



# Teacher-to-Teacher

Video Series  
for Secondary Educators

**TITLE: Chemistry in a Bag**

**PRIMARY SUBJECT AREAS:** Physical Science

**GRADE LEVEL:** 9-12

**OVERVIEW:** Chemistry in a Bag allows students to practice observational skills and note the difference between observation and inference. It also provides the student with the opportunity to design and perform simple inquiry investigations in order to answer a question posed by the instructor. By combining specific amounts of sodium bicarbonate, calcium chloride, and phenol red in a closed zip lock bag system, the learning experience focuses the student on the following concepts: physical properties of substances, evidence of chemical change, exothermic versus endothermic reactions, and reactants and products.

**APPROXIMATE DURATION:** One or two 50-minute learning sessions (depending on objectives)

## **LOUISIANA CONTENT STANDARDS:**

<http://www/DOE/assessment/standards/SCIENCE/pdf>

### **Science as Inquiry**

#### **Benchmarks:**

SI-H-A2 designing and conducting scientific investigations  
SI-H-A6 communicating and defending a scientific argument

#### **SI GLEs:**

3. Plan and record step-by-step procedures for a valid investigation, select equipment and materials, and identify variables and controls (SI-H-A2)
4. Conduct an investigation that includes multiple trials and record, organize, and display data appropriately (SI-H-A2)
9. Write and defend a conclusion based on logical analysis of experimental data (SI-H-A6) (SI-H-A2)

### **Physical Science**

#### **Benchmarks:**

PS-H-D1 observing and describing changes in matter and citing evidence of chemical change  
PS-H-D3 writing balanced equations to represent a variety of chemical reactions

#### **PS GLEs:**

21. Classify changes in matter as *physical* or *chemical* (PS-H-D1)

22. Identify evidence of chemical changes (PS-H-D1)  
26. Illustrate the laws of conservation of matter and energy through balancing simple chemical reactions (PS-H-D5) (PS-H-D3) (PS-H-D7)

**EDUCATIONAL TECHNOLOGY GUIDELINES: N/A**

**INTERDISCIPLINARY CONNECTIONS: N/A**

**OBJECTIVES:**

1. The student will make observations and form inferences.
2. The student will describe physical properties of different substances
3. The student will perform a chemical reaction.
4. The student will describe evidence of a chemical reaction.
5. The student will design an experiment.
6. The student will engage in an inquiry-based experience to determine what causes heat production.
7. The student will differentiate between physical and chemical change and between endothermic and exothermic reactions.

**LESSON MATERIALS AND RESOURCES:**

Per Cooperative Group of 4 Students

6-8 quart sized zip lock bags  
6-8 medicine-measuring cups  
4 plastic spoons or teaspoon sized measuring spoons  
toothpicks  
magnifying lenses  
100-500 mL bottle phenol red  
a small container of sodium bicarbonate  
a small container of calcium chloride  
trays for materials  
safety goggles  
"Reaction In A Baggie" Student Sheets (Attachment 1)  
"What Makes It Hot" Student Sheets (Attachment 2)  
student learning logs or journals

For Whole Group

Area for recording student hypotheses and results (dry erase board, overhead transparency, flip chart, etc.)

**TECHNOLOGY TOOLS AND MATERIALS:**

N/A

**BACKGROUND INFORMATION:**

Prior to this learning experience, students should be able to successfully make observations and draw inferences. In addition, students should be able to independently form hypotheses and engage in experimental design to conduct investigations in search of solutions to problems. Students should be able to differentiate between physical and chemical properties, as well as identify characteristics of a chemical change. If the teacher expects the student to draw

inferences based on pH, basic knowledge of acids, bases, and indicators must be attained. Furthermore, if the student is to successfully balance the accompanying chemical equation, understanding of chemical formulas, the Law of Conservation of Matter, and the ability to balance equations is required.

## LESSON PROCEDURES:

1. Prepare trays with appropriate materials for each cooperative group.
2. Review the following safety procedures with the students: wear safety goggles at all times during the learning experience; do not touch any chemical and remember to waft when determining if a chemical has an odor (a demonstration of the wafting technique may be required—hold the open container away from the face and with your free hand sweep the air above the container toward the nose to detect an odor); zip lock bags may explode if amounts of chemicals are increased; all experiments must be approved by the teacher before being conducted; if you come into contact with a chemical, flush the area with water (calcium chloride can be a skin irritant); dispose of all zip lock bags without opening them (the solution is acidic and can irritate eyes and skin); and wash hands following the learning experience.
3. Have the materials manager for each group obtain a tray of necessary materials and “*Reaction in a Baggie*” student sheet (Attachment 1).
4. Instruct the students to begin by carefully making observations of the three reagents on the tray: sodium bicarbonate, calcium chloride, and phenol red. Record all observations on the “*Reaction in a Baggie*” student sheet (Attachment 1).
5. Inform the students that they are then to follow the instructions on the student sheet and make further observations, recording them on the student sheet.
6. After the students have performed the reaction, have them share their results and record them on the board. Guide the students through effective questioning to the discovery that a chemical reaction has occurred and have them cite evidence to support this conclusion (gas produced, color change, temperature change, bubbling, new substance formed).
7. Pose the following question: “What makes the bag get hot?” Have the students brainstorm possible answers to the question and record them on the board.
8. Give each student a copy of the “What Makes It Hot?” student sheet (Attachment 2). Have each group design two different experiments that can be tested in search of an answer to the question posed. Inform students that all investigations must be approved before conducted. Make certain that all possible solutions posed are being tested by the class.
9. Have the students report their group results to the class and record them on the board.
10. Facilitate a discussion that leads the students to the discovery of which chemicals must be mixed in order to produce heat (both calcium chloride and an aqueous liquid are needed to produce the heat; sodium bicarbonate and the liquid will cause the bag to feel cold).

11. Introduce the terms “exothermic” and “endothermic” as part of the concept development to explain the differences in temperature. An exothermic reaction produces heat and feels hot; and endothermic reaction requires the input of energy in the form of heat and feels cool.
12. More experienced students can be challenged to balance the chemical equation that correlates to the learning experience and express their understanding of the Law of Conservation of Matter. In addition, connection to pH and acids and bases can be discussed as well as oxidation and reduction reactions (Attachment 3).
13. Have students differentiate between exothermic and endothermic reactions as well as physical and chemical change in a learning log or journal entry. Understanding of the balanced equation and other connections can be included in the entry as well.

### **ASSESSMENT PROCEDURES:**

The student’s ability to accurately record observations, draw inferences, and identify physical properties will be noted on the student worksheet. Student results will indicate the proper execution of the initial chemical reaction. The student’s ability to cite evidence of a chemical reaction on the student worksheet will indicate an understanding of the concept. Teacher approval of an independent inquiry process by the student to determine what makes the bag hot will indicate an understanding of experimental design. After analyzing experimental results, the student’s ability to determine what makes the bag hot will indicate the ability to successfully draw conclusions. Student learning log/journal entries differentiating between endothermic and exothermic reactions as well as physical and chemical change, will allow assessment of student understanding. The ability to successfully balance the equation plus demonstrate the connection to pH and the Law of Conservation of Matter will be recorded in Learning Logs as well.

A grading rubric for the “What Makes It Hot?” student sheet is provided in Attachment 6.

Guidelines to assist teachers in effective use of Learning Logs are provided in Attachment 4. A sample rubric for scoring Learning Log entries is provided in Attachment 5.

### **ACCOMMODATIONS/MODIFICATIONS:**

Because the students are working in cooperative groups, students with exceptional needs can be engaged in the learning experience through peer instruction and assistance. Group discussion will enable visually impaired students to visualize the experimental system. Due to the nature of the closed zip lock bag system, students can hold it and feel some of the changes that occur (bag swells as gas is produced, temperature change). Hearing impaired students will be able to follow the procedure on the student worksheet while observing and participating. With the assistance from students within the groups, most students should be able to successfully engage in the entire learning experience.

## **REPRODUCIBLE MATERIALS:**

Attachment 1: "Reaction in a Baggie" Student Sheet

Attachment 2: "What Makes It Hot?" Student Sheet

Attachment 3: The Reaction: Teacher Notes

Attachment 4: Learning Logs: Why Do We Have Students Keep Them?

Attachment 5: Rubric for Grading Learning Logs

Attachment 6: "What Makes It Hot?" Scoring Rubric

## **EXPLORATION AND EXTENSION:**

Further questions about the "Reaction in a Baggie" experience should be developed and tested as deemed appropriate by the instructor. Students can also develop independent investigations that allow the students to test different variable as they search for the answer to a question or solution for a problem.

## **LESSON DEVELOPMENT RESOURCES:**

Project LIFE, School of Biological Sciences, Louisiana Tech University

Linda Ramsey, School of Biological Sciences, Louisiana Tech University

Dr. William C. Deese, Department of Chemistry, Louisiana Tech University

Great Explorations in Math and Science (GEMS), Chemical Reactions, Lawrence Hall of Science, University of California at Berkeley, 1993, p. 12-25.

## **REFLECTIONS:**

Facilitating inquiry-based learning can be demanding in that it can require tremendous amounts of materials as well as enormous blocks of time. "Chemistry in a Bag" enables the student to engage in an inquiry based learning experience while keeping supplies needed, as well as time required, to a minimum. Multiple concepts are reinforced or introduced, as dictated by the objectives stated, and the students are fully engaged in hands-on/minds-on learning that facilitates connections in science.

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## ATTACHMENT 1

NAME \_\_\_\_\_

LAB GROUP \_\_\_\_\_

### Reaction in a Baggie

Record 5 physical properties of each of the following chemicals.

1. Calcium chloride ( $\text{CaCl}_2$ )

2. Baking Soda ( $\text{NaHCO}_3$ )

3. Phenol Red Solution

**Complete the following steps:**

1. Put about 8.4 g (5 mL or 1 teaspoon) of baking soda into a zip lock bag.
2. Add about 16.9 g (10 mL or 2 teaspoons) of calcium chloride to the same bag.
3. Mix the two chemicals. Describe what happens.
4. Measure 10 ml of phenol red solution in a medicine-measuring cup.
5. Put the container of phenol red solution into the zip lock bag so that the liquid does not spill. Press the air out of the baggie. Seal the zip lock bag.
6. Tip the vial of phenol red solution. Record your observations.

## ATTACHMENT 2

NAME \_\_\_\_\_

LAB GROUP \_\_\_\_\_

### What Makes It Hot?

What is required to make the mixture get hot?

#### *Experiment 1:*

**We mixed:**

**We observed:**

**We concluded:**

#### *Experiment 2:*

**We mixed:**

**We observed:**

**We concluded:**

**What has to be present for the mixture to get hot? (Answer in complete sentences.)**

## ATTACHMENT 3: *Teacher Notes*

### The Reaction

The need for you or your students to understand the precise chemical events that take place in this reaction will depend upon the level of student understanding prior to the learning experience and the objectives set forth by the teacher when planning. Scientific observation of the reaction itself is the essence of this learning experience. However, should there be a need for more concept development for higher-level students, the following information is provided to enhance the learning experience. **In any and all cases, DO NOT present this information to the students prior to the learning experience!**

- Calcium chloride, sodium bicarbonate (baking soda), and a liquid combine to produce a carbon dioxide gas
- Calcium chloride and water produce heat
- Phenol red is an acid/base indicator; it changes color in the presence of acids and bases. Baking soda is a base so it maintains the bright color of the phenol red at the beginning of the reaction. As acidic products form, the phenol red changes color from bright pink to orange then yellow. Carbon dioxide gas is one of the acidic products formed. If the gas is allowed to escape, the liquids may turn slightly orange or pink again.

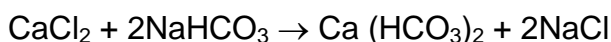
The results of the individual experiments should be as follows:

- $\text{NaHCO}_3 + \text{phenol red} \rightarrow \text{cold}$
- $\text{CaCl}_2 + \text{phenol red} \rightarrow \text{hot}$
- $\text{CaCl}_2 + \text{NaHCO}_3 + \text{H}_2\text{O} \rightarrow \text{hot}$
- $\text{NaHCO}_3 + \text{H}_2\text{O} \rightarrow \text{cold}$
- $\text{CaCl}_2 + \text{H}_2\text{O} \rightarrow \text{hot}$

Some of the products in this reaction include:

- Sodium chloride (NaCl): table salt
- Calcium carbonate ( $\text{CaCO}_3$ ): the main component of chalk
- Carbon dioxide ( $\text{CO}_2$ ): one of the gases we exhale

The events that take place in the zip lock bag are part of a dynamic and fairly complex reaction. Many individual events occur to form a series of intermediate products. High School teachers may want to challenge their students to determine the steps of the reaction and balance the equation. The following notation represents what takes place:



(According to disproportionate process by which a substance, in this case  $\text{Ca}(\text{HCO}_3)_2$  undergoes oxidation and reduction at the same time)

## **ATTACHMENT 4: *Teacher Notes***

### **Learning Logs: Why Do We Have Students Keep Them?**

Students who record observations over time improve their observational skills.

Students who record observations of living things over time recognize patterns and can identify similar patterns in other organisms.

Students who record observations and data in Learning Logs are acting as scientists do.

Students who write in Learning Logs improve their written communication skills and clarify their understanding of science concepts.

### **Why Do We Respond to Student Learning Logs?**

1. Responding to students' observations, comments, and answers to questions foster an on-going dialogue that results in a closer working relationship between the teacher and the student.
2. Posing questions based on students' observations causes students to reflect on their observations, observe more closely, and clarify inferences they make based on the observations.
3. Reading students' comments and answers to teacher-posed questions help identify misconceptions or unclear understandings that need to be addressed.
4. Commenting on students' answers and asking probing written questions of students provides a mechanism for re-enforcing science concepts discussed in class.
5. Positive re-enforcement of students' improved observational skills, clearer understandings, and more insightful inferences provides opportunities to encourage continued hard work and increase students' confidence in their scientific ability.

## ATTACHMENT 5

### Rubric for Grading Learning Logs

- 0 Did not turn in Learning Log
- 5 Some observations; observations are sketchy, limited, or unclear  
Draws few or invalid inferences or does not support inferences with observations  
Does not answer all instructor's questions  
Does not include all assignments  
Does not use appropriate vocabulary to record observations, inferences, and answer questions
- 10 Clear and concise observations  
Draws valid inferences that are supported by observations  
All instructors' questions answered  
All assignments are included and completed  
Uses appropriate vocabulary to record observations and inferences and answer questions
- 12 All of the criteria for a 10 plus  
Observations are detailed and include sketches and diagrams  
Inferences are insightful and suggestions are made for ways to test hypothesis (inferences) generated by observations  
Thoughtful, in-depth answers provided to instructor's question

## ATTACHMENT 6

### “What Makes It Hot?” Scoring Rubric

0 points	No student sheet turned in
1-3 points	Hypothesis stated (answer to initial question posed); one experiment partially recorded
4-6 points	Hypothesis stated with one experiment fully recorded
7-9 points	Hypothesis stated; one experiment fully recorded; second experiment partially recorded
10-12 points	Hypothesis stated; both experiments fully recorded
13-14 points	Hypothesis stated; both experiments fully recorded; conclusion stated in an incomplete sentence (answer to second question posed)
15 points	Hypothesis stated; both experiments fully recorded; conclusion stated in a complete sentence