

# 11-1 What is air?

- Objectives** ▶ Recognize that air is matter.  
▶ Identify and describe the main gases in air.

## TechTerms

- ▶ **atmosphere** (AT-mus-feer): envelope of gases that surrounds the earth
- ▶ **matter**: anything that has mass and volume
- ▶ **respiration** (res-puh-RAY-shun): process by which living things combine oxygen with food to get energy

**A Mixture of Gases** Air is a colorless, tasteless, odorless mixture of gases. Air is **matter**. Matter is anything that has mass and takes up space, or has volume.

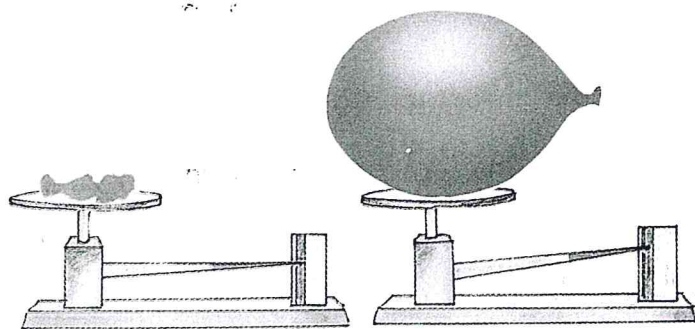


Figure 1 Air has mass and volume.

The **atmosphere** (AT-mus-feer), or air, is the envelope of gases that surrounds the earth. Air is made up mostly of nitrogen and oxygen. Air also is made up of other gases. The pie graph shows the percentages of the gases that make up air.

■ **Analyze:** What percentage of the air is made up of helium, neon, krypton, and xenon?

**Nitrogen** About 78% of the atmosphere is nitrogen. Living things, or organisms (AWR-guh-niz-ums), need nitrogen. However, most living things cannot use nitrogen gas from the air. Bacteria (bak-TEER-ee-uh) are microscopic organisms that live in soil, in water, and in the air. Some bacteria can change the nitrogen gas in the air into nitrogen compounds. Plants get the nitrogen they

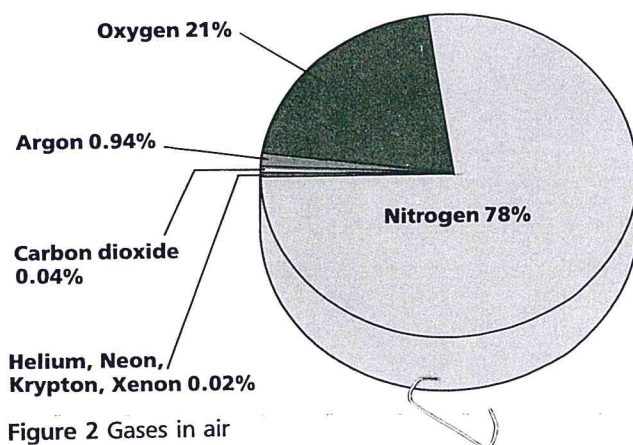


Figure 2 Gases in air

need from the nitrogen compounds made by bacteria. Animals get the nitrogen they need by eating plants.

||||▶ **Define:** What are bacteria?

**Oxygen** About 20% of the air is oxygen. Oxygen is needed for things to burn. Living things also need oxygen to carry on **respiration** (res-puh-RAY-shun). Respiration is the process by which living things combine oxygen with food to produce energy. Food is the fuel that provides living things with energy. A fuel is a substance that gives off energy when it is burned. During respiration, oxygen "burns," or breaks down, the food you eat to release energy. Most living things get the oxygen they need from the air.

▶ **Infer:** How do you get the oxygen you need to carry on respiration?

**Carbon Dioxide** About 0.04% of the air is made up of carbon dioxide. Carbon dioxide is released when things burn. Respiration produces carbon dioxide as a waste product. You get rid of this carbon dioxide when you breathe out. Plants need carbon dioxide to make food.

||||▶ **State:** How is carbon dioxide added to the air?

**11-1 What is air?**

**Lesson Review**

**Part A** *Decide which gas is described by each characteristic in the table. Place a check mark in the correct column.*

**Table 1 Characteristics of the Gases in the Air**

Characteristic	Oxygen	Nitrogen	Carbon Dioxide
1. Makes up about 20% of air			
2. Used by plants to make food			
3. Cannot be used directly by most organisms			
4. Makes up about 78% of the air			
5. Given off by animals when they breathe out			
6. Needed for respiration			
7. Needed for burning			
8. Changed into a usable form by bacteria			
9. Released into the air when things burn			
10. Makes up about 0.04% of the air			

**Part B** *Answer the following questions.*

1. What is matter? \_\_\_\_\_
2. What is the atmosphere? \_\_\_\_\_
3. What is respiration? \_\_\_\_\_
4. Name two gases other than oxygen, nitrogen, and carbon dioxide that make up air. \_\_\_\_\_  
\_\_\_\_\_
5. What are bacteria? \_\_\_\_\_

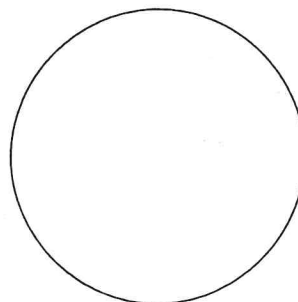
**Skill Challenge**

**Skills:** *organizing data, graphing*

*The percentages of the gases that make up air are listed below. In the space provided, organize the information in a pie graph.*

**Gases in Air**

- carbon dioxide      0.04%
- oxygen                20%
- nitrogen              78%
- helium, xenon,  
krypton, and neon    0.02%



# 11-3

# How does the earth get its heat?

**Objective** ▶ Describe how energy from the sun reaches the earth's surface.

### TechTerms

- ▶ **radiant** (RAY-dee-unt) **energy**: energy that can travel through empty space
- ▶ **radiation** (RAY-dee-AY-shun): movement of energy through empty space

**Radiant Energy** The sun gives off **radiant** (RAY-dee-unt) **energy**. If you go out into the sunlight, you can feel the radiant energy from the sun warming your skin. Heat and light are forms of radiant energy.

Radiant energy can travel across millions of kilometers of empty space. The movement of energy through empty space is called **radiation** (RAY-dee-AY-shun). Most of the earth's energy comes from radiation from the sun.

▶ **Name:** What kind of energy can travel through empty space?

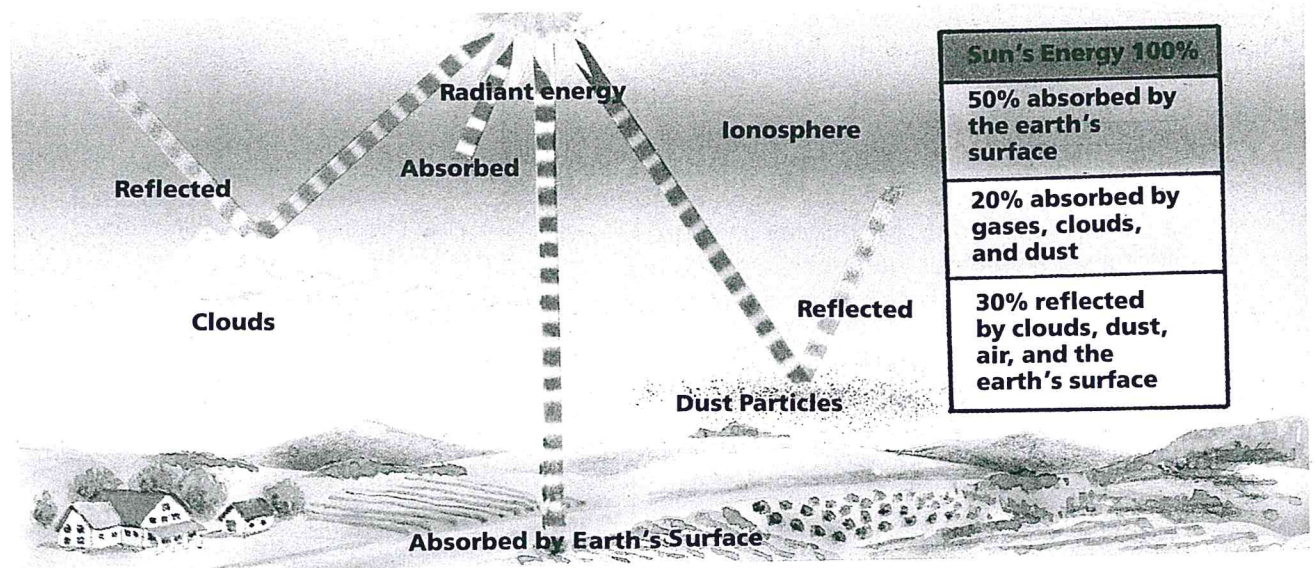
**Absorption of Energy** When light is absorbed, or taken in, it is changed into heat. Suppose you wrap two ice cubes with cloth. You wrap one ice

cube in a dark-colored cloth and the other in light-colored cloth. You place both ice cubes in sunlight. Which one would melt first? The ice cube wrapped in the dark-colored cloth would melt faster than the one wrapped in the light-colored cloth. Dark-colored surfaces absorb light. This light is changed into heat energy. Light-colored surfaces reflect light. Surfaces that reflect light remain cooler than surfaces that absorb light.

▶ **Describe:** What happens when light is absorbed?

**Energy from the Sun** Only a small part of the sun's energy reaches the earth. Some of the sun's energy is absorbed by the ionosphere. Clouds, dust particles, and water droplets in the atmosphere also absorb or reflect some of the sun's energy. The energy that is reflected goes back into space. Energy that passes through the atmosphere is absorbed by the earth's surface. The absorbed energy is changed into heat. As a result, the earth becomes warmer.

▶ **State:** What happens when the sun's energy is absorbed by the earth's surface?



### 11-3 How does the earth get its heat?

#### Lesson Review

**Part A** *In the space provided, write the term that best completes each statement.*

1. Heat and light are two forms of \_\_\_\_\_ energy.
2. The movement of energy through empty space is called \_\_\_\_\_.
3. Most of the earth's energy comes from radiation from the \_\_\_\_\_.
4. Light energy that is absorbed by the earth's surface is changed into \_\_\_\_\_.
5. Clouds, dust particles, and water droplets in the air, \_\_\_\_\_ some of the sun's energy back into space.
6. Some of the sun's energy is absorbed by the \_\_\_\_\_.

**Part B** *Decide whether each thing listed will absorb or reflect radiant energy. Write "A" for absorb and "R" for reflect in the space provided.*

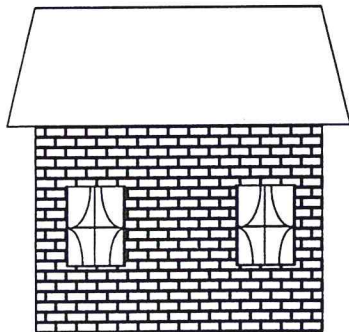
- \_\_\_\_\_ 1. Earth's surface      \_\_\_\_\_ 2. Dark suit      \_\_\_\_\_ 3. Concrete sidewalk  
\_\_\_\_\_ 4. White shirt      \_\_\_\_\_ 5. Tar-covered street      \_\_\_\_\_ 6. A dark green tent

#### Skill Challenge

**Skills:** *applying concepts, decision-making*

Imagine that you are going to buy a house in a part of Canada that has cool temperatures in summer and cold temperatures in winter. One of the factors you must consider before buying the house is the cost of heating the home in the winter and cooling the home in the summer. The real estate agent shows you two homes that are alike in size and layout. The prices of the homes also are equal. The only difference between the two houses are the colors of the materials from which the houses are made.

*Read the description below each house. On the back of this worksheet, identify which house you would buy. Explain your choice.*



**House A**  
House is made of white brick.  
The house has a light gray roof.



**House B**  
House is made of red brick.  
The house has a black roof.

# 11-7 How is air pressure measured?

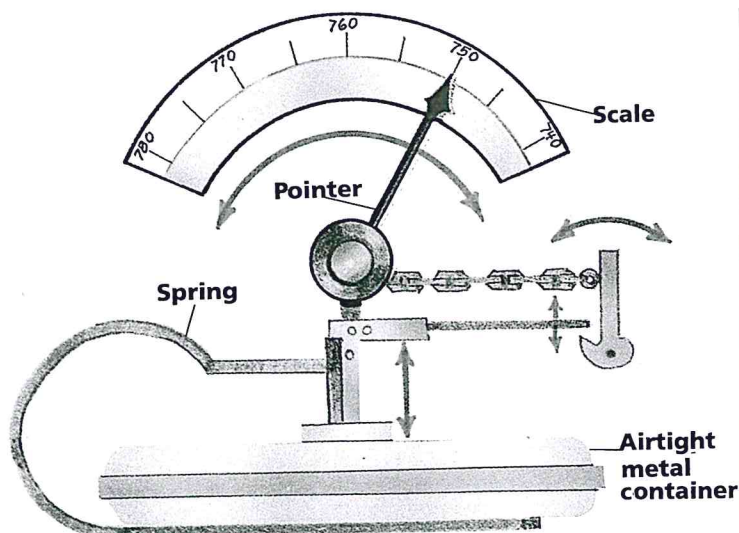
**Objective** ▶ Explain how a barometer is used to measure air pressure.

## TechTerm

▶ **barometer** (buh-ROM-uh-ter): instrument used to measure air pressure

**Mercury Barometer** Air pressure is measured with an instrument called a **barometer** (buh-ROM-uh-ter). One kind of barometer is a mercury barometer. Look at the mercury barometer on page 225. The mercury barometer was invented by an Italian scientist, Evangelista Torricelli (eh-van-jeh-LEE-stuh tor-ih-CHEL-ee). A mercury barometer is made of a glass tube filled with mercury. The tube is open at one end. The open end of the tube is placed in a container of mercury. Air pressure pushes down on the surface of the mercury in the container. The mercury is pushed up the tube. At sea level, air pressure can hold up a column of mercury 760 mm high. As the air pressure changes, the level of mercury in the tube rises or falls.

▶ **Define:** What is a barometer?

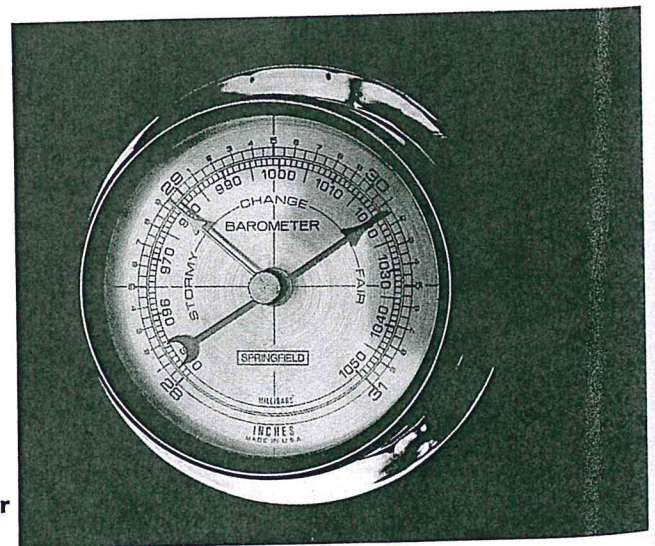


**Aneroid Barometer** Another kind of barometer is called an aneroid (AN-uh-royd) barometer. The word "aneroid" means "without liquid." An aneroid barometer is made of an airtight metal container. The sides of the container are very thin. They can bend in or out. When the air pressure increases, the sides of the container bend in. When the air pressure decreases, the sides bend out. A pointer is connected to the container. As the container changes shape, the pointer moves along a scale. The scale shows air pressure in millimeters of mercury. Some aneroid barometers keep a continuous record of air pressure.

▶ **Define:** What does the word "aneroid" mean?

**Measuring Air Pressure** Standard air pressure is 760 millimeters of mercury. Sometimes, this is called one atmosphere. Air pressure also is measured in millibars (mb). Standard air pressure is equal to 1013.20 millibars.

▶ **Analyze:** How many millimeters of mercury equal 1013.20 millibars?



### 11-7 How is air pressure measured?

#### Lesson Review

Match each term in Column B with its description in Column A. Write the correct letter in the space provided.

#### Column A

- \_\_\_\_\_ 1. invented by Evangelista Toricelli
- \_\_\_\_\_ 2. means "without liquid"
- \_\_\_\_\_ 3. instrument used to measure air pressure
- \_\_\_\_\_ 4. measured with a barometer
- \_\_\_\_\_ 5. standard air pressure
- \_\_\_\_\_ 6. unit of measure of air pressure
- \_\_\_\_\_ 7. made of an airtight metal container

#### Column B

- a. air pressure
- b. aneroid
- c. aneroid barometer
- d. barometer
- e. mercury barometer
- f. millibars
- g. 1013.20 millibars

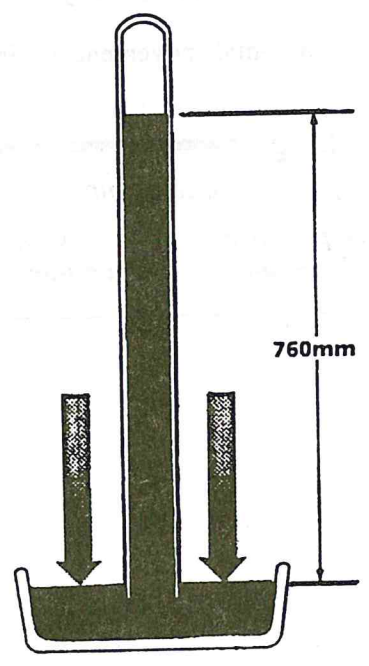
#### Skill Challenge

**Skills:** identifying, describing, comparing

Identify the tool shown in the diagram in the space provided. Then, answer the questions.

**Tool:** \_\_\_\_\_

- 1. What do the arrows in the diagram represent?  
\_\_\_\_\_
- 2. What is standard air pressure in millimeters of mercury? \_\_\_\_\_
- 3. What happens to the liquid in the tube if air pressure increases? \_\_\_\_\_
- 4. What happens to the liquid in the tube if air pressure decreases? \_\_\_\_\_



5. How does the barometer shown differ from an aneroid barometer? \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

# 11-9 What are global winds?

**Objective** ▶ Describe global wind patterns.

## TechTerms

- ▶ **global winds:** large wind systems around the earth
- ▶ **jet stream:** belt of high-speed wind

**Global Winds** Winds blow from regions of high pressure to regions of low pressure. Warm air over the equator forms a region of low pressure. Bands of high pressure are found north and south of the equator. Cold air over the poles forms regions of high pressure. These differences in air pressure produce patterns of **global winds**. Global winds are large systems of winds around the earth. At the equator, warm air rises and moves toward the poles. At the poles, cool air sinks and moves toward the equator. The diagram shows global winds.

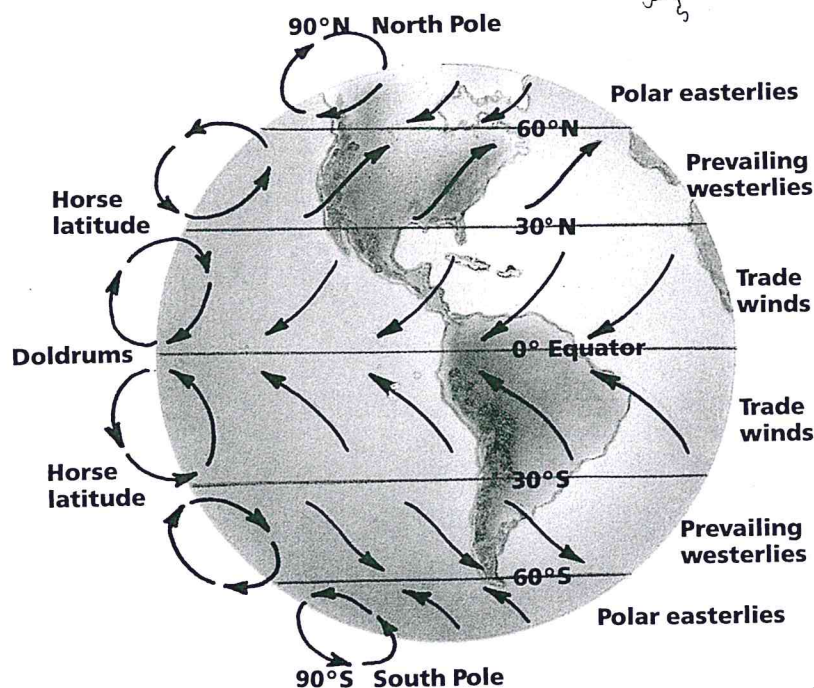
▶ **Explain:** What causes patterns of global winds?

**Curving Winds** Global winds do not move in straight lines. Because the earth rotates, or spins like a top, winds curve as they move from high-pressure to low-pressure regions. Winds moving toward the equator curve to the west. Winds moving toward the poles curve to the east.

▶ **Identify:** In what direction do winds near the equator curve? C

**Jet Streams** In the 1940s, global winds called **jet streams** were discovered. They are belts of high-speed air in the upper troposphere. The jet streams weave back and forth through the atmosphere. Jet streams are located at altitudes between about 6 km and 12 km. Their speeds may be as high as 500 km/hr. The jet streams flow from west to east. Airplanes flying in a jet stream gain speed going from west to east. They lose speed going the other way.

▶ **Define:** What is a jet stream?



**11-9 What are global winds?**

**Lesson Review**

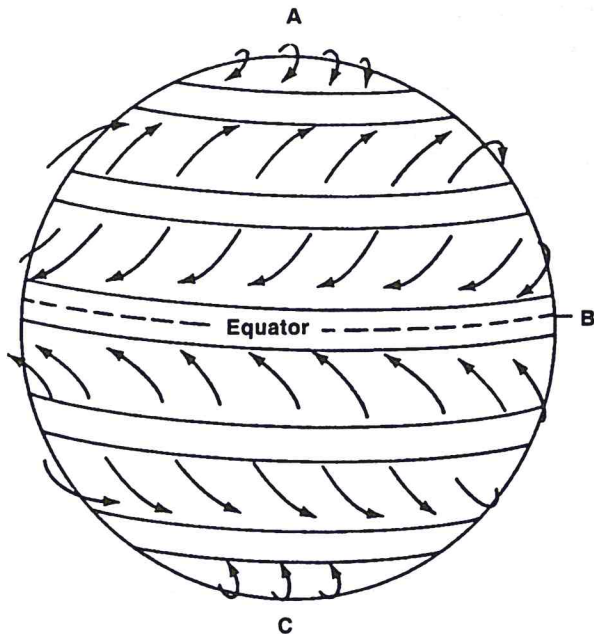
Write the term that best completes each statement in the space provided.

1. Winds blow from regions of \_\_\_\_\_ to regions of low pressure.
2. Large systems of winds around the world are called \_\_\_\_\_ .
3. Winds moving toward the equator curve to the \_\_\_\_\_ .
4. Belts of high-speed air in the upper atmosphere are called \_\_\_\_\_ .
5. Global winds curve because of the earth's \_\_\_\_\_ .
6. Airplanes flying in the jet stream \_\_\_\_\_ speed going from east to west.
7. Winds moving toward the poles curve to the \_\_\_\_\_ .
8. Bands of high pressure are found north and south of the \_\_\_\_\_ .
9. Warm air over the equator forms a region of \_\_\_\_\_ pressure.
10. At the \_\_\_\_\_, cool air sinks and moves toward the equator.

**Skill Challenge**

*Skills: observing, applying concepts*

Answer the questions about the diagram shown.



1. The diagram shows \_\_\_\_\_ patterns.
2. Cold air that forms regions of high pressure are located in Parts \_\_\_\_\_ of the diagram.
3. Warm air that forms a region of low pressure is located at Part \_\_\_\_\_ of the diagram.
4. Air located in Part \_\_\_\_\_ of the diagram is rising.
5. Air located at Parts \_\_\_\_\_ of the diagram is sinking.



# 11-11 How is wind measured?

**Objective** ▶ Explain how weather instruments are used to measure wind.

## TechTerms

- ▶ **anemometer** (an-uh-MOM-uh-tur): instrument used to measure wind speed
- ▶ **wind vane**: instrument used to measure wind direction

**Measuring Wind Direction** A wind is named according to the direction from which the wind comes. If a wind comes from the north, it is a north wind. If it comes from the east, it is an east wind. The direction of a wind is measured with a **wind vane**. A wind vane shows the direction a wind is coming from. Many wind vanes are shaped like arrows. When the wind blows, the arrow turns and points into the wind.

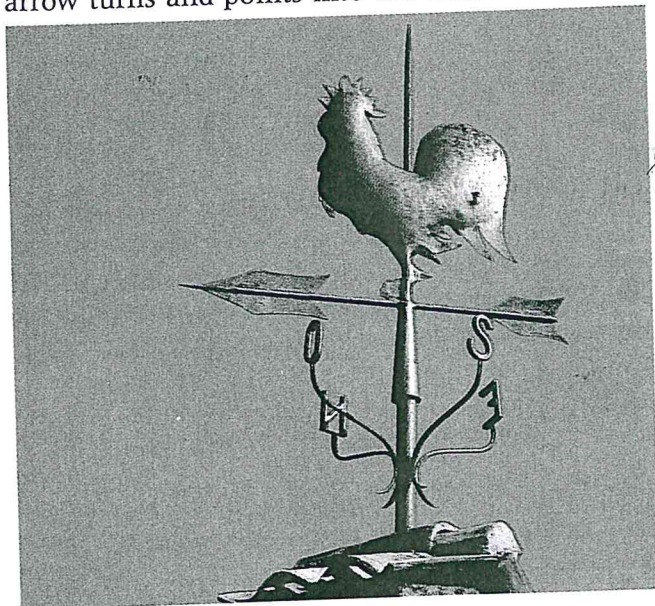


Figure 1 A wind vane

- ▶ **Name:** What is a wind that blows from the northeast named?

**Measuring Wind Speed** An **anemometer** (an-uh-MOM-uh-tur) is an instrument used to measure wind speed. An anemometer is shown in Figure 2. An anemometer is made of cups turned on their sides and attached to rods. Wind blowing

against the cups causes the anemometer to turn. The faster and stronger the wind, the faster the anemometer turns. Some anemometers have a meter attached to them. This meter is like the speedometer in a car. The meter measures how fast the wind is blowing by measuring how fast the cups on the anemometer turn.



Figure 2 An anemometer

- ▶ **Analyze:** An anemometer turns at a speed of 18 km/hr. At what speed is the wind blowing?

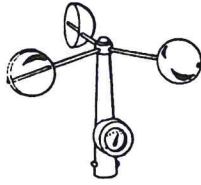
**Weather Balloons** Scientists sometimes use weather balloons to measure wind speed and direction. A weather balloon is filled with helium gas. Helium gas is lighter than air. As a result, balloons filled with helium gas rise in the air. Winds high in the air move a weather balloon. Scientists can measure the speed of the wind by measuring the speed at which the balloon moves. The direction the balloon moves shows the direction of the wind.

- ▶ **Identify:** What two things are measured by weather balloons?

## 11-11 How is wind measured?

### Lesson Review

**Part A** Identify the weather instrument shown in each drawing. Write your answer in the space provided.




1. \_\_\_\_\_ 2. \_\_\_\_\_ 3. \_\_\_\_\_

**Part B** Write true if the statement is true. If the statement is false, change the underlined term to make the statement true. Write your answers in the spaces provided.

- \_\_\_\_\_ 1. A wind vane measures the speed of a wind.
- \_\_\_\_\_ 2. A weather balloon can be used to measure wind speed and direction.
- \_\_\_\_\_ 3. A wind that blows from the south toward the north is called a north wind.
- \_\_\_\_\_ 4. Wind speed is measured with a wind vane.
- \_\_\_\_\_ 5. A wind that blows from the northeast is called a northeast wind.
- \_\_\_\_\_ 6. Weather balloons are most often filled with carbon dioxide gas.

### Skill Challenge

**Skills:** analyzing, inferring

Winds are shown on weather maps by the symbol . The symbol shows the direction a wind is moving toward and the direction from which the wind is blowing. For example, the wind moves toward the ball symbol. The tail of the symbol shows the direction the wind is blowing from.

Use the compass to name the direction from which each wind is blowing. Write the direction in the space provided. Then, draw an arrow next to each symbol to show the direction the wind is moving toward. The first one has been done for you.

