

THINKING AND ACTING LIKE A SCIENTIST

TEACHER'S GUIDE

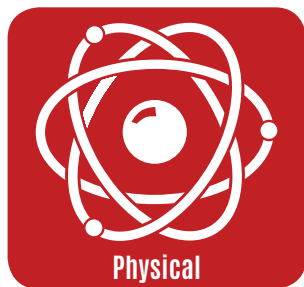
Chemistry in a Bag

Which chemicals are responsible for observed changes when Calcium chloride, Sodium bicarbonate, water, and a phenol red solution are combined?

GRADES 6–8

Physical Science





Chemistry in a Bag

Grade Level/Content	6–8/Physical Science
Lesson Summary	In this lesson, students will collect and use evidence to identify what chemicals are responsible for specific observations. They will also learn how matter can undergo both physical and chemical changes.
Estimated Time	2, 45-minute class periods
Materials	sealable quart bags, plastic spoons, Calcium chloride, Sodium bicarbonate, 0.2% phenol red solution, 10ml graduated cylinder, water, Investigation Plan , journal
Secondary Resources	<ul style="list-style-type: none">• Bozeman Science: Physical and Chemical Changes• Bozeman Science: Endothermic and Exothermic Reactions• Chemical Magic-Classic Clock Reaction
NGSS Connection	MS-PS1-2 Analyze and interpret data on the properties of substances before and after the substances interact to determine if a chemical reaction has occurred.
Learning Objectives	<ul style="list-style-type: none">• Students will identify physical and chemical changes.• Students will determine if a chemical reaction has occurred.• Students will use evidence to identify what chemicals are responsible for specific observations.

Which chemicals are responsible for observed changes when Calcium chloride, Sodium bicarbonate, water, and a phenol red solution are combined?

Matter can be identified by its physical and chemical properties. Physical properties refer to characteristics that can be observed without changing a material's chemical composition. Mass, color, odor, shape, volume, and density are some physical properties of matter. Chemical properties can only be observed by changing the chemical composition of the substance during a reaction. Chemical changes are also known as chemical reactions. In this lesson, students will explore the physical and chemical properties of matter and determine if a chemical reaction (change) has occurred. They will also design and conduct an investigation to identify the chemicals responsible for specific observations made in their plastic bag.

Investigation is based on the Van Andel Education Institute (VAEI) Instructional Model for Inquiry-Based Science.
In all investigations:



Students don't know the "answer" they are supposed to get.



Students play a driving role in determining the process for learning.



Teachers and students construct meaning together by journaling.



Students are working as hard as the teacher.

Part 1

INVESTIGATION SETUP

- Sealable quart bags
- Plastic spoons
- Calcium chloride (ice melt)
- Sodium bicarbonate (baking soda)
- 0.2% phenol red solution (in a dropper bottle)
- Water
- 10 ml graduated cylinder
- [Investigation Plan](#)
- Journal



Materials for Each Team

Part 2

INVESTIGATION FACILITATION



Personal Knowledge

Students capture what they already know about physical and chemical changes.

- Find out what students know about physical and chemical changes of matter.
- Have students share their ideas to create a class list. This list will be revisited after they conduct their investigation.

DISCOURSE

Conduct a *Pass the Paper* with students working in pairs. One student writes “Physical Changes” at the top of their paper and the other student writes “Chemical Changes” at the top of another piece of paper. Each student writes something they know about the word and passes it to their partner. They then add ideas to their partner’s list. Students continue to pass back and forth until the time is up.



Investigation Plan

Students conduct an experiment to observe the physical and chemical changes of Calcium chloride, Sodium bicarbonate, water, and a phenol red solution.

- Divide students into teams of two.
- Review the materials and [Investigation Plan](#) as a whole class.
- Have students complete Part I of the **Investigation Plan**. Ask students to record their observations before and after they mix the substances in the bag.

INVESTIGATION PLAN CHEMISTRY IN A BAG

Part I:

1. Gather all materials needed for this investigation.
2. Make observations of each substance before mixing them in the bag. Record your observations in your data table.
3. Lay the plastic bag on the lab counter.
4. Place 1 level spoonful of Sodium bicarbonate in one corner of the bag.
5. Place 1 level spoonful of Calcium chloride in the other corner of the bag.
6. Add 10 mL of water to the bag in a different spot.
7. Add 2 drops of the 0.2% phenol red solution to the water.
8. Immediately work the air out of the bag and seal it.
9. Mix all the materials in the bag and observe what happens using your senses.
10. Record all your observations.
11. When there are no more changes in the bag, carefully open the bag and pour the contents down the sink while running the water.
12. Rinse the bag well and dry it out with a paper towel.

Part II:

1. Design and conduct your own investigation to answer the investigation question. **Note: Because phenol red is diluted in water, be sure to include water any time you are testing with the phenol red.**
 2. Write your investigation plan in your journal. Have your teacher check your plan before you begin. Record your observations.
- Be sure to follow your teacher's safety guidelines and procedures throughout this investigation.*

Van Andel Education Institute | VAEI.org

Investigation Plan



Observation

Students record their observations.

- Have students create a data table and record their observations. (Possible observations: *first the bag was hot, then became cold, bubbles appeared and the bag expanded, the solution turned yellow*)
- Ask students to share their observations with another group and highlight any observations that were the same.

Part 1: Chemistry in a Bag	
Observations Before Mixing	
Water	liquid
.2% phenol red	liquid, looks like red food coloring
Sodium bicarbonate	fine, white powder (baking soda)
Calcium chloride	small, white spheres
Observations After Mixing	solution was warm at first solution cooled and stayed cold for a while the solution turned yellow and bubbled the bag expanded

Data Table Example



Question

Introduce the investigation question.

Which chemicals are responsible for observed changes when Calcium chloride, Sodium bicarbonate, water, and a phenol red solution are combined?



Prediction

Students communicate an expected outcome, based on prior knowledge.

- In their journals, have students make a prediction based on the investigation question using the following format: *I predict _____ because _____.*



Investigation Plan

Students design and conduct an investigation to answer their question.

- Have students develop their own investigation plan to answer the investigation question.
- Inform students to only use the phenol red solution when water is present. It may be helpful to demonstrate the combination of Calcium chloride, Sodium bicarbonate, and phenol red in the dry powder form. There will not be a chemical reaction with any of the combinations. Since the phenol red solution contains water, it can only be used when there is also water in the test.
- Check each group's investigation plan before they move on.
- If students are struggling to develop a plan, choose 1–2 student groups to share their investigation plan and discuss as a whole class.

CRITICAL THINKING

Use the [Fair Test](#) checklist to help students think critically about the investigation plan. Help them understand that a good investigation plan must include a test that is repeatable, generates quality data, and minimizes error. The more critically students think about their investigation plan, the more confident they will be in their results.

STUDENT CHOICE

Encourage students to collaboratively contribute to the development of the investigation plan. Offering students choices within set parameters lets them take a leadership role in their learning without losing focus of your learning objectives.



Observation

Students record their observations.

- Have students create a data table to record their observations.

PERSEVERANCE

Students may be challenged by how they should organize the data they collect from their observations. Encourage students to not give up and keep trying until they find a method that works consistently.

DISCOURSE

If students need additional support, it may be helpful to have students share examples with a *Research in Progress*. Choose 1 or 2 groups to share their investigation progress and allow time for the audience to respond with questions and/or feedback.

water	0.2% red phenolphthalein solution	sodium bicarbonate	calcium chloride	Observations
x		x		solution was a lighter red solution became cold
	x	x	x	slightly warm, then slightly cold, turned yellow
x			x	solution became warm no color change
x		x		solution became cold no color change
x		x	x	solution became warm first, then turned cold solution stayed cold many bubbles bag expanded no color change

Data Table Example

Part 3

INVESTIGATION ANALYSIS AND DEVELOPMENT OF CLAIM



Data Analysis

Students make sense of their data by organizing it and representing it visually.

Have students analyze their data. They may wish to use the [Data Analysis](#) prompt as a guide.

- Have students **evaluate** their data for trustworthiness. Ask students: *How confident are you in your data? What data do you wonder about?*
- Then, have them analyze their data to find patterns and trends. They may **organize** the data visually to construct meaning. Ask students to make connections between their initial observations from Part I of their investigation plan to those of Part II.
- Have students **interpret** what the identified patterns or trends mean.
- Ensure they have enough data that it can be used as evidence to support a claim.



Secondary Knowledge

Students use secondary sources to understand the difference between physical and chemical changes.

- Provide students with resources to deepen understanding of the difference between physical and chemical properties of matter before and after interactions.
- Possible resource: [Bozeman Science: Physical and Chemical Changes](#)
- Return to the list of physical and chemical changes made by the class at the beginning of the lesson. Determine what edits and additions should be made to the list.
- In their group, have students determine which data they collected are examples of physical and chemical changes. Add these changes to the class list.

Continued

- Have students find information regarding the chemical and physical properties of the chemicals used in this investigation. They will use this information in the reasoning portion of their explanation.

RICH LANGUAGE

This would be a good opportunity to discuss the difference between exothermic and endothermic reactions. Use [Bozeman Science: Endothermic and Exothermic Reactions](#) as a potential resource. Have students identify what reaction was exothermic (*Calcium chloride and water*) and what reaction was endothermic (*Sodium bicarbonate and water*) in their investigations.

OPENNESS TO NEW IDEAS

Students will find that there is conflicting information regarding the dissolving of salts in water. This can be argued as a physical or chemical change. Look at the information as a class and determine how you are going to identify this change.



Explanation

Students write a claim and provide evidence and reasoning to support it.

- Have students use what they've discovered from their analyzed data to write an explanation that answers their investigation question. Students may wish to use the [Explanation](#) prompt as a guide. Have them write their explanation in their journal.
- Have students develop a **Claim** to answer the question: Which chemicals are responsible for observed changes when Calcium chloride, Sodium bicarbonate, water, and a phenol red solution are combined?
- Then, have them add **Evidence** (the analyzed data) to support their claim.
- Finally, have them add **Reasoning** to their claim. Reasoning should include the information obtained from this investigation as well as science principles they have learned.

Claim

We claim that:

- *the phenol red solution was responsible for the color change when water, Calcium chloride, and Sodium bicarbonate were combined*
- *Calcium chloride and water were responsible for the heat given off*
- *Sodium bicarbonate and water caused the cold temperature change*
- *Sodium bicarbonate, Calcium chloride, and water caused the production of gas*

Evidence

When we mixed all 4 substances together, the bag first became warm, then it turned cold and stayed cold for a while. The solution turned yellow and produced a gas, causing the bag to expand. We found that when we tested 2 or 3 substances at a time, we were able to determine which chemical was responsible for our observations. For example, when we mixed water and Sodium bicarbonate, the temperature of the bag was colder. There was no gas released. The only time gas was released was when the Sodium bicarbonate and Calcium chloride were mixed together with the water.

Reasoning

Investigation: We followed Part I of the investigation plan very carefully. We are confident that the plan we wrote for Part II was a fair test. We recorded all data we observed and compared the data from Part I and II to answer the investigation question.

Continued

Science: From our reading and class discussions we learned that matter can go through physical and chemical changes. We observed a change when the Calcium chloride was mixed with water and the solution gave off heat. We learned that this was an exothermic reaction. There was conflicting information on whether this was a physical or chemical change. Since the solid disappears in water but can return back to Calcium chloride in the same form due to evaporation, we are going to consider this a physical change.

From our research we also learned that when Calcium chloride (dissolved in water) and Sodium bicarbonate (dissolved in water) are mixed, they react to form Calcium carbonate, Sodium chloride, water, and Carbon dioxide. The Carbon dioxide gas released is responsible for the fizzing and bubbling. This is a chemical change because new products were formed as a result of this reaction.

We learned that phenol red turns yellow in an acid. When Calcium chloride and Sodium bicarbonate are mixed with water, the CO_2 gas that is produced will react with the water and make the water acidic (carbonic acid).

- Once the explanation is written, have students discuss their results using a [Present and Defend](#).

DISCOURSE

Have students conduct a [Present and Defend](#) to develop presentation skills as well as audience participation. Research teams present a summary of their investigation to the class. The class analyzes the information presented and asks clarifying questions, challenges and/or supports the arguments made, and even presents alternative explanations as appropriate. Research teams defend their explanation with evidence and reasoning. If students are doing the same investigation plan, choose 1 or 2 groups to share.



Evaluation

Students reflect on the investigation.

Ask students:

- *What surprised you?*
- *What question would you like to investigate next?*

Part 4

INVESTIGATION ASSESSMENT AND EXTENSION



Application

Students demonstrate understanding of physical and chemical changes of matter.

- Have students use their knowledge and choose other substances to test. Have them determine if chemical reactions have occurred and provide evidence for it. (Examples: burning sugar, fat reacting with Sodium hydroxide, mixing zinc with Hydrogen chloride.) Then, have the students share their findings with the class.
- Nurture student curiosity about chemical reactions by demonstrating or showing video clips of chemical reactions (i.e., [Chemical Magic-Classic Clock Reaction](#)). Ask students: *How do you know this is a chemical reaction? How do you know a chemical change has taken place?*

Assessment

Evaluate how well students:

- identify physical and chemical changes.
- provide evidence determining if a chemical reaction has occurred.
- use evidence to identify what chemicals are responsible for specific observations.

For additional lessons or to customize this lesson, go to www.nexgeninquiry.org.

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INVESTIGATION PLAN

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