Table of Contents

What Causes Weather Patterns?

INVESTIGATION: Water on the Move

If you've ever been soaked in a rainstorm or even surprised by a thundershower in the desert, you know that water is a big part of the weather. Rain, snow, hail, and fog are all examples of water on the move. Even when you can't see it or feel it, water is moving around you. What evidence can you find in this investigation that water is on the move?

Working Environment

Work cooperatively in your new team of three. Figure out a way to position your desks or to sit at a table so that each of you can see the others and has equal access to the materials. Use the roles of Manager, Tracker, and Communicator. Practice the social skill Use your teammates' names.

Materials

For each team of three students:

#8 1 empty can, soup size
water, room temperature (1/2-2/3 of a can)
3 ice cubes 1 stirring stick 1 paper towel

Procedure: Part A—The Social Skill

1. Write your teammates' first and last names in your notebook.

2. Create a positive two-line rhyme to go with each of your teammates' first names.

Notebook entry: Record your name rhymes.

Procedure: Part B—A Chilling Experience

1. Obtain the materials for Part B.
2. Fill the can about half-full of room-temperature water.
3. Observe how the can looks and feels on the outside.

   Notebook entry: Record your observations.
4. Add three ice cubes to the can.

   The Communicator should do this.
5. Stir the water and ice slowly.

   The Manager should do this. Do not hold the outside of the can while stirring.
6. Keep stirring for 3 minutes.

   The Tracker should keep track of time.
7. Look at the can and touch the outside.

   Notebook entry: Record these observations.
8. Empty the can and dry it off. Then return your materials.

   Check that the outside of the can is dry.
9. If you haven't looked closely at it yet, observe the glass containers your teacher has set up.

   Notebook entry: Record your observations. Make sure that your observations account for the differences between the setups.

BSCS (1994). *Investigating patterns of change.* Dubuque, IA: Kendall Hunt

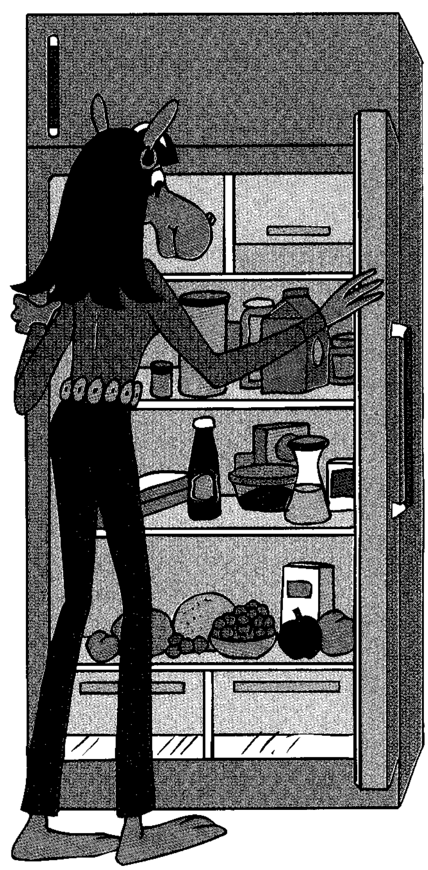
Wrap Up

Discuss the following questions with your teammates. Record your answers in your notebook. Each of you should be prepared to explain your answers if the teacher calls on you during a class discussion.

1. Explain what you think happened to the outside of your can.
2. How might you test the explanation you provided in question 1?
3. What similarities did you see between what happened with your can of icy water and what happened in the demonstration?
4. Write a two-line rhyme that describes how well you used each other's names as you worked. Combine this two-line rhyme with the name rhymes you created to make one short poem. As a team recite this poem to the rest of the class.

INVESTIGATION: Wind in a Box

After one particularly long day at school, Marie arrived at home feeling exhausted, hot, and thirsty. She went to the refrigerator to



find something cool to drink. When she opened the refrigerator door, she noticed a particular phenomenon. What do you think happened? In this investigation you will have the opportunity to investigate this and other similar patterns.

Working Environment

Work cooperatively in your team of three. Meet in the threesome configuration you decided on for your team. Use the roles of Manager and Communicator. As you work, concentrate on the skill Treat others politely.

Materials

For the entire class:
- 1 box of safety matches
- 1 large bucket of water
- 1 fire extinguisher

For each team of three students:
- 1 convection box with candle
- 6 wooden splints
- 3 pairs of goggles

Procedure: Part A—The Social Skill

1. Discuss what it means to be polite when doing team work.
2. Discuss the strategies your Unit 2 team used when practicing this skill.

   Share what seemed to work and what didn't work.
3. Record three ways your teammates can be polite to each other.

Procedure: Part B—The Box

1. Prepare your work space for the safe use of the convection boxes.

¤ **CAUTION:** Safety procedures include moving all papers and extra notebooks to the side of the classroom, tying back long hair, wearing goggles, and moving slowly while the boxes are in use. **NEVER LEAVE THE BOX UNATTENDED.**

2. Stand the box on its side, with the tubes up in the air. Take off the lid of the box.

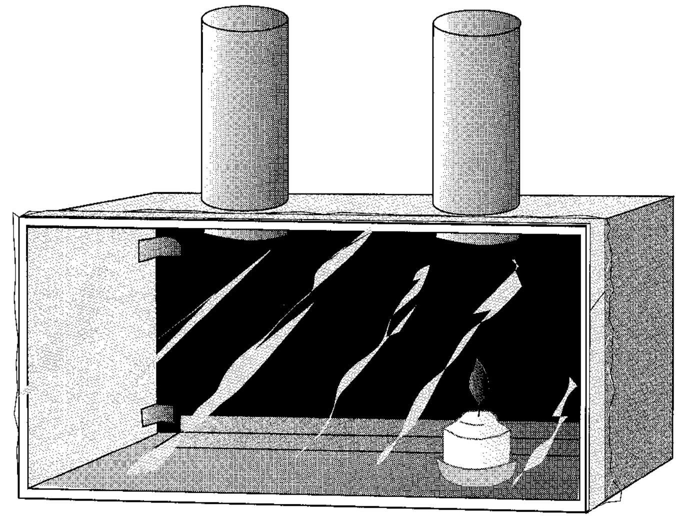
   This is the Tracker's job.
3. Carefully light the candle and place it directly under one of the tubes (see Figure 10.1).

   This is the Manager's job. Be careful not to place the candle too near the back or sides of the box.
4. Put the lid on the box.
5. Carefully light a wooden splint and then blow it out. Lower the smoking splint 1 or 2 cm into the tube above the candle.

   This is the Communicator's job.

Figure 10. 1

Before you light the candle that goes in the convection box, be certain that you've taken all the precautions you can to avoid fire hazards.



¤ **CAUTION:** A smoking splint can still cause burns and fires because it is very hot. Be careful not to touch yourself, a teammate, or the box with the smoking part of the splint.

6. Observe what happens to the smoke.
7. Lower the smoking splint 1 or 2 cm into the other tube and observe what happens.

   Take turns.

   Notebook entry: Record your observations.
8. Extinguish the candle.

   This is the Tracker's job.
9. Return the materials.

Wrap Up

On the basis of your experience with a convection box, answer the following questions as a team. Record your answers in your notebook. Be sure each of you can justify your answers in a class discussion.

1. How did the smoke help you observe what the air was doing?
2. What do we call moving air?
3. If you could stand inside the convection box, where would you be standing if you feel air sinking down on you?
4. Where would you have to stand inside the box if you wanted to feel air rising upward?
5. Would you find rising air above a warm area of the earth's surface or above a cool area?

6. Rate your team on politeness: good, fair, or poor. If you rated yourself a fair or a poor, modify or add to the three ways your team decided to be polite.

READING:
Changing Weather Patterns

If you've ever lived in a place where the temperatures can plummet from comfortably warm to freezing cold in just a few hours, you know how drastic weather changes can be. If you ever have been soaked in a rainstorm, trapped in a snowstorm, or burned by too much sunshine, you have experienced the results of weather patterns. To understand why certain weather patterns exist, think about some of the things you've experienced in this chapter.

Stop and Discuss

1. In what places have you seen water during this chapter?
2. Explain how the water got to those places.
3. Think of a method to test your explanation.

The air around you has water in it, water that you cannot see under normal circumstances. Water in the air is present in microscopic particles. If you live where it is very humid during the summer, you probably have experienced the feeling of water in the air. If you live in a dry area, you may have never even detected the water that's in the air and all around you. When the water particles in the air come in contact with something cool, the tiny water particles in the air clump together to form drops of water. This process is called **condensation.**

Stop and Discuss

4. What happens when you leave a glass of water out for a day or two?
5. What would happen if you left the glass out for a week or more?

When tiny water particles move into the air, the process is called **evaporation.** People often think that when water evaporates, it disappears, but in fact the small particles of water move into the air.

This process of water evaporating and then condensing happens all the time in nature. This is because heat from the sun is constantly warming the earth's surface. Warm water then evaporates from lakes, rivers, oceans, puddles, and moist ground. As the moist air rises away from the warm surface of the earth, the air cools. Soon the air is so cool that the water in it condenses into tiny water droplets and forms clouds (see Figure 10.2).

As the air cools, water condenses and forms clouds.

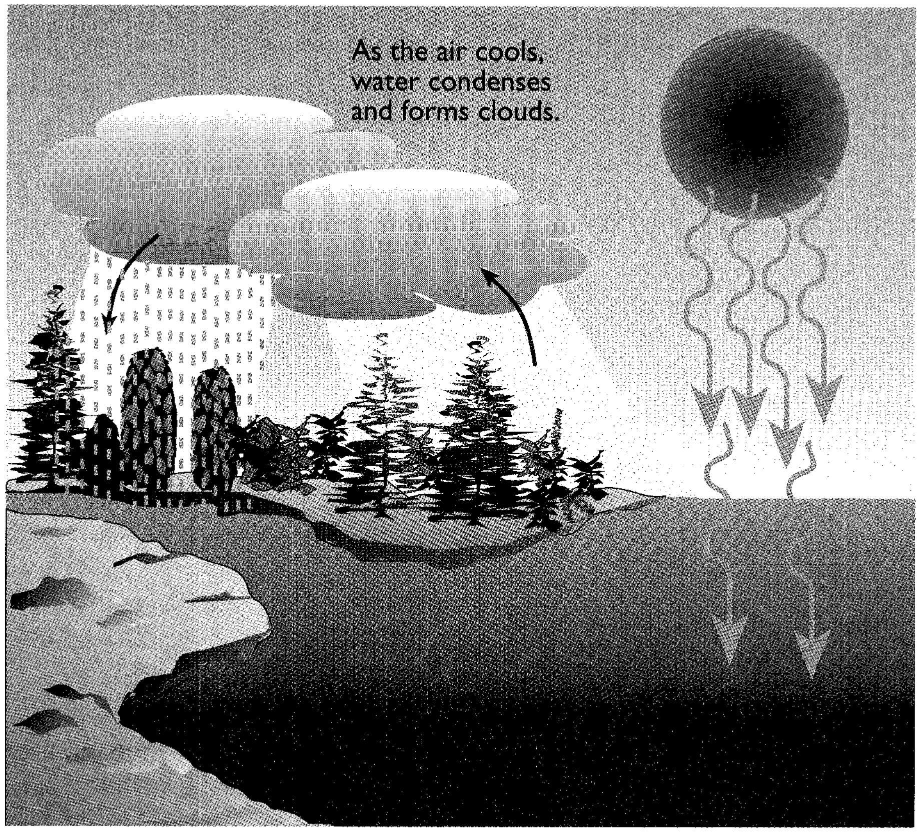


Figure IO.2

Because water is always losing heat energy (and condensing) or gaining heat energy (and evaporating), water particles are constantly moving.

When a lot of water condenses, the droplets in the clouds become larger and heavy enough so that they eventually fall as rain.

Stop and Discuss

6. Think back to the fish bowl demonstration. How could you keep the cycle going? See Figure 10.3 if you need a reminder.

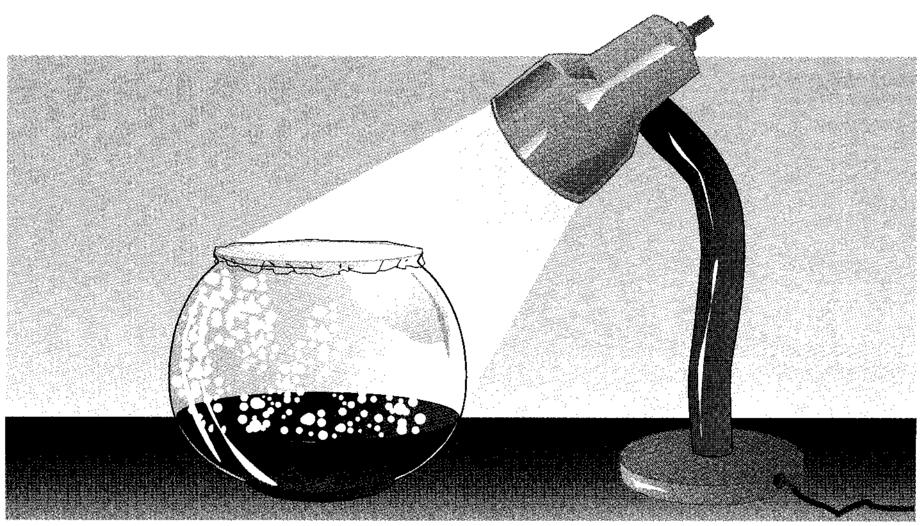


Figure IO.3

When your teacher originally set up the fish bowl with the water in it, the sides of the fish bowl were dry. Where did the water droplets come from?

The pattern of water movement on the earth is called the water cycle. Water is constantly on the move. In some places it is going into the air, or evaporating, and in other places it is coming out of the air, or condensing.

The movement of water is a major part of the weather. As you think about the way water moves on the earth, remember that when rain or snow is falling, water is moving out of the air. In another place, where perhaps it is a sunny day, water is evaporating and moving into the air.

Stop and Discuss

7. Think about your explanations for why you saw water on the can and in the fish bowl. How could you change those explanations now?
8. Look at the diagram in Figure 10.4. The teakettle is plugged in, and the glass plate is cold. Describe what will happen as the water in the teakettle continues to heat. You may draw and label a diagram in your notebook or write several sentences to explain what will happen.

But *why* does water move? The short answer is because of heat. The sun's energy warms the earths surface, including the water on the surface. If the water is heated enough, it changes from a liquid (the way we usually think of it) to a vapor, or a gas. When water is a gas, its particles are far apart. When it's a liquid, its particles are closer together. When water loses heat energy, it changes from a liquid to a solid. In other words, it becomes ice.

The heat energy that warms the water on the surface of the earth also warms the air. This causes the air to move. This moving air is the wind you feel outside. Wind is one of the factors behind weather patterns.

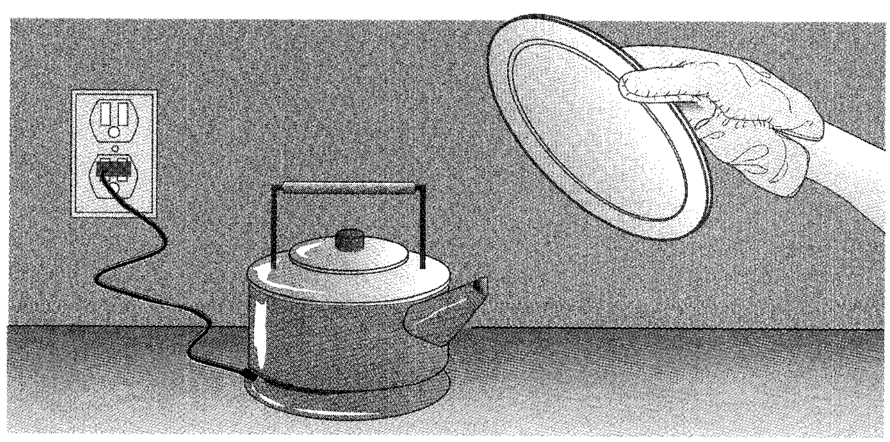
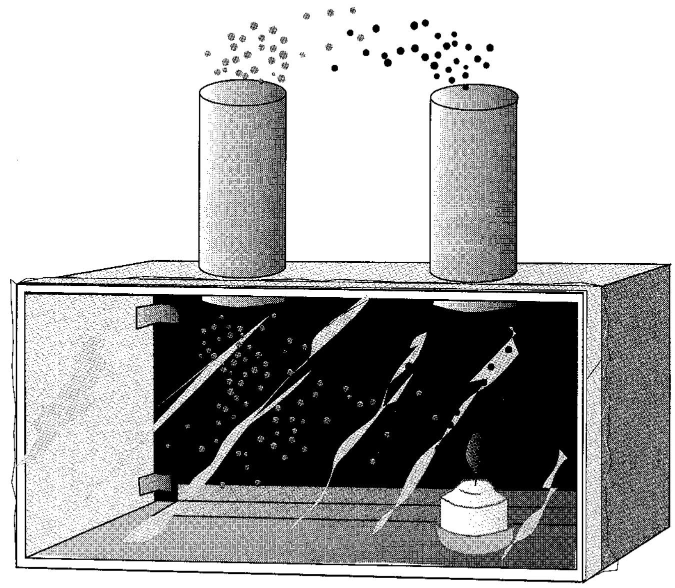


Figure IO.4

The water within this teakettle is being heated. What will happen to the water?

Figure 10.5

This diagram shows air particles in a convection box.



But how does heat energy cause wind? As the sun's energy reaches the earth's surface, the heat is absorbed unequally This happens in part because the earths surface is covered with land, as well as water, and solid materials absorb heat in a manner different from the way water does. Furthermore the sun's rays strike the earth more directly at the equator than they do at the poles. As a result the air in some places is warmer than in other places.

Stop and Discuss

9. Look at Figure 10.5. What parts of the convection box represent the following:
   - a warm place like the land at the equator
   - a cool place that does not receive direct rays from the sun
   - the wind

10. Describe the patterns you see in Figure 10.5.

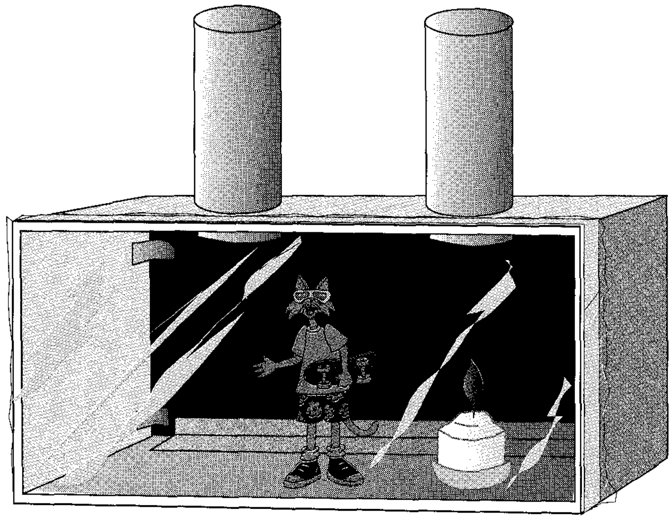
The type of circulation or movement shown in Figure 10.5 is a **convection cell.** When air moves in a convection cell, you can feel it. For example, when cold winds in the Northern Hemisphere rush from the north to the south, those winds are part of a convection cell. In fact, one definition of **wind** is the air moving horizontally in a convection cell.

Stop and Discuss

11. As you can see in Figure 10.6, Al volunteered to become small enough to fit into a convection box. In your notebook describe what Al is experiencing with the air around him.

Figure 10.6

Al is standing exactly in the middle of the box, between the two tubes.



12. What would Al experience if he moved to his right? To his left? Forward? Backward?
13. If you have seen a hot air balloon like the one in Figure 10.7, you have seen an object floating in the air. How can this happen?
14. Why would an object sink?
15. In Unit 1 you placed pieces of wood, cork, and wax into several different liquids. Why would the same object float in one liquid but not in another?

Figure IO.7

Why do you think hot air balloons are able to float?

Think about how objects can float on water. A piece of wood, for example, can float on water because the wood pushes down (we sometimes say it weighs) less than the water pushes it up.

When objects float, it is because the objects push down with less force than whatever is pushing them up. The force that allows something to float is called the **buoyant force.**

You have read about many factors causing weather patterns: the movement of water (evaporation and condensation), the difference in the amount of heat received and absorbed by parts of the earth, and the buoyant force. A scientist named George Hadley thought about these factors and thought that the earth's winds should blow from a cold area (the poles) toward a warm area (the equator). To explain this idea, he proposed that the earth was surrounded by two large convection cells. See Figure 10.8 for an example of his model.

Actual wind patterns on the earth, however, are more complex. Because the earth has land masses that absorb heat in a manner different from the way the oceans do, there are different types and levels of winds, such as surface winds and global winds (see Figure 10.9). For example, some near-surface winds blow over land and are very dry. Other surface winds blow over oceans and pick up water vapor. Some surface winds blow beside mountain ranges and through canyons. Within three adjacent states, for example, surface winds could be blowing in three different directions. High above the earth, however, global winds usually are undisturbed by local features on the ground, and the winds can flow in fairly constant directions.

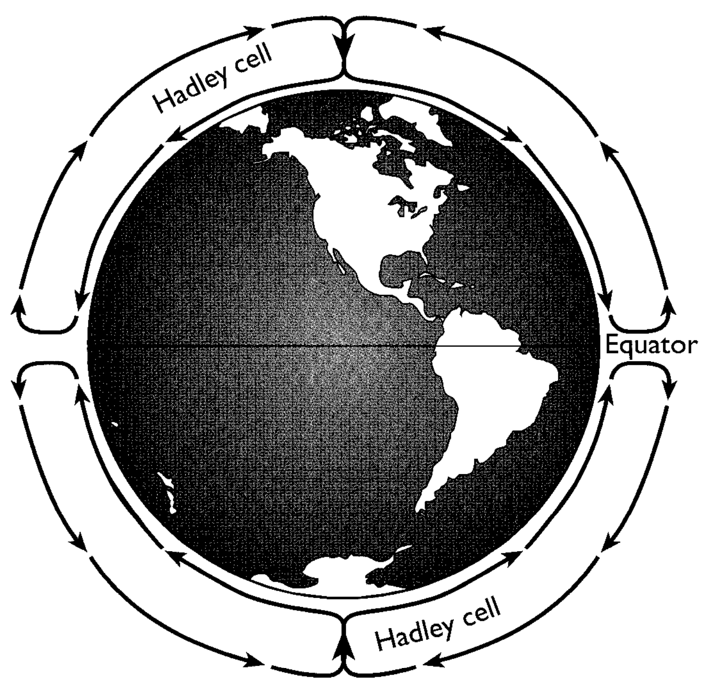
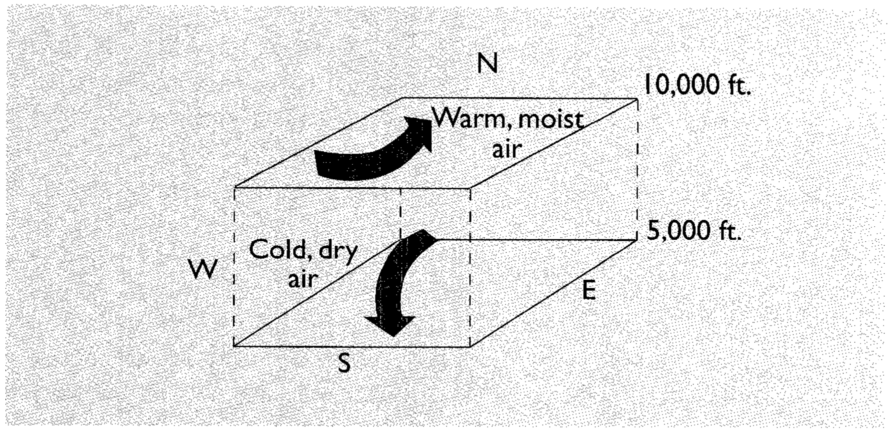


Figure 10.8

Hadley was the scientist who proposed this model. He envisioned two convection cells that covered the earth like bowls.

Figure 10.9

This diagram shows a low-level, or surface, wind blowing from north to south, and a high-level (global) wind blowing from the west.



By now you know that wind patterns can be complex. You have read that water and land absorb heat differently. But still another factor affects wind patterns—the rotation of the earth. To see how the earth's rotation affects global wind patterns, complete the next investigation.

INVESTIGATION:
Winds above a Rotating Earth

You now have observed several patterns caused by moving air and water. In this investigation you will see whether you can apply your understanding to a new pattern. You will try to answer the question, How does the earth's rotation affect the movement of the wind?

Working Environment

Work cooperatively in your team of three. You will need a work space beside your desks or table in which each of you can stand and move freely. Use the roles of Manager, Communicator, and Tracker. As you work, use the strategies and ideas you developed for the social skill *Treat others politely.*

Materials

For each team of three students:

- 1 square of corrugated cardboard, at least 25-by-25 cm
- 1 pen or pencil
- 1 sheet of paper, 8½-by-11 in.
- masking tape, 5 cm
- 1 felt-tip pen
- 1 ruler, 30 cm (12 in.), or 1 piece of string, at least 30 cm long
- 1 pair of scissors

Procedure

1. Obtain the materials.
2. Trim the paper to fit your piece of cardboard.

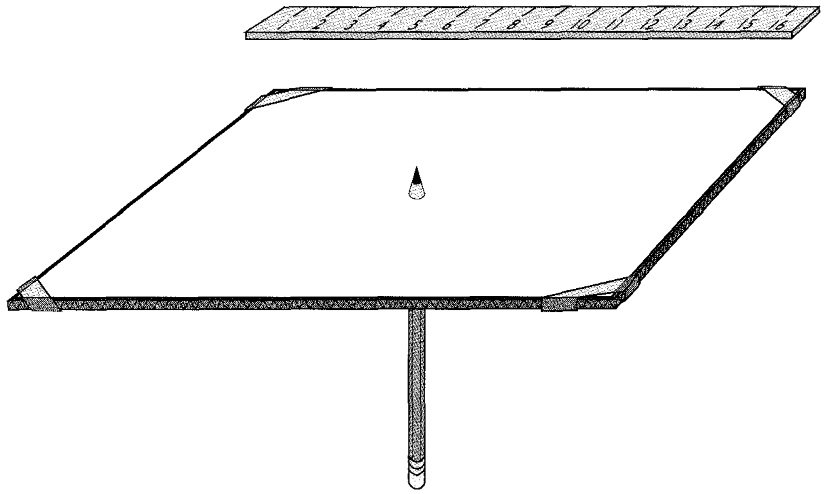


Figure 10.10

This diagram shows the cardboard ready to spin on the pencil, the paper on top of the cardboard, and the ruler held horizontally above the cardboard.

3. If there is no hole already, poke a pencil through the center of the cardboard as shown.

   The cardboard should spin freely on the pencil. See Figure 10.10.

4. Tape the sheet of paper onto the cardboard.

   The pencil should stick through the paper so that the paper and cardboard can spin together as shown in Figure 10.10.

5. Spin the cardboard on the pencil.

   The Communicator should do this.

6. Hold a ruler 5 cm above the middle of the cardboard.

   The Manager should do this as in Figure 10.10 (do not move the ruler).

7. On the spinning cardboard, draw a line on the paper with a felt-tip pen while keeping the pen against the ruler.

   The Tracker should do this as shown in Figure 10.11.

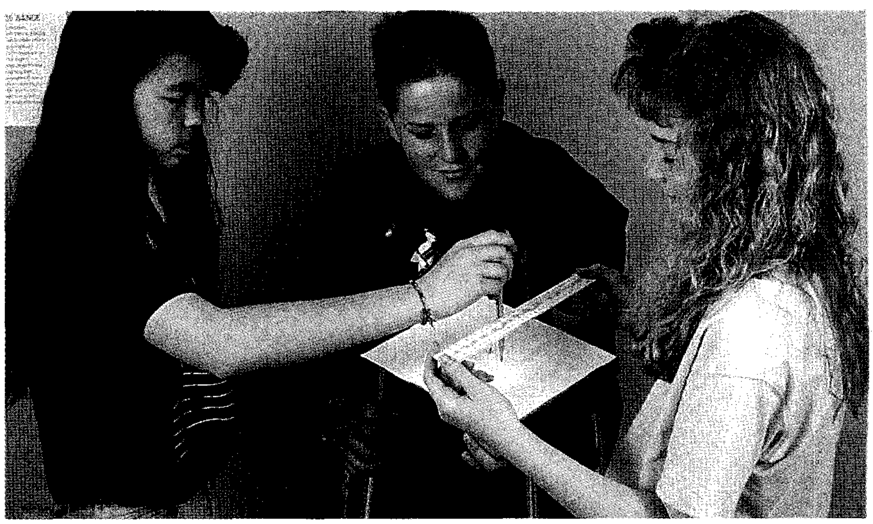


Figure 10.11

As the cardboard is spinning, move the pen along the ruler.

8. Take turns switching jobs so that each teammate has a chance to draw a line across the paper.
9. Read the Background Information.

Background Information

Coriolis Effect

If an object moves in a straight line across a spinning surface, the path the object leaves behind is a curved line. This is because the *surface* is spinning. When something moving in a straight line appears to curve, but in fact it is the surface beneath it that is curving, scientists describe this phenomenon as the **Coriolis effect.**

Scientists who observe wind patterns have noticed that the winds do not move in straight north and south lines across the surface of the earth. Scientists have noted that in the Northern Hemisphere, winds curve in a counterclockwise direction and that in the Southern Hemisphere, winds curve in a clockwise direction. The result is that winds tend to curve in more complicated patterns than we showed in Figure 10.8, the diagram of Hadley's convection cells. Instead wind patterns more closely resemble the diagram in Figure 10.12.

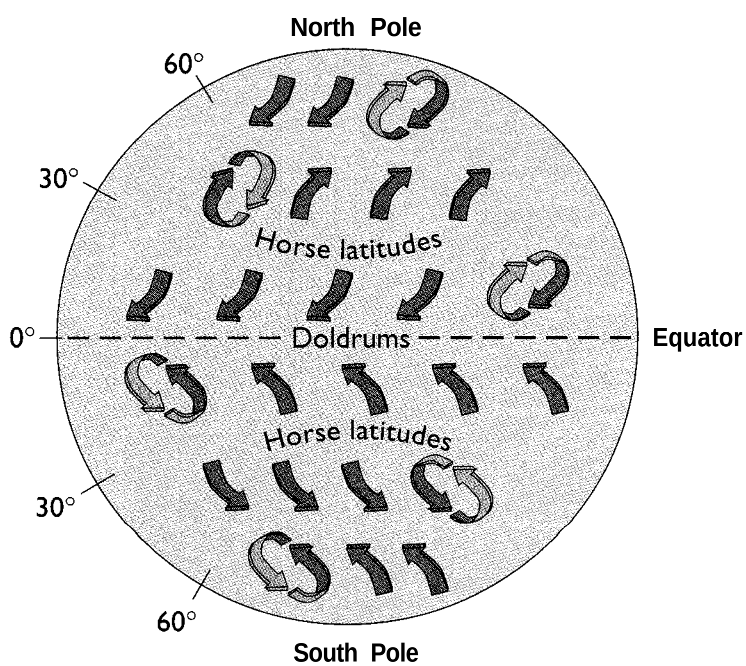


Figure IO. I2

This diagram of the Coriolis effect shows that the winds do not move in straight lines from north to south. The arrows in this diagram indicate which way winds are blowing in convection cells. The darker portion of the arrow indicates the near-surface winds, and the lighter portion of the arrow indicates the high-level winds.

Winds appear to us to curve because the earth is rotating beneath them. Across the United States, winds tend to move from west to east, so most weather patterns also move across the continent from west to east. Figure 10.12 indicates the global wind circulation patterns, but remember that the local wind patterns you experience during a storm might be completely different.

Wrap Up

Conduct research to answer the following questions in your notebook.

1. If the ruler is straight and you moved a pen along it, why did you observe what you did?
2. What does *rotate* mean?
3. What evidence do you have that the earth is rotating?
4. When your area has rain or snow storms, in which direction do the storms tend to move?
5. Name one weather trend or cycle in your area.
6. How often is the weather forecast accurate? (If you don't know, watch, listen, or read about 5 days' worth of weather forecasts and compare them with what you actually observe.)

SIDELIGHT

In the Doldrums

Sailing ships once followed the routes of the prevailing winds across the globe to carry their cargoes from one continent to another. But some places on the globe do not have prevailing winds.

Have you ever heard anyone say that he or she is "in the doldrums"? What did that person mean?

Above the hot tropical regions of the world, the air warms and rises. On the surface of the land and sea, only light breezes blow. The near-surface breezes often change direction and never blow strongly in any one direction. This area along the equator was a dangerous area for the great sailing ships of past centuries and was known as the "doldrums." There was so little wind that the ships could often be stuck in one area for weeks.

Farther north and south of the equator lie two other regions that posed hazards to sailing ships. In these subtropical areas, the air that has risen from the equator cools enough so that it sinks. This cool, dry air creates an area of fair weather. Most of the world's deserts are in these regions. Sailors called these belts of calm, high-pressure air around the world the "horse latitudes." Some people say that this is because horses sometimes died of thirst when the sailing ships they were on were stuck in calm waters. Because of the work of the early explorers, modern-day sailors have learned to avoid the horse latitudes and the doldrums.

CONNECTIONS:
Science in Your Bathroom

You have just studied some of the earth's weather patterns and explored some ways that air and water move in cycles. Can you apply your understanding to everyday phenomena? Try to explain what happens in the following two situations you might encounter in your bathroom.

Situation A

You take a shower and the mirror fogs up.

1. Where does this water come from?
2. How does it get to the mirror?

Situation B

You take a hot shower, and the curtain billows in and brushes against your legs.

1. What causes the curtain to move like this?
2. What would happen if the water were cold?

Title Page