

## MAKE YOUR SODA...POP!

(120 MINUTES)

**Introduction:** Members will be creating their own soda using the scientific property of chemical reactions among acids and bases.

**Objective:** To give members opportunities to explore mixtures and solutions as well as practice recording data in their science notebooks.

**NGSS Alignment: MS-PS1-1:** Develop models to describe the atomic composition of simple molecules and extended structures.

**MS-PS1-2:** Analyze and interpret data on the properties of substances before and after the substances interact to determine if a chemical reaction has occurred.

**MS-PS1-3:** Gather and make sense of information to describe that synthetic materials come from natural resources and impact society.

### MATERIALS

- Baking soda (8 oz. box)
- Citric acid (50 g) - you can find food-grade citric acid at your local health foods store or online
- Measuring teaspoons (1/4 tsp and 1/8 tsp)
- Plastic cups, clear
- Liquid measuring cup, 1 cup
- Wooden coffee stirrers
- Paper towels (1 roll)
- Sugar (50g)

### KEY VOCABULARY

**Grittiness** - Containing very small pieces of sand or stone

## MAKE YOUR SODA...POP! A: SIMPLE REACTIONS: ACIDS AND BASES (20 MINUTES)

### Facilitators:

1. Show or print an example of the data table for participants as a guide for them to make their own data table to record their soda experiments.
2. Let participants know they are free to spit out the liquid after they have tasted it. It won't harm them to swallow it, but it might not taste very much like soda yet. Swallowing will over-acidify their stomach (which could give them a slight stomach ache).
3. Reintroduce the scientific method before beginning the experiment. After answering the engagement questions, members should develop their own hypothesis about what they think will happen in the experiment.
4. At the end of the experiment, members will evaluate their hypothesis to determine if their analysis was correct.

**Instruct Members To:**

1. Add 1/16 teaspoon of baking soda to the plastic cup.
2. Add 1/4 teaspoon of citric acid to the same plastic cup.
3. Gently swirl the cup to mix the baking soda and citric acid together.
4. Using the measuring cup, add 1/4 cup of cool, clear water to the plastic cup.
5. Use the wooden stirrer to quickly mix the solution together and then taste the beverage.
6. Rate how much it bubbles on a scale of 1 to 5 - where 1 is very bubbly and 5 is not bubbly at all in the Initial Bubbliness column (first column) of the data table.

**Questions:**

**1** Are there a lot of bubbles?

**2** Is the liquid mildly bubbly or is it bubbling a lot?

**3** How does the liquid feel on your tongue?

**4** Is the liquid too gritty?

**Instruct Members To:**

1. Rate the grittiness of the beverage on a scale of 1 to 5 - where 1 is very gritty and 5 is not gritty at all - in the Initial Grittiness column of the data table.
2. Set the timer for one minute and leave the beverage alone. After one minute has gone by, take a sip of the beverage again.
3. Rate the bubbliness and grittiness using the same scale you used before in the Bubbliness After One Minute and Grittiness After One Minute columns in your data table.

**Questions:**

**1** How are the bubbliness and grittiness after sitting undisturbed for one minute?

**Tip:** Set the timer right after you mix the solution for each experiment. This ensures you are consistent about how long the mixture sits before you taste it.

**FACILITATOR'S TIP BLOCK**

Continue to emphasize the scientific method with an emphasis on the experiment and analysis steps used to test their experiments and hypothesis. Require members to use their scientific notebook to record their information.

| AMOUNT OF BAKING SODA | AMOUNT OF CITRIC ACID | TRIAL | INITIAL BUBBLINESS | INITIAL GRITTIENESS | BUBBLINESS AFTER ONE MINUTE | GRITTIENESS AFTER ONE MINUTE |
|-----------------------|-----------------------|-------|--------------------|---------------------|-----------------------------|------------------------------|
| 1/16 TSP.             | 1/4 TSP.              | 1     |                    |                     |                             |                              |
|                       |                       | 2     |                    |                     |                             |                              |
|                       |                       | 3     |                    |                     |                             |                              |
| 1/8 TSP.              | 1/4 TSP.              | 1     |                    |                     |                             |                              |
|                       |                       | 2     |                    |                     |                             |                              |
|                       |                       | 3     |                    |                     |                             |                              |
| 1/4 TSP.              | 1/4 TSP.              | 1     |                    |                     |                             |                              |
|                       |                       | 2     |                    |                     |                             |                              |
|                       |                       | 3     |                    |                     |                             |                              |
| 1/2 TSP.              | 1/4 TSP.              | 1     |                    |                     |                             |                              |
|                       |                       | 2     |                    |                     |                             |                              |
|                       |                       | 3     |                    |                     |                             |                              |
| 1 TSP.                | 1/4 TSP.              | 1     |                    |                     |                             |                              |
|                       |                       | 2     |                    |                     |                             |                              |
|                       |                       | 3     |                    |                     |                             |                              |

**Instruct Members To:**

1. Repeat the procedure four more times using the following mixtures of baking soda and citric acid:

| BAKING SODA | CITRIC ACID |
|-------------|-------------|
| 1/8 TSP.    | 1/4 TSP.    |
| 1/4 TSP.    | 1/4 TSP.    |
| 1/2 TSP.    | 1/4 TSP.    |
| 1 TSP.      | 1/4 TSP.    |

**Instruct members to do the following each time they make a mixture or solution:**

1. Pour any remaining liquid down the drain.
2. Rinse out all plastic cups and wipe them with a paper towel. Make sure there isn't any extra baking soda or citric acid in the bottom of the cup you use to mix the ingredients.
3. Repeat the procedure two more times, for a total of three trials for each measurement

**Note:** It is always necessary to repeat your experiment to ensure the data you have collected is reliable and reproducible. Record all data in your data table.

## MAKE YOUR SODA...POP! B: ADDING THE SUGAR (10 MINUTES)

### Instruct Members To:

1. Once you've decided on your favorite recipe, add sugar to sweeten the drink.
2. Make a table like the one shown below in your science notebook.

### Base recipes with sugar

| AMOUNT OF SUGAR | TRIAL | SWEETNESS OBSERVATIONS |
|-----------------|-------|------------------------|
| 1/4 TSP.        | 1     |                        |
|                 | 2     |                        |
|                 | 3     |                        |
| 1/2 TSP.        | 1     |                        |
|                 | 2     |                        |
|                 | 3     |                        |
| 1 TSP.          | 1     |                        |
|                 | 2     |                        |
|                 | 3     |                        |

### Instruct Members To:

1. Take a new, clean plastic cup and duplicate your favorite recipe from the first section.
2. Add 1/4 tsp. of sugar to the beverage and quickly stir in the sugar with a clean, wooden stirrer.
3. Taste the beverage and record your observations in the data table in your lab notebook.
4. Rate the sweetness of the beverage on a scale of 1 to 3, where 1 is not sweet at all and 3 is too sweet.
5. Record your data in your lab notebook.
6. Repeat these steps, adding 1/2 tsp. of sugar each time.
7. Repeat these steps again, but add 1 tsp. of sugar each time.
8. Discard all extra liquid and rinse out the plastic cups.
9. Repeat these steps two more times, for a total of three trials for each sugar amount.

## MAKE YOUR SODA...POP! C: ANALYZING YOUR DATA (30 MINUTES)

**Facilitator:** Encourage participants to work together to calculate the average. Encourage younger members to ask for help with the math if they need it. Have participants calculate the average sweetness for the data collected in the second table.

### Instruct Members To:

1. Go back to your first data table from Activity 3a where you rated the bubblyness and grittiness of your different mixtures/solutions on a scale of 1 to 5.
2. Use the equation below to calculate the average bubblyness and grittiness data that you collected in the first data table across all three trials for each solution.
3. Do the same for the sweetness to find the average sweetness for each amount of sugar.

$$\text{Average} = \frac{\text{Trial 1} + \text{Trial 2} + \text{Trial 3}}{3}$$

Use tables like the ones shown below to collect your average data.

| AMOUNT OF BAKING SODA | AMOUNT OF CITRIC ACID | AVERAGE BUBBLINESS | AVERAGE GRITTINESS |
|-----------------------|-----------------------|--------------------|--------------------|
| 1/16 TSP.             | 1/4 TSP.              |                    |                    |
| 1/8 TSP.              | 1/4 TSP.              |                    |                    |
| 1/4 TSP.              | 1/4 TSP.              |                    |                    |
| 1/2 TSP.              | 1/4 TSP.              |                    |                    |
| 1 TSP.                | 1/4 TSP.              |                    |                    |

| AMOUNT OF SUGAR | AVERAGE SWEETNESS |
|-----------------|-------------------|
| 1/4 TSP.        |                   |
| 1/2 TSP.        |                   |
| 1 TSP.          |                   |

### Instruct Members To:

1. Plot your data on a graph — you can plot the data by hand using graph paper, or you can plot the data online at a website such as Create a Graph.
2. Label the x-axis "Recipe" and label the y-axis "Average Bubblyness." Make an identical plot for the average grittiness.
3. Finally, make another plot for the average sweetness.

**Extension Activity Questions:**

**1**

According to your data, which combination of baking soda, citric acid and sugar yields the most enjoyable soda?

**2**

Was your hypothesis about the experiment verified? If not, what was incorrect about your hypothesis?