

Lesson Name: *Density Dances*

Expedition Link: Geophysics – The focus of this task is the search for geothermal heating sources and hydrothermal circulation. It will involve the quantification of water and soil temperature gradients, as well as the conductive heat flux through the lake bottom. The investigation will also include basic water chemistry analysis as a function of depth in the lake to determine the presence of thermal water input. This task involves diving for direct observation and sediment collection.

National Science Standards:

K-4.3 students should develop understanding of organisms and environments

K-4.4 students should develop understanding of changes in earth and sky

K-4.6 students should develop understanding of changes in environments

5-8.1 students should develop abilities necessary to do scientific inquiry

5-8.3 students should develop understanding about populations and ecosystems

5-8.6 students should develop understanding about natural hazards

9-12.1 students should develop abilities necessary to do scientific inquiry

9-12.4 students should develop understanding of energy in the earth system

9-12.6 students should develop understanding of natural resources

9-12.6 students should develop understanding of environmental quality

9-12.6 students should develop understanding of natural and human-induced hazards

California State Science Standards:

California State Science Standards 4th

Investigation and Experimentation

6. Scientific progress is made by asking meaningful questions and conducting careful investigations. As a basis for understanding this concept and addressing the content in the other three strands, students should develop their own questions and perform investigations.

California Science Standards 5th

Earth Science

4. Energy from the Sun heats Earth unevenly, causing air movements that result in changing weather patterns.

As a basis for understanding this concept:

- Students know uneven heating of Earth causes air movements (convection currents).

Scientific Investigation

6. Scientific progress is made by asking meaningful questions and conducting careful investigations. As a basis for understanding this concept and addressing the content in the other three strands, students should develop their own questions and perform investigations.

California State Science Standards 6th

Earth Science

3. Heat moves in a predictable flow from warmer objects to cooler objects until all the objects are at the same temperature.

5. Organisms in ecosystems exchange energy and nutrients among themselves and with the environment. As a basis for understanding this concept:

- e. Students know the number and types of organisms an ecosystem can support depends on the resources available and on abiotic factors, such as quantities of light and water, a range of temperatures, and soil composition.

Scientific Investigation

7. Scientific progress is made by asking meaningful questions and conducting careful investigations. As a basis for understanding this concept and addressing the content in the other three strands, students should develop their own questions and perform investigations.

California State Science Standards 7th

Earth and Life History (Earth Science)

Scientific Investigation

7. Scientific progress is made by asking meaningful questions and conducting careful investigations. As a basis for understanding this concept and addressing the content in the other three strands, students should develop their own questions and perform investigations.

California State Science Standards 8th Grade

Scientific Investigation

9. Scientific progress is made by asking meaningful questions and conducting careful investigations. As a basis for understanding this concept and addressing the content in the other three strands, students should develop their own questions and perform investigations.

9th-12th California State Science Standards

Heat and Thermodynamics

3. Energy cannot be created or destroyed, although in many processes energy is transferred to the environment as heat.

Chemical Bonds

7. Energy is exchanged or transformed in all chemical reactions and physical changes of matter. As a basis for understanding this concept: Students know how to describe temperature and heat flow in terms of the motion of molecules (or atoms).

Dynamic Earth Processes

5. Heating of Earth's surface and atmosphere by the sun drives convection within the atmosphere and oceans, producing winds and ocean currents. As a basis for understanding this concept: Students know how differential heating of Earth results in circulation patterns in the atmosphere and oceans that globally distribute the heat.

Ecology

6. Stability in an ecosystem is a balance between competing effects.

Biogeochemical Cycles

7. Each element on Earth moves among reservoirs, which exist in the solid earth, in oceans, in the atmosphere, and within and among organisms as part of biogeochemical cycles.

Investigation and Experimentation

1. Scientific progress is made by asking meaningful questions and conducting careful investigations. As a basis for understanding this concept and addressing the content in the other four strands, students should develop their own questions and perform investigations.

Density Dances

Materials: Each group of 3 – 4 students will need:

- 1 large test tube
- 1 source of heat (candle, buntson burner, etc.)
- 1 plastic cup (hole cut in bottom large enough to accommodate the test tube when cup is upside down)
- 1 test tube adjustable clamp or tongs
- graduated cylinder
- 20ml of light olive oil
- 20ml of glycerin
- red dye
- goggles
- 1 container sized so that the test tube will sit in it upright
- each student will need 1 “Scientific Process Record Sheet”
- each student will need 1 “Scientific Correlation” sheet

Overview

In this activity, students are creating a model for the process that takes place inside the mantle of the earth. By layering a test tube with two liquids of different density, a model of magma is created. The more dense liquid, glycerine, represents the superheated magma that wants to rise to the top. The less dense liquid, olive oil, represents another layer of magma that, in geologic terms, is cooler and therefore denser and is cycling down to a lower level of the mantle to be superheated. Thus the principle behind hot matter rising, cool matter sinking which is the basis for convection currents.

The actual experiment shows this when the red, cooler material, olive oil, begins to fall as the more dense material is heated and gives the illusion it is rising to the top. Bubbles of gas are formed and rise to the top much like gases inside the earth’s crust rise and escape through volcanoes and other geothermal activity.

Students reflect upon the parallels modeled by the experiment and the actual activity related to convection currents within the earth’s’ mantle and crust.

Procedure:

- A. Mix the light olive oil and red dye thoroughly.
- B. Fill the container with room temperature water.
- C. Place the test inside the plastic cup (while the cup is set upside down).
- D. Measure out 20ml of glycerine syrup and carefully pour it into the large test tube.
- E. Measure out 20ml of light olive oil and carefully pour it into the test tube.

STOP AND GUIDE THE STUDENTS THROUGH THE COMPLETION OF THE PURPOSE QUESTION, HYPOTHESIS AND PROCEDURE SECTIONS OF THE “SCIENTIFIC PROCESS RECORD SHEET”.

- Direct the students to write a purpose question that addresses the influence heat has on the density of materials (eg. changes it to a lesser density level).

F. Instruct students to gently remove the test tube from the plastic cup holder and secure the test tube clamp around it.

G. Instruct students to light their heat source and put on their goggles

H. Instruct the students to hold the bottom of the test tube over the heat source. Students should log any observations they make as the bottom, most dense material heats up.

I. After a period of time the glycerine will heat up, change density, and begin to rise. The red dye will begin to slowly drop down as its density is not altered by the heat. It will give the illusion that the olive oil is sinking as it's density level remains the same, while the glycerine rises to the top as its' density level is lowered.

J. After the glycerine has changed levels, remove it from the heat source and slowly immerse it into the cup of room temperature water to cool off.

STOP AND HAVE THE STUDENTS COMPLETE THE OBSERVATION AND CONCLUSION SECTIONS OF THE “SCIENTIFIC PROCESS RECORD SHEET”.

K. Debrief the students by holding a class discussion to review the results of the heating and cooling of the dense glycerine.

L. Distribute the “Scientific Correlation” sheets to the students. Instruct them to complete the sheet as each item is discussed as a group.

The Scientific Process

I. **Purpose** (ask a question that will be answered by the experiment or research)

II. **Hypothesis** (make a prediction on the outcome of the experiment or research)

III. **Procedure** (list of materials and steps to perform the experiment or research)

Materials Needed:

Experiment/Research Steps:

IV. **Experiment or Research**

V. **Observations** (record results in written form below or attach a data table and/or graph)

VI. **Conclusions** (Answer the “Purpose” question, compare results to “Hypothesis”, & explain why you either did or didn’t obtain the results you expected.)

The Scientific Correlation

1) Explain what the two layers of different density liquids represent in relationship to geology of the earth:

2) Explain what the heat source is representative of in relationship to the geology of the earth:

3) Explain the process the movement of the red dye from the top layer in the test tube to the bottom layer of the test tube represents in relationship to the geology of earth:

4) Explain what the gas bubbles from the bottom layer of liquid in the test tube is representative of in relationship to the geology of the earth:

5) Write a summary that explains your understanding of convection currents and how this relates to the cyclic building and recycling of the lands masses of the earth:
