Name _____ Class _____ Date _____

CHAPTER 1 The Atmosphere

SECTION 3

Global Winds and Local Winds

BEFORE YOU READ

After you read this section, you should be able to answer these questions:

- What causes wind?
- What is the Coriolis effect?
- What are the major global wind systems on Earth?

National Science Education Standards

ES 1j

What Causes Wind?

Wind is moving air caused by differences in air pressure. Air moves from areas of high pressure to areas of low pressure. The greater the pressure difference, the faster the air moves, and the stronger the wind blows. ☑

You can see how air moves if you blow up a balloon and then let it go. The air inside the balloon is at a higher pressure than the air around the balloon. If you open the end of the balloon, air will rush out.

STUDY TIP

Underline Each heading in this section is a question. Underline the answer to each question when you find it in the text.

READING CHECK

1. Define What is wind?

_____

_____

TAKE A LOOK

2. Identify On the drawing, label the high-pressure area with an **H** and the low-pressure area with an **L**.

What Causes Differences in Air Pressure?

Most differences in air pressure are caused by differences in air temperature. Temperature differences happen because some parts of Earth get more energy from the sun than others. For example, the sun shines more directly on the equator than on the poles. As a result, the air is warmer near the equator. ☑

The warm air near the equator is not as dense as the cool air near the poles. Because it is less dense, the air at the equator rises, forming areas of low pressure. The cold air near the poles sinks, forming areas of high pressure. The air moves in large circular patterns called *convection cells*. The drawing on the next page shows these convection cells.

READING CHECK

3. Explain Why isn't all the air on Earth at the same temperature?

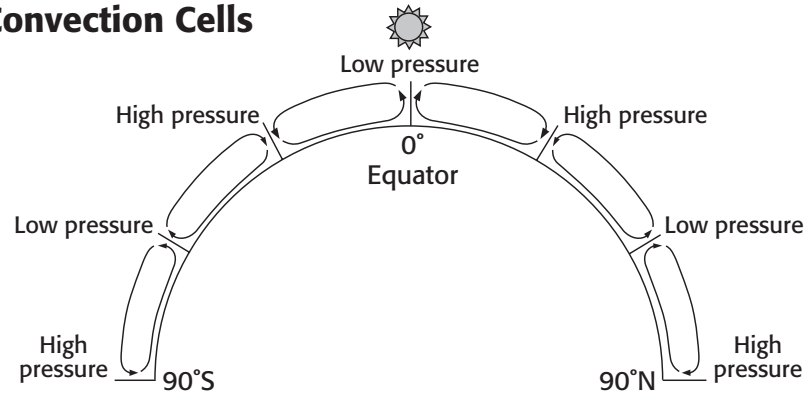
_____

_____

_____

Copyright © by Holt, Rinehart and Winston. All rights reserved.

Convection Cells



TAKE A LOOK

4. Describe Is air rising or sinking in areas of high pressure?

_____

What Are the Major Global Wind Systems?

Global winds are large-scale wind systems. There are three pairs of major global wind systems, or wind belts: trade winds, westerlies, and polar easterlies. ☑

READING CHECK

5. Identify What are the three main global wind belts?

_____

_____

_____

Trade winds are wind belts that blow from 30° latitude almost to the equator. They curve to the west as they blow toward the equator. **Westerlies** are wind belts that are found between 30° and 60° latitude. The westerlies blow toward the poles from west to east. Most of the United States is located in the belt of westerly winds. These winds can carry moist air over the United States, producing rain and snow.

Polar easterlies are wind belts that extend from the poles to 60° latitude. They form as cold, sinking air moves away from the poles. In the Northern Hemisphere, polar easterlies can carry cold arctic air over the United States. This can produce snow and freezing weather.

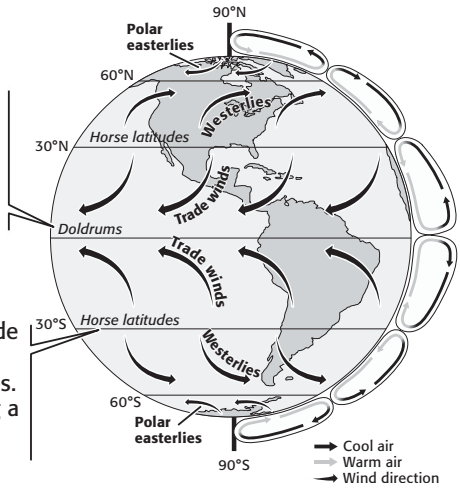
Wind belt	Location (latitude)	Toward the equator or toward the poles?
Trade winds	0° to 30°	toward the equator
Westerlies		
	60° to 90°	

TAKE A LOOK

6. Describe Fill in the blanks in the table.

The figure on the next page shows the locations of these different wind belts. Notice that the winds do not move in straight lines. The paths of the wind belts are controlled by convection cells and by the Earth's rotation.

Copyright © by Holt, Rinehart and Winston. All rights reserved.



The trade winds meet and rise near the equator in a region known as the doldrums. The wind in the doldrums is very weak.

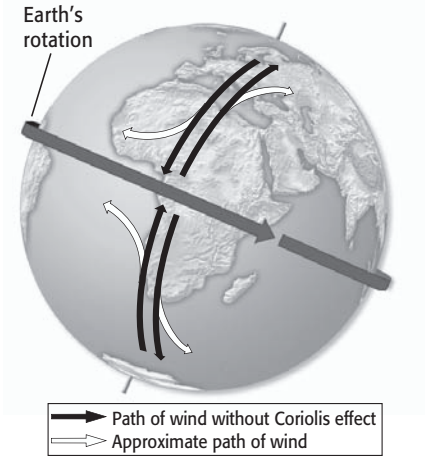
The region between the trade winds and the westerlies is known as the horse latitudes. Here, cool air sinks, creating a region of high pressure. The winds here are very weak.

There are three pairs of major global wind belts on Earth: the polar easterlies, the westerlies, and the trade winds.

Why Do Global Winds Curve?

Remember that pressure differences can cause air to move and form winds. If Earth did not rotate, these winds would blow in straight lines. However, because Earth does rotate, the winds follow curved paths. This *deflection*, or curving, of moving objects from a straight path because of Earth's rotation is called the **Coriolis effect**. ☑

As Earth rotates, places near the equator travel faster than places closer to the poles. This difference in speed causes the Coriolis effect. Wind moving from the poles to the equator is deflected to the west. Wind moving from the equator to the poles is deflected east.



The Coriolis effect causes wind and water to move along curved paths.

STANDARDS CHECK

ES 1j Global patterns of atmospheric movement influence local weather. Oceans have a major effect on climate, because water in the oceans holds a large amount of heat.

Word Help: major
of great importance or large scale

7. Explain Use the map to explain why surface winds are generally very weak near the equator.

_____

_____

_____

_____

_____

READING CHECK

8. Describe How does Earth's rotation affect the paths of global winds?

_____

_____

_____

TAKE A LOOK

9. Apply Ideas If air is moving south from California, which way will it tend to curve?

_____

Copyright © by Holt, Rinehart and Winston. All rights reserved.

What Are Jet Streams?

The polar easterlies, prevailing westerlies, and trade winds are all winds that we feel on the ground. However, wind systems can also form at high altitude. **Jet streams** are narrow belts of very high-speed winds in the upper troposphere and lower stratosphere. They blow from west to east all the way around the Earth. ☑

Jet streams can reach speeds of 400 km/h. Pilots flying east over the United States or the Atlantic Ocean try to catch a jet stream. This wind pushes airplanes along, helping them fly faster and use less fuel. Pilots flying west try to avoid the jet streams.

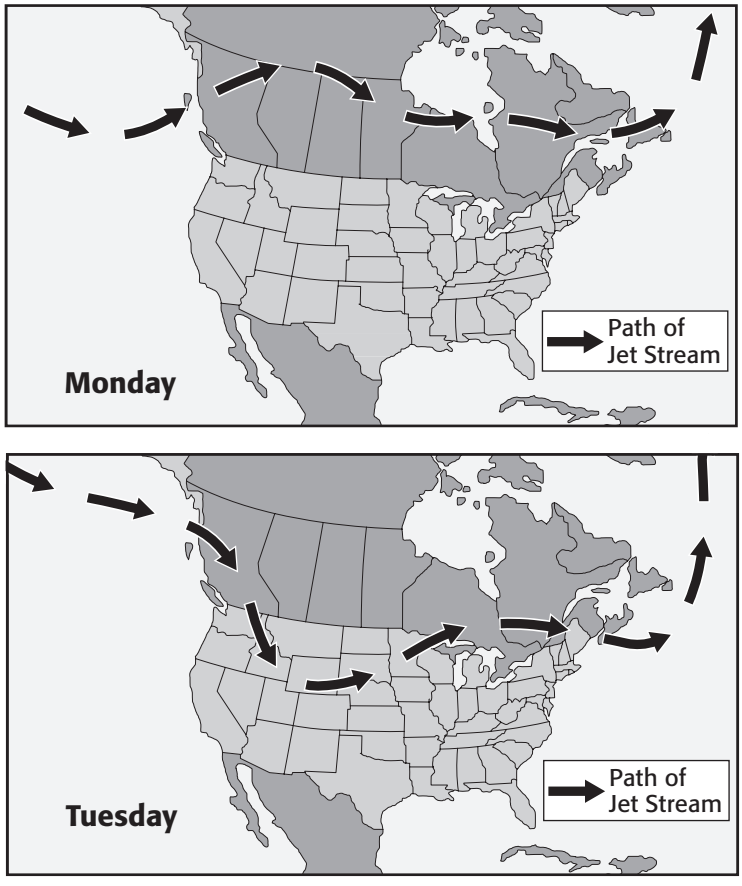
The global wind systems are always found in about the same place every day. Unlike these global wind systems, jet streams can be in different places on different days. Because jet streams can affect the movements of storms, meteorologists try to track the jet streams. They can sometimes predict the path of a storm if they know where the jet streams are.

READING CHECK

10. Identify In what two layers of the atmosphere are the jet streams found?

_____

_____



Jet streams form between hot and cold air masses. Unlike the other wind systems, jet streams are found in slightly different places every day.

TAKE A LOOK

11. Infer Why would a pilot flying across North America take a different route on Tuesday than on Monday?

_____

_____

_____

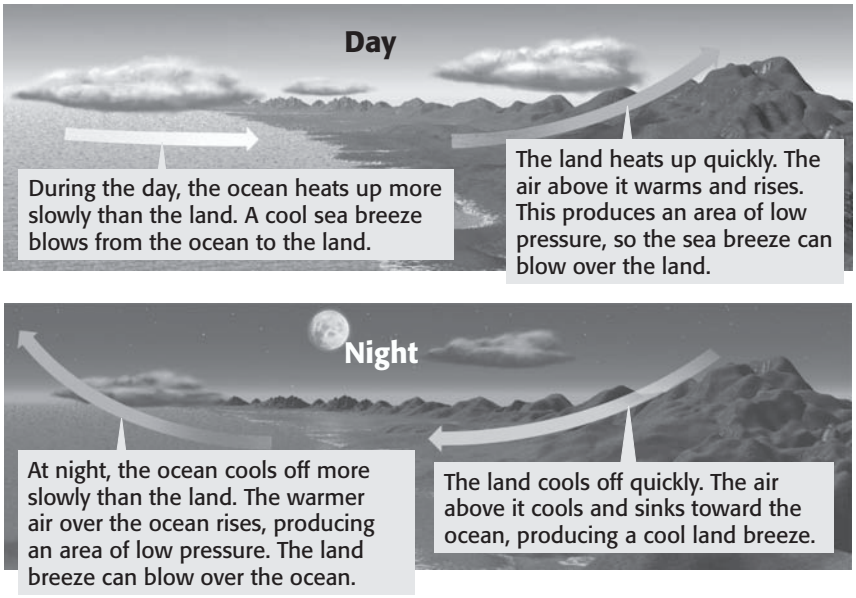
_____

Copyright © by Holt, Rinehart and Winston. All rights reserved.

What Are Local Winds?

Most of the United States is in the belt of prevailing westerly winds, which move from west to east. However, you've probably noticed that the wind in your neighborhood does not always blow from the west to the east. This is because global winds are not the only winds that blow. Local winds are also important. *Local winds* are winds that generally move over short distances and can blow from any direction.

Like the other wind systems, local winds are caused by differences in temperature. Many of these temperature differences are caused by geographic features, such as mountains and bodies of water. The figure below shows how water and mountains can affect local winds.



MOUNTAIN BREEZES AND VALLEY BREEZES

Mountain and valley breezes are other examples of local winds caused by geography. During the day, the sun warms the air on mountain slopes. The warm air rises up the mountain slopes, producing a warm valley breeze. At night, the air on the slopes cools. The cool air moves down the slopes, producing a cool mountain breeze.

Critical Thinking

12. Compare Describe one difference between global winds and local winds.

_____

_____

_____

_____

Say It

Share Experiences Have you ever been in a very strong wind? In groups of two or three, discuss the strongest or worst wind you've ever been in.

TAKE A LOOK

13. Identify In the figures, label the high-pressure areas with an **H** and the low-pressure areas with an **L**.

Copyright © by Holt, Rinehart and Winston. All rights reserved.

Name _____ Class _____ Date _____

Section 3 Review

NSES ES 1j

SECTION VOCABULARY

Coriolis effect the curving of the path of a moving object from an otherwise straight path due to the Earth's rotation

jet stream a narrow band of strong winds that blow in the upper troposphere

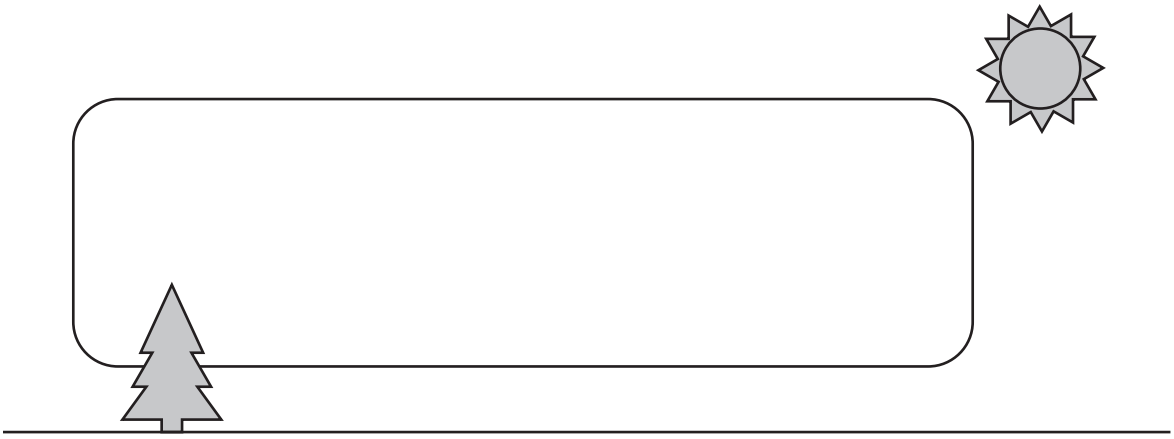
polar easterlies prevailing winds that blow from east to west between 60° and 90° latitude in both hemispheres

trade winds prevailing winds that blow from east to west from 30° latitude to the equator in both hemispheres

westerlies prevailing winds that blow from west to east between 30° and 60° latitude in both hemispheres

wind the movement of air caused by differences in air pressure

1. Identify The drawing below shows a convection cell. Put arrows on the cell to show which way the air is moving. Label high pressure areas with an **H** and low pressure areas with an **L**. Label cold air with a **C** and warm air with a **W**.



2. Identify Which global wind system blows toward the poles between 30° and 60° latitude?

_____

3. Explain Why does wind tend to blow down from mountains at night?

_____

_____

4. Apply Concepts Would there be winds if Earth's surface were the same temperature everywhere? Explain your answer.

_____

_____

_____

Copyright © by Holt, Rinehart and Winston. All rights reserved.

Chapter 1 The Atmosphere

SECTION 1 CHARACTERISTICS OF THE ATMOSPHERE

1. nitrogen and oxygen
2. about 11/50
3. water vapor, carbon dioxide
4. the pressure produced by the air above a surface
5. The air pressure is higher around the tree than around the plane.
6. Air temperature in the atmosphere can increase or decrease with altitude.
7. about 80 km
8. People and other living things live in the troposphere. It is where weather happens.
9. It differs from place to place.
10. It absorbs harmful ultraviolet energy.
11. because the temperatures are so high there
12.

Layer	How temperature and pressure change as you move higher	Important features
Troposphere	Temperature decreases; pressure decreases.	This densest layer contains most of the atmosphere. Weather and clouds are here.
Stratosphere	Temperature increases; pressure decreases.	Gases are arranged in layers; it contains the ozone layer.
Mesosphere	Temperature decreases; pressure decreases.	It has the lowest temperatures.
Thermosphere	Temperature increases; pressure decreases.	It has auroras and the highest temperatures.

Review

1. Possible answer: the gases that cover the surface of a body in space
2. Different layers are made of different gases. Different gases absorb different amounts of the sun's energy.
3. The pressure curve should go from the upper left to the lower right of the diagram (decreasing with altitude).
4. Gases in the atmosphere absorb energy from the sun; when they absorb energy, the air temperature goes up.

SECTION 2 ATMOSPHERIC HEATING

1. 50%
2. Some of it gets absorbed by the atmosphere. The rest of it gets scattered and reflected.
3. Possible answers: radiation from the sun, conduction from the ground, air convection
4. Conduction, because heat is transferred between two objects that are touching.
5. It rises and cools.
6. water vapor and carbon dioxide
7. **L** should be on a short-wavelength ray; **H** should be on a long-wavelength ray.

Review

1. Possible answers: radiation, because the heat moves as waves through the air to the marshmallow; convection, because hot air carries energy from the fire toward the marshmallow
2.

Type of energy transfer	How energy is transferred
Radiation	Energy travels as electromagnetic waves.
Convection	Heat circulates; warm air rises and cool air sinks.
Conduction	Heat moves from warm objects to cold objects.

3. The heat moves by convection. Warm air rises and cools off. Cool air sinks and then warms up. The air is constantly moving.
4. Global warming can be caused by the greenhouse effect. The greenhouse effect causes Earth's air temperature to increase.

SECTION 3 GLOBAL WINDS AND LOCAL WINDS

1. moving air caused by differences in air pressure
2. H should be inside the balloon; L should be outside the balloon.
3. Some parts of Earth get more energy from the sun than others.
4. sinking

Copyright © by Holt, Rinehart and Winston. All rights reserved.

5. trade winds, westerlies, polar easterlies

6.

Wind belt	Location (latitude)	Toward the equator or toward the poles?
Trade winds	0° to 30°	toward the equator
Westerlies	30° to 60°	toward the poles
Polar easterlies	60° to 90°	toward the equator

7. The trade winds meet and rise here. The air is moving up rather than along the surface.
8. Earth's rotation causes surface currents to follow curved paths.
9. toward the west
10. upper troposphere, lower stratosphere
11. The jet stream is in different places. The pilot would want to catch or avoid the jet stream.
12. Global winds blow in one direction, but local winds can blow in any direction.
13. An **L** should be on the arrow end of each wind path; winds blow from **H** to **L**.

Review

1. Arrows can go clockwise or counterclockwise; arrows should point from **H** to **L**; sinking air should be labeled "**C**"; rising air should be labeled "**W**."
2. westerlies
3. During the day, the mountains warm up and the air above them warms and rises. At night, as the mountains cool off, the air cools down and sinks, producing winds.
4. No. Winds are caused by differences in air pressure, which are caused by differences in temperature.

SECTION 4 AIR POLLUTION

1. Ozone forms when other pollutants react with one another and with air in the presence of sunlight.

2.

Pollutant	Primary pollutant or secondary pollutant?	Natural or caused by people?
Car exhaust	primary	human-caused
Dust	primary	natural or human-caused
Ozone	secondary	human-caused
Paint chemicals	primary	human-caused
Pollen	primary	natural
Sea salt	primary	natural
Volcanic ash	primary	natural

3. vehicle exhaust
4. motor vehicles
5. If there is not enough ventilation, pollutants can get trapped inside.
6. Answers will vary.
7. People burn coal for energy.

   Pollutants are released.

   Pollutants combine with water in the air.

   Acid rain falls in the lake.

   Fish die.
8. Ozone in the stratosphere blocks UV light, which can be harmful to humans.
9.

Ozone in the stratosphere	Ozone near the ground
Forms naturally	from human activity
Is not a pollutant	a pollutant
Protects Earth from UV rays	harmful to living things

10. Short-term effects happen quickly and go away once the pollution is gone. Long-term effects develop over a long time and do not go away easily.
11. The electricity to run them must be generated. Many electrical power plants burn fossil fuels to generate electricity. This causes pollution in the areas near, and downwind of, the power plants.

Review

1. Burning fossil fuels puts primary pollutants into the air, causing air pollution. Some of these pollutants can combine with water in the atmosphere to make acid precipitation. Vehicle exhaust combines with sunlight and forms secondary pollutants such as ozone.

Copyright © by Holt, Rinehart and Winston. All rights reserved.