Science Detectives

Summary

This activity is intended to introduce students to the difference between physical and chemical changes in matter.

Materials

Alka-Seltzer tablet
100 ml of water
100-200 ml graduated cylinder
Vinegar
Bromphenol blue indicator
Pipettes
- *Physical or Chemical Change?*

Small plastic baggies
Safety goggles
Metric rulers (optional)
Student white boards and markers

Additional Resources

Books

- *Kitchen Chemistry*
  , by John B. Bath, Ph D. and Sally C. Mayberry, Ed.D. ISBN 4-4222-1137-6
- *Simple Science Experiments With Everday Materials*
  , by Muriel Mandell ISBN 0-8069-5764-6
- *Hands-On Physical Science Activities*
  , by Marvin N. Tolman ISBN 0-13-230178-4
- *Science Experiments You Can Eat*
  , by Vicki Cobb ISBN 0-06-446002-9
- *Chemistry Matters*
  , AIMS Education Foundation, ISBN 1-3203-03-6
- *Crime Scene Investigations, Real Life Science Activities for the Elementary Grades*
  , by Pam Walker and Elaine Wood, Jossey-Bass ISBN 23812-48502

Videos

- *Chemical Reaction*
  , part of the Bill Nye The Science Guy Classroom Edition, by Disney
  http://dep.disney.go.com/educational/index Item #77AO7VLLOO

Organizations

The Children's Museum Of Utah, 840 N. 300 W. SLC, UT, 801-322-5268, www.childmuseum.org, contact Leah Zumbrunnen Outreach Manager lzumbrunner@childmuseum.org
The Chem Shop, 1134 W. 850 N. Centerville, UT 801-295-9591
Flinn Scientific Inc. www.flinsci.com (Item #B0065 Bromphenol Blue)

Background for Teachers

This lesson is intended to introduce students to the difference between physical and chemical changes in matter. When two or more materials are combined, either a chemical or physical change may occur. Chemical reactions are often indicated when materials: give off heat or cool as they take

in heat, give off light, give off gas, or change colors. In a chemical reaction or change, materials are changed into new substances. In a physical change, a new substance is not formed. It is important for students to continually use observation skills during this investigation. The teacher should continually check for student observation.
This activity involves the use of Alka Seltzer tablets. Stomachs can become upset as a result of excessive acidity levels. Alka Seltzer tablets contain sodium bicarbonate and citric acid. When the tablet is dropped into water, sodium citrate and carbon dioxide are formed. Sodium citrate is a weak base and neutralizes stomach acid (mainly HCL) Bromphenol blue is an acid base indicator. It turns yellow in the presence of an acid, in this case vinegar, and blue in the presence of a base, in this case the sodium citrate created from the Alka Seltzer reaction. Sometimes it is easier to locate bromothymol blue. Bromothymol blue can be used in the place of bromphenol blue. The pH range of bromothymol blue is not as sensitive to bases as bromphenol blue. When substituting with bromothymol blue, it is necessary to add one Tablespoon of baking soda with the Alka Seltzer tablet to the water. This will make the solution a stronger base, allowing solution color to return to blue once the acid is neutralized.
The *Physical or Chemical Change?* checklist will be used for all of the lessons. It includes the indicators for physical and chemical changes as outlined in the Core Curriculum. To help students make real life connections and practice determining the difference between the two types of changes, it is helpful to keep a large copy of the checklist on display. It is also helpful to have a visible writing space reserved for keeping an ongoing list of various chemical and physical changes the students observe in and outside of the classroom. Encourage students to look for physical and chemical changes in their environments and discuss the changes as a class.

Intended Learning Outcomes

1. Use Science Process and Thinking Skills
4. Communicate Effectively Using Science Language and Reasoning
5. Understand the Nature of Science

Instructional Procedures

Invitation to Learn
Read the scenario below to the students. Encourage them to take notes to determine if the incident was an accident or deliberate act.
Your class returned from lunch recess to find their teacher's favorite glass bell broken and shattered on the floor. You wonder if the broken bell was the result of an accident or a deliberate act. You decide to use careful observation and a review of the facts to determine if the bell was broken by way of an accident or on purpose.
This is what you know:
Two of your classmates have been not been getting along since the beginning of the school year. Violet thinks that Matilda is always trying to copy her. Violet is currently very upset with Matilda. One week before the teacher's birthday, Violet had told Matilda that she was planning on buying the teacher a glass bell for her birthday. The next day, Matilda told Violet that she had gone to the store and bought the glass bell as a birthday present for the teacher. Matilda gave the teacher a glass bell for her birthday. The teacher's birthday was two weeks ago. Since that time, Violet got in trouble for hiding Matilda's Science Fair Project on the day it was due.
The following events took place on the day the bell was broken:
Violet announced that she forgot her lunch money in the classroom. The teacher gave her permission to leave the lunch line and return to the portable classroom, alone, for her lunch money.
A group of third graders got in trouble at recess for playing wall ball on the side of your portable classroom -- the side of the classroom where the shelf hangs. The glass bell had sat at the end of the

shelf, the end of the shelf that was tilting down.
The morning of the accident, Melvin wanted the model airplane he had brought for Show and Tell to be kept safe. He asked the teacher if she would put it on the wall shelf. As the teacher lifted the model airplane onto the shelf and set it next to the bell, she said to Melvin, "Your plane is much heavier than it looks."
This is what you observe:
The wall shelf where the bell once stood has a loose screw and is slanting down. The end of the shelf where the bell once stood is lower than the rest of the shelf.
Melvin's model airplane is teetering on the end of the shelf where the bell once stood.
Aside from the glass shards on the floor, there are two pieces of glass from the bell on top of the file cabinet that sits just below the shelf.
Give students time to think about the information and ask clarifying questions before asking them if they think the described accident was an accident or a deliberate act. Discuss their conclusions. Relate their responses to scientific observations. Scientists use observations and knowledge to make the best possible conclusions. This will be valuable when helping students as they determine whether observed changes are chemical or physical. Sometimes a reaction or change can have characteristics of a physical and chemical reaction, leaving scientists to weigh the evidence.
Instructional Procedures

Discuss how scientists are often much like detectives. They must make frequent and careful observations. They use these observations as a way to collect information and make informed hypothesis and conclusions. Explain that we are going to use observation/detective skills to make some decisions involving changes in matter.

Give one Alka--Seltzer tablet to every two students. They will use their journals to record as many observations as they can about the physical characteristics of the tablet such as size, shape, marking and or chipping. Provide students with a metric ruler. Allow two to three minutes to make and record observations.

Collect the tablets from all of the groups. Mix them up and set them out on a table. Students must use their detailed observations to identify and retrieve their tablets.

Once groups locate their tablet, discuss some of the observation and location techniques that were used. Emphasize that they use observation of the physical characteristics of the tablets.

Instruct students to place their tablets in a small plastic bag. Using a heavier object such as the corner of a textbook, have them strike the tablet once. Record the observations, focusing on changes in appearance (size and shape--a physical change).

Explain to students that they will use their observations skills to observe the tablets (tablet pieces) as they react with other substances. Emphasize that they will need to be extra observant, because some of the reactions will happen quickly.

Each group of two to three students will add seven drops of bromphenol blue indicator to about 100ml of room temperature water. The water should turn blue. Ask the students, "Was this an expected color change?" Students will record any observations up to this point in their journal, under the heading "Step 1."

Each group will add a dropper full of vinegar to the bromphenol blue/water solution and record observations in their journal under the heading "Step 2" (the water should turn yellow). Ask the students, "Was this an expected color change?"

Each group will place their "Alka-Seltzer" tablets in the bromphenol blue/water and vinegar solution and record observations in their journal under the heading "Step 3" (as the Alka-Seltzer starts to fizz, the color changes back to blue/purple as the acid is neutralized). Ask the students, "Was this an expected color change?"

Share observations and discuss any discrepancies that arise between the observations. Ask the students to think about and discuss whether visual observations are always 100 percent

accurate. It is important as you prepare to introduce the difference between chemical and physical changes that students understand that we do our best to make accurate observations, but won't always arrive at absolutes. In other words, sometimes a color change can indicate a physical or chemical change, as can the production of a gas.

Introduce the *Physical or Chemical Change?* activity sheet. Because this sheet will be used for all of the investigations, it is important that students have a clear understanding of how to use it. Using the observations recorded in their journals, ask students to replay steps one to three in their minds to check all of the observations that apply on the checklist.

We categorize the way matter can change into two major categories--physical and chemical. There are general indicators or clues that can help us determine if a change is physical or chemical in nature. Review the clues/indicators on the checklist. Like the glass bell scenario, we use these clues or indicators in conjunction with observations to make educated conclusions.

Instruct students to look at the items they checked on the list for the Alka--Seltzer investigation to determine if the changes in each step were chemical or physical. Make sure students include changing the size and of the tablets when they crushed them and when the tablets dissolved in water as two of the changes (physical). Make sure students understand that the checklist includes many, but not all of the indicators of physical and chemical changes. We compare the checkmarks on both sides of the list to help determine if a change is physical or chemical. It may be necessary to repeat the experiment as a teacher demonstration, because the reactions happen so quickly.

Extensions

Curriculum Extensions/Adaptations/Integration

For students needing extra support, repeat the investigation as a teacher demonstration to give them another opportunity to make observations.

Challenge students to try other types of acids and bases, observe and compare the reaction to the ones they have already observed.

Challenge students to design an experiment, using water temperature as a variable.

Ask the students to think of or observe a physical or chemical change to share with the class on the following day

Family Connections

Send a copy of the *Physical or Chemical Change?* checklist home with the students. This will allow them to practice observation skills and classify changes in matter.

Test your family member's observation skills by using peanuts instead of Alka-Seltzer tablets. Observe as many physical characteristics of the peanut before mixing them together in a bowl and challenging family members to find their individual peanuts in the bowl.

Assessment Plan

After introducing the difference between physical and chemical changes, students will use individual whiteboards and markers to answer teacher questions. Questions might include, "Was the production of a gas in this experiment a physical or chemical change?, or are the color changes in this activity chemical or physical?" Scanning student whiteboard responses will help the teacher gauge understanding and determine pacing. The whiteboard responses can also be used at the end of the lesson to determine how much extra support students will need before moving onto other physical and chemical change investigations. This can be done using questions that relate to physical or chemical changes not observed in the activity. For example: vinegar and baking soda reacting to produce a gas, toasting bread, making ice cubes, melting ice cream.

Recorded observations and checklist.

A concept card sort can be used as a cumalative form of assessment. Using examples from the class generated list and learning activities, the teacher creates a set of 10-20 cards for each group of two students. Each card has an example of a physical or chemical change. Students first sort the cards into two categories, Physical Changes and Chemical Changes. Students will then sort the cards into more specific categories based on the indicators found on the *Physical or Chemical Change?* checklist

Classroom and small group discussions: When students are sharing solutions strategies throughout the activity using questions such as "Who has a different way to think about this?" For example: "mixing vinegar and baking soda produces a gas" would be sorted into a chemical change and more specifically, a change that produces a gas. Students glue the cards on a journal page and label sorting categories accordingly.

Bibliography

Burns, M. (Nov 2005). Looking at how students reason. *Educational leadership*,63 (3), pp.2-6

This activity uses a lot of classroom discussion. In this article, "Looking at How Students Reason," the author investigates the benefits of formative assessments such as small group discussions to provide insight into student thinking. She mentions specific strategies to get the most out of classroom and small group discussions. Among these strategies are: giving opportunity for whole group, small group and partner discussion and asking students to explain their responses. "Science Detectives" was designed to maximize the benefits of classroom discussion.

Leahy, S., Lyon, C., Thompson, M., & William D. (November 2005). Classroom assessment minute by minute, day by day. *Educational leadership* (63) (3), pp 21-22

This research-based article discusses the positive correlation between quality assessment and student learning. Specific strategies to integrate assessment and instruction are presented. Many of the assessments suggestions are formative in nature and require teacher flexibility. In other words, a teacher must be willing to shift gears mid instruction to meet the needs of his or her students. "To gauge understanding of the whole class, the teacher needs to get responses from the students in real time." One of the strategies used to check for student understanding in real time involves having each student write their individual responses to teacher's questions on small student whiteboards. The activity Science Detectives introduces what can be a difficult concept -- the difference between physical and chemical changes in matter. It is important that the teacher continually gauges student understanding and modifies instruction accordingly throughout the activity. For this reason, the use of student whiteboard responses is used throughout the activity.

Marzano, R., Pickering, D., Pollock, J., (2001) *Classroom instruction that works*, Alexandria, VA.ASCD

This text covers multiple research based strategies for increasing student learning and achievement. Explicitly teaching similarities and differences in relation to what students are learning "enhances their learning and ability to use knowledge." As encouraged in this text, this activity was designed to include both teacher and student directed opportunities to identify similarities and differences in chemical and physical changes. Research indicated that classifying is a "highly effective" form of comparing similarities and differences. Students use the Physical or Chemical Change? checklist to help guide them through the comparison process and eventually classify the reactions they observe.

Authors

Utah LessonPlans