Name_____

CASE

Activity 6.3.2 Drawing to Scale

Purpose

Scale ratios allow engineers, architects, and designers to represent objects, such as airplanes, cars, and structures, on a single sheet of paper. The designer can use a single sheet of paper to communicate and sell the idea to his or her customers.

Scale ratios are a useful tool when developing project plans. Consider an architect who is designing a barn for a producer. Creating a life size drawing of a barn would not be feasible. The drawing would be too large to fit on any standard size sheet of paper. This is why an architect or drafter would use a scale ratio and draft scale drawings. The use of a scale ratio allows the architect to "scale down" the barn so it fits onto the size of paper used by his or her firm for making plans. Once the drawing for the barn is complete, communicating with the producer becomes much easier.

What is the process of drawing a physical object to scale? How are scale drawings used to plan a project?

Materials

Per student:

- Calculator
- Ruler
- Pencil
- *Agriscience Notebook*

Procedure

Use algebra to solve for the unknown proportions of the scale ratios. Complete the problems below as practice for using scale in a drawing.

Part One – Ratios and Proportions

Ratios may be expressed as a fraction, such as $\frac{3}{4}$. Two ratios set equal to each other make up a proportion, such as $\frac{1}{2}=\frac{4}{8}$. A ratio that is a rate usually includes units of measure when written.

$\frac{12"}{1'}=\frac{36"}{3'}$ read as12 inches per foot is the same as 36 inches per 3 feet.

Use an algebraic technique called cross-multiplication when solving a proportion. Review the example below.

Example:	
$\frac{x}{4}=\frac{7}{2}$	x is an unknown quantity to find.
$\frac{x}{4}=\frac{7}{2}$	To solve for x, cross multiply.
$2x = 7\times4$ $2x = 28$	First, find the product of the left numerator, and the right denominator. Set this quantity equal to the product of left denominator and right numerator.
$\frac{2x}{2}=\frac{28}{2}$	Divide both sides of the equation by 2 to solve for x.
$x = 14$	Solution

Solve the three proportions in Table 1 on *Activity 6.3.2 Student Worksheet.* Show your work in the space provided.

Part Two – Solving Scale Ratios

Now that you can solve proportions, use your skill to solve scale ratios commonly used in planning and design. Review the example proportion problem. Then solve the problem in Table 2 of the student worksheet.

Example problem:
A cab on a model train engine is 2" long. A popular model train scale is 1:87, which means 1" on a model represents 87" on a real train. You can use the 1:87 scale ratio to calculate the actual length of a train cab.

Model dimensions → $\frac{1"}{87"} = \frac{2"}{x}$ ← The length of the real train cab
Real dimensions →

$\frac{1}{87} = \frac{2}{x}$
$1x = 174$
$x = 174$

← A model train cab that is 2" long represents a real train cab that is 174" long.

Part Three – Converting Inches to Decimals

This step is similar to a section in *Activity 6.3.1 How will it measure up?*; however, now you will need to understand how to convert to decimals for easier use of your calculator. An architect, who mistakenly draws a building using a scale off by a fraction of an inch on a design plan, would result in the entire building being constructed incorrectly.

Review the example measurement and conversion. Then measure and convert the lines on the student worksheet. Record your answers in Table 3. Remember when converting, the whole number will remain the same.

Example

Line.

Calculate the fraction	Length (fraction inches)	Length (decimal inches)
3 ÷ 16 = 0.1875	2 3/16	2.1875"

Part Four – Determining Dimensions

As a designer, you must be able to look at a plan, measure the drawing dimensions, and convert them to actual size using scale ratios.

Use your ruler to measure the projects in Table 4 and Table 5 of the student worksheet. Then use the scale provided to convert into project dimensions.

Part Five – Determining Scale

When you are the designer, you must determine your own scale ratio, which can be challenging. The plan needs to be big enough for you and your customer to read clearly. In addition, the plan must fit onto a sheet of paper. If the plan is too small, the drawing will be hard to read and your paper will be filled with white space.

To select a scale ratio, determine the biggest dimension of the building. Next, experiment with several scale ratios until you find one that works best for fitting the size of paper you are using.

Select the best scale for the barn in Table 6 of the student worksheet so the barn will fit on a paper of size 11"x17". Use Table 7 to determine the best fit. Circle the most appropriate choice.

Conclusion

1. Why is the use of scale important when planning and designing projects?

   Scale allows you to be accurate when planning projects about the lengths of materials. We can't always draw on a 1:1 scale and we still need to be accurate when we can't

2. How are scale drawings and object size related?

   It is a ratio of the actual measurements to a measurement which will fit on paper. It is a shrunken view of the actual object.

Name_____

Activity 6.3.2 Student Worksheet

Table 1. *Solve Proportions*

A.	B.	C.
$\frac{x}{4} = \frac{9}{6}$ $6x = 9 \times 4$ $\frac{6x}{6} = \frac{36}{6}$ $x = 6$	$\frac{15}{6} = \frac{x}{2}$ $6x = 2 \times 15$ $\frac{6x}{6} = \frac{30}{6}$ $x = 5$	$\frac{2}{x} = \frac{3}{6}$ $3x = 2 \times 6$ $\frac{3x}{3} = \frac{12}{3}$ $x = 4$

Table 2. *Proportion Problem*

The entire model engine is 6.75" long, how long is the actual engine using the same scale ratio? Solve in the space provided and show your work.

$\frac{1''}{87''} = \frac{6.75''}{x}$ $1x = 587.25$ $x = 587.25''$

Lines to be measured

A. _____

B. _____

C. _____

D. _____

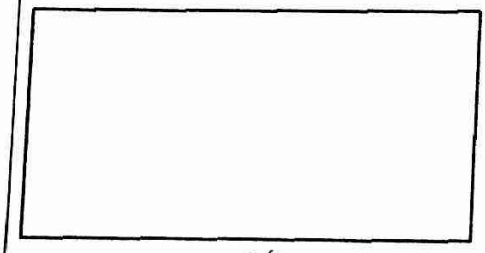
E. _____

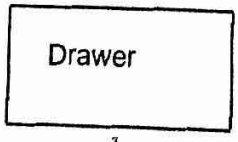
Table 3. Measurement and Conversion

	Length (fraction inches)	Length (decimal inches)
A.	$13/16''$	.8125"
B.	$2\frac{1}{4}''$	2.25"
C.	$2\frac{5}{16}''$	2.3125"
D.	$1\frac{3}{16}''$	1.1875"
E.	$1\frac{7}{16}''$	1.4375"

Table 4. *Show Box Measurements*

Determine the dimensions of the show box and drawer insert. The scale is 1" = 2'. Show your work. Record the actual length *x* width in the space provided.





$\frac{2.375}{x} \quad \frac{1}{24''}$

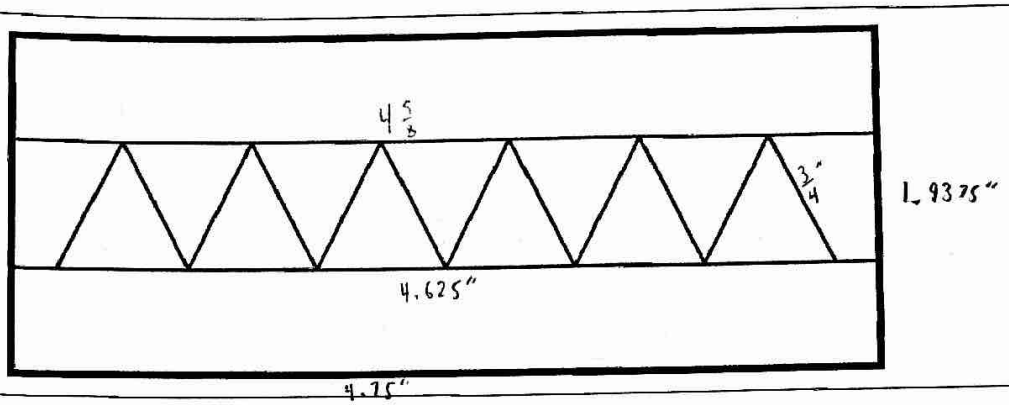
$x = 57$

$\frac{1.1875}{x} = \frac{1}{24}$ $\frac{.625}{x} = \frac{1}{24}$

Show box: 57" x 28.5" actual size Drawer: 28.5" x 15" actual size

Table 5. *Gate Measurements*

Determine the dimensions of the gate panel below including the overall dimensions of the gate, the length of horizontal support bars, the length of the vertical decorative bars, and the distance between each. The scale is 1" = 3'.



Measurements:	Outer dimensions of gate panel	Horizontal bars	Vertical bars
Length	171"	166.5	27"
Height or Distance between	69.75"		

Show your work:

Gate panel:

$\frac{4.75}{x} = \frac{1"}{36"}$ $\frac{1.9375}{x} = \frac{1"}{36"}$

Horizontal bars:

$\frac{4.625"}{x} = \frac{1"}{36"}$ $\frac{.75}{x} = \frac{1}{36"}$

Vertical bars:

11"x17"

Table 6. ***Barn Dimensions***

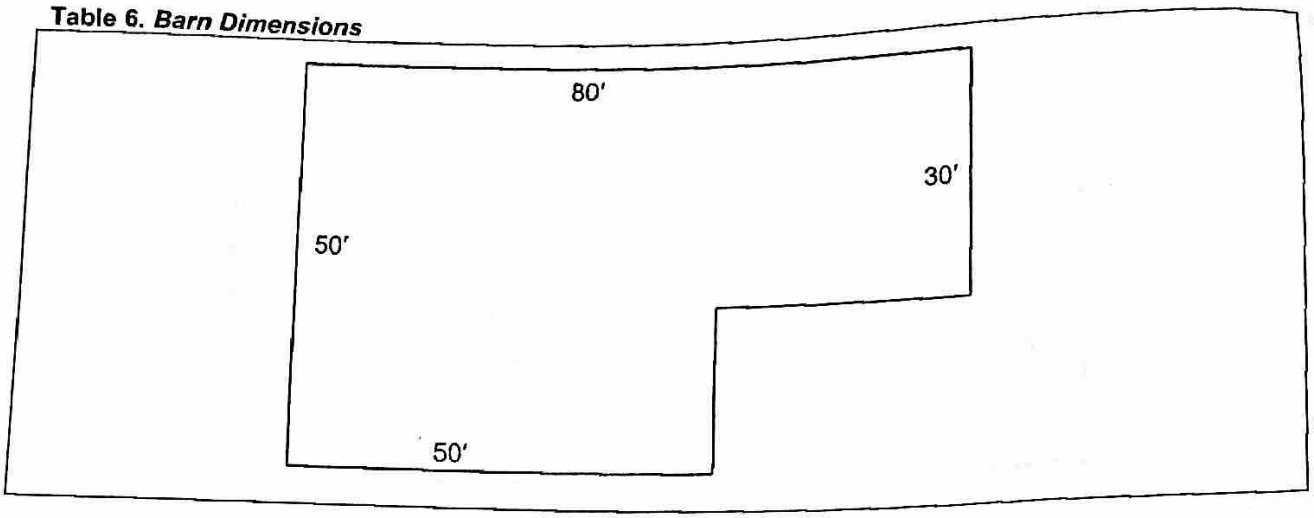


Table 7. ***Scale Choices***

A.	B.	C.	D.
$\frac{1''}{20'} = \frac{x}{80'}$ $\frac{80}{20} = \frac{20x}{20}$ $x = 4$	$\frac{1''}{10'} = \frac{x}{80}$ $\frac{80}{10} = \frac{10x}{10}$ $8 = x$	$\frac{1''}{5'} = \frac{x}{80}$ $\frac{80}{5} = \frac{5x}{5}$ $16 = x$	$\frac{1''}{2'} = \frac{x}{80}$ $\frac{80}{2} = \frac{2x}{2}$ $x = 40$

$\frac{1''}{5'} = \frac{x}{50'}$

$\frac{50}{5} = \frac{5x}{5}$

$10 = x$