[MUSIC PLAYING]

JESSICA HARROP: Hi, I'm Jessica and today I'm going to shed some light on a chemical demonstration I like to call anatomy of a glow stick. There are many different kinds of chemical reactions. Some absorb energy and some release energy. Some release energy as heat and others as light. And when a reaction produces light, the process is called chemiluminescence. Let's watch MIT's Dr. John Dolhun, his assistant, Shannon, and volunteers, Sarah, Catherine, and Trevor. They are going to show us some chemiluminescence at the Cambridge Science Festival.

[WHOOSH]

SHANNON MOREY: So not all reactions have this ability to produce light. And so we have to use some very special chemicals in order to do this. And we have some light sticks that I broke apart here, if you guys just want to take these solutions. Hold them carefully.

And so in a light stick, usually there's actually hydrogen peroxide. And it oxidizes different chemicals-- oh, yeah, you can just face the audience. That's cool. And it will oxidize different chemicals depending on what color you want to give off light. All right. So just pour one solution together. It doesn't matter which way.

AUDIENCE: Oh.

SHANNON MOREY: And there we go, OK. Beautiful, beautiful. All right. So in each of these, we have a different chemical that gets oxidized to give us a different color. All right, thank you guys so much.

[APPLAUSE]

[WHOOSH]

JESSICA: So how does a reaction produce light? Let's start with two molecules. Let's call them A and B. They react to produce C and D. Energy that's produced in the reaction causes the electrons in D to become excited.

As the electrons relax back down, they give off energy as light. So basically, chemical energy is transformed into light energy. This all happens in one step as the reaction is progressing. Here's what's happening.

This is the energy level of our reactants, A and B. When they react, they form C and D in its excited state. Now to relax back down to where it needs to be, D emits energy as light. Now there's a different amount of energy in our reactants than our products, so that's why these two energy levels are different.

All right, so in Dr. Dolhun's experiment, each volunteer has a cup containing a different chemical and adds hydrogen peroxide to each cup. And each cup glows a different color, red, blue, or green. This happens because the hydrogen peroxide is oxidizing each of the different chemicals. So oxidation is the chemical reaction that will ultimately cause the chemiluminescence.

So why did each of these chemicals glow a different color? Well it's because they each emitted a different amount of energy. And energy equals color. So let's think of it in terms of a rainbow spectrum.

So the amount of energy increases as you move up the spectrum. So red is lower energy than blue. So if the difference between the ground state and the excited state is small, there is a smaller amount of energy released, and the light is on the redder side of the spectrum. Conversely, if that gap is larger, there's more energy released. So the light is on the bluer side of the spectrum.

And this chemiluminescence chemistry has practical uses beyond glowsticks that light up a good party. We also use reactions like these to create flares that don't get too hot in use of emergency situations. And nature uses chemiluminescence too. [WHOOSH] If you've ever seen a firefly light up at night or an [WHOOSH] Angler fish hunt for prey, you've seen bioluminescence which is chemiluminescence in a biological system.

It's the exact same principle as the chemical reactions that Dr. Dolhun showed us. [MUSIC PLAYING] Hope you enjoyed the video. I'll see you next time.