

Formation of the Earth: Cooling Lab Teacher Notes

Materials for each group:

- Molten butter
- Shot glass
- Spoon
- waste/dump cup
- small piece of blue tape to label shot glass

Materials for class:

- Microwave or hot plate to melt butter
- freezer for cooling

Procedure:

1. Use a small piece of blue tape to label the side of the shot glass with your table #.
2. Send one person to fill the shot glass with 2-3 tablespoons of molten butter. Show your group.
3. Drop off the shot of butter on top of the freezer (the teacher will put all of the shots in at the same time).
4. **Fill in Box B:** Notice how exactly does the molten butter cool? Record your observations.
5. Use the spoon to gently tap on the surface until small cracks appear and you can see beneath the surface. Draw and label what you observe.
6. Make a bigger crack in the surface with the spoon, then pour the molten butter into the waste/dump cup. Examine the inside of the glass. Draw and label what you observe.
7. **Fill in Box C:** List a couple of questions you are wondering about related to this activity.
8. **Fill in Box D:**
 - a. How does this activity relate to the early earth?
 - b. Use our Model Tracking Sheet (Earth's Formation) to help you.
 - c. Write several **complete** sentences.
9. **Fill in Box E:** What should we add to our Model Tracking Sheet on Earth's Formation after today's activity? Write out your draft model statement in Box E. Include **WHY** "lava earth" began to cool, and **HOW** it would cool.

Procedure Notes for Teacher:

{A video of this preparation procedure has been included in the MBER resources.}

As noted above, you will need to have access to a microwave and freezer that are close to, if not in, your classroom. The key to the experiment is a) you need the butter to partially freeze (at least the top, and maybe the sides), and b) it fails if you leave the butter too long in the freezer and the butter fully freezes solid. It is ideal that the butter partially freeze in a relatively short amount of classroom time. Also, you want to minimize the amount of butter needed while still allowing students to see the point (that the outside freezes first, while the inside is still molten). It turns out that a full shot glass size is the perfect amount of butter, plus high school students love using the shot glasses (for what's that worth).

Because each freezer is set to a different temperature, it will be best to periodically check on the butter just like is done in the video. Start checking around 9 minutes, then each minute after that. We found that 12 minutes for a shot glass of butter was just enough time to freeze the top layer, while the inside was molten.

Keep in mind the timing is tricky. If you go too long, even by an extra minute, all the butter might freeze solid! There is a small window of time during the freezing process that we are taking advantage of. Another teacher tried to do this as a demo, so she decided to use a lot more butter in a larger cup. Guess what? It took like 30-40 minutes for the butter to freeze, and there was nothing for students to do with all of that time available, so plan carefully.



Just like most any labs, we highly recommend that you test this out ahead of time so you can be relatively confident of the timing to get the butter partially, but not fully, frozen.

Framing Notes:

The purpose of this lab is to observe how molten liquids cool. Early Earth was very, very hot due to the accretion and bombardment that was so frequent (as we established in the Shaking BB's lab). However, over time, the amount of stuff flying around our solar system significantly decreased because most had already been incorporated into planets or moons. With this decrease in bombardment came a cooling of the outside of earth (the inside was still incredibly hot, and continues to be today; see the article by Quentin Williams to learn more about this). The surface of Earth, being so hot, was essentially one giant lava ocean (often referred to as "Magma Earth") that began to cool from the outside down. During this process, differentiation based on density occurred, creating the layers of that we are familiar with (the inner core, outer core, mantle, and crust – we'll talk more about these in a future unit). This cooling happened over a long period of time (~ 500 million to 1 billion years), and left earth with a solid crust and liquid (plastic-y) mantle that circulates beneath that crust.

This is important information to know before we move into the next stage of Earth's history, when the atmosphere and oceans begin to form. Without establishing a solid crust, we can't begin to think about life, either.