

# 11-7

## How do winds form?

### Objective

Explain how winds form.

### Key Terms

**wind:** horizontal movement of air

**air current:** up-and-down movement of air

**Winds and Air Pressure** Earth's atmosphere is nearly always in motion. Some air movements are weak and end quickly. Others are strong and last a long time.

Air is free to move in any direction. Its actual movements are determined by many factors. The horizontal movement of air along Earth's surface is called **wind**. Wind has often been described as "air in a hurry."

Air can also move vertically. Instead of being called wind, small vertical movements are usually called updrafts or downdrafts. Vertical movements are also important in the atmosphere. However, a much greater volume of air moves horizontally.

Winds form as cool, heavy air moves toward warm, light air. Cool air moves in under warm air. The cool air moves along the surface of Earth toward warmer air.

Winds are caused by differences in air pressure. Regions of cold, heavy air have high air pressure. These regions are called highs. Regions of warm, light air have low air pressure. These regions are called lows.

Air moves from regions of high pressure to regions of low pressure. Winds form when air moves. The speed of the wind depends on the differences in air pressure.



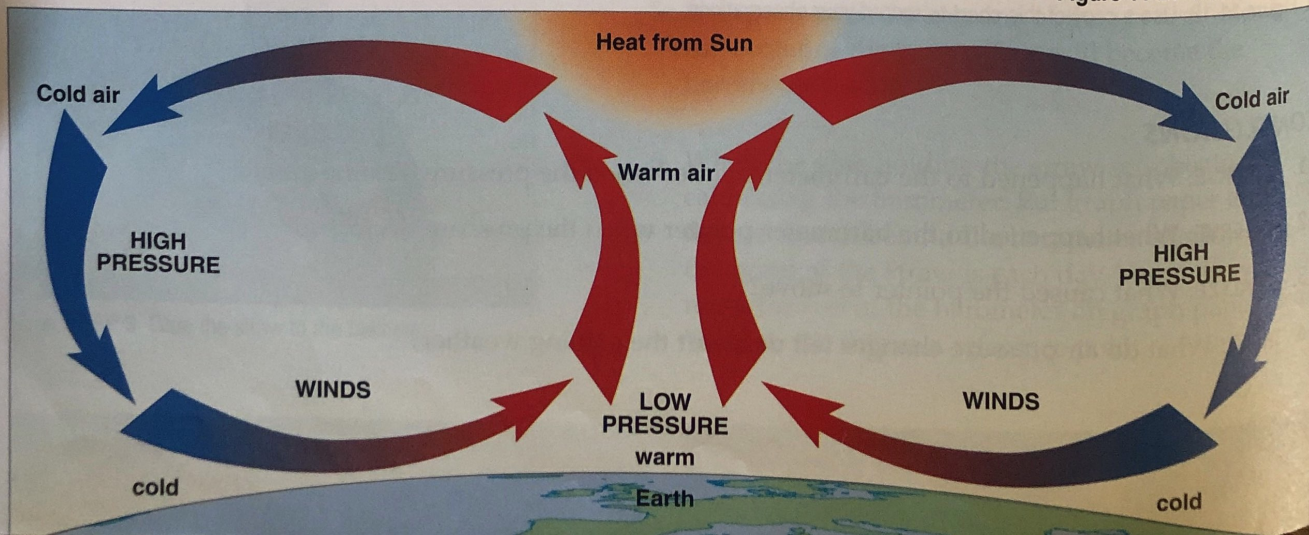
▲ **Figure 11-20** The winds that move these sailboards are produced by differences in air pressure.

**1 PREDICT:** Will the speed of a wind be greater if the difference in air pressure is large or small?

**Air Currents** Up-and-down movements of air are called **air currents**. Air currents are formed because the Sun does not heat all parts of Earth equally. Some areas of Earth are warmed more than other areas. As air over the warmer regions is heated, it expands and becomes less dense. As air over cooler regions is cooled, it becomes heavier, or denser. The cool air moves in under the warm air. It pushes the warm air upward. As the warm air mixes with the cool air, it becomes heavier and moves downward.

**2 DEFINE:** What is an air current?

▼ **Figure 11-21** How winds form





### ✓ CHECKING CONCEPTS

1. An air current is an \_\_\_\_\_ movement of air.
2. Cool air is more \_\_\_\_\_ than warm air.
3. As cool air moves in under warm air, it pushes the warm air \_\_\_\_\_.
4. Wind is the \_\_\_\_\_ movement of air along Earth's surface.
5. Wind speed depends on differences in \_\_\_\_\_.



### THINKING CRITICALLY

6. **INFER:** The Sun does not heat the surface of Earth equally. What effect does this have on weather patterns?
7. **CONTRAST:** What are the differences between highs and lows?
8. **EXPLAIN:** Why does cold air push warm air upward?

9. **INFER:** a. Where on Earth would you expect to find the warmest and least dense air? Why?  
b. Where would you expect to find the coldest and densest air? Why?

### Web InfoSearch

**El Niño** Changes in the temperatures of surface ocean water may be responsible for some global weather patterns. Such changes have been linked to El Niño events. El Niño is a warm ocean current that appears off the coast of Peru in December each year and may spread south. El Niño affects Earth's wind patterns and can cause extreme weather far from where it occurs.

**SEARCH:** Use the Internet to find out more about this. What happens during an El Niño event? Start your search at [www.conceptsandchallenges.com](http://www.conceptsandchallenges.com). Some key search words are El Niño, trade winds, and climate change.



## Hands-On Activity

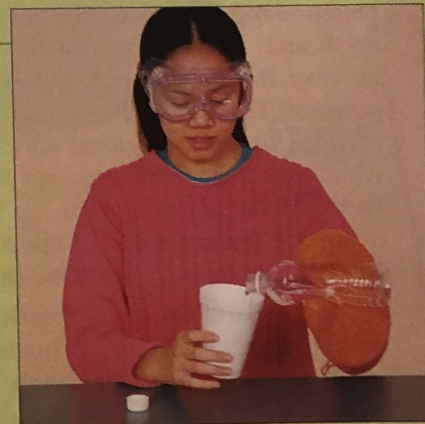
### OBSERVING AIR PRESSURE

You will need safety goggles, a plastic foam cup, hot water, a funnel, and a small plastic bottle with a screw-on cap.

1. Your teacher will provide you with some hot water in a plastic foam cup. Carefully pour the water into the plastic bottle using a funnel.  
**⚠ CAUTION:** Use an oven mitt to hold the bottle. Also, be careful when handling the cup of hot water.
2. Quickly pour the hot water out of the plastic bottle back into the plastic foam cup.
3. Immediately screw the cap on the plastic bottle.

#### Your Skills

1. What happened to the plastic bottle after you screwed on the cap?
2. What can you say about the pressure of the warm air compared to the pressure of the cold air?



▲ **STEP 2** Pour the hot water quickly into the cup.

6. **CONCLUDE:** Based on your observations, should wind move from cold areas to warm or from warm areas to cold?
7. **RELATE:** How does this activity relate to the way winds form?



# 11-8 What causes local winds?

## Objective

Describe patterns of local winds.

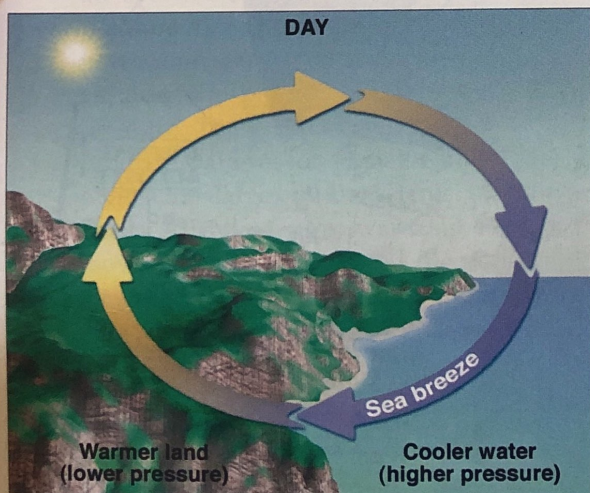
## Key Term

**monsoon:** wind that changes direction with the seasons

**Sea and Land Breezes** All winds are produced by temperature differences caused by unequal heating of Earth's surface. Local winds are simply small-scale winds produced by local changes in air pressure.

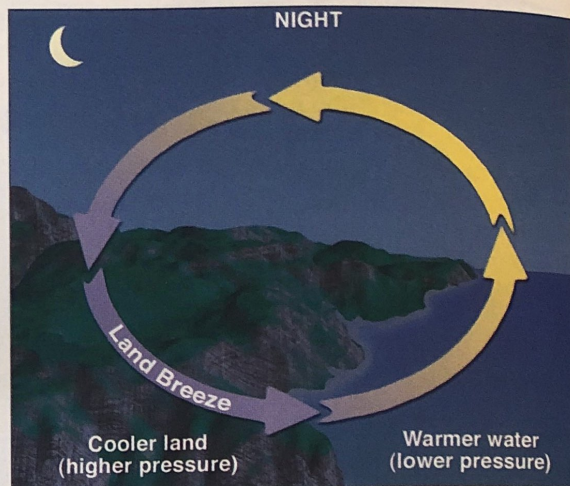
A breeze coming from the sea toward the land is a sea breeze. A breeze going from the land toward the sea is a land breeze. Land and sea breezes are local winds.

The Sun heats land faster than it does water. As a result, air over the land is warmer and lighter than air over the water. The cooler, heavier air over the ocean moves in toward the land. The warmer, lighter air over the land rises. The result is a sea breeze.



▲ Figure 11-23 Sea breeze

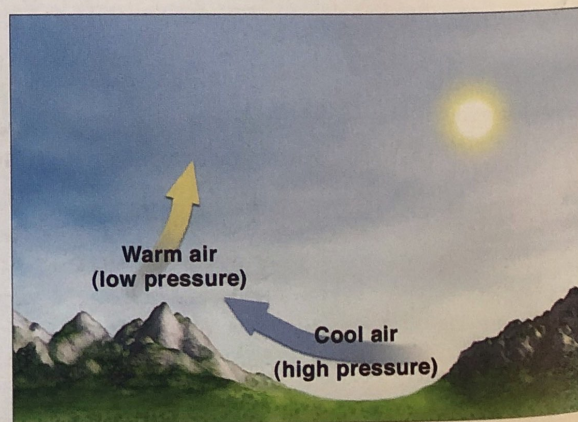
At night, the land cools faster than the water. The air over the land becomes cooler than the air over the water. The heavier air over the land moves toward the water. The warmer, lighter air over the water rises. The result is a land breeze.



▲ Figure 11-24 Land breeze

1 **COMPARE:** Which cools faster, land or water?

**Mountain and Valley Breezes** Mountain regions also have local winds. During the day, the air on a mountain slope is warmer than the air in the valleys. Warm air has low pressure. Air in the valley is cooler and has high pressure. Air moves from the high pressure of the valley to the low pressure of the mountain slope. This is a valley breeze. At night, the valleys are warmer than the mountaintops. The heavier mountain air moves downhill toward the valley. This is a mountain breeze.



▲ Figure 11-25 Valley breeze

2 **DESCRIBE:** In which direction do valley breezes move?



**Monsoons** Parts of some continents have winds that change direction with the seasons. These winds are called **monsoons**.

In the summer, when the land is warmer than the water, winds move from the ocean toward the land. In the winter, when the land is colder than the water, the winds move from the land toward the ocean. Winds blow toward the ocean all winter. India is famous for its monsoons. The summer monsoon brings warm, moist air with heavy rains. The winter monsoon carries dry air. There is little rain in winter.

**3 DEFINE:** What are monsoons?

### **✓ CHECKING CONCEPTS**

1. A sea breeze blows toward the \_\_\_\_\_ from the ocean.
2. Land is heated \_\_\_\_\_ than water.
3. Movement of air from the land toward the ocean is called a \_\_\_\_\_ breeze.

4. A \_\_\_\_\_ breeze moves downhill toward a valley.
5. Winds that change direction with the seasons are \_\_\_\_\_.



### **THINKING CRITICALLY**

6. **ANALYZE:** During part of the year, monsoons bring heavy rains and warm temperatures to many countries. Do these rainy seasons occur in the summer or winter? Explain.
7. **MODEL:** Draw and label a diagram of a mountain breeze. Use Figure 11-25 to help you.

### **BUILDING READING SKILLS**

**Vocabulary** Mistral, foehn (FAYN), and chinook are the names of three local winds. Use a dictionary or other references to look up each of these winds. Write a brief description of each wind on a sheet of paper. Where does each wind occur?



## *Science and Technology*

### **WIND ENERGY**

For years, farmers have used windmills to pump water. Today, many communities are using the wind to produce electricity. Modern materials and engineering could combine to make wind energy an important source of power for the future. Wind energy is a promising source of power because the wind is free and no pollution is produced. However, the speed and direction of the winds are unpredictable.

In some places, large windmill farms provide power for electric generators. Windmill farms may include hundreds or even thousands of windmills. Over 6,000 wind generators located at Altamont Pass, east of San Francisco, California, are already in operation and producing electricity. One of the largest windmills is in Medicine Bow, Wyoming. This one windmill can provide enough electricity for 1,200 homes.

Modern windmills do not look much like the windmills used to pump water on farms. Some of the newer windmills look more like airplane propellers or eggbeaters. Instead of wood, they are made of new, lightweight materials.

**Thinking Critically** Why are fields with many windmills called wind farms?



▲ **Figure 11-26** A large windmill farm near Palm Springs, California