

Hidden CO₂

Overview: If you've ever burped, you know that it's a lot easier to do after chugging an entire soda. Now why is that? Soda is loaded with gas bubbles — carbon dioxide (CO₂), to be specific. You will experiment to determine where carbon dioxide gas may be hiding in other household items. You'll also create your own scale to determine if CO₂ weighs the same as air, more, or less.

What to Learn: Focus on carbon dioxide for today's experiment. Where is it? How do you know? What does carbon dioxide look like as a solid?

Materials

Part I (Hidden CO₂)

- baking soda
- chalk
- distilled white vinegar
- washing soda
- disposable cups (3)
- popsicle sticks (3)
- Optional: Other items to experiment with: flour, baking powder, powdered sugar, or cornstarch (in place of baking soda/chalk/washing soda) and lemon juice, orange juice, or oil (in place of distilled white vinegar)

Part II (Bonus: Making a Scale to Measure CO₂)

- baking soda
- distilled white vinegar
- two disposable cups
- large container
- two water bottles or stacks of books
- two long pencils or skewers
- string

Experiment

1. Wear your gloves and put your goggles on. No exceptions!
2. Fill 3 cups with a few tablespoons of vinegar.
3. Put samples into each cup: chalk, sprinkle of baking soda, sprinkle of washing soda. Observe and fill out data sheet.

To continue with Bonus experiment (Making a Scale to Measure CO₂):

4. Construct a scale by following these steps:
 - a. Suspend a long dowel (pencil, skewer, etc) between two water bottles and attach with tape.
 - b. Use string to suspend two small disposable cups from either end of a second dowel.
 - c. Attach second dowel as a cross-piece across the first suspended dowel. Make sure the scale can go up and down very freely and easily and cups are balanced evenly.
5. In a large container, sprinkle baking soda to cover the bottom.
6. Add distilled vinegar just until bubbles reach the top of the container.
7. Wait a few minutes for the bubbles to completely pop. The container is now full of carbon dioxide gas
8. Pour gas into one of the cups and observe.

Hidden CO₂ Data Table

Mixture	Description of Reaction	Speed of Reaction
Vinegar + chalk		
Vinegar + baking soda		
Vinegar + washing soda		

Reading

If you've ever burped, you know that it's a lot easier to do after chugging an entire soda. Now why is that?

Soda is loaded with gas bubbles — carbon dioxide (CO₂), to be specific. And at standard temperature (68°F) and pressure (14.7 psi), carbon dioxide is a gas. However, if you burped in Antarctica in the wintertime, it would begin to freeze as soon as it left your lips. The freezing temperature of CO₂ is -109°F, and Antarctic winters can get down to -140°F. You've actually seen this before, as dry ice (frozen burps!).

Carbon dioxide has no liquid state at low pressures (75 psi or lower), so it goes directly from a block of dry ice to a smoky gas (called sublimation). It's also acidic and will turn cabbage juice indicator from blue to pink. CO₂ is colorless and odorless, just like water, but it can make your mouth taste sour and cause your nose to feel as if it's swarming with wasps if you breathe in too much of it (though we won't get anywhere near that concentration with our experiments).

The triple point of CO₂ (the point at which CO₂ would be a solid, a liquid, and a gas all at the same time) is around five times the pressure of the atmosphere (75 psi) and around -70°F. (What would happen if you burped then?)

What sound does a fresh bottle of soda make when you first crack it open? PSSST! What is that sound? It's the CO₂ (carbon dioxide) bubbles escaping. What is the gas you exhale with every breath? Carbon dioxide. Hmmm ... it seems as if the soda is already pre-burped. Interesting.

Exercises

1. How do you know carbon dioxide was inside the chalk, baking soda, and washing soda?
2. When the carbon dioxide bubbles popped, where did the carbon dioxide go?
3. What would happen to the chalk if you left it in the vinegar?
4. What is sublimation?
5. If you completed the bonus experiment, did carbon dioxide weigh more or less than air? How do you know?

Answers to Exercises

1. How do you know carbon dioxide was inside the chalk, baking soda, and washing soda? (When combined with vinegar, carbon dioxide bubbles were produced.)
2. When the carbon dioxide bubbles popped, where did the carbon dioxide go? (It stayed in the cup as an invisible gas.)
3. What would happen to the chalk if you left it in the vinegar? (It would eventually dissolve.)
4. What is sublimation? (when a substance goes from a gas to a solid)
5. If you completed the bonus experiment, did carbon dioxide weigh more or less than air? How do you know? (Carbon dioxide weighs more because when poured onto the scale it caused that side to lower.)