

Lesson 3: Oceans and Ocean Currents

☐ Getting Started

Imagine stepping onto a beach in England. Even though England is much farther north than many parts of Canada, its winters are often milder. Why? The answer is not in the air. It is in the ocean. Massive currents move warm and cold water around the planet, carrying heat from one place to another. These currents help shape weather, influence climate, and affect where plants and animals can survive. In this lesson, you'll investigate what causes ocean currents to move and how something as simple as temperature can influence the world's oceans.



Stuff You Need

- *Water: The Story of the Hydrosphere, Second Edition* by Lynne Z. Petkovic, M.Ed., J.D.
- blue food coloring (kit)
- cold water
- crayons, colored pencils, or markers
- glue or gluestick
- green food coloring (kit)
- hot water (not boiling, but warm enough to notice a difference)
- red food coloring (kit)
- room temperature water
- scissors
- small clear cups (kit)

Ideas to Think About

- How do the properties and structure of water impact Earth's systems and support life on Earth?

Things to Know

- A **current** is the steady flow of water in a particular direction, often caused by differences in temperature, salinity, or wind.
- **Thermohaline circulation** is the deep, slow-moving system of currents in the ocean.
- **Upwelling** is the process in which winds blow the surface water away, and deep, cold, nutrient-rich water rises to the top.
- Density plays a significant role in the movement of the oceans' waters. Variations in density due to variations in temperature and salinity drive a global pattern of interconnected ocean currents.
- The ocean exerts a major influence on weather and climate by absorbing energy from the sun, releasing it over time, and globally redistributing it through ocean currents.

- The complex patterns of the changes and the movement of water in the atmosphere, determined by winds, landforms, and ocean temperatures and currents, are major determinants of local weather patterns.

☐ Reading and Questions

Read Chapter 3 in the book *Water: The Story of the Hydrosphere*. Then, answer the questions.

1. What is thermohaline circulation?

2. How does upwelling help support ocean life?

3. Why are ocean currents important even for people who live far from the ocean?

Activities

☐ Activity 1: Density, Salinity, and Ocean Currents

Ocean stratification results when ocean water with different densities forms layers due to their properties. In this video, you will watch a science demonstration to see how differences in salinity can create ocean stratification, which may result in ocean currents. In some parts of the ocean, winds push surface water away, allowing deeper water to rise. This process is called **upwelling**. Upwelling brings cold, nutrient-rich water to the surface, which supports marine life.

1. Watch the video carefully to see how each layer in the container is colored.
2. Color your drawing of the container to match the colors shown in the video.
Use the same colors as the video for each layer.

3. Use the key below to show which layer is most dense and which is least dense:
4. *Most Dense (darkest color)
5. *Second Most Dense
6. *Least Dense (lightest color)
7. Next to each label in the key, shade a small box with the same color you used in your drawing for that layer. This will help others match the color to the density level.
8. On your drawing of the container, draw a big arrow pointing down from the top to the bottom. This arrow shows how salinity increases as you go deeper.
9. Label the arrow with the word "Salinity" to show that the salt content gets higher in the lower layers.



What causes currents in the ocean?

www.beyondthepage.com/link/13334/

☐ Activity 2: Water Molecule Movement

In the ocean, water is constantly moving, but not all water moves the same way. Some water sinks, some rises, and some flows across long distances. One important reason for this movement is temperature. But why does temperature matter?

To understand this, you need to zoom in—way in—to the level of tiny water molecules. These particles are always moving. When water is warmer, they move faster. When water is colder, they move more slowly. In this activity, you will observe how temperature affects particle motion and then develop a model to explain and predict what is happening.

Procedure

1. Fill one cup with room temperature water, one with cold water, and one with hot water (it does not need to be boiling, just warm enough to notice a difference).
2. Place the cups on a flat surface where you can easily see them.
3. Add one drop of red food coloring to the room temperature water and observe what happens.
4. Add one drop of blue food coloring to the cold water and observe what happens.
5. Add one drop of green food coloring to the hot water and observe what happens.
6. Watch how the food coloring disperses in each cup. Note whether it spreads quickly or slowly.

7. Pay attention to how the food coloring behaves in the different temperatures of water.

The food coloring helps you observe how quickly water molecules are moving, but it does not show the molecules themselves. When you create your model, remember what you learned in Lesson 1. Water molecules move in all directions, not just one direction. In colder water, draw the molecules closer together with short arrows to show slower movement. In warmer water, draw the molecules slightly farther apart with longer arrows to show faster movement. The arrows should point in different directions to represent molecules moving randomly. On the "Water Molecule Movement" Activity Page, answer the questions.

☐ **Activity 3: From Water Molecules to Ocean Currents**

In the last activity, you zoomed in to observe how tiny water molecules move faster when they are warm and slower when they are cold. Now, it's time to zoom back out.

Way out.

All the way to the scale of the entire Earth. The same idea you just explored—temperature affects movement—also helps explain something much bigger: how oceans move around the planet. Scientists use models to connect small ideas (like particle motion) to large systems (like ocean currents). In this activity, you will build a model that shows how unequal heating of Earth causes ocean circulation.

Part 1: Build an Earth System Model

Turn to the activity page titled "From Water Molecules to Ocean Currents."

1. Cut out the model pieces of Earth and the Sun provided on the page.
2. Glue or tape these pieces onto the model page.
3. Glue the labels for the equator and the poles.
4. Place the sunlight arrows between the Sun and Earth.
5. Place the ocean current arrows in the correct locations.

As you build your model, remember:

- The equator receives the most direct sunlight and is warmer.
- The poles receive less direct sunlight and are colder.
- Warm water tends to rise.
- Cold water tends to sink.

Part 2: Label Ocean Movement

Now, extend your model:

- Glue the arrows to show a loop or cycle of movement

As you connect your arrows into a loop, you are modeling a real system in Earth's oceans called **thermohaline circulation**—a deep, slow-moving system of currents driven by temperature and density differences. This global circulation helps move water and heat throughout the ocean.

Part 3: Add Earth's Rotation

Earth is always spinning. Add to your model:

- A note that Earth's rotation causes currents to curve

(Scientists call this the *Coriolis effect*, but you do not need to fully explain it—just recognize that rotation affects movement. You will learn more about this in 11-13 *The Atmosphere* unit)

The same idea you observed in a cup—particles moving faster when warm and slower when cold—also happens on a global scale. Unequal heating of Earth causes water to move, creating ocean currents that transfer heat around the planet. These movements help shape weather and climate in different regions.

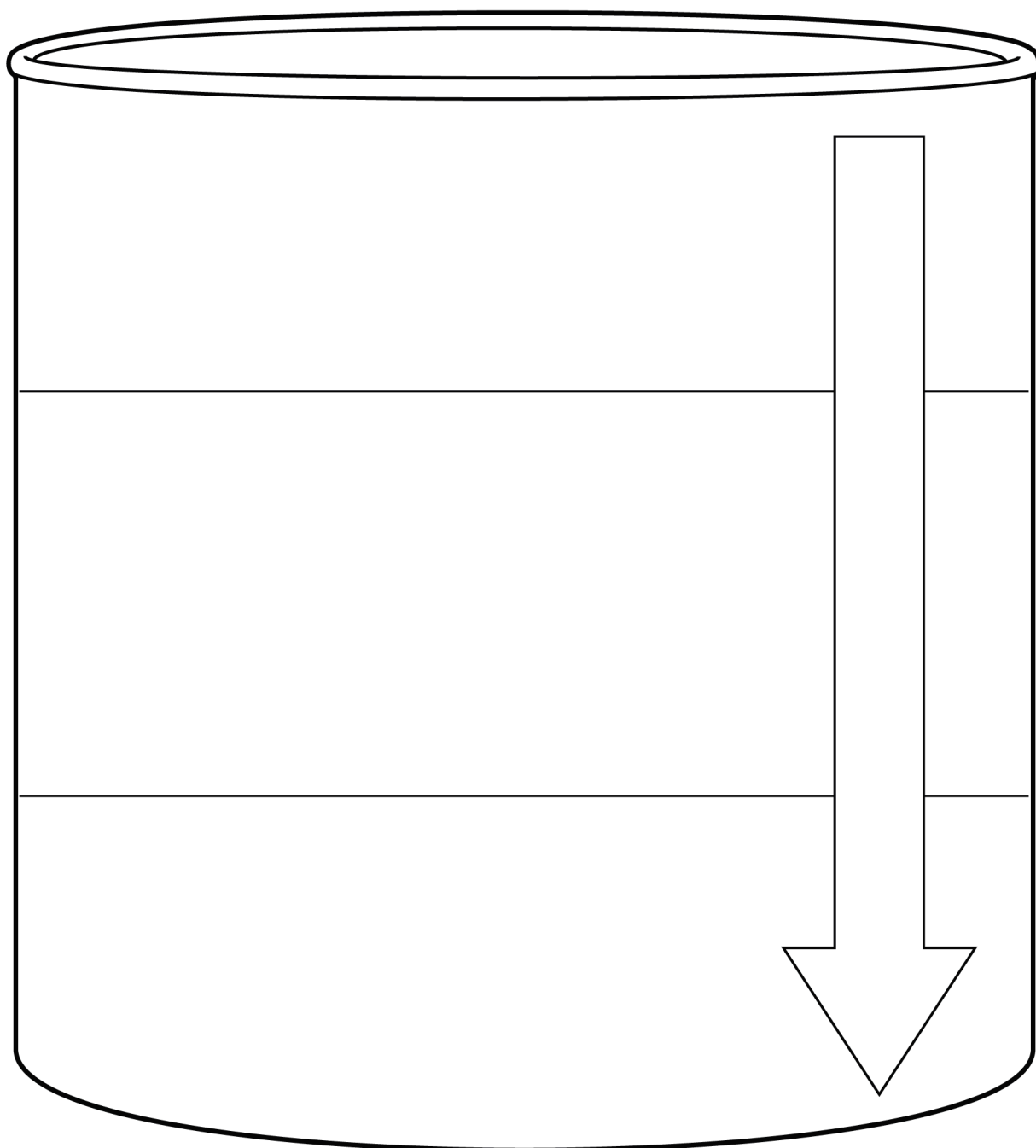
Wrapping Up

In this lesson, you explored how water moves, from tiny particles to powerful ocean currents that travel across the Earth. You discovered that differences in temperature and density help drive these movements and shape our planet's climate. Next, you'll shift your focus from oceans to another important part of the hydrosphere: freshwater and groundwater, and where the water we use every day comes from.

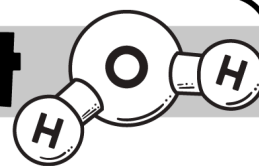
Density, Salinity, and Ocean Currents

Key:

- ☐ Most dense
- ☐ Second most dense
- ☐ Least dense



Water Molecule Movement

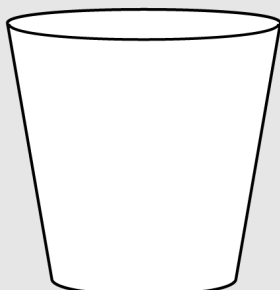


Develop a Model

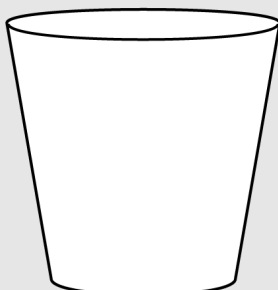
Scientists cannot see individual water molecules, so they create models to explain what is happening. Draw a model to show what is happening inside each cup.

In your model:

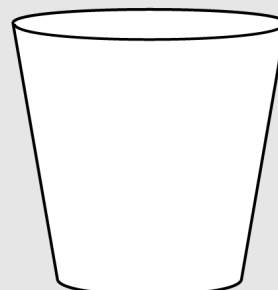
- Draw water molecules as small circles
- Use arrows to show how the particles are moving
- Show differences in speed by using shorter arrows for slower-moving molecules and longer arrows for faster-moving molecules. Draw arrows pointing in different directions to show that molecules move randomly.



Cold water



Room temperature water



Hot water

Use Your Model to Predict

 Use your drawing to answer:

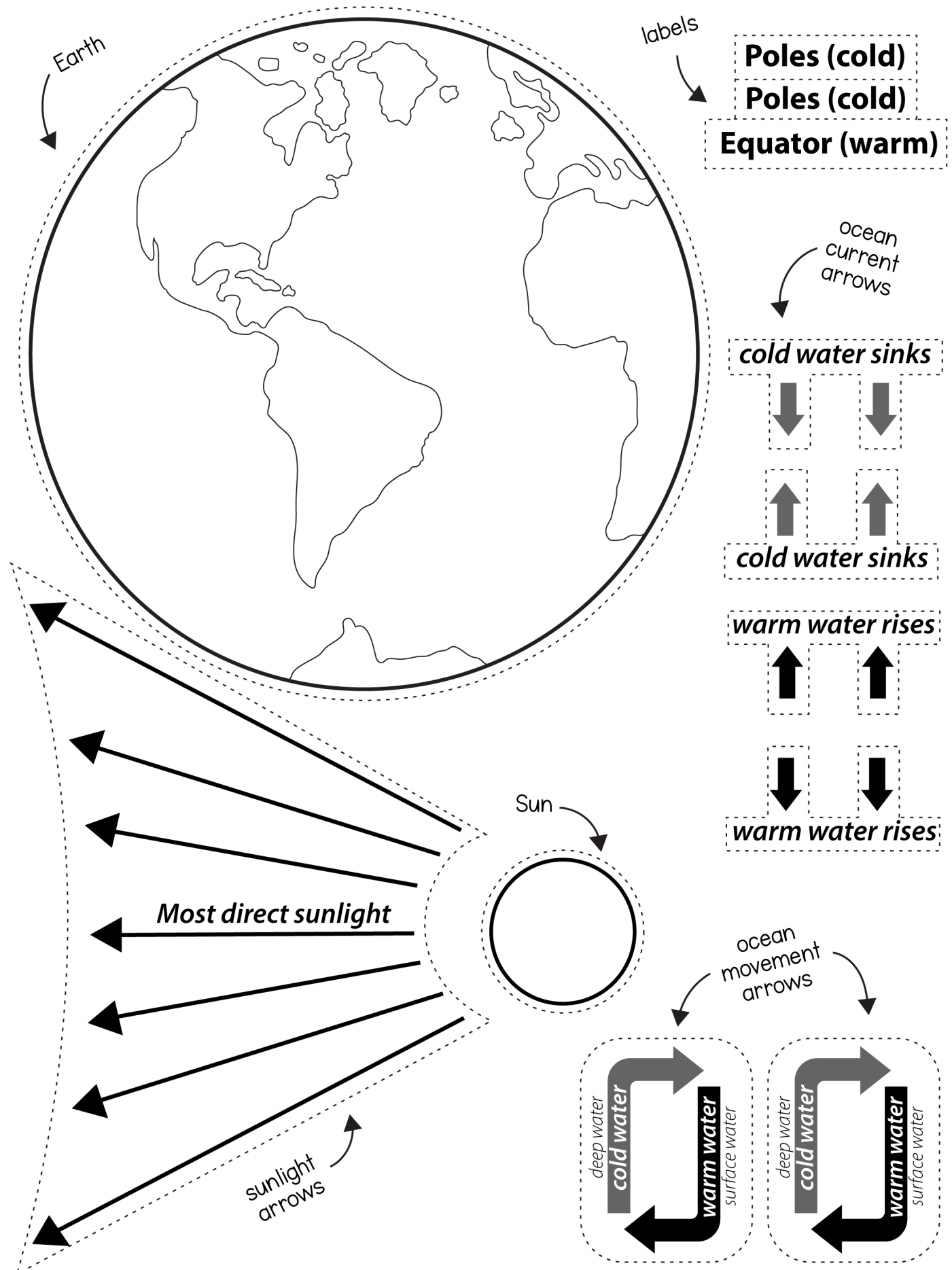
1. What happens to particle movement as temperature increases? _____
2. What would happen if the water became even hotter? _____
3. What would happen if the water froze into ice? _____

Reflection Questions

4. In which cup did the food coloring spread the fastest? The slowest? _____
5. What does this tell you about how water molecules move at different temperatures? _____
6. How does the movement of the food coloring show that particles are always moving? _____
7. How can differences in temperature help explain movement in oceans? _____

From Water Molecules to Ocean Currents

Directions: In the box below, build your model using the directions in the lesson activity.



Directions: Answer the questions below.

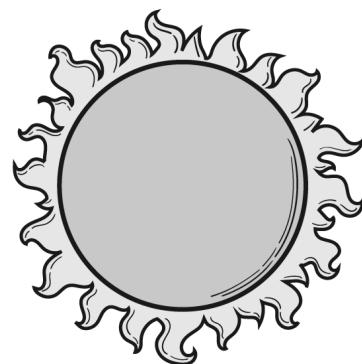
1. How does unequal heating of Earth cause water to move?

- A. Water moves randomly with no pattern.
- B. The Sun heats all parts of Earth equally.
- C. Temperature differences cause warm water to rise and cold water to sink.
- D. Ocean water only moves when wind blows.



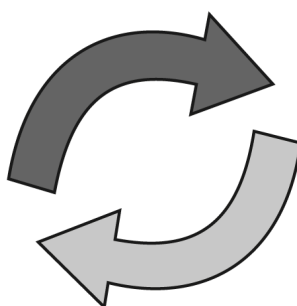
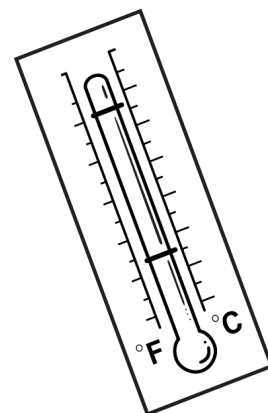
2. How does this movement help transfer heat around the planet?

- A. It traps heat at the equator.
- B. It moves heat from warmer regions to cooler regions.
- C. It prevents heat from reaching the poles.
- D. It stops ocean currents from forming.



3. How might this movement affect the climate in different regions?

- A. It can make some regions warmer and others cooler.
- B. It has no effect on climate.
- C. It only affects ocean animals.
- D. It causes all regions to have the same temperature.



Lesson 3: Oceans and Ocean Currents

Getting Started

✿ Ideas to Think About

- How do the properties and structure of water impact Earth's systems and support life on Earth?

Things to Know

- A **current** is the steady flow of water in a particular direction, often caused by differences in temperature, salinity, or wind.
- **Thermohaline circulation** is the deep, slow-moving system of currents in the ocean.
- **Upwelling** is the process in which winds blow the surface water away, and deep, cold, nutrient-rich water rises to the top.
- Density plays a significant role in the movement of the oceans' waters. Variations in density due to variations in temperature and salinity drive a global pattern of interconnected ocean currents.
- The ocean exerts a major influence on weather and climate by absorbing energy from the sun, releasing it over time, and globally redistributing it through ocean currents.
- The complex patterns of the changes and the movement of water in the atmosphere, determined by winds, landforms, and ocean temperatures and currents, are major determinants of local weather patterns.

Reading and Questions

1. What is thermohaline circulation?

Thermohaline circulation is a deep, slow-moving system of ocean currents driven by differences in temperature and salinity. Scientists often compare it to a global conveyor belt because it moves water throughout the world's oceans.

2. How does upwelling help support ocean life?

Upwelling brings deep, cold, nutrient-rich water to the surface. These nutrients help plankton grow, and plankton form the base of many ocean food chains. As a result, upwelling supports large populations of marine organisms.

3. Why are ocean currents important even for people who live far from the ocean?

Ocean currents move heat, nutrients, and water around the planet. They help regulate climate, influence weather patterns, and connect different parts of Earth's water system. Because of this, the effects of ocean currents can be felt far beyond the ocean itself.

● Skills

- Develop and use a model to describe how unequal heating of Earth causes ocean currents and influences climate. (MS-ESS2-6)
- Construct an explanation based on evidence for how temperature and density cause water to move in oceans. (MS-ESS2-2)
- Develop and use a model to describe how particle motion changes with temperature. (MS-PS1-4)
- Plan and carry out an investigation to observe how temperature affects the movement of water. (Science & Engineering Practice)

- Develop and use models to connect particle motion to large-scale ocean systems. (Science & Engineering Practice)
- Analyze and interpret observations to explain how temperature differences drive ocean currents. (Science & Engineering Practice)
- Evaluate evidence that Earth's oceans are a reservoir of nutrients, minerals, dissolved gases, and life forms such as in estuaries and marine ecosystems.
- Analyze evidence to explain observations, make inferences and predictions, and develop the relationship between evidence and explanation.
- Observe, collect, organize, and analyze data.
- Use oral and written language to communicate findings.
- Develop a model that predicts and describes changes in particle motion, temperature, and state of a pure substance when thermal energy is added or removed.

Introducing the Lesson

In this lesson, your child explores how and why ocean water moves. She investigates how differences in temperature and salinity affect water density and movement, beginning with small-scale observations and building to large-scale ocean patterns. Through modeling and hands-on activities, she connects these ideas to ocean currents and learns how they help regulate Earth's climate and influence weather patterns.

Activities

Activity 1: Density, Salinity, and Ocean Currents

In this activity, your child will watch a video of a science demonstration to see how differences in density and salinity can create ocean stratification, which may result in ocean currents.

Activity 2: Water Molecule Movement

In this activity, your child observes how temperature affects the movement of water molecules and creates a model to explain and predict these changes. Your child may need assistance getting hot water, although it does not need to boil. She learns that adding thermal energy increases particle motion, while removing it slows particles down, helping explain how temperature differences contribute to water movement in oceans.

Answer Key:

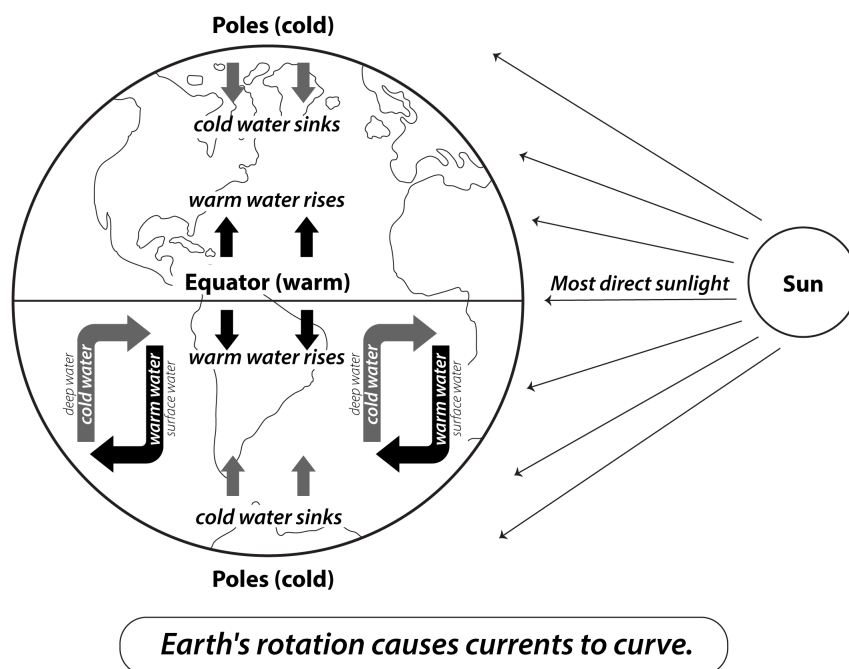
1. Particles move faster as temperature increases.
2. The particles would move even faster, causing the food coloring to spread more quickly.
3. The particles would slow down greatly and become locked in place, only vibrating slightly.
4. Fastest: hot water. Slowest: cold water
5. Water molecules move faster in warmer temperatures and slower in colder temperatures.
6. The food coloring spreads through the water, showing that particles are constantly moving and mixing.
7. Differences in temperature cause water to move, with warmer water rising and cooler water sinking, helping create ocean currents.

Activity 3: From Water Molecules to Ocean Currents

In this activity, your child builds a model showing how unequal heating of Earth causes ocean water to move. She connects particle motion to large-scale ocean currents and explains how this movement

redistributes heat and influences climate.

Answer Key:



1. C. Temperature differences cause warm water to rise and cold water to sink.
2. B. It moves heat from warmer regions to cooler regions.
3. A. It can make some regions warmer and others cooler.

Wrapping Up

In this lesson, your child learned how temperature and density drive ocean currents and influence climate. She connected small-scale particle motion to large-scale ocean movement. Next, she will explore freshwater and groundwater systems.

Questions to Discuss

- What causes ocean water to move? (Ocean water moves because of differences in temperature and salinity, which affect density and cause water to rise, sink, and flow.)
- How is what you observed in the cup experiment similar to what happens in the ocean? (In both cases, warmer water moves faster and rises, while colder water moves slower and sinks. This movement creates currents in the ocean, just like the movement seen with the food coloring.)
- Why are ocean currents important for Earth's climate? (Ocean currents move heat from warmer areas to cooler areas, helping regulate temperatures around the planet. This affects weather patterns and climates in different regions.)

Things to Review

- Temperature and salinity affect water density and cause water to rise, sink, and move
- Warm water moves faster and rises; cold water moves slower and sinks
- Ocean currents redistribute heat around Earth and influence climate