How Sweet It Is

Wow-there's a lot of sugar in drinks

Lesson Plan

Description: Visitors predict and determine the sugar content of a variety of commercial drinks, by comparing the weight of a given volume to that of standard sugar solutions.

Audience: Hands-on activity for families and children ages 8 and up

Length: 30 minutes

Learning Objectives

Visitors learn:

- Many drinks, including natural fruit juice, soda pop, and sports drinks, contain a surprising amount of sugar.
- Sugar content can be found in the nutritional label of a commercial product.
- The sugar content of some drinks can be checked by comparing their weight to that of a known standard.

Visitors develop skills related to chemistry and science, including:

- Measuring volumes of solids
- Pipetting liquids
- Weighing using a digital scale
- Recording and analyzing data
- Communicating and discussing experiment results

Learning Standards

National Science Education Standards

1. Science as Inquiry
   - K-4: Abilities necessary to do scientific inquiry
   - K-4: Understanding about scientific inquiry
   - 5-8: Abilities necessary to do scientific inquiry
   - 5-8: Understanding about scientific inquiry
   - 9-12: Abilities necessary to do scientific inquiry
   - 9-12: Understanding about scientific inquiry

2. Physical Science
   - K-4: Properties of objects and materials
   - 5-8: Properties and changes of properties in matter
   - 9-12: Structure and properties of matter

6. Personal and Social Perspectives
   - K-4: Personal health

Background Information

Sugar has no nutritional value, other than calories for energy, which is why it is often referred to as "empty calories."

Most of us are aware that soft drinks have lots of added sugar. But fewer people are aware that even 100% juice has lots of sugar!

When something such as sugar dissolves in water to make a sugar solution, the volume doesn't change very much but the weight of the solution increases. The more sugar that is dissolved, the more the solution weighs (compared to an equal amount of pure water).

You can determine how much sugar is in a drink by weighing a volume of water with a known amount of sugar dissolved in it, and then the same volume of another drink and compare their weights. (The bubbles must be removed from carbonated drinks.)

Materials

For each pair of visitors

- Digital scale
- Labeled 100-mL bottles of sugar standards:
    - Water (colorless)
    - 3 tsp sugar (colored **red** with food color)
    - 6 tsp sugar (colored **orange** with food color)
    - 9 tsp sugar (colored **blue** with food color)
    - 12 tsp sugar (colored **green** with food color)
- Test solutions (variety of drinks in small bottles)
    - Soda pop, diet and regular
    - Sweetened tea
    - 100% juices
    - Juice drinks
    - Sports drinks
- Small cups to pour test solutions in
- Marker to label cups
- Several jumbo, 15 ml thin-stem plastic transfer pipettes
- Data sheet
- Pencil
- Safety glasses (for each visitor)

For the presenter

- One set of the materials at the visitors' workstations
- Transparent container of water (large enough to float cans of soda pop)
- Can of diet soda pop and regular soda (same brand)
- Paper towels (to clean up spills)

Notes to the Presenter

- Inexpensive postal scales will work for this activity, so long as they measure in grams and are accurate to 0.1 g.
- If they're not refrigerated, the sugar standards and commercial drinks will keep for a week or so before they start to get slimy. They'll last some weeks if refrigerated.
- Before you do the density demonstration with visitors, try floating both of your soda pop cans in water. The diet soda should float and the regular soda should sink. Occasionally, however, there will be a big enough difference in the amount of air inside the cans that they will behave differently. If you don't get the correct results, try different cans.

CAUTION: Always supervise visitors during this activity.
Be sure visitors wear safety glasses and don't let them taste any chemicals (even drinks).

Set Up

Set up takes approximately 30 minutes. (Set up will take longer the very first time you do the activity.)

1. To measure the sugar in commercial carbonated beverages, you will need to remove the carbonation from the drink before the activity. You can do this by whirling it in a blender, a small amount at a time. Another method is to heat the drink to boiling and let it cool. Either way, return the drink to its bottle for the activity.
2. If your test drinks come in small bottles (16 ounces or smaller), you can have visitors work directly out of the product packaging. If your drinks come in containers that will be too large for visitors to use, you can decant them into smaller, labeled bottles or cups. In this case, you should find a place to display the original containers during the program.

Program Delivery

Welcome visitors. Explain that they will be working in pairs or groups of three, and divide them among the workstations. Explain to parents that this is a family activity, and they should work with their children.

DENSITY DEMONSTRATION
Here I have two cans of soda. They're both *[brand name].* **Who can tell me one important difference between them?** *Response*

Right! One is diet and one is regular. And that means one has sugar and one has artificial sweetener.

Now we're going to find out another difference between them. I'm going to drop them both into this bin of water. What do you think will happen? Any ideas? *Responses*

All good suggestions! Let's find out.

Place both cans in the container of water.

That's interesting! One floats and one sinks.

Which one floats? *Diet*

Which one sinks? *Regular*

Why do you think the regular soda sinks and the diet soda floats? *Response*

Right! The regular soda is heavier because it has lots of sugar in it. The diet soda floats because there's only a tiny amount of artificial sweetener and it doesn't weigh much. So, there's the same amount of liquid in the two cans, but the one with a lot of sugar is heavier.

We can use this information to figure out how much sugar is in other things we like to drink!

Who can tell me what their favorite thing to drink is? *Various responses.*

Have you ever had someone tell you your favorite drink isn't good for you? What did they say wasn't good for you? *Listen to responses until someone says, "sugar".*

Today, we're going to find out how much sugar really is in a variety of drinks. *Show some of the drinks.*

Based on what we just learned, which do you think weighs more—plain water *[hold up bottle]* **or the same amount of water with 12 teaspoons of sugar in it** *[hold up bottle]*? *Response: The water with sugar will weigh more.*

In order to find out how much sugar is in these drinks, we're going to weigh them. But first, we need something to compare them to. These five bottles contain what we're going to call our "sugar standards"—water with a known amount of sugar. *Explain how much water and sugar each contains.*

We're going to weigh each of these, so that we can find out how much each one weighs.

We need to weigh the same amount of each liquid. To do that, we're going to fill the bulb (the fat part) of one these pipettes with liquid, and weigh it. *Show pipette.*

I'm going to show you how to fill the pipettes, weigh them, and record your answers on the data sheet. Then you can get started on the experiment.

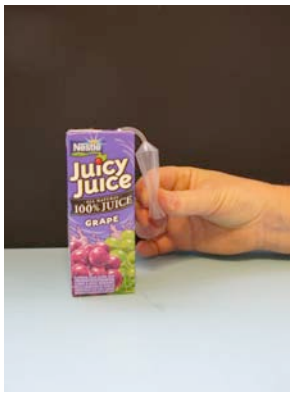
First, does everyone have on safety glasses? *Make sure everyone is wearing safety glasses.*

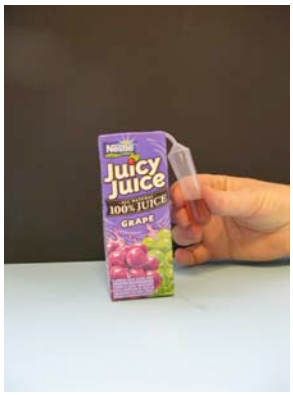
Filling pipettes for weighing

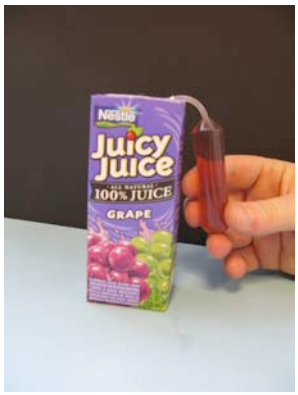
You will need to carefully fill a plastic pipette with liquid until the bulb is completely filled and contains no air bubbles, and there is no extra liquid in the stem. This can be a bit tricky and may take a few tries.

Demonstrate procedure, following the instructions below.

1. Insert the stem of the pipette into the bottle, then bend the stem so the bulb is pointing up and the stem makes a "U" shape.
2. Squeeze and release the bulb several times, so that the pipette is completely filled with water. There should be no air bubbles in the bulb and no water in the stem.
3. Unbend the pipette and hold it with the stem pointed down and squeeze out a drop of water.
4. Gently release pressure on the bulb and see if there is any water the stem.
5. If there is still water in the stem, squeeze out one drop at a time until the stem has no water in it and the bulb has no air.
6. If you get an air bubble stuck between the bulb and the stem, squeeze the bubble out into the liquid and refill it.





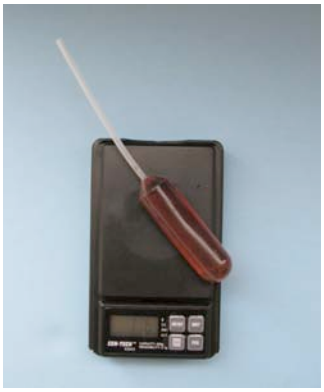


Setting up the scale

Now my pipette is ready to weigh. But first, I need to turn on my scale and make sure it's ready to use.

[Instructions for setting up your scales may be different. For the proper procedure, please consult your instruction manual.]

1. Push the "on/off" button on the scale. "8888" will appear on the screen. In about 5 seconds, this will change to "0.0"
2. There is a list of units of weight on the right side of the screen. Make sure the tiny arrow is pointing to "g" for "grams." If it is pointing to something else, press the "unit" key until the tiny arrow on the screen points to "g".
3. Now the screen reads "0.0" and the scale is ready to use.



Weighing the full pipette

1. Place the pipette on the small scale. Make sure the pipette stem is not touching anything other than the scale.
2. Read the weight on the screen. Notice the decimal point (dot)—it's important!
3. Write down the weight on your data sheet. Be sure that you write it in the correct space.

Show the worksheet and explain where to enter the data.

We're going to start with our standards: water and the four sugar solutions. You can do these in any order. After everyone has completed the standards, we'll stop and check our results together. Then we can test some different drinks.

Does anyone have any questions on the procedures? I will be available to help you while you work.

Circulate around the room, helping visitors fill the pipettes, weigh them, and record their data. After most visitors have finished with the standards, call for everyone's attention.

Now that you've all had a change to try all or most of the standards, let's share our results.

Take a look at your data sheets. As the amount of sugar increased in our solutions, did the pipettes weigh more or less? *More.*

Good. That means our method is working. We can compare the weights of different drinks to see how much sugar they contain.

Now, we're going to continue our experiment. If you're not done with the standards, you can finish those up first.

If you're ready to move on to testing different drinks, you can use the same method to see how much sugar they contain. Be sure to write down which drinks you're testing on your data sheet, so you don't forget.

You can compare the weight of different drinks to the weight of the standards, to get an idea of how much sugar they contain.

Before you weigh each drink, try predicting how much sugar it will contain. You can take two drinks at a time—like juice and soda—and try to predict which one will have more sugar.

Circulate and assist visitors. When most pairs have completed a few drinks, call for the group's attention.

Now it's time to share our results. Sharing results is one of the most important things that scientists do.

Who wants to share an interesting or surprising result? Tell us how much sugar one of your test drinks contains.

Let several visitors share one result, until most of the drinks have been covered. Many visitors will be able to compare the weights of the test drinks to the weights of the standards, and figure out about how much sugar the test drinks contain. You might need to assist others as they share their results.

Great! It sounds like everyone was able to learn something from this experiment.

What do you think about these results? *Responses will vary.*

What will you choose to drink next time you're thirsty? *Responses will vary.*

Is that a good choice for all the time, or just once in awhile?

Thank you for coming to our program. I'd be happy to answer any questions.

Clean Up

All the solutions used in this experiment can be poured down the drain.

Tips and Troubleshooting

Problem: The bulb isn't filling completely.
Solution: Make sure visitors are holding the pipette in a "U" shape, and the tip of it is below the surface of the liquid. Have them squeeze several times. They will eventually squeeze some liquid back out (not just air) and then the pipette will fill completely.

Problem: The bulb gets a stubborn bubble in it that won't come out.
Solution: Squeeze all the liquid and the air bubble out of the pipette, then start refilling it. Make sure visitors are holding the pipette in a "U" shape, and the tip of it is below the surface of the liquid.

Problem: Some visitors just can't get the pipette filled perfectly despite numerous tries and assistance.
Solution: Check their results to see if the problem is going to affect their results. The imperfect technique may not affect the overall pattern of results. It's more important that they see the big picture than that they get perfectly accurate results. If their overall results are being compromised, you or an assistant can work with them. If that's not possible, let them continue as best they can and explain that the procedure is tricky, that everyone is getting slightly different results, and that we'll all going to compare results at the end to figure out which drinks really have the most sugar.

Question: Why don't we need to worry about how much the pipette weighs?
Answer: Because we're comparing the drinks, not trying to find out exactly how much each one weighs. Every time we weigh a drink, we're using the same pipette, so the pipette adds the same amount of weight to every drink.

Credits
This project is made possible by a grant from the
Camille and Henry Dreyfus Special Grant Program in the Chemical Sciences.