This segment allows students to investigate a variety of chemical reactions in order to identify the indicators of a chemical reaction, explain the role of a catalyst and develop particle diagrams that represent how changes at the microscopic level affect macroscopic physical and chemical properties.	
Student Science Performance	
Grade or course: 9-12 Chemistry	**Title**
Topic: Chemical and Physical Properties	Properties of Matter

Performance Expectation for GSE:

SC2. Obtain, evaluate, and communicate information about the chemical and physical properties of matter resulting from the ability of atoms to form bonds.

a. Plan and carry out an investigation to gather evidence to compare the physical and chemical properties at the macroscopic scale to infer the strength of intermolecular and intramolecular forces.

SC3. Obtain, evaluate, and communicate information about how the Law of Conservation of Matter is used to determine chemical composition in compounds and chemical reactions.

b. Plan and carry out an investigation to determine that a new chemical has been formed by identifying indicators of a chemical reaction (e.g. precipitate formation, gas evolution, color change, water production, and changes in energy to the system).

SC4. Obtain, evaluate, and communicate information about how to refine the design of a chemical system by applying engineering principles to manipulate the factors that affect a chemical reaction.

c. Construct an explanation of the effects of a catalyst on chemical reactions and apply it to everyday examples.

Performance Expectations for Instruction:

- Design an investigation to explore the differences between physical and chemical properties.
- Predict the products of a chemical reaction and provide evidence to support this claim.
- Research the role of a catalyst in a chemical reaction and apply it to everyday examples.
- Develop particle diagrams that represent physical and chemical changes.

Additional notes on student supports

Materials

Teacher Demo - Elephant's Toothpaste

30% Hydrogen peroxide (H_2O_2) (*Obtained from Science Supplier*); Potassium iodide (KI); dish soap; and large container (ex. 500 mL graduated cylinder)

Student Investigation - Decomposition of Hydrogen Peroxide

3% Hydrogen peroxide (*obtained from drugstore*); baker's yeast; test tubes; test-tube rack; splint; flame source; beakers; water; and other reasonable equipment requested by students such as thermometer, boiling apparatus, etc.

Student Investigation - Physical or Chemical Properties?

Bunsen burner; test-tube rack; test-tubes; tongs; wooden Splints; striker; 5- mL beaker; thermometer; magnesium ribbon (Mg); zinc (Zn); potassium iodide (KI) solution; lead nitrate ($(Pb(NO_3)_2$ solution; sulfuric acid (H_2SO_4); effervescent tablets; Other reasonable lab supplies requested by students for investigation

Safety Equipment for all labs includes *ANSI Z87 chemical splash-proof goggles, aprons and gloves*

Students will continuously obtain, evaluate, and communicate information. This is not a linear process. Students will communicate through writing and discussions to allow for formative assessment. This benefits the teacher, student, and whole group to guide instruction to clarify misconceptions or extend content.

Engaging Learners The goal of this phase is to capture students' attention and interest. Get the students focused on the phenomenon and other specific aspects of the phenomenon that lead to the standard. The main point is that students are engaged in making sense of phenomenon using their own conceptual models and core ideas. Create opportunities to informally determine misconceptions expressed by the students.	**Phenomenon** **Teacher demo:** Elephant's Toothpaste. Students observe how the addition of a KI solution to a solution of 30% hydrogen peroxide and soap results in a very dramatic and exothermic reaction. The teacher asks the students to identify this as a physical or a chemical change (*giving indicators)* and brainstorm the products of the reaction *(Students should narrow the products down to a combination of hydrogen, oxygen and/or water.)*. Students should also brainstorm how they can identify the products of the reaction. Link to demo Elephant's Toothpaste
	Obtaining 1. Exploratory Investigation: Teacher informs the students that they will get materials to perform the decomposition of 3% hydrogen peroxide (*less exothermic than the 30% hydrogen peroxide used in the demo*) and investigate the properties of the products so they can be identified. Yeast is used as a catalyst (*instead of KI*). 2. Students will research a. standard testing techniques for chemicals (online resources or textbooks). Alternatively, teachers can share approved websites with students on Google Classroom. b. properties of the potential products and distinguish between physical and chemical properties. The students should also research how the particles in the substances change when they undergo a chemical and a physical change. c. The role of a catalyst in a reaction. 3. The students need to design an experiment that allows them to collect evidence to determine the correct products in the decomposition reaction. *To ensure safe laboratory practices, all student investigation procedures are approved by the teacher before students have access to the materials. Remind students of safety precautions when handling flames. Teacher can also recommend the relative quantities of chemicals to be used.* ***Example of Student-Developed Procedure:*** *a. Pour about ¼ test tube full of hydrogen peroxide. Analyze and record the physical properties.* *b. Create a data table to collect your data.* *c. Using a wooden splint, add about a **small pea-sized** portion of yeast to the test tube.* *d. Test the bubbles forming in the solution with a glowing splint. Light a splint using a match and allow the splint to burn for a few seconds. **Blow out the flame** so that the splint is glowing.* *e. Slowly place the tip of the splint down the test tube **ABOVE** the level of the liquid. **Do not get it WET**.* *f. Analyze the product left in the test-tube. What do you think it is?* *g. Clean up your test tube – you may dispose in sink. Wash wooden splints with water before returning to the teacher.*

	Do NOT throw them in the garbage can. 4. Students will develop a data table to record their data. 5. The group will analyze their data and provide evidence to support their claim of the products in the decomposition reaction. Click on link below for the student investigation worksheet to accompany this: Student investigation worksheet
	Evaluating The teacher should evaluate at least the following for accuracy (and safety precautions): ● Investigation procedure ● Chemical equation that shows $2H_2O_2 (l) \rightarrow 2H_2O(g) + O_2(g)$ ● Paragraph justifying the identification of the products ○ Oxygen reignites a glowing splint. ○ It is not hydrogen since it would cause a lighted splint to extinguish making a characteristic shrill pop sound. ○ Students may filter the yeast and test the resulting liquid with pH paper. It should have a pH of 7. ○ Students may use other tests for water like boiling point or testing with anhydrous copper sulfate crystals or cobalt chloride paper. Ensure students specify if the property tested is a physical or a chemical property.
	Communicating ● Groups will write a procedure that has to be approved by the teacher prior to the investigation. ● Groups will share their data tables, observations, and conclusions. This will give them an opportunity to revise and modify their investigation.
Exploring	*Obtaining* 1. **Student Investigation:** The students in groups of 2-3 are given 5 substances along with testing materials. The students are given safe investigation procedures and asked to investigate the properties of the changed substances and determine whether the resulting changes in macroscopic structures are physical or chemical changes. *To ensure safe laboratory procedures, the students are given the instructions on how to test the materials for reactivity. Students need to wear ANSI Z87 chemical splash-proof goggles, aprons and gloves. Acids and other chemical can be toxic by ingestion and inhalation and are corrosive to the skin and eyes. Teacher option: the mixing of the lead nitrate and potassium iodide can be done as a demo at the teacher station.* 2. The students will develop a data table that allows them to record changes in properties. They will then decide if a physical or a chemical change occurred and provide evidence to support their claim. Click the link below to access a suggested student worksheet for this activity Investigation – Physical or Chemical Changes?

<table>
<tr><td></td><td></td></tr>
<tr><td></td><td>Communicating
● Groups will share their data with each other and this may cause groups to investigate the substances more fully.
● Students will individually identify the changes as physical or chemical and provide supporting evidence from the investigation to back their claim.</td></tr>
<tr><td></td><td>Evaluating
Teachers should at least evaluate the following for accuracy and student thinking:
● Group-developed data table. A sample set-up is shown below.
● Student argument and supporting evidence - a table is included in the student version to facilitate grading. Sample Data Table for Property Changes
<table>
<tr><th>Experiment</th><th>Properties Before</th><th>Properties during and after</th><th>Physical or Chemical Change</th></tr>
<tr><td>1. Sugar</td><td></td><td></td><td></td></tr>
<tr><td>2. Mg ribbon</td><td></td><td></td><td></td></tr>
<tr><td>3. Potassium iodide</td><td></td><td></td><td></td></tr>
<tr><td>4. Zinc</td><td></td><td></td><td></td></tr>
<tr><td>5. Effervescent tablet</td><td></td><td></td><td></td></tr>
</table></td></tr>
<tr><td></td><td>Formative Assessment of Student Learning</td></tr>
<tr><td>Explaining
Finalizing Model
Explaining Phenomena
The scientific explanation for causes of phenomena are prominent in this phase. Students engage in three-dimensional performances. The focus is on accurate use of Core Ideas and Crosscutting Concepts in the performance of making sense of the phenomena featured in the engage and explore phase. The teacher directs students' attention to key aspects of the prior phases and first asks students for their explanations. Both the teacher and student formatively assess the</td><td>Obtaining
The teacher asks the students to think about the changes that are occurring on the particle level during both a physical change and a chemical change. Students are asked to pick one chemical change and one physical change that they observed and make a particulate representation (model) of the changes occurring. A before and after particulate diagram is required. Students may need to conduct more research in order to understand these reactions and devise the models.
Prior to this activity, teachers should instruct students on how to make particulate diagrams. A particulate diagram is a model or representation depicting the behavior, reactions, interactions, or motion of particles involved in the system. Atoms are usually represented as circles. In an aqueous solution, not all of the water molecules can be shown so a few are drawn, and the rest of the white space implies water. The spacing between particles allows the representations of the state of matter, with gas molecules shown far apart (occupying all the space) and solids atoms close together and occupying only part of the space. A student can conduct an internet search for visual representations of solid, liquid, gas</td></tr>
</table>

learning progress.	*and plasma to see representative models.*
	Evaluating Students in groups of 2-3, should utilize their research, data and prior knowledge to generate a diagram or model of a physical change (before and after representation of particles) and another diagram or model of a chemical change (before and after representation of the particles). ***Physical Change*** *- ex. Dissolving of sugar in water:* *<u>Before Model</u>: 5-10 sugar particles shown connected together in the solid phase surrounded by water molecules (short separation to show liquid phase)* *<u>After model:</u> All the individual particles are separated and surrounded by water molecules to indicate the dissolving process.* ***Chemical Change*** *-reaction of magnesium with oxygen to form magnesium oxide* *<u>Before Model:</u> At least 5-6 Zinc atoms arranged touching each other. Oxygen molecules above the zinc spaced far apart to indicate the gas phase.* *<u>After Model:</u> One Magnesium atom joined to one oxygen atom to indicate bonding in a molecule. 3-4 molecules can be represented in the solid state. Students should also show the addition of energy to the before system.*
	Communicating Groups will share their models with each other and may revise their final model. A paragraph is written summarizing the indicators of a chemical change and the role of a catalyst in certain reactions.
Elaborating Applying Model to Solve a Problems	**Phenomenon** Teacher demo: Coating of copper penny with zinc (allow 10-15 minutes) Place a zinc-coated penny in a bunsen flame and it turns to a gold color. Online research "turning penny into gold" for details on how to perform this demo. It could also be performed by students as a lab.
	Obtaining Students: ● Develop a model to represent the changes occurring during the teacher demo. ● Analyze four particulate diagrams and classify the change as physical or chemical along with supporting reasons.
	Evaluating The student worksheet provides a format on how to perform an evaluation. Teachers should check diagrams for accuracy and student understanding.
	Communicating Groups will share their models with each other, revise as necessary and individually answer the diagram analysis questions.
Evaluation	***Assessment of Student Learning***
	Formative assessment *is included in assessing and revising data in tables; initial student models; and student communication and presentations.* ***Summative assessment*** *is included in the analysis, explanation and elaboration parts of the student investigation worksheets.*
SEP, CCC, DCI	**Science Essentials**

Science and Engineering Practices	• Develop and use models to describe mechanisms at unobservable scales. • Plan investigations and collect data to answer scientific questions. • Analyze data to make sense and explain phenomena. • Share explanations and arguments based on multiple sources of evidence and peer review. • Generate and communicate ideas using scientific language and reasoning.
Crosscutting Concepts	• Use models to investigate patterns in phenomenon. • Cause and effect - identify and describe the causes of phenomena. • Scale, proportion and quantity - use patterns that can be observed on a macroscopic scale to explain microscopic phenomena. • System Model - Use diagrams and representations to model systems. • Energy and Matter - Account for the conservation of matter in a system.
Disciplinary Core Ideas	• Chemical and physical properties • Intermolecular forces • Intramolecular forces • Law of conservation of matter • Indicators of a chemical reaction • Effect of a catalyst

Additional Supports for struggling learners:

The following supports are suggestions for this lesson and are not the only options to support students in the classroom. These supports target students that struggle with science material, this lesson or a previous lesson. These are generalized supports and do not take the place of IEP accommodations as required by each student's Individualized Education Program.

General supports for the following categories:

Reading:	Writing:	Math:
1. Provide reading support by reading aloud or doing partner reads 2. Have the teacher model what they are thinking when reading the text 3. Annotate the text with students so that they may refer to it as they work through the lab	1. The teacher can provide a sentence starter for the students. 2. The teacher can give students an audience to write to (i.e. Write a letter to your sibling explaining this topic). 3. The teacher can provide constructive feedback during the writing process to help students understand the expectations.	1. Provide calculators as needed. 2. Provide graph paper as needed.

Supports for this specific lesson if needed:

Performance expectations for instruction:

1. The teacher should provide information to students in various formats to reach as many students as possible.
2. The students should be given adequate time to complete each part of the lesson.
3. The students should be allowed to express their knowledge in various formats.
4. The teacher should be sure to provide multiple ways for the students to communicate their knowledge of the material.
5.

Engage:

1. The teacher should consider doing the demo more than once to allow students adequate time to make observations.
2. The teacher should consider leading a class discussion of observations that were made during the demo.
3. The teacher should go over lab safety rules prior to pairing students up to design their experiment.
4. The teacher should consider giving students sources to use in their research.
5. The teacher should consider providing an organizer for students to record their research, design their experiment and record data.
6. The teacher should use intentional and flexible grouping to create student groups. Best practice is to use data to drive student groupings.
7. The teacher should consider showing students the materials that they are able to use in their experiment.
8. The teacher should be prepared to repeat directions as needed.

9. The teacher should consider using guiding questions to help students in designing their experiments.
10. The student should be sure to get teacher approval of their experiment prior to proceeding.
11. The teacher may need to consider providing students with a data table to record data from the experiment.
12. The teacher should consider a formative assessment. Then the teacher can re-teach, review or enrich as needed.
13. The teacher should be sure to provide multiple ways for the students to communicate their knowledge of the material. These formats could include writing, drawing or verbally explaining.
14. The teacher should consider having options to share the data, observations and conclusions. These options could include using technology to share, sharing in a walk through or presenting.

Exploring:

1. The teacher should use intentional and flexible grouping to assign student groups. Best practice is to use data to drive student groupings.
2. The teacher should go over lab safety procedures prior to the students beginning the lab.
3. The teacher should consider providing students with a data table to record their data.
4. The teacher should be sure to provide multiple ways for the students to communicate their knowledge of the material. These formats could include writing, drawing or verbally explaining.
5. The teacher should consider having options to share the data, observations and conclusions. These options could include using technology to share, sharing in a walk through or presenting.

Explaining:

1. The teacher should consider providing students with an organizer to record their model design.
2. The teacher should provide students with a rubric so that students can self-evaluate their work. This increases student ownership.
3. The teacher should consider explicitly show students how to make a particulate diagram. The students may need practice doing this as they work through making their model.
4. The teacher should use intentional and flexible grouping to assign student groups. Best practice is to use data to drive student groupings.
5. The teacher should consider providing student with manipulatives to match models to definitions.
6. The teacher should consider a formative assessment and then re-teach, review or enrich as needed.
7. The teacher should be sure to provide multiple ways for the students to communicate their knowledge of the material. These formats could include writing, drawing or verbally explaining.
8. The teacher should consider having options to share the data, observations and conclusions. These options could include using technology to share, sharing in a walk through or presenting.

Elaborating:

1. The teacher may need to show the demo more than once to ensure that students can make adequate observations.
2. The teacher should consider giving students sources to use in their research.
3. The teacher should consider providing students with an organizer to use in developing their model.
4. The teacher should be sure to provide multiple ways for the students to communicate their knowledge of the material. These formats could include writing, drawing or verbally explaining.
5. The teacher should consider having options to share the data, observations and conclusions. These options could include using technology to share, sharing in a walk through or presenting.

Evaluating:

1. The teacher should consider giving students multiple formats to communicate their knowledge. This could be drawing, writing or designing a presentation.
2. Students may need additional time to complete their assignments.

Decomposition of Hydrogen Peroxide

Engagement:

Phenomenon 1: Demo: Elephant's toothpaste

Record your observations and come up with some questions that you would like to answer.

Phenomenon 2: Investigation

Materials:

- Large test tube
- 3% hydrogen peroxide
- Wooden splints
- Goggles
- Matches
- Pinch of yeast

Safety:

Wear goggles and apron. Wash your hands when you are finished the lab. Do not throw away the burned splint in the trash as this is a fire hazard. Please wet the splint and return it to your teacher. Dispose of waste as instructed.

Research:

- Perform research to help answer your questions.
- Brainstorm the products of the reaction. What are the likely products?
- How can you test to see if these products are present?

Design a procedure and get it approved by your teacher before performing any testing.

Design a Data Table to use to collect your data:

Analysis: *Present your findings and make sure that you are answering the questions you formulated.*

Elaboration:

1. What products were produced by this reaction? What evidence proves this?

2. Yeast did NOT take part in this reaction. Why do you think it used it in the chemical reaction?

3. Give some everyday examples of other substances that have a similar role to yeast in this experiment.

Return to Instructional Segment

Investigation - Physical or Chemical Changes?

Guiding Question: *Macroscopic observations allow us to differentiate between physical and chemical change - how can you differentiate between both types of change in regard to how the molecules behave?*

TASK: Investigate carefully the five changes listed below. Record detailed observations. THEN, CONDUCT additional tests or research (as needed) to determine if a chemical or physical change occurred. Develop a particulate model to represent a physical and a chemical change.

Safety: Wear safety goggles, gloves and aprons. Keep lab area organized. If you spill something, ask for assistance when cleaning. Clean work area and wash your hands when finished. Recall and use your Bunsen burner safety rules.

Materials:

Bunsen burner	Striker	Tongs	3 large test tubes
Test tube rack	Sugar	Zinc pieces	1/3 effervescent tablet
Magnesium ribbon	Wood splint	Beaker (wastes)	Thermometer
Sulfuric acid	Potassium iodide (aq)	Lead nitrate (aq)	

Procedure for five tests:

After performing the testing below, you may conduct additional investigation to analyze any products.

1. Note the properties of the **sugar** and water. Place one level teaspoons of the sugar in 100 mL of water and stir well. Record your observations.

2. Get magnesium ribbon from your teacher. Note the color, luster, and flexibility of the metal. Holding one end with tongs, place the other end in the burner flame. **DO NOT LOOK directly at the burning magnesium.** Place the residue in a small beaker and examine its properties. Dispose in waste beaker. Record all observations in your data table.

   TURN OFF THE GAS TO THE BUNSEN BURNER after completing step 2 ! ! ! ! !

3. This portion must be done at the front lab table under teacher supervision: Put 2 or 3 drops of **lead (II) nitrate, $Pb(NO_3)_2$**, solution in a test tube and add 1 drop of potassium iodide, KI. Do NOT allow droppers to touch test tube to avoid contamination. Observe. Dispose in a designated waste container.

4. Obtain 5 mL of sulfuric acid (½ inch) in a test tube from instructor. Drop in piece of **zinc metal**, about the size of a pea. Observe for about 1-5 minutes. Carefully insert a burning splint into the mouth of the test tube to test, **WHILE POINTING THE OPEN END AWAY FROM YOURSELF, YOUR LAB PARTNER AND ANYONE ELSE NEAR YOU. Do not drop the splint into the test tube.** Observe what happens. Place liquid and zinc into the designated waste container.

5. Drop 1/3 of an **effervescent** tablet into a large test tube containing 5 mL of water (½ inch). Place the test tube into the rack and observe. After 15 seconds, insert a glowing splint into the upper portion of the test tube. Observe. You may discard the water mixture down the drain.

6. Develop a data table to record detailed observations for each of the five testing scenarios.

Data Table: Develop a data table to record your careful observations for each of the five testing scenarios. Please include details of any further testing that was performed.

Analysis:

Develop a claim – physical or chemical? Include EVIDENCE to support your claim.

	Claim	**Evidence to Support Claim**
1.		
2.		
3.		
4.		
5.		

Explaining: Finalizing a model of a Chemical and a Physical Change:

1. Based on your investigations, what are the indicators that a chemical change has occurred?

2. In the hydrogen peroxide investigation, you saw that either KI or yeast could be used in the experiment and the decomposition outcome was still the same. What does this tell you about the role of the yeast or KI in the experiment?

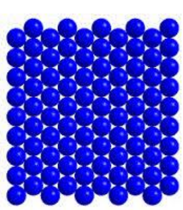
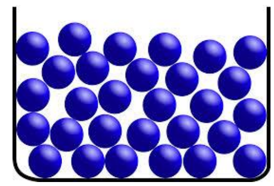
3. Choose a **PHYSICAL** change that you observed in your investigations and develop a model that explains and represent the changes in the particles. Clarification: you should draw a particulate diagram of the substance ***before the change*** and ***after the change*** in order to illustrate any rearrangement or change in particles. You may conduct more research if necessary.

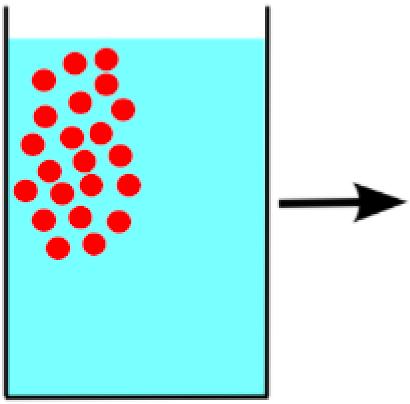
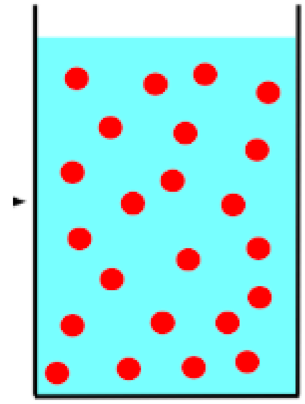
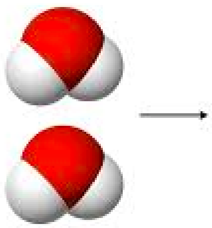
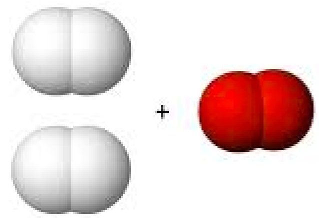
Before Model of Particle Diagram	Paragraph describing the Physical Change
After Model of Particle Diagram	

4. Choose a **CHEMICAL** change that you observed in your investigations and develop a model that explains and represent the changes in the particles. Clarification: you should draw a particulate diagram of the substance ***before the change*** and ***after the change*** in order to illustrate any rearrangement or change in particles. You may conduct more research if necessary.

<table>
<tr><td><u>Before Model of Particulate Diagram</u></td><td rowspan="2"><u>Paragraph describing the Chemical Change</u></td></tr>
<tr><td><u>After Model of Particulate Diagram</u></td></tr>
</table>

APPLICATION:

BEFORE	AFTER
A. 	

B. 	
C. 	

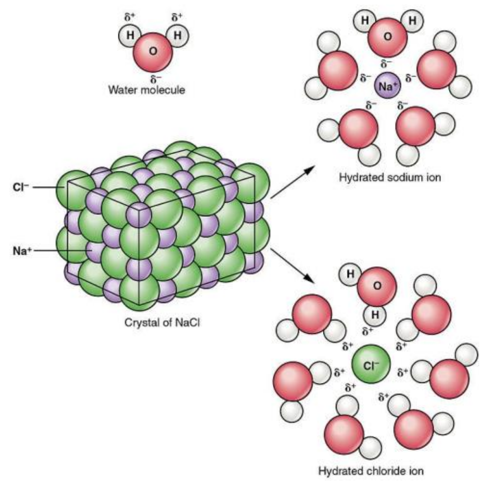
1. In the diagram below, explain what type of change is occurring and justify your reasoning:
   A.

   B.

   C.

2. In the teacher demo - a penny apparently turned into silver and then gold. Research alloys and develop a particulate diagram that represents the changes occurring (include a before and after diagram).. Be sure to discuss what type of change, physical or chemical, is been represented by your model.

3. The diagram below shows table salt (NaCl) dissolving in water. Discuss what type of change is being represented and explain your reasons for this claim.



Citations:

1. "File:Teilchenmodell Flüssigkeit.svg." *Wikimedia Commons, the free media repository*. 18 Mar 2015, 23:42 UTC. 20 Jul 2017, 19:54<https://commons.wikimedia.org/w/index.php?title=File:Teilchenmodell_Fl%C3%BCssigkeit.svg&oldid=153882290>.

2. "Diffusion." *Wikipedia, The Free Encyclopedia*. 22 Feb 2017, 21:54 UTC. 20 Jul 2017, 19:57<https://simple.wikipedia.org/w/index.php?title=Diffusion&oldid=5610639>.

3. "File:Electrolysis of Water.png." *Wikimedia Commons, the free media repository*. 23 Nov 2016, 02:25 UTC. 20 Jul 2017, 19:56 <https://commons.wikimedia.org/w/index.php?title=File:Electrolysis_of_Water.png&oldid=217799355>.

4. "File:214 Dissociation of Sodium Chloride in Water-01.jpg." *Wikimedia Commons, the free media repository*. 15 Nov 2016, 14:35 UTC. 20 Jul 2017, 19:52<https://commons.wikimedia.org/w/index.php?title=File:214_Dissociation_of_Sodium_Chloride_in_Water-01.jpg&oldid=214238543>.

Return to Instructional Segments

Data Table for Property Changes

Experiment	Properties Before	Properties during and after	Physical or Chemical Change
1. Sugar			
2. Mg ribbon			
3. Potassium iodide			
4. Zinc			
5. Effervescent tablet			

Return to Instructional Segment