Lesson: “Can you identify a mysterious ingredient?”

VIDEO TRANSCRIPT

EXPLORATION VIDEO 1

Hi. It's Jay from the Mystery Science team. Have you ever watched one of those baking competition shows? I especially like the ones where the contestants have to do intense challenges. Like on this one show called The Great British Baking Show, I watched a challenge where the bakers had to make a super complex cake with only a sentence recipe to guide them and a bunch of jars of ingredients. Cooking and baking can be fun. Making a mess in the kitchen is a blast. But honestly, I often find it stressful too. The more advanced your recipe is, the more there is to keep track of. Now imagine the pressure of baking on that TV show. Those bakers make mistakes all the time. I mean, how could they not mess up? Like, you're doing a baking show challenge, and you get a recipe that includes these ingredients. Half cup of sugar, one teaspoon of salt, one tablespoon of baking soda. The timer starts, the pressure's on. You look at the ingredients, and you see this: four jars of white dust. They look so similar, and no labels. I mean, I suppose you could just randomly guess which ingredient is which—like, I could just guess that this one is sugar, this one is salt, and this one is baking soda…or maybe it's this one that's salt, and this one that's baking soda, and this one is something we can leave out. You probably already know that guessing could be risky. What could happen if you guessed wrong?

EXPLORATION VIDEO 2

The stuff in these four jars looks so similar, but not all ingredients that look the same are the same. Every ingredient has many unique things about it. It has many properties you can observe. For example, salt and sugar look a lot alike, but you probably know that they taste really different. Get the sugar and salt in a recipe mixed up, and your cake will go very wrong, very fast. Now, you might be thinking there's a simple way to tell sugar from salt: just taste it. And that's true. You might think taste is the most important property to pay attention to when you're cooking or baking, and taste is very important. But there are other properties ingredients can have that matter a lot in food too. My cousin once found out about an ingredient's hidden properties the hard way. When we were kids, my family went out for pizza. My cousin was little at the time, maybe two or three. He saw us big kids putting this cheese on top of our pizza slices. So he reached for a shaker to put cheese on his pizza too, but he got the shakers on the table mixed up. He put salt on his pizza instead. He shook out a little, but after a minute, the salt looked like it disappeared. So he put more on. But after a minute, that seemed to disappear too. So he put on more, and then more, and then more. When he went to take a bite, he made a big face. He did not like how it tasted, way too salty. The cheese and the salt looked similar, but they have at least one important property that's different, And that property has to do with what these ingredients do when they are mixed with other ingredients. Like, take a look at this. This is cheese, like the kind we put on our pizza, and this is table salt. Watch what happens when we mix each of these ingredients into a glass of water. What do you notice?

EXPLORATION VIDEO 3

When we mix cheese into a glass of water, the water looks, well, like a glass of water with little bits of cheese mixed in, which is what it is. It's a mixture of cheese and water. But look what happens when we mix salt and water. This is a mixture of salt and water, but after some mixing, the salt seems to vanish. The salt is still there. The salt has just dissolved in the water, so it looks like it's gone. The ability to dissolve is a property that some ingredients like salt have, and some ingredients don't. This is the property that got my cousin in trouble. When you put salt on a saucy slice of pizza, the salt dissolves. It looks like it disappears even though it's still there. So my cousin thought he needed more and more and more. If you don't know about the property of dissolving, like my cousin didn't, it's easy to add way too much salt by accident. Properties like these matter whether you're topping a pizza or baking a cake. Obviously, a cake tastes different depending on which ingredients you mix into the batter, but some ingredients can change a cake in ways that have nothing to do with flavor. Add a spoonful of one ingredient, and you'll get a cake batter that's light and fluffy. Add a spoonful of another, and you'll get a cake batter that's thick and dense. And that's all before you put the cake into the hot oven. Heat can reveal properties too. To get the results you want, you need to know more than just what your ingredients look and taste like. You need to know as many of your ingredients' properties as you can. So how could you figure out those hidden properties? What kind of tests could you do with an ingredient to identify its properties before you start baking?

ACTIVITY INTRODUCTION VIDEO

Welcome to the Great Mystery Ingredient Bake Off, the science baking show with a Mystery twist. Your goal today is to figure out which ingredients to use to make a cake. But there's a

catch: all of the ingredients you have are unlabeled. Each of these mystery ingredients has unique properties. Some of them can make your cake fabulous, while others could make your cake flop. To figure out which ingredients to use and which to ditch, you'll need to uncover their identities first. You'll do three rounds of tests: the Water Test, the Vinegar Test, and the Heat Test. Each one will help you learn more about the unique properties of the mystery ingredients. Then you'll use your observations of those properties to identify which ingredient is which. Can you identify the mystery ingredients correctly, or will your cake be a catastrophe? We'll get you started, step by step.

ACTIVITY STEP 1

Today, you'll work with a partner to identify the mystery ingredients. If you're working alone, that's okay too. When you're ready to move on, click the arrow on the right.

ACTIVITY STEP 2

Get your supplies. You'll get more later.

ACTIVITY STEP 3

Take a moment to set up your testing area so that it looks like this. Both partners should be able to easily reach the Water Test sheet and the four mystery ingredients. Make sure that all your mystery ingredient cups are in the right place. The numbers on the outside of the cups should match the numbers on the sheet. Also make sure each cup has a scooping stick inside with the matching number on the end.

ACTIVITY STEP 4

To learn more about your ingredients' properties, you're going to run some tests. Let's get ready for our first test, the Water Test. Before you do anything, we suggest you watch this step all the way through first. Pick up your ingredient 1 cup and its scooping stick and bring them near box #1 on your Water Test sheet. Then carefully scoop a little bit of the ingredient into the circle in the middle of the box like this. Repeat this until the circle is just about full. Try your best to keep the ingredient inside the circle. When you're done, put your cup and stick back in their place. Okay. Go ahead and do this for ingredient 1 now.

ACTIVITY STEP 5

Now, one at a time, scoop the other three mystery ingredients into the matching circles on your Water Test sheet: Ingredient 2 into circle 2, ingredient 3 into circle 3, and ingredient 4 into circle 4. As you finish with each ingredient, put its cup and stick back in its place.

ACTIVITY STEP 6

Now look closely at the mystery ingredients on your test sheet. Make sure to only use your eyes. In this game show and in life in general, you never want to taste unknown materials. Discuss with your partner. What can you observe about these ingredients? Do you notice any similarities and differences?

ACTIVITY STEP 7

Soon, we'll need to add small amounts of water to our ingredients. First, watch how we do it, then you'll have a chance to try for yourself. Lower your straw into the water cup. Make sure that

it goes all the way to the bottom. Then put your finger tightly over the top of the straw to trap the water inside. While keeping your finger tightly on top, carefully bring your straw to one of the practice areas. When the straw is just above the circle, lift your finger to carefully release the water. Now you try. Take turns picking up water with the straw and carefully emptying it into the circles in your practice areas. Only add enough water to fill each circle.

ACTIVITY STEP 8

Now let's find out if any of the ingredients have the property to dissolve in water. It's time for the Water Test. Let's test ingredient 1 first. Partner 1, you'll use a straw to add water to ingredient 1 on your Water Test sheet like this. Add a little bit at a time until you fill up the circle. Partner 2, you'll use a mixing stick to mix the water and ingredient 1 together, like this. Mix them together for at least 30 seconds. Your partner can help by counting out loud as you mix. Try your best to keep everything inside your test box. Observe and discuss what you notice as ingredient 1 and water are mixed together.

ACTIVITY STEP 9

Now you repeat this for the remaining three mystery ingredients. For each ingredient, trade off who uses the straw to add water and who mixes with the mixing stick. Carefully observe what happens with each one.

ACTIVITY STEP 10

Now that you've finished your Water Test, it's time to record your observations. Find the Water Test section on your Mystery Ingredient Observation sheet. Write down what you observed for

each ingredient. Did they start to dissolve? Did they change color? Write down everything that you noticed.

ACTIVITY STEP 11

Get the rest of your supplies. Then put a paper towel on top of your water test sheet like this to soak up the water. This will make sure water doesn't spill while we do other tests. Don't wipe it up, though. We'll save that clean-up for the end. Make sure to hold on to your straws. Then, trade in your cup of water for a cup of vinegar. Rearrange your testing area like this so your cup organizer is over your Vinegar Test sheet.

ACTIVITY STEP 12

Now, let's get ready for the Vinegar Test. Scoop each mystery ingredient into its matching numbered circle on the Vinegar Test sheet. Just like last time, make sure to put the correct ingredient in each circle. As you finish with each ingredient, put the cup and stick back in its place. Try your best to fill up the circles with the ingredients without going too far outside of the lines.

ACTIVITY STEP 13

Let's see what happens when you add vinegar to the mystery ingredients. For this test, the only tools you'll need are your straws. You won't need the mixing stick. Use the straw to carefully add vinegar into ingredient one on your vinegar test sheet like this. Observe and discuss with your partner. What do you notice as ingredient 1 and the vinegar combined? Now do the same thing for the remaining three mystery ingredients. Be sure to switch who uses the straw each time.

ACTIVITY STEP 14

Now that you've finished your Vinegar Test, it's time to record your observations. Find the Vinegar Test section on your Mystery Ingredient Observations sheet. Write down what you observed for each ingredient. When you're finished writing, put a paper towel on top of your Vinegar Test sheet to soak up the vinegar. Don't wipe it up yet, though. We'll save that clean-up for the end.

ACTIVITY STEP 15

For the final test, you'll observe what happens to the four mystery ingredients when they're put over a flame. It's time for the Heat Test. As you watch, pay close attention to what happens to each one as it's heated. We'll play the videos a few times. Write down what you notice on your Mystery Ingredients Observation sheet. If you feel like nothing happened, that's also an observation. We'll play the videos a few times. Here we go. When you're ready to move on, click the arrow on the right.

ACTIVITY STEP 16

Now that you've finished your testing and learned a lot about the properties of your four ingredients, it's time to solve the mystery. One of the mystery ingredients is baking soda. These are some of the properties of baking soda. Based on your observations, which ingredient do you think is the baking soda? Is it Mystery Ingredient 1, 2, 3, or 4? Discuss with your partner, then when you're ready to lock in your answer, write “baking soda” on one of these lines.

ACTIVITY STEP 17

One of the mystery ingredients is cornstarch. Based on your observations, which mystery ingredient do you think is cornstarch? Discuss with your partner. When you're ready to lock in your answer, write “cornstarch” on one of these lines.

ACTIVITY STEP 18

And finally, two of the mystery ingredients are salt and sugar. Based on your observations, which mystery ingredient do you think is salt and which is sugar? Discuss with your partner. When you're ready, write your final answers on your worksheet.

WRAP-UP VIDEO 1

Each test we did got us closer to understanding the properties of the mystery ingredients, and that helped us identify them. Ingredient 3 fizzed when we added vinegar. Only one ingredient was known to have that fizzing property: baking soda. Many baking recipes call for a small spoonful of baking soda, but not because of how it tastes. No. Check this out. When the right ingredients are added to baking soda to set off the fizz, those fizzy air bubbles can make a batter bubbly. Baking soda is useful in baked goods because of that fizzing reaction, and that can result in a cake that's lighter and fluffier. Something that looks like this cake, not this one. On the other hand, when ingredient 4 mixed with water, it got thick, almost gluey. That's a well-known property of another ingredient: cornstarch. Chefs sometimes add cornstarch to a batter or a gravy when they want it to get thicker or heavier. That thickening property can be useful, but we don't want too much of it for this cake recipe. We want a light, fluffy, moist cake. So ingredient 4 is not going in our batter. That leaves two mystery ingredients: sugar and salt.

Sugar and salt are probably best known for their taste, but they have other properties that are important for cooking too. For example, sugar melts and turns brown and sticky when exposed to heat. That was a property we definitely saw for one of these ingredients: ingredient 2. We saw what looked kind of like a charred mess, but when sugar is heated at just the right temperature for just the right amount of time, this browning can actually be a useful property. It helps a perfectly baked cake have that golden brown top. Cooks and bakers have to get really good at knowing and working with the properties of their ingredients. They have to know how adding an ingredient will change a dish, how that ingredient will interact with other ingredients, and how it will respond to heating, cooling, cutting, and all the other many techniques a chef might use. Baking is an art, definitely, but it's also a science. We call this kind of science chemistry. And a chemist is a scientist who studies what things are made of, what properties those things have, and how they interact with each other. In chemistry, we might call the stuff in these jars substances. In cooking, we call them ingredients. You might think of a chef as a chemist who works specifically with substances you can eat. Like all chemists, chefs observe the properties of substances, and they do something else chemists do: they measure. If you've baked before, maybe you've measured out exact amounts of ingredients using a tablespoon or a cup. Some chefs even use a scale to measure the exact weight of every ingredient before they add it in. A baker heating up sugar might use a thermometer to measure the sugar's exact temperature. So they end up with a lovely golden-brown candy and not a scorched, overcooked disaster. This process of observing and measuring properties is what chemists do to identify substances for all kinds of reasons. In what other situations could identifying an unknown substance be useful?

WRAP-UP VIDEO 2

Many different scientists identify unknown substances for lots of different reasons. Like, check this out. These are forensic scientists. Forensic scientists collect materials from a crime scene and identify those materials to help solve the crime. To identify crime scene samples, they carefully observe the properties of substances, just like you did in the activity. But instead of looking at ingredients, like you did, they might look at any substance found at the scene of a crime. Like, imagine this tiny orange fiber is found at a crime scene. Where did that orange fiber come from? Did it come from the yarn in suspect number one's orange scarf? The orange picnic blanket in suspect number two's picnic basket? Or is it a hair from suspect number three's dog? A forensic scientist might test the fibers' properties to see which material the fiber is most similar to: wool yarn, cotton fabric, or dog hair. The answer could give a big clue to who was at the scene of the crime. This process can be used to identify anything from cloth fibers to explosive powders. And it's not just cooks and crime solvers either. Identifying a mysterious substance based on its properties is how many different scientists do their work. An environmental scientist might measure chemicals in water to understand how water quality impacts living things. A food safety scientist might test ingredients added to food in factories to make sure none of those ingredients have dangerous properties. A medical scientist might test the properties of a blood sample to see if a person is healthy. All these scientists are doing chemistry, just for very different reasons. Properties are the secret fingerprints of substances, and knowing about the properties of the stuff that makes up our world is helpful in so many different situations, from the serious to the silly. We're going to be exploring much more about chemistry in the next few lessons. Have fun, and stay curious.