Cleveland Section, American Chemical Society
National Chemistry Week 2021

1. Introduction

Welcome to the Cleveland Section of the American Chemical Society's (ACS') 2021 National Chemistry Week (NCW) celebration. This year's Program/Contest is all about how chemists speed up and slow down chemical reactions. We'll talk about what "chemical reactions" are in a minute.

All the materials that you'll need to participate in the Program can either be found around the home (or easily purchased at a nearby drugstore or grocery store)—see Section 2 below, or in the kit that you obtained from the Library. But there are two special items in each kit:

1. A set of child-sized safety goggles
2. Several special items from ACS which include a copy of *NCW 2021 Celebrating Chemistry* and several other small items that are our gifts to you for entering this year's contest.

Adult supervision is required for the performance of the Program. The experiments to be performed here aren't considered dangerous, but everyone performing them, especially the students, should wear eye protection while doing so. The students' goggles are theirs to keep. Adults should also wear safety glasses. Lastly, everyone should refrain from swallowing any of the materials or inhaling anything associated with the experiments.

This year's NCW Program consists of the following 5 Steps:

1. Demonstration 1: The Traffic Light
2. Experiment 1: Iron Filings' Oxidation
3. Experiment 2: Alka Seltzer Reactions
4. Experiment 3: Yeast Experiments
5. Demonstration 2: The Iodine Clock Reaction

2. ***Materials you'll need from around your Home***

In general: we advise that you have some paper towels on hand to clean up any spills. You're 3 hands-on Experiments will require a working surface (a table or counter to) that water won't damage.

- Demonstration 1:
    1. nothing
- Experiment 1, *Iron Filings' Oxidation*:
    1. white vinegar with a minimum 5% acid content
    2. 3% hydrogen peroxide
    3. table salt
    4. a spoon
    5. 1 8.5x11" piece of white paper (also used in Experiment 3)
    6. 1 magic marker (also used in Experiment 3)
    7. a ½-teaspoon measuring spoon (also used in Experiment 3)
    8. 1 small kitchen drinking glass
- Experiment 2, *Alka Seltzer Reactions*
    1. a small cup or glass about half full with tap water
- Experiment 3, *Yeast Experiments*
    1. ice or ice cold water that's been in the fridge
    2. room temperature water
    3. water near boiling hot from the microwave or a teapot [***to be handled by an adult only!***]
    4. oven mitts or pot holders
    5. a 1-tablespoon measuring spoon
    6. a microwaveable bowl
    7. sugar
- Demonstration 2:
    1. a stopwatch. The one on your cell phone will do nicely.

3. ***Materials Supplied in your Kit***

- Demonstration 1: none
- Experiment 1, *Iron Filings' Oxidation*:
    1. 2 small plastic cups or bowls
    2. 1 small bag containing iron filings
- Experiment 2, *Alka Seltzer Reactions:*
    1. 1 package containing 2 Alka Seltzer tablets
    2. 1 beryl pipette (a tube like a slim squeeze bottle)
    3. 2 small plastic cups or bowls
    4. 1 small plastic bag (not to be mixed up with the small bags in Experiment 3)
- Experiment 3, *Yeast Experiments:*
    1. 3 small plastic bags
    2. 1 packet of yeast
- Demonstration 2: none

4. ***Introduction to the Program***

So what's a chemical reaction? you ask. A chemical reaction occurs when starting substances called "reactants" are combined chemically to form different ending substances called "products". For example, over the years here in Cleveland we've had problems with rust: rusty bridges, rusty cars and rusty steel signposts to name a few. Rust is actually the "product" produced when oxygen from the air and iron in steel (the reactants) combine in a chemical reaction. This reaction is called oxidation and it produces rust and water (the products). So rusting is a chemical reaction, although a very slow one over time.

Chemical reactions often involve color changes, temperature changes, gas production, or precipitant (solid) formation from a liquid. The change to a rusty color, the heat from fire and the production of gas during the baking of bread are all indications that a chemical reaction is taking place. We're going to see examples of several chemical reactions during this Program.

Chemists have learned how to speed up or slow down some chemical reactions by changing something about the reactants. These changes (chemists call them "variables") could include:

1. the amount of stirring, mixing or shaking that's done (or not done),
2. heating the reactants (i.e., changing the temperature of the reactants),
3. concentration (i.e., the quantities) of reactants in a solution,
4. lowering or increasing pressure (when gases are involved),
5. surface area (the area of a solid reactant that's exposed to the other reactant),
6. and sometimes materials called catalysts[1].

Increasing or decreasing the values of these variables can cause reactions to speed up or slow down.

Here are a couple of examples of how chemists change the speed of reactions:

1. Rusting is usually a slow process often taking weeks or months before it's noticed. As you perform this year's Program, you'll see how chemists can speed this reaction up and why rusting is such a problem in this area.
2. A type of "catalyst" that you might be familiar with is the "hardener", which when mixed with a resin, creates epoxy glue. As long as the resin and its hardener are kept apart, they each stay gooey liquids. Maybe if we left the resin sit around for a couple of centuries, it might finally get hard. But mix some "hardener" with it, and you'll quickly get a strong, solid glue. The hardener is similar to what chemists call a catalyst—without it the chemical reaction would happen so slowly that you might live to old age before you would see the resin harden.

Just as in the movie series called *Fast and Furious*, in this Program we'll see examples of several methods to speed up reactions as we investigate how "**Fast or Slow…Chemistry Makes It Go**!". We might also see some "slowing down" methods too.

Let the fun begin!

[1] Interestingly, each year international prizes called Nobel Prizes are awarded to people in the Arts and Sciences who've made significant contributions to their area of specialty. The recipients of the 2021 Nobel Prize in Chemistry, one of whom is a professor at Princeton University, both specialize in research into catalysts.

5. ***The Program***

Complete the Program by doing the following:

1. Begin by watching the video titled *NCW Program Video.* Watch the Introduction and Demonstration 1, and then pause the video. Answer Question 1 (below) about Demonstration 1. This completes Step 1.
2. Continue by watching the set-up information about the first hands-on Experiment. Pause the video after you've watched this set-up information.
3. Use the instructions below to complete Experiment 1. Answer Question 2 about this first hands-on Experiment. This completes Step 2.
4. Repeat the last two items for the second and third hands-on Experiments and answer Questions 3 & 4. These are Steps 3 and 4.
5. Finally, watch Demonstration 2 on the video and answer Question 5. This completes Step 5.
6. Record your answers to the 5 questions on the form on the Library's website, complete the *Matching Table* there, make sure you record your name and grade in school and your parents'/guardians' email and submit this form to complete the Program.
7. One form must be completed for each student entering the contest, and the student's name and grade level and parents'/guardians' email must be entered on the form.

Let's get started!

Program Step 1: *Demonstration 1--The Traffic Light* (to be watched by the student)

A. Watch the first Demonstration in the video.
B. The video demonstrated how shaking (same idea as stirring or mixing) affected how fast the color of the "traffic light" changed. After a few changes of color, it took more vigorous shaking each time to change the starting color from yellow to red and then to green. Complex chemical reactions are occurring as the colors change, and some chemicals in the bottle are being used up. The question is:

Question 1: One chemical in the bottle causes the color changes you saw in the video. As we shook the bottle during the demonstration, the color changed from yellow to red to green. After getting to green, we waited for a while, and the color eventually returned to yellow. We didn't shake the bottle as hard the second time, and the color never changed to green. When we started shaking the bottle the next time, we had to shake to bottle longer and harder for the starting yellow color to change to red and then to green. This is because the chemical that causes the color change is slowly being used up so it's harder to get to green each time. That chemical is actually in the air space above the liquid, so it's either oxygen or the nitrogen in the air. Which of these two chemicals do you think is being used up?

Program Step 2: *Experiment 1--Iron Filings' Oxidation* (to be performed by the student)

A. Information about the Experiment

In this experiment we present a method to speed up the formation of iron oxide. Iron oxide (rust) is a chemical "compound" of iron and oxygen caused by the chemical reaction of these two elements.

B. Performing the Experiment

The student should now do the following:

1. With the magic marker, label the two small plastic cups or bowls NC and C.
2. Pick up the cups or bowls marked NC and C and place them on the white paper.
3. Divide the iron filings (provided in your kit in a single small plastic bag) evenly between the two cups or bowls provided.
4. Carefully fill a small drinking glass about ½" deep with the vinegar.
5. Using the measuring spoon, pour ½ teaspoon of this vinegar over the iron filings in each cup or bowl. Note any changes that you observe.
6. Clean and dry the measuring spoon.
7. Now fill the ½ teaspoon measuring spoon about ½ full with table salt (i.e., ¼ teaspoon of salt).
8. Sprinkle this salt evenly onto the iron filings and vinegar in the cup or bowl marked C (only!). Again note any changes that you observe.
9. Now carefully fill a second small glass about ½" deep with 3% hydrogen peroxide.
10. Using the measuring spoon, pour ½ teaspoon of 3% hydrogen peroxide over the iron filings in cups or bowls marked NC and then ***quickly*** add the same amount of 3% hydrogen peroxide over the iron filings in cups or bowls marked C. Note any changes that you observe.

The student should now observe what's happening in cups NC and C for about 3 minutes. Answer this question at the end of that time:

Question 2: What chemical caused the reaction to speed up in one of the cups? (Hint: it's the same chemical that used to cause so many cars to rust in the Cleveland area).

Program Step 3: *Experiment 2--Alka-Seltzer Reactions* (to be performed by the student)

A. Information about the Experiment

This experiment will demonstrate yet another way in which chemists can slow down or speed up a reaction. When an Alka-Seltzer tablet is immersed in water, the bubbles result from a chemical reaction between that water and a chemical inside the tablet (the reactants) to produce carbon dioxide bubbles (the product). It's important that the water surrounding the tablet have access to as much of the solid material in the tablet as possible. In this experiment, more bubbles will indicate a faster reaction.

B. Performing the Experiment

The student should now do the following:

1. Open the packet containing the Alka Seltzer. Place both bowls or cups on the white paper from the previous experiment. Put one tablet as is in one of the small cups or bowls.
2. Place the other tablet of Alka Seltzer in the 3x5" plastic bag provided and seal the bag. Using a soup can or a rolling pin, crush the Alka Seltzer **in the bag** by rolling the can or rolling pin over the bag. Pour the resulting powder into the second small cup or bowl.
3. Squeeze the top of the pipette, place it in your cup of water, and release the top. You should now have a pipette filled with water.
4. Discharge the water in the pipette onto the tablet of Alka Seltzer in the first small cup or bowl.
5. Re-fill the pipette with water and again discharge the water in the pipette onto the powdered Alka Seltzer in the second small cup or bowl.
6. Observe the difference between the two cups or bowls. Which one has more bubbles?

Question 3: What do you think made the reaction go faster in one of the cups or bowls?

Program Step 4: *Experiment 3*--Yeast Experiments (to be performed by the student)

A. Information about the Experiment

The holes inside sourdough and other breads are made by microscopic (really tiny) yeast! In this bubbly experiment you'll find out what temperature yeast likes best. Yeast are microscopic living creatures that use starch and sugar for energy. After they eat, they "burp" (release) carbon dioxide gas. When yeast are put into dough, the gas causes the dough to rise and can result in the holes you see in a loaf of bread. Here you'll determine what yeast's favorite temperature is—boiling hot, freezing cold, or room temperature. Here's a hint: this works a lot like Goldilocks and the 3 Bears.

B. Performing the Experiment

The student should now do the following:

1. With the magic marker, label 1 zipper-lock bag "C" for cold, 1 bag "RT" for room temperature, and 1 bag "H" for hot. Add ½ teaspoon yeast to each bag. Then add ½ teaspoon sugar to each bag.
2. Add 2 tablespoons of room-temperature water to the RT bag. Seal the bag, squeezing out as much air as possible.
3. ***ASK AN ADULT TO CAREFULLY*** add 2 tablespoons HOT water from a microwave or teapot to the H bag. Hot water from the sink will NOT be hot enough. Seal the bag, squeezing out as much air as possible.
4. Add 2 tablespoons ice cold water to the C bag. Seal the bag, squeezing out as much air as possible.
5. Put all 3 bags next to each other and wait 30-90 minutes. Check the bags as often as you like. The temperature the yeast prefer will have the most carbon dioxide, which will blow up the bag like a balloon.

Question 4: After 30-90 minutes, which bag, C, RT or H inflated the most?

Program Step 5: *Demonstration 2--The Iodine Clock Reaction* (to be watched by the student)

A. Watch the second Demonstration in the video.
B. ***Question 5***: We poured the contents of the first two cups together and waited. This was the first reaction. We repeated this action for the second set of cups for the second reaction. What caused the second reaction to go slower than the first one? (Hint: check the list of "variables" in Section 4, above.)

6. Completion of the Program

When you've watched the two Demonstrations, completed the three Experiments and answered all five questions, return to the Library's website and record your answers on the form provided there. Finally, complete the *Matching Table* there and submit the from with all of your answers to us. You must submit your answers to us in this way between October 17 and 31, 2021 only. Submissions before October 17, 2021 or after October 31, 2021 will not be accepted.

You'll be notified by email if you're a winner, and the winners' information will be posted on the Library's website at the same location. Thank you for participating in our Program. We hope you had a good time and learned some chemistry while having fun doing it!