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Chapter 26.2

The Coriolis Effect

Environmental Science Laboratory Kit

Introduction

Investigate the Coriolis Effect and how objects move over the surface of a rotating planet using hands-on activity models.

Concepts

- Coriolis Effect
- Wind current
- Ocean current

Background

The Coriolis Effect, a term first introduced by French mathematician Gustave Gaspard de Coriolis (1792–1843), is the "imaginary" force that seems to deflect objects such as wind and storms over the surface of a planet. When viewed from above the North Pole, the Earth spins counterclockwise. Objects moving on or near the Earth's surface are deflected to the right in the Northern hemisphere and to the left in the Southern hemisphere. This deflection would be apparent if an observer from space were to watch an object's path along a straight line. The Coriolis Effect plays a major role on the movement of wind and storms but also on ocean currents and the flight paths of airplanes and missiles.

The surface temperatures on the Earth vary depending on global location. Since the Earth's surface is curved rather than flat, not all areas receive the same amount of solar radiation (see Figure 1).

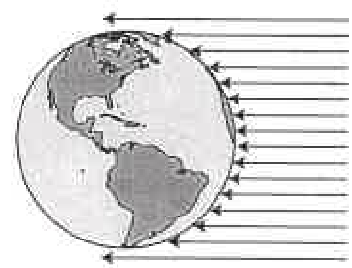

Figure 1.

Because of this, the air over the equator is heated more than other locations on Earth. Since less radiation is received at the Poles of the Earth, the air there is cooler and more dense. As this dense cool air sinks and moves along the surface of the Earth, it interacts with warm air creating pressure differences. These pressure differences and the Coriolis Effect create distinct wind patterns on the Earth's surface (see Figure 2). They also lead to the counterclockwise rotation of hurricanes in the Northern hemisphere and the clockwise rotation of typhoons in the Southern hemisphere.

A similar situation is seen in the Earth's oceans. Ocean water located near the North and South Pole regions is very cold and dense. The dense water at the pole regions sinks to the ocean floor and flows towards the equator. At the same time, less dense surface water at the equator flows towards the poles along the ocean surface. The combination of this temperature/density difference, and the deflection caused by the Coriolis Effect, creates a continuous ocean water cycle (see Figure 3).

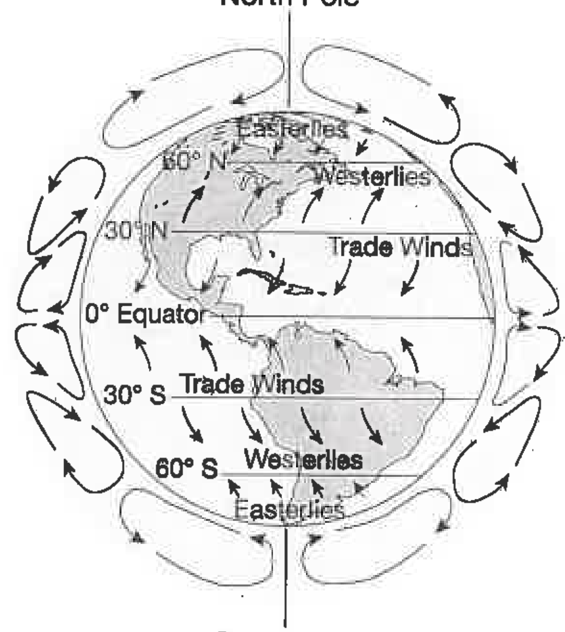

Figure 2.

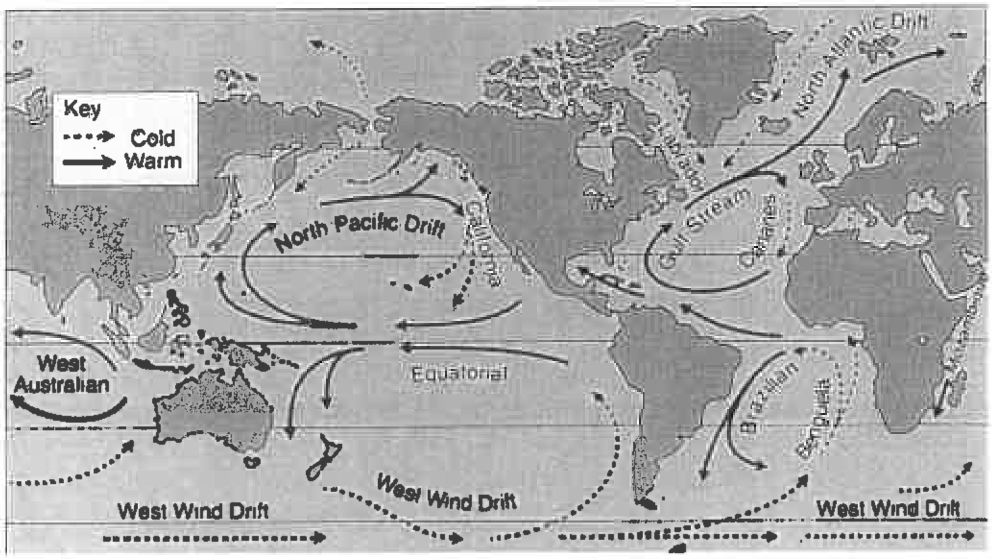

Figure 3. Major Ocean Surface Currents

Experiment Overview

In Part I of this activity, a model for the movement of an object across the surface of a rotating planet due to the Coriolis Effect will be explored. In Part II, the effect of temperature and the Coriolis Effect on ocean currents will be modeled.

Materials

Spinning Coriolis Effect Model	Pipet
Chalk	Pushpin
Clay, stick	Scissors
Construction paper, black	Styrofoam cup
Dye solution, blue	Tape
Ice cubes	Water, tap

Safety Precautions

Wash hands thoroughly with soap and water before leaving the laboratory. The food dye will stain skin and clothing. Please follow all laboratory safety guidelines.

Procedure

Part I. Modeling the Coriolis Effect

1. Obtain the Coriolis Effect Model, a piece of black construction paper, scissors, tape and a piece of chalk.
2. Cut the piece of black construction paper into circle just large enough to cover the bottom of the pan (see Figure 4).
3. Use several pieces of clear tape to affix the black construction paper circle to the bottom of the pan.
4. Set the Coriolis Effect Model on the tabletop and have a partner begin to slowly spin the pan of the model in a counterclockwise direction. This is the direction the Earth spins when viewed from above the North Pole.

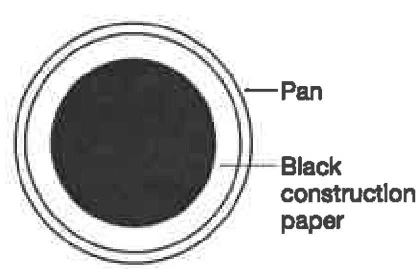

Figure 4. Construction paper and pan.

5. As the model is spinning, try to draw a straight line down the middle of the black construction paper using a piece of chalk. Stop spinning the pan and examine the chalk line. Record all observations in the data table.
6. Now have a partner begin to slowly spin the model in a clockwise direction. This is the direction the Earth spins when viewed from above the South Pole.
7. As the model is spinning, try to draw a straight line down the middle of the black construction paper using a piece of chalk. Stop spinning the pan and examine the chalk line. Record all observations in the data table.
8. Repeat steps 6 and 7 only this time spin the pan at a faster rate of speed. Record all observations in the data table.
9. Answer the ***Post-Lab Questions*** for Part I on the worksheet.

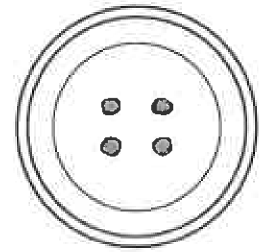

Figure 5. Clay over rivets

Part II. A Model for the Coriolis Effect and Ocean Currents

10. Obtain the Coriolis Effect Model from Part I, a Styrofoam cup half-filled with ice cubes, a clay stick, and blue food dye solution.
11. Remove the piece of black construction paper and tape from the Coriolis Effect Model.
12. Use small pieces of clay to cover the four rivets on the Coriolis Effect Model Pan. This will ensure the pan will not leak when water is added (see Figure 5).
13. Fill the pan half full with room temperature tap water.
14. Using a pushpin, poke four small holes evenly spaced along the sides of the Styrofoam cup just above the bottom of the cup (see Figure 6).
15. Place the Styrofoam cup in the center of the pan (see Figure 7).
16. Have a partner begin to spin the pan of the Coriolis Effect Model counterclockwise. Spin the pan for 30 seconds.
17. Continue to spin the pan and, using a pipet, place 9–10 drops of food coloring into the Styrofoam cup.
18. Fill the Styrofoam cup approximately ¼ full with tap water.
19. Continue to spin the pan for an additional 30 seconds and observe the diffusion pattern of the blue dye as it exits the cup. Record all observations in the data table.
20. Answer the *Post-Lab Questions* for part II on the Worksheet.

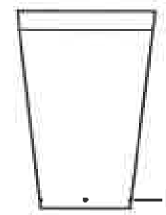

Figure 6. Pinholes in Styrofoam cup

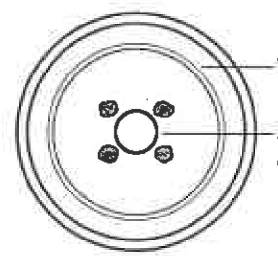

Figure 7.

Name: ____________________

The Coriolis Effect Worksheet

Part I. Modeling the Coriolis Effect Observations

Part II. A Model for the Coriolis Effect and Ocean Currents Observations

Post-Lab Questions

Part I. Modeling the Coriolis Effect

1. What does the spinning pan used in this activity represent? What does the chalk line represent?
2. Were the chalk lines that were drawn straight or curved?
3. Describe the differences between the chalk lines that resulted from both the clockwise and counter-clockwise spinning of the plate. Which way was each chalk line deflected?
4. What happened to the chalk line when the plate was spun at a faster rate of speed? What would happen to objects if the Earth were to spin at a faster speed?
5. Would an airplane departing from Ft. Lauderdale, FL to Chicago, IL, appear to be deflected to the right or to the left as it flies through the air?
6. Which way would a ship travelling from Melbourne, Australia to Santiago, Chile be deflected? What about the same ship travelling back to Australia from Chile?

Part II. A Model for the Coriolis Effect and Ocean Currents

7. In what manner/direction did the dye move initially when it left the cup?
8. What type of pattern did the blue dye eventually form toward the edge of the pan? Why did this pattern appear?
9. How is the motion of the water in the pan similar to ocean currents?
10. *Optional:* Why is the force associated with the Coriolis Effect sometimes called an "imaginary" force?