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Thermohaline Circulation

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STEM
Polar Connections

Thermohaline Circulation

Surface currents, such as the Gulf Stream, are pushed by the wind. Deep ocean currents, called the "Thermohaline Circulation", are the result of changes in the density of water. In this activity you can investigate how differences in the temperature and salinity of water can produce deep ocean currents.

Materials for Each Team of Students

- A transparent, plastic container (shoebox size or larger).
- Two transparent, plastic cups (one cup has a hole at the center of the bottom.)
- Food coloring
- Table salt
- Gloves (for example; lightweight, latex free, gloves), spoon or spatula
- A Thermometer
- Ice cubes
- Paper to cover work surface to prevent food coloring stains

An Optional Baseline Trial: Determine if water movements are produced in a body of water if all of the water is at the same temperature and has the same salinity.

1. Put cold tap water in transparent container until the surface of the water is a few centimeters from the rim of the container.
2. Add a small amount of table salt to the water and stir.
3. Measure and record the temperature of the cold saltwater.
4. Half fill a plastic cup (the one with **no hole** in the bottom) with some of the cold salt water from the large container of saltwater.
5. Add a few drops of food coloring to the cold salt water in the plastic cup. **Caution**: Food coloring can permanently stain materials. Use paper to cover work surface.
6. Obtain a plastic cup that has a hole in the bottom.
7. The person who is going to hold the plastic cup that has a hole in the bottom should wear a glove and **cover the hole** with their finger.
8. Another person should pour the water containing food coloring into the plastic cup that has a hole in the bottom.
9. The person covering the hole in the bottom of the plastic cup should lower that cup into the large container of water **at one end of the container** until the water level inside the cup is exactly the same as the water level in the larger container.
10. When the water in the large container is not moving very much, the person covering the hole in the bottom of the cup should slowly uncover the hole.
11. Record observations of the movement of the water that has been dyed with food coloring as it enters the large container of water.

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Evaluating the Baseline Trial

Question 1: What, if any, movements of water were observed as the water containing food coloring entered the larger container of water?

Question 2: What factors seem to influence the movement of the water containing food coloring?

Question 3: Why was it important that the water level inside the small cup be the same as the water level outside the cup?

Experimental Trial with Water of Different Salinities

1. Put cold tap water in transparent container until the surface of the water is a few centimeters from the rim of the container.
2. Add a small amount of table salt to the water and stir.
3. Half fill a plastic cup (the one with **no hole** in the bottom) with some of the cold salt water from the large container of saltwater.
4. Measure and record the temperature of the cold saltwater in the large container and also in the plastic cup.
5. Add more salt to the water in the cup to make it more saline than the saltwater in the transparent container of water.
6. Add a few drops of food coloring to the more saline water in the plastic cup. **Caution**: Food coloring can permanently stain materials. Use paper to cover work surface.
7. Obtain a plastic cup that has a hole in the bottom.
8. The person who is going to hold the plastic cup that has a hole in the bottom should wear a glove and **cover the hole** with their finger.
9. Another person should pour the water containing food coloring into the plastic cup that has a hole in the bottom.
10. The person covering the hole in the bottom of the plastic cup should lower that cup into the large container of water **at one end of the container** until the water level inside the cup is exactly the same as the water level in the larger container.
11. When the water in the large container is not moving very much, the person covering the hole in the bottom of the cup should slowly uncover the hole.
12. Record observations of the movement of the water that has been dyed with food coloring as it enters the large container of water.

Question 4: What movements of water were observed as the more saline water (containing food coloring) entered the larger container of less saline water?

Question 5: Why would a change in the salinity of water produce the motion that you observed?

Question 6: What factors could influence the speed of the movement of water that you observed?

Experimental Trial with Water at Different Temperatures

1. Put cold tap water in transparent container until the surface of the water is a few centimeters from the rim of the container.
2. Half fill a plastic cup (the one with **no hole** in the bottom) with some of the cold water from the large container.
3. Measure and record the temperature of the water in the large container and also in the plastic cup.
4. Add some ice cubes to the water in the plastic cup and stir gently until the water reaches approximately 4º Celsius.
5. Remove any un-melted ice cubes.
6. Add a few drops of food coloring to the colder water in the plastic cup. **Caution**: Food coloring can permanently stain materials. Use paper to cover work surface.
7. Obtain a plastic cup that has a hole in the bottom.
8. The person who is going to hold the plastic cup that has a hole in the bottom should wear a glove and **cover the hole** with their finger.
9. Another person should pour the water containing food coloring into the plastic cup that has a hole in the bottom.
10. The person covering the hole in the bottom of the plastic cup should lower that cup into the large container of water **at one end of the container** until the water level inside the cup is exactly the same as the water level in the larger container.
11. When the water in the large container is not moving very much, the person covering the hole in the bottom of the cup should slowly uncover the hole.
12. Record observations of the movement of the water that has been dyed with food coloring as it enters the large container of water.

Question 7: What movements of water were observed as colder water (containing food coloring) entered the larger container of water?

Question 8: Why would a change in the temperature of water produce the motion that you observed?

Question 9: What factors could influence the speed of the movement of water that you observed?

Question 10: Why is the movement of water that you observed referred to as a "Thermohaline Circulation"?

An Additional Optional Trial

You have observed the influence of differences in the temperature and/or salinity of water on the movement of water that is referred to as a thermohaline circulation. The flat bottom of the plastic container had very little influence on the movement of water.

Objects or materials can be put onto the bottom of the water container as a model of landforms that can influence the speed and direction of the thermohaline circulation. The positioning of the objects or materials can be placed in locations that simulate the changes in direction seen on a map of Earth's thermohaline circulation.