

**Layout foundation wall lines**

=

**Verify and apply geometric theorems as they relate to geometric figures**

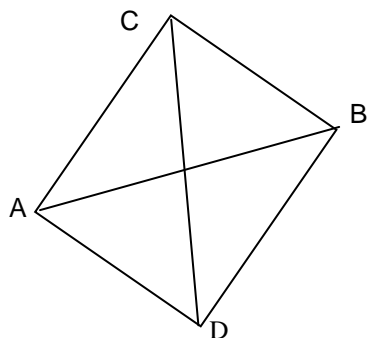
**Program Task:** Layout foundation wall lines with the use of batter boards, parallel lines, square corners, and bisecting diagonals.

**Program Associated Vocabulary:**  
 ANGLES, BATTER BOARDS, DIAGONAL, DIMENSION, INTERSECT, LINE, PARALLEL, SQUARE, WIDTH

**Program Formulas and Procedures:**  
 A perfectly square building foundation begins with a square layout. In the carpentry field, a rectangular house must also be a "square" rectangle, meaning each set of two sides are equal.

Carpenters set up batter boards on a building lot to identify property lines, building lines and pier locations. When using batter boards for building lines, the front and rear building lines will be parallel. The side building lines will also be parallel.

It is important to not only measure the length and the width of the building but also the diagonals to see if the corners are "square".



For the greatest accuracy the diagonals should be measured and the two measurements should be equal. If length  $AB = CD$  then the building will be square. In addition  $AD = CB$  and  $AC = BD$ .

In the example above if  $AD = 10' 8''$  then  $CB = 10' 8''$ .  
 If  $AC = 21' 3''$  then  $BD = 21' 3''$ .  
 The building dimensions are  $21' 3'' \times 10' 8''$ .  
 The diagonal measurement  $AB$  is  $23' 9 \frac{5}{16}''$ .

**Example:** If the diagonal measurement  $AB$  is  $23' 9 \frac{5}{16}''$ , what must diagonal measurement  $CD$  equal for the building to be "square"?  
 If  $CD = 23' 9 \frac{5}{16}''$ , then diagonal measurements  $AB$  and  $CD$  are equal, and the building is square.

**PA Core Standard:** CC.2.3.HS.A.3

**Description:** Verify and apply geometric theorems as they relate to geometric figures.

**Math Associated Vocabulary:**  
 CONGRUENT FIGURES, POLYGON, QUADRILATERAL, PARALLELOGRAM, PARALLEL, RECTANGLE, RHOMBUS, SQUARE, KITE, TRAPEZOID, ISOSCELES TRAPEZOID, SUPPLEMENTARY ANGLES

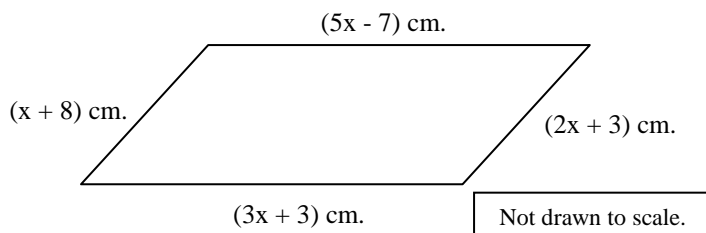
**Formulas and Procedures:**  
 The following ways prove a quadrilateral is a parallelogram:

1. Both pairs of opposite sides are parallel.
2. Both pairs of opposite sides are congruent.
3. Both pairs of opposite angles are congruent.
4. One pair of opposite sides are both congruent and parallel.
5. The diagonals bisect each other.
6. Adjacent angles are supplementary.

In order to prove that a parallelogram has right angles, you can measure the diagonals. If the diagonals are equal in length then it has right angles. Therefore, it is a rectangle.

If the diagonals of a parallelogram are perpendicular then it has equal side lengths. Therefore, it is a rhombus.

**Example:**



The figure above is a parallelogram. What are its side lengths?

$(5x - 7) = (3x + 3)$	Set opposite sides equal.
$2x - 7 = 3$	Subtract 2x.
$2x = 10$	Add 7.
$x = 5$	Divide by 2.
$3x + 3 = 3(5) + 3 = 18$	Substitute.
$x + 8 = 5 + 8 = 13$	Substitute.

The side lengths are 18 cm., 18 cm., 13 cm. and 13 cm.

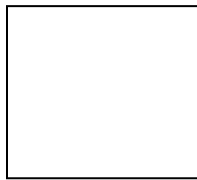
## Instructor's Script - Comparing and Contrasting

While carpenters may not need to memorize all the properties of parallelograms, they surely need to know that the diagonals of squares and rectangles are congruent.

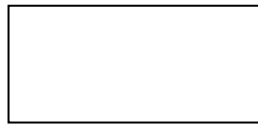
## Common Mistakes Made By Students

A common mistake made by students is to confuse the properties of different quadrilaterals. For example, a rectangle and square have congruent diagonals, but not every parallelogram has that property. Another common mistake is looking at the picture that may not be drawn to scale and making assumptions about the figure.

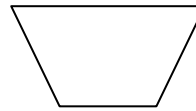
## Examples of Quadrilaterals:



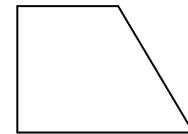
Square



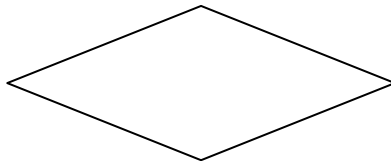
Rectangle



Trapezoid



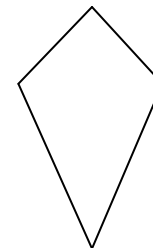
Right Trapezoid



Rhombus



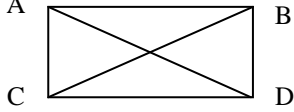
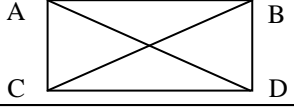
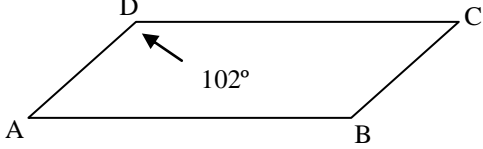
Parallelogram

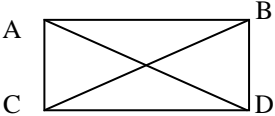
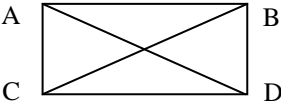
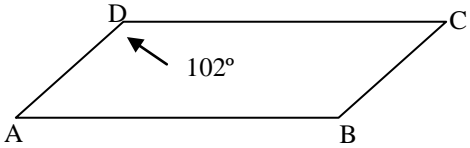


Kite

## CTE Instructor's Extended Discussion

Carpenters build projects that need to be square; checking for congruent diagonals will ensure the success of the layout.

Problems	Career and Technical Math Concepts	Solutions
1. If you are checking a foundation for “square” and one diagonal measurement equals $26' 8\frac{3}{8}"$ then what should the other diagonal measurement equal?		
2. Fill in the correct lengths for a “square” building: AD = 15' then CB = AB = 9' 6" then CD = AC = 11' 7 5/16" then BD =  		
3. If the foundation is not square and CD = 18' 9", what measurement will AD ≠?  		
Problems	Related, Generic Math Concepts	Solutions
4. If the angles of a quadrilateral are $(x + 7)^\circ$ , $(5x - 7)^\circ$ , $(2x + 2)^\circ$ and $10^\circ$ , what is each angle?		
5. If one side of a parallelogram measures $(2x + 10)$ in. and the opposite side measures $(3x - 2)$ in., what is the measure of these sides?		
6. If one diagonal of a rectangle is $(2x + 3)$ cm. and the other is $(x + 8)$ cm, what is length of the diagonal?		
Problems	Pa Core Math Look	Solutions
7. You have drawn a rhombus in a coordinate plane. The slope of one of the diagonals is $\frac{1}{4}$ . What is the slope of the other diagonal?		
8. What are the missing angles in the parallelogram?  		
9. Which type of quadrilateral has exactly one pair of opposite sides parallel?		

Problems	Career and Technical Math Concepts	Solutions
1. If you are checking a foundation for “square” and one diagonal measurement equals $26' 8\frac{3}{8}"$ , then what should the other diagonal measurement equal?		Since the diagonals of a “square” foundation should be equal in measure, the other diagonal measurement should = $26' 8\frac{3}{8}"$
2. Fill in the correct lengths for a “square” building: AD = 15’ then CB = AB = 9’ 6” then CD = AC = 11’ 7 5/16” then BD =		AD = 15’ then CB =15” AB = 9’ 6” then CD = 9’6” AC = 11’ 7 5/16” then BD=11’7 5/16”
3. If the foundation is not square and CD = 18’ 9”, what measurement will AD ≠?		If the foundation is not square and CD = 18’ 9” then AD ≠ 18’9”.
Problems	Related, Generic Math Concepts	Solutions
4. If the angles of a quadrilateral are $(x + 7)^\circ$ , $(5x - 7)^\circ$ , $(2x + 2)^\circ$ and $10^\circ$ , what is each angle?		$(x + 7) + (5x - 7) + (2x + 2) + 10 = 360$ $\rightarrow 8x + 12 = 360 \rightarrow 8x = 348 \rightarrow x = 43.5$ Substitute to find the angles. $(x + 7) = 50.5$ , $(5x - 7) = 210.5$ , $(2x + 2) = 89$ The angles of the quadrilateral are $50.5^\circ$ , $210.5^\circ$ , $89^\circ$ and $10^\circ$ .
5. If one side of a parallelogram measures $(2x + 10)$ in. and the opposite side measures $(3x - 2)$ in., what is the measure of these sides?		Since opposite sides of a parallelogram are congruent, they are also equal in length. $3x - 2 = 2x + 10 \rightarrow x = 12$ Substitute to find the side lengths: $3(12) - 2 = 34$  You can check your work by substituting into the expression for the other side length. $2(12) + 10 = 34$ The side length is 34 inches.
6. If one diagonal of a rectangle is $(2x + 3)$ cm. and the other is $(x + 8)$ cm, what is length of the diagonal?		Since the diagonals of a rectangle are congruent, $2x + 3 = x + 8 \rightarrow x + 3 = 8 \rightarrow x = 5$ Substitute to find the length of the diagonal: $2(5) + 3 = 13$ The diagonal has a length of 13 cm.
Problems	PA Core Math Look	Solutions
7. You have drawn a rhombus in a coordinate plane. The slope of one of the diagonals is $\frac{1}{4}$ . What is the slope of the other diagonal?		Since the diagonals of a rhombus are perpendicular the other diagonal would have a slope that is the negative reciprocal of the given slope. The slope of the other diagonal is -4.
8. What are the missing angles in the parallelogram?		Since opposite angles are congruent, the measure of angle B is $102^\circ$ . Since consecutive angles are supplementary angles A and C are $78^\circ$ .
9. Which type of quadrilateral has exactly one pair of opposite sides parallel?		A trapezoid is a quadrilateral with exactly one pair of opposite sides parallel.