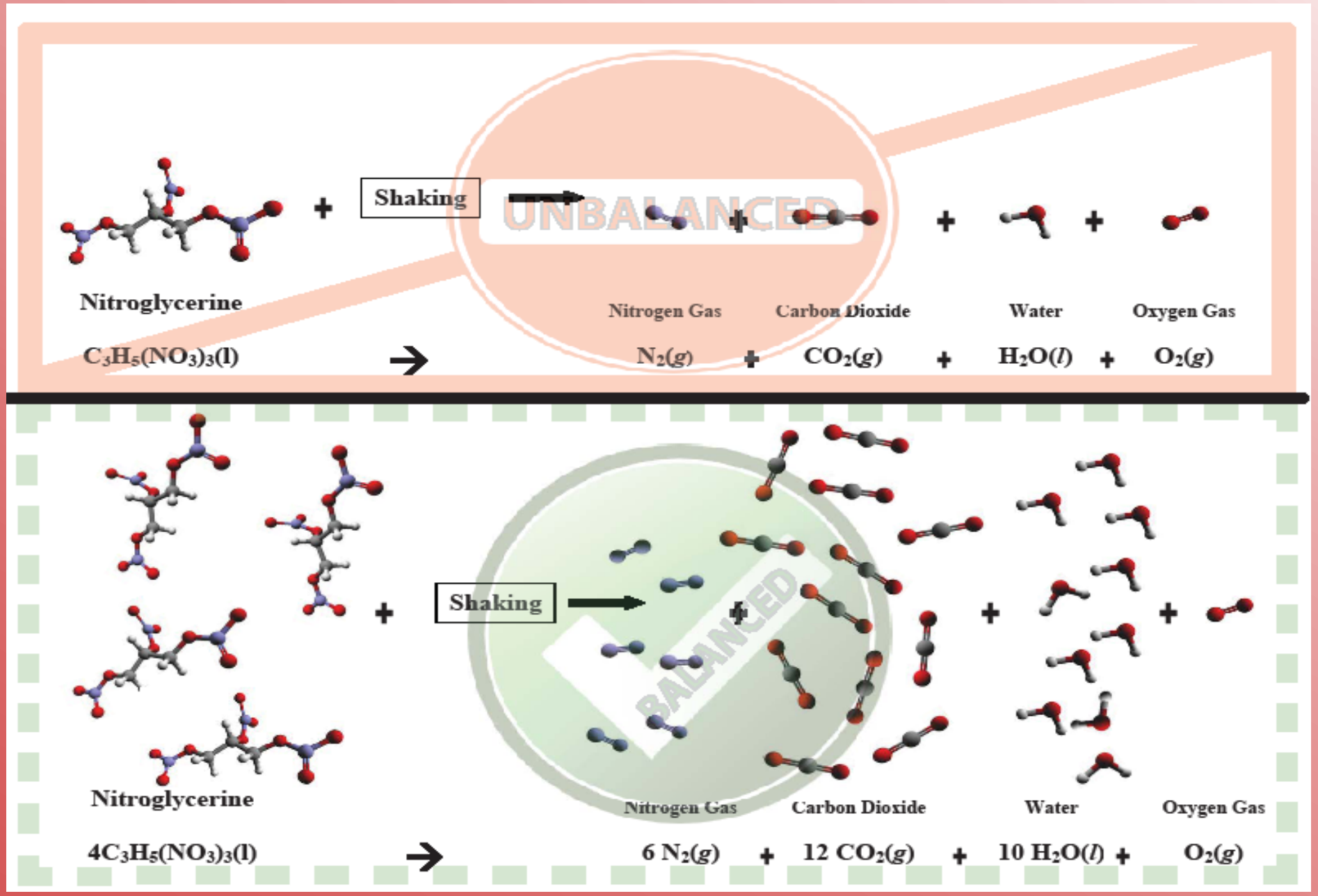
Examples of a Chemical Equation in it's Unbalanced and Balanced Forms (#3)



Examples of a Chemical Equation in it's Unbalanced and Balanced Forms (#4)



Examples of a Chemical Equation in it's Unbalanced and Balanced Forms (#5)



Balancing Equations Tips

1) Save oxygen for last
2) Only whole numbers are allowed, but if you end up with half a number, you can get yourself out of that situation by doubling ALL the coefficients in the equation. (if you end up with .25 you can get yourself out of that situation by quadrupling all coefficients)
3) Take your time. Balancing is a skill that takes practice but with enough patience an answer will be found.

Section 2 Additional Resources & Links…

- pHET simulator game on Balancing Equations
- WikiHow on balancing chemical equations.
- Khan Academy Video: "Balancing Chemical Equations."
- Tyler Dewitt's Video: "Introduction to Balancing Chemical Equations"
- Tyler Dewitt's Video: "Balancing Chemical Equations Practice Problems"

Section 3: Ions in Water

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Section 3: Ions in Water/ Objectives

- Students Will Be Able too…
  - …*describe* & *explain* the dissolving process for ionic compounds in water.”
  - …*write* chemical equations for ionic compounds dissolving in water.”
  - …*write* equations for acids (strong only) and bases (strong only) dissolving in water.
  - …*explain* neutralization & *write* the equation for an acid base neutralization when given a strong acid and a strong base.

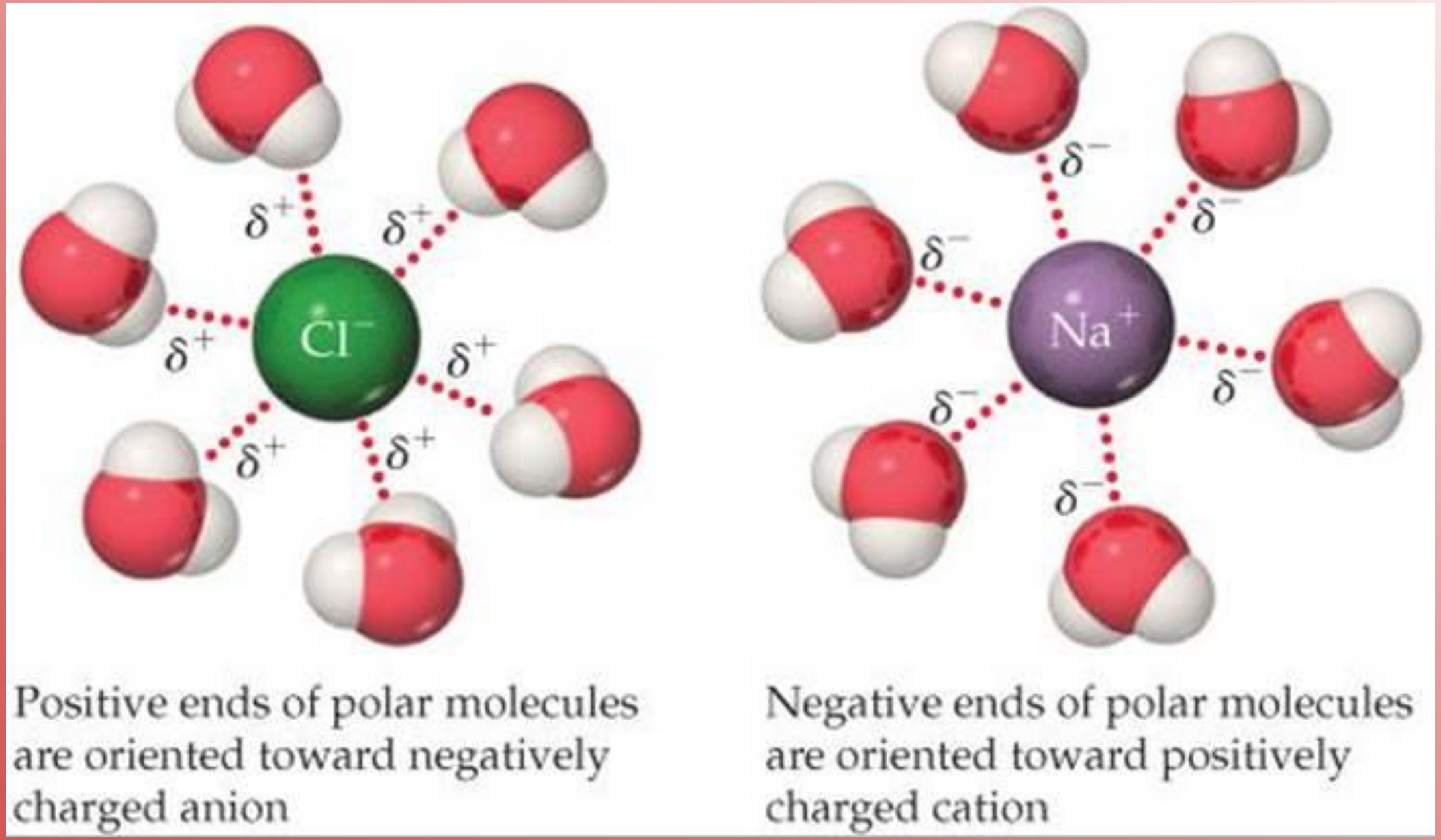
Ion-Dipole Interactions & The Dissolving Process

- Note that even though it takes very high temperatures to separate NaCl Units from one another, Salt and most other ionic compounds easily dissolve in water. In other words, it take tremendous heat to break apart the crystal lattice of table salt and get it to melt, but the crystal lattice can just as easily be broken apart by simply placing the table salt in some water.
- This is because the positive Ion in the compound is attracted to the negative dipole of the water molecule, and the negative ion is attracted to the positive dipole.
- The dissolving process can be modeled using chemical equations:
  - $NaCl(s) \rightarrow Na^{+}(aq) + Cl^{-}(aq)$
  - $CaCl_2(s) \rightarrow Ca^{2+}(aq) + 2\ Cl^{-}(aq)$
  - $Na_3PO_4(s) \rightarrow 3\ Na^{+}(aq) + PO_4^{3-}(aq)$
- Substances that form ions in solutions are called **electrolytes** because the ions help water to conduct electricity.
- Many molecular compounds that dissolve in water like sugar and alcohol are not electrolytes and do not form ions in water. We won't worry about the equations for these substances right now.
- There is rule set "solubility rules" for determining if an ionic compound will dissolve or not, but we will save that topic for chem B.

Video Time !!!

- McGraw Hill Video: "NaCl Dissolving in Water"
- CCC #27 Video: "Solutions"
  - *Note: Mass Percent, & Henry's Law are not apart of our learning objectives*

Images Depicting Ion-Dipole Interactions & The Dissolving Process



Positive ends of polar molecules are oriented toward negatively charged anion

Negative ends of polar molecules are oriented toward positively charged cation

Practice Problems: Ionic Compounds Dissolving in Water

Directions: Write the Equation for the following Ionic Compounds dissolving in water. Be Sure to include physical states and correct coefficients.

1) $LiBr$

2) Na_2CO_3

3) $FeCl_3$

4) $Ba(NO_3)_2$

5) $NiBr_3$

6) $Ti(NO_3)_4$

7) K_2SO_4

8) MgI_2

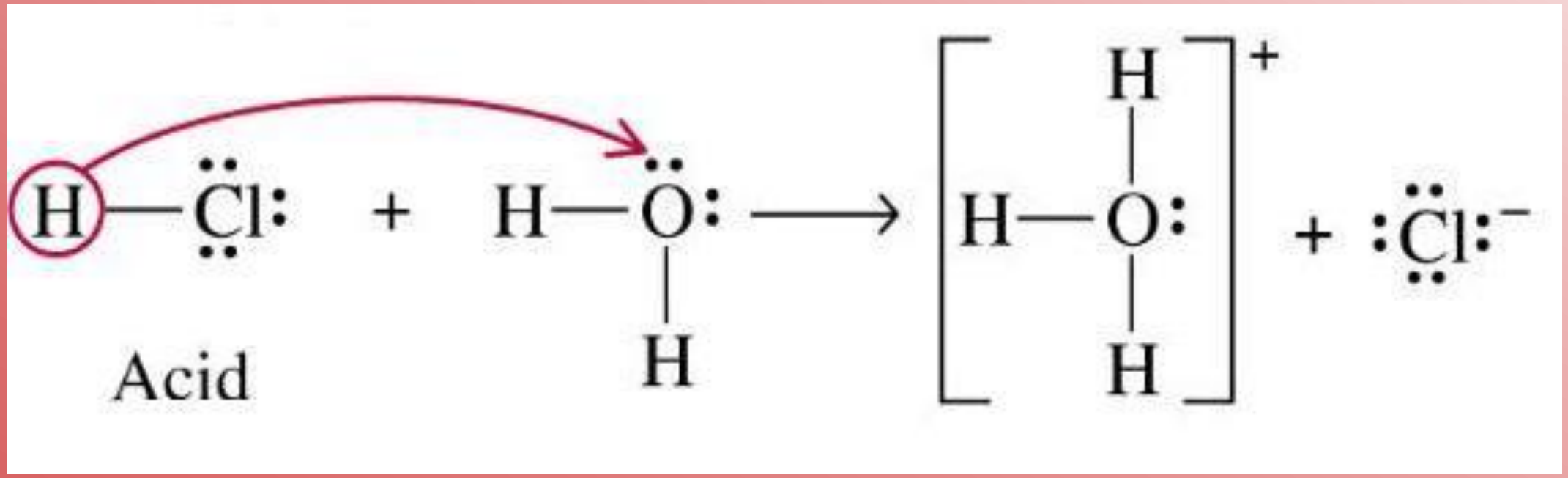
Intro to Acids & Bases

- When we are talking about Acids & Bases we are talking about aqueous solutions.
- Substances can technically behave as an acid or base outside of water. However, for the most part acids and bases involve substances dissolved in water so that is where we will focus our study.
- Just like Ionic compounds (some bases are ionic compounds), acids and bases form ions when dissolved in water (meaning they are electrolytes).
- Acids & Bases always form the same ion.
- For acids, the Ion formed is always **H^+**
  - Side Note, that H^+ ion in turns reacts with a water molecule to form H_3O^+, so H_3O^+ and H^+ can be used interchangeably when discussing acids.

$$H^+ + H_2O \rightarrow H_3O^+$$

- For bases, the Ion formed is always **OH^-**

Image Showing How The H^+ Ion Attaches To a Water Molecule



Acid & Base Definitions

- There are three different definitions for acids & bases and these definitions often overlap. We are only going to worry about one of them and you don't need to remember the dude's names that came up with these definitions.
- An **Acid** is a substance that…
  - Produces H^+ / H_3O^+ when dissolved in water
- A **Base** is a substance that…
  - Produces OH^- when dissolved in water

Video Time !!!

- Fuse School Video: "What is the Bronsted-Lowry Theory?"
- CCC #8 Video: "Acid Base Reactions in Solution"
  - *Note: conjugate acids and bases are not in our objectives*

Examples of Acids & Bases Dissolving in Water

- Examples of Acids. (Notice how they "donate" or give up H^+ ions.)
  - $HCl(g) \rightarrow H^+(aq) + Cl^-(aq)$
    - or $HCl(g) + H_2O \rightarrow H_3O^+(aq) + Cl^-(aq)$
  - $HNO_3(l) \rightarrow H^+(aq) + NO_3^-(aq)$
    - or $HNO_3(l) + H_2O \rightarrow H_3O^+(aq) + NO_3^-(aq)$
  - $HBr(g) \rightarrow H^+(aq) + Br^-(aq)$
    - or $HBr(g) + H_2O \rightarrow H_3O^+(aq) + Br^-(aq)$
- Examples of Bases. (Notice how they give off OH- ions.)
  - $NaOH(s) \rightarrow Na^+(aq) + OH^-(aq)$
  - $KOH(s) \rightarrow K^+(aq) + OH^-(aq)$
- Note that as mentioned previously, acids and bases are both electrolytes because they produce ions in water. The bases in these examples are in fact ionic compounds and the equations are no different that what we looked at previously

Examples of Acids & Bases Dissolving in Water

- Examples of Acids. (Notice how they "donate" or give up H^+ ions.)
  - $HCl(g) \rightarrow H^+(aq) + Cl^-(aq)$
    - or $HCl(g) + H_2O \rightarrow H_3O^+(aq) + Cl^-(aq)$
  - $HNO_3(l) \rightarrow H^+(aq) + NO_3^-(aq)$
    - or $HNO_3(l) + H_2O \rightarrow H_3O^+(aq) + NO_3^-(aq)$
  - $HBr(g) \rightarrow H^+(aq) + Br^-(aq)$
    - or $HBr(g) + H_2O \rightarrow H_3O^+(aq) + Br^-(aq)$
- Examples of Bases. (Notice how they give off OH- ions.)
  - $NaOH(s) \rightarrow Na^+(aq) + OH^-(aq)$
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- Note that as mentioned previously, acids and bases are both electrolytes because they produce ions in water. The bases in these examples are in fact ionic compounds and the equations are no different that what we looked at previously

Practice Problems: Writing Equations for Acids & Bases Dissolving in Water

Directions: Write the Equation for the following Acids & Bases dissolving in water.

1) HI

2) $HClO_4$

3) HBr

1) $Ba(OH)_2$

2) LiOH

3) NaOH

Acids & Base Neutralization

- When you mix an acid and a base together, they **neutralize** each other forming water.

$$H^+(aq) + OH^-(aq) \rightarrow H_2O$$

- Some sample equations involving strong acids and strong bases are below. Notice that a short hand equation can be used by placing *(aq)* next to the acid and the base. Whenever this is done, you must remember than an acid or base when dissolved in water is in fact ionized. This ionization is shown using the "complete" equation.

<u>Short hand equation:</u>

$$NaOH(aq) + HCl(aq) \rightarrow H_2O + NaCl(aq)$$

<u>More accurate or "complete" equation:</u>

$$Na^+(aq) + OH^-(aq) + H^+(aq) + Cl^-(aq) \rightarrow H_2O + Na^+(aq) + Cl^-(aq)$$

<u>Short hand equation:</u>

$$KOH(aq) + HNO_3(aq) \rightarrow H_2O + KNO_3(aq)$$

<u>More accurately or "complete" equation:</u>

$$K^+(aq) + OH^-(aq)\ H^+(aq) + NO_3^-(aq) \rightarrow H_2O + K^+(aq) + NO_3^-(aq)$$

Practice Problems: Writing Equations for Acids & Bases Dissolving in Water

Directions: complete the following acid-base neutralization using shorthand or simple. Then write the complete equation.

1) $RbOH(aq) + HBr(aq) \rightarrow$

2) $HCl(aq) + LiOH(aq) \rightarrow$

3) $\rightarrow H_2O + CsNO_3(aq)$

4) $+ HClO_4(aq) \rightarrow + KClO_4(aq)$

5) $Mg(OH)_2(aq) + HI(aq) \rightarrow$

Section 3 Additional Resources & Links…

- Khan Academy Video: Acid-Base Definitions