Making and Breaking Compounds

Type of Lesson:	Content with Process: Focus on constructing knowledge through active learning.	
IPC Content TEKS:	7E 8A 8B 8E	Classify samples of matter as being elements, compounds or mixtures. Distinguish between physical and chemical reactions Analyze energy changes that accompany chemical reactions and classify them as exergonic or endergonic reactions. Describe the environmental and economic impact of the end products of chemical reactions.
Learning Goal/ Instructional Goal:	In this investigation, students learn that elements lose their old properties when they combine to form a compound with new properties. Also, when a compound breaks up, it loses its old properties as it forms elements with properties that are different than the original compound. **Instructional Objectives:** • Given the element Magnesium, students are able to make observations before and after burning the elements and are able to observe that elements lose their properties as they combine to form the compound Magnesium oxide with new properties. • Given the compound Hydrogen peroxide, students are able to make observations before and after adding the catalyst manganese dioxide. They are able to observe that the end products (water plus the element oxygen) have new properties that are not the same as the properties of the original compound.	
Key Question:	1. What happens to the properties of the elements when a compound is made? 2. What happens to the properties of a compound when it breaks up?	
Related Process TEKS:	**(1) Scientific processes.** The student, for at least 40% of instructional time, conducts field and laboratory investigations using safe, environmentally appropriate, and ethical practices	The student is expected to: (A) demonstrate safe practices during field and laboratory investigations; and (B) make wise choices in the use and conservation of resources and the disposal or recycling of materials.
	(2) Scientific processes. The student uses scientific methods during field and laboratory investigations.	The student is expected to: (A) plan and implement experimental procedures including asking questions, formulating testable hypotheses, and selecting equipment and technology; (B) collect data and make measurements with precision; (C) organize, analyze, evaluate, make inferences, and predict trends from data; and (D) communicate valid conclusions.
	(3) Scientific processes. The student uses critical thinking and scientific	The student is expected to: (A) analyze, review, and critique scientific explanations, including hypotheses and theories, as to their strengths and weaknesses using scientific evidence

	problem solving to make informed decisions.	and information; (B) draw inferences based on data related to promotional materials for products and services; (C) evaluate the impact of research on scientific thought, society, and the environment; (D) describe connections between physics and chemistry and future careers; and (E) Research and describe the history of physics, chemistry, and contributions of scientists.
To the Teacher:	Magnesium is an element. When it is heated, it quickly combines with the element oxygen to form the new compound magnesium oxide. Magnesium is silver colored and is malleable. The end product is white and very powdery. Element lose their properties to form a new compound with new properties. Hydrogen peroxide is a compound made up of the elements hydrogen peroxide. It will break down on its own to form oxygen gas and water, but a catalyst will speed up the reaction. The catalyst such as manganese dioxide or liver will speed up the reaction but the catalyst can be used over and over again. Students will see new properties as the oxygen produced causes a glowing splint to go up on fire. Hydrogen peroxide can be purchased at local stores. Magnesium must be ordered through a chemical catalog. It comes in rolls and one roll will last a long time. Manganese dioxide can also be purchased through a chemical catalog. A substitution for manganese dioxide can be fresh liver from the meat center at the local grocery store. When students heat the magnesium (a 3 cm piece), tell them to hold the magnesium in the tongs at the end of the piece. The magnesium must be held in the hottest part of the flame and will glow with a very bright light. Stress that students should turn away and look at the light from the side of their eye so that the full light will not directly hit their eyes. If the students stare at the light directly, it could cause a "temporary loss of sight" as retina fatigue occurs and scare the student. Sparks could also hit their faces so goggles and aprons are required to protect their eyes and clothes. One small spoonful of manganese dioxide will start the break-up of hydrogen peroxide into water and oxygen. The oxygen escapes quickly so students must do the glowing splint test immediately. Loosely covering the top of the bottle will gold the gas in the bottle for a longer period of time. Make sure that the rubber stopper is larger than the opening of the bottle so that students cannot tightly stopper the bottle. If the stopper can fit into the opening, this could cause the bottle to shatter or the stopper to fly off at high speed. Discuss clean-up of end-products with students. The manganese dioxide does not dissolve in water so clean-up will be hard unless scrub brushes are used. The magnesium dioxide should be disposed of properly when cool. All end-products can be touched and thrown away. Remind students that chemical reactions can "create" end-products that are dangerous. Chemists always research how and where to dispose of all end-products of chemical reactions.	
Multiple Intelligences:	*Logical-Mathematical Intelligence—*	Consists of the ability to detect patterns, reason deductively and think logically. This intelligence is most often associated with scientific and mathematical thinking.
	Linguistic Intelligence—	Involves having a mastery of language. This intelligence includes the ability to effectively manipulate language to express oneself rhetorically or poetically. It also allows one to use language as a means to remember information.
	Spatial Intelligence—	Gives one the ability to manipulate and create mental images in order to solve problems. This intelligence is not limited to visual domains--Gardner notes that spatial intelligence is also formed in blind children.

Materials:

- a small piece of magnesium (about 3 cm is best)
- source of heat
- bottle (Pyrex) The bottle should hold at least 20 ml of liquid to allow space for the gas to collect.
- Splints (2)
- hydrogen peroxide (10 ml)
- manganese dioxide (a small amount)
- tongs
- rubber stopper (larger than the opening of the bottle)
- goggles
- apron
-

Teacher must supply graduated cylinders to measure liquid and spoons to take manganese dioxide out of a container.

SAFETY NOTE:

Remind students how to use the heat source (alcohol burner, Bunsen burner etc.) safely.
Students must be careful and not stare at the burning magnesium directly. The bright glow must be observed out of the corner of the eyes as the student is turned away from the glow. Staring at the bright glow causes retina fatigue and this "temporary blindness" is not only unsafe but scary to students.
Sparks can also be given off so goggles and aprons must be worn. The end-product will fall on the lab table so make sure that it is heat-proof.

Students will blow out the burning splint but allow the end of the splint to glow red. This glowing end is put into the top of the bottle after the reaction after taking off the rubber stopper. Students may be startled when the splint goes back on fire. They can blow out the splint again and it may light up again several more times. Without ruining the fun, let them know that something will happen and hold onto the splint. When it burns down too far, they can use the other splint. Make sure that the rubber stopper used to hold in the oxygen gas is larger than the opening to the bottle. This prevents the glass bottle from cracking or the rubber stopper from flying out due to the pressure of the gas produced.

Goggles and aprons must be used during the entire lab experiment.

Engagement:

Facilitation Questions:

1. Show the compound sodium chloride (table salt). What do the elements sodium and chlorine look like before they combine to make this compound? Were they white? Did they dissolve in water?
2. Show a bottle of hydrogen peroxide and have a student read the label for the expiration date. Discuss reasons why an expiration date was needed.
3. Do elements keep their properties when they combine to make a compound?
4. What happens to a compound when it breaks up into its elements? Will the properties change?
5. If the lab experiment on "Observing Gases" has already been done, show the compound water. Discuss the properties of the gases Hydrogen and Oxygen. Discuss the properties of the new compound formed. Hydrogen is flammable. Oxygen allows burning. Water is used to put out fires.

Explore:

1. Observe the properties of a piece of magnesium. Describe properties such as color, malleability, state of matter and any other properties that you observe. Record observations in your journal.
   The magnesium is shiny silver, malleable, solid and light weight in density.

2. Using tongs, heat the piece of magnesium in the flame. DO NOT STARE AT THE BRIGHT LIGHT. Record observations of what happened.
   There was a bright white light given off by the magnesium when it burned.

3. Observe the end result. This is magnesium oxide. Record your observations about this new compound in your journal.
   The magnesium oxide is white and powdery. It looks completely different from the magnesium before burning.

4. Fill the bottle with 10 ml of hydrogen peroxide (H_2O_2) and observe the liquid carefully. Write down properties such as color, density, smell, state of matter and anything else you observe in your journal.

The hydrogen peroxide is clear, liquid, odorless, medium density. (Students may want to test its flammability by bringing a lighted splint to the top of the bottle to see if any vapors from the liquid will ignite.)

5. Place a small amount of manganese dioxide into the bottle of hydrogen peroxide. Place the rubber stopper loosely on the top of the bottle.

6. Light one end of the splint and blow out the splint's flame so it glows. Remove the rubber stopper and put the glowing end near the opening of the bottle.

7. Blow out the splint again and place the glowing splint into the bottle.

8. Write your observations of what happened to the hydrogen peroxide as the manganese dioxide was added and what happened to the glowing splint.
Bubbling occurred. The glowing splint lights up again when placed over the bottle.. The splint also burns very brightly.
It did re-light a few more times. Eventually, the bubbling stopped and the splint stopped re-lighting.

9. Observe the remaining liquid. This is water with the black powder (manganese dioxide) in it. The manganese dioxide sped up breaking up of hydrogen peroxide into water and oxygen. The oxygen left the bottle when the stopper was removed.
The liquid is black although the powder is starting to settle. The bubbling is now stopped.

Explain:

1. In which part of this lab did you make a compound? Explain how you know.
In the first part of the lab, a compound was made because the magnesium combined with oxygen to make the compound magnesium oxide.

2. In which part of the lab did you break up a compound? Explain how you know.
In the second part of the lab we broke up the compound hydrogen peroxide. The new substances produced are water and oxygen gas.

3. Compare the properties of magnesium to the properties of the product after the magnesium was burned.
Before the reaction, the magnesium was silver in color and very malleable. After the reaction, the new product was white and powdery.

4. Compare the properties of hydrogen peroxide to the properties of the gas that left the bottle.
The hydrogen peroxide was clear and liquid. After the reaction, the gas left. The gas encouraged fire to burn as can be seen with the glowing splint.

5. Manganese dioxide is an example of a catalyst. Define the word catalyst and explain how it was used in this experiment.
A catalyst is a substance that speeds up the rate of a chemical reaction without being consumed itself. According to the bottle of hydrogen peroxide, there is an expiration date. At that point the hydrogen peroxide would have broken up into oxygen and water all by itself. A catalyst just speeds it up.

6. Did you observe any energy changes in these reactions.? Explain fully.
The burning magnesium gave off heat and light energy. It is exergonic. The hydrogen peroxide gave off heat when the oxygen was released so it is also exergonic. The glowing splint burst into flames when it came in contact with oxygen. It is also an example of an exergonic reaction.

6. Were these reactions physical or chemical reactions? Explain how you know.
Both reactions were chemical changes because new substances were made. The magnesium combined with oxygen in the air to make a new compound called magnesium oxide. The compound hydrogen peroxide broke down to make water and the element oxygen.

Conclusion:

Based on this experiment, answer the problem to this lab: What happens to the properties of elements when a compound is made? What happens to the properties of compounds when they break up?
Student answers will vary. They should recognize that chemical changes involve a change in the properties in the new substance made.

Elaborate:

1. Students can research other compounds and find out the elements in those compounds. A chart of physical and chemical properties of the elements and resulting compound can be compared. Use Internet, chemical catalog charts and reference materials as a resource.
2. Go back to the original engage questions. Research the properties of the element sodium and chlorine using the internet or references. Compare those properties to the properties of the compound sodium chloride.
3. What are the properties of hydrogen from a previous lab? What compound is formed by the chemical combination of

hydrogen and oxygen? Compare the properties before and after the compound is made.

Evaluate:

Use the following rubric to measure students' understanding of reactions in which a compound is made AND a compound is broken down.

POINTS	Scientific Accuracy	Reasoning	Communication	Collaboration	
4 Excellent	Student can always identify physical changes, chemical changes, exergonic, endergonic, elements and compounds correctly.	All observations were analyzed correctly. Conclusion showed great knowledge application of concepts.	All results were discussed fully and all lab questions answered with proper evidence.	Team worked very well together and each person did an equal part of work	
3 Good	Student can usually identify physical changes, chemical changes, exergonic, endergonic, elements and compounds correctly.	Most observations were analyzed correctly. Conclusion showed much knowledge and application of concepts.	Most results were discussed fully and most lab questions were answered with proper evidence.	Team worked well together and each person did an almost equal part of work	
2 Fair	Student can sometimes identify physical changes, chemical changes, exergonic, endergonic, elements and compounds correctly.	Some observations were analyzed correctly. Conclusion showed some knowledge and application of concepts.	Some results were discussed fully and some lab questions were answered with proper evidence.	Team somewhat worked together and each person did an unequal part of work	
1 Poor	Student can rarely identify physical changes, chemical changes, exergonic, endergonic, elements and compounds correctly.	Few observations were analyzed correctly. Conclusion showed little knowledge and application of concepts.	Few results were discussed fully and few lab questions were answered with proper evidence	Team did not work together and each person did very little work	
	Subtotal: ____	Subtotal: ____	Subtotal: ____	Subtotal: ____	**TOTAL: ____/16pts**

Sample TAKS questions:

1. Which of the following is an example of a physical change? (TEKS 8A)

   A wood burning

   B ice melting

C sodium reacting with water

D iron rusting

2. During a laboratory investigation, a student combined three chemicals in a plastic bag. After mixing the chemicals for a minute, they noticed the bag increased in size and it felt very warm. Without knowing the chemical formulas, the increase in temperature is an example of which of the following? (TEKS 8B)

A endergonic reaction

B exergonic reaction

C single replacement reaction

D double replacement reaction

3. Which of the following is evidence of a chemical change? (TEKS 8A)

A the liquid evaporated

B the solid expanded

C a gas is produced

D the density changed

4. During a simple laboratory investigation, an IPC student combined two chemicals in a test tube. The student felt the test tube and it felt very cool. The decrease in temperature is an example of which of the following? (TEKS 8B)

A endergonic reaction

B exergonic reaction

C single replacement reaction

D double replacement reaction

5. Which of the following is a difference between physical and chemical changes?

A In chemical changes, the mass before the reaction is greater than the mass after the reaction. In physical changes, the mass never changes.

B In chemical changes, new substances with new properties are made. In physical changes, the substance is still the same but in a different form.

C Chemical changes happen more often than physical changes.

D Chemical changes always involve a change in state of matter while physical changes always involve a change in size.

Which of the following is a physical change?

A. Magnesium burns brightly in a flame and becomes magnesium oxide

B. A rock is cracked by the water inside freezing and expanding during a cold winter.

C. Digestion of food in the stomach

D. An acid is poured into a base and forms salt and water.

Which of the following is an example of a chemical change involving water?

A Salt dissolves in water until the extra settles to the bottom.

B Liquid water freezes to become ice.

C Ice can change from solid to gas.

D Using electricity, water can be broken up into hydrogen and oxygen.

References/Resources/Websites:

The following sites contain information about chemistry especially matter:

- http://www.phschool.com/science/science_news/chemistry/properties_matter.html
- http://www.chem4kids.com
- http://www.school-for-champions.com/science.htm
- http://www.thinkquest.org/library/cat_show.html?cat_id=36
- http://school.discovery.com/lessonplans/physci.htm l (teacher lessons)

The following sites contain information about elements and the periodic table:

- http://chemicalelements.com/
- http://www.webelements.com/
- http://pearl1.lanl.gov/periodic/elements/29.html (Los Alamos National Lab)
- http://www.chemsoc.org/viselements/
- http://www.colorado.edu/physics/2000/waves_particles/wavpart3.html
- (Go to the Table of Contents.)

The following site has links to many sites that feature periodic tables and properties of elements:

- http://www.chemistrycoach.com/periodic_tables.htm

The following sites feature information about physical and chemical changes, reactions, energy changes during reactions, and balancing equations:

- http://www.visionlearning.com/library/science/chemistry-1/CHE1.8-equations.htm
- http://www.usoe.k12.ut.us/curr/science/sciber00/8th/matter/sciber/intro/htm
- http://www.chem4kids.com
- http://thinkquest.org
- http://www.chemtutor.com/react.htm (more advanced equations to balance)

The following sites have information about chemistry, elements and the periodic table. They are separated because they do feature advertisements.

- http://chemistry.about.com/library/blper5.htm
- http://environmentalchemistry.com/yogi/periodic/