

Use a set of working drawings to interpret an architectural scale rule

**Program Task:** Use a set of working drawings to interpret an architectural scale rule.

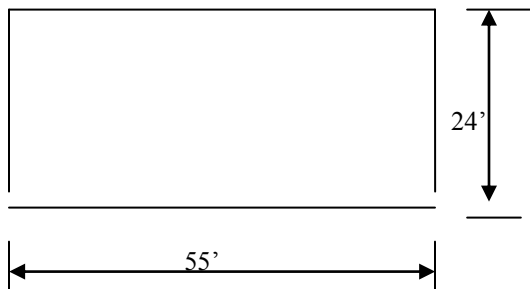
**Program Associated Vocabulary:**  
SCALE, DIRECT, INDIRECT, PROPORTION, RATIO

**Program Formulas and Procedures:**  
When carpenters build a house they use a set of working drawings; these drawings are also called blueprints. Blueprints are typically drawn in 1/4 scale. Using a 1/4inch scale ....

- 1/4 " on the drawing will represent 1' in real life
- 1" on the drawing will represent 4' in real life
- 1/8 " on the drawing will represent 1/2' or 6"

A detail or pictorial drawing will use a larger proportion, 1"= 1" to give the carpenter a better picture of the project.

**Example:**  
If the dimensions of a house measures 55' × 24' and the architect will draw blueprints at a proportion 1/4" = 1', on the blueprint what will the length of the building measure in inches? What will the width of the building measure in inches on the print?



1/4" = 1' (drawing not to scale)

**Solution:**  
Set up the proportion, cross multiple and divide to solve.

$$\frac{55'}{1'} = \frac{x''}{1/4''} \rightarrow 1x = 55(.25) \rightarrow x = 13.75'' \text{ length}$$

$$\frac{24'}{1'} = \frac{x''}{1/4''} \rightarrow 1x = 24(.25) \rightarrow x = 6'' \text{ width}$$

Use reasoning to solve equations and justify the solution method

**PA Core Standard: CC.2.2.HS.D.9**

**Description:** Use reasoning to solve equations and justify the solution method.

**Math Associated Vocabulary:**  
INVERSE, RECIPROCAL, PROPORTION, CROSS MULTIPLICATION, RATIO, CONSTANT

**Formulas and Procedures:**

**Direct Proportions:**  
**Two quantities, A and B, are directly proportional if by whatever factor A changes, B changes by the same factor.**

**Example 1:** Take the formula, distance = rate x time. If the rate remains constant, at 30 miles per hour, then the time and distance are directly proportional.

$$d = 30t$$

when t = 2, d = 60  
when t = 4, d = 120

\*Note that when the time doubles, so does the distance.

**Example 2:** If speed is directly proportional to distance, and a car can travel 100 miles at 50 miles per hour, how far can that car travel during the same time if it travels at 70 mph?

Step 1: Set up proportion.

$$\frac{50 \text{ mph}}{70 \text{ mph}} = \frac{100 \text{ mi.}}{x}$$

Step 2: Cross multiply and divide to solve.

$$50x = 70(100) \rightarrow 50x = 7000 \rightarrow x = 140 \text{ miles}$$

**Inverse Proportions:**

**Two quantities, A and B, are inversely proportional if by whatever factor A changes, B changes by the multiplicative inverse, or reciprocal of that factor.**

**Example 1:** Take the formula, distance = rate × time. If the distance, 100 miles is constant, then as the rate increases, the time decreases.

$$100 = rt$$

When r = 100, t = 1  
When r = 50, t = 2

\*Note that when the rate doubles, the time is halved.

**Example 2:** The time needed to complete a job is inversely proportional to the number of people working. If it takes one person 8 hours to pain the room alone, how long would it take 4 people to paint a room?

Step 1: Set up the proportion. Step 2: Invert (flip) one ratio.

$$\frac{1 \text{ person}}{4 \text{ people}} = \frac{8 \text{ hours}}{x \text{ hours}} \qquad \frac{1 \text{ person}}{4 \text{ people}} = \frac{x \text{ hours}}{8 \text{ hours}}$$

Step 3: Cross-multiply and divide to solve.

$$4x = 8, x = 2$$

4 people can paint the room in 2 hours.

### Instructor's Script - Comparing and Contrasting

The example provided on the carpentry side of the T-Chart on page one shows how proportional relationships are used to calculate missing lengths on a scale drawing. Scale factors are direct proportions. This example does not provide an opportunity to explore inverse proportions, but inverse proportions present themselves in other carpentry applications. For instance, if one carpenter can lay 10 square feet of flooring in 2 hours, how long will it take 3 carpenters to lay the same 10 square feet of flooring? If you increase the number of workers, you should decrease the time it takes to complete the project.

### Common Mistakes Made By Students

When students compare direct and inverse proportional relationships, they may become confused and have difficulty differentiating one from the other. One way to keep them straight is to:

1. Set up one pair of values on the same line, e.g.,  $\frac{12}{24} = \frac{100 \text{ lbs.}}{x \text{ lbs.}}$
2. Beneath that line, place the other pair of values,  $\frac{12}{24} = \frac{100 \text{ lbs.}}{x \text{ lbs.}}$
3. Students need to be aware that direct proportions mean that as one variable increases so does the other variable. An inverse proportion means that one variable increases when the other one decreases. Students struggle with this concept.
4. If the problem is a direct proportion, students should cross multiply (24 times 100) and (12 times x) and then divide to solve the problem.
5. If an inverse relationship exists, then students should first invert one ratio before cross multiplying and dividing to solve the problem.

If need be, have the student set up the problem and do it both ways to see which answer makes sense! We know in problem #9, for example, that it won't take 5 rabbits more time than it took 1 rabbit to eat 20 carrots, so it must be an inverse proportion.

### CTE Instructor's Extended Discussion

A carpenter will use an architect's scale to easily read and convert scaled dimensions on drawings, blueprints and construction drawings. An architect's scale will also be used on physical objects such as models to provide a quick reference to actual dimensions. Before using an architect's scale, it is important to know the scale of the drawing or item that is being measured.

# Carpentry (46.0201) T-Chart

Problems	Career and Technical Math Concepts	Solutions
1. A carpenter wants to build a garage that measures $36' \times 24'$ . To issue a building permit the township needs a blueprint that is drawn in $\frac{1}{4}'' = 1'$ scale. How many inches will the length measure on the blueprint? How many inches will the width measure on the blueprint?		
2. If it takes three bundles of shingles to cover 100 sq. ft., how many bundles of shingles will be needed to cover 966 sq. ft.?		
3. The scale on the plot plan is 1 in. = 20 ft. What are the actual dimensions of a house that measures $3 \frac{1}{2}'' \times 1 \frac{1}{2}''$ on the drawing?		
Problems	Related, Generic Math Concepts	Solutions
4. If you need 5 pounds of chicken to serve 20 people, how many pounds will you need to serve 50 people?		
5. The pressure of a gas and its corresponding volume are inversely proportional. If the pressure of $0.24 \text{ m}^3$ is 0.5 atm, what would the pressure be of $0.060 \text{ m}^3$ of the same gas at the same temperature?		
6. If it takes 26 lbs. of metal to make 10 castings, how many pounds of metal will be needed to make 14 castings?		
Problems	PA Core Math Look	Solutions
7. Given that y and x are <b>directly</b> proportional, and $y = 2$ when $x = 5$ , find the value of y when $x = 15$ .		
8. Given that y and x are <b>inversely</b> proportional, and $y = 2$ when $x = 5$ , find the value of y when $x = 15$ .		
9. If one rabbit can chew 20 carrots in 15 hours, how long will it take 5 rabbits to chew the same 20 carrots?		

Problems	Career and Technical Math Concepts	Solutions
1. A carpenter wants to build a garage that measures 36' × 24'. To issue a building permit the township needs a blueprint that is drawn in 1/4" = 1' scale. How many inches will the length measure on the blueprint? How many inches will the width measure on the blueprint?	(Direct)	$\frac{36'}{1'} = \frac{x''}{1/4''} \rightarrow 1x = 36(.25) \rightarrow x = 9'' \text{ length}$ $\frac{24'}{1'} = \frac{x''}{1/4''} \rightarrow 1x = 24(.25) \rightarrow x = 6'' \text{ width}$
2. If it takes three bundles of shingles to cover 100 sq. ft., how many bundles of shingles will be needed to cover 966 sq. ft.?	(Direct)	$\frac{3 \text{ bundles}}{x \text{ bundles}} = \frac{100 \text{ sq.ft.}}{966 \text{ sq.ft.}} \rightarrow 100x = 966(3) \rightarrow x = 29 \text{ bundles}$
3. The scale on the plot plan is 1 in. = 20 ft. What are the actual dimensions of a house that measures 3 1/2" x 1 1/2" on the drawing?	(Direct)	$\frac{3.5''}{1''} = \frac{x'}{20'} \rightarrow 1x = 3.5(20) \rightarrow x = 70' \text{ length}$ $\frac{1.5''}{1''} = \frac{x'}{20'} \rightarrow 1x = 1.5(20) \rightarrow x = 30' \text{ width}$
Problems	Related, Generic Math Concepts	Solutions
4. If you need 5 pounds of chicken to serve 20 people, how many pounds will you need to serve 50 people?	(Direct)	$\frac{5 \text{ pounds}}{20 \text{ people}} = \frac{x \text{ pounds}}{50 \text{ people}} \rightarrow 20x = 5(50) \rightarrow 20x = 250$ $x = 12.5 \text{ pounds}$
5. The pressure of a gas and its corresponding volume are inversely proportional. If the pressure of 0.24 m <sup>3</sup> is 0.5 atm, what would the pressure be of 0.060 m <sup>3</sup> of the same gas at the same temperature?	(Inverse)	$\frac{0.24 \text{ m}^3}{0.060 \text{ m}^3} = \frac{0.5 \text{ atm}}{x \text{ atm}}$ $\frac{0.24 \text{ m}^3}{0.060 \text{ m}^3} = \frac{0.5 \text{ atm}}{x \text{ atm}}$ $.24 \times 0.5 = .060x \quad x = 2 \text{ atm}$ <p>(Invert one ratio since it is an inverse proportion.)</p>
6. If it takes 26 lbs. of metal to make 10 castings, how many pounds of metal will be needed to make 14 castings?	(Direct)	$\frac{10 \text{ castings}}{14 \text{ castings}} = \frac{26 \text{ lbs.}}{x \text{ lbs.}} \rightarrow 10x = 26(14) \rightarrow x = 36.4 \text{ lbs.}$
Problems	PA Core Math Look	Solutions
7. Given that y and x are <b>directly</b> proportional and y = 2 when x = 5, find the value of y when x = 15.	(Direct)	$\frac{5}{15} = \frac{2}{y} \rightarrow 5y = 2(15) \rightarrow y = 6$
8. Given that y and x are <b>inversely</b> proportional and y = 2 when x = 5, find the value of y when x = 15.	(Inverse)	$\frac{5}{15} = \frac{y}{2} \rightarrow 15y = 2(5) \rightarrow y = 0.667$
9. If one rabbit can chew 20 carrots in 15 hours, how long will it take 5 rabbits to chew the same 20 carrots?	(Inverse)	$\frac{1}{5} = \frac{x}{15} \rightarrow 5x = 1(15) \rightarrow x = 3 \text{ hours}$