



Confounded Bubble Trouble

Games you can play at home

Equipment:

- 1) Ice cube tray
- 2) spoon
- 3) baking soda
- 4) salt
- 5) sugar
- 6) vinegar

Things to Try:

Experiment 1:

- 1) Put a spoonful of baking soda in one of the holes of the ice cube tray
- 2) Now sprinkle on some salt
- 3) Now sprinkle one some sugar
- 4) Now add a spoonful of vinegar and stir

Things to discuss:

Wow! Bubbles!

What did you need to do make the bubbles?

Well, you know you need vinegar because the powder didn't bubble until you added the vinegar.

But do you need baking soda AND salt AND sugar? Do you need all three or would just one ingredient work?



You can't tell, right? All three ingredients were present at the same time, so you can't tell which ingredient was the cause. Your evidence is **confounded**.

Can you think of a way to **isolate the variables**?

More things to try:

Experiment 2:

- 1) Put only salt in a different hole of the ice cube tray
- 2) Now add a spoonful of vinegar and stir

Things to discuss:

No bubbles, right? No bubbles – but your experiment succeeded! You isolated the variables and tried salt all by itself, without the sugar or the baking soda. Now you know that salt and vinegar do not make bubbles.

More things to try:

Experiment 3:

- 1) Put only sugar in a different hole of the ice cube tray
- 2) Now add a spoonful of vinegar and stir

Things to discuss:

Still no bubbles – but again your experiment succeeded! You isolated the variables and tried sugar all by itself, without the salt or the baking soda. Now you know that sugar and vinegar do not make bubbles.

One more thing to try:

Experiment 4:

- 1) Put only baking soda in a different hole of the ice cube tray
- 2) Now add a spoonful of vinegar and stir

Things to discuss:

Bubbles! Your experiment succeeded. You isolated the variables and tried baking soda all by itself, without the sugar or the salt. Now you know that baking soda and vinegar do make bubbles.

In Experiment 1, salt and sugar and baking soda were all present at once when the effect occurred so you couldn't tell which ingredients really made the bubbles. But you did a couple of experiments and now you know that salt and sugar aren't important but baking soda is.

Scientists often want to understand what makes things happen. However, if there are lots of possible causes of an effect and they all occur together, it's hard to tell what matters. When evidence is confounded, scientists can sometimes design experiments to separate the possible causes and test them one a time. By isolating the variables, scientists can figure out which factors are important and which ones aren't.

You might want to stop here!

In the Yana and Egbert series, we try to teach children how scientists think. We believe that understanding how scientists think is just as important, and often easier than, understanding the information that scientists have discovered. So you can stop right here. Your child can understand how to design a good experiment without understanding anything about chemical reactions.

However, in case you want an explanation for all those bubbles, we'll offer one -- but don't worry if you feel like it doesn't make sense to your child yet. It takes many years to learn everything scientists have learned about chemistry.

Why does mixing baking soda and vinegar make bubbles?

Baking soda, salt and sugar all look pretty similar. They are all white powders.

But if you looked at baking soda, salt or sugar under a powerful microscope, each ingredient would look very different from each other. Salt, sugar and baking soda are each made of their *own* special, tiny, ingredients called atoms.

Salt is made of atoms of Sodium and Chloride.

Sugar is made of atoms of Carbon, Hydrogen, and Oxygen.

Baking soda is made of atoms of Sodium, Hydrogen, Carbon, and Oxygen.

Vinegar is made of atoms too. In fact is made of exactly the same atoms as sugar -- Carbon, Hydrogen, and Oxygen (but with different amounts of each ingredient).

The smallest amount of salt, sugar, baking soda, or vinegar you can make with these atom ingredients is called a molecule.

When you mix baking soda and vinegar, the atoms act like tiny magnets. They tug at each other. This pulls the molecules of baking soda and vinegar apart. The vinegar lets go of its Hydrogen atom and the baking soda takes it.

When the Hydrogen atom from the vinegar snaps together with the Hydrogen and Oxygen atoms in the baking soda it makes a brand new thing -- water! (Water is made of two Hydrogen atoms and one Oxygen atom.)

What happens to the other atoms? Some of them combine to make a new kind of salt. The left over atoms are Carbon and Oxygen. They combine to make a gas called Carbon Dioxide. (Carbon dioxide is made of one Carbon atom and two Oxygen atoms.) The Carbon Dioxide escapes – and makes the bubbles you see!

Why don't you get bubbles if you mix vinegar with salt or with sugar?

When you mix salt or sugar and vinegar, there is no force pulling the ingredients apart. These atoms don't act like magnets. Instead, the molecules just move around. Pretty soon, instead of having a big group of vinegar molecules in one place and a big group of salt or sugar molecules in another place, the molecules of vinegar have gotten between the molecules of salt or sugar. When this happens we say that the salt or sugar has **dissolved** in the vinegar. But the salt and sugar is still there. If you taste the vinegar, it will be a little salty, or a little sweet. Because the salt is still salt, the sugar is still sugar, and the vinegar is still vinegar, there are no atoms left over to make anything new, like carbon dioxide. So – no bubbles!

