

POWDER PUZZLE

BENCHMARK and TASKS

SC.A.1.2.5 The student knows that materials made by chemically combining two or more substances may have properties that differ from the original materials.

- The student determines the properties of an object using qualitative observations and metric measurements that incorporate tools such as rulers, thermometers, balances, and graduated cylinders.
- The student observes the original materials and compares their properties to the properties of the new material produced in a chemical reaction.

KEY QUESTION

Can you identify a mystery powder by any chemical changes that take place when it is tested with different indicators?

BACKGROUND INFORMATION

Chemical properties of materials are demonstrated in reactions with other materials. When liquids are added to powders, students can observe bubbles and fizzing that indicate that a gas has been formed by the reaction. Color changes can indicate the presence of particular substances. Many chemicals react differently when heated. Heating can cause both **physical and chemical changes**. Vinegar indicates the presence of carbonates by fizzing and bubbling. Carbon dioxide gas is produced in such reactions. (Baking soda and vinegar will produce this gas.) Iodine can be used to indicate the presence of a starch by turning purple. Cornstarch mixed with iodine solution shows this reaction. Heating sugar causes it to form a liquid and then turn black. This type of change does not occur when heating the other powders in this activity. Salt does not react with vinegar, and iodine does not form a liquid nor turn black when heated.

MATERIALS

Per group

1 tray to hold the cups labeled
5 medicine cups labeled A-E
 5 mL cornstarch labeled A
 5 mL sugar labeled B
 5 mL baking soda labeled C
 5 mL salt labeled D
 5 mL Mystery Substance E
wax paper
2 copies of *Powder Puzzle* grid
paper towels
1 clothespin
newspaper

Per group (continued)

5 squares of aluminum foil
5 spoons labeled A-E
1 microscope and blank slides
2 droppers
2 dropper bottles of testing solutions:
 vinegar
 water
15 toothpicks
4 small squares of dark construction paper
Mystery Substance E (baking soda and sugar)

Per student

safety goggles
gloves
science journal
hand lens

Per teacher

matches
candle anchored with clay and foil
iodine, diluted 75 % water/25% iodine
vial of mystery powder (baking soda)

TEACHING TIPS

1. **Check student health records and ask parents if students have any allergies to iodine. Iodine is a mild poison.**
2. Buy 2-5 % strength iodine and then dilute it further by mixing it with water to create a weak solution – 75% water to 25% iodine – the color of weak tea.
3. The teacher should place the drops of iodine on the groups’ testing sheets so the students do not have to handle it.
4. Caution students not to taste anything during this activity.
5. A safe way to manage the heating of the chemicals is for the teacher to supervise a table with several candles and have students take turns heating a substance and then carrying the substance back to the group to observe. The teacher can also heat the substances, and when cool, the heated substances can be passed from group to group so students can record the results.
6. Have students wear gloves and safety goggles when handling the materials.
7. These tests should be conducted during several class periods.

ENGAGE

Show students a vial of Mystery Powder. Tell the class that you have been given this powder, and you need to determine what it is. You don’t want to taste it because you don’t know if it is safe to taste. Ask students for ideas on how to determine what is in the vial in a safe manner.

EXPLORE

1. Cover desks with newspaper. Distribute trays containing 4 medicine cups of mystery powders A-D and these materials: 2 copies of the grid, wax paper, 2 droppers, hand lenses, 1 bottle of vinegar, 1 bottle of water, spoons labeled A-D, a microscope, and toothpicks.
2. Tell students they are to work as a group on this activity, following these directions:
 - Have students label each dark square of paper A, B, C, and D. Then carefully place about ¼ teaspoon of each substance on the paper with the matching label. Using hand lenses and the microscope, students should observe each powder, noting color, consistency and texture. *Is this substance powdery or does it have a structure of crystals?* This information should be recorded on the grid under the “substances/observations” column.
 - Place one copy of the grid on your table and cover it with the wax paper. (Use the second copy of the grid to record the group’s observations.)
 - Place a bit of each powder down the first vertical column under *Water Test*. Drop approximately 2 drops of water on each substance and observe. Use a different toothpick to stir each substance. (Throw the toothpick away after each use.) Record your observations on the grid. If no reaction occurs, write “no reaction.”

- Place a bit of each powder down the second vertical column under *Vinegar Test*. Drop approximately 2 drops of vinegar on each substance and observe. Use a different toothpick to stir each substance. (Throw the toothpick away after each use.) Record your observations on the grid.
 - Place a bit of each powder down the third vertical column under *Iodine Test*. The teacher will walk by and drop approximately 2 drops of iodine on each substance while you observe. Use a different toothpick to stir each substance. (Throw the toothpick away after each use.) Record observations on the grid.
 - Have one student from each group shape a piece of aluminum foil into a bowl and attach a clothespin handle to create a spoon. Place some of the powder from cup A into the bowl of the spoon. The spoon should be taken to the candle station and heated under the teacher's guidance. The student who is heating the substance needs to have safety goggles and no loose clothing or hair that may accidentally get into the flame. After heating, the powder can be carried back to the group so observations can be added to the group's grid under "Reaction to Heat". (If the aluminum spoon containing the substance is placed right above the flame, heating occurs rapidly. A minute or less of heating is all that is required.) Have students continue this process for substances in cups B, C, and D.
3. Have students put the grids aside and then observe the powders again after a short time to see if any additional changes have occurred.

EXPLAIN

1. On the board write the following clues to the identity of the mystery powders.
 - Iodine will indicate the presence of cornstarch by turning purple or blue/black.
 - Vinegar will indicate the presence of baking soda by fizzing, which shows that a gas is being produced.
 - Water will dissolve substances such as sugar and salt at different rates.
 - Heat causes sugar to melt (change to a liquid) and then turn brown or black.
2. Ask students to use their grids to help them respond to these questions:

Which mystery substance reacted most dramatically with the iodine?
(Mystery Substance A)
What is the name of that substance? (cornstarch)
Which mystery substance reacted by producing bubbles when mixed with vinegar?
(substance C)
What is the name of that substance? (baking soda)
Which mystery substance turned black when heated? (substance B)
What is the name of that substance? (sugar)
Which of the mystery substances showed no reaction with vinegar, iodine, or heating? (salt)
3. Distribute samples of Mystery Substance E shown during the Engage activity. Students should place this sample on the grid in the spaces for Substance E, so they can compare it with the other powders. Have students observe the powder and then perform the water, vinegar, iodine, and heat tests. Using the results from the activity, students should be able to identify Mystery Substance E as baking soda due to its reaction with vinegar and the fact that it does not react with iodine or turn black or brown when heated.

EXTEND/APPLY

Make a mystery powder mixture by mixing baking soda and sugar. Students should perform tests on the mystery powder mixture and try to identify the substances it contains. In their science journals have students write the names of the two ingredients that make up the mystery powder mixture and a paragraph explaining how they identified those ingredients.

EXTENSION

Test each of the substances used in this activity by dropping a few drops of cabbage juice indicator on each one. Cabbage juice indicator can be made by placing several leaves of red cabbage in a sealed baggie of hot water and kneading until the liquid is dark in color. This will determine whether the substances are acids or bases. (Baking soda is basic, cornstarch is acidic, and salt and sugar are neutral.)

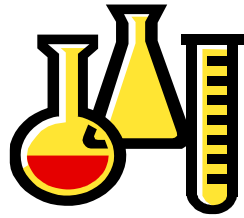
ASSESSMENT

Give students this scenario:

Last night a cherry pie disappeared from the school cafeteria. Several clues were left behind and discovered by the principal this morning. The first clue is a mysterious white powder found on the floor. One set of footprints was left in the powder. In addition, witnesses reported that four people were seen in the area: Salty Sammy, Sugar Susie, Baking Soda Billy and Corn Starch Clara.

Describe the test you could perform to find out what the mystery powder is and how you would decide who is guilty.

Student Scientists: _____



POWDER PUZZLE

Substance/ Observations	Water Test	Vinegar Test	Iodine Test	Reaction to Heat
Substance A				
Substance B				
Substance C				
Substance D				
Mystery Substance E				