Microwaving Soap

Overview: When you warm up leftovers, have you ever wondered why the microwave heats the food and not the plate? (Well, some plates, anyway.) It has to do with the way microwaves work. Microwaves generate high-energy electromagnetic waves that, when aimed at water molecules, make these molecules get super-excited and start bouncing around a lot. Which is why it's dangerous to heat anything not containing water in your microwave, as there's nowhere for that energy to go, since the electromagnetic radiation is tuned to excite water molecules.

What to Learn: Light you can see (visible light like a rainbow) makes up only a tiny bit of the entire electromagnetic spectrum. Microwaves emit "microwaves" that are lower frequency, lower energy waves than visible light, but are higher energy, higher frequency than radio waves. The soap in this experiment will show you how a bar of Ivory soap contains air, and that air contains water vapor which will get heated by the microwave radiation and expand.

Materials

- 3 Ivory soap bars
- microwave (not a new or expensive one)
- plate

Experiment

1. Open the microwave.
2. Unwrap the bar of Ivory soap and place it on the plate (be sure it's glass or ceramic).
3. Set the time for 2-3 minutes.
4. Watch it very closely and remove it when it reaches its maximum volume (when it stops expanding).
5. NOTE: the soap may be hot after the experiment, so please be careful! Allow it to cool for a few minutes prior to touching it.
6. You can even use the soap after you're done.
7. After you have done your experiment once, design an experiment to test a question you have about Ivory soap. This experiment should be designed to answer a specific question, and you'll make a guess (called a hypothesis) as to how things will turn out. After making a guess, perform the experiment and write down what you observed happen. In the last column of your data table, you'll write what you conclude. The first one has been done as an example for you. The question that the sample is answering is: *How does soap bar volume affect how much it puffs up?* You can test all sorts of questions, from what happens if you put more than one bar of soap in, or what if you use lower power for longer, or what if you chill the bar in the freezer overnight first? The questions are endless. Have fun!

Microwaving Soap Data Table

Hypothesis	Experiment	Observation	Conclusion
Half a bar of soap will only puff just as big as a whole bar.	*Put half a bar of soap in microwave for 2.5 minutes and a whole bar in for 2.5 minutes and compare.*	*When compared, the half bar puffed up more than the whole bar!*	*There might be less mass to move out of the way, so the bar puffs up more easily. Needs more testing. Maybe test a quarter of a bar next?*

Reading

Microwaves generate high-energy electromagnetic waves that, when aimed at water molecules, make these molecules get super-excited and start bouncing around a lot.

We see this happen when we heat water in a pot on the stove. When you add energy to the pot (by turning on the stove), the water molecules start vibrating and moving around faster and faster the more heat you add. Eventually, when the pot of water boils, the top layer of molecules are so excited they vibrate free and float up as steam.

When you add more energy to the water molecule, either by using your stove top or your nearest microwave, you cause those water molecules to vibrate faster. We detect these faster vibrations by measuring an increase in the temperature of the water molecules (or in the food containing water). Which is why it's dangerous to heat anything not containing water in your microwave, as there's nowhere for that energy to go, since the electromagnetic radiation is tuned to excite water molecules.

This following experiment is a quick example of this principle using a naked bar of Ivory soap. The trick is to use Ivory, which contains an unusually high amount of air. Since air contains water moisture, Ivory also has water hidden inside the bar of soap. The microwave will excite the water molecules and your kids will never look at the soap the same way again.

Note: Scientists refer to 'light' as the visible part of the electromagnetic spectrum, where radio and microwaves are lower energy and frequency than light (and the height of the wave can be the size of a football field). Gamma rays and X-rays are higher energy and frequency than light (these tend to pass through mirrors rather than bounce off them).

Exercises

1. What is it in your food (and the soap) that is actually heated by the microwave?

2. How does a microwave heat things?

3. Touch the soap after it has been allowed to cool for a few minutes and record your observations.

Answers to Exercises: Microwaving Soap

1. What is it in your food (and the soap) that is actually heated by the microwave? (water molecules)
2. How does a microwave heat things? (using electromagnetic waves to heat water molecules)
3. Touch the soap after it has been allowed to cool for a few minutes and record your observations. (the soap should be more brittle and flakes easily)