Convection

Background

Convective heat transfer – or convection – is one of the major modes of heat transfer, and convection is also a major mode of mass transfer in fluids which includes liquids and gases. Convective heat and mass transfer take place both by diffusion and by advection. Advection is that in which matter or heat is transported by the larger-scale motion of currents in the fluid. In the context of heat and mass transfer, the term "convection" is used to refer to the sum of advective and diffusive transfer. In common use, the term may refer loosely to heat transfer by convection, as opposed to mass transfer by convection, or the convection process in general.

Convection is one of the major mechanisms by which heat is transferred from an area of high temperature to an area of lower temperature in a fluid. It is the essential force behind a number of Earth processes involving the atmosphere, the ocean, and even the tectonic plates. In this simple activity, you will observe the phenomenon of convection in action.

Objective(s)

- ✓ to observe the process of convection
- ✓ to model how the fluids of the ocean and atmosphere move
- ✓ to model how the interior of the Earth behaves

Materials

- bottle w/rheoscopic fluid
- ring stand
- iron ring
- wire gauze
- tea light
- matches

Pre-Lab Questions

Answer the following questions on your lab paper. For actual questions, you must either write out the questions, or include the questions in your responses. Be sure to use complete sentences and show your work for math problems.

1. What does the term "rheoscopic" mean?
2. Convection is only one method of heat transfer. Describe how convection contrasts with conduction, radiation, and evaporative cooling.
3. What is density? Describe how a substance's density changes with temperature.

Safety

★ *WARNING – The iron ring, wire gauze, and bottle may become very hot!*

Procedure

In this observation, you will model convection using a rheoscopic fluid.

1. Set up the ring stand, iron ring, and tea light so that the iron ring is positioned about 4 – 5 cm above the top of the wick.
2. Place the wire gauze securely on the iron ring.
3. Shake the bottle vigorously to mix up the contents since the solids in the fluid have likely settled on the bottom. Lay the bottle on its side on top of the wire gauze.
4. Place the tea light directly beneath the bottle make sure that the wick is directly beneath the glass and not the plastic lid.

5. Light the tea light and wait a few moments for the fluid to begin moving. In the **Results & Analysis** section, record your observations and make a basic, labeled sketch of the phenomenon.
6. After a few moments of observation have passed, carefully – **and slowly** – slide the bottle on the same side, so that a new area of the glass is being heated. Wait a few more moments, then, in the **Results & Analysis** section, record your observations.
7. Extinguish the tea light.

Clean Up

- ✓ everything returned to its original location – **AFTER** sufficient cooling time

Results & Analysis

Answer the following questions on your lab paper. For actual questions, you must either write out the questions, or include the questions in your responses. Be sure to use complete sentences and show your work for math problems.

1. Create a labeled sketch of the bottle, its contents, and the heat source. In a caption to your sketch, describe the motion of the fluid you observed.
2. Describe what happened when you moved the bottle to heat a different area of the bottle.
3. How is density involved in convection?
4. For each of the following, in a couple sentences or short paragraph, describe how convection is important to: ocean currents, the atmosphere, plate tectonics.
5. What is a "hot spot?" Give at least two examples of locations on Earth where hot spots are present. What part of this activity demonstrated the action of a hot spot? Explain.