Investigation 1

Coordinate Grids

In this Investigation, you will use a coordinate grid to locate points on the plane. You will then explore how to find distances between points and areas of figures on a coordinate grid.

In the first two Problems of this Investigation, the coordinate grid is in the form of a street map of a fictional city called Euclid. The streets in most cities do not form perfect coordinate grids as they do in Euclid. However, many cities have streets that are loosely based on a coordinate system. One well-known example is Washington, D.C.

Common Core State Standards

Essential for 8.G.B.6 Explain a proof of the Pythagorean Theorem and its converse.

Essential for 8.G.B.8 Apply the Pythagorean Theorem to find the distance between two points in a coordinate system.

The map on the next page shows the central part of Washington, D.C. The city's street system was designed by Pierre L'Enfant in 1791.

L'Enfant's design is based on a coordinate system. Here are some key features of L'Enfant's system:

- The north-south and east-west streets form grid lines.
- The origin is at the Capitol.
- The vertical axis is formed by North and South Capitol Streets.
- The horizontal axis is the line stretching from the Lincoln Memorial, through the Mall, and down East Capitol Street.
- The axes divide the city into four quadrants known as Northeast (NE), Northwest (NW), Southwest (SW), and Southeast (SE).
- Describe the locations of these landmarks:

  George Washington University

  Dupont Circle

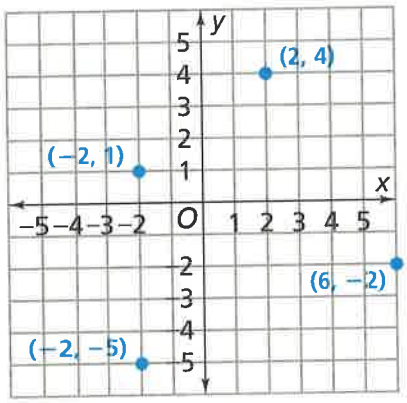
  Benjamin Banneker Park

  The White House

  Union Station

- How can you find the distance from Union Station to Dupont Circle?
- Find the intersection of G Street and 8th Street SE and the intersection of G Street and 8th Street NW. How are these locations related to the U.S. Capitol Building?

In mathematics, you use a coordinate system to describe the locations of points. Recall that horizontal and vertical number lines, called the x- and y-axes, divide the plane into four quadrants.

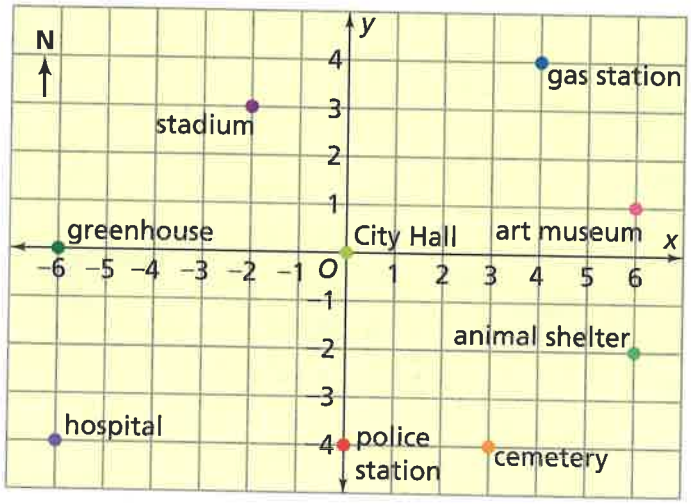


You describe the location of a point by giving its coordinates as an ordered pair of the form (x, y). The coordinate grid above shows four points labeled with their coordinates. For example, the point $(-2, -5)$ is 2 units to the left and 5 units below the origin.

1.1 Driving Around Euclid

Locating Points and Finding Distances

The founders of the city of Euclid loved math. They named their city after a famous mathematician, and they designed the street system to look like a coordinate grid. The Euclideans describe the locations of buildings and other landmarks by giving coordinates. For example, the art museum is located at (6, 1).



- In the city of Euclid, how does driving distance compare to flying distance?

Problem 1.1

A Give the coordinates of each landmark in the map above.

1. gas station
2. animal shelter
3. stadium

Problem 1.1 continued

B Euclid's chief of police is planning emergency routes. She needs to find the shortest route between the following pairs of locations:

Pair 1: the police station to City Hall

Pair 2: the hospital to City Hall

Pair 3: the hospital to the art museum

1. Give precise directions for an emergency car route for each pair.
2. For each pair, find the total distance in blocks a police car following your route would travel.

C

1. The stadium is at $(-2, 3)$ and the high school is at $(1, 8)$. What is the shortest driving distance (in blocks) between these two locations? Can you figure this out without looking at the grid? Explain.
2. Suppose you know the coordinates of two landmarks in Euclid. How can you determine the shortest driving distance (in blocks) between them?

D

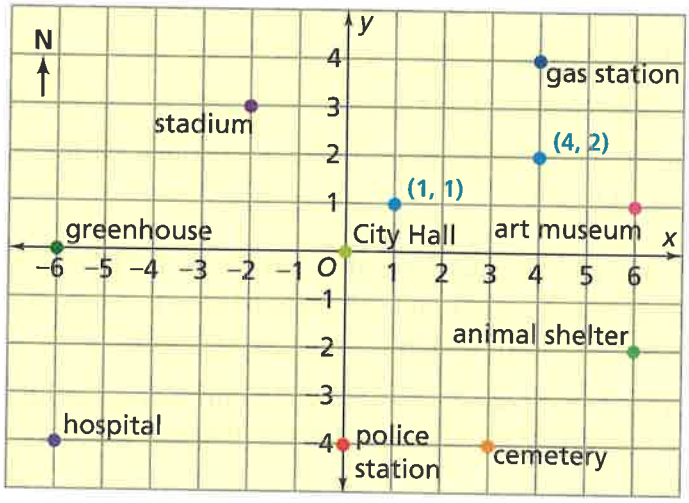
1. A helicopter can travel directly from one point to another. For each pair in Question B, find the approximate distance (in blocks) a helicopter would have to travel to get from the starting location to the ending location. You may find it helpful to use a centimeter ruler.
2. Will a direct helicopter route between two locations always be shorter than a car route? Explain your reasoning.

ACE Homework starts on page 14.

1.2 Planning Parks

Shapes on a Coordinate Grid

The Euclid City Council is developing parks with geometric shapes. For some of the parks, the council gives the park designers constraints. For example, Descartes Park must have corners at vertices (1, 1) and (4, 2).



- What information do you need to show that the shape made by connecting four vertices is a square?

Problem 1.2

For each Question, explain how you know Descartes Park is the given shape.

A Suppose the park is a square. What could the coordinates of the other two vertices be? Give two answers.

B Suppose the park is a rectangle that is not a square. What could the coordinates of the other two vertices be?

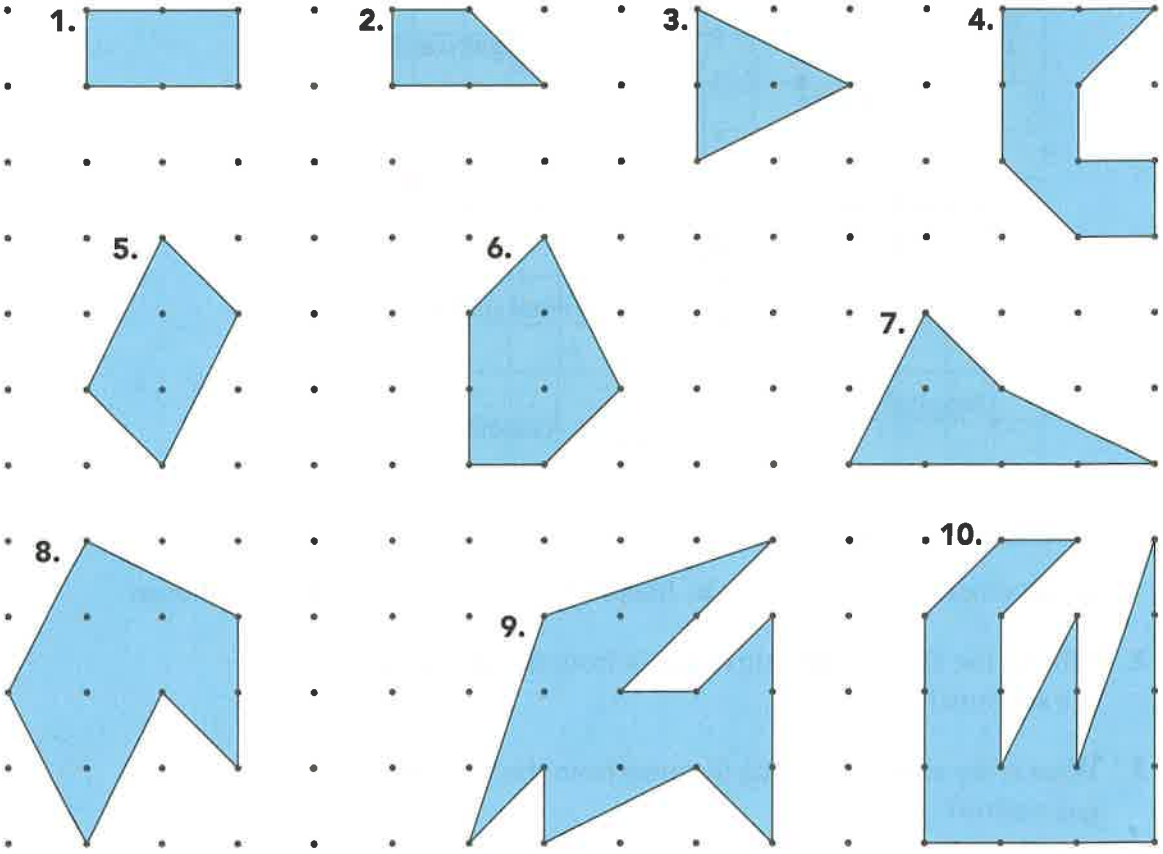
C Suppose the park is a right triangle. What could the coordinates of the other vertex be?

D Suppose the park is a parallelogram that is not a rectangle. What could the coordinates of the other two vertices be?

ACE Homework starts on page 14.

1.3 Finding Areas

Below are some park designs submitted to the Euclid City Council. To determine costs, the council needs to know the area of each park.



- How might you find the areas of irregular figures on dot paper?

Problem 1.3

Consider the horizontal or vertical distance between two adjacent dots to be 1 unit.

A Find the area of each figure.

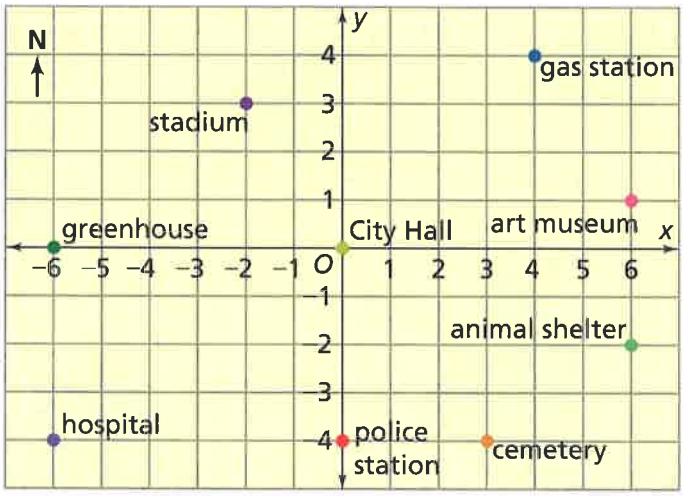
B Find the area of one of the square parks you suggested in Problem 1.2.

C Describe the strategies you used in Questions A and B.

ACE Homework starts on page 14.

Applications

For Exercises 1–7, use the map of Euclid from Problem 1.1.



1. Give the coordinates of each landmark.

a. art museum **b.** hospital **c.** greenhouse

2. What is the shortest driving distance from the animal shelter to the stadium?

3. What is the shortest driving distance from the hospital to the gas station?

4. Suppose you travel by taxi. What are the coordinates of a point halfway from City Hall to the hospital? Is there more than one possibility? Explain.

5. Suppose you traveled by helicopter. What are the coordinates of a point halfway from City Hall to the hospital? Is there more than one possibility? Explain.

6. a. Which landmarks are 7 blocks from City Hall by car?

b. Give precise driving directions from City Hall to each landmark you listed in part (a).