

## Convection Currents

<b>Type of Lesson:</b>	Content with Process: Focus on constructing knowledge through active learning.	
<b>IPC Content TEKS:</b>	6B	Investigate and demonstrate the movement of heat through liquid solids and gases.
<b>Learning Goal/ Instructional Goal:</b>	Students observe, explain, and evaluate the movement of heat through convection currents.	
<b>Key Question:</b>	How does temperature affect the movement of water in a fish tank?	
<b>Related Process TEKS:</b>	<p><b>(1) Scientific processes.</b> The student, for at least 40% of instructional time, conducts field and laboratory investigations using safe, environmentally appropriate, and ethical practices</p>	<p>The student is expected to:</p> <p>(A) demonstrate safe practices during field and laboratory investigations; and</p>
	<p><b>(2) Scientific processes.</b> The student uses scientific methods during field and laboratory investigations.</p>	<p>The student is expected to:</p> <p>(A) plan and implement experimental procedures including asking questions, formulating testable hypotheses, and selecting equipment and technology;</p> <p>(B) collect data and make measurements with precision;</p> <p>(C) organize, analyze, evaluate, make inferences, and predict trends from data; and</p> <p>(D) communicate valid conclusions.</p>
	<p><b>(3) Scientific processes.</b> The student uses critical thinking and scientific problem solving to make informed decisions.</p>	<p>The student is expected to:</p> <p>(A) analyze, review, and critique scientific explanations, including hypotheses and theories, as to their strengths and weaknesses using scientific evidence and information;</p>
<b>To the Teacher:</b>	<p>During these investigations students investigate how heat moves through water, as in ocean currents. Convection currents are circular patterns that move air and liquids as a result of unequal heating and cooling. Hot air rises because it is less dense and then sinks as it cools. In the investigation, students observe hot water rising and then the cold water sinks.</p> <p>Convection currents are responsible for the movement of tectonic plates on the crust of the Earth. The mantle has convection currents that cause the plates to move which cause the plates of the crust to move. In some cases the plates push into one another causing mountains and in other cases, the plates pull apart causing mid-ocean ridges in deep in the ocean. Hot air balloons rise when the flame is turned on warming the air causing the balloon to rise. When the flame is turned off, the air cools and the balloon makes its way back to the surface of the Earth.</p>	

	Fish tanks or large clear plastic containers can be used for this activity. It is helpful if each group has their own container to use so their results are not mixed with other groups. The marbles are to hold the container down so other materials (rocks) can be used if marbles are not available. Safety must be observed during the lab as the students remove the warm water from the hot plate. Make sure heat resistant gloves are present for them to use.	
<b>Multiple Intelligences:</b>	<i>Logical-Mathematical Intelligence</i>	Consists of the ability to detect patterns, reason deductively and think logically. This intelligence is most often associated with scientific and mathematical thinking.
	<i>Spatial Intelligence</i>	Gives one the ability to manipulate and create mental images in order to solve problems. This intelligence is not limited to visual domains--Gardner notes that spatial intelligence is also formed in blind children.
	<i>Bodily-Kinesthetic Intelligence</i>	Is the ability to use one's mental abilities to coordinate one's own bodily movements. This intelligence challenges the popular belief that mental and physical activities are unrelated.

### Materials:

- Large clear plastic container or fish aquarium
- Hot plate
- Beaker
- Ice
- Heat resistant gloves
- 2 Styrofoam cups
- marbles
- food coloring – 2 colors (red & blue work well)
- colored pencils/markers (to match the food coloring)
- 2 tacks or push pins
- water
- paper towels
- large beakers/containers for water



**SAFETY NOTE:** Be sure students are using the proper safety procedures when working with hot water. Review fire hazards and rules if working with Bunsen burners. See also Texas Science Safety Manual for lab and investigation guidelines: [http://www.tenet.edu/teks/science/safety/safety\\_manual.html](http://www.tenet.edu/teks/science/safety/safety_manual.html)

**Engagement:** A friend of yours thinks a hot air balloon is full of helium gas and that is how it rises in the air. They also think a hole is put in the balloon to make the balloon come down. How could you convince them they are wrong? Support your argument with facts and scientific reasoning.

*The flame is turned on causing the air to warm and rise. As the hot air rises inside the balloon, it pushes the balloon up in the air. To lower the balloon, the flame is turned off allowing the air to cool. As the air cools, it becomes less dense and the balloon sinks back to Earth.*



### Explore:

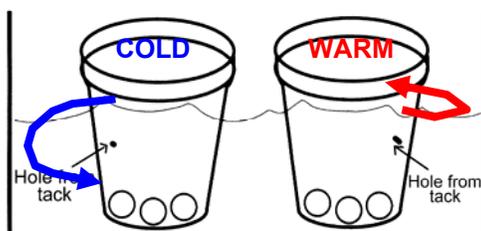
1. Heat 200 mL of water. Keep it hot but not boiling.
2. Place 200 mL of water and ice in a container and allow the water to cool.
3. Place room temperature water (not hot or cold) in the bottom of the fish aquarium so the Styrofoam cups will sit in the water but not let the water go over the edge.
4. Fill the 2 Styrofoam cups half way with marbles. Carefully put the cups in the water to make sure the water doesn't go over the edge.
5. Push the tacks in the cup just under the edge of the water level. DO NOT REMOVE the tacks. Turn the cups so the tacks are facing the opposite edges of the tank.
6. Put 6 drops of blue food coloring in one of the cups directly on top of the marbles.
7. Put 12 drops of red food coloring in the other cup of marbles directly on top of the marbles.



8. Carefully remove the hot water from the hot plate using the heat resistant gloves and pour the hot water over the red cup of marbles.
9. Remove the ice cubes, if any, from the cold water and pour the cold water over the marbles of the blue food coloring.
10. Make a prediction of what you think will happen once the tacks are removed from the cups. Write your answers in your journal and draw on the diagram below. Using the colored pencils, color your drawing to indicate your prediction of the movement of the colored water once the tacks are removed.
11. Carefully remove the tacks and observe for 5 minutes.
12. Clean up your area and put equipment away.

## Explain:

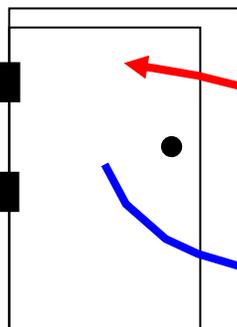
1. Describe what you saw happen once the tacks were removed. *The warm water started to rise and the cold water started to sink.*
2. Draw a diagram of what you saw happen during the 5 minutes. Use the colored pencils to help make your diagram look like what you saw.



3. How did your prediction compare to the actual results? Describe any differences. *Answers will vary with their predictions.*
4. Explain why the colored water moved like it did. *Warm water is less dense than the cold water so it rose. The cold water is more dense so it sank to the bottom.*
5. What would you predict the water would look like after it sat for 3 days without anything disturbing the water? Explain your answer. *All the water would reach equilibrium and become the same temperature. The colors would mix and all become one.*
6. Would air of different temperatures have the same movements? Defend your answer. *Yes, air acts the same as water. Air becomes less dense when heated and rises. Air also becomes denser when cooled and sinks.*
7. How does this experiment demonstrate the movement of heat through convection currents? *Convection currents are the circular pattern with warm substances rising and cool substances sinking.*

## Elaborate:

Parents tell young children to shut the door when they go outside or step outside for a moment. How could you convince a young brother or sister that they are wasting energy by leaving the door open, especially in the summer with the running air conditioner. Draw a picture to help explain to them what is happening to the air. *When the door is opened, the cool air will sink out the door into the hot air. As the cool air sinks out the door, the hot air will rush in taking the place of the exiting cool air. The air conditioner now has to work harder to cool the new warm air.*



**Hot air from outside rises and goes inside.**

Cool air from inside sinks and leaves outside.

**Evaluate:** Use the rubric below to evaluate student understanding and participation in the activities in this lesson.

POINTS	Scientific Accuracy	Reasoning	Communication	Collaboration	
<b>4</b>	I accurately observed, explained, and evaluated the movement of heat through convection currents.	I analyzed data accurately and answered the all the analysis questions accurately.	I communicated answers to the investigation questions completely and thoroughly using correct grammar. I shared my ideas about the investigation in the whole group discussion and with my team mates.	I worked extremely well with my group. Each person had a lot of input and participated in the investigation.	
<b>3</b>	I observed, explained, and evaluated the movement of heat through convection currents.	I analyzed data somewhat accurately and answered most of the analysis questions accurately.	I communicated answers to the investigation questions thoroughly using correct grammar. I shared my ideas about the investigation in the whole group discussion and with my team mates.	I worked well with my group. Each person had some input and participated in the investigation.	
<b>2</b>	I observed, but did not explain, or evaluate the movement of heat through convection currents.	I analyzed data and answered only a few of the analysis questions accurately.	I communicated answers to the investigation questions using correct grammar. I shared some of my ideas about the investigation in the whole group discussion and with my team mates.	I worked with my group. Some people did not have input and participated in the investigation.	
<b>1</b>	I did not observe, explain, nor evaluated the movement of heat through convection currents.	I did not analyzed data accurately and did not answer the analysis questions.	I did not communicate answers to the investigation questions using correct grammar. I did not share my ideas about the investigation in the whole group discussion and with my team mates.	I did not work well with my group. Few had input and participated in the investigation.	
	Subtotal: _____	Subtotal: _____	Subtotal: _____	Subtotal: _____	<b>TOTAL:</b> _____/16pts

**References/Resources/Websites:**

- <http://www.fortbragg.k12.ca.us/AG/convection.htm>
- [http://www.northstar.k12.ak.us/schools/joy/denali/DAuria/density\\_convect.html](http://www.northstar.k12.ak.us/schools/joy/denali/DAuria/density_convect.html)
- <http://www.newton.dep.anl.gov/askasci/env99/env160.htm>

