[THEME MUSIC]

JESSICA: Hi, I'm Jessica, and today, I'm going to be talking about a chemical demonstration I like to call, "Money to Burn." And chemist Dr. Bassam Shakhashiri-- here he is-- is actually going to be showing us the demo. He's the president of the American Chemical Society, and is performing this demo right here at MIT. Let's see if he has some money to burn.

DR. BASSAM SHAKHASHIRI: What I am going to do now is going to reach in here. I'm going to take dollar bill, and I'm going to put it in the flame just like that.

[AWED GASPS]

STUDENT: Whoa!

DR. BASSAM SHAKHASHIRI: Was that too fast? What we always do in science is repeat the experiment, so I take out what looks like a dollar bill, but it's not a real dollar bill. I bring it close to the flame.

STUDENT: [INAUDIBLE].

DR. BASSAM SHAKHASHIRI: Disappears into thin air. It looks like magic, right? I love magic. Magic is engaging, but not informative.

JESSICA: How is that dollar bill burning up so quickly? Well, it's actually not a dollar bill. It's called flash paper, and it's paper that has been treated with chemicals to make it burn quickly and leave no ashes.

Now, flash paper has been nitrated. Practically, what that means is that you soak the paper in a mixture of concentrated nitric and sulfuric acids. The cellulose in the paper then reacts with the acid to produce nitrated cellulose and water. The reaction is this.

So our nitric acid here mixes with the cellulose. Now, this is actually just one unit in the big polymer that is cellulose. It's got lots of little units of $C_6H_{10}O_5$, so in this equation, I'm only writing one unit. And that's creating nitrated cellulose and water.

Now, the nitro group, the NO_2 is the reactive group, and it can be very reactive depending on the molecule that it's in. You've no doubt heard of nitroglycerin, which looks like this. It's an explosive liquid. Or TNT, which actually stands for trinitrotoluene. It looks like this.

So all of these molecules have nitro groups in them, and it's the nitro, or NO2, groups that make these molecules explosive. Now, let's watch what happens when Dr. Shakhashiri tries this again, but this time, with a real dollar bill.

DR. BASSAM SHAKHASHIRI: I'd like someone in the audience to let me borrow from them a real $1 bill. Is there someone in the audience who would let me-- who would trust me with a real $1 bill or a $5 bill? Steve, how about a $20 bill, huh? You got a $20 bill?

OK, here's $1 bill. It's a real $1 bill. You know what I'm going to do with it, don't you? So I have a jar right here, and I have, in this jar-- what do you suppose-- what does this look like?

I have a liquid. What does it look like? Looks like?

STUDENT: [INAUDIBLE].

DR. BASSAM SHAKHASHIRI: Looks like water. The way we describe this liquid is to say it's a clear and colorless liquid, which is what water is. So I'm going to take this liquid, and-- so I want everybody to see the jar right here. Get this out of the way.

I'm going to take the dollar bill. I'm going to soak it in this clear and colorless liquid, which looks like water, and I'm going to fish it out using those tongs. You see, it's dripping like any wet object would. And then I'm going to take it to the flame.

Take a good look at it, now, [? Judy. ?] It may be the last time you see it. So here is the dollar bill on fire. Or is it?

[AWED GASPS]

DR. BASSAM SHAKHASHIRI: But you did see a flame, didn't you?

STUDENT: Yes!

DR. BASSAM SHAKHASHIRI: So now, I ask you, can this liquid be water?

STUDENT: No!

DR. BASSAM You know from experience that water does not burn under these conditions. Right? So I will

SHAKHASHIRI: tell you what's in this jar. This clear and colorless liquid is a mixture of rubbing alcohol and water, isopropyl alcohol and water. You know also from experience that when you burn alcohol, what color flame do you see? It's kind of bluish.

You remember what color flame you saw here? It was a little yellowish. Right? That's because we also added a little bit of sodium chloride in there. The eye is more sensitive to the yellow color than it is to the blue color, so we added the sodium chloride to enhance the visibility of what's going on.

JESSICA: All right, so what happened there? Dr. Shakhashiri soaked the money in a solution of water, rubbing alcohol, and a little bit of table salt. When he puts the money in the flame, the alcohol burns, producing heat and light, energy, and carbon dioxide and water. The reaction is this. There's our alcohol reacting with oxygen, producing carbon dioxide, water, and energy.

So why doesn't the bill burn? If you have a beaker of alcohol and light it on fire, it's just that very top layer of alcohol and the gas above it that burns. The rest of the alcohol in the beaker does not. So that's what's happening with our dollar bill. Let's draw a dollar bill right here.

So the alcohol, ROH could be any alcohol, is evaporating off the bill, turning into a gas, and burning, so those are the flames that you see. But remember that the solution is 50% water. The water is evaporating much less quickly than the alcohol, staying in the bill and preventing the paper from burning. So that's one way to hold onto your cash. Hope you enjoyed "Money to Burn," and I'll see you next time.

[MUSIC PLAYING]