Activity 1: Rotation of the Earth

Procedure

Materials (per student group)

1 world globe (12-cm)
1 wooden dowel (13-in)

1. Obtain the following materials for your group: a world globe and a wooden dowel.
2. Place the dowel through the holes at the poles of the globe. The dowel serves as the axis of the globe. It should protrude above and below the globe so that a member of your group can rotate the globe on its axis.
3. While one partner is holding the dowel straight up and down with the North Pole at the top, have another group member stand opposite the person dolding the globe and rotate the earth from west to east (Figure 1). We refer to the rotation of the earth as counterclockwise. Observe the direction of rotation while looking at the equator. Observe both sides of the earth while it is rotating.
4. Now have one partner hold the dowel at the South Pole and another partner hold the other end at the North Pole and hold the axis horizontal.
5. Slowly rotate the globe in the same direction as before, from west to east (Figure 2).
6. Observe the direction the globe appears to spin while looking at the North Pole and then while looking at the South Pole. Refer to the rotation as clockwise or counterclockwise movement. (Refer to the rotation of a clock's hands if unsure of the direction for clockwise and counterclockwise rotation.)

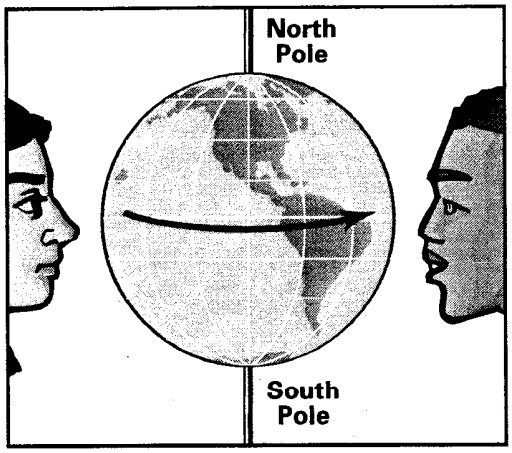


Figure 1

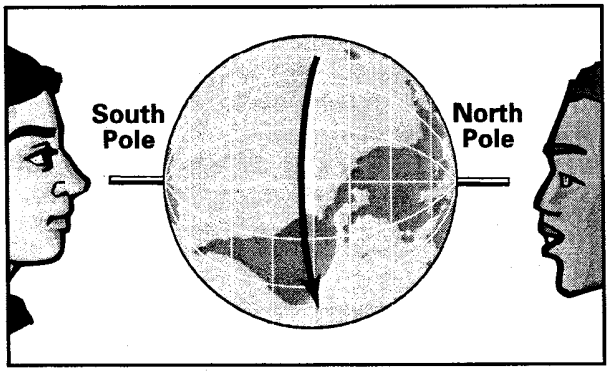


Figure 2

Activity 1 Reflection Questions

1. As you looked at the equator while the axis was held vertical, in which direction did the globe rotate, from left to right or right to left? Was this direction of rotation the same for both observers?

2. In which direction (clockwise or counterclockwise) did the globe appear to rotate as you observed the North Pole? In which direction, as you observed the South Pole?

Activity 2: Rotation in Two Dimensions

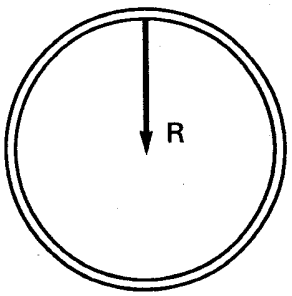
Materials (per student group)

1 turntable
1 black dry-erase marker
1 green dry-erase marker

Procedure

1. Obtain the following materials for your group: turntable, a black dry-erase marker, and a green dry-erase marker.

2. With the turntable stationary, have one member of your group draw a straight line from the edge to the center of the turntable, using the black marker. Label this line "R." This is your reference line.



3. Have one person in your group slowly and consistently rotate the turntable counterclockwise.

4. While the turntable is being rotated, have another person make a straight line starting at the edge and moving toward the center of the turntable, using the black marker. Observe the path of the marker.

5. Stop the turntable and label this line "1CCW" (for first trial, counterclockwise). Place an arrowhead at the end of the line to indicate the direction the marker was moving.

6. Repeat steps 3 and 4 two more times. After each trial, stop the turntable and label the line with the trial number.

7. Repeat the process by rotating the turntable counterclockwise, but this time draw lines from the center toward the edge. Label the first line "4CCW" (for fourth trial, counterclockwise). Again, place an arrowhead at the end to indicate the direction the marker was moving. Perform the trial two more times and label the lines.

8. Observe the lines that were made while the turntable rotated. Discuss the path of the marker during each trail with the members of your group. Answer Reflection Questions 1–5.

9. Erase the lines except for one that moves from the edge towards the center and one that moves from the center toward the edge.

10. With the turntable stationary, have one member of your group draw a straight line from the edge to the center of the turntable, using the green dry-erase marker. Label this line "R." This is your clockwise reference line.

11. Have one person in your group slowly and consistently rotate the turntable clockwise.

12. While the turntable is being rotated, have another person make a straight line starting at the edge and moving toward the center of the turntable, using the green marker. Have the other members of your group observe the path of the marker.

13. Stop the turntable from rotating and label this line "1CW" (for first trial, clockwise). Place an arrowhead at the end of the line to indicate the direction the marker was moving.

14. Repeat steps 10 and 11 two more times. After each trial, stop the turntable and label the line with the trial number.

15. Repeat the process by rotating the turntable clockwise but this time drawing lines from the center toward the edge. Label the first of these lines "4CCW" (fourth trial, clockwise). Again, place an arrowhead at the end of the line to indicate the direction the marker was moving. Perform this trial two more times and label the lines.

16. Observe the lines that were made while the turntable rotated clockwise. Discuss the path of the marker during each trail with the members of your group. Also note the difference between the two remaining black arrows and the newly drawn green arrows. Answer Reflection Questions 6–10.

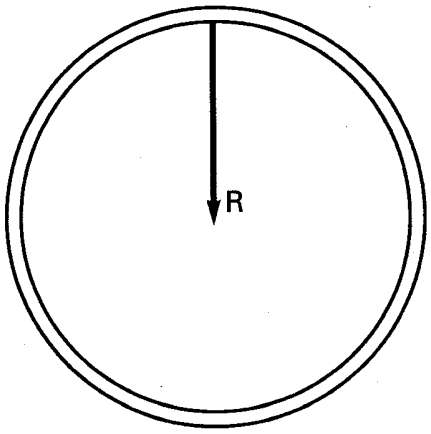
17. Erase the lines and labels from the surface of the turntable.

Activity 2 Reflection Questions

1. Describe the mark that was made from the edge of the turntable toward the center while the turntable rotated counterclockwise.

2. Describe the mark that was made from the center toward the edge while the turntable rotated counterclockwise.

3. Record the paths of both types of marks on the turntable illustration that follows. Label the illustration with the rotational direction of the turntable.



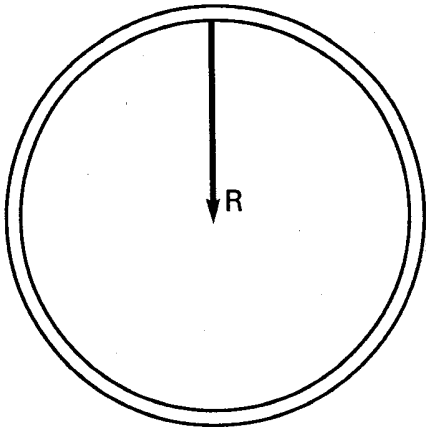
4. Describe the path of the marker itself as observed by the members of your group.

5. If you were viewing the marker from the surface of the turntable as it rotated counterclockwise, how would the marker appear to move? How does this apparent path compare with the path of the marker as observed by your group?

6. Describe the mark that was made from the edge of the turntable toward the center while the turntable rotated clockwise.

7. Describe the mark that was made from the center toward the edge while the turntable rotated clockwise.

8. Record the paths of both types of marks on the turntable illustration that follows. Label the illustration with the rotational direction of the turntable.



9. Describe the path of the marker itself as observed by the members of your group.

10. If you were viewing the marker from the surface of the turntable as it rotated clockwise, how would the marker appear to move? How does this apparent path compare with the path of the marker as observed by your group?

Activity 3: Rotation in Three Dimensions

Materials (per student group)

1 world globe
1 black dry-erase marker
1 green dry-erase marker
1 turntable with black and green lines drawn from Activity 2

Procedure

1. Obtain the following materials for your group: world globe, a black dry-erase marker, and a green dry-erase marker.

2. Holding the globe with the North Pole at the top and South Pole at the bottom, have one member of your group draw arrows that represent the following air mass movement. Refer to the lines made on the turntable during Activity 2 and the rotation of the earth observed in Activity 1 to predict the movement of the air masses.

   A. Direction of air mass flowing from the North Pole toward the equator

   B. Direction of air mass flowing from the South Pole toward the equator

   C. Direction of air mass flowing from the equator toward the North Pole

   D. Direction of air mass flowing from the equator toward the South Pole

3. Redraw the arrows on the diagram below.

4. Answer Reflection Questions 1–6.

Activity 3 Reflection Questions

1. When drawing the lines on the Northern Hemisphere, which turntable model did you reference, and why?

2. When drawing the lines on the Southern Hemisphere, which turntable model did you reference, and why?

3. As air masses move in the Northern Hemisphere, to which direction are they deflected?

4. As air masses move in the Southern Hemisphere, to which direction are they deflected?

5. How might the Coriolis effect influence global air circulation?

Activity 4: Observing Fluid Convection

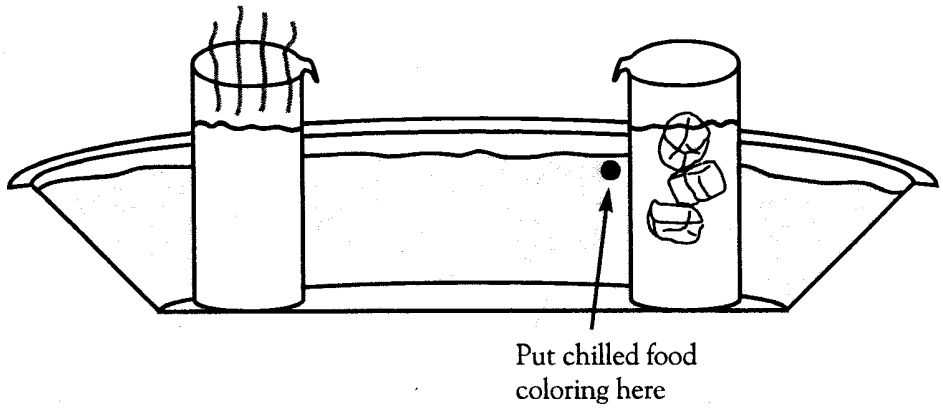
Procedure

1. Obtain the following materials for your group: aluminum pie pan, two 100-mL beakers, bottle of chilled food coloring, room-temperature water, ice, hot water, and paper towels.
2. Place a small amount of ice in one of the 100-mL beakers. Fill the beaker with room-temperature water to the 80-mL mark. **Tip:** To make sure that the bottle of food coloring remains chilled, place the bottle in the beaker of ice water while you are preparing the other materials.

Materials (per student group)

1 aluminum pie pan (9-in)
2 beakers (100-mL)
1 bottle of food coloring (chilled)
water (room-temperature)
ice
hot water
paper towels

3. Pour about 3/4 inch of room-temperature water into the pie pan.
4. Pour 80 mL of hot water into the other 100-mL beaker.
5. Inside the pie pan of water, place the beaker of ice water on one side and the beaker of hot water on the opposite side.
6. Place one or two drops of chilled food coloring in the water of the pie pan at the base of the beaker of ice water.
7. Observe the movement of the food coloring in the water of the pie pan. Answer all the Reflection Questions for this activity.



Activity 4 Reflection Questions

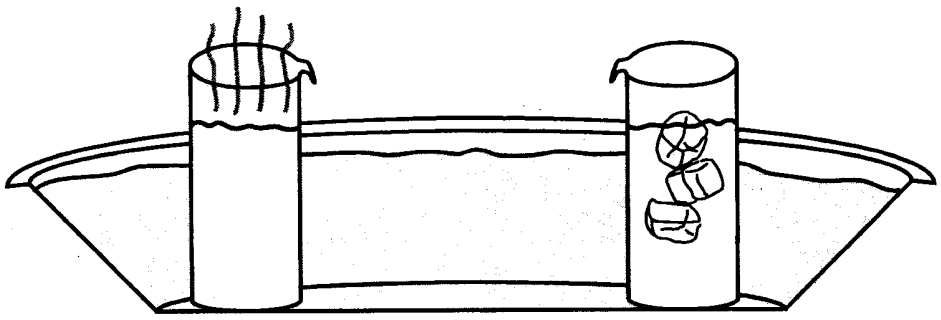
1. Below, record your observations of the food coloring's movement in the water of the pie pan. Be as detailed as possible.

2. Why did the majority of the chilled food coloring initially sink to the bottom of the water in the pie pan?

3. What happened to the food coloring once it reached the beaker of hot water?

4. What type of heat transfer does this model represent?

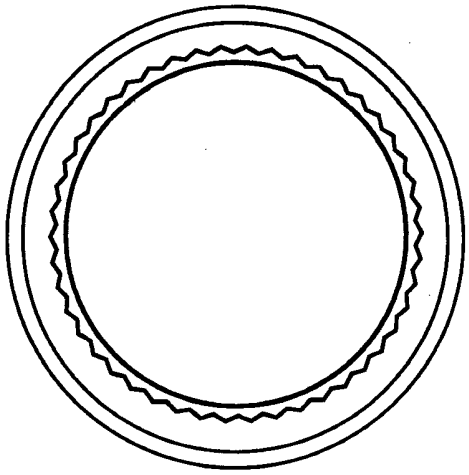
5. Complete the following diagram to explain what happens to the water molecules during this heat exchange. Use arrows to indicate the flow of the water molecules.



6. Knowing that air, like water, moves as a fluid, predict what will happen to air masses as they heat and cool.

Activity 5 Reflection Questions

1. In the following diagram, draw your observations of the food coloring's movement in the pie pan while the turntable was rotating counterclockwise. Use arrows to indicate rotational direction.



2. Explain what you observed as the food coloring was dropped into the pie pan.

3. What was the rotational direction of the food coloring?

4. Compare your observations with what is known about the rotation of large storms, such as hurricanes. What similarities did you observe? What differences?

5. What differences do you think you would observe if the turntable were rotating clockwise? Test your hypothesis.

6. Given the results from your test in question 5, what would you expect the rotational motion of typhoons in the Southern Hemisphere to be? (Hint: Hurricanes and typhoons form over the warm waters of the tropics and move toward the cooler polar regions.)