Lesson 15

Shapes in the Coordinate Plane

Goals

- Determine the total length of multiple horizontal and vertical segments in the coordinate plane that are connected end to end.
- Draw a polygon in the coordinate plane given the coordinates for its vertices.
- Explain (orally) that coordinates can be a useful way of describing geometric figures or modeling real-world locations.

Learning Targets

- I can find the lengths of horizontal and vertical segments in the coordinate plane.
- I can plot polygons on the coordinate plane when I have the coordinates for the vertices.

Lesson Narrative

In this lesson, students apply their understanding of rational coordinates and distance in the coordinate plane to construct polygons and navigate a maze. Students begin by constructing a polygon in the coordinate plane to meet given requirements. Next students plot coordinates in all four quadrants and connect points to create polygons. Lastly, students analyze the structure of a maze drawn in a coordinate plane to determine coordinates and distances.

Student Learning Goal

Let's use the coordinate plane to solve problems and puzzles.

Access for Students with Diverse Abilities

- Engagement (Activity 1)
- Representation (Activity 2)

Access for Multilingual Learners

- MLR5: Co-Craft Questions (Activity 2)

Required Materials

Materials to Gather

- Graph paper: Lesson

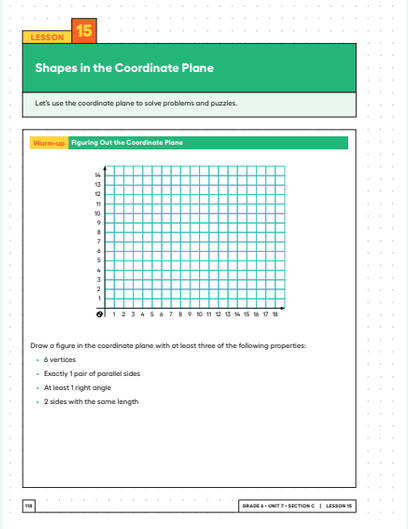
Required Preparation

Activity 1:
For the digital version of the activity, acquire devices that can run the applet.

Lesson Timeline

Warm-up	Activity 1	Activity 2	Lesson Synthesis	Assessment
5 min	15 min	15 min	10 min	5 min
				Cool-down

Student Workbook


LESSON 15

Shapes in the Coordinate Plane

Let's use the coordinate plane to solve problems and puzzles.

Warm-up Figuring Out the Coordinate Plane

Draw a figure in the coordinate plane with at least three of the following properties:

- 6 vertices
- Exactly 1 pair of parallel sides
- At least 1 right angle
- 2 sides with the same length

Warm-up

Figuring Out the Coordinate Plane

5 min

Activity Narrative

In this *Warm-up*, students review properties of figures and polygons within the context of graphing points in the coordinate plane. This will be useful when students create polygons in the coordinate plane in following activities.

Launch

Arrange students in groups of 2.

Give students 2 minutes of quiet work time.

Then tell students to check with their partner that their figures have at least three of the listed properties. Follow with a whole-class discussion.

Student Task Statement

1. Draw a figure in the coordinate plane with at least three of the following properties:
   - 6 vertices
   - Exactly 1 pair of parallel sides
   - At least 1 right angle
   - 2 sides with the same length

   Answers vary.

Activity Synthesis

The goal of this discussion is to review the characteristics of a polygon. Invite students to share their figure and its properties. Display these figures for all to see. After each student shares, ask the class if it is a polygon and how they know.

If necessary, remind students of these defining characteristics of a polygon:

- It is composed of line segments.
- Each line segment meets one and only one other line segment at each end.
- The line segments never intersect each other except at their endpoints.
- It lays flat in the coordinate plane.

Activity 1
Plotting Polygons

15 min

Activity Narrative

There is a digital version of this activity.

In this activity, students practice plotting points in the coordinate plane to make polygons.

In the digital version of the activity, students use an applet to plot points in the coordinate plane. The applet allows students to drag points to their location in the coordinate plane and quickly check their accuracy. The digital version may be helpful for students to quickly plot and adjust points of polygons without needing to erase.

Launch

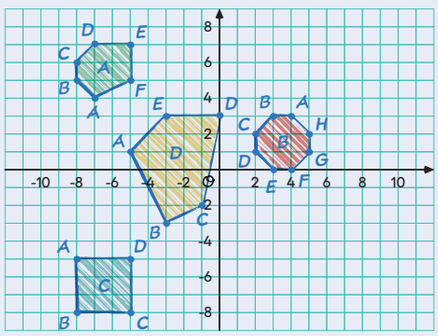
Arrange students in groups of 2.

Give students 10 minutes of quiet work time, and follow with a whole-class discussion.

Student Task Statement

Here are the coordinates for four polygons. Plot them on the coordinate plane, connect the points in the order that they are listed, and label each polygon with its letter name.

1. Polygon A: (-7, 4), (-8, 5), (-8, 6), (-7, 7), (-5, 7), (-5, 5), (-7, 4)
2. Polygon B: (4, 3), (3, 3), (2, 2), (2, 1), (3, 0), (4, 0), (5, 1), (5, 2), (4, 3)
3. Polygon C: (-8, -5), (-8, -8), (-5, -8), (-5, -5), (-8, -5)
4. Polygon D: (-5, 1), (-3, -3), (-1, -2), (0, 3), (-3, 3), (-5, 1)



Are You Ready for More?

Find the area of Polygon D in this activity.

19.5 square units

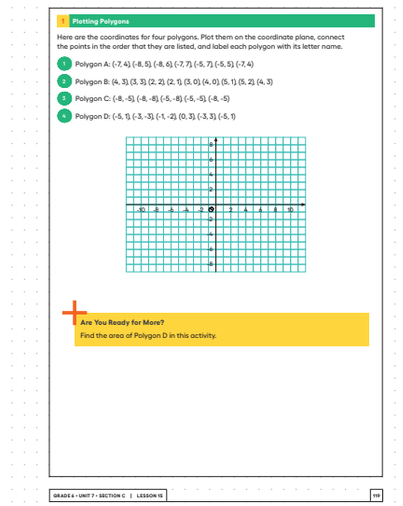
There are many possible approaches to this problem: Students can partition the polygon into squares and right triangles, or they can draw a rectangle around the polygon, then subtract the area outside the polygon from the area of the rectangle.

Access for Students with Diverse Abilities (Activity 1, Student Task)

Engagement: Provide Access by Recruiting Interest.
Leverage choice around perceived challenge. Invite students to select 2–3 of the polygons to plot on the coordinate plane.

Supports accessibility for: Organization, Social-Emotional Functioning

Student Workbook


1 Plotting Polygons

Here are the coordinates for four polygons. Plot them on the coordinate plane, connect the points in the order that they are listed, and label each polygon with its letter name.

1. Polygon A: (-7, 4), (-8, 5), (-8, 6), (-7, 7), (-5, 7), (-5, 5), (-7, 4)
2. Polygon B: (4, 3), (3, 3), (2, 2), (2, 1), (3, 0), (4, 0), (5, 1), (5, 2), (4, 3)
3. Polygon C: (-8, -5), (-8, -8), (-5, -8), (-5, -5), (-8, -5)
4. Polygon D: (-5, 1), (-3, -3), (-1, -2), (0, 3), (-3, 3), (-5, 1)

Are You Ready for More?
Find the area of Polygon D in this activity.

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Access for Multilingual Learners (Activity 2, Launch)

MLR5: Co-Craft Questions
Keep books or devices closed. Display only the maze, without revealing the questions. Give students 2–3 minutes to write a list of mathematical questions that could be asked about this situation, then give students time to compare their questions with a partner. Invite each group to contribute one written question to a whole-class display. Ask the class to make comparisons among the shared questions and their own. Reveal the intended questions for this task, and invite additional connections.

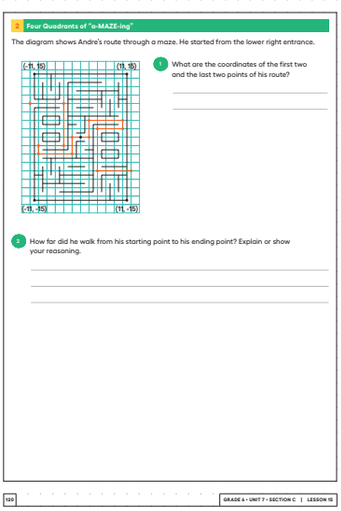
Advances: Reading, Writing

Access for Students with Diverse Abilities (Activity 2, Student Task)

Representation: Internalize Comprehension.
Check in with students after the first 2–3 minutes of work time. Check to make sure students have selected appropriate coordinates for the first points of Andre's route through the maze.

Supports accessibility for: Conceptual processing; Organization

Student Workbook


Four Quadrants of "a-MAZE-ing"

The diagram shows Andre's route through a maze. He started from the lower right entrance.

(-11, 15) (11, 15)

(-11, -15) (11, -15)

1. What are the coordinates of the first two and the last two points of his route?

2. How far did he walk from his starting point to his ending point? Explain or show your reasoning.

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Activity Synthesis

The purpose of the discussion is to emphasize the connection between numbers, the coordinate plane, and geometry. To highlight these connections, ask:

- *"How is the coordinate plane related to the number line?"*

  The coordinate plane has two axes that are both number lines.

- *"How are we able to make polygons in the coordinate plane?"*

  The vertices of a polygon are plotted as points in the coordinate plane.

Complete the connection by explaining to students that the coordinate plane allows us to describe shapes and geometry in terms of numbers. This is how computers are able to create two- and three-dimensional images even though they can only interpret numbers.

Activity 2

Four Quadrants of "a-MAZE-ing"

15 min

Activity Narrative

In this activity students practice plotting coordinates in all four quadrants and find horizontal and vertical distances between coordinates in a puzzle. Students must determine from the information given that each grid square has length 2.

Launch

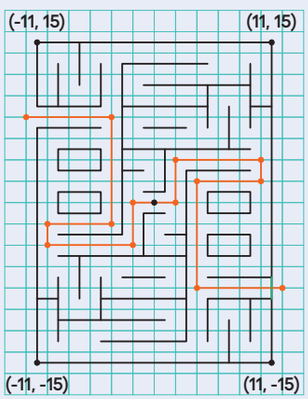
Arrange students in groups of 2. Tell students that they should not assume that each grid box is 1 unit.

Give students 8 minutes of quiet work time and 2 minutes for a partner discussion.

Follow with a whole-class discussion.

Student Task Statement

The diagram shows Andre's route through a maze. He started from the lower right entrance.



1. What are the coordinates of the first two and the last two points of his route?

   The coordinates of the first two points are (12, -8) and (4, -8). The coordinates of the last two points are (-4, 8) and (-12, 8).

2. How far did he walk from his starting point to his ending point? Explain or show your reasoning.

   80 units

   Sample reasoning: Counting grid squares as steps, Andre went 40 steps. Each step was 2 units, so the journey was a total of 80 units.

Activity Synthesis

The purpose of this discussion is for students to see that it is possible to find distances and describe situations involving movement using the coordinate plane. This idea is important because it means we can use numbers (in this case, pairs of numbers in the coordinate plane) to model situations that involve distance or movement, which will be useful in later lessons. To highlight these ideas, consider asking:

- *"How were you or your partner able to find the coordinates in the maze? Did you come up with any strategies or shortcuts?"*
- *"How did you find the distances that Andre and Jada traveled?"*
- *"What other situations involving movement could be represented with a coordinate plane?"*

Students may come up with examples like board games, maps, and perhaps even three-dimensional examples.

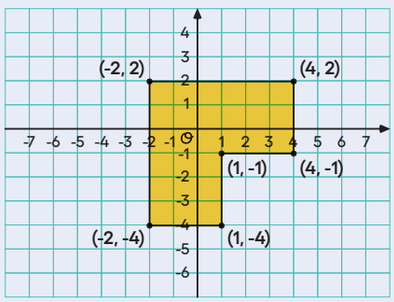
Lesson Synthesis

Give each student graph paper, and tell them to draw and label the axes in a coordinate plane. Ask students to create a drawing with a perimeter of 30 units using a continuous path of horizontal and vertical line segments. Tell students to identify the coordinates of the vertices and verify that the perimeter is the given length.

If time allows, arrange students in groups of 2, and ask them to recreate their partner's figure in a coordinate plane with only verbal information. Ask students to explain why coordinates are useful for communicating information about flat space. Consider displaying student work for all to see throughout the rest of the unit. It may be interesting for students to see the variety of figures that all have a perimeter of 30 units.

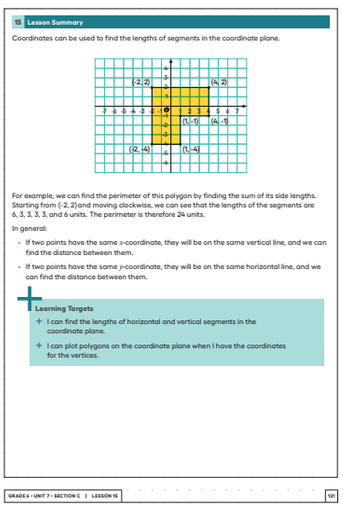
Lesson Summary

Coordinates can be used to find the lengths of segments in the coordinate plane.



For example, we can find the perimeter of this polygon by finding the sum of its side lengths. Starting from (-2, 2) and moving clockwise, we can see that the lengths of the segments are 6, 3, 3, 3, 3, and 6 units. The perimeter is therefore 24 units.

Student Workbook


15 Lesson Summary

Coordinates can be used to find the lengths of segments in the coordinate plane.

For example, we can find the perimeter of this polygon by finding the sum of its side lengths. Starting from (-2, 2) and moving clockwise, we can see that the lengths of the segments are 6, 3, 3, 3, 3, and 6 units. The perimeter is therefore 24 units.

In general:

- If two points have the same x-coordinate, they will be on the same vertical line, and we can find the distance between them.
- If two points have the same y-coordinate, they will be on the same horizontal line, and we can find the distance between them.

Learning Targets

- I can find the lengths of horizontal and vertical segments in the coordinate plane.
- I can plot polygons on the coordinate plane when I have the coordinates for the vertices.

Responding To Student Thinking

Press Pause
If most students struggle with finding distances between points plotted in all four quadrants, make time to revisit this concept in the practice problem referred to here. See the Course Guide for ideas to help students re-engage with earlier work.

Grade 6, Unit 7, Lesson 17, Practice Problem 4

In general:

- If two points have the same x-coordinate, they will be on the same vertical line, and we can find the distance between them.
- If two points have the same y-coordinate, they will be on the same horizontal line, and we can find the distance between them.

Cool-down

Perimeter of a Polygon

5 min

Student Task Statement

1. Plot the following points in the coordinate plane, and connect them in the order listed to create a polygon.

$A(1, 3)$

$B(3, 3)$

$C(3, -2)$

$D(-2, -2)$

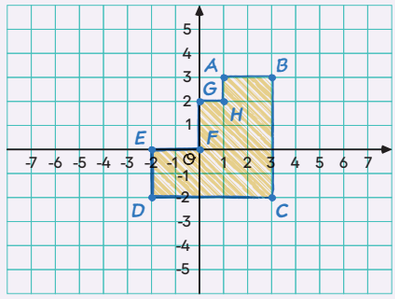
$E(-2, 0)$

$F(0, 0)$

$G(0, 2)$

$H(1, 2)$

$I(1, 3)$



2. Find the perimeter of the polygon.

The perimeter is 20 units.

Lesson 15

Practice Problems

4 Problems

Problem 1

The coordinates of a rectangle are (3, 0), (3, -5), (-4, 0) and (-4, -5).

a. What is the length and width of this rectangle?

The length is 7 units, and the width is 5 units.

b. What is the perimeter of the rectangle?

The perimeter is 24 units, because 7 + 7 + 5 + 5 = 24.

c. What is the area of the rectangle?

The area is 35 square units, because 7 · 5 = 35.

Problem 2

Draw a square with one vertex on the point (-3, 5) and a perimeter of 20 units. Write the coordinates of each other vertex.

Sample response: The coordinates of each point are (-3, 5), (-3, 0), (2, 5), (2, 0).

Problem 3

a. Plot and connect the following points to form a polygon.

(-3, 2), (2, 2), (2, -4), (-1, -4), (-1, -2), (-3, -2), (-3, 2)

The plotted polygon is a hexagon.

b. Find the perimeter of the polygon.

22 units

Sample reasoning: Going in the same order as the points listed, the sides of the polygon have lengths 5, 6, 3, 2, 2, and 4 units.

Problem 4

from Unit 6, Lesson 4

For each situation, select **all** the equations that represent it. Choose one equation and solve it.

a. Jada's cat weighs 3.45 kg. Andre's cat weighs 1.2 kg more than Jada's cat. How much does Andre's cat weigh?

$x = 3.45 + 1.2$ $x = 3.45 - 1.2$ $x + 1.2 = 3.45$ $x - 1.2 = 3.45$

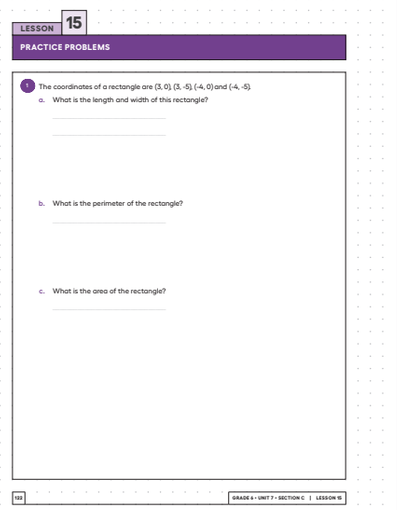
$x = 4.65$

b. Apples cost $1.60 per pound at the farmer's market. They cost 1.5 times as much at the grocery store. How much do the apples cost per pound at the grocery store?

$y = (1.5) \cdot (1.60)$ $y = 1.60 \div 1.5$ $(1.5)y = 1.60$ $\frac{y}{1.5} = 1.60$

$y = 2.40$

Student Workbook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PRACTICE PROBLEMS

1 The coordinates of a rectangle are (3, 0), (3, -5), (-4, 0) and (-4, -5).

a. What is the length and width of this rectangle?

b. What is the perimeter of the rectangle?

c. What is the area of the rectangle?

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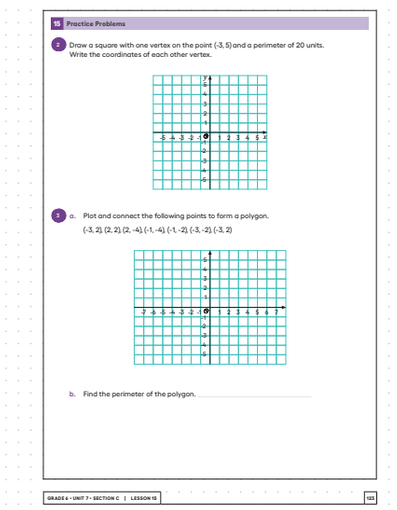
Student Workbook


15 Practice Problems

2 Draw a square with one vertex on the point (-3, 5) and a perimeter of 20 units. Write the coordinates of each other vertex.

3 a. Plot and connect the following points to form a polygon.
(-3, 2), (2, 2), (2, -4), (-1, -4), (-1, -2), (-3, -2), (-3, 2)

b. Find the perimeter of the polygon.

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