The Hidden Loop

Trace how cooling water connects surface and deep-ocean flow.

ESS.3.3 "Explain how temperature and density of ocean water influence circulation."

NAME _____ DATE _____

1 READ AND MARK

Read it twice

YOUR JOB Underline the sentence that explains how cooling changes seawater density. Then number these three movements in the second paragraph: sinking, surface-water replacement, and deep-water spreading.

Where Ocean Water Sinks

1 On a winter voyage across the North Atlantic, a research ship can cross water that feels mild near the surface and water that becomes icy farther north. Sunlight heats ocean regions unevenly, and moving air pushes some surface water toward colder regions. As that water gives heat to the atmosphere, its temperature falls. When salinity is the same, cooler seawater is denser than warmer seawater: the same volume has more mass. Dense water tends to sink beneath less dense water. This difference helps connect what happens at the surface with movement far below a ship.

2 Near Greenland, surface seawater can cool enough to become denser than the water beneath it. The cooled water sinks, making room for other surface water to move into the area. Deep water then spreads away from the sinking region, following paths shaped by the ocean floor. This sinking does not pull water around the whole planet by itself. Winds also drive surface currents, and Earth's rotation steers their paths. Still, temperature-driven changes in density help explain why some water moves downward and why water at different depths can flow in different directions.

3 Temperature is not the only influence on seawater density. When sea ice forms, much of the salt stays in the surrounding liquid water, raising its salinity and helping it sink. When ice on land melts and freshwater enters the ocean, the surface layer can become less salty and less dense. That lighter layer may stay above colder, saltier water and slow sinking, even in a cold place. If less water sinks, less deep water forms there, which can change the circulation that carries heat and dissolved gases through the ocean over long distances.

2 ANSWER WITH EVIDENCE

Use the passage

1. If salinity stays the same, why can seawater that cools near Greenland move downward?

2. How does sinking water near Greenland affect movement at the surface and in the deep ocean?

3. Why might freshwater from melting land ice slow sinking, even where the ocean is cold?

4. If winter cooling near Greenland weakens but salinity stays the same, what would you expect to happen to deep-water formation there? Explain.

3 YOUR TURN

Your own words

Imagine a long tank of seawater with the same salinity throughout. A heater warms the left end, and a chiller cools the right end. In four sentences, predict where water sinks and rises, which way surface and deep water move, and how temperature and density cause that circulation.

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PART 1 · READ AND MARK

Underline the sentence that explains how cooling changes seawater density. Then number these three movements in the second paragraph: sinking, surface-water replacement, and deep-water spreading. Accept any marking that follows this job and points at the right text.

PART 2 · ANSWERS

#	QUESTION	ANSWER
1	If salinity stays the same, why can seawater that cools near Greenland move downward?	**Cooling makes the seawater denser than the water beneath it, so it sinks.**
2	How does sinking water near Greenland affect movement at the surface and in the deep ocean?	**Other surface water moves into the area left by sinking water, while deep water spreads away from the sinking region.**
3	Why might freshwater from melting land ice slow sinking, even where the ocean is cold?	**Freshwater lowers the surface water's salinity and density, so it can remain above colder, saltier water.**
4	If winter cooling near Greenland weakens but salinity stays the same, what would you expect to happen to deep-water formation there? Explain.	**Less deep water may form because surface water that cools less is less likely to become dense enough to sink.**

PART 3 · YOUR TURN (SAMPLE ANSWER)

At the right end, chilled water becomes denser and sinks. At the left end, heated water is less dense and rises. Surface water moves from left to right to replace the sinking water. Deep water moves from right to left to replace the rising water.

Accept equivalent descriptions of the predicted flow. In Question 4, accept a decrease in deep-water formation if the explanation connects weaker cooling to reduced density and sinking.