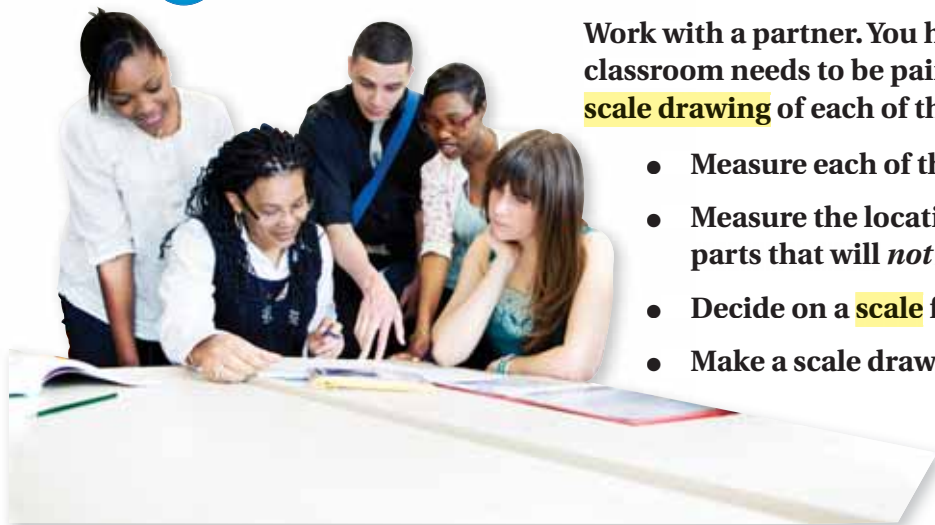## 5.4 Scale Drawings

**Essential Question** How can you use a scale drawing to estimate the cost of painting a room?

1 ACTIVITY: Making Scale Drawings

Work with a partner. You have decided that your classroom needs to be painted. Start by making a scale drawing of each of the four walls.

- **Measure each of the walls.**
- **Measure the locations and dimensions of parts that will *not* be painted.**
- **Decide on a scale for your drawings.**
- **Make a scale drawing of each of the walls.**

Sample: Wall #1

Scale: 1 cm : 1 ft

Blue region needs to be painted.

Chalk Board

9 ft
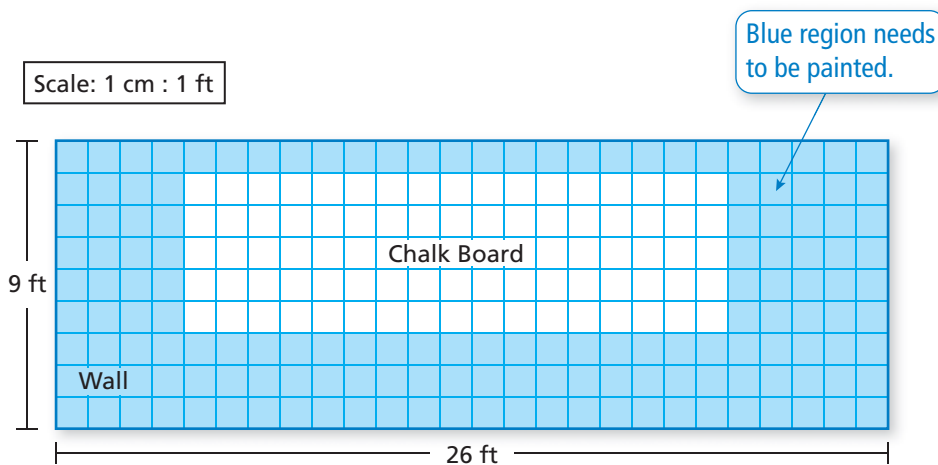
Wall

26 ft

● **For each wall, find the area of the part that needs to be painted.**

	Dimensions	*Area*
Dimensions of the wall	9 ft by 26 ft	$9 \times 26 = 234$ sq ft
Dimensions of the part that will *not* be painted	5 ft by 17 ft	$5 \times 17 = 85$ sq ft
Area of painted part		149 sq ft

ACTIVITY: Using Scale Drawings

Work with a partner.

You are using a paint that covers 200 square feet per gallon. Each wall will need two coats of paint.

a. Find the total area of the walls from Activity 1 that needs to be painted.

b. Find the amount of paint you need to buy.

c. Estimate the total cost of painting your classroom.

| Interior latex paint | $40 per gallon |
| Roller, pan, and brush set | $12 |

What Is Your Answer?

3. IN YOUR OWN WORDS How can you use a scale drawing to estimate the cost of painting a room?

4. Use a scale drawing to estimate the cost of painting another room, such as your bedroom or another room in your house.

5. Look at some maps in your school library or on the Internet. Make a list of the different scales used on the maps.

```
0        1        2        3        4
|        |        |        |        |
                                      Miles
```

6. When you view a map on the Internet, how does the scale change when you zoom out? How does the scale change when you zoom in?

Oh brother!

"I don't get it. According to this map, we only have to drive $8\frac{1}{2}$ inches."

Practice Use what you learned about scale drawings to complete Exercises 4–7 on page 216.

5.4 Lesson

Key Vocabulary
scale drawing, *p. 214*
scale model, *p. 214*
scale, *p. 214*
scale factor, *p. 215*

Key Ideas

Scale Drawings and Models

A **scale drawing** is a proportional two-dimensional drawing of an object. A **scale model** is a proportional three-dimensional model of an object.

Scale

Measurements in scale drawings and models are proportional to the measurements of the actual object. The **scale** gives the ratio that compares the measurements of the drawing or model with the actual measurements.

$$\frac{1 \text{ in.}}{10 \text{ mi}}$$ ← drawing distance
← actual distance

1 in. : 10 mi
drawing   actual

Study Tip

Scales are written so that the drawing distance comes first in the ratio.

EXAMPLE 1   **Finding an Actual Distance**

What is the actual distance *d* between Cadillac and Detroit?

Step 1: Use a centimeter ruler to find the distance on the map between Cadillac and Detroit.

The map distance is about 3.5 centimeters.

Step 2: Use the scale to write and solve a proportion.

$$\frac{1 \text{ cm}}{50 \text{ mi}} = \frac{3.5 \text{ cm}}{d \text{ mi}}$$ ← map distance
← actual distance

1 cm : 50 mi

$d = 50 \cdot 3.5$ Cross Products Property

$d = 175$ Multiply.

∴ The distance between Cadillac and Detroit is about 175 miles.

On Your Own

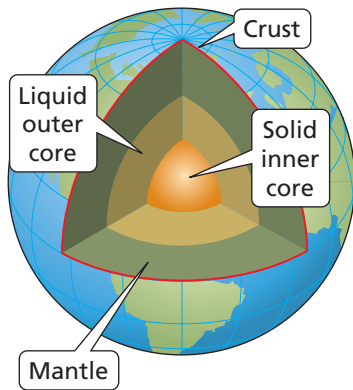**1.** What is the actual distance between Traverse City and Marquette?

EXAMPLE **2**   **Standardized Test Practice**

The liquid outer core of Earth is 2300 kilometers thick. A scale model of the layers of Earth has a scale of 1 in. : 500 km. How thick is the liquid outer core of the model?

Ⓐ 0.2 in.   Ⓑ 4.6 in.   Ⓒ 0.2 km   Ⓓ 4.6 km

Crust

Liquid outer core

Solid inner core

Mantle

$$\frac{1 \text{ in.}}{500 \text{ km}} = \frac{x \text{ in.}}{2300 \text{ km}}$$ model thickness   actual thickness

$$\frac{1 \text{ in.}}{500 \text{ km}} \cdot 2300 \text{ km} = \frac{x \text{ in.}}{2300 \text{ km}} \cdot 2300 \text{ km}$$ Multiply each side by 2300 km.

$$4.6 = x$$ Simplify.

⋮• The liquid outer core of the model is 4.6 inches thick. The correct answer is Ⓑ.

🔴 **On Your Own**

2. The mantle of Earth is 2900 kilometers thick. How thick is the mantle of the model?

A scale can be written without units when the units are the same. A scale without units is called a **scale factor**.

EXAMPLE **3**   **Finding a Scale Factor**

A scale drawing of a spider is 5 centimeters long. The actual spider is 10 millimeters long. (a) What is the scale of the drawing? (b) What is the scale factor of the drawing?

5 cm

a. $$\frac{\text{drawing length}}{\text{actual length}} = \frac{5 \text{ cm}}{10 \text{ mm}} = \frac{1 \text{ cm}}{2 \text{ mm}}$$

⋮• The scale is 1 cm : 2 mm.

b. Write the scale with the same units. Use the fact that 1 cm = 10 mm.

$$\text{scale factor} = \frac{1 \text{ cm}}{2 \text{ mm}} = \frac{10 \text{ mm}}{2 \text{ mm}} = \frac{5}{1}$$

⋮• The scale factor is 5 : 1.

🔴 **On Your Own**

Now You're Ready
Exercises 12–16

**3.** A model has a scale of 1 mm : 20 cm. What is the scale factor of the model?

✓ Vocabulary and Concept Check

1. **VOCABULARY** Compare and contrast the terms *scale* and *scale factor*.

2. **CRITICAL THINKING** The scale of a drawing is 2 cm : 1 mm. Is the scale drawing *larger* or *smaller* than the actual object? Explain.

3. **REASONING** How would you find a scale factor of a drawing that shows a length of 4 inches when the actual object is 8 feet long?

Practice and Problem Solving

Use the drawing and a centimeter ruler.

4. What is the actual length of the flower garden?

5. What are the actual dimensions of the rose bed?

6. What are the actual perimeters of the perennial beds?

7. The area of the tulip bed is what percent of the area of the rose bed?

perennial bed | rose bed

tulip bed | perennial bed

1 cm : 5 ft
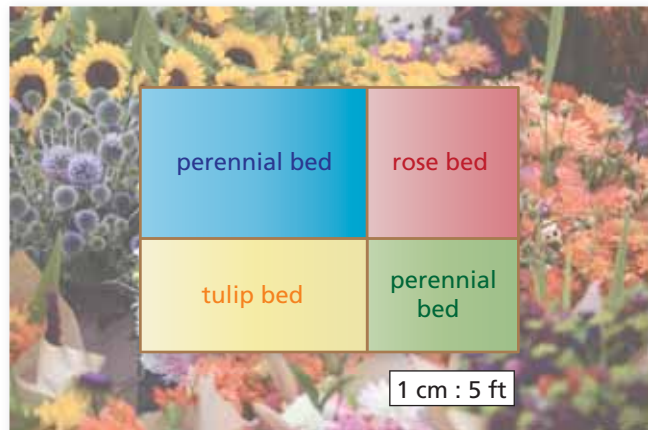
Use the map in Example 1 to find the actual distance between the cities.

❶ 8. Kalamazoo and Ann Arbor

9. Lansing and Flint

10. Grand Rapids and Escabana

11. Saginaw and Alpena

Find the missing dimension. Use the scale factor 1 : 12.

Item	Model	Actual
12. Mattress	Length: 6.25 in.	Length: ___ in.
13. Corvette	Length: ___ in.	Length: 15 ft
14. Water Tower	Depth: 32 cm	Depth: ___ m
15. Wingspan	Width: 5.4 ft	Width: ___ yd
16. Football Helmet	Diameter: ___ mm	Diameter: 21 cm

❷ ❸ (applies to 12.)

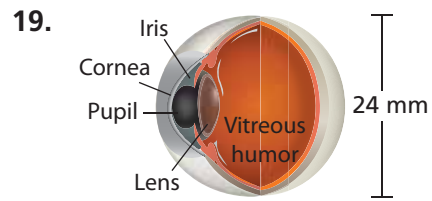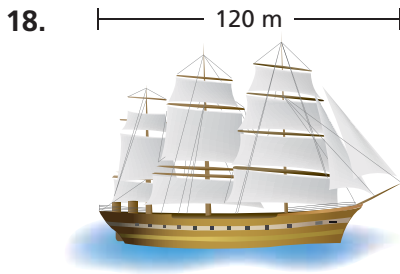17. **ERROR ANALYSIS** A scale is 1 cm : 20 m. Describe and correct the error in finding the actual distance that corresponds to 5 cm.

$$\frac{1\ cm}{20\ m} = \frac{x\ m}{5\ cm}$$

$$x = 0.25\ m$$

Use a centimeter ruler to measure the segment shown. Find the scale of the drawing.

18.

← 120 m →

**19.**
Iris
Cornea
Pupil
Vitreous humor
Lens
24 mm

20. REASONING You know the length and width of a scale model. What additional information do you need to know to find the scale of the model?

21. OPEN-ENDED You are in charge of creating a billboard advertisement with the dimensions shown.

  a. Choose a product. Then design the billboard using words and a picture.

  b. What is the scale factor of your design?

16 ft
8 ft
YOUR AD HERE

Reduced drawing of blueprint

Bedroom
Living room
Bathroom
1 in. : 16 ft
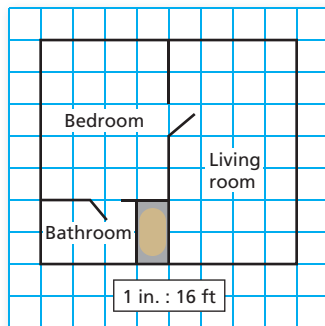
22. BLUEPRINT In a blueprint, each square has a side length of $\frac{1}{4}$ inch.

  a. Ceramic tile costs $5 per square foot. How much would it cost to tile the bathroom?

  b. Carpet costs $18 per square yard. How much would it cost to carpet the bedroom and living room?

  c. Which has a higher unit cost, the tile or the carpet? Explain.

23. REASONING You are making a scale model of the solar system. The radius of Earth is 6378 kilometers. The radius of the Sun is 695,500 kilometers. Is it reasonable to choose a baseball as a model of Earth? Explain your reasoning.

24. **Critical Thinking** A map on the Internet has a scale of 1 in. : 10 mi. You zoom out one level. The map has been reduced so that 2.5 inches on the old map appears as 1 inch on the new map. What is the scale of the new map?

Fair Game Review What you learned in previous grades & lessons

Plot and label the ordered pair in a coordinate plane.

25. $A(-4, 3)$ **26.** $B(2, -6)$ **27.** $C(5, 1)$ **28.** $D(-3, -7)$

29. MULTIPLE CHOICE A backpack is on sale for 15% off the original price. The original price is $68. What is the sale price?

  (A) $10.20   (B) $53   (C) $57.80   (D) $78.20