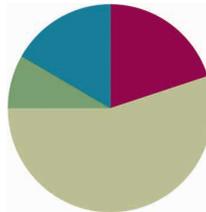


Lesson 16

Objective: Reason about attributes to construct quadrilaterals on square or triangular grid paper.

Suggested Lesson Structure

■ Fluency Practice	(12 minutes)
■ Application Problem	(5 minutes)
■ Concept Development	(33 minutes)
■ Student Debrief	(10 minutes)
Total Time	(60 minutes)



Fluency Practice (12 minutes)

- Add and Subtract **4.4A** (4 minutes)
- Find the Unknown Angle **4.7A, 4.7B** (5 minutes)
- Classify the Quadrilateral **4.6D** (3 minutes)

Add and Subtract (4 minutes)

Materials: (S) Personal white board

Notes: This concept reviews the yearlong Grade 4 fluency standard for adding and subtracting using the standard algorithm.

T: (Write 765 thousands 198 ones.) On your personal white boards, write this number in standard form.

S: (Write 765,198.)

T: (Write 156 thousands 185 ones.) Add this number to 765,198 using the standard algorithm.

S: (Write $765,198 + 156,185 = 921,383$ using the standard algorithm.)

Continue with the following possible sequence: $681,959 + 175,845$.

T: (Write 716 thousands 450 ones.) On your boards, write this number in standard form.

S: (Write 716,450.)

T: (Write 325 thousands 139 ones.) Subtract this number from 716,450 using the standard algorithm.

S: (Write $716,450 - 325,139 = 391,311$ using the standard algorithm.)

Continue with the following possible sequence: $451,151 - 122,616$ and $500,000 - 315,415$.

Find the Unknown Angle (5 minutes)

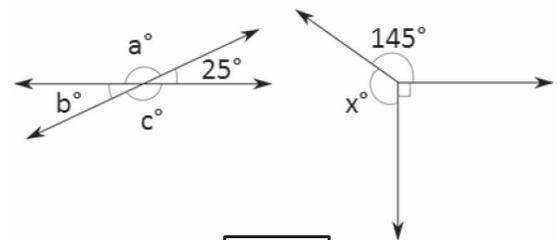
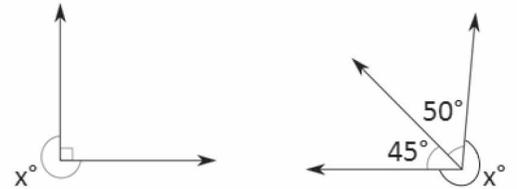
Materials: (S) Personal white board

Note: This fluency activity reviews Lesson 10.

T: (Project the first unknown angle problem. Run a finger along the horizontal line.) This is a straight angle. On your personal white boards, write a number sentence to find the measure of $\angle x$.

S: (Write $180 - 135 = x$. Below it, write $x^\circ = 45^\circ$.)

Continue with the remaining unknown angle problems.

**Classify the Quadrilateral (3 minutes)**

Notes: This fluency exercise reviews Lesson 15.

T: (Project square.) How many sides does the polygon have?

S: Four sides.

T: What's the name for polygons with four sides?

S: Quadrilateral.

T: Each angle in this quadrilateral is 90° . It also has four equal sides. What's a more specific name?

S: Square.

T: (Project second polygon.) Is this polygon a quadrilateral?

S: Yes.

T: Why?

S: Because it has four sides.

T: Is this quadrilateral a square?

S: No.

T: How do you know?

S: The sides are not the same length.

T: Each angle is 90° . What type of quadrilateral is it?

S: Rectangle.

T: Does a rectangle have two sets of parallel sides?

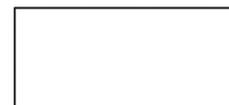
S: Yes.

T: (Project parallelogram.) Is this polygon a quadrilateral?

S: Yes.

T: This quadrilateral has two sets of parallel sides. Is it a rectangle?

S: No.



T: How do you know?

S: All four angles are not 90° .

T: What's the name of a quadrilateral with two sets of parallel sides that best defines this figure?

S: Parallelogram.

T: (Project trapezoid.) Is this polygon a quadrilateral?

S: Yes.

T: How do you know?

S: It has four sides.

T: Is it a rectangle?

S: No.

T: How do you know?

S: Each angle doesn't measure 90° .

T: Is it a parallelogram?

S: No.

T: How do you know?

S: It doesn't have two sets of parallel sides.

T: Classify this quadrilateral.

S: It's a trapezoid.

T: Describe its attribute.

S: It has at least one pair of parallel sides.

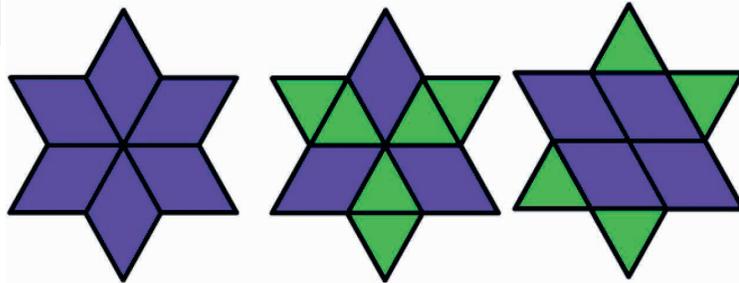


Application Problem (5 minutes)

Within the stars, find at least two different examples for each of the following. Explain which attributes you used to identify each.

- Equilateral triangles
- Trapezoids
- Parallelograms
- Rhombuses

Note: Identifying these polygons within the star serves as a review for identifying the shapes and introduces the students to drawing these shapes on triangular grid paper used during the Concept Development.



To find the equilateral triangles, I looked for triangles with equal side lengths.

To find the trapezoids, I looked for quadrilaterals with at least one set of parallel sides.

To find the parallelograms, I looked for quadrilaterals with two sets of parallel sides.

To find the rhombuses, I looked for quadrilaterals with equal side lengths.

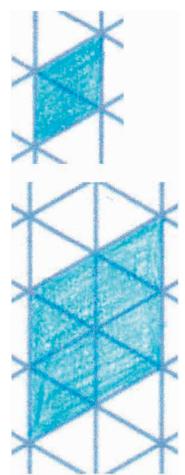
I used my ruler to measure the sides.

Concept Development (33 minutes)

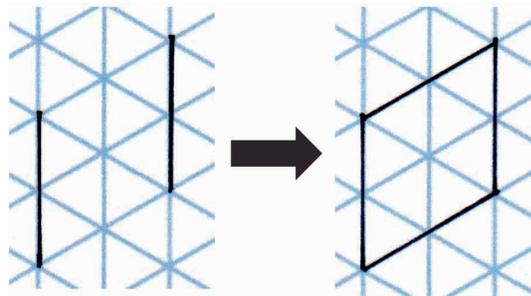
Materials: (T/S) Rectangular and triangular grid paper, ruler, right angle template (created in Lesson 2)

Problem 1: Construct a rhombus on a triangular grid.

- T: On your triangular grid paper, all the small triangles are equilateral. Please shade in two triangles that share a side. (Allow students time to complete the task.) Talk to your partner. What do you notice about the side lengths and angle sizes of the larger shape you have shaded?
- S: The sides are all the same length. → The acute angles are the same size because I know that the angles of equilateral triangles are equal. → The obtuse angles are the same size, too, because both of them are the sum of two of the equilateral triangle's angles.
- T: Which of the following terms relate to this shape? (Write *quadrilateral*, *trapezoid*, *parallelogram*, *rectangle*, and *square*.)
- S: It's a quadrilateral because it has four straight sides. → It's a trapezoid because it has parallel sides. → It's a parallelogram because it has two sets of parallel sides. → It's like a square because it has equal sides, but it doesn't have right angles.
- T: This is a rhombus, a parallelogram with four equal sides. Shade a larger rhombus on your triangular grid paper. (Allow students time to complete the task.)
- T: Now that you have shaded two rhombuses, draw a pair of parallel segments that are the same length. Draw two more segments that are parallel and the same length. They must be drawn so that the endpoints of all four segments are connected. Now, you have a rhombus.



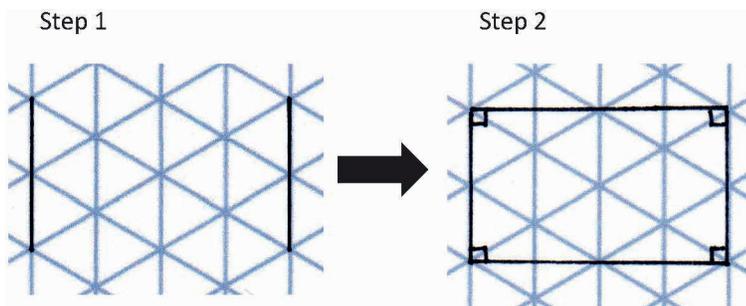
Circulate as the students draw, supporting them to construct a rhombus beginning with a pair of equal parallel sides.



Problem 2: Construct a rectangle on a triangular grid.

- T: On the triangular grid, begin the construction of a rectangle just as we did yesterday with a pair of parallel segments. To begin, locate a pair of parallel lines on the triangular grid paper, and trace them. (See Step 1 below.)

- T: Discuss with your partner: What did we do next to draw a rectangle?
- S: We drew two segments perpendicular to these. → We can also draw one line that is perpendicular and then draw a line that is parallel to that third line. → I can connect the vertices on the grid paper and check to make sure the segments form four right angles.
- T: Let's connect these two points on the grid. (Draw two horizontal lines.) Use your ruler and right angle template to verify the parallel lines and the perpendicular lines. Use right angle symbols. (See Step 2 below.)
- S: That is tricky. I am going to try again. → Neat! I can see where I can connect vertices of the grid to form the other segments of the rectangle even though there wasn't a line on the grid to trace.



- T: Try another one by beginning with drawing the perpendicular segments at the vertex of one of the equilateral triangles and extending to another vertex. Compare your rectangles with a partner's. Try another while you wait.
- T: Talk to your partner about what was challenging about drawing the rectangle on the triangular grid paper.
- S: (Discuss.)
- T: What is another word for any parallelogram with four right angles?
- S: A rectangle.

Problem 3: Construct non-rectangular parallelograms on a rectangular grid.

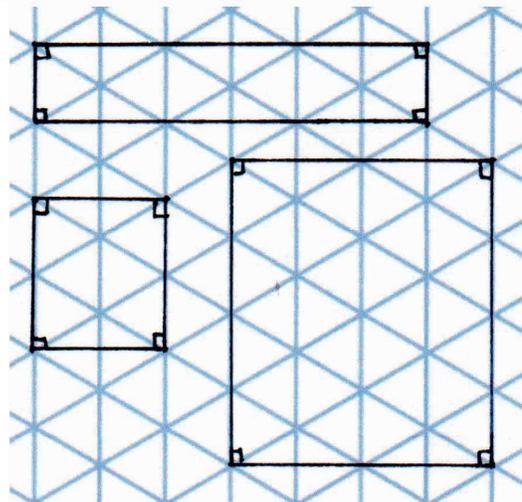
- T: (Display a rectangular grid.) What polygons can you identify inside this rectangular grid? Shade them.
- S: I see a square. → I can make a larger square by shading four smaller squares. → I see many rectangles.



**NOTES ON
MULTIPLE MEANS
FOR ACTION AND
EXPRESSION:**

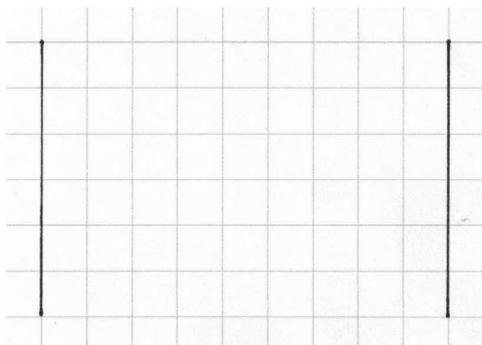
Constructing a rectangle on a triangular grid may be tricky for students working below grade level and others. Offer the following supports:

- Enlarge the grid.
- Download this triangular grid: <http://www.gwydir.demon.co.uk/jo/tess/bigtri.htm>. Students may draw segments in a word processing or drawing program, if beneficial. Offer a touch-screen (interactive white board), if available. (In the absence of virtual angle templates and straightedges, students may use the real tools with assistance.)
- Have students work in pairs. Encourage successful students to speak and demonstrate the steps.

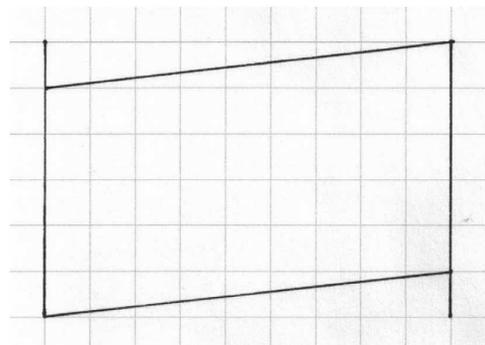


Other various rectangles

- T: Can you identify a parallelogram? Can you identify a trapezoid?
- S: No, these lines are all perpendicular. → Squares and rectangles are parallelograms and trapezoids.
- T: Visualize a parallelogram with no right angles. Let’s begin constructing one. Identify a pair of parallel lines of equal lengths, and trace them. (See Step 1 below.) Next, can you use the grid to draw a third segment that cannot be traced on the rectangular grid? (See Step 2 below.)
- S: Yes, I can connect these two points.
- T: Now, use the grid again to connect two more points to draw the fourth segment, which is parallel to the third segment. (See Step 3 below.)
- S: I think if I connect these two points here that the segments will be parallel.
- T: Go ahead and try. What do you need to do to confirm the lines are parallel?
- S: Use our right angle template and ruler.
- T: Go ahead and do so.



Step 1

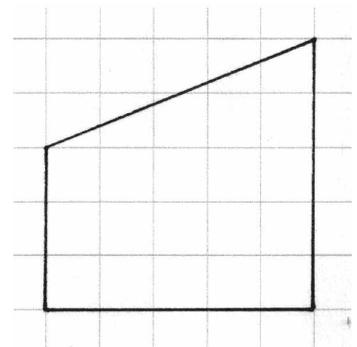


Steps 2 and 3

- T: Talk to your partner about what changes could be made to your figure to make it a trapezoid that has only one set of parallel lines.
- S: We could make the third and fourth segments not parallel.
- T: Construct a trapezoid that has only one set of parallel lines.

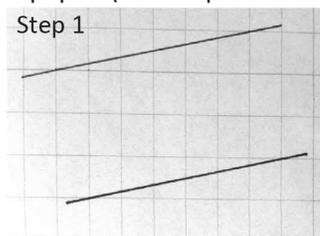
Students construct trapezoid on grid. (See example to the right.)

- T: Construct another parallelogram. This time, draw your first segment from one vertex to another so that the segment does not trace the rectangular grid. (See Step 1, below.)

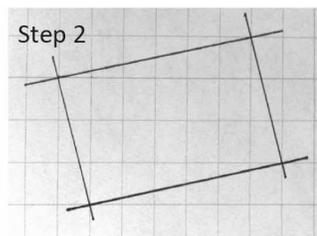


Students draw first segment on grid.

- T: Draw a segment parallel to that. Work with your partner on how to construct the last set of parallel lines so that they do not trace the gridlines. Make sure the vertices of the parallelogram meet at the vertices of the grid paper. (See Step 2 below.)



Step 1

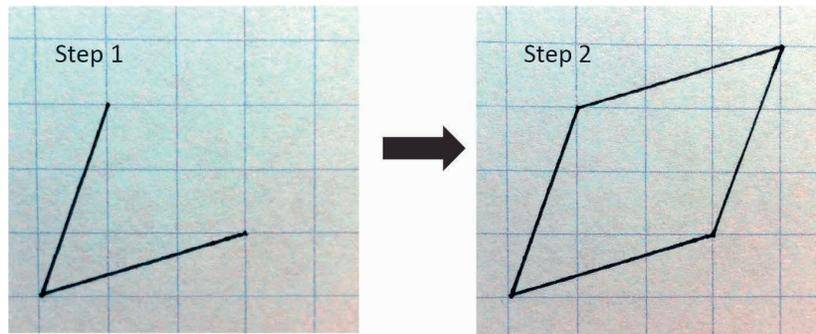


Step 2

- T: Discuss with your partner the challenges that you faced during the construction of this parallelogram.
- S: It was tricky with the lines of the parallelogram not on the gridlines. → I had to make sure to use my tools to help me draw parallel lines. → I saw a pattern in the grid to help me draw the lines.

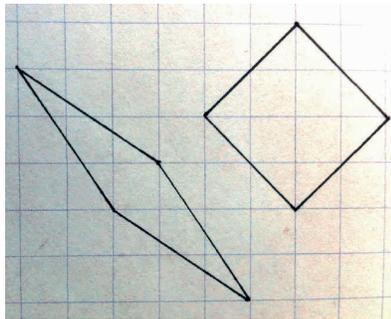
Extension: Construct rhombuses on a rectangular grid.

Draw the figure below step by step for students without identifying it as a rhombus. Ask them to copy it, and then, using their tools, verify what shape it is.



- S: We drew a rhombus! All the sides measure the same, and it has two sets of parallel sides.

Have students draw two more rhombuses of different sizes.



Problem Set (10 minutes)

Students should do their personal best to complete the Problem Set within the allotted 10 minutes. For some classes, it may be appropriate to modify the assignment by specifying which problems they work on first. Some problems do not specify a method for solving. Students should solve these problems using the RDW approach used for Application Problems.

Student Debrief (10 minutes)

Lesson Objective: Reason about attributes to construct quadrilaterals on square or triangular grid paper.

The Student Debrief is intended to invite reflection and active processing of the total lesson experience.

Invite students to review their solutions for the Problem Set. They should check work by comparing answers with a partner. Look for misconceptions or misunderstandings that can be addressed in the Debrief. Guide students in a conversation to debrief the Problem Set and process the lesson.

Any combination of the questions below may be used to lead the discussion.

- What figure did you draw in Problem 1(a)? Why are there so many different shapes that can be constructed?
- How did the gridlines in Problem 1(b) help you to draw the right angles?
- How are the shapes in Problems 2(a) and 2(b) similar and different?
- How are the attributes of a rhombus and a rectangle similar? What two attributes distinguish a rhombus from a rectangle in Problem 3?
- Which grid is more challenging for you, the triangular or the square grid? Explain which quadrilaterals are easiest for you to draw on either grid. Why do you think that is so?

Exit Ticket (3 minutes)

After the Student Debrief, instruct students to complete the Exit Ticket. A review of their work will help with assessing students' understanding of the concepts that were presented in today's lesson and planning more effectively for future lessons. The questions may be read aloud to the students.

Name Jack Date _____

1. On the grid paper, draw at least one quadrilateral to fit the description. Use the given segment as one segment of the quadrilateral. Name the figure you drew using one of the terms below.

parallelogram	trapezoid	rectangle
square		rhombus
<p>a. A quadrilateral that has at least one pair of parallel sides.</p> <p>trapezoid</p>	<p>b. A quadrilateral that has four right angles.</p> <p>rectangle</p>	
<p>c. A quadrilateral that has two pairs of parallel sides.</p> <p>parallelogram</p>	<p>d. A quadrilateral that has at least one pair of perpendicular sides and at least one pair of parallel sides.</p> <p>trapezoid</p>	

2. On the grid paper, draw at least one quadrilateral to fit the description. Use the given segment as one segment of the quadrilateral. Name the figure you drew using one of the terms below.

parallelogram	trapezoid	rectangle
square		rhombus
<p>a. A quadrilateral that has two sets of parallel sides.</p> <p>parallelogram</p>	<p>b. A quadrilateral that has four right angles.</p> <p>rectangle</p>	

3. Explain the attributes that make a rhombus different from a rectangle.

A rhombus is different from a rectangle because all four sides of a rhombus are always equal. In a rectangle, the opposite sides are equal. A rhombus does not need to have four right angles. A rectangle has four right angles.

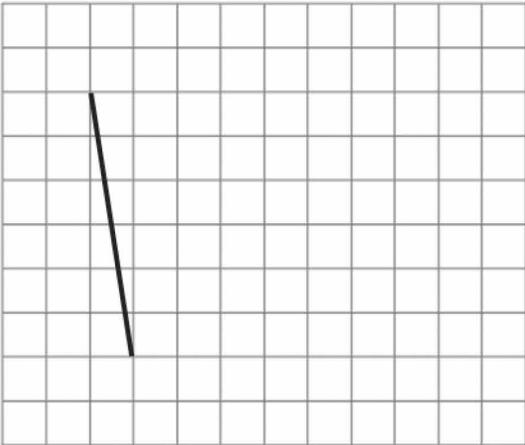
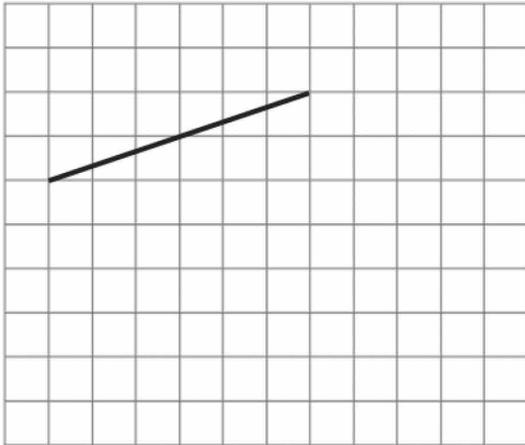
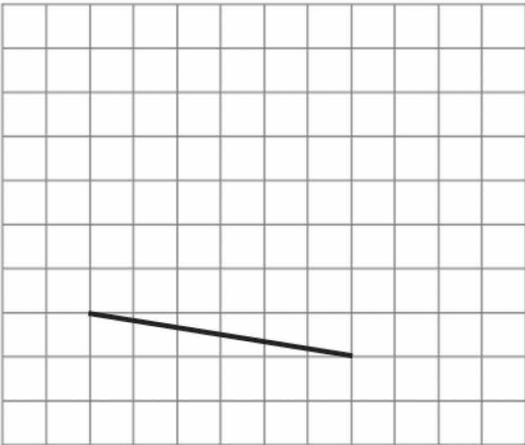
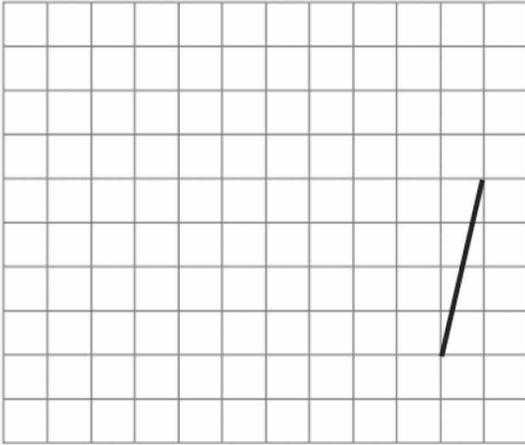
4. Explain the attribute that makes a square different from a rhombus.

A square is different from a rhombus in that a square must have four right angles and four equal length sides while a rhombus only needs to have four equal sides.

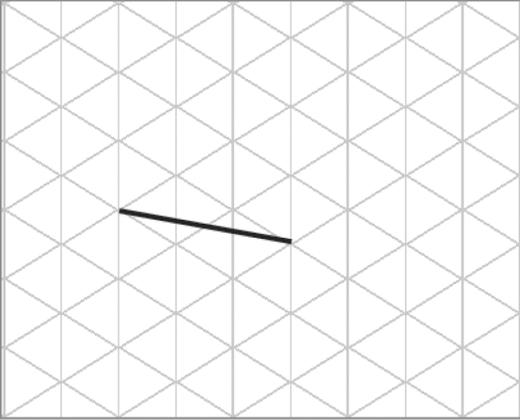
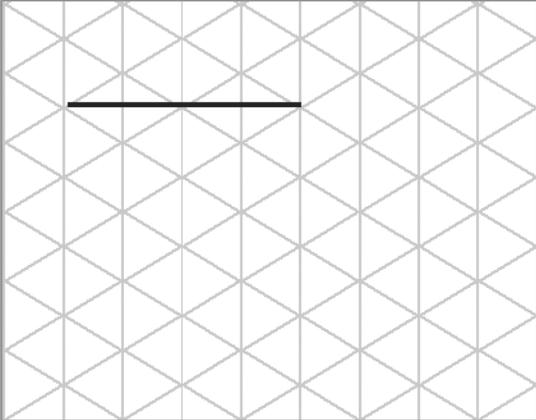
Name _____

Date _____

1. On the grid paper, draw at least one quadrilateral to fit the description. Use the given segment as one segment of the quadrilateral. Name the figure you drew using one of the terms below.

Parallelogram	Trapezoid	Rectangle
Square		Rhombus
<p>a. A quadrilateral that has at least one pair of parallel sides.</p> 	<p>b. A quadrilateral that has four right angles.</p> 	
<p>c. A quadrilateral that has two pairs of parallel sides.</p> 	<p>d. A quadrilateral that has at least one pair of perpendicular sides and at least one pair of parallel sides.</p> 	

2. On the grid paper, draw at least one quadrilateral to fit the description. Use the given segment as one segment of the quadrilateral. Name the figure you drew using one of the terms below.

Parallelogram	Trapezoid	Rectangle
Square		Rhombus
<p>a. A quadrilateral that has two sets of parallel sides.</p> 	<p>b. A quadrilateral that has four right angles.</p> 	

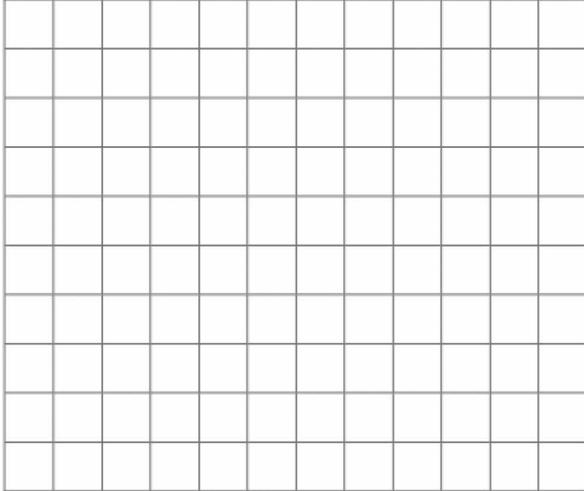
3. Explain the attributes that make a rhombus different from a rectangle.

4. Explain the attribute that makes a square different from a rhombus.

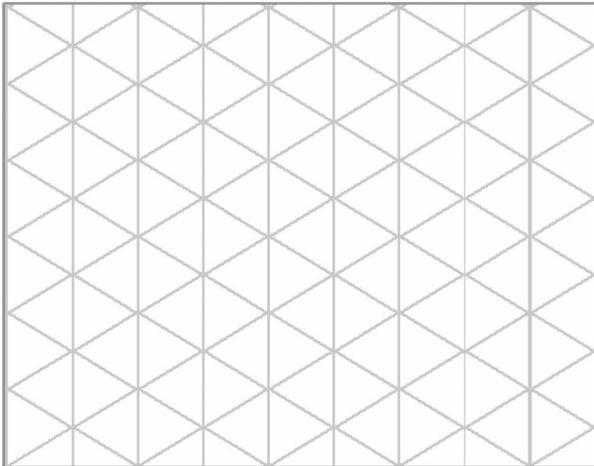
Name _____

Date _____

1. Construct a parallelogram that does not have any right angles on a rectangular grid.



2. Construct a rectangle on a triangular grid.



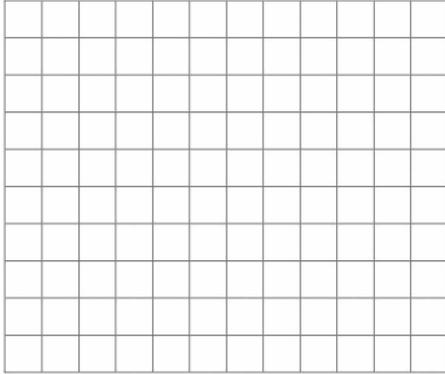
Name _____

Date _____

Use the grid to construct the following. Name the figure you drew using one of the terms in the word box.

1. Construct a quadrilateral with only one set of parallel sides.

Which shape did you create?

**WORD BOX**

Parallelogram

Trapezoid

Rectangle

Square

Rhombus

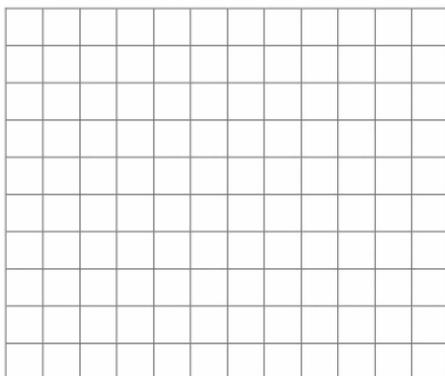
2. Construct a quadrilateral with one set of parallel sides and two right angles.

Which shape did you create?

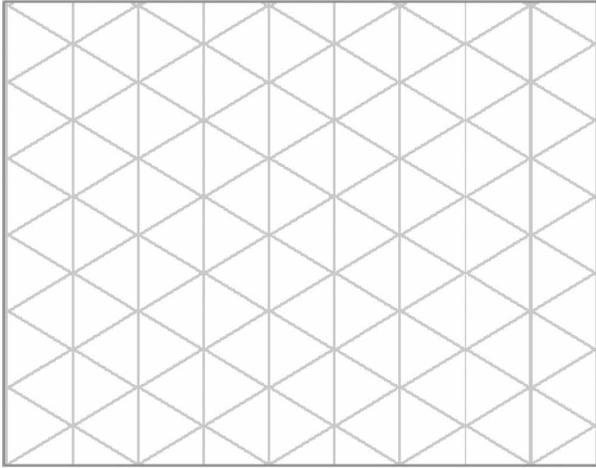


3. Construct a quadrilateral with two sets of parallel sides.

Which shape did you create?



4. Construct a quadrilateral with all sides of equal length.
Which shape did you create?



5. Construct a rectangle with all sides of equal length.
Which shape did you create?

