

## 2. Acid's Effect on Teeth

### *Why do we Brush Our Teeth?*

#### Driving Question

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Why do we need to brush our teeth after we eat and drink?

#### Materials and Equipment

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##### *For each student or group:*

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| <input type="checkbox"/> Data collection system            | <input type="checkbox"/> Orange juice, 50 mL                            |
| <input type="checkbox"/> pH sensor                         | <input type="checkbox"/> Soda pop, 50 mL (3 different kinds)            |
| <input type="checkbox"/> Beaker, 250-mL                    | <input type="checkbox"/> Water, distilled, 50 mL                        |
| <input type="checkbox"/> Beakers (4), 100-mL or paper cups | <input type="checkbox"/> Labeling materials (such as marking pen, tape) |
| <input type="checkbox"/> Graduated cylinder, 50-mL         | <input type="checkbox"/> Wash bottle with distilled water, 100 mL       |
| <input type="checkbox"/> Vinegar, white, 50 mL             |   |

#### Safety

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Add these important safety precautions to your normal laboratory procedures:

- Wear safety glasses and lab coats or aprons.
- Consider the juice and soda as chemicals; they are not for drinking.

#### Thinking about the Question

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As you probably know, your teeth are made of the same material as your bones, which include such minerals as calcium and phosphorus. You may even have heard people claim that calcium helps build strong bones and teeth, and therefore a healthy diet should include calcium-rich foods. This is especially true for growing children.

Nature uses calcium to build strong or protective structures, including bones, teeth, and egg shells. Despite its strength, calcium is a substance that reacts easily with many types of acids.

Many of the foods you eat, such as oranges, green apples, pickles, and cranberries, taste sour, due to their acid content. Many of the beverages you drink, such as orange juice, lemonade, and soda pop, contain natural or added acids.

Some of the foods that are considered the most nutritious and healthful are those that contain vitamin C. Vitamin C is also known as ascorbic acid. In fact, ascorbic acid is sometimes added to foods that do not naturally contain it, such as breakfast cereal. Foods that have had this acid added often state on their labels, "Fortified with Vitamin C."

In this activity, you measure the acid present in various liquids by using a pH sensor and you use the pH scale to compare the results.

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Discuss with your lab group members which foods you commonly eat that contain vitamin C.

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How can you tell from the package if a food contains a particular ingredient, such as sugar or vinegar?

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What are some of the results of not brushing one's teeth on a regular basis? Can permanent damage be caused to teeth if they are not regularly brushed?

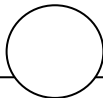
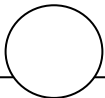
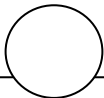
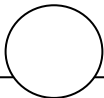
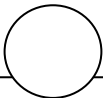
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### Sequencing Challenge

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The steps below are part of the Procedure for this lab activity. They are not in the right order. Determine the proper order and write numbers in the circles that put the steps in the correct sequence.

				
Measure and record the pH of the three soda samples and the orange juice.	Arrange the orange juice and soda samples for measuring the pH.	Make certain that each member of your lab group is familiar with the safety rules and procedures for this activity.	Set up the data collection system and measure and record the pH of distilled water and vinegar.	Compare the acidity of all the samples.

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## Investigating the Question

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**Note:** When you see the symbol "◆" with a superscripted number following a step, refer to the numbered Tech Tips listed in the Tech Tips appendix that corresponds to your PASCO data collection system. There you will find detailed technical instructions for performing that step. Your teacher will provide you with a copy of the instructions for these operations.

### Part 1 – Making predictions

1.  Using the terms such as "neutral," "acidic," "more acidic," and "most acidic," predict how your samples of beverages will compare to each other.

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2.  Put your predictions about the sample beverages in order from least acidic to most acidic.

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### Part 2 – Distilled water, vinegar, and pH

3.  Using a graduated cylinder, measure 50 mL of distilled water into a 100-mL beaker and measure 50 mL of vinegar into another 100-mL beaker.

4.  Start a new experiment on the data collection system. ◆<sup>(1.2)</sup>

5.  Connect a pH sensor to the data collection system. ◆<sup>(2.1)</sup>

6.  Change the number of digits displayed to show one decimal place (tenths). ◆<sup>(5.4)</sup>

7.  Remove the storage bottle from the pH sensor tip and set the bottle aside.

8.  Rinse the tip of the pH sensor with distilled water over the empty beaker.

**Note:** Use the 250-mL beaker to collect waste water.

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9.  Why is the sensor tip rinsed with distilled water before testing each sample? How might your results be affected if you did not rinse the sensor between trials?

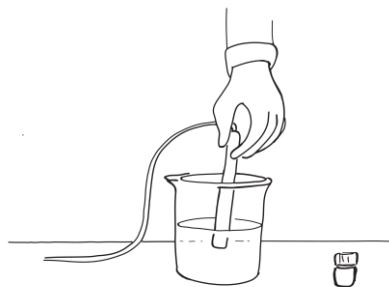
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10.  Monitor live data without recording. ♦<sup>(6.1)</sup>

11.  For each sample, measure the pH as follows:
- Place the pH sensor into the beaker containing the sample.
  - When the pH reading has stabilized, record the result in Table 1.
  - Rinse the tip of the pH sensor with distilled water.



12.  Put the pH sensor tip back into the storage bottle.
13.  Was the pH of the vinegar higher or lower than the pH of the distilled water?

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### Part 3 – Juice, soda pop, and pH

14.  Empty the beakers and rinse them with distilled water.
15.  Obtain two more 100-mL beakers so you have a total of 4.
16.  Determine a way to label the four beakers so you can identify the four solutions you will be measuring.
17.  How did you label the beakers so you could identify their contents?

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18.  Record the names of the soda corresponding to the order they will be measured in Table 1.
19.  Rinse the graduated cylinder with distilled water.

20.  Use the graduated cylinder to measure 50 mL of each solution and pour them into the appropriately labeled beaker.

**Note:** Rinse the graduated cylinder thoroughly before measuring the next solution. Give it a final rinse with distilled water if tap water was used.

21.  Why would you rinse the graduated cylinder with distilled water if it was first rinsed with tap water?

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22.  Monitor live data without recording. ♦<sup>(6.1)</sup>

23.  Remove the storage bottle from the pH sensor tip and set the bottle aside.

24.  Starting with the orange juice, measure the pH of each sample as follows:

a. Place the pH sensor into the beaker containing the sample.

b. When the pH reading stabilizes (after about 30 seconds), record the result in Table 1.

c. Rinse the tip of the pH sensor with distilled water.

25.  Put the pH sensor tip back in the storage bottle.

26.  Clean up according to your teacher's instructions.

## Answering the Question

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### Analysis

Table 1: pH values of water, vinegar, orange juice and soda

Sample	pH	Rank (most acidic is 1)	Degree of Acidity (neutral, acidic, more acidic, most acidic)
Distilled water			
White vinegar			
Orange juice			
Soda 1:			
Soda 2:			
Soda 3:			

1. Fill in the "Rank" column in Table 1 to order the liquids you measured from most acidic (#1) to least acidic (#6).

**Note:** On the pH scale, "1" represents the most acidic, and "14" represents the most alkaline (also known as basic). A pH of 7 is neither acidic nor basic.

2. Which of the liquids you measured, if any, have a pH close to 7?

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3. Compare your predictions with the data you collected. Using the same descriptive words as in your predictions (neutral, acidic, more acidic, most acidic), use the data for each liquid to enter the description you now think is appropriate in the last column of Table 1.

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4. If the calcium materials that bones and teeth are made of were to be coated with an acidic substance, the calcium would begin to react and dissolve. According to your results, which beverages would be harmful to teeth?

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5. Using your results from this investigation as evidence, how would you convince someone to brush his or her teeth after drinking one of the beverages you sampled?

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6. Is it possible for nutritious foods or beverages to be harmful to your teeth if left in contact with them for a long period of time?

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**Multiple Choice**

Circle the best answer or completion to each of the questions or incomplete statements below.

- Which of the following describes a substance with a pH of 2?
  - Healthy food
  - Acid
  - Compound
- Which of the following will determine how acidic a substance is?
  - A pH sensor
  - A base
  - A neutral substance
- What is the range of the pH scale?
  - 2 to 15
  - 7 to 14
  - 0 to 14

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4. Which number on the pH scale represents neutral?
- A. 0
  - B. 14
  - C. 7
5. Which pH number indicates an extremely acidic substance?
- A. 0
  - B. 14
  - C. 7

### True or False

- Enter a "T" if the statement is true or an "F" if it is false.

- \_\_\_\_\_ 6. Teeth contain the some of the same key chemicals as bones and egg shells.
- \_\_\_\_\_ 7. Foods that are healthy and necessary for good nutrition can be harmful to our teeth.
- \_\_\_\_\_ 8. Teeth exposed to acids for a long period of time will not suffer any harmful effects.
- \_\_\_\_\_ 9. Some acids, such as ascorbic acid (vitamin C), are added to food to make them more nutritious.

### Key Term Challenge

- Fill in the blanks from the randomly ordered words below. Note that not all of the words may be used:

hydrogen ions	hydroxide ions	pH	element
compound	more acidic	less acidic	neutral
acidic	basic	0	5
7	9	14	calcium
phosphorous	carbon dioxide		

1. The pH scale ranges from \_\_\_\_\_ to \_\_\_\_\_.
2. A \_\_\_\_\_ value of 3 is considered \_\_\_\_\_, while a \_\_\_\_\_ value of 10 is considered \_\_\_\_\_ and a \_\_\_\_\_ value of 7 is considered \_\_\_\_\_.



3. The \_\_\_\_\_ that makes bones and teeth strong is\_\_\_\_\_.
  
4. There are more \_\_\_\_\_ in an acid than in pure water and more \_\_\_\_\_ in a base than in pure water.
  
5. A liquid with a pH of 5 is\_\_\_\_\_ than a liquid with a pH of 1.

