Lesson: “What would happen if you drank a glass of acid?”

VIDEO TRANSCRIPT

EXPLORATION VIDEO 1

Hi, it's Doug! In a previous Mystery, you learned that the alchemists were a group of people in ancient times who were convinced that it might be possible to create gold and become incredibly wealthy. To try to do that, they had workshops where they mixed all sorts of different substances. By substances, I mean they mixed together different stuff—powders, liquids, anything they could find. One of the substances that really got their attention was this—vinegar. You've seen what vinegar can do to a penny. It makes it all shiny and clean. But alchemists discovered something even more about vinegar, something weird. If you put metal, like this aluminum can here, and you leave it sitting in concentrated vinegar for a long time, watch what happens. This is a sped-up video. But you can see it's starting to bubble. It's doing something. Now, let's jump ahead a few days. Look at the aluminum can now. This video is still sped-up a lot. But you see this? You can see that given enough time, vinegar dissolves metal. The aluminum can disintegrates, as if eaten away by the vinegar. This property of vinegar was interesting to the alchemists. They thought maybe this could be the first step to figuring out how to transform a plain, ordinary metal into gold. So what is this vinegar stuff that the alchemists discovered? Well, these days, you can actually buy it in a grocery store. Vinegar is a clear liquid that's left when fruit or vegetables completely rot. This sounds gross, but as long as the food has completely rotted and it's just the vinegar liquid that's left, it's safe to eat. Why would anyone

want to do that? Well, you actually probably do eat vinegar. It's used in lots of foods. For example, it's one of the ingredients in salad dressing. It's used because it has a sour taste to it. Sometimes people want a sour flavor in their food and so they use vinegar. The alchemists were interested in vinegar, though, because it can dissolve metal. And soon they discovered vinegar is not the only liquid that could dissolve metal. There are other ones, too. Here's one of them—lemon juice. Now, if you think about it, that's kind of funny. Just like vinegar, lemon juice also tastes very sour. But you probably never thought to put metal in lemon juice. Well, let's see what happens. This is a steel chain in lemon juice. And you can see it's bubbling and starting to dissolve very slowly. So lemon juice and vinegar have at least two properties in common. They're both sour, and they can both dissolve metal. The alchemists then discovered even more liquids that can dissolve metal, like this. This is a liquid that was probably discovered when an alchemist was stirring a mixture of hot water and a yellow powder called sulfur. Watch what this liquid can do. This person is going to pour some into a glass container. And you can see she's wearing gloves. What she's going to do is she's going to put an aluminum can in there and leave it for a few minutes. And now, here, after a few minutes, look at this. Keep in mind, unlike the earlier video I showed you, this video is not sped up. Whatever this liquid is, it dissolves metal way more quickly than vinegar or lemon juice. Look at this. What is this liquid? I mean, is it really that similar to lemon juice or vinegar? Like, what would happen if someone tried to taste it? Well, seeing how quickly it dissolved metal, that's probably not a good idea to try to taste it. But back in the day, some alchemists actually did try a little taste of it, after watering it down a bit. And they discovered that it does taste sour. It's not a pleasant kind of sour like you'd want to put on food, but it is sour, just like vinegar and lemon juice are. So it was eventually decided that these three liquids—vinegar, lemon juice, and this strong sulfur water—they all seemed to have enough in common. They can all dissolve metal. And they all taste sour. It might be worth giving

them all a name. The word that we still have to this day comes from the Latin word for "sour," which is "acid." So altogether, all these liquids with these properties are called the acids. Vinegar is known more scientifically as acetic acid. Lemon juice contains something known more scientifically as citric acid. And this new one that was discovered by the alchemists because of its containing sulfur as part of the ingredients, it became known as sulfuric acid. Now, this probably isn't the first time you've heard the word "acid." What sorts of things does the word "acid" make you think of?

EXPLORATION VIDEO 2

Part of what makes an acid an acid is the fact that when you put something in an acid, it almost always reacts in some way. The alchemists were excited about the fact that acids can react with metal, dissolving it. But as you're about to see here with sulfuric acid, even putting a strong acid on a cheeseburger causes a reaction. Watch what happens. Now, this takes a little while, so we'll speed it up. Whoa. So, you see this? The cheeseburger turns black, and then dissolves. Now you know why it was a good idea for an alchemist to water down sulfuric acid before trying to taste it. Let me show you some more examples of how reactive acids are when you combine them with other substances. This is sulfuric acid being poured on sugar. Now, it'll take a little while to seep down all the way through the sugar, so we'll speed it up. But as it does, watch how it reacts. Whoa. So you can see this is really quite a reaction. The sugar turned black, it rose up, and it gave off steam. And there are other strong acids, too, that were discovered by the alchemists. Like this one is called nitric acid. Check out the kind of reaction you get when you put nitric acid on copper pennies. Whoa, you see that? Let's watch this again. Now, you notice first, the pennies turn green. Watch this. They change color. Then the pennies start to dissolve. And notice, the reaction gives off a reddish-brown gas. Interesting. You can imagine from these

examples I'm showing you, safety is really important when you're working with strong acids. What makes strong acids dangerous to work with, and the reason you actually can't buy strong acids unless you're a trained scientist or a teacher, is because strong acids are so reactive. If you were to get some on your skin, it would start reacting immediately and cause a burning feeling. Now, weaker acids, like vinegar and lemon juice, they don't react nearly as violently. I mean, come on, we eat things with this in it. But think about this. Have you ever had a cut, and then bit into something sour? How does it feel? It burns, doesn't it? So even weak acids still have that property. Acids can cause a burning feeling. So acids can dissolve things. They can cause things to change color. They can burn skin. What other ways do acids react? Well, why don't you experiment yourself and find out? You'll get to experiment with strong acids when you get to high school and college. But you don't need a strong acid to have fun and explore more of the acid reactions. You already know of at least two weak acids that you might have right in your own kitchen. So what other ways might acids react? Go ahead and experiment in today's activity.

ACTIVITY INTRODUCTION VIDEO

In today's activity, you're going to experiment like an alchemist. You'll start with vinegar, an acid known by every alchemist. You'll experiment to see how vinegar reacts with three different substances. Vinegar mixed with baking soda—that's a white powder that people use when baking. Vinegar mixed with a purple liquid made from beans or cabbage. And vinegar mixed with baking powder—that's a different white powder that people use when baking. Now, even though baking soda and baking powder look alike and have similar names, note that they're not the same thing. What will you observe? Will any of these react with vinegar? Now, to make sure any of these reactions are really because of vinegar being an acid, we'll also compare how

these react with water. After you figure out how acid reacts with these three things, you'll decide how you could test other things to find out if they're acids, too. You'll get one or two other substances that you can find in most kitchens or homes. Okay, I'll show you how to get set up, step by step.

ACTIVITY STEP 1

If you're in a class, find a partner. You and your partner will work with another team of two sharing supplies. If you're not in a class, you can do this activity on your own or with just one other person. When you're done with this step, press the arrow on the right.

ACTIVITY STEP 2

Cover your work area with newspaper or plastic.

ACTIVITY STEP 3

Decide which team is A and which is B. Then get these supplies to share. Team A, get the acid reaction supplies. Team B, get the testing supplies. Be careful not to mix up which cup is which.

ACTIVITY STEP 4

Set up your supplies in the center of the table, like this, so that both teams can reach them and share. You're going to put each cup on the correct spot, then put the straws in the liquids and the sticks in the powders.

ACTIVITY STEP 5

Get these supplies for you and your partner. You won't be sharing these with the other team; they're just for the two of you. Put them near your team on the table.

ACTIVITY STEP 6

Get your Mixing Sheet and your sheet protector. Carefully slide the Mixing Sheet inside the sheet protector. Then, check to make sure your setup looks like this. If you're missing something, go ahead and get it now.

ACTIVITY STEP 7

Now we're going to use these practice squares to practice an easy technique to move one drop of liquid onto the mixing sheet. Here's how to practice. Dip the straw into any of the liquids. Then, press a finger over the end. Move to a practice square and lift your finger off. Take turns with your partner, so that you can both practice. Use as many practice squares as you need, until you and your partner can move one drop of liquid on.

ACTIVITY STEP 8

Decide who will be Dropper and who will be Tester.

ACTIVITY STEP 9

Now it's time to figure out what reacts with acid. Let's do the first one together. We'll start by mixing water and baking soda. Dropper: put a drop of water in the first box. Tester: add baking soda to the water. Both of you: watch what happens.

ACTIVITY STEP 10

Both of you: on your Results Sheet, describe what happened when the water and the baking soda mixed. Now remember, sometimes you won't see anything happen. That tells you that the two substances did not react.

ACTIVITY STEP 11

Continue until you've completed all of the boxes' tests. The arrows tell you which substances to mix in each box. So, for example, mix vinegar and baking soda in this box. You'll mix purple liquid and water in this box. Make sure to stop after each test to write down what happened on your Results Sheet. Now, you can do the tests in any order. If you make a mistake, that's okay; that's part of the process of science. Just use a paper towel to soak up the liquid and try again.

ACTIVITY STEP 12

When you've done all the tests, answer questions one, two, and three.

ACTIVITY STEP 13

Discuss these questions as a group.

ACTIVITY STEP 14

If you're in a class, your teacher will have some substances for you to test. If you're working at home, you can check the refrigerator for possibilities. Get a substance to test, a toothpick, and a straw if it's a liquid or a stick if it's a powder.

ACTIVITY STEP 15

Put a drop of your substance in this box on your mixing sheet. Try your test. Stir it with a toothpick if you need to.

ACTIVITY STEP 16

On your Results Sheet, answer question number four.

ACTIVITY STEP 17

If you have time, test another substance. Write down the results of your test on your Results Sheet.

ACTIVITY STEP 18

When it's time to clean up, use a paper towel to soak up the liquid on your Mixing Sheet.

ACTIVITY STEP 19

Discuss, then watch the final video.

WRAP-UP VIDEO

So, what would happen if you drank a glass of acid? When you first heard this question, you might have assumed that acid only means a strong reactive substance that would be dangerous to get on your skin, or especially to drink. That definitely describes the strong acids like sulfuric acid and nitric acid. But the reality is that you probably drink or eat at least a little acid every day. I mentioned that at least two weak acids can be found in your kitchen: vinegar and lemon juice. But you might not have known how many different places the weak acids pop up in your life. Both of these weak acids are used for their sour taste, a property of all acids. Vinegar is a major ingredient found in most salad dressings, as I mentioned earlier, but also in ketchup. And that's not all. Look on the label of any food product you have. Find the ingredient list, and you can check for vinegar. Or sometimes, it's given by its scientific name, acetic acid. You'll see vinegar is a major ingredient, not just in ketchup, but also in mustard, and sometimes it's used in mayonnaise. And guess what happens when you take a cucumber and leave it soaking in vinegar? Well, that's what we call a pickle. Pickles are cucumbers that have been soaked in acetic acid, in vinegar. That's what gives pickles their sour taste. So you eat and drink acetic acid all the time, but what about citric acid, lemon juice? As you can guess from the fact that citric acid is found in lemon juice, it occurs naturally in lemons. And these are used to give a sour flavor to lots of things, including not just lemonade, but drinks like Kool-Aid as well. But lemons aren't the only food that contains citric acid. Oranges, limes, and grapefruits do, too. If you drink a glass of orange juice, you're drinking a glass that contains acid. It's just a weak acid, one that tastes good and doesn't cause you any harm. Now, besides having the property of tasting sour, you observed in the activity how acids also have the property of reacting with baking soda. Whenever an acid comes into contact with baking soda, it starts fizzing violently.

This reaction turns out to have some usefulness, actually. Next time you eat a sandwich, look closely at the bread. Do you see those little holes in it? Those are made by bubbles forming in the bread when it's baking. It's what gives bread that light fluffy texture. Well, that happens because when you make bread, you actually combine a weak acid with baking soda so that they react and fizz while the bread is baking, creating all those little bubbles in the dough. So next time you have lunch or dinner, drink a glass of acid, and eat some too for good measure. Stay curious, and see you next Mystery!