Egg Shell Experimenting

Estimated Time: 60 minutes

SUMMARY
In this activity, kids use eggshells to learn about how foods can affect your teeth. After emptying an egg of its contents without breaking it, kids test the strength of the eggshell, then use egg shells to grow crystals from cleaning supplies.

WHAT YOU'LL LEARN

- How different liquids can stain teeth
- Observation skills, measurement skills, and experimental design
- Basics of solution concentrations
- The relationship between temperature and concentration of a solution

Materials Used	**Resources Used**
• Eggs Staining Egg Shells • Several liquids to stain shells (water, milk, juice, sports drinks, sodas, coffee, vinegar, lemon juice, etc.) • Several cups or bowls Egg Shell Strength • 1 push pin or tack • 1 toothpick • 1 straw (optional, but recommended) • 2 caps to plastic bottles • Several similarly sized objects to add weight (books and magazines work well) Growing Crystals • Egg shells • Borax • Water • 3 cups, bowls, or jars • Food coloring (optional) • Kitchen scale (optional, but recommended) • 1 pan or pot • Stove or hot plate • 1 spoon	• Emptying an egg: https://www.youtube.com/watch?v=O6T0Jf2GhT4 • Simple omelet recipe: https://www.seriouseats.com/recipes/2016/04/diner-style-ham-and-cheese-omelette-for-two-recipe-food-lab.html • Egg Shell Crystals Activity: https://littlebinsforlittlehands.com/crystal-eggs-easter-science-borax-crystals-activity/ • Sci Guys Red Cabbage pH Measurement Video: https://www.youtube.com/watch?v=I18K2upEHLc • Home Science Tools Crystal Growing: https://learning-center.homesciencetools.com/article/crystal-growing-science/ • Crystal Chemistry: http://www.siuestemcenter.org/wp-content/uploads/2019/02/STEM-Center-MOSAIC-Crystal-Chemistry-combined.pdf

WHAT TO DO

Staining Egg Shells

1. Hard boil or steam eggs. (See "Protect Your Eggs" activity for the best way to get eggs to easily peel and that will leave you with large egg shell pieces)
2. Peel the eggs, trying to keep as large of pieces as possible. It's not necessary to use an entire shell for each liquid, but you want pieces that are about a quarter of the total egg shell.
3. In a notebook, record observations of an egg shell before adding liquid. How does it feel? What is the color? Is it all one piece, or is something attached to the shell?
4. Place a pieces of egg shell in each cup or bowl. There should be one piece of egg shell for each liquid you want to test.
5. In the notebook, record observations of each liquid. This may include color, consistency, temperature, brand, and pH (see Tips section).
6. Add enough of each liquid to cover the shell. It is important that one liquid is water for a "control," or the one that shows what water alone does, as each liquid will have water in it. It is also important that all of the liquids start at about the same temperature. Otherwise, you're adding temperature as a variable. Something hot might affect the shell more than something cold, but we want to learn about how each liquid affects the shell, not temperature.
7. Leave the shells in the liquid for 24 hours. Periodically, pull the shells out and take observations of how they have changed. See Tips section for table organization help.
8. After the experiment is done, draw conclusions about each liquid. What effect does each liquid have on the shells over time? How do you know? How might those results relate to the effects on our teeth? What recommendations might you make to people that drink these liquids?

Egg Shell Strength

1. Drain uncooked eggs for each trial you will conduct. See the Resources section for a video on how to do this. Essentially, poke holes in the top and bottom of the egg with a pin, needle, or tack, insert a toothpick and wiggle it around to break the yoke, and blow the egg out into a bowl. The egg won't be used otherwise, but there should be enough to make an omelet. There's also a video for that in the Resources section.
2. Place a bottle cap on a sturdy surface with the open side up.
3. Put the egg with the top part down in the cap.
4. Place the other cap on top of the shell.
5. In a notebook, make a table to track your data. It may look something like:

Egg #	Objects Added Before Break	Object Added That Broke Shell	Total Mass Added Before Break
Ex. 1	4 books (*Paradise Lost, Catch-22, Slaughterhouse-5, Webster's Dictionary*)	*Harry Potter and the Prisoner of Azkaban*	1,154 g

6. Add objects on top of the bottle cap, balanced carefully, until the egg breaks. Record data in your notebook.
7. Additional questions for experimental design discussion:
    a. Why is it important to measure what was on the shell before it broke, and not just the mass when it broke?
    b. Does it matter if the objects put on top are all the same mass? Why?

c. Does the order of the objects put on the shell matter? Why?
d. Why do you need to be careful to put each object on the same way?
e. Would the egg shell hold more weight if the egg were hard boiled prior to the experiment? Why not try it out?

Growing Crystals on Egg Shells

1. Clean your egg shells with warm water. It doesn't matter if the eggs were cooked or not.
2. Bring 3 cups of water to a boil in a pan on your stove or hot plate.
3. Measure the mass of 1 Tbsp. of Borax and record it in a notebook.
4. Measure the mass of each egg shell and then place them into a labeled (numbered or a fun name because why not?) cup, jar, or bowl.
5. Add the Tbsp of Borax to the water and stir to dissolve it in the water. Because the water is hot, all of the Borax solution will dissolve in the water. Hot water can hold more solute (Borax in this case) than cold water, so it's important that the water is hot or not all of the Borax will dissolve.
6. Put one cup of the hot Borax solution in each of the 3 cups, jars, or bowls on top of the egg shell. Be careful to pour slowly to prevent the shell from breaking.
7. Add several drops of food coloring to the solutions and mix (this step is optional).
8. Let the solutions cool and sit for at least 24 hours. Take observations in the notebook at several points or pictures to document how the crystals form. Kids can also practice their drawings by sketching what they see.
9. Remove the egg shells from the solutions and allow them to dry completely.
10. Measure the mass of the crystallized egg shells and record them in the notebook. A data table might look like:

Egg Shell #	Initial Mass	Crystallized Mass	Mass of Crystals (Crystallized – Initial)
Ex. 1	6.1g	13.5g	7.4g

11. Some questions for discussion:
    a. Did all of them form the same amount of crystals? How do you know?
    b. Why did we have to measure the mass of the shell first?
    c. Is there still Borax in the solution, or is it all in the crystals? (Do not taste the solution to check. There's still some in there.)
    d. Why did crystals form only after the water cooled down? (Solubility lowered as the temperature lowered, so the Borax helped form crystals on the egg shells.)
    e. If we heat up the water again, will the crystals disappear, or are they here to stay? (Try it!)
    f. How does the total mass of the crystals on all of the shells compare to the mass of the Borax we added?
    g. How can the mass of the crystals be more than the mass of the Borax we added? (This is tricky, but the crystals capture some of the water as the crystals form.)

TIPS

- One way to make each of these activities better for students is to challenge them to organize their own data, rather than providing them with a table. This skill is important, as they will be asked to use computers to organize data throughout their lives, often in table form.

- Tables for the Egg Staining activity can be done in several ways. One large table, like you would use on a computer, might look like the one below. It may be less confusing for students to make a table for each egg shell instead.

Liquid	Time	Color	Texture	pH	Other Notes

- An addition to the staining activity is to also measure the pH, or acidity, of the liquids. pH test strips are cheap and easy to find online, but you can also use red cabbage to test pH. See the Resources section for more on this.
- The entire Egg Shell Staining and Egg Shell Strength activities can be replaced by challenging students to design their own experiments. In that case, you'll want them to identify the independent variable (what they're testing, like liquid), dependent variable (what they're measuring, like color or mass when the shell breaks), confounding variables (things to hold constant, like temperature of liquids), have them make predictions, come to a conclusion (red liquids stain shells the most), and defend their conclusion with their data (red liquids stain shells the most because the egg shell color changed more for the two red liquids than any other liquids.)
- The Egg Shell Crystals activity can be done with sugar instead of Borax, in which case you would be making rock candy. While that is fun and delicious, it didn't seem to make sense to have activities that show the dangers to our teeth and then have kids make colored sugar in the same document. Making rock candy also doesn't use egg shells unless you want to accidentally eat egg shells.
- There are many solubility and crystal extensions available online. There are two in the Resources section.