The Mystery Reaction

A Lesson on Chemical Reactions

Tonya Williams
Kelly Miller Middle School
Washington, District of Columbia
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Research Host:
Dr. Georges E. Haddad
Howard University

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Editor's notes:

Website URLs listed in this resource were current as of publication, but may now be obsolete. If you know of a replacement URL, please suggest it in the resource's "Comments" section http://www.apsarchive.org/resource.cfm?submissionID=3726.

The APS encourages teachers to give students a copy of the "ABC" (Appropriate, Beneficial, Caring) rules for use of animals in the classroom, to discuss the rules, and to ask students to sign the "ABC" rules contract (see References). Also, teachers should have a plan for short term care of the animals (with supporting references for appropriate care guidelines) and for disposal or long-term care of all classroom organisms.

Teachers should carefully review any stimulus or environmental change for an animal being used in experiments or observations before students are allowed to use that stimulus. This is especially important if the stimulus could cause pain or distress to the organism. Teachers may be able to identify a less stressful stimulus for the students to use in their experiment.

Although mammals provide excellent opportunities for observational studies, they require particular care in terms of handling and may cause allergic reactions in some students. The teacher should check local and state guidelines before using mammals in the classroom.

Disclaimer:

This activity was created by the author and reviewed by the American Physiological Society. Any interpretations, statements, or conclusions in this publication are those of the author and do not necessarily represent the views of either the American Physiological Society or the funding agencies supporting the professional development program in which the author participated.

PURPOSE

The purpose of this lesson is to design an investigation and conduct an experiment that will allow students to explore the differences between physical and chemical changes. In this investigation, they are given the opportunity to develop a list of evidence for determining whether or not a chemical change has occurred.

OBJECTIVES

Upon completion of this activity, the student will:

- design and conduct an investigation
- formulate and test a hypothesis
- identify types of chemical reactions (color change, precipitation, gas production, changes in temperature, changes in properties)
- identify distinct chemical changes due to several chemical reactions.
- determine which chemical combinations are responsible for which chemical changes.
- create tables, charts and graphs to record and communicate scientific data.

GRADE LEVEL

This activity is designed for students in middle school grades 6th-8th.

PRIOR KNOWLEDGE

Students should have prior understanding of:

- how to distinguish between physical and chemical changes
- how substances react chemically with other substances to form new substances
- evidence of a chemical reaction such as color change, precipitation, gas production, change in temperature, and change in properties.

TIME REQUIRED

This lesson is designed for three to four days in a 45 minute class period.

INCLUDING ALL STUDENTS

The lessons are designed as student-centered in cooperative groups that would consist of four students. Each student will be assigned a task. This lab experiment incorporates a variety of learning styles:

- tactile (experimental work)
- auditory (poster presentations)
- kinesthetic (hands-on activities)

QUESTIONS TO ASK ALONG THE WAY

- How might new substances be formed by a chemical reaction?
- What types of changes might indicate that a chemical reaction has occurred?
- What chemical combinations are responsible for which chemical changes?
- How can a chemical change be identified?

Tonya Williams
Washington, DC
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APS Works in Progress

NATIONAL SCIENCE EDUCATION STANDARDS

Content
B.1.b
Substances react chemically in characteristic ways with other substances (compounds) with different characteristic properties.

Process
A.2-8
Design and conduct an investigation
Use tools to gather and interpret data
Use evidence to describe, predict, explain, model
Think critically to make relationships between evidence and explanation
Recognize different explanations and predictions
Communicate scientific procedures and explanations

DISTRICT OF COLUMBIA SCIENCE STANDARDS

8.3
Chemical reactions are processes in which atoms are rearranged into different combinations of molecules.
8.1
Scientific progress is made by asking relevant questions and conducting careful investigations.

MATERIALS

- 4 plastic sandwich bags that can be securely sealed
- a permanent marker for marking the bags
- 5 grams of Epsom salts (magnesium sulfate)
- 50 milliliters of household ammonia (ammonia hydroxide)
- 50 milliliters of hydrogen peroxide
- a slice of potato
- 10 grams of baking soda
- 10ml of red cabbage juice
- 5 grams of calcium chloride
- a glow stick
- a charcoal-activated heat pack
- goggles and lab apron for each student

SAFETY

- Goggles and apron should be worn at all times.
- Teacher will provide students with the materials and equipment needed to carry out each chemical reaction.
- Students must thoroughly wash hands at the end of the lab.

PREPARATION AND PROCEDURE

I. Day 1: *Introduction: "Activate prior knowledge"*

A. Teacher will use photographs illustrating a chemical changes (rust forming, digestion of food, combustion of fuels and extracting of metals from ore) and physical changes (ice melting, water boiling, an object broken into smaller pieces, a whole apple next to applesauce, etc.) to facilitate a class discussion with the students asking:
   - What changes are you observing in this reaction?
   - What are the differences between chemical and physical changes?
   - What are the roles of physical and chemical changes in nature?

PREPARATION AND PROCEDURE

Questions for further discussion:

- How might new substances be formed by a chemical reaction?
- What types of observations might indicate that a chemical reaction has occurred?

B. Students' prior understanding of a chemical reaction will be explored in K-W-L chart activity. The students will be organized into cooperative groups of four and the K-W-L charts will be distributed. The student will begin to explore what they know about chemical reactions and what they would like to know about chemical reactions. The students will be asked to at least generate 3 questions for each section.

II. Day 2: *Making the connection*

Based upon the questions in the "What they would like to know section?" of the K-W-L chart, students will use the Internet Treasure Hunt to further assist the group with understanding the process of a chemical change.

III. Day 3: *Engaging Scenario*

A. Students will carry out and observe six different chemical reactions. Students will also, develop a set of guidelines for determining the occurrence of a chemical change, "What is the evidence of a chemical change?" The student will be provided with an engaging scenario. The students will create a poster comparing their findings.

B. "Imagine you are associates at a chemical investigation firm. Your firm would like to submit an application for a million dollar contract. The contract requires background knowledge of the characteristics of chemical and physical changes. In order to qualify for the contract, your firm must develop a set of guidelines for identifying the occurrence of a chemical change. Your firm's challenge is to carefully observe a series of chemical reactions and create a list of the evidence for determining the occurrence of a chemical change. Your firm will be provided with the materials and equipment to carry out a series of six chemical reactions. Below you will find the sets for Reaction 1- 6. Your report must contain your observations and detailed information to make your claim. Your firm must also explain the five clues that an investigator can use to tell if a chemical reaction has taken place.

PREPARATION AND PROCEDURE

C. The students will work in groups of three to five students.

Reaction# 1
1. Put 5 grams of Epsom salts into a baggie.
2. Add 50 milliliters of ammonia solution to the baggie and close it.
3. Feel the baggie with your hands as the reaction proceeds.
4. Record all observations.
5. Let the baggie sit until you are finished with the other reactions and record and further observations.

Reaction# 2
1. Place a potato slice into a baggie.
2. Add 50 milliliters of hydrogen peroxide to the baggie and close it.
3. Feel baggie with your hands as the reaction proceeds.
4. Record all observations.
5. Let the baggie sit until you are finished with the other reactions and record any further observation.

Reaction# 3
1. Put 5 grams of baking soda into a baggie.
2. Add 10 milliliters of red cabbage juice and 50 milliliters of vinegar. Close the baggie.
3. Feel the baggie with your hands as the reaction proceeds.
4. Record all observations.
5. Let the baggie sit until you are finished with the other reactions and record any further observations.

Reaction# 4
1. Put 10 grams of calcium chloride and 5 grams of baking soda into a baggie.
2. Add 50 milliliters of red cabbage juice and close the baggie.
3. Feel the baggie with your hands as the reaction proceeds.
4. Record all observations.
5. Let the baggie sit until you are finished with the other reactions and record any further observations.

Reaction# 5
1. Activate the glow stick as instructed by your teacher.
2. Feel the glow stick as the reaction proceeds.
3. Record all observations.

Reaction# 6
1. Activate the heat pack
2. Feel the heat pack with your hands.
3. Record all observations.

PREPARATION AND PROCEDURE

IV. Day 4: *Evaluation: Poster Session*

A. Look over your observations for each reaction.
B. Categorize your observations using terms such as: bubbles, color change, etc.
C. Identify the evidence of a chemical change for each observation category.
D. The students will create a chart to record your observations.
E. The students will then use the observation table to design a poster. The students will develop a set of rules for determining when a chemical change has occurred.
F. The students will evaluate the posters of their peers. They will be given a rubric.

Teacher Tip: *Prepare all materials for student groups. To make red cabbage juice, cut up a quarter-head of red cabbage into small pieces. Boil the cabbages pieces in 500 mL of water until the solution turns dark purple. You may wish to try out the reactions for yourself in order to anticipate student observations.*

WHERE TO GO FROM HERE

The students will also research the works and life of Antoine Lavoisier as it relates to the idea of substances reacting with each other.

SUGGESTIONS FOR ASSESSMENT

- *Experimental design:* Students understanding how to perform and observe a series of chemical reactions will be assessed.
- *Poster Presentations:* Students will demonstrate their understanding of how to determine the occurrence of a chemical change by developing their own rules.
- *Peer Evaluations:* Incorporates student-centered instruction encouraging peer teaching.
- *K-W-L Chart:* The chart will assessed the student's prior knowledge as well as what the student has learned.

REFERENCES AND RESOURCES

1. American Chemical Society
http://www.chemistry.org
The American Chemical Society's website of chemistry information.

2. ClassZone
http://www.classzone.com
The website companion to McDougal Littell's chemistry textbook.

3. Fuel Cell Basics
http://americanhistory.si.edu/fuelcells/basics.htm
A general overview of fuel cells and historical materials relating to fuel cells.

4. Hsu, Tom (2002). *Foundations of Physical Science* (1st ed.). Maine: Cambridge Physics Outlet.

REFERENCES AND RESOURCES

5. Pearson Prentice Hall
http://www.phschool.com
The website companion to Pearson Prentice Hall's chemistry textbook.

6. Rubistar
http://rubistar.4teachers.org
A free tool to help teachers create quality rubrics.

7. WonderNet
http://www.chemistry.org/wondernet
Chemistry topics and activities for kids from the Education Division of the American Chemical Society.

KWL

What I *Know*
What I *Want* to Know
What I *Learned*

Name ____________________
Period ________

Topic of Discussion:	**How can a chemical reaction be determined?**	
What I *Know* about this topic/question	What I *Want* to know about this topic/question	What I *Learned* about this topic/question

Tonya Williams
Washington, DC

Internet Treasure Hunt Name: _____ Date: _____

This web info search will help you find information about the characteristics of a chemical reaction. You will be looking at pre-selected web sites to answer each question. It is important to not only find the information at the site, but also to consider who wrote the site, what their purpose is in writing it, and how credible (accurate) you think the information is.

Question 1: How can a chemical reaction be determined?		
	Site 1 *Physical and Chemical Changes* http://www.mcwdn.org/chemist/pcchange.html	**Site 2** *Distinction between Chemical and Physical Changes* http://dl.clackamas.cc.or.us/ch104-01/DistChemPhyChange.htm
Who created this web site (organization, etc.)?		
Why did they create it? (check all that apply)	☐ To provide factual information ☐ To influence the reader's opinion ☐ To sell a product or service ☐ I'm not sure	☐ To provide factual information ☐ To influence the reader's opinion ☐ To sell a product or service ☐ I'm not sure
How credible (accurate) do you think the info is?	☐ Very accurate ☐ Somewhat accurate ☐ Not very accurate ☐ I'm not sure	☐ Very accurate ☐ Somewhat accurate ☐ Not very accurate ☐ I'm not sure
What did you learn?		

Internet Treasure Hunt Name: _____ Date: _____

This web info search will help you find information about the characteristics of a chemical reaction. You will be looking at pre-selected web sites to answer each question. It is important to not only find the information at the site, but also to consider who wrote the site, what their purpose is in writing it, and how credible (accurate) you think the information is.

Question 2: What are the characteristics of chemical reactions?		
	Site 1 *What are Chemical Properties and Changes?* http://www.elmhurst.edu/~chm/vchembook/105Achemprop.html	**Site 2** *Chemical Reactions* http://www.chem4kids.com/files/react_intro.html
Who created this web site (organization, etc.)?		
Why did they create it? (check all that apply)	☐ To provide factual information ☐ To influence the reader's opinion ☐ To sell a product or service ☐ I'm not sure	☐ To provide factual information ☐ To influence the reader's opinion ☐ To sell a product or service ☐ I'm not sure
How credible (accurate) do you think the info is?	☐ Very accurate ☐ Somewhat accurate ☐ Not very accurate ☐ I'm not sure	☐ Very accurate ☐ Somewhat accurate ☐ Not very accurate ☐ I'm not sure
What did you learn?		

Chemical Reactions Name: _____ Date: _____

1. Create a chart to record your observations.

2. Look over your observations for each reaction.

3. Categorize your observations in the chart below by using terms such as: bubbles, color change, etc.

4. Identify the evidence of a chemical change for each observation category.

Observation category	Evidence of chemical change
Example: Bubbles/ gas formation	The formation of a gas indicates that a new substance exists as a gas at room temperature

Poster Session

1. Use the observation table to design a poster. Develop a set of rules for determining when a chemical change has occurred.

2. Each group will evaluate the posters of their peers. A rubric will be provided.

Poster Rubric

CATEGORY	4	3	2	1
Title	Title can be read from 6 ft. away and is quite creative.	Title can be read from 6 ft. away and describes content well.	Title can be read from 4 ft. away and describes the content well.	The title is too small and/or does not describe the content of the poster well.
Graphics - Clarity	Graphics are all in focus and the content easily viewed and identified from 6 ft. away.	Most graphics are in focus and the content easily viewed and identified from 6 ft. away.	Most graphics are in focus and the content is easily viewed and identified from 4 ft. away.	Many graphics are not clear or are too small.
Required Elements	The poster includes all required elements as well as additional information.	All required elements are included on the poster.	All but 1 of the required elements are included on the poster.	Several required elements were missing.
Content - Accuracy	At least 7 accurate facts are displayed on the poster.	5-6 accurate facts are displayed on the poster.	3-4 accurate facts are displayed on the poster.	Less than 3 accurate facts are displayed on the poster.

Poster Presentation Rubric

CATEGORY	4	3	2	1
Presentation Style	Team consistently used gestures, eye contact, tone of voice and a level of enthusiasm in a way that kept the attention of the audience.	Team usually used gestures, eye contact, tone of voice and a level of enthusiasm in a way that kept the attention of the audience.	Team sometimes used gestures, eye contact, tone of voice and a level of enthusiasm in a way that kept the attention of the audience.	One or more members of the team had a presentation style that did not keep the attention of the audience.
Information	All information presented in the debate was clear, accurate and thorough.	Most information presented in the debate was clear, accurate and thorough.	Most information presented in the debate was clear and accurate, but was not usually thorough.	Information had several inaccuracies OR was usually not clear.
Use of Facts/Statistics	Every major point was well supported with several relevant facts, statistics and/or examples.	Every major point was adequately supported with relevant facts, statistics and/or examples.	Every major point was supported with facts, statistics and/or examples, but the relevance of some was questionable.	Every point was not supported.
Organization	All arguments were clearly tied to an idea (premise) and organized in a tight, logical fashion.	Most arguments were clearly tied to an idea (premise) and organized in a tight, logical fashion.	All arguments were clearly tied to an idea (premise) but the organization was sometimes not clear or logical.	Arguments were not clearly tied to an idea (premise).
Understanding of Topic	The team clearly understood the topic in-depth and presented their information forcefully and convincingly.	The team clearly understood the topic in-depth and presented their information with ease.	The team seemed to understand the main points of the topic and presented those with ease.	The team did not show an adequate understanding of the topic.

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