Biology Magnets Module 14: Chemical Reactions – Teacher and Student Guides

Teacher Information

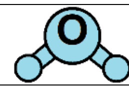
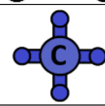
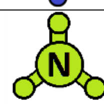
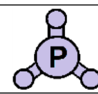
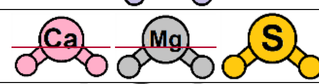
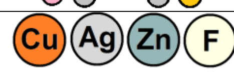
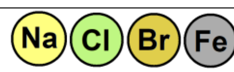
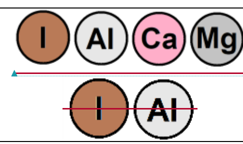
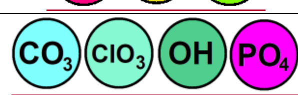
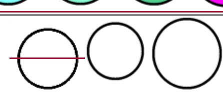
This module uses magnets designed for teacher and student interaction to guide learning types of chemical reactions. Contained in this guide are different lesson ideas that can last from 10 minutes each to an entire class period, depending upon teacher preference. Each lesson has both teacher-centered and student-centered activities. The student-centered activities are most effective if students are in small groups. It may be necessary to have multiple magnet sets for large classes. A student handout is provided which can be printed out and given to each student group to help guide their progress as they work with the magnets. If budget or white board space is limited, groups can alternate between using a set of magnets and doing other activities. Teachers can refer to the videos posted at the Biology Magnet web site at Biologymagnets.com for guided teaching instructions.

Magnet Care and Maintenance

Biology magnets are made to last for years. Periodically magnets will fall off or are knocked off the plastic. A piece of magnetic tape is included with each module, which should be able to replace around 10-12 magnets if necessary. Simply cut a new magnet and peel off the back to replace. Magnetic tape can also be purchased from a hobby store to replace magnets lost over time. Laminate may peel off, especially on small pieces. Use transparent tape to re-attach laminate that comes loose, curling the tape over the back of the magnet. The machines used to cut Biology Magnets are not always perfectly accurate. Sometimes a bit of white or black outline on the edges occurs or a cut might be slightly off center. Use scissors to remove extra outline that is unnecessary if desired. Store magnets in the clasp envelopes in which they arrived for easy organization.

Types of Chemical Reactions Copyright and Licensing Information

Biology Magnets Module 14 Materials List

Magnet Name	Quantity	Picture
Hydrogen Atom	~~8~~15	
Oxygen Atom	4	
Carbon Atom	2	
Nitrogen Atom	2	
Phosphorus Atom	2	
~~Calcium, Magnesium,~~ Sulfur Atom~~s~~	2 ~~each~~	
Copper, Siver, Zinc, Fluorine Atoms	2 each	
Sodium, Chlorine, Bromine, Iron Atoms	2 each	
Iodine, ~~and~~ Aluminum, Calcium, Magnesium Atoms	2 each	
Potassium, Lead, Boron Atoms	2 each	
Nitrate, Sulfate, Ammonium Polyatomic Ions	2 each	
Phosphate, Carbonate, Hydroxide, Chlorate Polyatomic Ions	2 each	
Blank Variable Atom and Groups (Use dry erase marker to make any atom or group)	~~4~~9	
3" Magnetic Tape Strip	1	
Total Quantity	**~~49~~81**	

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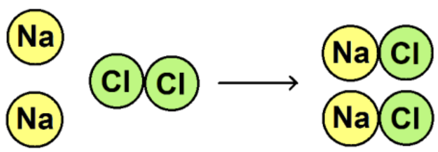
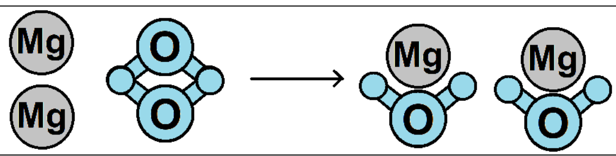
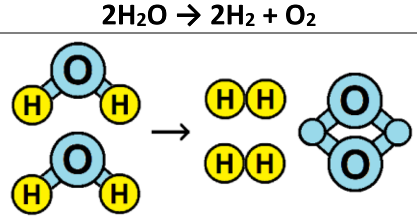
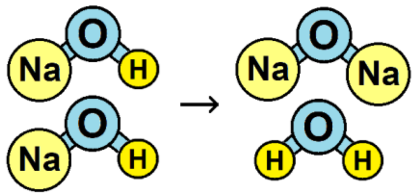
Lesson 14 – Types of Chemical Reactions (10-100 minutes)

Teacher Centered Activity (10-20 minutes): This lesson utilizes the magnets to demonstrate the various types of chemical reactions. The first type are synthesis reactions. These reactions use the general formula A + B -> AB. Two examples of synthesis reactions using the magnets are shown below. Manipulate the magnets starting with the configuration on the left side of the arrow and ending with the configuration on the right side of the arrow to show how the molecules come together. (**Figure 14.1).**

Figure 14.1: Synthesis Reactions
$2Na + Cl_2 \rightarrow 2NaCl$

$2Mg + O_2 \rightarrow 2MgO$


The next type of reaction are decomposition reactions. These reactions use the general formula AB -> A + B . Two examples of decomposition reactions using the magnets are shown below (**Figure 14.2)**.

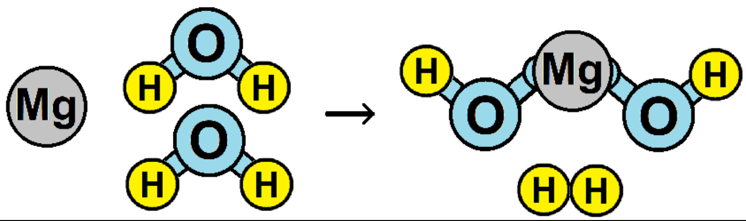
Figure 14.2: Decomposition Reactions
$2H_2O \rightarrow 2H_2 + O_2$

$2NaOH \rightarrow Na_2O + H_2O$



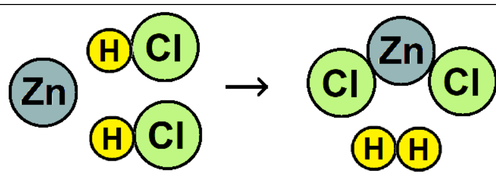
Single replacement reaction have the general formula A + BC → B + AC . Two examples of single replacement reactions using the magnets are shown below (**Figure 14.3**).

Figure 14.3: Single Replacement Reactions

$Mg + 2H_2O \rightarrow Mg(OH)_2 + H_2$



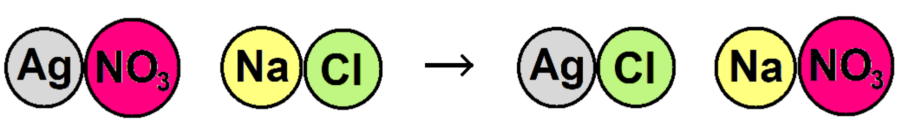
$Zn + 2HCl \rightarrow ZnCl_2 + H_2$



Double replacement reactions have the general formula AB + CD → AD + CB. Two examples of double replacement reactions using the magnets are shown below. It may be helpful to use a dry erase marker to write "+" and "-" signs on the magnets to distinguish ionic charges in these reactions (**Figure 14.4)**.

Figure 14.4: Double Replacement Reactions

$AgNO_3 + NaCl \rightarrow AgCl + NaNO_3$



~~Zn + 2HCl~~$Na_2S + 2HCl \rightarrow 2NaCl$ ~~$ZnCl_2$~~ + H_2S ~~H_2~~

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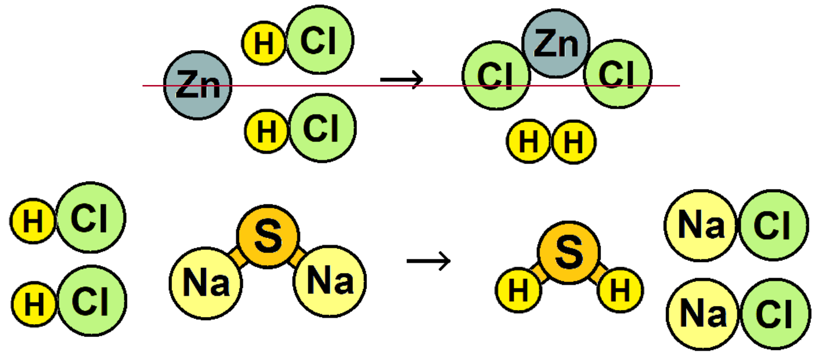
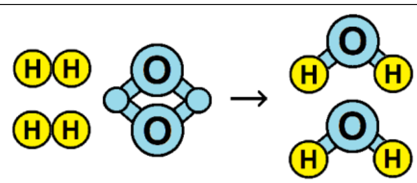


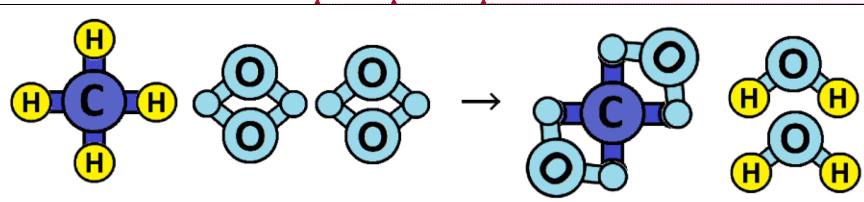
Combustion reactions involve a compound reactiong with oxygen or an oxidant to produce heat and a new product. Often hydrocarbons are involved in combustion reactions and carbon dioxide and water are products, but this is not always the case. Two examples of combustion reactions are shown below (**Figure 14.5)**.

Figure 14.5: Combustion Reactions

$2H_2 + O_2 \rightarrow 2H_2O$



$CH_4 + 2O_2 \rightarrow CO_2 + 2H_2O$



Student Centered Activity (10-30 minutes): After teaching the various types of reactions, put students into small groups. A copy of the student guide for the lesson may be given to each group if necessary. Have the students model the various types of chemical reactions when given the reactants. For higher level students, have the students model the types of reactions without giving them the reactants in advance. Allow the students to correct and help one another. Students can demonstrate for the teacher when they are ready.

Extra exercises:

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Additional reactions: Have the students model other reactions as shown in the equations below using the magnets. Students can be given the entire equation to model, or just the reactants and have to figure out the products. Blank atoms are provided for use with dry erase markers to produce extra atoms or atoms not included in the kit.

- **Synthesis**: $2Fe + O_2 \rightarrow 2FeO$; $C + O_2 \rightarrow CO_2$; $2C + O_2 \rightarrow 2CO$; $2K + I_2 \rightarrow 2KI$; $SO_2 + H_2O \rightarrow H_2SO_3$
- **Decomposition**: $CaCO_3 \rightarrow CaO + CO_2$; $H_2CO_3 \rightarrow CO_2 + H_2O$; $H_2SO_4 \rightarrow SO_3 + H_2O$
- **Single Replacement**: $2Na + 2H_2O \rightarrow 2NaOH + H_2$; $Mg + 2HCl \rightarrow H_2 + MgCl_2$; $F_2 + 2NaCl \rightarrow 2NaF + Cl_2$
- **Double Replacement**: $FeS + 2HCl \rightarrow H_2S + FeCl_2$; $HCl + NaOH \rightarrow NaCl + H_2O$
- **Combustion:** $2CH_3OH + 3O_2 \rightarrow 2CO_2 + 4H_2O$ (requires 4 blank magnets as extra oxygen atoms)

Balancing equations: Give students the- equations above unbalanced and have them use magnets to add additional reactants and products to be able to form balanced products. For example, $Fe + O_2 \rightarrow FeO$. When students break up the O_2 they will realize that another Fe is needed to form FeO, thus it should be 2Fe as one of the reactants.

Ionic Charges and ionic equations: Use dry erase markers to denote the ionic charges on the various elements in the reactions to demonstrate ionic and net ionic equations. For example, consider the equations below and refer to the figure showing the magnets **(figure 14.6).**

Consider the following molecular equation:

$Pb(NO_3)_2$ (aq) + 2KI (aq) → PbI_2 (s) + $2KNO_3$ (aq)

For this, the ionic equation is:

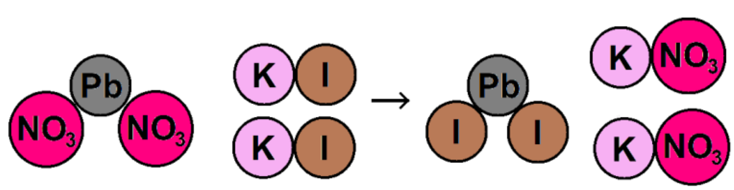
Pb^{2+} (aq) + $2(NO_3)^-$ (aq) + 2 K^+ (aq) + $2I^-$(aq) → PbI_2 (s) + $2K^+$ (aq) + $2(NO_3)^-$ (aq)

Use a dry erase marker to write the ionic charges on the various atoms or groups as shown in the diagram. Remove the spectator ions to produce the net ionic equation, which is:

Pb^{2+} (aq) + $2I^-$(aq) → PbI_2 (s)

Figure 14.6: Molecular, Ionic and Net Ionic Equations

Molecular Equation: $Pb(NO_3)_2$ (aq) + 2KI (aq) → PbI_2 (s) + $2KNO_3$ (aq)



Ionic Equation: Pb^{2+} (aq) + $2(NO_3)^-$ (aq) + 2 K^+ (aq) + $2I^-$(aq) → PbI_2 (s) + $2K^+$ (aq) + $2(NO_3)^-$ (aq)

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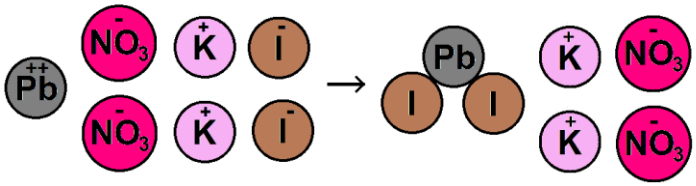
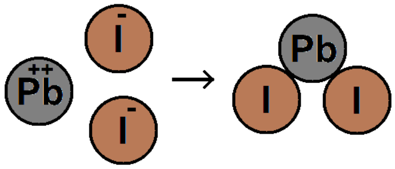
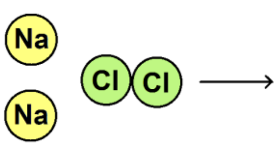
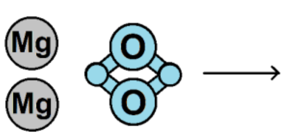
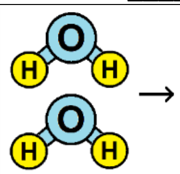
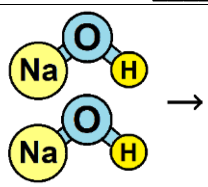

Net Ionic Equation: Pb^{2+} (aq) + $2I^{-}$(aq) → PbI_2 (s)


Lesson 14 – Types of Chemical Reactions – Student Handout

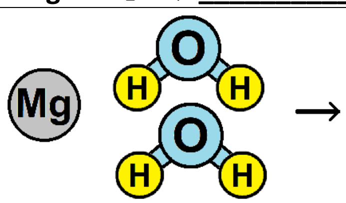
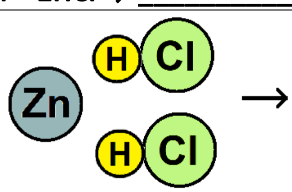
This lesson utilizes the magnets to demonstrate the various types of chemical reactions. The first type are synthesis reactions. These reactions use the general formula A + B -> AB. Two examples of synthesis reactions using the magnets are shown below. Manipulate the magnets starting with the reactants on the left side of the arrow and determine the products on the right side of the arrow to complete the reaction. Show your teacher the completed reaction and write the chemical formulas in the space (**Figure 14.1).**

Figure 14.1: Synthesis Reactions
$2Na + Cl_2 \rightarrow$ ______________________

$2Mg + O_2 \rightarrow$ ______________________


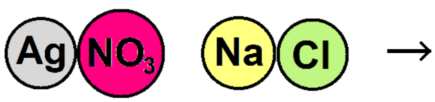
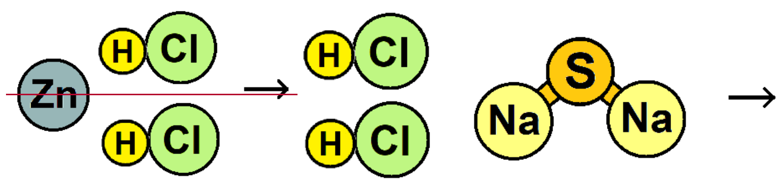
The next type of reaction are decomposition reactions. These reactions use the general formula AB -> A + B . Two examples of decomposition reactions using the magnets are shown below Manipulate the magnets starting with the reactants on the left side of the arrow and determine the products on the right side of the arrow to complete the reaction. Show your teacher the completed reaction and write the chemical formulas in the space (**Figure 14.2)**.

Figure 14.2: Decomposition Reactions
$2H_2O$ → ______________________

2NaOH → ______________________


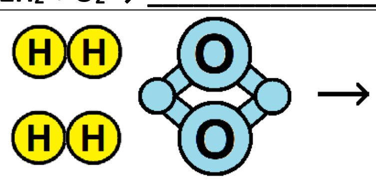
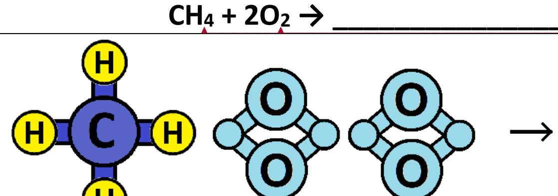
Single replacement reaction have the general formula A + BC → B + AC . Two examples of single replacement reactions using the magnets are shown below. Manipulate the magnets starting with the reactants on the left side of the arrow and determine the products on the right side of the arrow to complete the reaction. Show your teacher the completed reaction and write the chemical formulas in the space. (**Figure 14.3)**.

Figure 14.3: Single Replacement Reactions
Mg + $2H_2O$ → ______________________

Zn + 2HCl → ______________________


Double replacement reactions have the general formula AB + CD → AD + CB. Two examples of double replacement reactions using the magnets are shown below. Manipulate the magnets starting with the reactants on the left side of the arrow and determine the products on the right side of the arrow to complete the reaction. Show your teacher the completed reaction and write the chemical formulas in the space. (**Figure 14.4)**.

Figure 14.4: Double Replacement Reactions
$AgNO_3$ + NaCl → ____________________

Na_2S + 2HCl ~~Zn + 2HCl~~ → ____________________


Combustion reactions involve a compound reactiong with oxygen or an oxidant to produce heat and a new product. Often hydrocarbons are involved in combustion reactions and carbon dioxide and water are products, but this is not always the case. Two examples of combustion reactions are shown below. Manipulate the magnets starting with the reactants on the left side of the arrow and determine the products on the right side of the arrow to complete the reaction. Show your teacher the completed reaction and write the chemical formulas in the space. (**Figure 14.5)**.

Figure 14.5: Combustion Reactions
$2H_2$ + O_2 → ____________________

CH_4 + $2O_2$ → ____________________


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Student Centered Activity (10-30 minutes): After teaching the various types of reactions, put students into small groups. A copy of the student guide for the lesson may be given to each group if necessary. Have the students model the various types of chemical reactions when given the reactants. For higher level students, have the students model the types of reactions without giving them the reactants in advance. Allow the students to correct and help one another. Students can demonstrate for the teacher when they are ready.

Extra exercises:

Additional reactions: Model the following other reactions as shown in the equations below using the magnets. Make sure the equations are balanced.

- **Synthesis**: $2Fe + O_2 \rightarrow$ _______; $C + O_2 \rightarrow$ _______; $2C + O_2 \rightarrow$ _______; $2K + I_2 \rightarrow$ _______; $SO_2 + H_2O \rightarrow$ _______
- **Decomposition**: $CaCO_3 \rightarrow$ _______; $H_2CO_3 \rightarrow$ _______; $H_2SO_4 \rightarrow$ _______
- **Single Replacement**: $2Na + 2H_2O \rightarrow$ _______; $Mg + 2HCl \rightarrow$ _______; $F_2 + 2NaCl \rightarrow$ _______
- **Double Replacement**: $FeS + 2HCl \rightarrow$ _______; $HCl + NaOH \rightarrow$ _______
- **Combustion:** $2CH_3OH + 3O_2 \rightarrow$ _______(requires 4 blank magnets as extra oxygen atoms)

Ionic Charges and ionic equations: Use dry erase markers to denote the ionic charges on the various elements in the reactions to demonstrate ionic and net ionic equations. For example, consider the equations below and use the magnets to model the ionic and net ionic equations **(figure 14.6).**

Consider the following molecular equation:

$Pb(NO_3)_2$ (aq) + 2KI (aq) → __________________

For this, the ionic equation is:

Pb^{2+} (aq) + $2(NO_3)^-$ (aq) + 2 K^+ (aq) + $2I^-$(aq) → __________________

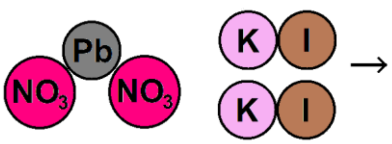
Use a dry erase marker to write the charges on the various atoms or groups.

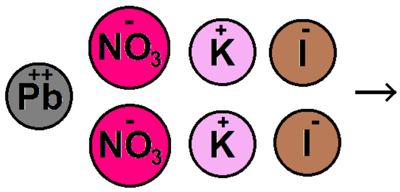
Remove the spectator ions to produce the net ionic equation, which is:

___________________ ~~Pb^{2+} (aq) + $2I^-$(aq)~~ → __________________

Figure 14.6: Molecular, Ionic and Net Ionic Equations

$Pb(NO_3)_2$ (aq) + 2KI (aq) → ____________________



Ionic Equation: Pb^{2+} (aq) + $2(NO_3)^-$ (aq) + 2 K^+ (aq) + $2I^-$(aq) → ______________________

Net Ionic Equation: ______________________ → ______________________

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