THINKING AND ACTING LIKE A SCIENTIST

TEACHER'S GUIDE

Mystery Powders

What substance is my mystery powder?

GRADE 5

Physical Science

VAN ANDEL EDUCATION INSTITUTE

VAEI.ORG

INQUIRY-BASED SCIENCE

Physical

Mystery Powders

Grade Level/ Content	5/Physical Science
Lesson Summary	In this investigation, students will explore the properties of solid matter by testing and observing a set of powders. They will collect data to be used to identify an unknown substance.
Estimated Time	3, 45-minute class periods
Materials	3 pounds of salt, 5 pounds of sugar, 4 pounds of baking soda, 4 pounds of cornstarch, 5 pounds plaster of paris, small clear cups, ¼ c measuring cup, wooden stir sticks, dropper bottles, small aluminum dishes for heating, heat source (hot plate, candles, or Sterno), hand lenses or dissecting microscope, spoons, iodine, vinegar, safety goggles, Investigation Plan, Observation Form, journal
Secondary Resources	Video: What's My Property: Crash Course Kids (5:08) Video: The Physical and Chemical Properties of Matter (5:42)
NGSS Connection	**5-PS1-3** Make observations and measurements to identify materials based on their properties.
Learning Objectives	• Students make observations about the physical and chemical properties of matter. • Students use evidence to identify an unknown substance. • Students will apply evidence from the investigation to develop an explanation that materials can be identified by their observable properties.
Cross-Curricular Project Connections	Science Fair, Tour Guide

What substance is my mystery powder?

Matter is everything around you. Matter is defined as anything that has mass (the amount of stuff in an object) and takes up space. Even air contains matter! Matter can be identified by its physical and chemical properties. Physical properties refer to the characteristics that can be seen without changing how that object looks. Mass, color, odor, shape, volume, and density are some physical properties of matter. Chemical properties can only be observed by changing the identity of the substance during a reaction, such as adding vinegar to baking soda. In this investigation, students will explore the physical and chemical properties of solid matter by testing and observing a set of powders. Then, they will use their data to identify a mystery substance.

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

Before the investigation begins, place the salt, sugar, baking soda, cornstarch, and plaster of paris in containers for students to access during the first part of the investigation. Next, put each substance in a smaller, numbered container (but not named) for each team to identify during part two of the investigation.

Materials needed:

- 3 pounds of salt
- 5 pounds of sugar
- 4 pounds of baking soda
- 4 pounds of cornstarch
- 5 pounds plaster of paris
- small clear cups
- ¼ c measuring cup
- wooden stir sticks
- dropper bottles
- small aluminum dishes for heating
- heat source: hot plate, candles, or Sterno
- hand lenses or dissecting microscope
- spoons
- iodine
- vinegar
- sponges
- paper towels
- safety goggles
- Investigation Plan
- Observation Form
- Journal

Part 2

INVESTIGATION FACILITATION

Personal Knowledge

Students capture what they already know about how materials are identified.

- Find out what students know about how materials are identified.
- Have the students share their ideas to create a class list. This list will be revisited later to clarify the difference between chemical and physical properties.

CURIOSITY

Nurture student curiosity about how materials are identified. Place a container of an unknown substance (baking soda, sugar, salt, cornstarch, plaster of paris). Ask students: *How are different materials identified? What properties can be used to identify a substance? How could you identify this substance?*

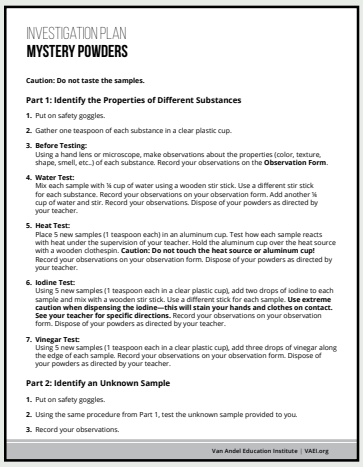
DISCOURSE

Conduct a *Think, Write, Pair,* Share to ensure all students participate. Ask them what they know about how materials are identified and give them think time. Then, have them write down at least four things they know. Have them share their thoughts with their partner, then call on a few pairs to share their ideas with the class.

Investigation Plan

Students investigate how various substances react with water, heat, vinegar, and iodine.

- Divide students into teams of two.
- Review the materials, Investigation Plan and Observation Form, as a whole class.
- Have students gather the materials they need for Part 1 of the **Investigation Plan**. Ask students to make observations before they test, and have them record their observations on the **Observation Form**.
- Provide students with the information that they will need to safely and properly test the 5 powder samples using water, heat, vinegar, and iodine.
- Have students test the properties of the 5 samples and record their observations.



INVESTIGATION PLAN
MYSTERY POWDERS

Caution: Do not taste the samples.

Part 1: Identify the Properties of Different Substances

1. Put on safety goggles.
2. Gather one teaspoon of each substance in a clear plastic cup.
3. **Before Testing:** Using a hand lens or microscope, make observations about the properties (color, texture, shape, smell, etc.) of each substance. Record your observations on the **Observation Form**.
4. **Water Test:** Mix each sample with ¼ cup of water using a wooden stir stick. Use a different stir stick for each substance. Record your observations on your observation form. Add another ¼ cup of water and stir. Record your observations. Dispose of your powders as directed by your teacher.
5. **Heat Test:** Place 5 new samples (1 teaspoon each) in an aluminum cup. Test how each sample reacts with heat under the supervision of your teacher. Hold the aluminum cup over the heat source with a wooden clothespin. **Caution: Do not touch the heat source or aluminum cup!** Record your observations on your observation form. Dispose of your powders as directed by your teacher.
6. **Iodine Test:** Using 5 new samples (1 teaspoon each in a clear plastic cup), add two drops of iodine to each sample and mix with a wooden stir stick. Use a different stick for each sample. **Use extreme caution when dispensing the iodine—this will stain your hands and clothes on contact. See your teacher for specific directions.** Record your observations on your observation form. Dispose of your powders as directed by your teacher.
7. **Vinegar Test:** Using 5 new samples (1 teaspoon each in a clear plastic cup), add three drops of vinegar along the edge of each sample. Record your observations on your observation form. Dispose of your powders as directed by your teacher.

Part 2: Identify an Unknown Sample

1. Put on safety goggles.
2. Using the same procedure from Part 1, test the unknown sample provided to you.
3. Record your observations.

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Investigation Plan

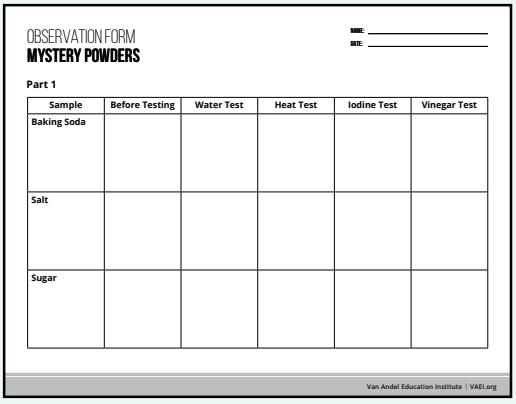
CRITICAL THINKING

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.

Observation

Students record their observations of the properties of five substances.

- Have students record their observations on the **Observation Form**.
- Ask students to share their observations with another group and highlight any observations that were the same.



OBSERVATION FORM
MYSTERY POWDERS

NAME: _____
DATE: _____

Part 1

Sample	Before Testing	Water Test	Heat Test	Iodine Test	Vinegar Test
Baking Soda					
Salt					
Sugar					

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Observation Form

Results should include:

Water: Baking soda turns a milky color and gets sticky, sugar dissolves, cornstarch turns to a soft solid, salt dissolves, and plaster absorbs water and hardens.

Heat: There will be no change for the baking soda, plaster of paris, and salt. The cornstarch will turn brown and smell like burnt toast. Sugar will melt, bubble, smoke, caramelize, turn black, and finally harden. The heat test is a good one to detect sugar.

Iodine: Plaster turns a mustard yellow color, baking soda turns brown, cornstarch starts out red, then ends black, sugar turns purple, and salt turns multi-colored.

Vinegar: Cornstarch thickens like glue, then hardens, baking soda fizzes, foams, bubbles, and makes noise, sugar partially dissolves, plaster bubbles, melts, hardens, and salt shows no change.

Question

Introduce the investigation question.

What substance is my mystery powder?

Prediction

Students communicate an expected outcome, based on prior knowledge.

- Randomly give each group one of the five substances (unlabeled) to identify.
- Have students make observations of their mystery powder before testing (color, texture, shape, smell, etc.) and record their observations.
- In their journals, have students predict what powder they believe to have been given using the format: I predict_____because_____.

Investigation Plan

Students investigate how a mystery substance reacts with water, heat, vinegar, and iodine.

- Have students gather the materials they need for Part 2 of the **Investigation Plan**. Provide students with the information that they will need to safely and properly test the mystery sample using water, heat, vinegar, and iodine.
- Have students test the properties of the mystery sample and record their observations in Part 2 of the **Observation Form**.

INTEGRITY

Encourage students to record data objectively. Discourage them from trying to identify their mystery powder before completing their tests and analyzing their data. Disciplined researchers collect data first and then analyze it. This helps to avoid biased data.

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. Have students make connections between their mystery powder data and the data from the five known powders.
- 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 how matter can be identified by its physical and chemical properties.

- Provide students with resources to deepen understanding of how matter can be identified by its physical and chemical properties. Possible resources include: What's My Property: Crash Course Kids and The Physical and Chemical Properties of Matter videos.
- Return to the list of properties made by the class at the beginning of the lesson. As a class, identify which properties on the list are physical and which are chemical.
- In their group, have students determine which data they collected are examples of physical (adding water and heat) and chemical (mixing with iodine and vinegar) properties. Add those properties to the class list.
- Provide students with resources (or have them find their own) regarding the chemical and physical properties of what they believe their mystery substance is. They will use this information in the reasoning portion of their explanation.

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: What substance is my mystery powder?
- 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 mystery powder is sugar.

Evidence

We observed both physical and chemical changes during this investigation. In water, our powder dissolved. This was a physical change. When mixed with vinegar, there was not much change. This was a chemical property that we tested. With the iodine, it turned purple. This was a chemical change. When we added the heat to our powder, it melted and eventually caramelized. Sugar was the only powder to carmelize when heated from our known data. This was a physical change. All of the observations of our mystery powder matched the data we collected for sugar.

Reasoning

Investigation: We followed the investigation plan carefully. We used the data we collected from our mystery powder and matched it with the data from the five known powders. We used the same procedure for both parts of the investigation.

Science: From our class discussions and resources we learned that matter can be identified by its physical and chemical properties. Physical properties include appearance, texture, boiling point, and how it mixes in water. Chemical properties are properties of matter observed during a reaction (mixing with iodine and vinegar), where the matter changes in what it is made up of. From our research we also learned that sugar is a colorless and odorless powder of small crystals that will melt into caramel when heated.

- Once the explanation is written, have students discuss their results using a Present and Defend.

Continued

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.

Evaluation

Students reflect on the investigation.

Ask students:

- What surprised you in this investigation?
- What question would you like to investigate next?

Part 4

INVESTIGATION ASSESSMENT AND EXTENSION

Application

Students demonstrate understanding by applying their learning in a new context.

- Have each pair create a mixture of 2 powders (1 teaspoon of each powder) and trade with another group. Have students repeat the investigation, following the same procedure, to determine the two mystery substances.
- Have students work in pairs to be crime scene investigators. Use the Science Olympiad Crime Busters Kit as a potential resource.

Assessment

Evaluate how well students:

- made observations about the physical and chemical properties of matter.
- used evidence to identify an unknown substance.
- collected data to serve as the basis of evidence for an explanation about the idea that materials can be identified by their observable properties.

Take This Lesson Across the Curriculum

Science Fair

You just found out that your school is hosting a science fair and you are so excited to share your knowledge of how matter is identified by its chemical and physical properties! You decide to investigate 4 different substances and how their properties help you identify them.

Reading/Language Arts	Math	Science	Social Studies
Mythbusters Read *Mythbusters Science Fair Book* and discuss ways you can use this information in your science fair set-up. CCSS.ELA-LITERACY.RI.5.9	**How much?** Determine the volume you will need of each substance using ml and cubic centimeters. CCSS.MATH.CONTENT.5.MD.C.4	**Mystery Powders** Use the information you learned about identifying properties of matter to design your own science fair project using 4 new mystery substances. NGSS: 5-PS1-3	**Back in the Day** Conduct research on how unknown substances have been identified during human history. Have we always used the same tests? How has technology influenced our identification of unknown materials? NCSS: D2.His.2.3-5

Tour Guide

Your class is going on a field trip around the school to make observations about the physical and chemical properties of matter. Your teacher has asked you to help plan this and be the official tour guide for the class.

Reading/Language Arts	Math	Science	Social Studies
Giving it Props Create a brochure for your class outlining the difference between chemical and physical properties and how to check for these properties along the tour. CCSS.ELA-LITERACY.W.5.2	**Timing is Everything!** Determine how long (in minutes and seconds) you can be at each stop along the tour. CCSS.MATH.CONTENT.5.MD.A.1	**Mystery Powders** Use the information you learned about identifying properties of matter to plan the tour and activities for your class. NGSS: 5-PS1-3	**Tour Stops** Construct a map showing the path of your tour. Share your map and the reason for choosing those particular locations. NCSS: D2.Geo.1.3-5

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

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INVESTIGATION PLAN
MYSTERY POWDERS

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OBSERVATION FORM
MYSTERY POWDERS

NAME: _____

DATE: _____

Part 1

Sample	Before Testing	Water Test	Heat Test	Iodine Test	Vinegar Test
Baking Soda					
Salt					
Sugar					

OBSERVATION FORM

MYSTERY POWDERS

NAME: _____

DATE: _____

Sample	Before Testing	Water Test	Heat Test	Iodine Test	Vinegar Test
Cornstarch					
Plaster of paris					

Part 2

Mystery Substance					