

Test Tube Cannon

Overview: Today you get to combine a solid and a liquid substance to generate a gas that will pop the stopper off your test tube. The better you make your solution, the further the stopper will go.

What to Learn: You'll learn about the key ingredient in an explosive eruption like the one we're simulating in lab today.

Materials

- test tube
- rubber stopper
- toilet paper
- goggles
- distilled white vinegar
- baking soda powder
- measuring tape
- scale that weighs in grams
- ruler

Experiment

1. Put on your safety goggles. NO EXCEPTIONS!
2. Tear off a single sheet of toilet paper.
3. Pour a small pile of baking soda right in the middle of the toilet paper.
4. Fold the toilet paper in half, and then wrap the sides around until you make a mini-burrito or mini-plug. You want it to fit snugly into your test tube (but don't put it in there yet!)
5. Carefully pour vinegar into your test tube. You want about an inch (2-3 cm) of vinegar.
6. Gently push the toilet paper burrito plug into the test tube, but don't let it touch the vinegar yet.
7. Push in your rubber stopper, making sure it's nice and snug.
8. Point the stopper away from you or anyone else ... like straight up.
9. Place a thumb on the stopper and shake the tube several times. Remove your thumb before the stopper pops!
10. After you've tried this a few times, it's time to start taking real measurements. Here's what you do:
11. Place the sheet of toilet paper on the scale and zero it (hit "tare").
12. Add baking soda and record the mass of the baking soda (in grams) on your data table.
13. Fill your test tube with vinegar. Rest the bottom of the test tube on the table, and using a ruler, measure many centimeters of vinegar you added and record this number on your data table.
14. Roll up the toilet paper into the burrito plug and insert it into the test tube.
15. Add the stopper and shake!
16. Measure the distance that your stopper traveled in your data sheet and repeat the experiment until you've found the perfect ratio of baking soda and vinegar to make the stopper fly the farthest.

Test Tube Cannon Data Table

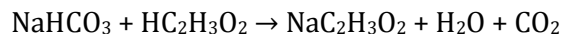
Trial #	Amount of Baking Soda	Amount of Vinegar	Distance Stopper Traveled

Reading

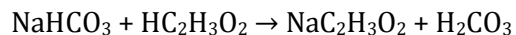
Active volcanoes create domes inside the eruption chamber which act like giant plugs, stopping up the magma and building up pressure until ... BOOM! The dome explodes and out comes all the material from inside, just like the plug in the test tube.

Baking soda (sodium bicarbonate) and vinegar (acetic acid) chemically react and combine to form carbon dioxide bubbles and a solid form of sodium acetate, which looks like little white flakes at the bottom of the solution.

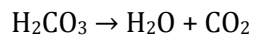
For baking soda and vinegar, the chemical equation for the reaction looks like this:



The chemical reaction actually occurs in two steps. The first reaction looks like this as the vinegar reacts with the baking soda to form sodium acetate and carbonic acid:



But the carbonic acid isn't a stable molecule, so it breaks down to make the carbon dioxide gas like this:



Since the bubbles are heavier than air, the carbon dioxide builds up and overflows, and stays in the test tube until you dump it out.

Exercises

1. Does the stopper go further when you add more or less vinegar?
2. Look at your answer for #1 above. Why is that?
3. Which gases are produced by this reaction?

Answers to Exercises: Test Tube Cannon

1. Does the stopper go further when you add more or less vinegar? (less)
2. Look at your answer for #1 above. Why is that? (More space for the gas to build up, leading to a higher pressure and a bigger "explosion.")
3. Which gases are produced by this reaction? (carbon dioxide)