Lesson: “What do fireworks, rubber, and Silly Putty have in common?”

VIDEO TRANSCRIPT

EXPLORATION VIDEO 1

Hi, it's Doug! You live in a world today where you're surrounded by a huge range of materials, or the stuff that things are made of. There is wood, but there's also plastic. There's rubber, there's metal, glass, and cement. Now, you know that wood comes from trees, and trees just naturally grow in the ground. But most materials, like plastic, concrete, and glass, don't grow like trees, and you can't just dig them out of the ground either. They don't form naturally. Take windows, for example. Before windows could be invented, someone had to create glass. New materials have to be created. Where did new materials come from? The answer is chemical reactions. The mixing of different substances that cause some kind of change. In an earlier Mystery, I showed you many different kinds of reactions that acids do: fizzing, color changes, dissolving. But there's something I haven't told you about chemical reactions. Any time there's a reaction, a new substance is made. That might sound crazy, so let me show you one of the acid reactions again. You saw the metal and how it dissolved when you poured acid on it. You don't see a new substance yet. As you do this, it just looks like the metal disappears. But when you wait a couple of days, the acid will eventually evaporate, like all liquids do. And you'll find that there's something left. It looks like little grains of something. Some kind of powder. Now, this particular powder is what you get if you react copper metal with acid. What if you try this with other metals? Well, other metals also make a powdery substance when you react them with acid.

Like, here's the powder you get by reacting aluminum with acid. And here's the powder you get when you react steel with acid. And silver. These powders may not look very exciting. I'm sure the first person that made these new substances didn't think very much of them. But they're definitely a new substance. They're not metal, and they're not acid. They have a new property. They're powdery. It's some kind of powder. And that's not the only thing that's different about them. It was discovered that they have yet another property, which I can reveal to you by placing a little bit of one of these powders in a flame. Check this out. Now, it's kind of hard to see that, so let's get the lights turned low here. Whoa. This powder turns the flame green. So the acid and the metal reacted to create this new substance, this powder that has an interesting new property. When you put it in a flame, the flame turns green. But this was just the powder from reacting copper with acid. Let me show you the powders from the reaction of other metals in acid. Here's one of the powders from reacting the metal lead with acid. Whoa. So you see, it turns the flame blue. And here's a powder that makes the flame purple. And here's one that turns the flame red. And so on. The alchemists were fascinated by this. They weren't trying to discover this. Their goal was to create gold. This didn't create gold. Instead, it created completely new substances. Some new types of powder, which could change the color of a flame. Could this be used in any way? Take a minute to think about anything that you could do with these powders.

EXPLORATION VIDEO 2

So did you have any ideas for how those powders could be used? You may not have. And to be honest, it's not obvious. But some early Chinese inventors saw these powders and had a new idea. What if we made explosions that shot up into the air and made colored sparkles? Does that sound familiar? These powders are what make fireworks. Each color you see in a firework

is caused by one of these different powders. The alchemists had discovered these special powders by reacting different metals with acids. When the alchemists had discovered that, they hadn't been trying to create new substances. Any reactions they were doing, they were hoping would create gold. It turns out they never succeeded in creating gold. They tried for hundreds of years. It just never worked. But by trying to do that, that led the alchemists to do something that no one else had done before: To mix different substances and so to discover the idea of a reaction, where two substances come together and make something new with different properties. You've heard me call that a chemical reaction. In fact, that's a phrase we use in honor of the alchemists, from the chem part of the word alchemist. And any of the substances that can cause a chemical reaction, like acids, we call those things chemicals—a word you probably have heard before. So it's because of the alchemists discovering the idea of doing chemical reactions that we accidentally discovered all kinds of wonderful new substances. Not only the discovery of how to make fireworks, but also new materials—substances like rubber, and soap, and paper, and cement, and plastic. Take rubber, for example. Now, besides things like rain boots, erasers, and hoses, without rubber there'd be no tires for cars and trucks. And there'd be no rubber gloves for medical doctors and nurses to wear during surgery so that patients don't get infections. Rubber is an amazingly important material. But the only reason we have rubber is because of someone accidentally discovering a chemical reaction that creates it. In this case, funny enough, it was discovered that if you mix acid with the white milky sap of a South American tree, that's how you get rubber. That's how rubber was invented. Let me show you what I mean. This is the South American tree I'm talking about. Now, if you cut the tree, it drips this white liquid. This is a sap. It's called latex. Some people collect this in a bucket here, and then bring it here into a laboratory. And you mix it with acid. And then you have rubber. Now, here you can see it get pulled out of the container. And then after washing it off, isn't that

strange? Rubber is this tough and bouncy material. And it comes from a chemical reaction between two liquids—latex and acid. That makes rubber. Lots of different materials were discovered this way. Simply by mixing two or more chemicals and seeing if those two chemicals reacted to make a new substance. Now, often, strong acids are needed to make new substances. The reason for that is because they're so reactive. Almost any substance you put in acid will react with the acid to form some kind of new substance. But acids aren't the only chemical that can create new substances. In fact, there are some chemicals that are safe to handle and can create new substances. See if you can discover one in today's activity.

ACTIVITY INTRODUCTION VIDEO

In today's activity, you're going to take different chemicals, mix them together, and watch for a reaction that makes something new. The something new that you're going to make is this stuff: goo. I'm sure at some point in your life you've played with goo before. Maybe you've made something out of this, Play Doh. Just about every kid has. Play Doh is a type of goo. Or maybe you've stretched and bounced this stuff. It's called Silly Putty. Or maybe you've played with an ooey, gooey substance called gak, a goo that makes, let's say, an unmentionable noise. All of these are various kinds of goo. They all have different properties. Some of them ooze and drip. Some of them bounce and stretch. Some are slimy. Some are dry. But with all of them, in order to make these goos, people had to do a chemical reaction, reacting two or more chemicals together to get a new material that has different properties than the chemicals you started with. Take Silly Putty, for example. Silly Putty was made in the 1940s when scientists tried to create a new type of rubber. They mixed a certain kind of acid with a slippery sort of oil. The acid and oil reacted chemically, forming not rubber, but Silly Putty, a new stretchy, bouncy goo that kids back in the day loved to play with. But all of the great goo inventors, they aren't a thing of the past.

People are still discovering chemicals that make gooey materials. And you could be one of those people. Today, you'll experiment by mixing chemicals together to find a chemical reaction that makes goo. You'll have five different chemicals you'll try mixing in different ways to see what happens. Then, if you have time, you can try one of our favorite goo recipes and make a batch of goo that you can keep. I'll walk you through the steps one-by-one, ready? Let's get "goo-ing." I mean, let's get going!

ACTIVITY STEP 1

If you're in a class, find a partner. If you're working alone, that will work, too. When you're done with this step, press the arrow on the right.

ACTIVITY STEP 2

Cover your workspace with newspaper or plastic.

ACTIVITY STEP 3

Get these supplies. You'll get more later.

ACTIVITY STEP 4

Get the page with the dark boxes and your sheet protector. Carefully slide the page inside the sheet protector, like this. Then, lay it on the table.

ACTIVITY STEP 5

Let's do a practice drop in these boxes, right here on the worksheet. Line up the line on the straw to the top of the water, then press a finger over the end. Move to a practice square, and lift your finger off. When you lift your finger off, that's when it'll drop. You want just one drop on the square. Take turns until everyone can do it.

ACTIVITY STEP 6

Get five cups of chemicals and five straws for each table. If you're working in a classroom, each group also needs ten toothpicks.

ACTIVITY STEP 7

On the first box, put a drop of milk (M) and baking soda (S), just like this. Then, use a clean toothpick to mix them. If you mess up a box, do that test in one of the practice boxes.

ACTIVITY STEP 8

Write down your results on the second page in the Milk and Baking Soda box. Was there a chemical reaction? If there was, describe it. Remember, sometimes nothing will happen because not all chemicals react with each other.

ACTIVITY STEP 9

Keep going until you complete all the boxes. Remember, put a drop of the two chemicals and mix them with a clean toothpick. Then write the results on the other page. If you mess up a box, do that test in one of the practice boxes.

ACTIVITY STEP 10

Discuss.

ACTIVITY STEP 11

It's time to clean up. Wipe your tests with paper towels.

ACTIVITY STEP 12

Now that you know which chemicals make goo, do you have time to make a batch of Mystery Goo? You need about 15 more minutes. If you don't have time now, be sure to try this another day.

ACTIVITY STEP 13

Mystery Goo starts with glue and borax. Each person making a batch of Mystery Goo needs these supplies.

ACTIVITY STEP 14

Get a partner for this step. Have your partner hold the baggie open, pour in the half cup of Borax, and the full cup of glue. Then zip the baggie closed. Make sure it's closed tight. Afterward, trade jobs and help your partner.

ACTIVITY STEP 15

Mix the stuff in your baggy for three minutes, until the timer on the screen runs out. You'll feel the mixture getting thicker as you mix it.

ACTIVITY STEP 16

Get out your goo, turn your bag inside out, like this, and peel the goo off onto a plate. When you have it all out, pick it up and play with some. How does it feel? Take a minute to notice some of the properties of your goo. Does it jiggle? Does it stretch? Does it ooze?

ACTIVITY STEP 17

Always store your goo in the ziplock bag to keep it from drying out. It's yours to keep. For more ways to experiment with your goo, see the Extras.