Lesson: “Why do some things explode?”

VIDEO TRANSCRIPT

EXPLORATION VIDEO 1

Hi. It's Jay with the Mystery Science team. I want to show you one of my favorite things about science: explosions. Besides movies, the first time I saw big explosions were these: fireworks. Those are some beautiful explosions. But some explosions are designed to be powerful. Watch this twenty-ton boulder meet its match. Three, two, one. Wow. Intense, right? Let's see that again in slow motion. That blast was carefully planned by experts. The boulder had slid down a hillside and was too heavy to move out of the road. An explosion was the fastest way to safely break it apart so it could be cleared away. Explosions can be surprisingly helpful when there's a big job to do, like this bridge that needed to be replaced. Experts made sure any people were far away, then carefully planned a set of explosions to bring it down safely. Ready? Woah. Now here it is in slow motion. Look at all those explosions. And check this out. This is another very carefully planned blast. It takes a series of controlled explosions to safely launch this rocket into space. Three, two, one, boosters in ignition. Maybe you've wondered why some things explode. Like, what materials does it take to make an explosion? I'm not sure what comes to mind for you, but I'm guessing it probably isn't this: plain old everyday water. But watch what happens when you throw in this ordinary-looking piece of metal. Wow. Let's see that again in slow motion. There's a flash of fire, then whoosh, explosion. That's so cool and so weird. I'm sure you've poured enough glasses of water to know they don't usually explode. And if you've ever

tossed a metal coin into a water fountain, that probably didn't blow up either. So what is going on here? What was it that made this explosion happen? Was it the metal or the water, or was it both? What do you think?

EXPLORATION VIDEO 2

You know that water doesn't just explode all the time. So maybe you guessed that the explosion has something to do with this metal. Does it explode at the slightest touch? Well, just wait and watch. Turns out you can touch it, and it doesn't explode. You can actually do some strange stuff with this metal. It's so soft, you can easily cut it or squish it. But even then, it doesn't explode. And watch what happens if you put it in a different liquid like oil. See that? Nothing. No explosion. Not very exciting, but it does give us some interesting evidence. Even though this metal has some unusual properties, it doesn't explode just randomly. Something special happens when you put it together with water. It's the mixing of both that makes an explosion happen. Of course, you don't need to be in a science lab to mix things. You've probably mixed lots of things together before, and I'm guessing most didn't explode. Like in the morning, maybe you pour milk on your cereal. When you mix those two things together, you might notice some small changes. Maybe the milk makes your crunchy cereal get soggy, and maybe the cereal adds some color to your milk. But you've still got the things you started with, cereal and milk. When this metal and water mix, it's clear that a much bigger change is taking place. But even in slow motion, it's hard to observe exactly what happens to make such an explosive change. To get a better sense of what's going on, let's check out an explosion that's a bit slower. Right here are several different substances. Each one is a material with specific properties. They're all everyday things you might have at home, and none of them are exploding, not yet. But if you mix them all together? Woah. See all that foam oozing out of the container? And with a similar

but more powerful mix, you can make an even bigger messier explosion. This foamy eruption looks very different from the fiery blast made by the metal and water, but they do have similarities. For one thing, they both start with substances that aren't particularly explosive on their own, but mix them together, and they change in big ways. A lot of substances don't do that when they mix. So how do you figure out which mixes won't explode and which ones will? That's what you're going to find out in the activity. To get ready, think about how you could test three mystery substances. Two powders and one clear liquid. You know that some combination will make an explosion. What could you do to find the right combination?

ACTIVITY INTRODUCTION VIDEO

In today's activity, you'll become an explosion investigator. Your mission: create a safe explosion right in your classroom. So far, you've seen that some combinations of substances end in awesome explosions, while others, well, don't. One of these powders, when mixed with this liquid, will create an explosion. Your job is to run a fair test using these mixtures to see which one ends with a boom. For each setup, you'll carefully measure your substances into a bag. Then you'll mix the substances together and see what happens. Can you find the explosive combination? We'll get you started, step by step.

ACTIVITY STEP 1

In today's activity, you'll work with a partner. Decide which of you will be Explosion Expert and which of you will be Boom Boss. When you're ready to move on, click the arrow on the right.

ACTIVITY STEP 2

Today, you're doing a fair test to see which of these powders, when mixed with this mystery liquid, creates an explosion. A fair test is an experiment where everything is kept exactly the same in each setup except for one thing. That way, you know if the results are different, it's because of the one thing you changed. In your test, the one thing you'll change is the type of powder you put in each setup, powder A or powder B. Now think, what are some things you should keep the same in both setups? Discuss. What are some things you should keep the same in both setups to make your investigation a fair test? Here's a hint. Think of what you'll put in each bag and how much.

ACTIVITY STEP 3

Here's what we said. To make it a fair test, we'll use the same amount of each powder in both setups and the same amount of liquid in both setups. We'll also use the same size and type of bag to mix everything together in. The only thing that changes is the type of powder that you'll use in each setup. You'll be doing all of these today in your investigation.

ACTIVITY STEP 4

Get your supplies. When you have them, set up your testing station so that it looks something like this.

ACTIVITY STEP 5

Scientists plan their investigation before they start. To help you do that, you're going to write down the amounts of each substance you need before you do your experiment. Find the Setup

A section on your worksheet. Write down that you're going to add two spoons of powder A into the cup and ten spoons of the mystery liquid into the bag. In the Setup B section, write down that you'll add two spoons of powder B and ten spoons of the mystery liquid. If your spoon is a different size than ours, your teacher may give you different numbers to write down.

ACTIVITY STEP 6

Now that you've got everything planned out, let's put it all together. First, you're going to make two small containers, one to put each powder in. You'll modify some empty paper cups for this. Both partners, squash your empty paper cup, like this, then cut across it, like this. After you cut it, shape it back into a cup again and set it on your plate.

ACTIVITY STEP 7

In a minute, you're going to add your powders to your cut cups, but first, we'll show you how. To properly measure out each spoonful, scoop up your powder with its spoon and run a craft stick over the spoon like this to even out the top. Then carefully put the spoonful of powder into your cut paper cup. Repeat this again for your second scoop. Now it's your turn. Explosion Expert, you're in charge of Setup A, so add two spoonfuls of powder A to your cup. Boom Boss, you're in charge of Setup B. Add two spoonfuls of powder B to your cup. When you're done, carefully move these cups off to the side. Keep them separate so you'll remember which one is which.

ACTIVITY STEP 8

Next, you're going to add the mystery liquid to your bags. Watch us do it first, then it'll be your turn. Boom Boss, hold your partner's bag open on their plate like this. Explosion Expert, add ten spoonfuls of the mystery liquid to the bag. Your spoon doesn't have to be filled to the top. Just

try your best to keep all your spoonfuls the same size. Boom Boss, count along to help your partner keep track of what number scoop they're on. When they're done, stand the bag on the plate so that it won't spill. Then switch jobs and do the same thing for the other bag. Try your best to make your spoonfuls of the mystery liquid the same size as your partner's. Now it's your turn. Work with your partner to add the mystery liquid to each of your bags.

ACTIVITY STEP 9

You're almost ready to run your investigation. There's just one final setup step, and it'll be a bit of a challenge. You need to get your powder cup into the bag without spilling any of it into the liquid. It'll take teamwork. It'll take laser focus. It'll take steady hands. Are you up for it? Watch us do it first, then it'll be your turn. Boom Boss, you'll hold your partner's bag wide open while still keeping it on its plate. Then Explosion Expert, you'll carefully lower your cut cup with powder A into the bag and rest it at the bottom like this. Once the cup's in the bag, Boom Boss, carefully zip the bag shut. Pinch one side like this and slide your fingers across the top to seal it like this. Then do it again going the other way. Make sure that your bag is completely sealed. Leave it resting on the plate for now. Don't flip it over yet. Then switch roles and do the same thing with Boom Boss's bag with the cup with powder B in it. Okay. Are you ready? Now it's your turn to try.

ACTIVITY STEP 10

Now, the moment you've been waiting for, it's time to see which mixture will create an explosion. Watch us do it first. When the countdown reaches zero, you'll flip both of your bags over on your plates so that all the powder mixes with the liquid. Make sure that the cups fully turn over, then

lean back and watch what happens. Okay. Now it's your turn. Ready? Initiate countdown. Three, two, one, flip.

ACTIVITY STEP 11

A lot just happened. Take a moment to discuss what you noticed with your partner. Then fill out the results section on your worksheet and draw a sketch of what happened to Setup A and Setup B. Your drawings don't have to be perfect. Just try your best to show the main things that happened to each bag and the substances inside of them. You can add words and label your drawings to help explain them as well.

ACTIVITY STEP 12

Scientists usually run their experiments more than once. This way, they can see if they get the same results every time. You and your partner only ran the experiment once, but since everyone in your class also ran this experiment, it's like it was done many times. Share your results with your class to see what you can learn. Discuss what happened in the experiments across your class. Based on those results, which combination of substances can make an explosion?

WRAP-UP VIDEO 1

In the activity, you took a closer look at what happens when substances combine and sometimes explode. In Setup A, the substances made a white goopy mixture. Something happened, but not a lot. Sort of like the small changes when cereal gets soggy in milk. But in Setup B, a big change happened. When the substances mixed, they started to bubble. Then the bag puffed up until finally, there was an explosion. The bag puffing up might have been a surprise. It looks a lot like a balloon expanding. When you blow up a balloon, you're filling it with

air. As you may already know, that air is made of invisible gases. Even though you can't see those gases, they are still a state of matter, just like solids and liquids. All matter is made up of tiny particles that take up space, and particles of gas really like to take up space, like when they spread out to fill a balloon or a bag. When your bag expanded, it was filling up with something you couldn't see, an invisible gas. Eventually, there was so much of that invisible gas that it made the bag burst. It's kind of like how a balloon will eventually pop if you keep blowing. But here's what feels like magic. How did all that gas get inside of the bag if it was zipped up tight? With a balloon, you're blowing more and more gas into it. During the activity, the only things you added to the bag were a powder and a liquid. Gas or any state of matter can't just magically appear. It has to come from somewhere. So let's take a closer look at what's happening when the substances mix. What do you notice happening here? Where could the gas be coming from?

WRAP-UP VIDEO 2

Watch again as powder B and the mystery liquid mix. See those tiny bubbles forming? Maybe you can guess what's filling up each of those bubbles. It's a gas. That means a solid and a liquid made of gas. Amazing, right? These mystery substances aren't anything rare or unusual. It's baking soda and vinegar, things you might find in a kitchen. But when they mix together, the matter they're made of combines to make a totally new substance. That might seem strange, and it kind of is. This type of change is so special that scientists gave the process a name. You can call it a chemical reaction. Let's take another look at a chemical reaction. Remember what happened when this metal mixed with water? The explosion from this chemical reaction is way more dramatic than the one in your bag. There's even fire, but it is similar. When this metal and water mix, they also make a gas. The slow explosion I showed you before is also a chemical

reaction. When these substances mix, they react to form a whole bunch of gas, creating an explosion of gas-filled foam. Maybe you're noticing a pattern here with chemical reactions and gas. You might even wonder if the new substances they make are always gases. Could chemical reactions create other things? Like, could substances mix together to make a liquid or a solid? What do you think?

WRAP-UP VIDEO 3

You know that gases, solids, and liquids are all made of matter, but these different states of matter act very differently. Like how gases spread out to fill a space, or solids can hold their shape, or how liquids are flowy. So check this out. This person is going to combine two different liquids. Now watch what they do next. Strange. Right? Something new is forming here. Whatever this new substance is, it does not act like a gas, and it's not flowy like a liquid either. See how you can wrap it around a stick or break it into pieces? This new substance is a solid. That means two liquids reacted to form a solid, a totally different state of matter. Chemical reactions are weird that way. Let's take a look at another one. Inside of each of these cups is a small amount of clear liquid, but just watch what happens as they mix. This might seem like a magic trick, but it's really just chemical reactions. At the end, the substance is still a liquid, but it didn't just change colors; it actually became a totally different kind of liquid. With each pore, substances are mixing to form something new. Chemical reactions produce new substances that can be gases, solids, or liquids. And being able to make new substances with new properties can be really useful. For instance, the stringy substance formed by this reaction is actually a kind of plastic called nylon. It's used to make things like thread and fishing line since it's strong but lightweight. Chemical reactions are how we create lots of other materials too. In the kitchen, it's chemical reactions between certain ingredients that help you bake a cake.

And when chemical reactions form gases, that's often when explosions can happen. Some explosions are small enough to fit in a bag or big enough to send things to space. Lots of chemical reactions are important parts of our lives, but explosions are definitely still my favorite. Have fun, and stay curious.