Dan Taylor

Lesson Plan: Exploring Heat in Liquids

Big Ideas

- Heat moves from hot areas to cool areas.
- Temperature can be used to detect/measure heat change.
- We categorize the transfer of heat into three methods: conduction, convection, and radiation.
- The density of a substance/object is changed as its temperature changes.
- Warmer fluid expands and will rise in a cooler fluid (in the presence of gravity).

State Standards

- Recognize that heat is a form of energy and that temperature change results from adding or taking away heat.
- Give examples of how heat moves in predictable ways, moving from warmer objects to cooler ones until they achieve equilibrium.
- Differentiate among radiation, conduction, and convection, the three mechanisms by which heat is transferred through the Earth's systems.

SWBAT

- Explain that the temperature of the mixture of two liquids will be in between the temperatures of the two liquids when separate.
- Describe and explain an activity that demonstrates the convection of hot water in cooler water.
- Explain in terms of molecular motion the difference of movement of dye in hot and cold water.

Materials & Prep Work

Per group:
* Hot Plate;
* Several 5 ml vials (weighted);
* Ice;
* Tongs for moving hot beakers
* Funnels;
* Several beakers of various sizes;
* Thermometers (w/ring stand holders);
* Food coloring of several colors;
* Straws (for inserting a liquid into another);
* Safety Goggles.

Prep: Gather all the materials. Make ice as needed.

ACTIVITIES (Italics represent what statements could be made by the teacher to the class)

EXPLORATION: Mixing different samples of water

Time: 30-45 min

Opening Tasks/Questions	IN GROUPS: *Once again, you are free to explore how heat behaves, this time in water. Water will be our representative liquid. For now, we will not use other liquids. If there are some other materials you would like to use, ask me. I will decide on a case by case basis. Carefully record all observations on the left side of a new page in your x-book.* ***Remember all safety rules! Wear goggles when using a heat source. Be extra careful with glassware****. Be careful not to stain your clothes with the food coloring.*
Follow up	WHOLE CLASS: With input from each group, summarize & record.
Leading Questions	How did you distinguish between different samples of water? What made them different? What characteristics can you measure in a sample of water? What happens to the characteristics of water samples when mixed?
Closing Tasks	*Clean-up. Turn off all burners. Use the red cloths to cleanup all spills.*
Comments	

DISCUSSION: Sharing/Concept Clarification: **What did we learn?** Time: 10-20 min

Opening Tasks/Questions	*Let's bring our thoughts together now. See if we can agree on some conclusions about heat in liquids.* Have reporters from each group give 1 or 2 statements.
Follow up	Write down ideas on unit pad. Consolidate and clarify ideas. Have students write down resulting statements in their x-book (right side).
Leading Questions	How did liquid behave differently from solids when heated or cooled?
Concept Goals	* The density of a substance/object is changed as its temperature changes. * Warmer fluid expands and will rise in a cooler fluid (in the presence of gravity).
Closing Tasks	
Comments:	

CHALLENGE: **Create Different Temperature Layers (with different colors)** Time: 20-30 min

Opening Tasks/Questions	IN GROUPS: *Here's a challenge for you. With what we have learned about heat and density, let's see if you can create a multi-layered beaker of water with different colored bands. You should have all you need at your lab station already accept for a variety of dye colors. Share with other groups so that you can create multiple colors.* ***ONCE AGAIN, PLEASE BE VERY CAREFUL NOT TO BURN YOURSELF ON HOT OBJECTS AND TREAT GLASS WARE VERY CAREFULLY****.*
Follow up	
Leading Questions	*How can we get one sample into another without too much disturbance? What would cause different water samples to form layers? Have you ever experienced different layers of water when swimming?*
Comments:	

Lecture/Demo: Heat Transfer: Conduction, Convection, Radiation Time: 20-30 min

Opening Tasks/Questions	*We have been exploring heat for the past week or so. What is heat? What does heat do? How does it get from one place to another? Think in terms of the motion of particles.* Use students as "molecules/atoms" to demonstrate the 3 forms of heat transfer. Students can put their hands on the shoulders of those next to them to form a molecular structure. When one "molecule" is hot, they all will pick up some of its energy (conduction). Have a collection of free-moving hot "molecules" move about the room taking their heat with them to other locations (convection). Have a "molecule" start moving when a heat lamp is shined on it (radiation). Work out definitions with the students and write them on the board. Have students write them in their x-books. They will need these concepts and terms to carry on a thorough discussion of heat, and in particular to answer our driving question: Why is it often windy at the beach?
Follow up	Review the big ideas brought out by the Heat in Liquids activity.
Leading Questions	
Comments:	

JOURNALING **How did this activity help you learn?** Time: 10 min

Opening Tasks/Questions	*Now it's time again to think about how you learn. In your science journal, write down what about this activity helped you learn. Include what went well and what not so well. Add anything you would like to do to follow up.*
Follow up	Share follow up ideas. Put ideas in Parking Lot or Question Bank as appropriate.
Comments:	This activity could easily be given as a **homework** assignment.

Other Homework Ideas

Read about Conduction, Convection, and Radiation in the text book. Answer related questions in book.

Assessment

* Ongoing formative assessment by teacher observing/questioning students as they work in groups.

* Short answer Quiz (2 questions):
  - Name and explain examples of the 3 types of heat transfer.
  - It's a hot sunny day. There is a black top parking lot next to a green grassy field. What might be different, if anything, about the air above the parking lot and the air above the grass? Think in terms of heat transfer

Assessment Rubric

	Novice	**Competent**	**Expert**
Content	Student may state the 3 forms of heat transfer but give no examples or give inaccurate examples. Student may correctly answer for one of the types of heat transfer but not the other two.	Student will clearly state an example for each type of heat transfer and explain why the example applies to the particular form.	Student will state and explain in detail an example for each type of heat transfer. Student will further discuss the transfer of heat in terms of particle motion, and/or indicate that radiation needs no matter through which to travel and/or conduction is particularly effective in solids and convection is not.
Application	Student may mention the 3 forms of heat transfer, but will not be able to accurately apply them to the situation. He/She may recognize that the black top is hotter than the grass, but will not extend that to the air above.	Student makes a connection between the absorption of radiation by the black top and the re-radiation and conduction to the air above it. Student compares this to the lesser absorption and re-radiation of the green grass and so concludes that the air is warmer above the parking lot.	Student will recognize the differences in heat in the air above each surface and will conclude that air over the blacktop will rise due to its reduced density.