Geometry

In fifth grade, students are introduced to the coordinate plane. They learn to identify a location in the plane as an ordered coordinate pair (x, y), where x and y indicate the distances from the origin in the horizontal and vertical directions, respectively. Students use the coordinate plane to address geometry topics such as parallel and perpendicular lines and to represent real-world contexts such as locations on maps. In fifth grade, students work only in the first quadrant of the plane, where both the x- and y-coordinates are positive. When students are introduced to integers in sixth grade, they will work in all four quadrants.

Students in fifth grade also classify two-dimensional figures. They learn that attributes belonging to a category of two-dimensional figures also belong to all subcategories of that category. For example, given the fact that all rectangles have four right angles and that squares are rectangles, students conclude that all squares have four right angles.

The Grade 5 Common Core State Standards for Geometry specify that students should–

- Graph points on the coordinate plane to solve real-world and mathematical problems.
- Classify two-dimensional figures into categories based on their properties.

Geometry is a particularly visual domain, so concrete experiences are especially useful to students when they study geometry. The following hands-on activities provide teachers with a means to deliver the concrete experiences that many students will need. During the activities, teachers should elicit discussion among students to help them refine their communication skills and to help them construct their own understanding.

Geometry

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LESSON 1

Objective

Locate points on a coordinate plane.

Common Core State Standards

- **5.G.1** Use a pair of perpendicular number lines, called axes, to define a coordinate system, with the intersection of the lines (the origin) arranged to coincide with the 0 on each line and a given point in the plane located by using an ordered pair of numbers, called its coordinates. Understand that the first number indicates how far to travel from the origin in the direction of one axis, and the second number indicates how far to travel in the direction of the second axis, with the convention that the names of the two axes and the coordinates correspond (e.g., *x*-axis and *x*-coordinate, *y*-axis and *y*-coordinate).
- **5.G.2** Represent real world and mathematical problems by graphing points in the first quadrant of the coordinate plane, and interpret coordinate values of points in the context of the situation.

Geometry

Points on a Coordinate Plane

Students have been learning about distance, location, and direction. Now they will build on their knowledge as well as deepen their understanding of these concepts. Students are ready to learn that the numbers of an ordered pair are used to identify specific points on a coordinate plane. Using ordered pairs to identify and name points on a coordinate grid prepares students to find and navigate distances between points on a coordinate plane.

Try It! *Perform the Try It! activity on the next page.*

Talk About It

Discuss the Try It! activity.

- **Say:** *An ordered pair tells the location of a point on a grid.* **Ask:** *What does the first number tell us? What does the second number tell us?*
- **Ask:** *If two ordered pairs are (4, 3) and (3, 4), are they referring to the same location on the coordinate grid? Why or why not?*
- **Ask:** *What if a coordinate grid had the letters* A *through* D *along the side instead of numbers? How would that have changed the ordered pairs you named?*

Solve It

With students, reread the problem. Have them answer the question by writing a short paragraph. Tell students to be sure to use the term *ordered pair* and explain what it means in their answers by giving examples.

More Ideas

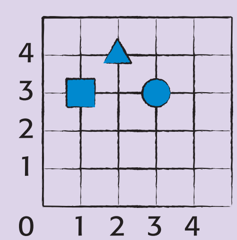
For other ways to teach about locating points on a coordinate plane—

- Have students use rubber bands to create simple shapes on Geoboards and then write down the coordinates for each peg that the rubber band touches.
- Have students gently toss five Two-Color Counters onto a Coordinate Grid (BLM 2). Students will record the coordinates indicating the locations of the counters that landed red side up. If a counter does not land exactly on a point, tell students to find the pair closest to where the counter landed.

Formative Assessment

Have students try the following problem.

Which ordered pair tells the location of the triangle?



A. (2, 4)

B. (1, 3)

C. (3, 3)

D. (4, 2)

Try It!

20 minutes | Pairs

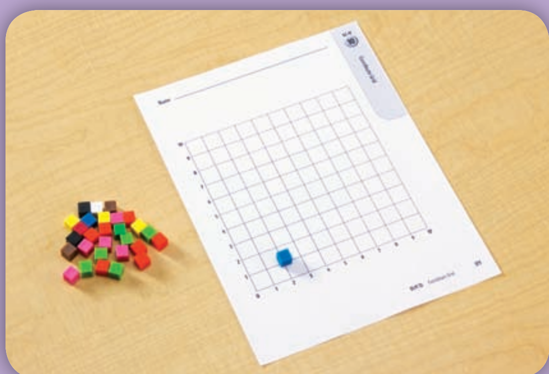
Here is a problem about locating points on a coordinate plane.

In the game Treasure Search, players mark secret spots on a grid where their treasure is. Then players take turns guessing the locations of their partner's treasure. If you are playing Treasure Search with a partner, how can you tell your partner which spot on the grid you are guessing without pointing to it?

Introduce the problem. Then have students do the activity to solve the problem. Distribute Centimeter Cubes, Coordinate Grids (BLM 2), and textbooks or folders to students.

Materials

- Centimeter Cubes (1 each of 3 different colors per student)
- Coordinate Grid (BLM 2; 2 per pair)
- large textbook or folder (1 per pair)



1. Say: *Ordered pairs tell you about locations on a grid. They have two numbers. The first one tells you how far right you should go. The second tells you how far up you should go.* Explain that ordered pairs always describe a location where two lines intersect. Have students find the ordered pair (2, 1) on their grids.

2. Instruct students to stand a textbook or folder on end between them, and place their Coordinate Grids on either side of the book so that neither partner can see the other's grid. Have students place each of their three cubes at a different point on the grid and label that point with the correct ordered pair.

3. Have pairs take turns guessing the locations of each other's cubes. Each time a student makes a guess, he or she should use an ordered pair to describe the location. Tell students that the partner who finds all three of his or her partner's cubes first wins the game.

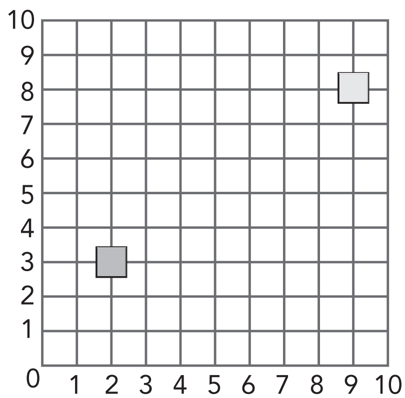
Look Out!

Students may have difficulty remembering which coordinate indicates the vertical position and which indicates the horizontal position on a plane. To help them remember to go over first and then up, relate the movements to climbing a tree. First, students must go *over* to the tree, and then they can climb *up* the tree.

Answer Key

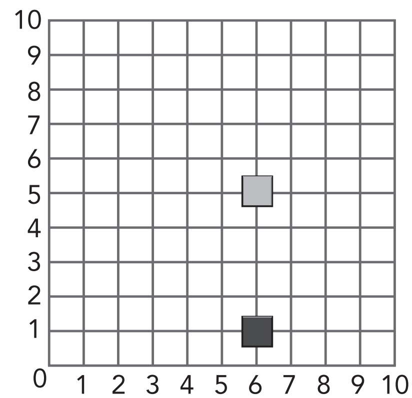
Use Centimeter Cubes to match each model. Write the ordered pair that corresponds to the location of the cube. (Check students' work.)

1.



(9, 8) (2, 3)

2.



(6, 5) (6, 1)

Using Centimeter Cubes and the coordinate grid, locate the point for each ordered pair. Then plot the point on the grid. Label each point.

3. *A* (1, 7)

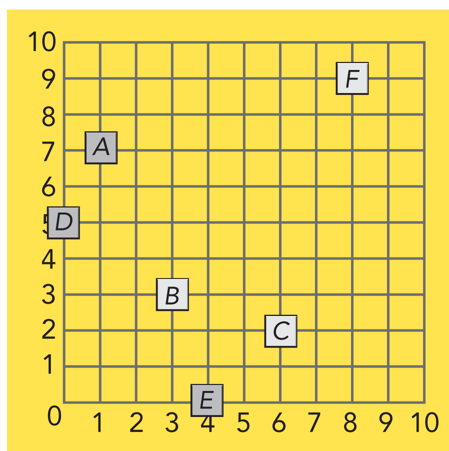
4. *B* (3, 3)

5. *C* (6, 2)

6. *D* (0, 5)

7. *E* (4, 0)

8. *F* (8, 9)



Graph each point on the coordinate grid. Label each point.

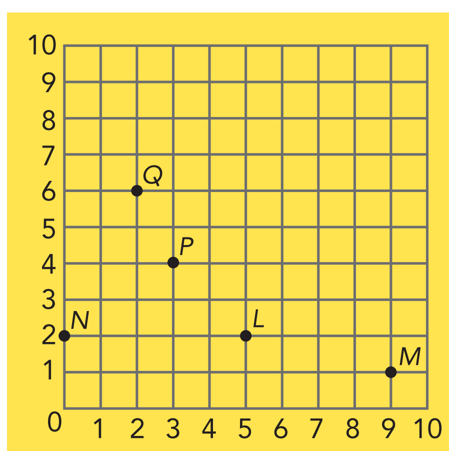
9. *L* (5, 2)

10. *M* (9, 1)

11. *N* (0, 2)

12. *P* (3, 4)

13. *Q* (2, 6)



Answer Key

Challenge! Describe to a friend how to graph an ordered pair on a coordinate grid.

Challenge: (Sample) Begin at the origin (0, 0). The first number of the ordered pair tells you how many places to move to the right. From that point, move up the number of places indicated by the second number.

LESSON 2

Objective

Locate and name points in the first quadrant of a coordinate grid.

Common Core State Standards

- **5.G.1** Use a pair of perpendicular number lines, called axes, to define a coordinate system, with the intersection of the lines (the origin) arranged to coincide with the 0 on each line and a given point in the plane located by using an ordered pair of numbers, called its coordinates. Understand that the first number indicates how far to travel from the origin in the direction of one axis, and the second number indicates how far to travel in the direction of the second axis, with the convention that the names of the two axes and the coordinates correspond (e.g., *x*-axis and *x*-coordinate, *y*-axis and *y*-coordinate).
- **5.G.2** Represent real world and mathematical problems by graphing points in the first quadrant of the coordinate plane, and interpret coordinate values of points in the context of the situation.

Geometry

Locating Points on a Coordinate Grid

A coordinate grid is formed by two perpendicular number lines, which are used to locate and name ordered pairs. The horizontal number line is referred to as the *x*-axis. The vertical number line is referred to as the *y*-axis. The two axes intersect at the origin. The origin is labeled with the ordered pair (0, 0). When naming ordered pairs, the *x*-axis coordinate is first, followed by the *y*-axis coordinate. The ordered pair is written with the *x*- and *y*-coordinates separated by a comma in a set of parentheses. For example, the ordered pair for the point five units right of (0, 0) (along the *x*-axis) and three units above (0, 0) (along the *y*-axis) is written as (5, 3).

Try It! *Perform the Try It! activity on the next page.*

Talk About It

Discuss the Try It! activity.

- Have students look at their coordinate grids.
- **Ask:** *How did you know where to mark the final ordered pair?*
- **Ask:** *What ordered pair marks the location of Sean's final cone?*

Solve It

With students, reread the problem. Suppose Sean wanted to alter his course to form a square. How could he move two points on his grid to make a square course? Name all four ordered pairs.

More Ideas

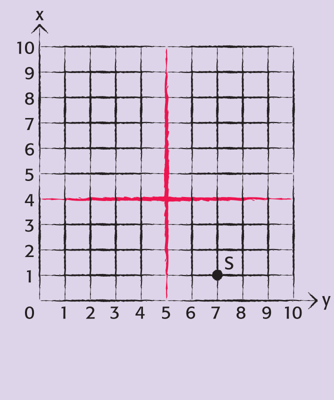
For other ways to teach about coordinate grids—

- Have students mark on a Coordinate Grid (BLM 2) ordered pairs that form a simple picture. Have students create a set of directions for other students to replicate the picture.
- Have students play "battleship" with Coordinate Grids; one student secretly marks locations of "ships" and the other guesses.

Formative Assessment

Have students complete the following activity.

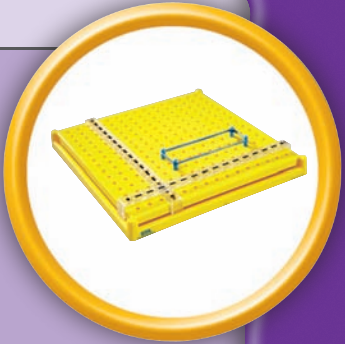
Name the point S *on the coordinate grid as an ordered pair. Mark a second point* B *on the grid that has a location of (5, 2).*



Try It! 30 minutes | Pairs

Here is a problem using a coordinate grid.

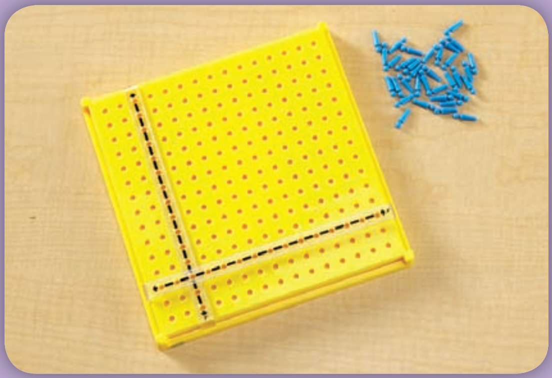
Sean wants to set up an obstacle course in his backyard. He wants to put cones at four corners of the course to make a rectangle. He makes a grid to mark the course. He marks the ordered pairs (2, 2), (10, 2), and (2, 8) as locations for placing cones. At which ordered pair should he place the final cone?



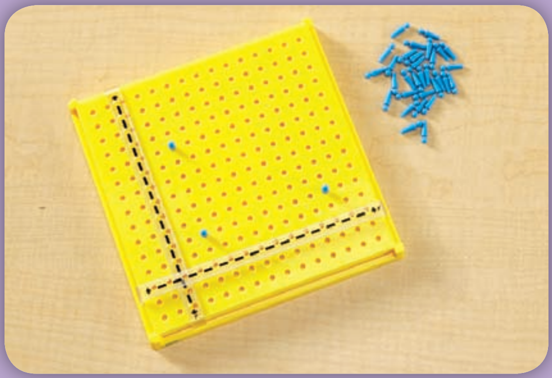
Introduce the problem. Then have students do the activity to solve the problem Distribute the XY Coordinate Pegboards to students.

Materials
- XY Coordinate Pegboard (1 per pair)

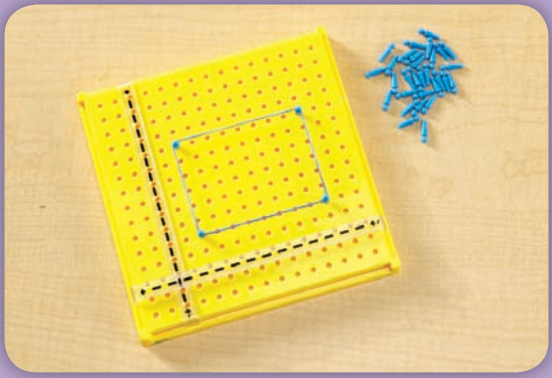
Say: *Follow the steps below to show Sean where to place the final cone.*



1. To begin, have students slide the bars that represent the horizontal and vertical number lines (axes) so the intersection of the lines is near the bottom left of the grid.



2. Have students use the pegs to mark the cones Sean has already set. Make sure they remember to start at the origin (the intersection of the axes) and count across the horizontal axis the number of units given first in each ordered pair, then up the number of units given second in the ordered pair.



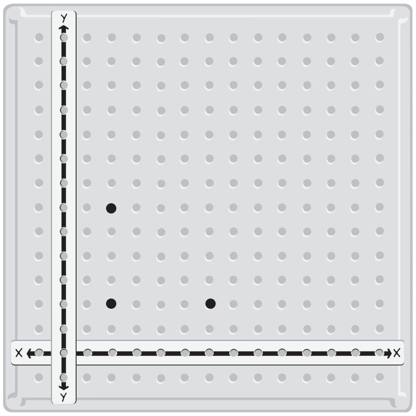
3. Determine the location of the fourth vertex that completes the rectangle. Determine its horizontal and vertical coordinates. Place a peg at the location of the ordered pair. Use a rubber band to check that your figure is a rectangle.

⚠ Look Out!

Watch for students who interchange the horizontal and vertical coordinate values when reading or writing ordered pairs. Remind them to start by moving left or right the distance specified by the first number and then going up or down the distance specified by the second number.

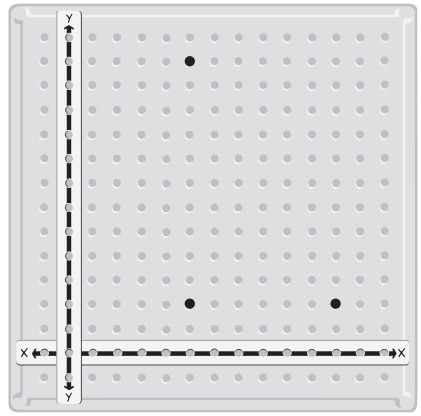
Use an XY Coordinate Pegboard, pegs, and rubber bands to model the points shown. Find the missing vertex of each rectangle. Write the ordered pair. (Check students' work.)

1.



(6, 6)

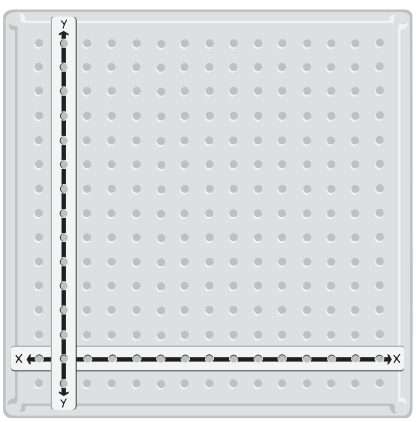
2.



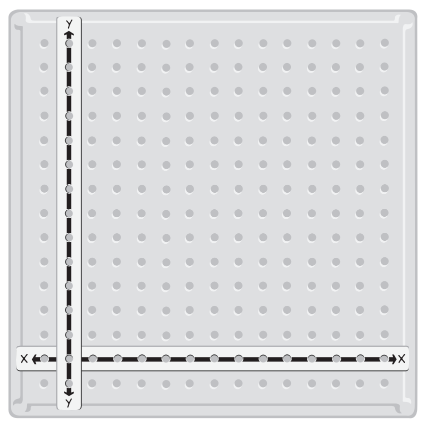
(11, 12)

Using an XY Coordinate Pegboard, pegs, and rubber bands, model each rectangle. Sketch the rectangle on the pegboards. Write the ordered pair for the missing vertex. (Check students' models.)

3. (3, 6), (3, 2), (8, 6), (8, 2)



4. (4, 4), (9, 4), (9, 11), (4, 11)



Find the missing vertex of each rectangle. Write the ordered pair.

5. (5, 5), (7, 7), (7, 5), (5, 7)

6. (1, 8), (1, 5), (2, 5), (2, 8)

7. (7, 3), (7, 9), (4, 3), (4, 9)

8. (2, 2), (5, 2), (2, 5), (5, 5)

9. (3, 0), (3, 6), (4, 6), (4, 0)

10. (4, 1), (8, 5), (8, 1), (4, 5)

Answer Key

Challenge! If you are given two ordered pairs that are vertices of a rectangle and the ordered pairs have different *x*-coordinates and different *y*-coordinates, can you find the ordered pairs of the other two vertices? If the *x*-coordinates of the ordered pairs you are given are the same, can you find the ordered pairs of the other two vertices? Explain both of your answers. Draw a picture to help. Assume the sides of the rectangle are parallel and perpendicular to the axes.

Challenge: (Sample) Yes; No; In the first case, you know the opposite vertices, so you can find the other vertices because you figure out the length and the width of the rectangle. In the second case, you have the vertices at the ends of one side of the rectangle and you only know one of the dimensions.

LESSON

3

Objective

Follow and create directions between points in the first quadrant of a coordinate grid.

Common Core State Standards

- **5.G.1** Use a pair of perpendicular number lines, called axes, to define a coordinate system, with the intersection of the lines (the origin) arranged to coincide with the 0 on each line and a given point in the plane located by using an ordered pair of numbers, called its coordinates. Understand that the first number indicates how far to travel from the origin in the direction of one axis, and the second number indicates how far to travel in the direction of the second axis, with the convention that the names of the two axes and the coordinates correspond (e.g., *x*-axis and *x*-coordinate, *y*-axis and *y*-coordinate).
- **5.G.2** Represent real world and mathematical problems by graphing points in the first quadrant of the coordinate plane, and interpret coordinate values of points in the context of the situation.

Geometry

Directions on a Coordinate Grid

Each location on a coordinate grid is unique. An ordered pair names the specific location on the grid. There are numerous paths that can be followed from one ordered pair to another.

Try It! *Perform the Try It! activity on the next page.*

Talk About It

Have students look at the marked grids and written directions used in the Try It! activity on the next page to explore following directions on coordinate grids.

- **Ask:** *What ordered pair represents the location of Laura's friend's house?*
- **Ask:** *Which other way could Laura locate her friend's house on the map?*

Solve It

With students, reread the problem. After leaving her friend's house, Laura decides to walk to the library, which is located at (3, 6) on the map. Write a sentence giving her directions to find the library from her friend's house and then from the library back to her house.

More Ideas

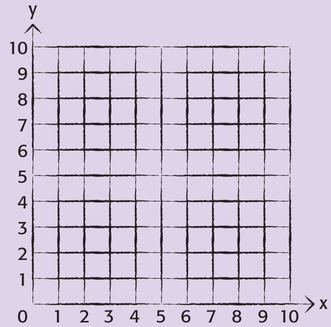
For other ways to teach about directions on coordinate grids—

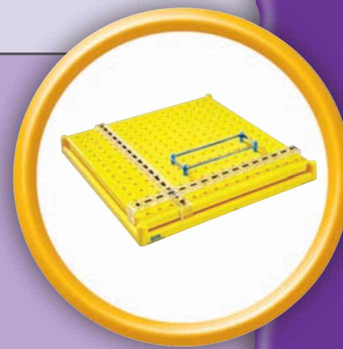
- Have students make coordinate grids and maps of the classroom or school on a Centimeter Grid (BLM 6) and write directions to and from various locations.
- Have students label a city street map (real or fictional) as a coordinate grid. They should write and follow directions to and from certain locations.
- Have students conduct an archeological "dig" (or other similar activity) using square netting with lines labeled as a coordinate grid to document the locations of "important findings."

Formative Assessment

Have students complete the following activity.

Write directions to get from (3, 10) to (7, 5) on a coordinate grid.





Try It! 30 minutes | Pairs

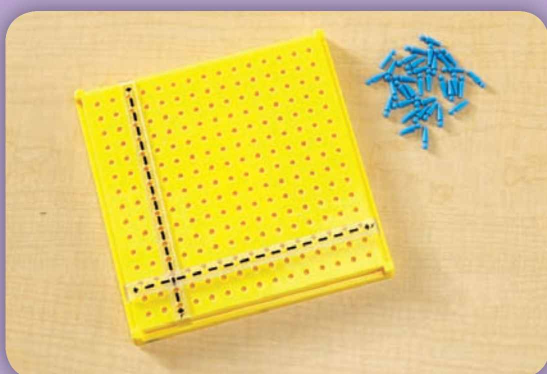
Here is a problem using a coordinate grid.

Laura is trying to get from her house to a friend's house by looking at the grid on a map. Laura's house is located at (4, 1). Her friend told her to follow the map up seven blocks and right four blocks. At what ordered pair on the map is her friend's house located?

Introduce the problem. Then have students do the activity to solve the problem.

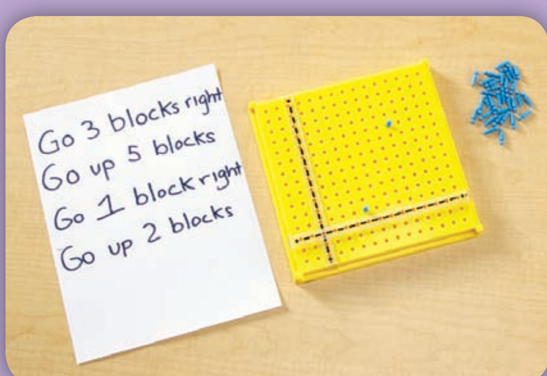
Say: *Follow the steps below to show Laura how to get to her friend's house.*

Materials
- XY Coordinate Pegboard (1 per pair)
- paper
- pencils



1. Slide the bars that represent the horizontal and vertical number lines (axes) so the intersection of these lines is near the bottom left of the grid.

2. Use a peg to mark the location of Laura's house. From the peg, follow the directions to find the location of Laura's friend's house. Name the ordered pair that represents the location of her friend's house.



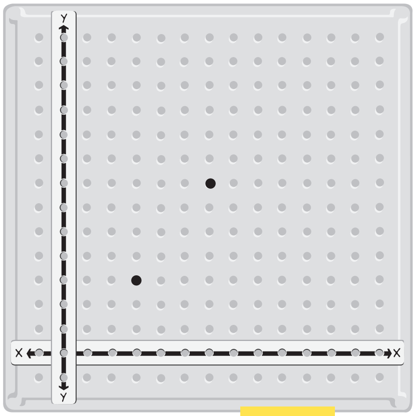
3. Write a set of alternative directions to locate Laura's friend's house on the map.

⚠ Look Out!

Watch out for students who reverse the directions. Remind them that you can start all sets of directions from the origin (0, 0). Also, look out for students who reverse the order of the coordinates.

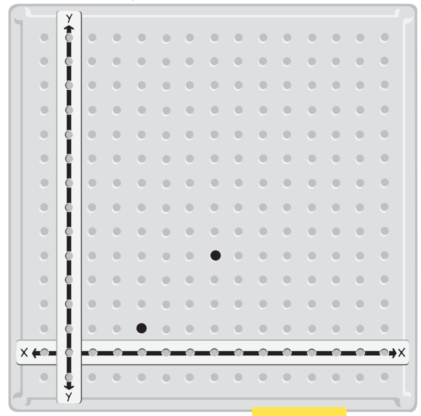
Use an XY Coordinate Pegboard and pegs to model each starting point and ending point. Find the ordered pair of the ending point, given the starting point. (Check students' work.)

1. From (6, 7), go 3 units left and 4 units down



Ending point: (3, 3)

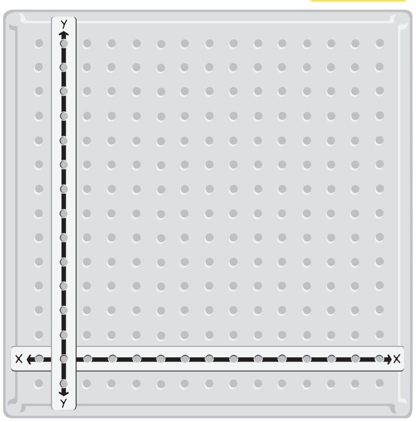
2. From (3, 1), go 4 units right, 3 units up, and 1 unit left



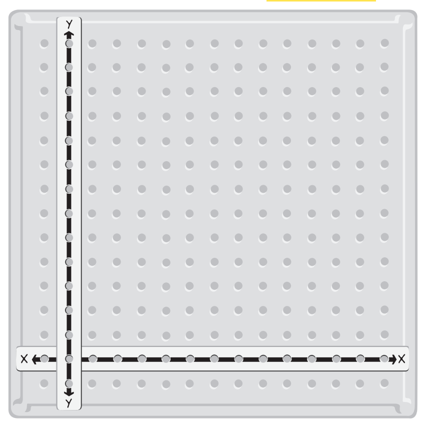
Ending point: (6, 4)

Using an XY Coordinate Pegboard and pegs, model each set of directions. Sketch the starting point and ending point. Write the ordered pair of the ending point. (Check students' models.)

3. **Start:** (2, 7); **Move:** 5 units right, 6 units down; **End:** (7, 1)



4. **Start:** (8, 9); **Move:** 3 units left, 4 units up; **End:** (5, 13)



Begin at the Start and follow the directions. Write the ordered pair where you end.

5. **Start:** (0, 2); **Move:** right 8 units, 4 units up; **End:** (8, 6)

6. **Start:** (6, 10); **Move:** left 1 unit, 3 units up; **End:** (5, 13)

7. **Start:** (4, 7); **Move:** left 2 units, 2 units down; **End:** (2, 5)

8. **Start:** (8, 6); **Move:** left 6 units, 3 units up; **End:** (2, 9)

Answer Key

Challenge! From the point (5, 3) you are given the direction to move left. What are the possible *x*-values of the ordered pair of the new point?

Challenge: 0, 1, 2, 3, and 4

LESSON 4

Geometry

Identify and Classify Triangles

Objective

Identify and classify triangles.

Common Core State Standards

- **5.G.3** Understand that attributes belonging to a category of two-dimensional figures also belong to all subcategories of that category. *For example, all rectangles have four right angles and squares are rectangles, so all squares have four right angles.*
- **5.G.4** Classify two-dimensional figures in a hierarchy based on properties.

Classifying triangles helps students develop reasoning skills that they will use when they study similar and congruent triangles. By building triangles, students visualize possible and impossible combinations of angles and side lengths. They also can learn to make generalizations about the properties of triangles.

Try It! *Perform the Try It! activity on the next page.*

Talk About It

Discuss the Try It! activity.

- **Ask:** *Is it possible to build a triangle with two right angles? Two obtuse angles? A right angle and an obtuse angle? What do you notice when you build a triangle that has a right or obtuse angle?*
- **Ask:** *Looking at the equilateral, isosceles, and scalene triangles, can you suggest any generalizations about these triangles?*

Solve It

Reread the problem with students. Have students describe the triangles they built and discuss the different ways students could sort the triangles.

More Ideas

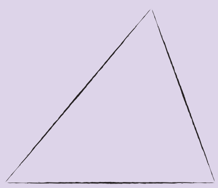
For other ways to teach about identifying and classifying triangles—

- Have students work in pairs. One student makes a triangle on a Geoboard and the other classifies the triangle by its angles and its sides.
- Draw a shape on the board, such as a rectangle bisected by two diagonals. Ask students to duplicate the shape on the Geoboard and find as many triangles as they can. Have students classify the triangles.

Formative Assessment

Have students try the following problem.

Which best describes the triangle?



A. acute, equilateral

B. obtuse, isosceles

C. acute, scalene

D. obtuse, scalene

Try It! 25 minutes | Groups of 4

Here is a problem about identifying and classifying triangles.

Andrew wants to make a quilt using triangles. How many types of triangles could Andrew use?

Introduce the problem. Then have students do the activity to solve the problem. Distribute AngLegs, recording charts, and pencils. Explain that all triangles have three sides and three angles. **Say:** *Triangles can be classified by their angles, their sides, or both.* Have students start two charts with the headings *Name of Triangle, Angles,* and *Sketch* on one chart and *Name of Triangle, Sides,* and *Sketch* on the other to record their results.

Materials

- AngLegs® (1 set per group)
- 4-Column Recording Chart (BLM 3; 3 per group)
- pencils (1 per group)

1. Say: *Triangles can be classified by their angles as* acute, obtuse, *or* right. Review the types of angles. Have students build a right triangle they can use to judge the angles in other triangles. **Say:** *Build examples of each type of triangle and record their properties.*

2. Say: *Triangles can be classified by their sides as* equilateral, isosceles, *or* scalene. Describe the triangles according to the number of congruent sides. Have students build and record each type of triangle. **Ask:** *Is an equilateral triangle also isosceles?*

3. Say: *Build all the different types of triangles classified by their angles and sides, for example* acute scalene. Have students start a third chart to record their findings. **Ask:** *How many types of triangles can you build?*

⚠ Look Out!

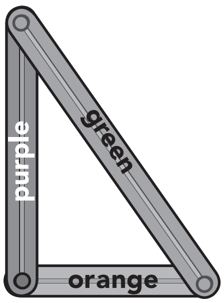
Some students may have difficulty building and sorting triangles classified by both angles and sides. Suggest that they start with the first type of angle on their recording sheet and then build as many triangles as possible using that type of angle and the three different types of sides. Then have them repeat this for each of the other types of angles.

Answer Key

Use AngLegs to model each triangle. Identify the triangle as acute, obtuse, or right. Also identify the triangle as equilateral, isosceles, or scalene.

(Check students' work.)

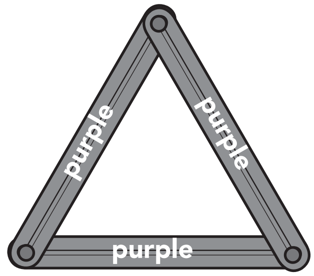
1\.



right

scalene

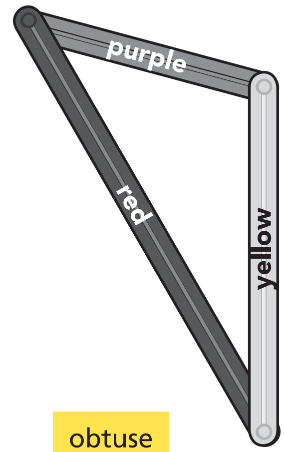
2\.



acute

equilateral

3\.



obtuse

scalene

Using AngLegs, model each of the triangles named. Sketch the model.

4. acute, scalene
Check students' sketches.

5. right, isosceles
Check students' sketches.

6. acute, equilateral
Check students' sketches.

7. obtuse, scalene
Check students' sketches.

8. obtuse, isosceles
Check students' sketches.

9. right, scalene
Check students' sketches.

The side lengths of triangles are given. Idenfity each triangle with as many names as you can.

10. 4 ft, 4 ft, 4 ft
acute
equilateral

11. 6 in., 10 in., 12 in.
obtuse
scalene

12. 12 cm, 12 cm, 5 cm
acute
isosceles

Answer Key

Challenge! Can you draw or build an equilateral obtuse triangle? Explain why or why not. Draw a picture to help.

Challenge: (Sample) No; An obtuse triangle must have an angle that has a measure greater than 90˚. An equilateral triangle has three angles that are congruent. The sum of the angles of a triangle is 180˚. Three obtuse angles cannot equal 180˚.

LESSON 5

Geometry

Identify and Classify Quadrilaterals

Objective

Identify and classify quadrilaterals.

Common Core State Standards

- **5.G.3** Understand that attributes belonging to a category of two-dimensional figures also belong to all subcategories of that category. *For example, all rectangles have four right angles and squares are rectangles, so all squares have four right angles.*
- **5.G.4** Classify two-dimensional figures in a hierarchy based on properties.

In this lesson, students investigate the properties of quadrilaterals by making models. They learn that some quadrilaterals can be classified in more than one way. Knowing the properties of quadrilaterals prepares students to find area and volume.

Try It! *Perform the Try It! activity on the next page.*

Talk About It

Discuss the Try It! activity.

- **Ask:** *Why can neither student make a trapezoid?*
- **Ask:** *What type of AngLegs® piece would you need to make a trapezoid? Which quadrilaterals have all right angles?*

Solve It

Reread the problem with students. Have them sketch each of the quadrilaterals and justify why they can or cannot make the quadrilaterals given each set of AngLegs. Have students compare their sketches.

More Ideas

For other ways to teach about identifying and classifying quadrilaterals—

- Have students use Pattern Blocks to identify and classify as many quadrilaterals as possible. Challenge them to combine shapes to build any type of quadrilateral that is missing from the Pattern Blocks set.
- Have students work in pairs. The first student describes at least three characteristics of a quadrilateral and the other student makes the quadrilateral on a Geoboard. The two students classify the quadrilateral in as many ways and as specifically as possible.

Formative Assessment

Have students try the following problem.

Which best describes the quadrilateral?

A. parallelogram

B. rectangle

C. rhombus

D. square

Try It! 25 minutes | Pairs

Here is a problem about identifying and classifying quadrilaterals.

Owen and Lili are using AngLegs to model shapes for an art project. Owen has 2 purple and 2 orange AngLegs. Lili has 4 green AngLegs. How many quadrilaterals can each student make?

Introduce the problem. Then have students do the activity to solve the problem. Distribute AngLegs, charts, and pencils to students. **Say:** *Figures with four sides and four angles are* quadrilaterals.

Materials

- AngLegs® (2 purple, 2 orange, and 4 green per pair)
- Quadrilaterals Chart (BLM 4; 2 per pair)
- paper (2 sheets per pair)
- pencils (2 per pair)

1. Tell students to refer to the chart and note the characteristics of a trapezoid. Then have them determine whether they can build a trapezoid. Tell students to mark the appropriate column—yes or no—at the bottom of the sheet.

2. Instruct students to repeat this process for each of the shapes listed in the chart. Have students tally the yes and no responses.

3. Have students note the similarities that exist among some of the shapes. Discuss, for example, that a square is a special rectangle, and that a rhombus is a special kite.

⚠ Look Out!

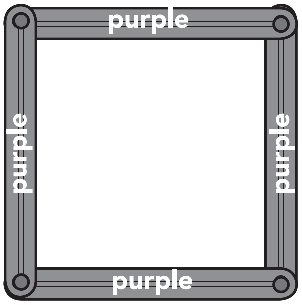
Some students may think that since any rhombus, rectangle, or square is a parallelogram that any parallelogram also must be a rhombus, a rectangle, and a square. Guide students to see that by definition a square, rectangle, and rhombus have special characteristics.

Answer Key

Use AngLegs to model each quadrilateral. Identify its characteristics. Name the quadrilateral.

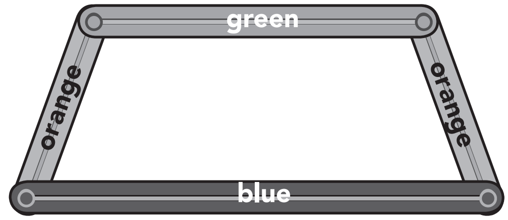
(Check students' work.)

1.



4 congruent sides, 4 right angles, 2 sets of parallel sides; square

2.



one set of parallel lines; trapezoid

Using AngLegs, model each quadrilateral named. Sketch the model.

3. rectangle

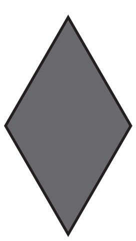
Check students' sketches.

4. parallelogram

Check students' sketches.

Identify each quadrilateral by name. Name the characteristics of the figure.

5.

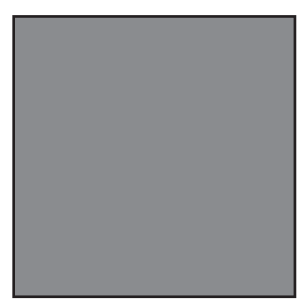


rhombus; 2 sets of parallel sides, 4 congruent sides

6.

rectangle; 2 sets of parallel sides, 4 right angles, 2 sets congruent sides

7.



square; 2 sets of parallel sides, 4 right angles, 4 congruent sides

Answer Key

Challenge! What do all quadrilaterals have in common? What do all parallelograms have in common? Name all the specific types of parallelograms and draw a picture of each.

Challenge: (Sample) All quadrilaterals have four sides; All parallelograms have two sets of parallel lines; square, rectangle, rhombus

LESSON 6

Objective

Identify and classify regular polygons.

Common Core State Standards

- **5.G.3** Understand that attributes belonging to a category of two-dimensional figures also belong to all subcategories of that category. *For example, all rectangles have four right angles and squares are rectangles, so all squares have four right angles.*
- **5.G.4** Classify two-dimensional figures in a hierarchy based on properties.

Geometry

Regular Polygons

Once students can identify and classify triangles and quadrilaterals by the measures of their sides and by their angles, they can explore the properties of regular polygons. In this lesson, students will characterize regular polygons in terms of their internal angles.

Try It! *Perform the Try It! activity on the next page.*

Talk About It

Discuss the Try It! activity.

- **Say:** *Consider all the shapes that you made.* **Ask:** *How are they the same? How are they different?* Elicit that the shapes are all polygons, and more specifically, that they are all regular polygons. Elicit also that the shapes have different side lengths, different numbers of sides, and different angle measures.
- **Ask:** *Is a right triangle a regular polygon? A trapezoid? Why is it not possible to classify these polygons as regular polygons?*
- **Ask:** *Can you see a pattern in the number of sides that a polygon has and the number of triangles that can be formed from one vertex? How can you state this as a rule?*

Solve It

Reread the problem with students. Have them sketch or trace the model of the hexagon and explain why the floor of the gazebo is a hexagon.

More Ideas

For other ways to teach about regular polygons—

- Extend the lesson by having students work in pairs using AngLegs® to build regular polygons with 7, 8, 9, and 10 sides. Have them draw each polygon and predict the measure of each internal angle and the sum of the angles using what they learned in the lesson. Tell students to test their predictions by dividing the polygons into triangles using a pencil and a straightedge.
- Give pairs of students Pattern Blocks. Have them sort the blocks into groups based on their properties. Have students verify their classification for each type of polygon by using rulers to measure the sides of the polygon and protractors to measure the angles.

Formative Assessment

Have students try the following problem.

Each angle in a regular polygon is 108°. Which polygon is it?

A. square **B.** pentagon **C.** hexagon **D.** octagon

Try It! 30 minutes | Groups of 4

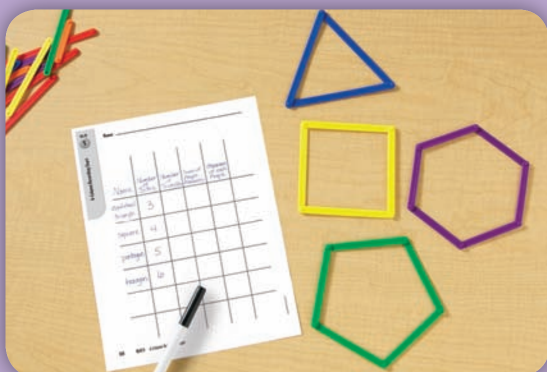
Here is a problem about classifying regular polygons.

The floor of a gazebo has the shape of a regular polygon. Each angle of the polygon measures 120°. What polygon describes the shape of the floor?

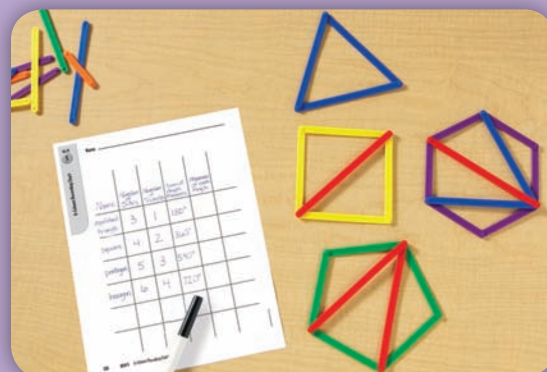
Introduce the problem. Then have students do the activity to solve the problem. Distribute AngLegs, recording charts, paper, and pencils to students. **Say:** *A* regular polygon *is a closed figure with all sides the same length and all angles the same measure.* Have students write the headings *Name, Number of Sides, Number of Triangles, Sum of the Angle Measures,* and *Measure of Each Angle* on their charts.

Materials

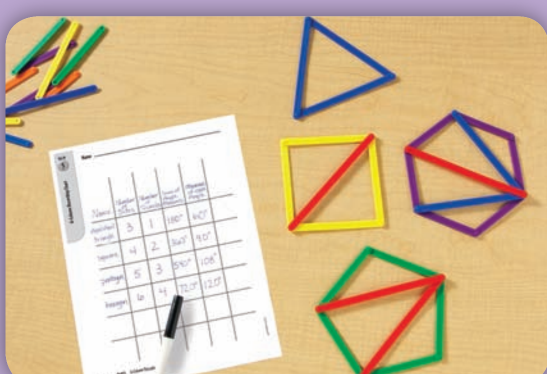
- AngLegs® (1 set per group)
- 6-Column Recording Chart (BLM 5; 1 per group)
- paper (1 sheet per group)
- pencils (1 per group)



1. Say: *Build a 3-sided polygon with blue AngLegs and a 4-sided polygon with yellow AngLegs.* **Ask:** *What are the names of these polygons? Are they regular?* Have students build 5-sided and 6-sided polygons using green and purple AngLegs, respectively, and name each polygon on the chart.



2. Say: *You can divide a polygon with more than three sides into triangles. Choose a vertex. Connect a red or blue AngLegs piece from that vertex to each of the other vertices.* Demonstrate to students how the sum of the internal angles is equal to 180° multiplied by the number of triangles formed. Have students find the sums of the internal angles of the polygons.



3. Say: *To find the measure of each angle in a regular polygon, divide the sum of its angle measures by the number of sides it has.* Have students complete the recording chart and determine the shape of the gazebo floor.

⚠ Look Out!

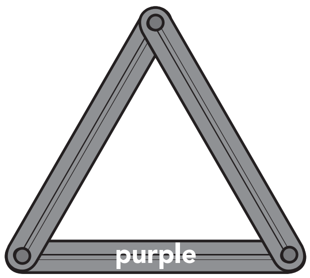
If students make models in Step 1 that look like irregular polygons, draw a regular pentagon and hexagon on the board and have students correct their models. The diagonals make the polygons rigid and enable students to count the triangles. Remind students that the angle measures in a regular polygon are equal.

Answer Key

Use AngLegs to model each regular polygon. What is the name of the polygon? Identify the sum of the measures of the interior angles of the polygon.

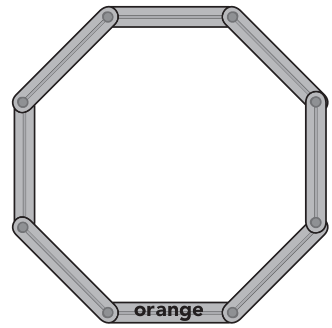
(Check students' work.)

1.



triangle; 180°

2.



octagon; 1,080°

Using AngLegs, model each regular polygon named. Sketch the model. What is the sum of the measures of the interior angles of the polygon?

(Check students' models.)

3. hexagon

720°

4. pentagon

540°

How many sides does each regular polygon have? What is the sum of the measures of the interior angles of each polygon?

5. decagon

10; 1,440°

6. heptagon

7; 900°

Answer Key

Challenge! Can the sum of the measures of the angles of a regular polygon be equal to 450°? Explain.

Challenge: No; 450° is not a multiple of 180°.

LESSON 7

Objective

Classify quadrilaterals using the lengths of their sides and the measurements of their angles.

Common Core State Standards

- **5.G.1** Use a pair of perpendicular number lines, called axes, to define a coordinate system, with the intersection of the lines (the origin) arranged to coincide with the 0 on each line and a given point in the plane located by using an ordered pair of numbers, called its coordinates. Understand that the first number indicates how far to travel from the origin in the direction of one axis, and the second number indicates how far to travel in the direction of the second axis, with the convention that the names of the two axes and the coordinates correspond (e.g., *x*-axis and *x*-coordinate, *y*-axis and *y*-coordinate).
- **5.G.2** Represent real world and mathematical problems by graphing points in the first quadrant of the coordinate plane, and interpret coordinate values of points in the context of the situation.
- **5.G.3** Understand that attributes belonging to a category of two-dimensional figures also belong to all subcategories of that category. *For example, all rectangles have four right angles and squares are rectangles, so all squares have four right angles.*
- **5.G.4** Classify two-dimensional figures in a hierarchy based on properties.

Geometry

Exploring Quadrilaterals: Sides and Angles

Students can be expected to examine the features of a variety of shapes, such as quadrilaterals, and describe the characteristics of those shapes. Even without specific exposure to the concept of *parallel,* many students will begin to form that understanding by measuring the sides and angles of the quadrilaterals encountered in this lesson. Students also will learn to articulate the differences and similarities among the types of quadrilaterals.

Try It! *Perform the Try It! activity on the next page.*

Talk About It

Discuss the Try It! activity.

- **Ask:** *Are all squares also rectangles? Explain.*
- **Ask:** *Are all rectangles also squares? Explain.*
- **Ask:** *Are all squares also parallelograms? Explain.*

Solve It

Reread the problem with students. Have them form quadrilaterals on a coordinate graph. Have them refer to the properties of quadrilaterals to determine which shape they have graphed.

More Ideas

For other ways to teach about the classification of quadrilaterals by sides and angles—

- Have students create the following quadrilaterals using AngLegs®: a square, a rectangle, a rhombus, a parallelogram, and a trapezoid. Have students measure and record the angles of the shapes they assemble. Then have students discuss the similarities and differences they notice among the figures.
- Have students use the XY Coordinate Pegboard and their knowledge of the properties of quadrilaterals to show that squares are rectangles, rectangles are parallelograms, and squares are rhombuses.

Formative Assessment

Have students try the following problem.

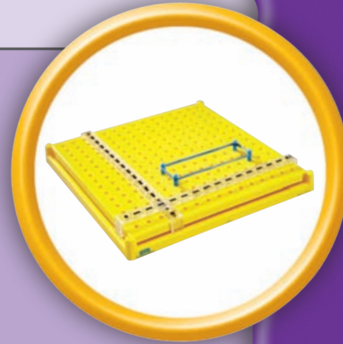
Which of the following statements is true?

A. All rectangles are squares.

B. All squares are rhombuses.

C. All parallelograms are rectangles.

D. All quadrilaterals are trapezoids.



Try It! 20 minutes | Pairs

Here is a problem about classifying quadrilaterals.

Jesse's soccer coach has the team doing drills from cone to cone. For each drill, the coach places four cones into a different configuration. The drills are named for the shape the cones make. Her coach made a grid to mark the placement of each cone. He marked the following ordered pairs on his grid:

Drill 1: (9, 12), (1, 12), (1, 4), and (9, 4)

Drill 2: (11, 14), (5, 14), (5, 2), and (11, 2)

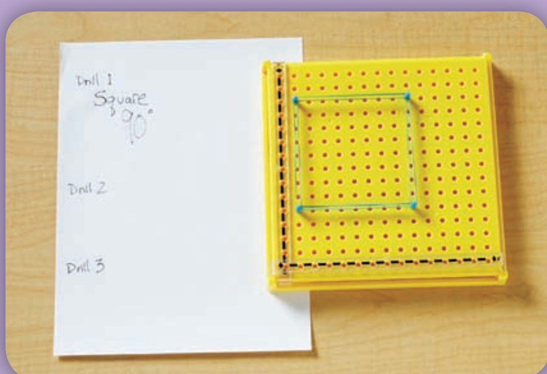
Drill 3: (13, 8), (4, 8), (0, 3), and (9, 3)

What are the names of the soccer drills Jesse will be doing? What angle will she have to turn at each cone?

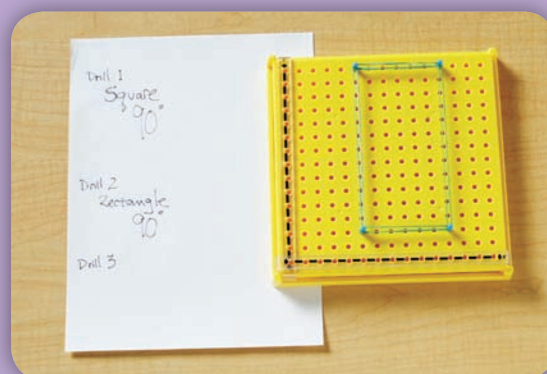
Introduce the problem. Then have students do the activity to solve the problem. If necessary, review quadrilaterals briefly with students. Distribute the materials. Have students set up their pegboards for Quadrant I graphing.

Materials

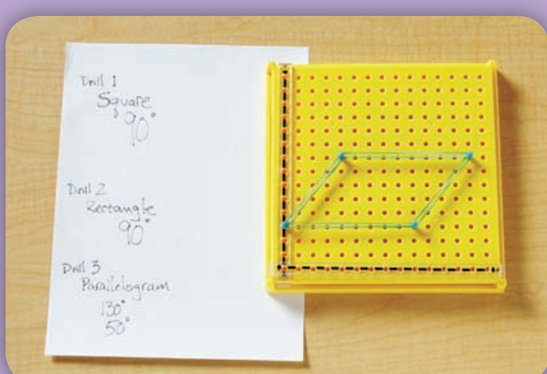
- XY Coordinate Pegboard (1 per pair)
- protractor or angle ruler
- Centimeter Grid (BLM 6; 1 per pair)



1. Have students plot the points for Drill 1 on the pegboard and connect the pegs with a rubber band. **Ask:** *What is the name of Jesse's first drill? What angle will Jesse have to turn at each cone?*



2. Next, have students plot Drill 2 on the pegboard and connect the pegs with a rubber band. **Ask:** *What is the name of the second drill? What angle will Jesse have to turn at each cone?*



Look Out!

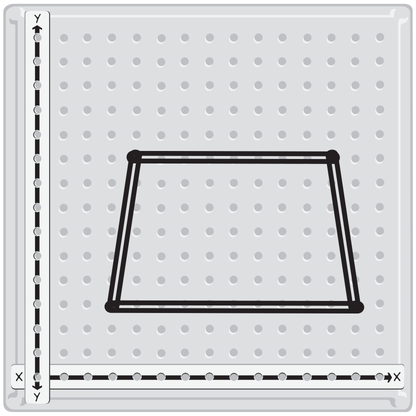
Some students may have trouble remembering the properties of the less common quadrilaterals and may benefit from illustrations and definitions of the quadrilaterals.

3. Have students plot Drill 3 on the pegboard and connect the pegs with a rubber band. **Ask:** *What is the name of the third drill?* Have students transfer this figure to graph paper and measure the angles. **Ask:** *What angle will Jesse have to turn at each cone?*

Use an XY Coordinate Pegboard. Model each quadrilateral shown. Classify the quadrilateral by measuring its sides and its angles. Justify your answer.

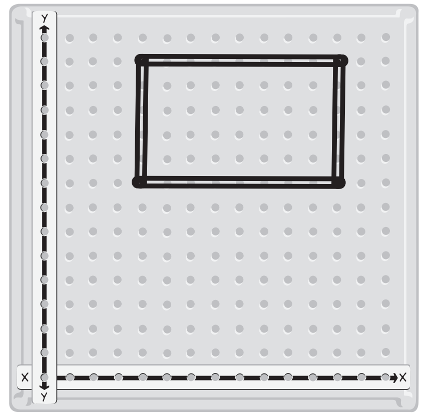
(Check students' work.)

1.



Trapezoid; the quadrilateral has exactly one pair of parallel sides.

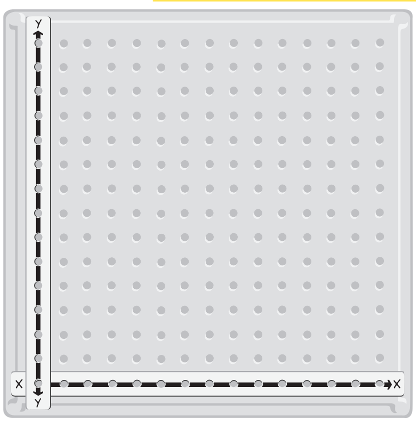
2.



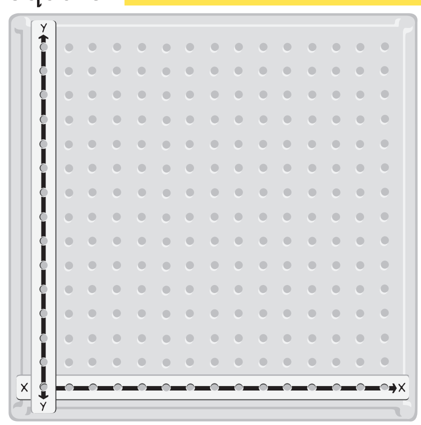
Rectangle; the quadrilateral has opposite sides that are the same length and four 90° angles.

Using an XY Coordinate Pegboard, model each quadrilateral named. Sketch the model.

3. rhombus Check students' models.



4. square Check students' models.



Name each quadrilateral described.

5. four equal sides, one angle 50°, another angle 130°

rhombus

6. two sides 6 inches long, two sides 4 inches long, one set of parallel lines, no right angles

trapezoid

7. two sides 30 cm long, two sides 70 cm long, four equal angles

rectangle

8. four equal sides, four 90° angles

square

Answer Key

Challenge! You are given the length of two adjacent sides of a quadrilateral. There are two sets of parallel sides and one right angle. Can you classify the quadrilateral? Explain. Can you identify the lengths of all four sides and all four angles? Draw a picture to help.

Challenge: (Sample) Yes; if the adjacent sides are congruent, the quadrilateral is a square, otherwise it is a rectangle; yes.