LESSON 22: Scale Drawings

[Objective]
The student will use scaling and scale drawings to solve mathematical and real-world problems.

[Prerequisite Skills]
writing ratios, solving proportions, measurement conversions

[Materials]
Student pages **S279 – S294**
Map of your town, city, or state
Measuring device (meter stick, yard stick, measuring tape) – 1 per student pair

[Essential Questions]
1. Explain how to use a scale factor to find dimensions in a scale drawing.
2. Describe two different methods to find the perimeter of a scale drawing.
3. Describe two different methods to find the area of a scale drawing.

[Words For Word Wall]
scale drawing, dimensions, scale factor, scale, perimeter, area

[Grouping]
Cooperative Pairs (CP), Whole Group (WG), Individual (I)
*For Cooperative Pairs (CP) activities, assign the roles of Partner A and Partner B to students. This allows each student to be responsible for designated tasks within the lesson.

[Levels of Teacher Support]
Modeling (M), Guided Practice (GP), Independent Practice (IP)

[Multiple Representations]
SOLVE, Algebraic Formula, Verbal Description, Pictorial Representation, Graphic Organizer, Table

[Warm-Up] (IP, I, WG) S279 (Answers are on T557.)
- Have students turn to S279 in their books to begin the Warm-Up. Students find equivalent ratios, solve proportions, and determine unit rate. Monitor students to see if any of them need help during the Warm-Up. Give students time to complete the problems and then review the answers as a class. **{Algebraic Formula, Verbal Description, Table}**

[Homework]
Take time to go over the homework from the previous night.

[Lesson] [1 – 2 Days (1 day = 80 minutes) – M, GP, WG, CP, IP]

SOLVE Problem (WG, GP) S280 (Answers on T558.)

Have students turn to S280 in their books. The first problem is a SOLVE problem. You are only going to complete the S step with students at this point. Tell students that during the lesson they will learn how to determine the dimensions of a figure, given a scale. They will use this knowledge to complete this SOLVE problem at the end of the lesson. **{SOLVE, Graphic Organizer, Verbal Description}**

Introduction to Scale Drawings

(M, GP, WG, CP, IP) S280, S281, S282 (Answers on T558, T559, T560.)

M, GP, WG, CP: Students will work with proportions to determine missing distances for scale drawings in mathematical and real-world situations. Make sure students know their designation as Partner A or Partner B. **{Algebraic Formula, Verbal Description, Graphic Organizer, Pictorial Representation}**

MODELING

Introduction to Scale Drawings

Step 1: Mr. Taley is working on a geometry project with his class. He wants students to create a drawing of the classroom.

Step 2: Have students look around their own classroom and discuss with their partner what things they would have to consider if they had to complete a drawing of the classroom. Have students share their ideas with the class.

Step 3: Have students look at the table in Question 3 and describe what information is contained in the table. (measurement of the sides of the room)

- Have student pairs discuss Questions 4 – 5 and then discuss as a whole group. It is important that students see that it is not practical to create such a large drawing and how important it is to find a strategy to use.
- Have you every seen a drawing of a real object that is proportionally smaller or larger than the real object? (Have students share their experiences.)

***Teacher Note:** Show the map you are using and talk about how the objects on the map compare in size to the real distances in towns or states.

- The **dimensions** of the drawing are in (proportion) to the dimensions of the real object. Record.

Step 4: Have students turn to page S281. Let's look at another example: distances on a map. Let's imagine that the rectangle we see on the top of S281 is actually a representation of the local park.

- Partner A, could that possibly be the actual size of the park? (No) Explain your thinking. (It is a very small rectangle which can represent the park.)
- Partner B, how can we use the idea of proportional numbers to create a drawing of the park? (we can use a proportional relationship) Record.

Step 5: When we worked with proportional relationships with ratios, there were several ways we could determine whether or not there was a proportional relationship. What were some of those ways? (Students may share answers that include: graph of a straight line, using a table.)

- One way we know if a relationship is proportional is if the two ratios have equal (cross products). Record.
- Another way we can determine if the relationship is proportional is if the two ratios have equivalent (unit rates). Record.

Step 6: When we are working with a proportional relationship of an object or a drawing, we have to determine the proportion we will use so that each measurement will be consistent. Have students discuss why the consistent measurement is important. (Possible answers may include: if you change the units it will change the proportion values.)

- Have students discuss possible proportions to use and then share their answers as a whole group. Although we have a predetermined scale for this activity, this is an important discussion for students. For example, if a student says, "Let's use 1 foot = 100 feet", that is not really a practical scale because the drawing would have to be 5 feet wide and 10 feet long. It would be beneficial to actually mark off that area on the floor so that students could see how large the drawing would be.
- Let's use a proportion of 1 cm = 100 feet for our park drawing.

Step 7: Partner A, what is the first dimension of our drawing? (width)

- Have students look at the proportion on the left-hand side underneath width.
- Partner B, describe the relationship that you see between the map and the actual size of the park. (There are two ratios set up as a proportion.)
- Partner A, what does the x represent in the proportion? (width of the park on the map)
- Partner B, what does the ratio $\frac{1}{100}$ represent in the proportion? (Every 1 centimeter on the map is 100 feet in the real world).

Step 8: Have students look back at the two strategies that they identified to use with proportional relationships.

- What strategy can we use with these equivalent ratios? (equal cross products)
- Partner A, what does equal cross products mean? (When we multiply the numerator of the first ratio times the denominator of the second ratio, the product will be equal to the product of the first denominator and the second numerator.)
- Partner B, what is the first operation I need to use? (multiplication)
- Partner A, identify the numbers I have to multiply. (500 and 1, 100 and x) Record.
- Partner B, what is the next operation I use? (division)
- Partner A, what do I divide by on both sides? (100) Explain your answer. (I divide by 100 so that I can isolate the variable.) What is the solution to my equation when I divide both sides by 100? ($5 = x$) Record.
- Partner B, what is the width of the park on the map? (5 cm) Record.
- Model and have students draw a line of 5 cm on the grid paper on S282 to represent the width of the park.

Step 9: Model using the same **scale** to find the length of the park.

- Partner A, how is this proportion similar to the proportion for the width? (It has $\frac{1}{100}$ and x over the actual dimension.)
- Partner B, what is the first operation I need to use? (multiplication) How can I find the missing number in the proportion? (Multiply the cross products)
- Partner A, identify the numbers I have to multiply. (1000 and 1, 100 and x) Record.
- Partner B, what is the next operation I need to use? (division)
- Partner A, what value do I divide by? (100) Explain your answer. (I am solving an equation, and I divide both sides by 100 to isolate my variable.)
- Partner B, what is the solution to the equation? ($10 = x$) Record
- Partner A, what is the length on the map? (10 cm) Record.
- Model and have students draw the length and the rest of the rectangle to represent the Park Model 1.

Step 10: Have students look at the chart on the bottom of S281. Model how to determine the dimensions of a drawing of the same park with a different scale. Use the questioning strategies from Steps 8 and 9.

IP, CP, WG Have student pairs complete the rest of the problems in the table on S281, draw the rectangles on S282, and then discuss the answers as a whole group. **{Algebraic Formula, Verbal Description, Graphic Organizer, Pictorial Representation}**

Step 11: Partner A, what do you notice is the same for each of the boxes under the width of the park? (the ratio that represents the distance on the map, x, over the actual width of the park which is 500)

- Partner B, what do you notice is the same for each of the boxes under the length of the park? (the ratios that represent the distance on the map, *x*, over the actual length of the park which is 1000)
- Have students discuss the conclusion on the bottom of S281.
- When we use this strategy to scale down each dimension of an object or drawing, we create a representation that is called a **(scale drawing).** Record.
- Have student pairs go back to page S280 and complete the chart for Question 3 using a scale of 2 feet = 1 cm and then share the answers as a whole group.

Scale Factor

(M, GP, WG, CP) S283, S284 (Answers on T561, T562.)

M, GP, WG, CP: Students will use scale drawings to explore scale factor. Make sure students know their designation as Partner A or Partner B **{Verbal Description, Graphic Organizer}**

MODELING

Scale Factor

Step 1: Direct students' attention to the top of page S283.

- When we create scale drawings, we (multiply) by a value that will create the shape or distance in a size that we are able to use in a (drawing). Record.

Step 2: Jarrod is making a scale drawing of his room. He wants to use the representation of 1 inch = 2 feet.

Step 3: Have student pairs discuss how to write the relationship as the ratio. $\left(\frac{1 \text{ inch}}{2 \text{ feet}}\right)$ Record.

- Jarrod wants to explain the relationship between the actual size of his room and the size of the representation of the room. Have student pairs share some examples of ways that we compare the size of two objects. In order for him to compare the two he needs to have a numerical value.
- Have students discuss Question 2. Partner A, how can we use the ratio we have to find an equivalent ratio that has only numbers and no units? (We can multiply by the conversion factor of: 1 foot = 12 inches written as a ratio: $\frac{1 \text{ foot}}{12 \text{ inches}}$.) Record.
- Partner B, why did we choose that conversion factor? (Those are the units contained in the scale.) Record.

- Partner A, how can we multiply by that conversion factor and not change the value of the answer? (The conversion of $\frac{1 \text{ foot}}{12 \text{ inches}}$ is equivalent to the value of 1, so we can multiply by 1 and not change the value.) Record.

  Scale: $\frac{1 \text{ inch}}{2 \text{ feet}}$ $\quad \frac{1 \text{ inch}}{2 \text{ feet}} \bullet \frac{1 \text{ foot}}{12 \text{ inches}} = \frac{1 \cancel{\text{ inch}} \bullet 1 \cancel{\text{ foot}}}{2 \cancel{\text{ feet}} \bullet 12 \cancel{\text{ inches}}} = \frac{1}{24}$

Step 4: The scale written as a ratio in simplest form with the same units is called the **(scale factor)**. Record.

- Partner A, what is the scale factor of Jarrod's drawing compared to the dimensions of his actual room? $\left(\frac{1}{24}\right)$ Record.
- Partner B, explain the meaning of the scale factor. (It means that each dimension of the drawing is $\frac{1}{24}$ of the size of the dimensions of the actual room.) Record.

Step 5: Have students turn to page S284.

- Have students discuss how to use the scale factor to find the measurements on the drawing. (Multiply the actual dimensions times the scale factor.) Record.
- Model how to determine the length and width of the room using the scale factor.
- Partner A, what is the length of the room? (6 inches) Record.
- Partner B, what is the width of the room? (8 inches) Record.

IP, CP, WG Have students work with a partner to complete Questions 9 and 10 at the bottom of S284. Circulate around the room to answer questions and assist students. Have students come back together as a class and share their results. **{Graphic Organizer, Verbal Description}**

Perimeter of a Scale Drawing

(M, GP, WG, CP, IP) S285, S286 (Answers on T563, T564.)

M, GP, WG, CP: Have students turn to S285 in their books. Students will find the perimeter of scale drawings using scale factors. Make sure students know their designation as Partner A or Partner B. **{Algebraic Formula, Verbal Description, Graphic Organizer}**

MODELING

Perimeter of a Scale Drawing

Step 1: Direct students' attention to the problems on S285. Have students complete Question 1 and review the answers as a whole group.
- Partner A, how do you find the perimeter of a rectangle? (Add all four sides.)
- Partner B, what is the perimeter of the actual door? (288 inches) Record.

Step 2: Read Question 2 together.
- Partner A, how can we find the **perimeter** of the scale drawing of the door? (We can use the dimensions of the scale drawing to add together and find the perimeter.) Record.
- Partner A, what is the length of the drawing of the door? (4 inches) Record.
- Partner B, what is width of the drawing of the door? (2 inches) Record.
- Partner A, what is the perimeter of the drawing of the door? (4 + 4 + 2 + 2 = 12 inches) Record.

Step 3: Partner B, what is the scale factor of the drawing? $\left(\frac{1}{24}\right)$ Record.
- Partner A, what do you get when you multiply the original perimeter by the scale factor? (12) Record.
- Partner B, what do you notice about the perimeter when you add the dimensions from the scale drawing and when you multiply the original perimeter by the scale factor? (When you multiply the actual perimeter by the scale factor, you get the perimeter of the scale drawing.) Record.

Step 4: Have students turn to page S286. Model and complete Questions 1 – 4 using Steps 1 through 3 from the Modeling Box.

IP, CP, WG Have students work with a partner to complete the table at the bottom of S286. Circulate around the room to answer questions and assist students. Have students come back together as a class and share their results. **{Graphic Organizer, Algebraic Formula, Verbal Description}**

Area of a Scale Drawing

(M, GP, WG, CP, IP) S287, S288 (Answers on T565, T566.)

M, GP, WG, CP: Have students turn to S287 in their books. Students will find the area of scale drawings using scale factor. Make sure students know their designation as Partner A or Partner B. **{Algebraic Formula, Verbal Description, Graphic Organizer}**

MODELING

Area of a Scale Drawing

Step 1: Direct students' attention to Question 1 on S287. Read the first problem together.

- Partner B, how do you find the area of a rectangle? (multiply length by width)
- Partner A, what is the area of the actual door? (4,608 in.^{2}) Record.
- Partner B, what is the height of the drawing of the door? (4 in.) Record.
- Partner A, what is the width of the drawing of the door? (2 in.) Record.
- Partner B, what is the **area** of the drawing of the door? (8 in^2.) Record.

Step 2: What is the scale factor of the drawing? $\left(\frac{1}{24}\right)$ Record.

- Have students discuss Question 6. How did we find the perimeter of the drawing? (We could find the measure of each dimension using the scale factor and add to find the perimeter, or we multiplied the perimeter by the scale factor of $\frac{1}{24}$.) Record.
- Have students discuss Question 7 and explore to find out if that same strategy will work for finding the area and explain why. ($4608 \bullet \frac{1}{24} = 192$. No, area is a two-dimensional measurement, so we have to multiply it by the scale factor twice or the scale factor squared.) Record.
- Partner A, what is the scale factor squared? $\left(\frac{1}{24} \bullet \frac{1}{24} = \frac{1}{576}\right)$ Record.
- Have students multiply the actual area by the scale factor squared. ($4608 \bullet \frac{1}{576} = 8$) Record.
- Is this the same area that we found in Problem 4? (Yes) Record.

Step 3: Have students turn to page S288. Model and use the questioning strategies for Questions 12 – 15 using Steps 1 though 2.

IP, CP, WG

Have students work with a partner to complete the table at the bottom of S288. Circulate around the room to answer questions and assist students. Have students come back together as a class and share their results. **{Graphic Organizer, Algebraic Formula, Verbal Description}**

SOLVE Problem **(GP, WG) S289 (Answers on T567.)**

Remind students that the SOLVE problem on S289 is the same one from the beginning of the lesson. Complete the SOLVE problem with your students. Ask them for possible connections from the SOLVE problem to the lesson. Students should say that they need to write proportions using the scale to find the dimensions of the couch in the advertisement. **{SOLVE, Algebraic Formula, Verbal Description, Graphic Organizer}**

SOLVE Problems **(IP, CP, WG) S290, S291, S292 (Answers on T568, T569, T570.)**

There are a variety of ways to complete these problems. Here are a few suggestions which are alternatives to having students complete all 3 problems in student pairs:

- Have students work in groups of 4 or 5 and assign them one of the SOLVE problems to complete as a group. Students can then transfer answers to chart paper and present to the whole group.
- Have students work in groups. Post each SOLVE problem on a chart around the room. Students can start at one poster and complete the S step. After a few minutes, have student groups move to the next poster, read the S step, and then complete the O step. After a few minutes, have students move to the next poster, read the S and O steps, and complete the L step. Continue with this procedure until student groups have returned to their original problem. They can also present their problem to the whole group.
- Have a copy of one of the SOLVE problems at each table or group. Have students complete the S Step and then pass the problem on to the next group when you give a signal. Students will continue this process until they get back their original problem.

If Time Permits **(CP, IP) S293 (Answers on T571.)**

Have students complete the Problems 1-5 on S293.

[Closure]

To wrap up the lesson, go back to the essential questions and discuss them with students.

- Explain how to use a scale factor to find dimensions in a scale drawing. *(Set up a proportion using the scale factor as one of the ratios. The other ratio is the drawing dimensions over the actual dimensions. Solve using cross products.)*
- Describe two different methods to find the perimeter of a scale drawing. *(One way is to use proportions to find the dimensions of the scale drawing and then add all sides to find the perimeter. A second way is to multiply the actual perimeter by the scale factor.)*
- Describe two different methods to find the area of a scale drawing. *(One way is to use proportions to find the dimensions of the scale drawing and then multiply to find the area. A second way is to multiply the actual area by the scale factor squared.)*

[Homework] Assign S294 for homework. (Answers on T572.)

[Quiz Answers] T573 – T575

1. **D** 2. **C** 3. **B** 4. **B** 5. **C** 6. **B** 7. **A** 8. **D** 9. **C** 10. **C**

The quiz can be used at any time as extra homework or to assess how students progress on understanding using scales and scale factors to find dimensions, perimeter, and area in scale drawings.

Here is the key to **S279.**

Warm–Up

Directions: Circle the two ratios that will make a proportion.

1. $\frac{2}{3}$ $\frac{10}{11}$ $\frac{8}{12}$

2. $\frac{5}{8}$ $\frac{35}{63}$ $\frac{5}{9}$

Directions: Find the missing number in each proportion.

3. $\frac{7}{11} = \frac{x}{132}$ $x =$ **84**

4. $\frac{4}{15} = \frac{32}{x}$ $x =$ **120**

Directions: Identify the unit rate.

5. The table shows the number of hours Shelby worked and her pay.

Hours	1	2	3	5
Pay ($)	8	16	24	40

The unit rate is $8 per hour.

Here is the key to **S280.**

Directions: Complete the following SOLVE problem with your teacher. You will only complete the S step.

Nigel is making a drawing of a couch for a new advertisement. The actual measurements of the couch are 8 feet long by 3.5 feet tall. He is using a scale of 3 centimeters equals 2 feet. What should the dimensions of the couch be in the advertisement?

S Underline the question.
This problem is asking me to find **the length and width of the couch in the advertisement.**

Directions: Complete this page with your teacher and partner.

Scale Drawings:

1. Mr. Taley is working on a geometry project with his class. He wants students to create a drawing of the classroom.

2. Take a look around your classroom. If someone were to ask you to make a drawing of the classroom, what kind of things would you have to consider? **(Answers may vary: length and width of room, furniture in the room, location of doors and window, etc.)**

3. Mr. Taley has his students measure the four sides of the room. The measurements are shown in the table below.

Room Sides	Measurement	Scaled Picture
Side 1	16 feet	**8 cm**
Side 2	22 feet	**11 cm**
Side 3	16 feet	**8 cm**
Side 4	22 feet	**11 cm**

4. If you were one of Mr. Taley's students, would you want to try and create a drawing that has the measurements in the table above? **No, because the drawing would be so large that it would be the actual size of the room.**

5. Discuss with your partner strategies that you could possibly use to create a drawing of Mr. Taley's room. **(Answers will vary: use proportions, make a smaller drawing, etc.)**

6. Have you ever seen a drawing of a real object that is proportionally smaller or larger than the real object? In other words, the dimensions of the drawing are in **proportion** to the dimensions of the real object.

LESSON 22: Scale Drawings

Here is the key to **S281.**

Directions: Complete this page with your teacher and partner.

Let's look at another example, distances on a map.
Start with a rectangle that could represent a park on a map.

If the park is actually 500 feet wide by 1,000 feet long, we would not be able to represent that on a map. However, we can use smaller, proportional numbers. We can use a **proportional relationship**.

How do we know if a relationship is proportional?

- The two ratios have equal **cross products**.
- The two ratios have equivalent **unit rates**.

Let's use the proportion of 1 cm = 100 feet for our park drawing.

1. Width

Map → $\frac{x}{500} = \frac{1}{100}$
Actual →

Find the cross products: **500(1)** = **100*x***
Divide both sides by 100: **5** = ***x***
The width on the map should be **5 cm.**

Length

Map → $\frac{x}{1000} = \frac{1}{100}$
Actual →

1000(1) = **100*x***
10 = ***x***
The length on the map should be **10 cm.**

Round your answers to the nearest tenth.

Scale	Width of park on map	Length of park on map
2. 200 ft = 1 cm	$\frac{x}{500} = \frac{1}{200}$**; 500 = 200*x*;** ***x* = 2.5 cm**	$\frac{x}{1000} = \frac{1}{200}$**; 1000 = 200*x*;** ***x* = 5 cm**
3. 20 ft = 0.2 cm	$\frac{x}{500} = \frac{0.2}{20}$**; 100 = 20*x*;** ***x* = 5 cm**	$\frac{x}{1000} = \frac{0.2}{20}$**; 200 = 20*x*;** ***x* = 10 cm**
4. 300 ft = 2 cm	$\frac{x}{500} = \frac{2}{300}$**; 1000 = 300*x*;** ***x* = 3.3 cm**	$\frac{x}{1000} = \frac{2}{300}$**; 2000 = 300*x*;** ***x* = 6.7 cm**
5. 200 ft = 3 cm	$\frac{x}{500} = \frac{3}{200}$**; 1500 = 200*x*;** ***x* = 7.5 cm**	$\frac{x}{1000} = \frac{3}{200}$**; 3000 = 200*x*;** ***x* = 15 cm**

Conclusion: When we use this strategy to scale down each dimension of an object or drawing, we create a representation that is called a **scale drawing**.

Here is the key to **S282.**

Grid Paper (1.0 cm)

1.

2.

3.

4.

5.

LESSON 22: Scale Drawings

Here is the key to **S283.**

Directions: Complete this page with your teacher and partner.

Scale Factor

When we create scale drawings, we **multiply** by a **value** that will create the shape or distance in a size that we are able to use in a **drawing**.

Jarrod is making a scale drawing of his room. He wants to use the representation of 1 inch = 2ft.

1. How can we write that relationship as a ratio? $\frac{\textbf{1 inch}}{\textbf{2 feet}}$
Jarrod wants to explain the relationship between the actual size of his room and the size of the representation of the room. What are some examples of ways that we compare the size of two objects? **(Sample answer: My math book is 2 times the thickness of my science book, David's pencil is $\frac{1}{2}$ the length of Tina's pencil, etc.)** In order for him to compare the two, he needs to have a **numerical value.**

2. How can we use the ratio we have to find an equivalent ratio that has only numbers and no units? **We can multiply by the conversion factor of: 1 foot = 12 inches written as a ratio.** $\frac{\textbf{1 foot}}{\textbf{12 inches}}$

3. Why did we choose that conversion factor? **Those are the units contained in the scale.**

4. How can we multiply by that conversion factor and not change the value of the answer? **The conversion of** $\frac{\textbf{1 foot}}{\textbf{12 inches}}$ **is equivalent to the value of 1, so we can multiply by 1 and not change the value.**

Scale: $\frac{\textbf{1 inch}}{\textbf{2 feet}}$ $\frac{\textbf{1 inch}}{\textbf{2 feet}} \bullet \frac{\textbf{1 foot}}{\textbf{12 inches}} = \frac{\textbf{1 } \cancel{\textbf{inch}} \textbf{ } \bullet \textbf{ 1 } \cancel{\textbf{foot}}}{\textbf{2 } \cancel{\textbf{feet}} \textbf{ } \bullet \textbf{ 12 } \cancel{\textbf{inches}}} = \frac{\textbf{1}}{\textbf{24}}$

5. A scale written as a ratio in simplest form with the same units is called a **scale factor.**

What is the scale factor of Jarrod's drawing compared to the dimensions of his actual room? **Scale Factor:** $\frac{\textbf{1}}{\textbf{24}}$

6. What does this mean? **It means that each dimension of the drawing is $\frac{\textbf{1}}{\textbf{24}}$ of the size of the dimensions of the actual room.**

Here is the key to **S284.**

Directions: Complete this page with your teacher and partner.

7. How can we use the scale factor to find the measurements on the drawing? **We multiply the actual dimensions times the scale factor of $\frac{1}{24}$.**

8. If Jarrod's room is 12 feet long, what would the length of the room be on the drawing?

$$\frac{\textbf{12 feet}}{\textbf{1}} \bullet \frac{\textbf{1}}{\textbf{24}} = \frac{\textbf{12 feet}}{\textbf{24}} = \frac{\textbf{12}}{\textbf{24}} \textbf{ feet} = \frac{\textbf{1}}{\textbf{2}} \textbf{ foot = 6 inches}$$

If Jarrod's room is 16 feet wide, would be the width of the room on the drawing?

$$\frac{\textbf{16 feet}}{\textbf{1}} \bullet \frac{\textbf{1}}{\textbf{24}} = \frac{\textbf{16 feet}}{\textbf{24}} = \frac{\textbf{16}}{\textbf{24}} \textbf{ feet} = \frac{\textbf{2}}{\textbf{3}} \textbf{ foot = 8 inches}$$

9. A door is 96 inches tall and 48 inches wide. Use the scale factor of $\frac{1}{24}$ to find the dimensions of the door in a scale drawing.

Height:

$$\frac{\textbf{96 inches}}{\textbf{1}} \bullet \frac{\textbf{1}}{\textbf{24}} = \frac{\textbf{96 inches}}{\textbf{24}} \textbf{ = 4 inches}$$

Length:

$$\frac{\textbf{48 inches}}{\textbf{1}} \bullet \frac{\textbf{1}}{\textbf{24}} = \frac{\textbf{48 inches}}{\textbf{24}} \textbf{ = 2 inches}$$

10. Some things have to be drawn larger than they are, such as a cell. In this case, five centimeters on the drawing might represent 1 millimeter of the actual cell. Use the scale you have been given to find the scale factor.

Scale: $\frac{5 \text{ cm}}{1 \text{ mm}}$ Scale Factor: $\frac{\textbf{5 cm}}{\textbf{1 mm}} \bullet \frac{\textbf{10 mm}}{\textbf{1 cm}} = \frac{\textbf{50}}{\textbf{1}} \textbf{ = 50}$

Find the dimensions of the cell drawing if the actual cell is 2 mm long and 0.5 mm wide.

Length:

$$\frac{\textbf{2 cm}}{\textbf{1}} \bullet \textbf{50} = \frac{\textbf{100 cm}}{\textbf{1}} \textbf{ = 100 cm}$$

Width:

$$\frac{\textbf{0.5 cm}}{\textbf{1}} \bullet \textbf{50} = \frac{\textbf{25 cm}}{\textbf{1}} \textbf{ = 25 cm}$$

Here is the key to **S285.**

Directions: Complete this page with your teacher and partner.

Perimeter of a Scale Drawing

1. Let's use the dimensions of the door from page S284.
A door is 96 inches tall and 48 inches wide. The scale factor of $\frac{1}{24}$ is used to find the dimensions of the door in a scale drawing.

The height is **96 inches**, and the width is **48 inches.** What is the perimeter of the actual door?

96 + 96 + 48 + 48 = 288 inches.

2. How do you think we can find the perimeter of the scale drawing of the door?

We can use the dimensions of the scale drawing to add together and find the perimeter.

3. What is the height of the door on the scale drawing? **4 inches**

4. What is the width of the door on the scale drawing? **2 inches**

- What is the perimeter of the door on the scale drawing? **4 + 4 + 2 + 2 = 12 inches.**
- What is the scale factor of the drawing? $\mathbf{\frac{1}{24}}$
- How can we use the scale factor to find the perimeter of the drawing of the door if we know the actual perimeter of the door? **Multiply the actual perimeter by the scale factor of $\frac{1}{24}$. 288 • $\frac{1}{24}$ = 12**
- What do you notice? **When you multiply the actual perimeter by the scale factor, you get the perimeter of the scale drawing.**

LESSON 22: Scale Drawings

Here is the key to **S286.**

Directions: Complete this page with your teacher and partner.

1. Let's look at the example of Jarrod's room from S284. Jarrod's room is 12 feet long and 16 feet wide.

What is the perimeter of the room? **12 + 12 + 16 + 16 = 56 feet**

2. Let's create a drawing with a scale factor of $\frac{1}{16}$.

Length: Width:

$\frac{\textbf{12 feet}}{\textbf{1}} \bullet \frac{\textbf{1}}{\textbf{16}} = \frac{\textbf{12 feet}}{\textbf{16}} = \frac{\textbf{3}}{\textbf{4}}\ \textbf{feet} = \textbf{9 inches}$ $\frac{\textbf{16 feet}}{\textbf{1}} \bullet \frac{\textbf{1}}{\textbf{16}} = \frac{\textbf{16 feet}}{\textbf{16}} = \textbf{1 foot} = \textbf{12 inches}$

3. What is the perimeter of the room on the drawing? **9 + 9 + 12 + 12 = 42 inches**

4. Use the drawing dimensions and the scale factor to find the perimeter.

What is the total perimeter of the room? **56 feet**

Find the perimeter using the scale factor: $\frac{\textbf{56 inches}}{\textbf{1}} \bullet \frac{\textbf{1}}{\textbf{16}} = \frac{\textbf{56 feet}}{\textbf{16}} = \textbf{3}\frac{\textbf{1}}{\textbf{2}}\ \textbf{feet} = \textbf{42 inches}$

Actual Dimensions	Actual Perimeter	Scale Factor	Drawing Dimensions	Drawing Perimeter Using Dimensions	Drawing Perimeter Using Scale Factor
Pool Length: 40 ft Width: 15 ft	**40 + 40 + 15 + 15 = 110 feet**	$\frac{1}{10}$	**Length: 40 • $\frac{1}{10}$ = 4 ft** **Width: 15 • $\frac{1}{10}$ = 1.5 ft**	**4 + 4 + 1.5 + 1.5 = 11 ft**	**110 • $\frac{1}{10}$ = 11 ft.**
Ladybug Length: 3 cm Width:1.5 cm	**3 + 3 + 1.5 + 1.5 = 9**	12	**Length: 3 • 12 = 36 cm** **Width: 1.5 • 12 = 18 cm**	**36 + 36 + 18 + 18 = 108 cm**	**9 • 12 = 108 cm**
Building Length: 1,100 ft Width: 200 ft	**1,100 + 1,100 + 200 + 200 = 2,600**	$\frac{1}{400}$	**Height: 1,100 • $\frac{1}{400}$ = 2.75 feet** **Length: 200 • $\frac{1}{400}$ = 0.5 feet.**	**2.75 + 2.75 + 0.5 + 0.5 = 6.5 feet**	**2,600 • $\frac{1}{400}$ = 6.5 feet**

Conclusion: List the two ways to find the perimeter of a scale drawing:

- **Find the dimensions of the drawing and add them.**
- **Multiply the perimeter of the actual object by the scale factor.**

Here is the key to **S287.**

Directions: Complete this page with your teacher and partner.

Area of a Scale Drawing

1. Let's use the dimensions of the door from page S284 to find the area of a scale drawing.
A door is 96 inches tall and 48 inches wide. The scale factor of $\frac{1}{24}$ is used to find the dimensions of the door in a scale drawing.

What is the area of the front of the actual door? **96 • 48 = 4,608 square inches**

2. What is the height of the door on the scale drawing? **4 inches**

3. What is the width of the door on the scale drawing? **2 inches**

4. How do you think we can find the area of the scale drawing of the door?
Use the dimensions of the door to multiply and find the area.
4 • 2 = 8 square inches

5. What is the scale factor of the drawing? $\mathbf{\frac{1}{24}}$

6. How did we find the perimeter of the drawing? **We could find the measure of each dimension using the scale factor and add to find the perimeter, or we multiplied the perimeter by the scale factor of $\frac{1}{24}$.**

7. Will this same strategy work to find the area of the drawing? Why?
4608 • $\frac{1}{24}$ = 192. No, area is a two-dimensional measurement, so we have to multiply it by the scale factor twice or the scale factor squared.

8. What is the scale factor squared? $\mathbf{\frac{1}{24} \bullet \frac{1}{24} = \frac{1}{576}}$

9. Multiply the actual area by the scale factor squared.

10. What is the area of the drawing? **4608 • $\frac{1}{576}$ = 8**

11. Is this the same area that we found in Problem 4? **Yes**

Here is the key to **S288.**

Directions: Complete this page with your teacher and partner.

12. Let's look at the example of Jarrod's room from S284. Jarrod's room is 12 feet long and 16 feet wide.

What is the area of the room? **12 • 16 = 192 square feet**

13. Let's create a drawing with a scale factor of $\frac{1}{16}$.

Length: Width:

$\mathbf{\frac{12\ feet}{1} \bullet \frac{1}{16} = \frac{12\ feet}{16} = \frac{3}{4}\ foot = 9\ inches}$ $\mathbf{\frac{16\ feet}{1} \bullet \frac{1}{16} = \frac{16\ feet}{16} = 1\ foot = 12\ inches}$

14. What is the area of the room on the drawing? **9 • 12 = 108 square inches**

15. Use the drawing dimensions and the scale factor to find the area.

What is the total area of the room? **192 square feet**

Find the area using the scale factor:

$\mathbf{192 \bullet \frac{1}{16} \bullet \frac{1}{16} = \frac{192}{256} = 0.75\ square\ foot = 0.75 \bullet 144 = 108\ square\ inches}$

Actual Dimensions	Actual Area	Scale Factor Squared	Drawing Dimensions	Drawing Area Using Dimensions	Drawing Area Using Scale Factor
Pool Length: 40 ft Width: 15 ft	**40 • 15 = 600 ft²**	$(\frac{1}{10})^2 = \frac{1}{100}$	**Length: 4 ft Width: 1.5 ft**	**4 • 1.5 = 6 ft²**	**600 • $\frac{1}{100}$ = 6 ft²**
Ladybug Length: 3 cm Width: 1.5 cm	**3 • 1.5 = 4.5 cm²**	$12^2 = 144$	**Length: 36 cm Width: 18 cm**	**36 • 18 = 648 cm²**	**4.5 • 144 = 648 cm²**
Building Length: 1,100 ft Width: 200 ft	**1,100 • 200 = 220,000 ft²**	$(\frac{1}{400})^2 = \frac{1}{160,000}$	**Height: 2.75 ft Length: 0.5 ft**	**2.75 • 0.5 = 1.375 ft²**	**220,000 • $\frac{1}{160,000}$ = 1.375 feet²**

List the two ways to find the area of a scale drawing:

- **Find the dimensions of the drawing and multiply them.**
- **Multiply the area of the actual object by the scale factor squared.**

Here is the key to **S289.**

Directions: Complete the following SOLVE problem with your teacher.

~~Nigel is making a drawing of a couch for a new advertisement.~~ | The actual measurements of the couch are 8 feet long | by 3.5 feet tall. | He is using a scale of 3 centimeters equals 2 feet. | What should the dimensions of the couch be in the advertisement?

S Underline the question.
This problem is asking me to find **the length and width of the couch in the advertisement.**

O Identify the facts.
Eliminate the unnecessary facts.
List the necessary facts. **Actual length: 8 ft**
Actual height: 3.5 ft
Scale: 3 cm = 2 ft

L Write in words what your plan of action will be. **Set up a proportion comparing the actual length to the scale for each measurement of the couch. Use cross products to solve.**

Choose an operation or operations. **Multiplication, division**

V Estimate your answer. **About 10 cm for the length, about 4 cm for the height**

Carry out your plan. **Length:** $\frac{x}{8} = \frac{3}{2}$**;** $2x = 24$**,** $x = 12$

Height: $\frac{x}{3.5} = \frac{3}{2}$**;** $2x = 10.5$**;** $x = 5.25$

E Does your answer make sense? (Compare your answer to the question.) **Yes, I found the measurement for the drawing.**

Is your answer reasonable? (Compare your answer to the estimate.) **Yes, because 12 is more than 10, and 5.25 is close to 4.**

Is your answer accurate? (Check your work.) **Yes**

Write your answer in a complete sentence. **The couch should be 12 cm long and 5.25 cm tall in the advertisement.**

Here is the key to **S290.**

Directions: Complete the following SOLVE problem with your partner.

~~Maria is making a scale drawing of her bedroom for her math class~~. | ~~She is drawing it on centimeter grid paper.~~ | Her bedroom is 12 feet long | by 9 feet wide. | She is using a scale of 3 cm = 1 foot. | How many centimeters should she make the length and the width of her bedroom?

S Underline the question.
This problem is asking me to find **the length and width of the bedroom in centimeters.**

O Identify the facts.
Eliminate the unnecessary facts.
List the necessary facts. **12 feet long**
9 feet wide
Scale of 3 cm = 1 foot

L Write in words what your plan of action will be. **Set up two proportions, one for the length and one for the width comparing actual measurements to scale drawing measurements. Solve each proportion.**

Choose an operation or operations. **Multiplication, division**

V Estimate your answer. **30 centimeters by 30 centimeters**

Carry out your plan. **Width: $\frac{x}{9} = \frac{3}{1}$; 27 = *x*, 27 centimeters**

Length: $\frac{x}{12} = \frac{3}{1}$; 36 = *x*, 36 centimeters

E Does your answer make sense? (Compare your answer to the question.) **Yes, I used the scale in a proportion to find each measurement.**

Is your answer reasonable? (Compare your answer to the estimate.) **Yes, because both 27 and 35 are close to my estimate of 30 by 30.**

Is your answer accurate? (Check your work.) **Yes**

Write your answer in a complete sentence. **In the scale drawing, the length of the room is 36 centimeters and the width is 27 centimeters.**

Here is the key to **S291.**

Directions: Complete the following SOLVE problem with your partner.

~~Treyvon is making a scale drawing of his backyard~~. | There is a rectangular-shaped sandbox | with a length of 6 feet | and a width of 8 feet. | He is using the scale 1 inch = 2 feet. | Find the area of the sandbox in his drawing. (Round your answer to the nearest hundredth.)

S Underline the question.
This problem is asking me to find **the area of the sandbox in the drawing.**

O Identify the facts.
Eliminate the unnecessary facts.
List the necessary facts. **Rectangle**
Length of 6 feet
Width of 8 feet
Scale of 1 in. = 2 feet

L Write in words what your plan of action will be. **Find the area of the actual sandbox. Change the scale into a scale factor. Multiply the scale factor squared by the actual area.**

Choose an operation or operations. **Multiplication**

V Estimate your answer. **About 12 square inches**

Carry out your plan. **Actual Area: 6 • 8 = 48 ft²**

$$\textbf{Scale Factor: } \frac{1 \text{ in.}}{2 \text{ ft}} \bullet \frac{1 \text{ ft}}{12 \text{ in.}} = \frac{1}{24}$$

$$\textbf{Drawing Area: } 48 \bullet \left(\frac{1}{24}\right)^2 = 48 \bullet \left(\frac{1}{576}\right) = 0.08 \text{ foot}^2$$

E Does your answer make sense? (Compare your answer to the question.) **Yes, I found the scale factor and multiplied its square by the actual area.**

Is your answer reasonable? (Compare your answer to the estimate.) **Yes, 0.08 square feet is close to my estimate of about 12 square inches.**

Is your answer accurate? (Check your work.) **Yes**

Write your answer in a complete sentence. **In the scale drawing, the area of the sandbox will be 0.08 square feet.**

Here is the key to **S292.**

Directions: Complete the following SOLVE problem with your partner.

~~Stacy is making a scale drawing of her backyard~~. | There is a triangular-shaped flower garden | with dimensions of 6 feet, | 8 feet, | and 10 feet. | She is using the scale 1 inch = 2 feet. | Find the perimeter of the flower garden in her drawing.

S Underline the question.
This problem is asking me to find **the perimeter of the flower garden in the drawing.**

O Identify the facts.
Eliminate the unnecessary facts.
List the necessary facts. **Triangle**
6 feet, 8 feet, 10 feet
Scale of 1 in. = 2 feet

L Write in words what your plan of action will be. **Find the perimeter of the actual garden. Change the scale into a scale factor. Multiply the scale factor by the actual perimeter.**

Choose an operation or operations. **Add, multiply**

V Estimate your answer. **About 12 inches**

Carry out your plan. **Actual Perimeter: 6 + 8 + 10 = 24 ft**

Scale Factor: $\frac{\text{1 in.}}{\text{2 ft}} \bullet \frac{\text{1 ft}}{\text{12 in.}} = \frac{1}{24}$

Drawing Perimeter: $24 \bullet \frac{1}{24} = 1$ **foot**

E Does your answer make sense? (Compare your answer to the question.) **Yes, I found the scale factor and multiplied it by the actual perimeter.**

Is your answer reasonable? (Compare your answer to the estimate.) **Yes, 1 foot is 12 inches.**

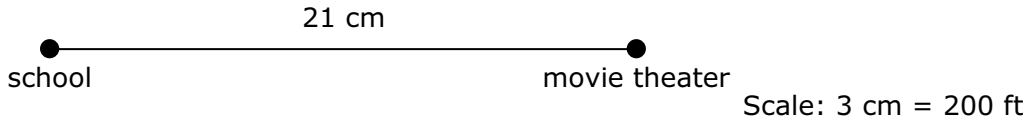
Is your answer accurate? (Check your work.) **Yes**

Write your answer in a complete sentence. **In the scale drawing, the perimeter of the garden will be 1 foot or 12 inches.**

Here is the key to **S293.**

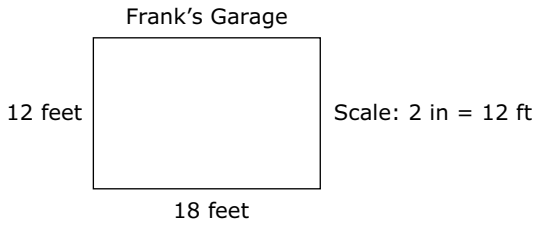
Directions: Solve the following problems using what you have learned about scale drawings.

1. What is the distance from the school to the movie theater?



1,400 feet

Directions: Use the drawing to answer Questions 2 – 5.



2. Frank is making a scale drawing of his garage. What are the dimensions of the garage in his drawing?

Length: $\frac{2}{12} = \frac{x}{18}$; $12x = 36$; $x = 3$ **in.** Width: $\frac{2}{12} = \frac{x}{12}$; $12x = 24$; $x = 2$ **in.**

3. What is the scale factor?

$$\frac{2 \text{ in}}{1 \text{ ft}} \bullet \frac{1 \text{ ft}}{(12 \text{ in})^2} = \frac{2}{144} = \frac{1}{72}$$

4. Using the scale factor, what is the perimeter of the garage in his drawing?

Actual perimeter: $12 + 18 + 12 + 18 = 60$ ft $60 \bullet \frac{1}{72} = 0.83$ **feet**

5. Using the scale factor, what is the area of the garage in his drawing?

Actual area: $12(18) = 216$ ft^2 $216 \bullet \left(\frac{1}{72}\right) = 3$ ft^2

Here is the key to **S294.**

Homework

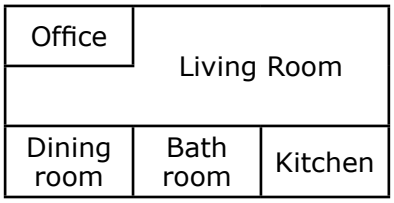
Name _____ **Date** _____

Directions: Solve the following problems using what you have learned about scale drawings.

1. The distance between two cities on a map is 6 cm. If the scale on the map is 2 cm = 50 miles, how many miles apart are the two cities?

150 miles

Directions: Use the scale drawing below to answer Questions 2 - 6.



Scale: 2 in. = 1 ft

2. Jenna's father is going to use the blueprint above to make a playhouse for her. In the drawing, the length of the entire first floor is 12 in. What is the actual length? **6 ft**

3. The width of the entire first floor in the drawing is 8 in. What is the actual width? **4 ft**

4. What scale factor did Jenna's father use to go from the drawing to the actual house?

$$\frac{1 \text{ ft}}{2 \text{ in.}} \cdot \frac{12 \text{ in.}}{1 \text{ ft}} = \frac{12}{2} = 6$$

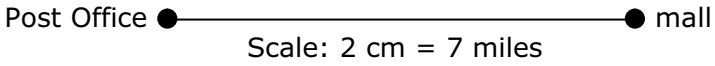
5. What is the perimeter of the first floor Jenna's father built?
120 inches or 20 feet

6. What is the area of the first floor Jenna's father built? **3,456 sq. inches or 24 feet^2**

Name _____ Date _____

Quiz

1. On the map below, the mall is 6 cm from the post office. Maria has to go from the post office to the mall. What is the actual distance she will travel?



Scale: 2 cm = 7 miles

A. 2 miles
B. 7 miles
C. 14 miles
D. 21 miles

---

2. Tyleek is making a scale drawing of a flea. He is using the scale of 3 mm is equal to 4 inches. If the flea's body is 9 mm long, how long will his drawing be?

A. 9 inches
B. 10 inches
C. 12 inches
D. 16 inches

---

3. Natalie is making a scale drawing of her apartment building. The building in her drawing has a height of 24 cm. The scale she used was 6 cm is equal to 11 feet. How tall is her apartment building?

A. 41 feet
B. 44 feet
C. 66 feet
D. 90 feet

4. Tiana is making a drawing of her school. She is using a scale of 1 in. = 5 feet. Which correctly shows how to change her scale into a scale factor?

A. $\frac{1}{5} \bullet \frac{12}{1}$

B. $\frac{1}{5} \bullet \frac{1}{12}$

C. $\frac{1}{5} \bullet \frac{5}{1}$

D. $\frac{5}{1} \bullet \frac{1}{12}$

---

5. The base of a model car has a perimeter of 30 centimeters. The scale factor to make it an actual car is 24. What is the perimeter of the actual car?

A. 54 cm

B. 360 cm

C. 720 cm

D. 17,280 cm

---

6. A tennis court is 78 feet long and 36 feet wide. Charley is making a model tennis court using a scale of $\frac{1}{12}$. What is the perimeter of the model?

A. 9.5 ft

B. 19 ft

C. 114 ft

D. 228 ft

---

7. A tennis court is 78 feet long and 36 wide. Charley is making a model tennis court using a scale of $\frac{1}{12}$. What is the area of the model?

A. 19.5 ft^2

B. 117 ft^2

C. 234 ft^2

D. 2808 ft^2

8. On a map, a rectangular pond has dimensions of 4 in. long and 10 in. wide. If the scale used was 2 in. = 50 feet, what is the perimeter of the actual pond?

A. 28 ft

B. 350 ft

C. 500 ft

D. 700 ft

---

9. On a map, a rectangular pond has dimensions of 4 in. long and 10 in. wide. If the scale used was 2 in. = 50 feet, what is the area of the actual pond?

A. 5,000 ft^2

B. 20,000 ft^2

C. 25,000 ft^2

D. 100,000 ft^2

---

10. A rectangle has an area of 45 square cm. Jamal is going to redraw the rectangle using a scale factor of 3. What is the new area of the rectangle?

A. 135 cm^2

B. 270 cm^2

C. 405 cm^2

D. 1215 cm^2