Berkeley Engineers and Mentors

The Soda-Mentos Reaction

Lesson Type: Module
Target Grade: Elementary
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Brief Overview

In this lesson, students will learn about the properties of soda and will use scientific investigation to figure out what causes soda to react with mentos candy.

Teaching Goals

- Scientific method – plan, experiment, analyze results, experiment again, and draw conclusions
- To determine the basic properties of soda, mentos, and the gas in the soda which cause the mentos-soda reaction to happen.
- To have fun playing with soda and mentos

Agenda

- Introduction: What is soda?
- Investigating the Gas: Mentos-Soda Demo
- Investigating the Soda: What works and why
- Investigating the Mentos: Surface properties

Lesson Introduction

- Introduce what soda is to the students: water, sugar, and fizz. Along the way we'll ask what they think is in soda, etc. Then we'll talk about what the students think fizz is (we'll tell them at the end it's dissolved CO2 gas).
- Then we will demo the mentos and coke reaction out of a 710 mL bottle. We will capture the CO2 released in a balloon, allowing kids to see that the captured gas is not regular air.
- We will tell the students that the lesson will be focused on doing an investigation, using scientific skills to figure out what is going on in the mentos soda reaction and what causes it to happen.
- We will then split the students into groups and have them investigate the different properties of the soda, looking at the properties of both the mentos and the soda.

Module 1: Gas Investigation

Introduction

- For the students to determine what kind of gas is released in the reaction. A demonstration of the soda-mentos reaction will be done, inflating a balloon which the students can play with to determine that a gas is released in the reaction which is heavier than air.

Materials

- 4 uninflated balloons
- Two 710 mL soda bottle (2x, in case the first one doesn't work)
- One mentos per soda bottle

Material to Teach

- We would like to first give the kids an introduction to the exciting reaction that occurs between mentos and soda. The first thing they should see is that some kind of gas is released in the reaction – which we can capture in a balloon to study. Most importantly, the kids should see that it's different from air.

Procedure for Module 1

  - After the introduction, gather all of the students in a circle, preferably outside so it doesn't make a mess. Put ONE mentos inside of a deflated balloon, and place the balloon over the neck of a 710 mL soda bottle. Make sure to ask the kids what they think will happen. Then, carefully overturn the balloon until the mentos falls in, taking care to keep the soda bottle upright and the balloon *vertical*.
  - Also, prepare a regular mouth-blown air balloon, which will be for comparison with the CO2 balloon. Make it the same size as the CO2 balloon.
  - Observe the balloon inflating and ask the kids what they think is going on. It should be obvious that some gas is being released by the reaction. The question is, what gas?
  - Tie off the balloon carefully. Allow the kids to pass the balloon to each other, holding it and testing it relative to the air balloon. They should see that the CO2 balloon drops more rapidly in air (due to its higher density) than a regular air balloon does.

Notes for Mentors

- When the reaction happens the balloon will inflate to about half of its full inflatable size. Liquid will fire into the balloon – just hold it vertical and the liquid will drain back down (if you don't, the weight may make the balloon break off from the soda neck).
- CO2 has a molecular weight of 44 g/mol, compared to 29 g/mol for air. Our breath has CO2 in it, but only about 5%, so it will not be as heavy as the CO2 balloon. The CO2 balloon also has some air in it (which was initially in the soda bottle). Overall, the CO2 balloon will fall about 20% faster than the air balloon (it works!)

- If the students are confused about why one balloon floats and another sinks, make an analogy with water – things float in water when they are lighter (less dense) than water, and sink when they are heavier (more dense)

Module 2: Soda Investigation

Note: The following two modules will be done in 2-3 groups, indoors.

Introduction

- For the students to determine whether it is the fizz or the sugar in soda that causes the reaction. The students will experiment with the different ingredients of soda to discover what property of the soda causes the mentos-soda reaction to occur, and how the effect can be lessened or strengthened.

Materials

- A few cups
- Regular soda, plain water, plain sugar, and sparkling water (sugarless)
- Mint Mentos
- A few sheets of paper

Material to Teach

- After we told the kids that soda has three main ingredients: water, sugar, and fizz, we now give the kids each of these ingredients separately, so they can play with each one and see whether the mentos reaction works with each one. They should conclude that sugar has little or no effect on the reaction, but rather, fizz is what matters to the reaction.
- Throughout the lesson, the kids should use their various senses (not taste) to analyze what they are seeing. They should be able to see the gas bubbles leaving the mentos surface, hear the fizz coming out, etc.

Procedure for Module 2

- This one is easy to prepare for. Mentors should fill up the red cups to their mid-lower line (150 mL) based on what the students want to test.
- Mentors need to be a supporting role to the teams of students as they conduct experiments, and as they try to analyze their results. Mentors should encourage students to try different things with the tools in front of them (for example, try diluting the soda with water and see if the reaction is as strong), etc, without giving away the answers. The goal is to get kids to analyze a problem they haven't seen before, and use their observations and experiments to figure out what is going on. The mentors should make sure to include all students in the group activity.
- The students can write down their observations/conclusions etc on a piece of paper as they go along.

Notes for Mentors

- The mentors should understand that it's the fizz that causes the reaction to happen. One interesting thing is that if you add plain sugar (no mentos) to sugar water, the sugar itself causes a mentos-like reaction when it is dropped in. The sugar crystals can act as nucleation sites just as the rough surface of the mentos do. If the kids discover this, they will definitely find it hard to explain - so mentors should encourage them to think about it, but not to just conclude that it is sugar that causes the reaction (which wouldn't make sense, since the soda is already so sugary!)

Module 3: Mentos Investigation

Introduction

- For the students to determine what properties of the mentos cause them to react the way they do. Students will experiment with regular mentos versus special, smoothed-out mentos which no longer have a rough surface. They will find that the smooth mentos don't perform the reaction, and can observe the surface roughness versus smoothness with a magnifying glass. Students should conclude that the rough surface of the mentos plays a part in the reaction.

Materials

- Mentos
- Mentos which have been put in water and microwaved for 1 min, then taken out and left to cool overnight
- Soda
- Magnifying glass

Material to Teach

- Here we investigate what in the mentos causes it to react the way it does. We provide students with regular mentos, compared to mentos that we have prepared which are melted (the surface is now visibly smooth).We also give kids a magnifying glass so they can examine the mentos' surfaces more closely.
- The kids should hopefully see that it is *not* some chemical in the mentos interior that causes the reaction – rather it has to do with the rough surface. If you observe the mentos while it is in the soda, you can see CO2 bubbles forming on the surface and leaving – hopefully this should tip the students off that the surface facilitates the fizz leaving the soda.

Procedure for Module 3

- Fairly simple – just lay out the different materials, explain what they are, and let the kids experiment. Mentors should facilitate their experimentation and discussion of the results

Notes for Mentors

- The science: the rough surface of the mentos provides nucleation sites – areas where CO2 bubbles can form easily (due to lowered surface tension, etc), allowing them to be formed rapidly. When they are formed, they float up and are released, allowing more bubbles to be formed continuously. Remember that once the soda bottle is opened, the system will tend towards releasing fizz from the soda since it was previously over-pressurized with CO2. The mentos surface (and many other rough surfaces) just acts as a physical catalyst, speeding up the release of CO2.

Conclusion:

- At the end, briefly discuss with the students what they learned during the lesson, and what they think is going on in the mentos-soda reaction. Tell them that it is the soda's fizz which is being released as a gas, and that the rough surface of the mentos that causes this release to happen. Hopefully they figured most of that out already!

References

- http://www.newscientist.com/article/dn14114-science-of-mentosdiet-coke-explosions-explained.html
- http://antoine.frostburg.edu/chem/senese/101/consumer/faq/why-phosphoric-acid-in-soda-pop.shtml