Elephant Toothpaste

A classic chemical reaction that is easy and great for all ages.

https://www.youtube.com/embed/x9bKLO2wj6Y

Materials

- 30% Hydrogen Peroxide
- Potassium Iodide (KI) Solution
- 500mL Graduated Cylinder or Erlenmeyer Flask
- Soap
- Food Dye
- 50mL Centrifuge Tube
- Large Clear Bin

Safety Precautions

Please read the Liquid Chemical section of the Demonstration Safety page before performing this demonstration.

This demonstration requires: safety glasses or goggles, rubber or latex gloves.

Demonstration

Preparation

24 hours before the event, be sure to check if there is enough of the KI solution. If there is not, follow these steps to prepare it:

1. Get a 500g bottle of KI. Get a 1L beaker and a hot plate, and start warming 500mL of water on the hot plate set to medium.
2. When the water is hot, add the KI in increments, waiting for the previous addition to dissolve fully until adding more. Once all of it has been added, fill the 500G bottle of KI 2/3 with water, close it and shake it to get the last of the KI from the container. Pour this into the 1L beaker and stir.
3. Fill the KI solution bottles with the still-hot solution, close them, and let them cool to room temperature on a table or counter. Label the bottles with the month and year, and your initials.

Presentation

Note: do NOT handle the chemicals in this show unless you are wearing gloves and goggles.

1. Set out the clear bin with the graduated cylinder in the center. Measure out 100mL of the hydrogen peroxide into the cylinder.
2. Ask the audience if they have ever heard of hydrogen peroxide. Likely they have, and explain that it is sometimes used to clean cuts or for bleaching hair. State that the hydrogen peroxide we are using is ten times stronger than what they have at home, and it can be dangerous, so to not try this at home.
3. Add a small amount of liquid soap to the cylinder, and a couple drops of food dye. After doing so, swirl the cylinder to mix them in and point out that hydrogen peroxide reacts with light, so it is breaking down as we speak.
    - *Note: Be dramatic when saying that it is breaking down! Act like it is exploding the moment you say this, and give the audience a few seconds to laugh at your overreaction.*
4. Point out that it is a slow reaction, and show the catalyst that you will be adding in. Measure out 10mL of the catalyst using the centrifuge tube, and then ask for a countdown. Pour it in at the end of the countdown, and watch as it turns into a big pile of bubbles!
5. Use the rising steam from the reaction to introduce the term "exothermic". Finish by explaining how the catalyst made the reaction faster, using either the Hill Metaphor or the Race Metaphor for younger audiences.

Why This Works

Hydrogen Peroxide (H_2O_2) is a very reactive molecule, and breaks down into water and oxygen gas. When exposed to light it will break down, but this happens very slowly. This is why we include our catalyst, Potassium Iodide (KI). A Catalyst is a molecule that will help another reaction go faster, without being used up in the process. This means that at the end of the reaction, we could get back all of the catalyst that we used in the reaction, which we see as the yellow-brown discoloration in the bubbles.

The Hydrogen Peroxide reaction releases a lot of energy, which we see as the steam that is rising out of the bubbles. This means that this is an Exothermic reaction. A way to explain this is by breaking down the word "exothermic" for the audience. "Exo" they may have heard before, such as an exoskeleton, and it sounds similar to "exit". "Thermic" is similar to "Thermo", like in thermometer, and refers to heat. So by breaking the word down we can see that exothermic means to have heat exit, or leave, the reaction.

Hill Metaphor

Imagine that you are on one side of a big hill. On the other side of this hill is a party that you want to go to, but to get there you have to climb all the way up the hill and all the way down the other side. All of that climbing is going to tire you out, and you'll use up all of your energy before getting to the party. So let's imagine that you find a tunnel that goes right through the hill. This tunnel makes it possible for you to get to the other side pretty quickly, and you won't be tired when you get to the party. When you use the tunnel, does it magically disappear? No! The tunnel is still there, so anyone else who also needs to go over the hill to the party can also use the tunnel to get there!

The "hill" is the amount of energy needed for the reaction to take place, and the "tunnel" is our catalyst that we add. Before adding it, the reaction needs a lot of energy to take place, and so it goes very slowly. Once we add a catalyst though, the reaction can now take this lower energy path, and happens very quickly!

Race Metaphor

Imagine that you are in a race with some of your friends. You are going to run from one end of the park to the other, which both of you know will be tiring. Just before the race though, you get a bicycle to use for the race. By using the bike, do you think you will be faster than your friends? Of course! Not only that, but you will be less tired at the end of the race. When you finish the race, does your bike suddenly disappear? Nope, the bike is still there!

The "race" is the amount of energy needed for the reaction to take place, and the "bicycle" is our catalyst we add. Before adding it, the reaction will take a lot of energy to move forward, and so it goes slowly. Once we add in a catalyst, the reaction can now move much faster!

Additional Information

Catalysts are common in many things, including:

- Catalytic converters in cars to help remove pollutants from car exhaust.
- The Haber Process for adding nitrogen into fertilizer.
- Yeast contain enzymes, which speed up the bread and beer making processes.
- We have enzymes in our digestive tracts, which break down food for us!

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