Mystery Powders

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FCAT topics related to the study of mystery powders:

- Properties of matter—using tools to describe properties. Students should know the use for the following: Celsius thermometer, centimeter ruler, graduated cylinder, gram scale, balance, scale, measuring utensils
- Properties of matter—changing states. Students should know that common materials can be changed from one state to another by heating and cooling. States to know are gas, liquid, plasma, solid.
- Properties of matter—mixtures. Students should know that combining materials produces different substances which may have different properties.
- Properties of matter—physical and chemical changes. Students should know that physical changes (making mixtures) do not change the properties of each substance, but chemical changes (solutions or compounds) result in substances that differ from the original materials. Mixtures can be physically separated (e.g., salt and pepper, sand and pebbles) but solutions cannot be physically separated. Students should know that compounds and solutions are similar if not synonomous.
- Properties of matter—microscopic details. Students should know that materials are made of parts too small to be seen without magnification. Students should know that microscopes differ in power, that the smallest objects require the greatest magnification.

Vocabulary:

1. atom
2. change of state
3. chemical change
4. compound
5. density
6. element
7. evaporation
8. gas
9. heat
10. liquid
11. mass
12. matter
13. microscopic
14. mixture
15. physical change

Overview: Students will use the scientific method to determine the physical and chemical properties of seven commonly used white powders. Students will collect data from a series of tests and put together their findings to describe each of the powders.

Duration of study: Approximately five 60-minute sessions not including time needed to teach students how to use measurement tools.

Extension of study: Different microscopes and microscopic images will be incorporated. Students will be taught to use the simple (glass tube) light microscope, the QX3 and the QX5. Students will use observation skills and artwork to draw a representation of each powder's basic structure. Students will acquire the understanding that there is far more to each powder (and hence to all things) than can be seen with the naked eye.

Key concepts

A ***physical property*** of a substance can be observed or described; e.g., color, state of matter, texture, solubility, melting point.

A ***chemical property*** is the substance's ability to react chemically with other substances to create new physical and chemical properties.

A ***physical change*** occurs when the appearance of matter changes, but composition of the matter does not change. Changes in size, shape, color, odor, hardness, or in state such as gas, liquid, or solid are all considered physical changes.

A ***chemical change*** occurs when new kinds of matter are formed. The composition of the matter changes and the new kinds of matter have different properties from the old matter. Evidence of a chemical change may include a change in temperature, a change in color, or production of a gas or solid.

The mystery powders

1. **detergent**
2. **flour**
3. **salt**
4. **baking soda**
5. **powdered sugar**
6. **sugar**
7. **cornstarch**

(Other powders that could be used: plaster of Paris, powdered milk, baking powder)

Outcomes: The mystery powders in this activity have different physical properties, even though they are all white. Also, they will have different chemical reactions. Some will not react at all with the substance, only creating a physical change (wetting). Others will produce obvious chemical reactions.

The following changes and reactions can be expected in this activity:

1. Baking soda fizzes with vinegar (chemical reaction).
2. Cornstarch turns black with iodine (chemical reaction).
3. Plaster of Paris turns hard and warm with water (warm: chemical reaction; hard: physical change).
4. Sugar turns brown, then black with heat (chemical reaction).
5. Iodine changes powders to its own color, but does not create a new powder (physical change).

Students should demonstrate a greater comfort level with the microscope, both in their ability to operate it correctly and to explain its function.

Materials needed

White powders in numbered containers with lids
Measuring spoons
Candles
Lighter or matches
Construction paper (black)
Clothespins (spring, wooden)
Petrie dishes or other water resistant containers for testing powders
Hand lenses
Classroom microscopes
Plastic spoons
Stir sticks
Vinegar
Iodine
Water
Eyedroppers
Wax paper
Aluminum foil
Paper towels
Balance
Small container for determining volume
Paper cups
Toothpicks
Classroom microscope(s)

Background information on the powders:

Detergent - Synthetic, water-soluble cleaning agent that acts like soap. All detergents work in basically the same manner. They contain molecules that enable them to be soluble in water and to attract oil and dirt.

Flour - The finely ground grain of wheat, corn, oat, rye or barley used in breads, cakes and cookies.

Salt – sodium chloride; a colorless or white crystalline solid, found native in the earth, and is also produced by the evaporation and crystallization of sea water and other water impregnated with saline particles. Salt is used extensively in ground or granulated form as a food seasoning and preservative.

Baking soda – sodium bicarbonate; a naturally occurring earth mineral that is available in the form of a white powder at grocery stores. It is used as a deodorizer, in tooth cleansers, and also as a leavening agent in muffins, breads, cakes and cookies

Powdered sugar - Granulated sugar, also known as confectioners' sugar or icing sugar, that has been crushed to a fine powder.

Sugar - a simple carbohydrate molecule, composed of hydrogen, carbon and oxygen with the general formula Cx(H2O)y. Sugars are usually crystalline, soluble in water and have a sweet taste.

Cornstarch - A fine, white powder milled from dried corn; used primarily as a thickener for sauce and occasionally as an ingredient in batters.

Vinegar - A weak solution of acetic acid and water used in pickling, preserving, tenderizing, and to add a sour flavor to foods.

Iodine - is a chemical element in the periodic table that has the symbol I and atomic number 53. This is an insoluble element that is required as a trace element for living organisms. Iodine is primarily used in medicine, photography and in dyes. Tincture of iodine is a solution of iodine in ethyl alcohol; applied topically to wounds as an antiseptic

Caramel - Caramel is a mixture produced when sugar has been cooked until it melts to become a thick clear liquid ranging in color from gold to brown. Caramel is used to flavor soups, stocks, desserts, and sauces. Caramel candy is produced by melting sugar to between 320 F. and 350 F. When cooled, it is hard and brittle. Soft caramel, used as an ice cream topping, is made by mixing butter and milk with the caramel.

Plaster of Paris - Dehydrated gypsum that is mixed with water to form a rapidly setting material; used chiefly for casts and molds in the form of a quick-setting paste with water.

Baking powder - Commercial baking product combining three ingredients: baking soda, the source of the carbon dioxide that causes quick batters and doughs to rise; an acid such as cream of tartar, which when the powder is combined with a liquid, causes the baking soda to release its gas; and a starch such as corn starch or flour, to keep the powder from absorbing moisture.

Mystery Powders – Procedures

Preparing to test:
Students can work individually, with partners, or in small groups. Warn students not to taste the powders. To perform the tests, students will need a water resistant container (such as a petrie dish), an eyedropper, and a toothpick for stirring. Instruct students to take a small amount or powder for each test and to wash the container carefully to avoid contamination. Provide recording sheets or instruct students how to record their data after completing each test.

Using Senses to Observe Powders:
Ask students to use their senses of sight (with and without magnifying glass), touch, and smell to gather details about each powder. Record data.

Solubility Test:
Put equal amounts of each powder into water resistant containers. Add twenty drops of water. Students can tell the substance has dissolved if it is no longer visible. If the water is cloudy, substance is insoluble. Record data.

Iodine Test:
Repeat powder procedure. Dispense two drops of iodine onto each powder sample. If the iodine turns purple / black, starch is present. If the iodine doesn't change color, no starch is present. Record data.

Vinegar Test:
Repeat powder procedure. Dispense two to four drops of vinegar. A fizzing indicates a chemical reaction. Record data.

Heat Test:
Make a cup out of foil. Use a clothespin to hold foil cup over the flame of a small candle. Place small amount of powder into cup. Heat for up to two minutes if necessary. Repeat procedure for each powder. Record data. (Use only dry powders to avoid splattering.)

Using the microscope:
Allow students to practice viewing the powders using classroom microscopes. They can sketch the image they see and use it to compare the image obtained with the digital microscope. Instruct students in the use of the digital microscope, showing them how to focus, change powers, and obtain a photograph of their sample using the digital microscopes. Students will be able to sketch the structure of each sample using images from the microscope as a guide.

Assessment

Students will:

- Take a vocabulary quiz.
- Complete required data collection.
- Write to explain physical and chemical changes.
- Draw each crystal / powder particles as viewed under the microscope(s).

Relating the study of mystery powders to the FCAT:

Properties of matter—using tools to describe properties
Students will:

- Measure a sample of each powder using a teaspoon
- Calculate the mass of each sample
- Calculate the density of each sample (mass / volume)
- Calculate the temperature of the heated powders

Properties of matter—changing states

- Compare the solid powders to the liquids water and vinegar
- Compare sugars before and after heating (caramelization)

Properties of matter—mixtures

- Demonstrate properties of a mixture using available materials that are easily separated: e.g., different sizes of balls, different types of nuts, different colors of crayons.
- Relate mixture to powders. Have students choose 2-3 powders to mix together. Using a magnifying glass and a toothpick, is it possible to separate the powders after they are mixed? If time, make a mystery mixture for students to test after they finish the powders. Challenge them to determine which powders are in the mystery mixture

Properties of matter—physical and chemical changes

- Refer to the chemical changes observable in the vinegar, iodine and heat tests.
- Ask students to write to explain these chemical changes.
- Ask students to compare in writing physical and chemical changes in the powders.

Properties of matter—microscopic details

- Assign students to view each powder under the classroom microscope. Using the highest power, sketch each powder's crystal structure.
- Compare students' sketches to micro-images of each powder photographed on the environmental scanning electron microscope (ESEM).
- Finalize the project by preparing an identification sheet with an image of each powder, its name and its properties.

Information on the Digital Blue QX5 Computer Microscope:

- The QX5 is a computer microscope with a built in digital camera that allows you to see your specimens live on your PC. You can also take snapshots and video for further manipulation and experimentation.
- The QX5 kid microscope connects directly to your PC through the attached USB cable.
- The QX5 computer microscope allows you to magnify anything from 10x all the way to 200x.
- The QX5 kid microscope is the brand new version of the award winning Intel QX3 microscope powered by Intel technology

The Digital Blue QX5 Microscope lets you:

- View a variety of specimens
- Magnify objects and view them on your PC, up to 200X
- Take snapshots and time-lapse movies
- Manipulate images with drawing and painting tools
- Experiment with your creations using special effects and sound
- Share your discoveries through e-mail

The New Digital Blue QX5 Features:

- Super-brite LED lighting for brighter, longer lasting top and bottom illumination
- Higher resolution (640x480) for more detailed images
- Video playback now three times faster at 15 frames per second*
- Sample measurement tools built into the software

What comes with the Digital Blue QX5?

- Digital Blue QX5 Computer Microscope
- Software CD-ROM to view, capture and manipulate images - special effects enhanced for Intel™ Pentium ™ 4 Processor
- Lab Supplies:
- 2 specimen jars
- 2 containment dishes
- Sample slide
- Tweezers
- Eyedropper
- Slide Clip

Here's what you need:

- Intel® Pentium® or Celeron™ processor, 200 MHz or faster (or equivalent). Special effects are enhanced for the Intel® Pentium® 4 processor.
- Windows XP, 2000, 98, 98 SE, ME
- 32 MB RAM
- 150 MB free hard disk space
- SVGA 800 x 600 resolution video support (min. 16-bit color)
- 4x CD-ROM drive
- USB interface/port enabled
- 16-bit Windows-compatible sound device
- Direct X8 (included on CD-ROM)