Lesson 3

Air Currents

Reading Guide

Key Concepts

ESSENTIAL QUESTIONS

- How does uneven heating of Earth's surface result in air movement?
- How are air currents on Earth affected by Earth's spin?
- What are the main wind belts on Earth?

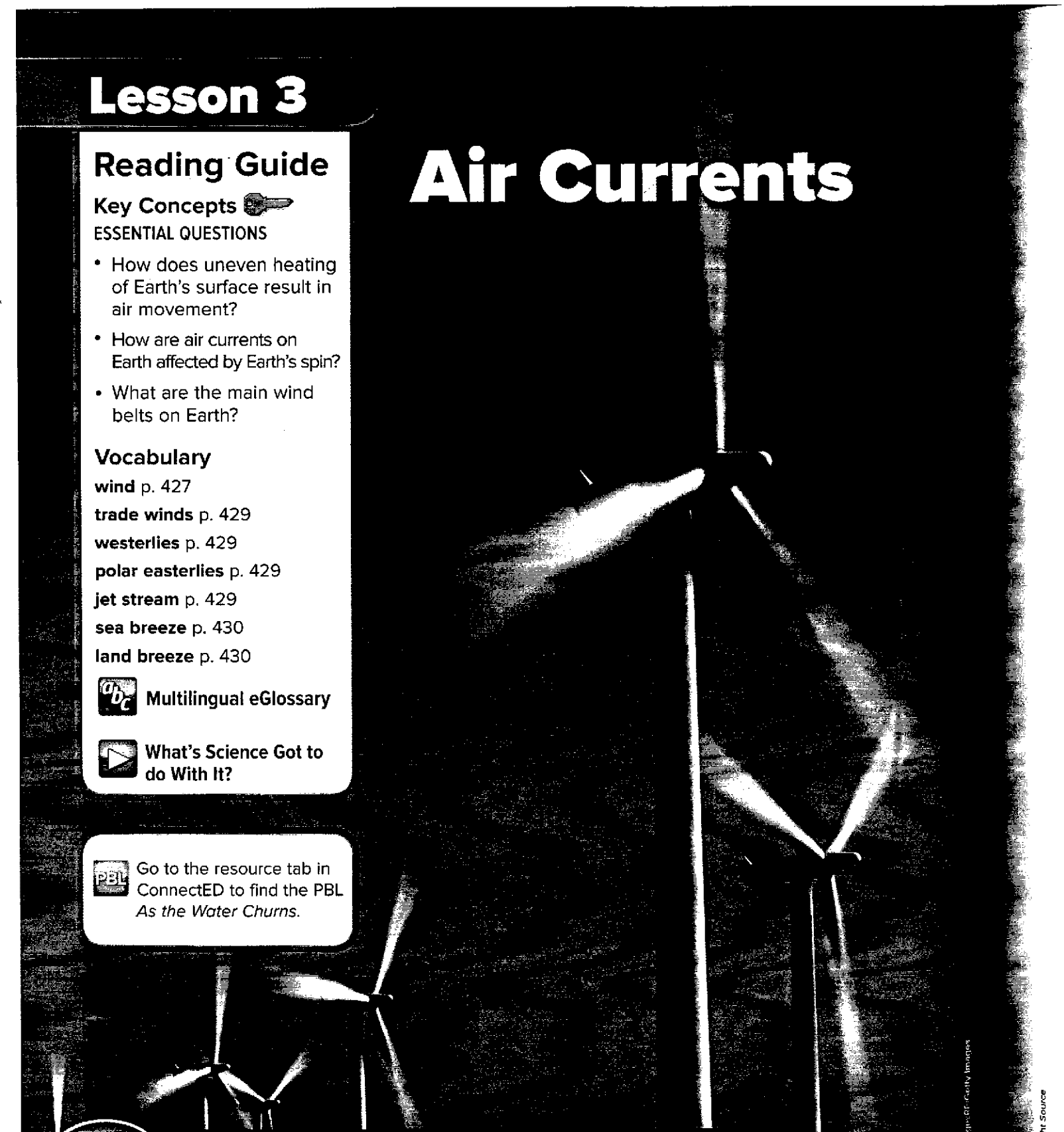
Vocabulary

wind p. 427
trade winds p. 429
westerlies p. 429
polar easterlies p. 429
jet stream p. 429
sea breeze p. 430
land breeze p. 430

Multilingual eGlossary

What's Science Got to do With It?

Go to the resource tab in ConnectED to find the PBL *As the Water Churns.*



Hutchings Photography/Digital Light Source

Inquiry How does air push these blades?

If you have ever ridden a bicycle into a strong wind, you know the movement of air can be a powerful force. Some areas of the world have more wind than others. What causes these differences? What makes wind?

Launch Lab

15 minutes

Why does air move?

Early sailors relied on wind to move their ships around the world. Today, wind is used as a renewable source of energy. In the following activity, you will explore what causes air to move.

1. Read and complete a lab safety form.
2. Inflate a **balloon.** Do not tie it. Hold the neck of the balloon closed.
3. Describe how the inflated balloon feels.
4. Open the neck of the balloon without letting go of the balloon. Record your observations of what happens in your Science Journal.

Think About This

1. What caused the inflated balloon surface to feel the way it did when the neck was closed?
2. What caused the air to leave the balloon when the neck was opened?
3. **Key Concept** Why didn't outside air move into the balloon when the neck was opened?

Global Winds

There are great wind belts that circle the globe. The energy that causes this massive movement of air originates at the Sun. However, wind patterns can be global or local.

Unequal Heating of Earth's Surface

The Sun's energy warms Earth. However, the same amount of energy does not reach all of Earth's surface. The amount of energy an area gets depends largely on the Sun's angle. For example, energy from the rising or setting Sun is not very intense. But Earth heats up quickly when the Sun is high in the sky.

In latitudes near the equator–an area referred to as the tropics–sunlight strikes Earth's surface at a nearly 90° angle year round. As a result, in the tropics there is more sunlight per unit of surface area. This means that the land, the water, and the air at the equator are always warm.

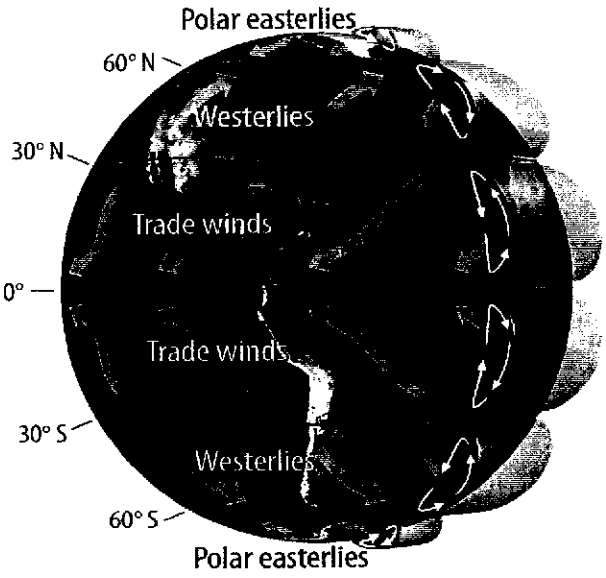
At latitudes near the North Pole and the South Pole, sunlight strikes Earth's surface at a low angle. Sunlight is now spread over a larger surface area than in the tropics. As a result, the poles receive very little energy per unit of surface area and are cooler.

Recall that differences in density cause warm air to rise. Warm air puts less pressure on Earth than cooler air. Because it's so warm in the tropics, air pressure is usually low. Over colder areas, such as the North Pole and the South Pole, air pressure is usually high. This difference in pressure creates wind. **Wind** *is the movement of air from areas of high pressure to areas of low pressure.* Global wind belts influence both climate and weather on Earth.

Key Concept Check How does uneven heating of Earth's surface result in air movement?

Figure 16 Three cells in each hemisphere move air through the atmosphere.

Visual Check Which wind belt do you live in?



Global Wind Belts

Figure 16 shows the three-cell model of circulation in Earth's atmosphere. In the northern hemisphere, hot air in the cell nearest the equator moves to the top of the troposphere. There, the air moves northward until it cools and moves back to Earth's surface near 30° latitude. Most of the air in this convection cell then returns to Earth's surface near the equator.

The cell at the highest northern latitudes is also a convection cell. Air from the North Pole moves toward the equator along Earth's surface. The cooler air pushes up the warmer air near 60° latitude. The warmer air then moves northward and repeats the cycle. The cell between 30° and 60° latitude is not a convection cell. Its motion is driven by the other two cells, in a motion similar to a pencil that you roll between your hands. Three similar cells exist in the southern hemisphere. These cells help generate the global wind belts.

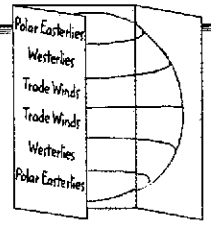
The Coriolis Effect

What happens when you throw a ball to someone across from you on a moving merry-go-round? The ball appears to curve because the person catching the ball has moved. Similarly, Earth's rotation causes moving air and water to appear to move to the right in the northern hemisphere and to the left in the southern hemisphere. This is called the Coriolis effect. The contrast between high and low pressure and the Coriolis effect creates distinct wind patterns, called prevailing winds.

Key Concept Check How are air currents on Earth affected by Earth's spin?

FOLDABLES

Make a shutterfold. As illustrated, draw Earth and the three cells found in each hemisphere on the inside of the shutterfold. Describe each cell and explain the circulation of Earth's atmosphere. On the outside, label the global wind belts.



Prevailing Winds

The three global cells in each hemisphere create northerly and southerly winds. When the Coriolis effect acts on the winds, they blow to the east or the west, creating relatively steady, predictable winds. Locate the trade winds in **Figure 16.** *The* **trade winds** *are steady winds that flow from east to west between 30°N latitude and 30°S latitude.*

At about 30°N and 30°S air cools and sinks. This creates areas of high pressure and light, calm winds at the equator called the doldrums. Sailboats without engines can be stranded in the doldrums.

The prevailing **westerlies** *are steady winds that flow from west to east between latitudes 30°N and 60°N, and 30°S and 60°S.* This region is also shown in **Figure 16.** *The* **polar easterlies** *are cold winds that blow from the east to the west near the North Pole and the South Pole.*

Key Concept Check What are the main wind belts on Earth?

Jet Streams

Near the top of the troposphere is a narrow band of high winds called the **jet stream.** Shown in **Figure 17,** jet streams flow around Earth from west to east, often making large loops to the north or the south. Jet streams influence weather as they move cold air from the poles toward the tropics and warm air from the tropics toward the poles. Jet streams can move at speeds up to 300 km/h and are more unpredictable than prevailing winds.

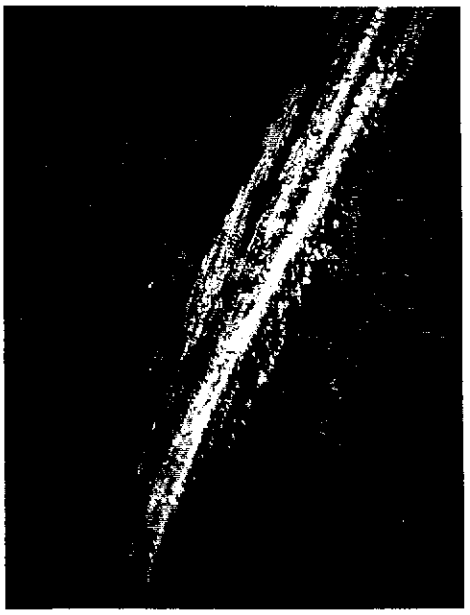


Figure 17 Jet streams are thin bands of high wind speed. The clouds seen here have condensed within a cooler jet stream.

Personal Tutor

MiniLab

20 minutes

Can you model the Coriolis effect?

Earth's rotation causes the Coriolis effect. It affects the movement of water and air on Earth.

1. Read and complete a lab safety form.
2. Draw dot A in the center of a piece of **foamboard.** Draw dot B along the outer edge of the foamboard.
3. Roll a **table-tennis ball** from dot A to dot B. Record your observations in your Science Journal.
4. Center the foamboard on a **turntable**. Have your partner rotate the foamboard at a medium speed. Roll the ball along the same path. Record your observations.

Analyze and Conclude

1. **Contrast** the path of the ball when the foamboard was not moving to when it was spinning.
2. **Key Concept** How might air moving from the North Pole to the equator travel due to Earth's rotation?

Local Winds

You have just read that global winds occur because of pressure differences around the globe. In the same way, local winds occur whenever air pressure is different from one location to another.

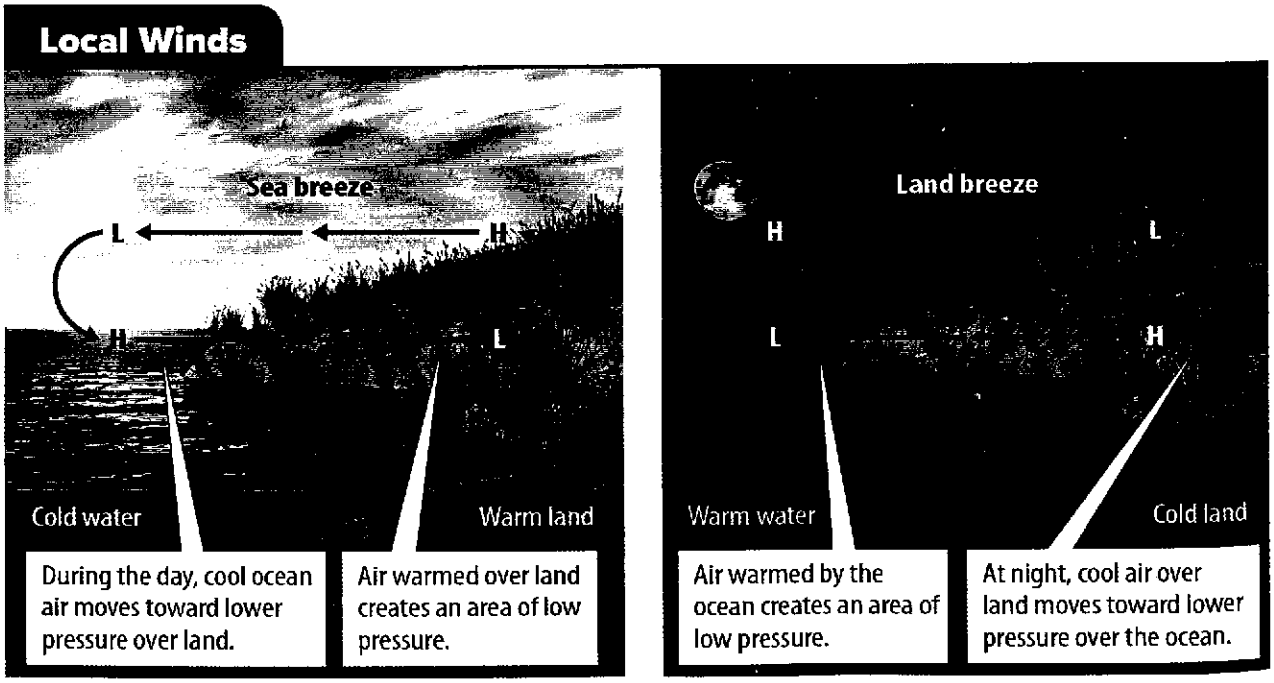
Sea and Land Breezes

Anyone who has spent time near a lake or an ocean shore has probably experienced the connection between temperature, air pressure, and wind. *A* **sea breeze** *is wind that blows from the sea to the land due to local temperature and pressure differences.* **Figure 18** shows how sea breezes form. On sunny days, land warms up faster than water does. The air over the land warms by conduction and rises, creating an area of low pressure. The air over the water sinks, creating an area of high pressure because it is cooler. The differences in pressure over the warm land and the cooler water result in a cool wind that blows from the sea onto land.

A **land breeze** *is a wind that blows from the land to the sea due to local temperature and pressure differences.* **Figure 18** shows how land breezes form. At night, the land cools more quickly than the water. Therefore, the air above the land cools more quickly than the air over the water. As a result, an area of lower pressure forms over the warmer water. A land breeze then blows from the land toward the water.

Reading Check Compare and contrast sea breezes and land breezes.

Figure 18 Sea breezes and land breezes are created as part of a large reversible convection current.



Visual Check Sequence the steps involved in the formation of a land breeze.