RESOURCE LIBRARY
ACTIVITY : 50 MINS

Circulation of the Seas

Students record their expectations and observations of water properties using a physical demonstration. Next, they watch a video and read an article to label a simple model of thermohaline circulation. Finally, students predict how the movement of water in ocean currents via thermohaline circulation might contribute to or interact with global warming and climate change.

GRADES

6 - 8

SUBJECTS

Earth Science, Climatology, Oceanography

CONTENTS

2 Resources, 1 PDF

OVERVIEW

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For the complete activity with media resources, visit:
http://www.nationalgeographic.org/activity/circulation-seas/

In collaboration with

DIRECTIONS

This activity is part of the Climate Change Challenge unit.

1. Initiate a physical demonstration to inform students' initial hypotheses about ocean circulation.

- Introduce a simple demonstration consisting of a tank/aquarium full of room temperature water, a capped bottle of cold salty water (labeled with blue food coloring), and a capped bottle of hot freshwater (labeled with red food coloring).
    - See the *Setup* section for more information on how to conduct this demonstration.
- Explain to students the contents of the two bottles, distribute the *Circulation of the Seas* handout, and ask students to record their predictions for this demonstration in Part A:
    - *What is your prediction for where the cold, salty blue water will flow when I uncap it sideways within the tank?*
    - *What is your prediction for where the hot, fresh red water will flow when I uncap it sideways within the tank?* (Students' expectations may vary but should include a statement regarding the flow of this water, and a justification using prior knowledge.)
- Uncap the bottles gently and prompt students to record their observations in the chart from Part B of the *Circulation of the Seas* handout.
- Solicit volunteers' responses.
- Ask students:
    - *How might the phenomena you are observing here in this tank be relevant to the oceans?* (Students' responses will vary, but listen for any connections between water flow in this demonstration and the flow of water from place to place within ocean basins.)

2. Use a video and article to introduce the relationship between water temperature, salinity, and ocean currents.

- Prompt students to begin Part C of the *Circulation of the Seas* handout as they watch the *Ocean Currents and Climate* video (2:33).

- After watching the video, have students share their responses to check for initial understanding. Emphasize that the video only addresses one factor (temperature) that drives ocean circulation.
- Then assign students to work in pairs to read and annotate the *Ocean Currents and Climate* article. Prompt students to identify additional factors influencing the density of water and record the information in Part C of the *Circulation of the Seas* handout.
- Solicit volunteers' responses to ensure that students have a comprehensive list of characteristics that:
    - Make water more dense/sink (low temperature and high salt content).
    - Make water less dense/rise (high temperature and low salt content).

3. Prompt students to predict the movement of water in ocean currents using a model of thermohaline circulation.

- Introduce the concept of *thermohaline circulation* by first breaking down the origin of the term. Thermo refers to heat, and haline, to saltiness.
- In a Think-Pair-Share, ask students to complete Part D of their handout using their knowledge of how water behaves depending on temperature and salt content.
- Review students' responses by projecting the *Ocean Conveyor Belt* diagram, also shown on students' handouts, and asking volunteers to choose the correct labels from each pair.
- Students' labeled diagrams should indicate that:
    - Near the poles, the temperature is cold. As ice forms, it forces out the salt crystals, so the water below the ice gets saltier, causing it to sink.
    - Near the equator, the temperature is warmer. Compared to the poles, the water is less salty and rises.
- Next, project *The Global Conveyor Belt* infographic showing a more detailed depiction of the process. Draw students' attention to:
    - The cold, salty, deep current near the South Pole.
    - The warm, less salty, shallow current near the equator.
    - The direction of flow, indicated by the Ocean Water Flow inset graphic.
    - The locations where changes in the temperature and salt content of the water cause it to sink or rise, driving the currents around the globe (where the currents make sharp bends in the North Atlantic, Indian, and North Pacific oceans).

4. Lead a class discussion on the interactions of thermohaline circulation with effects of global warming and climate change.

- Prompt students to revisit the causes of three main impacts on the world’s oceans in the *Oceanic Impacts* handout from the *Oceanic Impacts* activity:
- Warming oceans
- Rising sea levels
- Ocean acidification
- In a Think-Pair-Share format, ask students how thermohaline circulation might contribute to or interact with each of these processes.
- (Listen for students' responses that incorporate the movement of water around the globe distributing the effects of global warming or climate change, for example by moving water warmed at the equator to the poles, where it might melt additional sea ice and raise sea levels).
- Revisit the class *Know and Need to Know* chart to incorporate new insights regarding how thermohaline circulation drives ocean currents, and how these currents can interact with global warming and climate change impacts on the oceans.

Modification

Step 2: If it is not possible to conduct the thermohaline circulation demonstration, there are videos with similar demonstrations online. However, these demonstrations may not align precisely with the lesson instructions (for example, water colors may differ).

Tip

Step 2: The demonstration in this activity requires preparation; please check the *Setup* instructions a few days before conducting the activity to ensure that you have the necessary supplies. To view a video of a similar demonstration, please visit *Surfing Scientist live experiment: Thermohaline circulation* (1:45).

Informal Assessment

Informally assess students’ understanding of thermohaline circulation and its role in ocean currents by examining their responses to the video, demonstration, and discussion in their *Circulation of the Seas* handout.

Extending the Learning

Step 3: For a more detailed dive into how ocean currents move water and objects around the world, students may complete the activity *Mapping Ocean Currents*.

OBJECTIVES

Subjects & Disciplines

Earth Science

- Climatology
- Oceanography

Learning Objectives

Students will:

- Identify the variables that drive thermohaline circulation.
- Generate and evaluate predictions related to thermohaline circulation.
- Predict movement of water in ocean currents using their understanding of thermohaline circulation.
- Relate what they learn about thermohaline circulation to ocean temperature rises and acidification.

Teaching Approach

Teaching Methods

- Demonstrations
- Discussions
- Lab procedures

Skills Summary

This activity targets the following skills:

- 21st Century Student Outcomes
  - Learning and Innovation Skills
    - Communication and Collaboration
    - Critical Thinking and Problem Solving
  - Life and Career Skills
    - Initiative and Self-Direction
    - Social and Cross-Cultural Skills
- 21st Century Themes
  - Environmental Literacy
  - Global Awareness
- Critical Thinking Skills
  - Applying
  - Evaluating
  - Understanding
- Geographic Skills
  - Acquiring Geographic Information
  - Answering Geographic Questions
- Science and Engineering Practices
  - Constructing explanations (for science) and designing solutions (for engineering)
  - Developing and using models

National Standards, Principles, and Practices

COMMON CORE STATE STANDARDS FOR ENGLISH LANGUAGE ARTS & LITERACY

• **CCSS.ELA-LITERACY.SL.7.1:**
Engage effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on Grade 7 topics, texts, and issues, building on others' ideas and expressing their own clearly.

NEXT GENERATION SCIENCE STANDARDS

• **Crosscutting Concept 2: Cause and Effect:**

Cause and effect relationships may be used to predict phenomena in natural or designed systems.
• **MS-ESS2-6:**
Develop and use a model to describe how unequal heating and rotation of the Earth cause patterns of atmospheric and oceanic circulation that determine regional climates.
• **Science and Engineering Practice 2:**
Developing and using models
• **Science and Engineering Practice 6:**
Constructing explanations and designing solutions

Preparation

What You'll Need

MATERIALS YOU PROVIDE

- Beakers
- Blue food coloring.
- Clear-walled tank/aquarium
- Distilled water
- Red food coloring
- Salt
- Tap water
- Two small (<100mL) clear-walled bottles (glass or plastic) with corks or caps

REQUIRED TECHNOLOGY

- Internet Access: Required
- Tech Setup: 1 computer per classroom, Monitor/screen, Projector, Speakers

PHYSICAL SPACE

- Classroom

GROUPING

- Large-group instruction
- Large-group learning
- Small-group learning

- Small-group work

BACKGROUND & VOCABULARY

Background Information

Currents carry the Earth's ocean water around the planet, moving it between the five major basins—the Atlantic, Pacific, Arctic, Indian, and Southern oceans. These currents are driven by factors such as density differences, wind, and gravitational attraction. Ocean currents are also responsible for determining local weather patterns, even over dry land.

Thermohaline circulation is also called the ocean conveyor belt. It is a particular type of current driven by differences in temperature and salinity within ocean waters. Cold, saltier water is denser and, therefore, sinks. Warm, less salty water is less dense and, therefore, floats. At a few positions in the north and south called deep water formations, water cools, becomes saltier, and sinks, pushing water around the globe and making a full circuit about once every thousand years. If these deepwater formation sites become less cold and salty due to global warming, thermohaline circulation could be disturbed, with major consequences for climate around the world.

Prior Knowledge

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Recommended Prior Activities

- Carbon All Around
- Global Trends
- Heating Up
- Local Emissions
- Meteorological Models
- Now and Then
- Oceanic Impacts
- Our Greenhouse
- Plot It!
- Weather Interconnections
- Weather, Meet Climate

Vocabulary

Term	Part of Speech	Definition
climate change	*noun*	gradual changes in all the interconnected weather elements on our planet.
density	*noun*	number of things of one kind in a given area.
global warming	*noun*	increase in the average temperature of the Earth's air and oceans.
ocean conveyor belt	*noun*	system in which water moves between the cold depths and warm surface in oceans throughout the world. Also called thermohaline circulation.
salinity	*noun*	saltiness.
temperature	*noun*	degree of hotness or coldness measured by a thermometer with a numerical scale.
thermohaline circulation	*noun*	ocean conveyor belt system in which water moves between the cold depths and warm surface in oceans throughout the world.

For Further Exploration

Instructional Content

- National Geographic: Resource Library: Collection: Weather
- National Geographic: Resource Library: Collection: Catastrophic Weather Events
- National Geographic: Resource Library: Collection: Climate
- National Geographic: Resource Library: Collection: Climate Change
- National Geographic: Mapping Ocean Currents

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