



Drexel-SDP GK-12 ACTIVITY

A Functional Fountain

Subject Area(s): Chemistry, Geometry, Data Analysis & Probability, Physical Science, Science & Technology

Activity Title: A Functional Fountain

Grade Level : 6 (4-12)

Time Required : 1 ½ hours - 2 hours

Group Size: 3-4

Expendable Cost per Group: US\$1

Summary:

Students will use the scientific method to investigate the cause of the Diet Coke and Mentos reaction, which has become somewhat of an urban legend. Most will assume that this is a chemical reaction, but in fact it is a physical reaction. Students will enjoy making the huge geyser outdoors and afterwards will return to the classroom or laboratory to investigate the cause of what they observed. Using the scientific method, this inquiry based activity will reinforce experimental design techniques, illustrate the difference between a physical and a chemical reaction, and introduce the concept of surface area. Many types of engineers use and exploit this fundamental knowledge.

Engineering Connection:

The Diet Coke and Mentos reaction can be used to illustrate important concepts in chemistry, thermodynamics, fluid dynamics, surface science and the physics of explosions. In this lesson we'll focus on surface science, but extensions to this activity can be used in older grades to include more concepts. One of the main causes of the reaction is the increased nucleation sites provided by the rough surface of the Mentos. These sites allow carbon dioxide to turn into gas quickly and at the bottom of the bottle (since the Mentos sink.) Because of these factors a large eruption is observed. Materials engineers are developing increasingly smaller particles through nanotechnology. These particles have very high surface to volume ratios (high surface areas). Surface area is especially important in chemical kinetics and increasing the surface area of a

substance generally increases the rate of a chemical reaction. This property also allows engineers to use a smaller amount of a material which minimizes waste. Environmental engineers have developed and utilized materials with these properties for water treatment, where both fast and efficient chemical reactions and minimal waste are desired.

Engineering Category

(1) relates science concept to engineering,

Keywords

Surface area, nucleation, chemical reaction, physical reaction, surface science

Pre-requisite knowledge

Students should be aware that carbon dioxide is a dissolvable gas commonly found in soda.

Educational Standards

3.2.7.A Explain how certain questions can be answered through scientific inquiry and/or technological design*

3.2.7.B Use evidence, such as observations or experimental results, to support inferences about a relationship*

Learning Objectives

After this activity, students should be able to:

1. Explain the difference between a chemical and a physical reaction.
2. Identify the steps of the scientific method.

Materials List

2 liter bottle of Diet Coke (for demonstration)

2 liter bottle of seltzer (for demonstration)

6 pack of 12 or 16 oz. Diet Coke bottles (for class experiments)

1 -12 or 16 oz. bottle of regular Coke

1 – 12 or 16oz bottle of seltzer or carbonated water

1 – 12 or 16oz bottle of water

5 tubes of Minty Mentos

1 tube of Sugar-Free Mentos

1 tube of Fruity Mentos

1 small rock about the same size as a Mento

A yard stick for each group (9 minimum)

Measuring cups or graduated cylinders to share (4 minimum)

Plastic bins or basins (9 minimum)

Introduction / Motivation

Review the steps of the scientific method with the class.

Ask the class what happens when we combine baking soda and vinegar. (Do a demonstration.) Talk about how this is a chemical reaction pointing out that the reactants are no longer present at the end of the reaction. Ask the student what they could observe about the reaction (time, volume changes, presence of heat, odor, color changes, etc.) Tell the students that chemical reactions are not the only types of reactions. Define a physical reaction. Ask for examples (i.e. phase changes). Take the class outside for the demonstration.

Vocabulary / Definitions

Word	Definition
Surface area	The measure of how much exposed area a solid object has, expressed in square units
Physical reaction	the change in the appearance of a substance in which it can change back to its original state
Nucleation	A physical location where energy transfer is more efficient (due to high surface area) and phase changes can occur readily (like dissolved gases in liquids can become bubbles)

Procedure

Before the Activity

- Open a 12 or 16 oz bottle of Diet Coke and allow it to go flat.
- Prepare a minimum of 9 Mentos cartridges by drilling a small hole in 36 Mentos and stringing 4 Mentos together. You could also use a small amount of tape or roll them into a small piece of paper. This will allow you to drop them into the soda at the same time
- Take students outside and do two demonstrations:
 - Drop 3 Mentos into a freshly open bottle of Diet Coke
 - Drop 10 Mentos into a freshly open bottle of Diet Coke
- Have the students document the experimental conditions in their notebooks: approximate temperature, height of fountain, approximate volume left in the bottle and appearance of the Mentos after the demonstration.

With the Students

Break the students up into 9 groups. Let them review their observations and discuss what their hypothesis is about the cause of the reaction for about 5 minutes. Form a class hypothesis and write it on the board. Discuss ways to test the hypothesis.

Tell the students what materials are available to test the hypotheses and assign experiments to the groups.

- Assign one of the following experiments to each group for this investigation:
Examine the same number of Mentos in equivalent volumes (12 or 16 oz.) bottles of:
 1. Diet Coke
 2. flat Diet Coke
 3. regular Coke

4. Seltzer or carbonated water
5. Bottled water

Also, examine the following in equivalent volumes of Diet Coke:

6. Fruity Mentos
7. Sugar Free Mentos
8. Regular Mento after the coating has been removed (the easiest way is to let the students dissolve it in their mouths)
9. Small Rock

Hand out the materials.

Have the students record the same observations they did during the demonstration in their notebooks: approximate temperature, height of fountain, approximate volume left in the bottle and appearance of the Mentos after the demonstration.

Make a graph of the heights of the fountains from each group on the board.

Interpret the results together. Guide the interpretation.

Wrap Up with the MythBusters episode (can be found on YouTube or at <http://dsc.discovery.com/videos/mythbusters-diet-coke-and-mentos.html>)

Investigating Questions

1. What did you observe to support your hypothesis?
2. Based on the result of the experiments what would your revised hypothesis be?

Assessment

Post-Activity Assessment

Have student hand in a lab report with their observations from both the demonstration and experiments, their hypothesis and an explanation of the results of the experiments.

Activity Extensions

See literature/references below.

References

Diet Coke and Mentos eruption. (2010, February 28). In *Wikipedia, The Free Encyclopedia*. Retrieved 16:14, March 4, 2010, from http://en.wikipedia.org/w/index.php?title=Diet_Coke_and_Mentos_eruption&oldid=346972740

Eichler, J., H. Patrick, B. Harmon and J. Coonce (2007) Mentos and the Scientific Method: A Sweet Combination *Journal of Chemical Education* Vol. 84 No. 7

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Owner

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A Functional Fountain Worksheet

Observations from class demonstrations:

2 liter coke with 3 Mentos

Approximate temperature _____

Approximate height of fountain _____

Approximate volume left in the bottle _____

Appearance of Mentos after demonstration (i.e. shiny, dull, rough or smooth in comparison to before the experiment)

2 liter coke with 6 Mentos

Approximate temperature _____

Approximate height of fountain _____

Approximate volume left in the bottle _____

Appearance of Mentos after demonstration (i.e. shiny, dull, rough or smooth in comparison to before the experiment)

What else did we learn from the demonstration?:

Hypothesis

Other thoughts:

Things we can do to test our hypothesis:

Examine the same number of Mentos in equivalent volumes (12 oz) bottles of:

1. Diet Coke
 2. flat Diet Coke
 3. regular Coke
 4. Seltzer or carbonated water
 5. Bottled water

Also, examine the following in equivalent volumes of Diet Coke:

6. Fruity Mentos
7. Sugar Free Mentos
8. Regular Mento after the coating has been removed
9. Small Rock

Other tests:

Circle the experiment that your group will test from the list above.

Explain what question(s) your experiment will answer.

Perform your experiment.

Record the following observations:

Approximate temperature _____

Approximate height of fountain _____

Approximate volume left in the bottle _____

Appearance of Mentos after demonstration (i.e. shiny, dull, rough or smooth in comparison to before the experiment):

Conclusions