Chemical Magic: Creating Magical Demonstrations to Elicit Analytical Writing in the Middle School Classroom

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This curriculum unit is recommended for:
Grade 8/Science

Keywords: The Law of Conservation of Mass, forming a gas, forming a precipitate, Creating hydrogen gas, making a HHO generator, creating a color change with a chemical reaction

Teaching Standards: See Appendix 1 for teaching standards addressed in this unit.

Synopsis: This curriculum unit includes dramatic demonstrations, as though by magic, to engage the middle school student in the areas of chemistry and physical science. This unit has suggestions for creation of lesson plans, magical demonstrations, and writing prompts and exercises to promote engagement and analysis of chemistry experiments through creative writing. The Law of Conservation of Mass and evidences of chemical changes, and balancing elementary chemical equations are showcased in this paper. The creation of hydrogen gas through the use of a HHO generator, which can be easily and cheaply made, as well as color changes and precipitates created with the use of common chemicals and supplies found in the science laboratory are demonstrated and discussed. These demonstrations and activities can be used in 6^{th}, 7^{th}, and 8^{th} grade, dependent upon the school systems core curriculum and state standards. The typical inner city middle school student is targeted in this unit. An emphasis is placed upon analytical writing and inclusion of writing prompts to assist the teacher in promoting literacy to inner-city students in lower than grade reading levels. The demonstrations and lessons in this unit can be implemented with very few resources and a minimal cost to the teacher. Hopefully, this curriculum unit can be of use to a middle school science teacher struggling to find experiments and demonstrations to engage or hook students in today's middle schools.

I plan to teach this unit during the coming year to 27 students in Science Grade 8.

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Introduction

The main purpose of this unit is to assist in the intrinsic motivation and engagement of middle school students with *Chemical Magic* demonstrations that are visually impressive and dramatic in the average everyday science classroom. These demonstrations of chemical reactions in a magic show format will assist the teacher in eliciting interest in abstract and mundane topics such as the Laws of Conservation of Energy and Mass, chemical reactions, and balancing equations. These topics are so abstract to middle school students, and as a teacher it is difficult to fold these concepts into a teaching strategy. Also, these exciting visual presentations will provide a launching pad for students to engage in creative analytical writing and stimulate the senses. Another main objective of this unit is to provide a few reasonably priced demonstrations that are easy to teach and create. The curriculum standards that relate to this unit include: understanding chemical bonding, identifying signs of a chemical reaction, chemical interactions, the properties of matter, and the basics of chemical equations. One area emphasized in the curriculum unit is the creation of hydrogen gas. Hydrogen gas manufacturing has a promising future as the world's dependence on energy increases. The demonstration of the creation of hydrogen gas is applicable to STEM curriculum units as well. After all, future scientists, mathematicians, engineers, and information technicians are present in our middle school classrooms.

Another focus and intention of this curriculum unit is to enhance reading comprehension and increase implementation of higher order reasoning while providing a more effective analysis of science demonstrations and activities. Thus, resources and methods have been included to assist science content teachers in the preparation and motivation for struggling middle grades writers. The focus of this unit was developed to target the specific needs of this middle school; targeting below level readers in transient living conditions. This unit encompasses higher order thinking, rigorous activities, and teaching methods to utilize Gardner's Multiple Intelligences as well as some common reading and writing strategies.

My intended audience for this curriculum unit is 7^{th} and 8^{th} grade inner city middle school students in a large metropolitan area. These students have internet access but no quiet place to complete homework or the family support group needed to raise a productive individual. These particular students today face a myriad of learning challenges including attention deficit problems, due to excessive exposure to video games and internet usage. Smart TVs are in every home, however, books, newspapers or e-readers are looked upon with disdain. Low reading levels and transient living conditions are the norm at this school. These children face many challenges to become prepared to contribute to the world of Science, Technology, Engineering, and Mathematics. As a

teacher, I find it very difficult to explain the abstract concepts such as The Law of Conservation of Mass/Energy to an audience who is fixated on cell phone and hip hop music. Doing worksheets and watching power point presentations are so dislocated from teaching constructivist-inquiry learning. Teachers need a connection that will motivate students to prepare for *21st Century Learning*. The concept of *21st Century Learning* is geared towards enhancing a student's ability to communicate. The concept of *21st Century Learning* is geared towards enhancing a student's ability to communicate effectively and function dynamically in the fast paced world we live in today. The 21st Century Skills Student Outcomes include: Learning and Innovation Skills, Creativity and Innovation, Critical Thinking, and Problem Solving, Communication and Collaboration, Information, Media, and Technology Skills, Information Literacy, Media Literacy, ICT Literacy, and Life and Career Skills. (Partnership for 21st Century Skills n.d.)

Background

This curriculum unit addresses 8th grade integrated science at a middle school in Charlotte, North Carolina. With 1200 or so students, the school is located in an affluent area of Charlotte, located near The University of North Carolina at Charlotte and in the prestigious Research Park area of North Charlotte. The demographic makeup is approximately 90% African-American and the rest, mostly Hispanic students. 80% of the student population receives free or reduced lunches. Charlotte and this school system see a great transient population with many students living in hotels. Most students read below grade level (60 %+) and are seldom seen reading books. These kids are not really poor, such as society today portrays poor children. These students have electronic devices, high priced athletic shoes, but do not eat breakfast and dinner at home. Reading comprehension is weak in all subject areas; therefore, reading and writing about science activities and experiments are non-existent. This situation requires scaffolding and differentiation strategies while staying true to the Common Core Standards and New Science Essential Standards that are required for students to pass the North Carolina 8th grade science End of Grade Test and transition into high school. North Carolina End of Grade Tests are packed with higher order questions; not just memorization questions, so, it is imperative that students can properly analyze, write, and describe concepts and experiments performed and discussed in the classroom.

The *Chemistry Magic* demonstrations are intended to elicit some excitement from the middle school student. Students today face a myriad of learning challenges including attention deficit problems, due to excessive exposure to video games and internet usage. Low reading levels and transient living conditions are the norm at this school. This curriculum unit was developed to target the specific needs of this middle school targeting below level readers and transient living conditions. This unit encompasses higher order thinking, rigorous activities, and teaching methods to utilize Gardner's Multiple Intelligences as well as some common reading and writing strategies. I find it very difficult to relate the abstract concepts such as The Law of Conservation of Mass/Energy to an audience who is fixated on cell phone and hip hop music. Doing worksheets and watching power point presentations are so dislocated from teaching constructivist-inquiry

learning. Teachers need a connection that will motivate students to prepare for *21st Century Learning*.

Engaging today's middle grade student is a monumental task. After all the students have seen so much on digital media and see updated and new media every day. Children today tire quickly of existing media and mobile apps and search the internet and ask friends for new and different software and apps. Their attention span is growing shorter every year. The *chemical magic show* that a teacher puts on in the classroom is so very important in building engagement and excitement in the classroom. The typical middle school teacher hears, "Lets blow something up", yelled loudly and excitably at least once a week in science class. The teacher can use this enthusiasm and excitement to promote excitement in their science class.

Creating hydrogen gas in the science lab can be an exciting and easy venture. The hydrogen creation demonstration can be related to STEM interdisciplinary lesson plans. With collaboration between teachers, this lesson plan can benefit all parties, including elective teachers. In an entrepreneurial setting, in collaboration with a business teacher, the creation of hydrogen gas for use in automobile or big rig can be combined with a project about the economics of the production of hydrogen gas. The economics and profit margin can be analyzed and projected as part of a long term project by groups or individuals. This project could be used in a middle school science fair project and or part of a FBLA business fair project. Creating hydrogen gas, which is the fuel of the future, could inspire a young entrepreneur to start his own business and become a millionaire.

Teaching Strategies

Literacy and Science: In most schools systems in the country there is an interdisciplinary push for literacy. This Core Curriculum with an emphasis on reading, writing, and math can be related to and integrated into 8th grade science. As all teachers know, the student must know how to read safety rules and instructions before any experiments or activities can begin. Literacy can be taught in any situation. For example: a higher reading and writing activity can be used to analyze and explain what occurred in the activity/experiment, even if only the teacher demonstrates it.

In this curriculum unit, the major objective along with fun magical classroom experiments and demonstrations should be to motivate the students to write good sentences, paragraphs, and essays. The teacher will integrate collaboration, problem solving, research, writing, using writing prompts, and sharing information that will integrate the demonstrations into lesson plans and teaching methods. Using *21st Century Learning* skills such as communication, collaboration, and media technology skills are necessary in order for students to be able to analyze and complete inquiry based projects.

This being said, it is extremely time-consuming and stressful to grade 100 or so writing papers. Students analyzing experiments and demonstrations can use an effective and productive strategy in this unit: just write a sentence or two about what the student thinks occurred during the experiment and relate to something they learned from class

from notes. With that being said, very few students at any inner-city middle school are able to articulate the concept; even having difficulty with a sentence or two without some type of graphic organizer or writing prompt. There are thousands of different graphic organizers, Venn diagrams, and KWL charts that are extremely valuable to the science content teacher. In this unit I have included a few examples to help the teacher teach and re-loop the content until the students has mastered the concept. Collaboration is very important in a middle school setting. The social needs of the student can be interwoven into a group activity. English Language Learners and lower level students can draw or take pictures of the chemical reactions during the demonstration. Word walls, and vocabulary words can be effective scaffolding tools with lower level students and ELL, as well.

An emphasis will be placed on vocabulary words and a science notebook. Students can be encouraged to design an experiment to demonstrate vocabulary words and concepts in this unit. Vocabulary activities such as looking up words on students' cell phones during group activities can be encouraged. The science notebook will become a valuable resource where definitions of vocabulary words will be written in the students' own words. Word walls, anticipation guides, and writing probes and prompts can be utilized to motivate students in activity of writing sentences and paragraphs and also kept in the science notebook.

Websites and books used for research for this unit are located in the works cited page and helpful comments are included. Some strategies for conducting the class as a laboratory (different groups doing differentiated tasks) are as follows: observe students to diagnose poor work/study habits, show students where to find information, show students how to use the tools of learning, clarify assignments, show the students how to get the most out of their studying, help student form goals for study, help students summarize, point out errors and incorrect problems, and suggest methods for attacking problems. (Clark 1996)

Balancing Equations, Creation of Hydrogen, Creating Substances, such as Gases, Precipitates, and Color Changes

Eighth grade science is not concerned with students having a deep understanding of chemical equations and the different types of equations, but they need to be able to understand the concept of the Law of Conservation of Mass by practicing balancing chemical equations, students can gain the understanding that matter isn't destroyed, but is rearranged. They also can learn the concept that a chemical reaction takes place anytime there is a chemical change, as well as the indicators that a chemical change has taken place through real-life examples of chemical reactions. The indicators of a chemical reaction include: 1) the production of light, 2) color change, 3) formation of a precipitate, 4) change in temperature (production of heat or cold), and 5) production of gas (bubbles, smoke, etc.).

When performing the magic show/demonstration, teachers should dress up, perhaps in a white tie dyed lab coat and a bald wig with white hair on the side and act goofy. The

more a teacher can integrate fun and drama into the demonstration, the more the student will be engaged and pay attention. This drama and excitement will add meaning to the title Chemical Magic!

1. The Law of Conservation of Mass as related to balancing equations

Objective: To teach students to balance equations with common math rules and demonstrate their proficiency by writing a sentence about the relationship between math and the scientific equation.

Students can learn the concept that a chemical reaction takes place anytime there is a chemical change, as well as the indicators that a chemical change has taken place through real-life examples of chemical reactions. The three following lessons have been prepared to include activities to incorporate balancing equations along with the literary side of the lesson. Math is part of balancing equations, using basic mathematic rules of exponents and bases to solve chemical equation balancing.

An easy method to easily teach balancing equations is use of a Reactant & Product Chart with reactions on one side and products on the other. This table and graphic organizer easily organizes the atoms and molecules for an easy-to-understand lesson and presentation.

If a chemical equation does not obey the Law of Conservation of Mass the equation is said to be what? NOT BALANCED

Look at the steps we need to take to BALANCE chemical equations

Let's work with the following equation: $Fe + O_2 \rightarrow Fe_2O_3$

Step 1. Create a RAP table
What is a RAP table? A table that shows us which atoms are present in this reaction; and the number and identify if they are reactants or products?

For example:

$Fe + O_2 \rightarrow Fe_2O_3$

#R	atom	#P
1	Fe	2
2	O	3

Step 2. Go to the first atom that's not balanced and balance it!
Since Fe atoms are not balanced what do we need to do to balance it?
Right! Multiply it by 2 (Only multiply)

	#R	atom	#P
2x	1	Fe	2
	2	O	3

Step 3. Move to the next unbalanced atom. What is it?

How can we balance the Oxygen?
Multiply Reactants by 3 and Products by 2

	#R	atom	#P
	2	Fe	2
3x	2	O	3x2

Adjust the equation to reflect your changes
$2Fe + 3O_2 \rightarrow 2Fe_2O_3$
Notice that by changing Oxygen we also Changed Iron. We need to go back and fix this!

Write out the updated RAP table. Can we balance the Iron? Sure! Multiply the # of Reactant Fe atoms by 2

	#R	atom	#P
2x	2	Fe	4
	6	O	6

Re-write the equation reflecting the new changes you've made
$4Fe + 3O_2 \rightarrow 2Fe_2O_3$

Do we have a balanced Chemical Equation now? Yes we do!

Have students write about balancing the equations and how they used math rules to solve them in a few sentences for a do now exercise.

1. Forming a color change, precipitate, and gas from three pure substances

Objective: The student will observe the reactions then discuss the mechanics in a paragraph.

To effectively demonstrate and create some magic when mixing chemicals, this group of experiments can be done with just the teacher as a demonstration or stations can be set up for groups. In this safe demonstration, the students can combine two clear colorless solutions and see the formation of a solid and a gas. The demonstration will consist of 2 stages; the first will create and color change and the second will produce a brown precipitate. The student will analyze, describe, and write about the chemical reaction and

make a note that all atoms in the reactants ended up in the product. This will demonstrate the Law of Conservation of Mass and, later, demonstrate the objective of balancing equations and how it relates to the Law as well. The objective will be for the student to explain that for a chemical reaction to take place, the reactants must interact, new bonds formed and or bonds broken, and energy given off or absorbed. The use of writing prompts is essential when describing abstract concepts for the first time. The chemical equation is: CuSO4(aq) + 2NH3(aq) + 2H2O (since they are both in soln.)-yields-Cu(OH)2 + (NH4)2SO4.

Sample writing prompts:

> Can you tell that something new was made when the copper II sulfate and ammonia reacted? Answer: A precipitate was produced.
>
> How can you tell that something new was made when these substances reacted with hydrogen peroxide? Answer: The color change and other precipitate are evidence of another chemical reaction.

Procedure

1. Pour 15–20 mL of copper II sulfate solution into a test tube so it is about ½ full.
2. Add about 10–20 drops of ammonia (1^{st} stage, Color change).
3. Add about 10–20 drops of hydrogen peroxide (2^{nd} stage, precipitate creation).

Materials needed:
Sodium Bicarbonate
Magnesium sulfate (Epsom Salt will work)
2 clear plastic cups
Test Tube
Water
Copper II sulfate (really any copper solution will work)
Household ammonia
Hydrogen Peroxide (3%)
Graduated Cylinder
2 droppers

Creating a color change and precipitate in a classroom experiment

The students will be able to first create a color change, using 2 colorless solutions, and then a form a precipitate with the same experiment. The copper compound is called "copper II" because copper can make different types of ions. It can lose one electron and be just Cu^{+} or it can lose two electrons and be Cu^{2+}. This type of copper ion is called copper II. The "sulfate" in copper II sulfate is also an ion. This ion is made up of more than one atom. The sulfate ion is made up of a sulfur atom bonded to four oxygen atoms and is treated as one ion (SO_4^{2-}). This will allow 2 different objectives and concepts to be

analyzed within the same demonstration. Follow all safety precautions regarding use, storage, and disposal of mentioned chemicals.

Materials needed:
Test tubes
Graduated cylinder
Sodium chloride
Hydrogen peroxide

Sample Writing Prompts for the Color Change and formation of a Precipitate Demonstration

Effective writing prompts are necessary to motivate and engage the student to write about the demonstration.
What chemicals are being combined?
What are the reactants and products?
What energy is needed to start the reaction?
Why did the color change?
Was there a temperature change during the demonstration?
Were any new molecules created? Why?
Were atoms rearranged or destroyed? Why?

2. Forming a Precipitate Key Concepts

The ions or molecules in two solutions can react to form a solid. A solid formed from two solutions is called a precipitate. The students will combine two clear colorless solutions (baking soda solution and calcium chloride solution) and see the formation of a solid and a gas. Students will analyze the chemical equation for the reaction and see that all atoms in the reactants end up in the products. The student can make the connection between the chemical equation and the real substances and see that the solid and gas produced in the actual reaction are also in the products of the equation.

Students will be able to explain that for a chemical reaction to take place, the reactants interact, bonds between certain atoms in the reactants are broken, the atoms rearrange, and new bonds between the atoms are formed to make the products. Students will also be able to explain that this definition applies to the production of a solid called a precipitate.

Sample Writing Prompts
What did you observe when you mixed the baking soda solution and the calcium chloride solution?
Answer: The solutions bubbled and little white particles of solid formed.
Did you observe a precipitate?
Answer: Yes. The white particles appeared after the two solutions were combined.

Do you think this was a chemical reaction? Yes. Why?
Answer: The two substances that were combined were liquids and the substances that were produced were a solid and a gas. These products seem to be different from the reactants.

Procedure

1. Use masking tape and a pen to label 2 plastic cups baking soda solution and calcium chloride solution.
2. Use a graduated cylinder to add 20 mL of water to each cup.
3. Add 2 g (about ½ teaspoon) of calcium chloride to the water in its labeled cup. Swirl until as much of the calcium chloride dissolves as possible.
4. Add 2 g (about ½ teaspoon) of baking soda to the water in its labeled cup. Swirl until as much of the baking soda dissolves as possible. There may be some undissolved baking soda remaining in the bottom of the cup.
5. Carefully pour the baking soda solution into the calcium chloride solution. Try not to pour in any undissolved baking soda. Observe.

Copper II sulfate is available from various chemical suppliers, including Sargent Welch, Product #WLC94770-06 or Flinn Scientific, Product #C0110. Follow all safety precautions regarding use, storage, and disposal of copper II sulfate and sodium carbonate. Sodium carbonate is Product #WLC94291-06 or #S0052.

Materials needed:
Calcium Chloride
Sodium carbonate
2 clear plastic cups
Test tube
Water
Copper II sulfate
Household ammonia
Hydrogen peroxide (3%)
Graduated cylinder
2 droppers

Materials for Each Group:
Baking soda
Calcium chloride
Water
Graduated cylinder
Measuring spoon (½ teaspoon) or balance
2 clear plastic cups
Masking tape

Pen

3. Creation of Hydrogen Through Use of a HHO Generator (Dry Cell and Wet Cell)

Objective: The student should be able to articulate in a paragraph or essay how the hydrogen is created and demonstrate to teacher the steps and illustrate a basic outline of the reaction.

Hydrogen is a good, clean fuel, producing only water as a by-product. Unfortunately, it produces so much energy that it can get out of control, resulting in an explosion. But, forget about that explosive part for a minute and think about the possibilities - Hydrogen as a New Clean Fuel - it could be the end of the energy crisis - but where would we get the hydrogen? Can we create Hydrogen from Water? Oh Yes! Like Magic!

$$2H_2O + ENERGY = 2H_2 + O_2$$

Notice now that the requirement is for energy to be ADDED TO the reactants. This is an example of an Endothermic reaction. This means that we could use Water as a Fuel! IF (and this is a big if) we could find an easy way to convert the water to hydrogen and oxygen, then the hydrogen could be used as a clean fuel.

One area open for exploration is the creation of hydrogen gas that will one day soon be powering out automobile, planes, and ships. One demonstration or experiment that would be useful and related to STEM is the use of an HHO dry cell hydrogen generator. This can be made cheaply and easily by any middle school science teacher with a few common household items. It is recommended that the teacher assembles the generator grid then the students can hook up the power source wire small wires with alligator clips and add water and saline solution to the plastic bucket. The experiment proposed in this unit consists of assembling a sealed unit with a window of Plexiglas/plastic that allows the students to visualize chemical reaction that creates the hydrogen bubbles. This demonstration will be a powerful visual tool, as well as practical way to prove the Law of Conservation of Energy, as well as a display for a chemical reaction. Also, the student will be able to ignite a small amount of hydrogen gas with a loud pop, demonstrating that hydrogen is highly flammable. This flammability experiment supports the fact that two or more elements with certain characteristics bond together and form entirely new substances that have no characteristics of the original elements.

The vocabulary word *catalyst* also can be demonstrated by adding sodium chloride (salt) or sulfuric acid to the water to speed up the production of Hydrogen.

4. Creating Hydrogen Gas (HHO) Generator (wet cell)

The teacher will be able to create hydrogen gas in a dramatic demonstration with a few stainless steel light switch plates available readily at Home Depot or any local hardware store. Contact your favorite electrician and he might have some old ones lying around! All that is needed is two long screws and 10 spacers (made from little snips of plastic tubing similar to the type your refrigerator uses for the icemaker hookup to your water line. Connect the plates together using 2 hollow wall anchors (available at any hardware store) in a grid configuration using the holes already in the plates (figure 1 and 3). The spacers keep the plates separated to create a large amount of surface area needed to generate the chemical reaction. Two alligator clips with wires attached to a 12 volt AC adapter is required to generate the energy needed to create hydrogen in a sodium chloride and water solution (pictured in figure 2). There are many videos online at you tube for inexpensive ideas for building a HHO generator. The plastic tubing is not needed for the open wet cell non-sealed generator. The hydrogen bubbles come up through the water and into the ambient air.

Items needed:
5 stainless steel light switch plates
2 hollow wall anchors
Plastic washers 1/8” thick
Plastic tub
120 volt to 12 volt converter
2 wires with alligator clips on end

Attach alligator clips to each of the opposite switch plate and submerge plates in a salt water bath. Plug in and bubbles will start. Any spark from a loose connection to the stainless steel plates could create a small explosion. Be careful of producing too much hydrogen in an enclosed space; it is highly flammable! The dry cell is much safer because it’s sealed, but more complex to build.

Figure 1

Figure 2

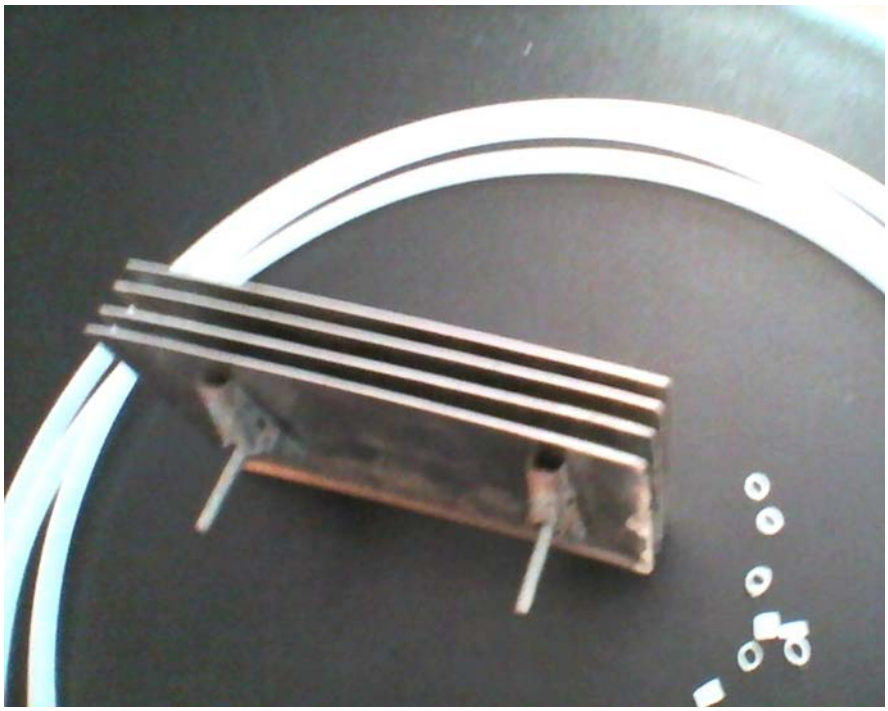

Figure 3

Figure 4

Figure 5

Figure 6

5. Creating a Hydrogen Gas Generator (dry cell)

A safer version of the wet cell HHO generator is the dry cell sealed HHO generator. This unit has plastic hoses that allow the hydrogen to be captured under or in water, instead of the hydrogen being dissipated through the water. This requires a little more engineering that the wet cell generator.

First cut the handles off the spatulas with a hack saw (figure 5). You will need to sandwich the spatula blades in between 2 plastic see through panels (figure 6) cut a great deal larger than the spatulas. The see-through panels need to be larger because of the bolts that will not go through the spatulas. Each layer will have to be sealed with some type of rubber gasket/spacer to keep the spatulas apart and the solution form leaking out. Rubber silicone gasket material from an auto part store is great to seal in between the spatulas. This is why this demonstration is called a dry cell HHO generator. Also needed are at least 8 large bolts to provide enough tension on the rubber gasket material to seal them. 10 holes (slightly larger than ½ inch) will need to be drilled (about the size of the plastic tubing) in the 2 plastic panels (8 for the sealing bolts and 2 for the hydrogen and solution hoses) to enter and exit the generator (figure 4). Before assembling the unit, attach two wires by soldering or clipping the wires to the 2 outer spatula parts; one will be negative and one will be positive. It is important to make sure the container of saline solution is up higher than the generator so that gravity will pull the solution into the generator. The current will flow through all the spatula ends and the saline solution, creating hydrogen that will escape through the exit hose.

(5) Stainless steel spatulas with handles cut off with hack saw
(2) Pieces of clear plastic tubing (1/4 inch refrigerator ice maker tubing will work)
(8) ½ inch dia. 6 in. in length bolts, washers, and nuts
(1 tube) Rubber gasket material from an auto part supplier (to separate each layer and seal to prevent leaks)
(10) 1/8 plastic spacers/washers for spacing between spatulas to provide surface area
Epoxy or rubber gasket material in a tube to seal where tubing enters and exits the plastic panels on each side
Plastic hose (for the hydrogen to escape into water)

An excellent video to view the assembly of the dry cell generator is on you tube:
http://www.youtube.com/watch?feature=player_detailpage&v=dAoS6yMmffY

A flame can be utilized to ignite the small hydrogen gas bubbles at the water level. An entire lesson could be created just by demonstrating how powerful and explosive the newly created hydrogen gas is.

Writing Prompts for the Creation of Hydrogen Demonstration

Effective writing prompts are essential to motivating and helping students get started on what they intend to write.

What is happening during the chemical reaction?
Why are bubbles present?
Why is the hydrogen coming out into water?
What are the reactants and products?
Is energy needed to produce the reaction and creation of hydrogen?
How is energy being used to create the hydrogen?
What is the difference between and wet cell and a dry cell hydrogen generator?
What is the input and what is the output?
Why is the hydrogen flammable?

Appendix

Chemistry Background and Vocabulary

Vocabulary words, as any science teacher knows, are very important to comprehension of demonstrations and experiments. Proper grammar usage of terminology and vocabulary words can enhance the understanding of the unit. Also, teachers should provide a basic understanding of the Periodic Table of the Elements and the following vocabulary: (this list is not all-inclusive)

Conductivity: The intensive property of a material that indicates its ability to conduct heat (thermal) or electricity (electrical).
Density: The amount of matter in a given volume. Formula: D=m/v
Melting point: The temperature at which a solid changes state from solid to liquid.
Boiling point: The temperature at which a liquid begins to turn in to a gas (steam/vapor).
Reactivity: The rate at which a chemical substance tends to undergo a chemical reaction
Covalent bond: The chemical bond that involves the sharing of pairs of electrons.
Endothermic reaction: absorbs heat an "inside" reaction
Exothermic reaction: fire, "outside" reaction produces heat
Evidences of a Chemical Change/Reaction/Bonding
Open vs closed container
Reactivity: How Reactive are elements with other elements
Physical change vs Chemical change
Precipitate: A solid that forms and settles out after the reaction
Reactant: The elements before the reaction takes place
Chemical vs physical property
Evidences of chemical changes
Flammability: How easily flammable an element compound is
Ionic bond: A type of chemical bond formed through an electrostatic attraction between two oppositely charged ions. Ionic bonds are formed between a Cation (+ charge), which is usually a metal, and an Anion (- charge), which is usually a nonmetal or Halogen. *Pure* ionic bonding cannot exist: all ionic compounds have some degree of covalent bonding.
Combustion: The sequence of exothermic chemical reactions between a fuel and an oxidant accompanied by the production of heat and conversion of chemical species. The release of heat can result in the production of light in the form of either glowing or a flame. Fuels of interest often include organic compounds (especially hydrocarbons) in the gas, liquid or solid phase.
Combustion Reaction: A combustion reaction is when all substances in a compound are combined with oxygen, which then produces carbon dioxide and water.
Law of Conservation of Energy: Energy can be neither created nor destroyed; it only changes form (e.g.: chemical to thermal energy).
Law of Conservation of Mass: Mass (matter) can neither be created nor destroyed, although it may be rearranged. Balancing of chemical equations is a great way to reinforce this concept. **Element:** A substance that is composed of one type of atom; an element cannot be chemically separated.

Appendix 1: Implementing the Common Core Standards

North Carolina Department of Public Instruction Essential Standards and Questions
Students should be able to write fluently about and relate these sentences to any experiments/activities/demonstrations regarding each of these topics

- I can give real world examples of physical and chemical changes.
- I can perform an experiment that shows both physical and chemical changes taking place.
- I can perform an experiment that shows the mass of the product as being equal to the mass of the reactant in a chemical reaction that takes place in a closed container.
- I can balance a chemical equation so that the mass of the product is to the mass of the reactant.

These particular EQs can be answered with some simple experiments and demonstrations included in this unit. In each experiment/demonstration, I will be answering these questions in the activities area.

8.P.1.3:

1. How can you tell if a chemical change has taken place?
2. How do chemical changes affect the chemical makeup of a substance?
3. How do physical changes affect the chemical makeup of a substance?

8.P.1.4:

1. How does the mass of the product compare to the mass of the reactant after a chemical reaction has taken place in a closed container?
2. Explain how the mass might compare if the reaction took place in an open container.

North Carolina Department of Public Education 8th Grade Science Standards applicable to this unit.

- 8.P.1.3: Students know that physical properties involve things that can be measured without changing the chemical composition of the element. Physical properties include appearance, texture, color, odor, melting point, boiling point, density, solubility, polarity and many others. Chemical properties are those that will change the chemical makeup of the substance after a chemical change has occurred. Chemical properties include flammability and reactivity. Students know that a chemical change has taken place if the following are observed: gas production (bubbling or an odor), formation of a precipitate, production of heat and a color change.
- 8.P.1.4: Students know that the mass of the product is always the same as the mass of the reactant after a chemical reaction has taken place. Students know that mass cannot be created or destroyed.

Annotated Bibliography

Teacher Specific Resources

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American Chemical Society http://www.middleschoolchemistry.com website with great middle school lesson plans and experiments.

Partnership for 21st Century Skills, http://www.p21.org