

Investigating Ocean Currents

Levels V-VI



Grades 9-12

Overview:

Students go from station to station, investigating basic principles that relate to thermohaline circulation. Then, they view a short video that connects those concepts to oceanic circulation and the potential for climate change. (NOTE: This lesson assumes students have a basic understanding of density.)

Objectives:

The student will:

- conclude salt water is more dense than fresh water;
- conclude density increases as temperature decreases;
- visualize the effect of continental placement on oceanic currents; and
- explain the potential effect of massive amounts of freshwater on the great ocean conveyor belt.

GLEs Addressed:

Science

- [9] SA1.1 The student demonstrates an understanding of the processes of science by asking questions, predicting, observing, describing, measuring, classifying, making generalizations, inferring, and communicating.
- [9] SA1.2 The student demonstrates an understanding of the processes of science by hypothesizing, designing a controlled experiment, making qualitative and quantitative observations, interpreting data, and using this information to communicate conclusions.
- [9] SD1.2 The student demonstrates an understanding of geochemical cycles by applying knowledge of the water cycle to explain changes in the Earth's surface.
- [10-11] SA1.1 The student demonstrates an understanding of the processes of science by asking questions, predicting, observing, describing, measuring, classifying, making generalizations, analyzing data, developing models, inferring, and communicating.
- [10] SD1.2 The student demonstrates an understanding of geochemical cycles by describing their interrelationships (i.e., water cycle, carbon cycle, oxygen cycle).
- [11] SC3.2 The student demonstrates an understanding that all organisms are linked to each other and their physical environments through the transfer and transformation of matter and energy by analyzing the potential impacts of changes (e.g., climate change, habitat loss/gain, cataclysms, human activities) within an ecosystem.
- [11] SD1.2 The student demonstrates an understanding of geochemical cycles by integrating knowledge of the water cycle and biogeochemical cycling to explain changes in the Earth's surface.

Whole Picture:

The water in all the world's oceans is constantly in motion. Ocean currents carry water around the globe, intermingling Atlantic and Pacific, Indian and Mediterranean, and all the great bodies of water. This circulation drives the "Great Ocean Conveyor," also known as the thermohaline circulation, which is powered by heat ("thermo"), and saltiness ("haline," which is similar to a name for table salt, "halite.") The Great Ocean Conveyor works like a giant conveyor belt, carrying tremendous amounts of cold, salty water from the North Atlantic to the Northern Pacific. That water is replaced by fresher, warmer water. The Great Ocean Conveyor is important because it affects the weather all over the world; cold waters offshore of an area like Europe will cool the continent, for example. Scientists have found that melting glaciers are introducing more fresh water into the world's oceans, which might slow down the global thermohaline circulation.

Materials:

- 200-milliliter beaker
- Clear baking pans (2)
- Salt
- Spoon
- Food coloring
- Paper
- Pie pan
- 1/2 cup whole milk
- Clear dish soap
- 2-3 small rocks
- Scissors
- Sheet of cardboard
- Pitcher of hot water
- Pitcher of cold water
- Colored pencils
- (2005). *Hot Planet, Cold Comfort* [Motion Picture]. United States: PBS Home Video. (NOTE: Also available at <http://www.pbs.org/saf/1505/video/watchonline.htm>)
- STUDENT WORKSHEET: "Investigating Ocean Currents"
- STUDENT WORKSHEET: "Anticipation Guide"

Vocabulary:

climate - the average weather conditions of a particular place or region over a period of years

Arctic - of, relating to, or suitable for use at the north pole or the region around it <Arctic waters>
<Arctic animals> <Arctic clothing>

impact - to have a strong effect on <Volcanic ash impacted weather conditions worldwide.>

Activity Preparation:

Prepare three separate stations each equipped with the necessary materials listed on the Student Worksheet: "Investigating Ocean Currents."

Activity Procedure:

1. Inform students that today they will be investigating salinity, density, temperature and continental placement and their relationship with oceanic circulation. Differences in density are the main cause of deep ocean currents.

Critical Thinking Question: Anticipation Guide Method. Before exploring the topic of ocean circulation and weather further, distribute the STUDENT WORKSHEET: "Anticipation Guide" and instruct students to complete the worksheet. After students have had a chance to answer the questions independently, go through each question and ask for volunteers to provide an answer and defend it. Encourage debate among students. The "Anticipation Guide" will provoke thought and determine students' knowledge and misconceptions. Answers to the "Anticipation Guide" are not provided, since not all statements are true or false, but allow students to come to their own educated conclusions throughout the remainder of the lesson.

2. Divide the students into pairs and distribute the STUDENT WORKSHEET: "Investigating Ocean Currents." Review the information on the worksheet and direct students to the stations.
3. After students have completed Part 1 of the worksheet, ask them to share their sketches from Station A, question 2 and Station B, question 2. Review students' results.

- View Part 1: The Sea's Greatest River in *Hot Planet—Cold Comfort* either via home video or on the PBS Web site.
- Make sure students understand the ocean conveyor belt is driven by changes in density as they relate to salinity and temperature, as demonstrated at Stations A and B, and that the path of the ocean conveyor belt is influenced by continents, as demonstrated at Station C.

Answers:

STUDENT WORKSHEET: “Investigating Ocean Currents”

Part 1:

Station A:

- Answers will vary.
- Answers will vary, but observations should reflect that saltwater is denser than freshwater.
- More

Station B:

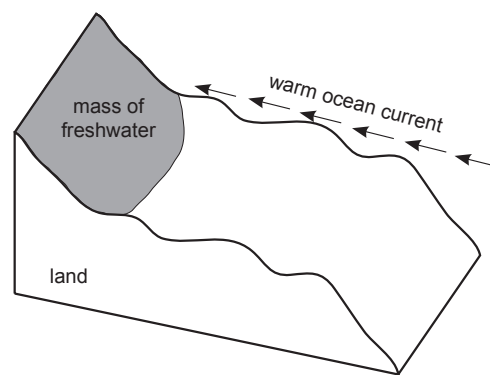
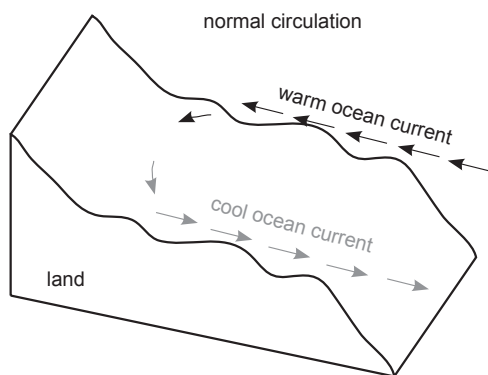
- Answers will vary.
- Answers will vary, but observations should reflect that cold water is denser than hot water.
- decreases

Station C:

- Answers will vary.
- The milk represents the ocean. The food coloring represents currents. The rocks represent continents.

Part 2:

- The great ocean conveyor belt is the worldwide circulation of ocean current that redistributes heat around the planet.
- Explanations and diagrams should show that too much freshwater released into the great ocean conveyor belt has the potential to stop the dense waters from forming. The dense waters are necessary in creating the current that operates the “conveyor belt.” Without the conveyor belt, the heat will not be distributed around the planet as it has in the past.



STUDENT WORKSHEET: “Anticipation Guide”

Answers to the “Anticipation Guide” are not provided, since not all statements are true or false, but allow students to come to their own educated conclusions throughout the remainder of the lesson.

Name: _____

Investigating Ocean Currents: Part 1

Student Worksheet

Levels V-VI



Directions: With a partner, rotate through three stations to investigate concepts that apply to oceanic circulation.

Station A: Density and Salinity

1. Hypothesis: Predict what will happen to the water when salt water is poured into freshwater.

If _____

then _____

because _____.

Experiment:

Materials:

- 200-milliliter beaker
- Clear container
- Salt
- Spoon
- Food coloring
- Paper

Procedure:

STEP 1. Fill the beaker with water, then add food coloring. Stir in a spoonful of salt until the salt is dissolved.

STEP 2. In the clear container, pour just enough water so that it doesn't overflow when the water from the beaker is added. Add food coloring of a different color.

STEP 3. Place small pieces (approximately 1 inch square) of paper on the surface of the freshwater in the clear container.

STEP 4. Gently pour the colored saltwater into the side of the container.

2. Sketch the actions of the saltwater, freshwater and pieces of paper.

3. Circle the correct answer. Saltwater is _____ (more/less) dense than freshwater.

STEP 5. Clean up the area and prepare for the next group.

Name: _____

Investigating Ocean Currents: Part 1

Student Worksheet

Levels V-VI



Directions: With a partner, rotate through three stations to investigate concepts that apply to oceanic circulation.

Station B: Density and Temperature

1. Hypothesis: Predict what will happen when hot water and cold water interact.

If _____
then _____
because _____.

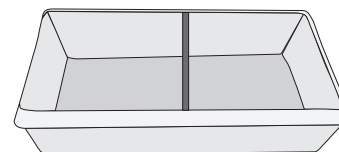
Experiment:

Materials:

- Clear baking pan
- Pitcher of cold water
- Pitcher of hot water
- Scissors
- Sheet of cardboard
- Food coloring
- Paper
- Colored pencils

Procedure:

- STEP 1. Cut the cardboard to fit snug across the center of the pan.
- STEP 2. Dye the water in each pitcher a different color.
- STEP 3. One person must hold the cardboard as the other person pours the water from one pitcher in one side and the water from the other pitcher on the other side.
- STEP 4. Observe from the side of the pan as the cardboard is pulled to let the hot and cold water interact.



2. Sketch observations.

3. Circle the correct answer. Density increases as temperature _____ (increases/decreases).

STEP 5. Clean up the area and prepare for the next group.

Name: _____

Investigating Ocean Currents: Part 1

Student Worksheet



Directions: With a partner, rotate through three stations to investigate concepts that apply to oceanic circulation.

Station C: Currents and Continents

Materials:

- Pie pan
- 1/2 cup whole milk
- Food coloring
- Clear dish soap
- 2-3 small rocks

Procedure:

- STEP 1. Pour milk into the pan.
- STEP 2. Place rocks in the pan.
- STEP 3. Drop five drops of one color of food coloring on one spot at the edge of the pan.
- STEP 4. Drop five drops of a different color on one spot on the opposite edge of the pan.
- STEP 5. Squirt dish soap on the two spots of food coloring.

1. Describe or sketch your observations.

2. In this model, the pie plate represents Earth. What do the milk, food coloring, and rocks represent?

STEP 6. Clean up the area and prepare for the next group.

Name: _____

Investigating Ocean Currents: Part 2

Student Worksheet

Levels V-VI



Directions: View “Part 1: The Sea’s Greatest River” in *Hot Planet—Cold Comfort*. Afterwards, answer the following questions.

1. What is the great ocean conveyor belt?

2. Explain the potential effect of massive amounts of freshwater on the great ocean conveyor belt. Make a diagram to help clarify the explanation, if necessary.

Name: _____

Anticipation Guide

Student Worksheet

Levels V-VI



Directions: Circle “T” for True or “F” for False in response to each of the following statements.

1. T F The Gulf Stream is part of the Great Ocean Conveyor Belt.
2. T F The Gulf Stream carries warm water south toward the tropics.
3. T F The Great Ocean Conveyor Belt redistributes heat throughout the entire planet.
4. T F Salinity is higher in the poles because precipitation adds more water to the ocean in the northern and southern latitudes.
5. T F The melting of glaciers adds freshwater to the ocean.
6. T F If a large enough chunk of the Greenland Ice Sheet breaks off, the Ocean Conveyor Belt will speed up, causing global cooling.
7. T F The warming of the planet is indirectly causing an increase in precipitation.
8. T F Since the 1990s, glaciers have been decreasing in height by almost two meters per year.
9. T F The “little ice age” was caused when the Ocean Conveyor Belt stopped.
10. T F Scientists study ocean sediment cores and ice cores to determine information about past climate.