Choreography of Lab Activity on Density, Buoyancy and Convection

0:10 Introduction to Lab

- The underlying driving force for plate movement is a process called **convection**, which occurs in Earth's mantle. (Show overhead of mantle convection)
- Earth's mantle is solid rock, but it is very hot and it can flow. It behaves like a very slowly flowing fluid.
- Convection consists of currents within a fluid. For example, you can see convection currents in soup when it's on the stove. The soup in a pot moves around in a very systematic way, vertically and horizontally, even when nobody is stirring it. Similarly, mantle rock moves around in a very systematic way, even though there's no physical object stirring it around.
- Our job, in this lab, is to figure out **why** and **under what conditions** convection occurs.

How we will do this:

Activity #1: Observe convection carefully, using pieces of seaweed in soup as markers. Realize that the seaweed moves with the water; it's just a marker showing what the water is doing.

In the rest of the activities we will explore different concepts that are needed to understand why and under what conditions convection occurs. Some may seem totally unrelated to convection. But all are essential puzzle pieces for understanding the process of convection.

Activity #2: Exploring what makes one fluid rise up through another fluid.

Activity #3: Exploring how a change in temperature can cause a change in volume.

Activity #4: Exploring what makes parts of the same fluid rise while other parts sink.

Activity #5: Comparing two ways to heat a fluid, from above and from below. Put together all previously learned concepts.

Activity #6: A twist on the concept of convection.

Notes on the Activities

Activity #2: Comparison of Motor Oil and Corn Syrup

Main point: Low-density substances will rise up through high-density fluids. High-density substances will sink down through low-density fluids.

Misconception that frequently comes up: Substances that are less dense have more air in them. I think students are often equating air with empty space. Or they may not be able to conceive of empty space with no matter in it at all. It might be helpful to remind them that even atoms are mostly empty space. The universe has MUCH more empty space than space filled with matter.

Activity #3: Volume Change Caused by Temperature Change

Main point: Any substance will expand when it is heated and contract when it is cooled.

Misconception that frequently comes up: The molecules themselves are expanding.

Many students realize that water expands when it freezes. Lead them to see that something different is going on; a change of state. Show them the diagrams of how ice crystals inherently have large empty spaces.

Activity #4: Sinking and Floating Water

Main points: When fluids are heated, their density decreases and their buoyancy increases.

Activity #5: Comparison of Two Ways to Heat a Fluid

Main points: Putting it all together

- If you heat from below, you get convection and the temperature is quite evenly distributed.
- If you heat from above, you do not get convection and you get dramatic temperature gradients.
- During convection, hot fluid on the bottom rises; cold fluid on the top sinks; the fluid circulates.
- Convection is a very effective mechanism for transferring energy.

Activity #6: Cooling a Fluid from Above

Main point: Convection requires a temperature gradient in which temperatures increase downward. A heat source is not required. Mere cooling at the top can do the trick.