[MUSIC PLAYING]

JESSICA HARROP: Hi, I'm Jessica. And I'm going to show you a chemical demonstration that I like to call let's drink to that. Now performing chemistry demos is hard work. And MIT's Dr. John Dolhun-- here he is-- is thirsty. Let's watch him and his assistant Barry at the Cambridge Science Festival.

[WHOOSH]

BARRY KRIEGSMAN: Here you've got some Fiji Water, but I figured you could try some of, I don't know, my personal favorite tap water as well. I don't know.

JOHN DOLHUN: I think I'm going to stick with the Fiji water.

BARRY KRIEGSMAN: You're going to stick with that? OK, that's fine. Well, if you'd like I could treat you to something a little better. I don't know. What would you imagine? What it would like to drink right now?

JOHN DOLHUN: A glass of wine.

BARRY KRIEGSMAN: A glass of wine, absolutely.

JOHN DOLHUN: Do you have a list? Wine list?

BARRY KRIEGSMAN: Oh, yeah.

JOHN DOLHUN: Oh, you do have?

BARRY KRIEGSMAN: Oh.

JOHN DOLHUN: You left me a wine list.

BARRY KRIEGSMAN: Is there one in particular you'd like?

JOHN DOLHUN: Actually, you have a cabernet on there, $15 a glass though, Barry.

BARRY KRIEGSMAN: OK, I got it just for you. So one cabernet.

JOHN DOLHUN: That's a nice light wine.

BARRY KRIEGSMAN: There you go.

JOHN DOLHUN: Has a little color in it. Nice.

[WHOOSH]

JESSICA HARROP: So Barry turned water into wine. In our video recording of the experiment, the wine doesn't look very red, but you can see the red color forming at the bottom of the glass. He started with a clear, colorless liquid that looks like water but that actually contains sodium carbonate.

Now, in water, sodium carbonate breaks apart into CO32 minus, HCO3 minus, and OH minus. To go from water to wine, Barry poured this sodium carbonate solution into a wine glass that contained a little bit of the indicator phenolphthalein. In acidic solutions, phenolphthalein is colorless. But in basic solutions, it's dark pink.

So here's a pH scale. At around 8 on the pH scale, phenolphthalein turns pink. So it goes from acidic to basic. And the OH ions in Barry's fake water make it basic, so the indicator turns pink. So when mixed with phenolphthalein, the sodium carbonate looks like wine. Now, let's see what happens next.

[WHOOSH]

BARRY KRIEGSMAN: I have my own favorite drink, milk, you know. It goes well with cookies and everything. I really love it. So I'd love to show you that if you--

JOHN DOLHUN: All right, you convinced me, Barry.

BARRY KRIEGSMAN: OK.

JOHN DOLHUN: I'll go with milk--

BARRY KRIEGSMAN: OK, absolutely.

JOHN DOLHUN: --and cookies.

BARRY KRIEGSMAN: I'll give you the cookies afterwards, yes. So just take that from me for a sec. Here's your milk.

JOHN DOLHUN: Wait a minute, Barry. That was my $15 cabernet and it just turned into a glass of milk.

[WHOOSH]

JESSICA HARROP: So Dr. Dolhun wants milk for his cookies, but all he has is wine. So to go from wine to milk, Barry pours the wine into another glass. This glass contains barium chloride. And barium chloride dissolves in water, forming barium 2 plus and 2 Cl minus. Now, the barium 2 plus reacts with the carbonate ions in the original solution to produce barium carbonate, which is a solid white precipitate.

And, of course, the solid white precipitate makes it look like milk. But is Dr. Dolhun satisfied with milk? Let's find out.

[WHOOSH]

JOHN DOLHUN: That was my $15 cabernet. And it just turned into a glass of milk.

BARRY KRIEGSMAN: Oh, sorry about that. I thought you wanted the milk.

JOHN DOLHUN: Barry, it's a bad deal. Is this milk organic?

BARRY KRIEGSMAN: Uh, no. [LAUGHTER]

JOHN DOLHUN: Barry, come on. You you have to do something for me.

BARRY KRIEGSMAN: OK, fine. How about this? I'll treat you. I'll give you some beer. It's on the house.

JOHN DOLHUN: Beer?

BARRY KRIEGSMAN: Yeah.

JOHN DOLHUN: Now you're talking.

BARRY KRIEGSMAN: As a little substitute, a little pay, you know, return for messing up your order. So just take that from you right here.

JOHN DOLHUN: That is nice.

[APPLAUSE]

A beer with a frothy top on it.

BARRY KRIEGSMAN: Enjoy, enjoy.

[WHOOSH]

JESSICA HARROP: Finally, Barry turns the milk into beer. To do this, he adds some hydrochloric acid to the mix. Now this dissolves the barium carbonate, the solid white precipitate. And this is the reaction.

So he adds the hydrochloric acid, which breaks apart the barium carbonate solid. This yields barium, water, and carbon dioxide gas is released. And this H plus in the reaction comes from the hydrochloric acid.

To get the yellow beer color, Barry throws in some dichromate, which is yellow. And he puts a lump of solid carbon dioxide or dry ice in it to make it bubble.

So what did Dr. Dolhun and Barry show us today? They took a clear solution with certain chemicals in it that turns color, pink, when another chemical is added, then goes milky when another chemical is added, then goes clear again when another is added, and then goes yellow and bubbles when two more chemicals are added. This shows us how chemistry can be used to program a system to take on different observable properties. It's truly magical.

[MUSIC PLAYING]

That's it for me. Hope you enjoyed the magic.