Teacher Guide: City Tour

Learning Objectives

Students will…

- Describe the position of a point on a city map based on its avenue and street.
- Write coordinates as an ordered pair.
- List the coordinates of a location on a grid.
- Given the coordinates of a point, move to the correct location on a grid.

Vocabulary

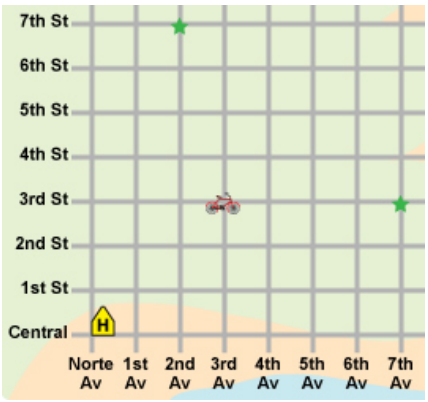
coordinates, horizontal axis, ordered pair, origin, vertical axis

Lesson Overview

In the *City Tour* Gizmo™, students are sightseers visiting fictional cities full of interesting landmarks. Students will list the coordinates of a given point on a grid, and move to a point given its coordinates.

The Student Exploration sheet contains two activities:

- Activity A – Students learn to write the coordinates of a point and find a point based on its coordinates.
- Activity B – Students practice their coordinate skills by participating in a scavenger hunt in several cities.



Bike tour of San Cristobel

Suggested Lesson Sequence

1. **Pre-Gizmo activity** (10 – 20 minutes)
   Arrange the chairs in your classroom into rows and columns. (Be sure to use the terms "rows" and "columns" the same way they are used in graphs – rows go across, columns go front-back or up-down.) After students sit down, ask them to describe the position of a student in the room. For example, a student may be in the 3rd row, 4 seats from the left.

   Project a street map of Midtown Manhattan in New York City. (See **Selected Web Resources**.) Point out the grid system, with numbered streets and avenues. Ask why it would be easy to find your way around Manhattan, even if you don't have a map.

   Read the address of a street corner, such as 5th Avenue and 42nd Street, and have students practice locating these points on the Manhattan map. When students are comfortable identifying these locations, switch to ordered pair notation, such as (5, 42).

2. **Prior to using the Gizmo** (10 – 15 minutes)
   Before students are at the computers, pass out the Student Exploration sheets and ask students to complete the Prior Knowledge Questions. Discuss student answers as a class. At this point, letting students share how they thought about the questions is more valuable than "going over" the correct answers. After the discussion, if possible, use a projector to introduce the Gizmo and demonstrate its basic operations.

3. **Gizmo activity** (15 – 20 minutes per activity)
Assign students to computers. Students can work individually or in small groups. Have students work part of the Student Exploration sheet using the Gizmo. Alternatively, you can use a projector and do the Exploration as a teacher-led activity. (Gizmo note: The landmarks in Randomaria are randomly placed. Each student will find them at different locations, and those locations will change each time the student returns there.)

It may be overwhelming for students to do all of the activities in the Student Exploration in one sitting. We recommend starting with the first page of the Student Exploration sheet (Prior Knowledge Questions and Gizmo Warm-up) plus one of the two activities. Extend the lesson if you want using the extensions below. Return to the Gizmo and the unused activities in future class periods to reinforce the concepts.

4. **Extending the Gizmo** (15 – 20 minutes each)
Here are some suggestions for extending the activities in the Student Exploration sheet.

Activity A Extension – Project the Gizmo to the class. Drag arrows from the left side of the Gizmo to points on the San Cristobel map, and ask students to list the coordinates of each point. Then ask students to mark a point based on the coordinates you read out.

In the Gizmo, have students practice moving from point to point using the "Move from my location" mode. Then ask students how they would get from one point to another if all they know are the coordinates. For example, how would you travel from (2, 9) to (8, 4)? (Correct answer: Move 6 blocks east and 5 blocks south.)

Activity B Extension – With students at their computers, ask additional questions based on the fictional landmarks in the Gizmo. You can have a contest based on which student (or group) finds the answer first. Here are a few examples:

- Where would you go to buy pemmican or a rabbit fur? (Snowden trading post)
- Where can you learn to ride a bucking bronco? (Cactus Dude Ranch in Saltuna)
- What is the smelliest thing to do in Morivec? (Sewer tours)
- Where is the "ancient technologies" exhibit? (Randomaria Archaeology Museum)

5. **Follow-up activity: Four-quadrant grids** (30 – 40 minutes)
In the elementary grades, most grids have a single quadrant (no negative numbers). When students are comfortable with these coordinate systems, you can introduce the four-quadrant grids (with negative numbers) that are used extensively in later grades.

Continuing the city map analogy, you can show students a four-quadrant grid where directions (north, south, east, west) are used rather than positive and negative numbers. When students have mastered this type of map, introduce four-quadrant grids that use positive and negative numbers to specify locations relative to the origin.

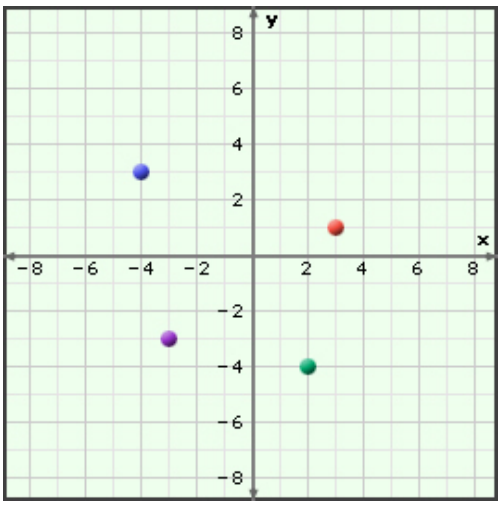
A closely related skill is finding the latitude and longitude of a point on a map. However, be sure to point out that the order of the coordinates on a map is the opposite of the order used on an *xy* graph. On a graph, the ordered pair (5, 3) means a point is 5 units east and 3 units north of the origin. On a map, the ordered pair (50° N, 30° E) is a point 50 degrees *north* of the Equator and 30 degrees *east* of the Prime Meridian.

Mathematical Background

The coordinate system we use today is known as the **Cartesian coordinate system**. It is named after the French mathematician René Descartes (pronounced "reh-NAY day-KART"). According to legend, Descartes was lying in bed one morning, watching a fly buzzing around on a ceiling of square tiles. Descartes realized that he could describe the position of the fly by stating its distance from the edges of the ceiling.

In reality, the basics of coordinate systems had been used for hundreds of years, starting with the Greeks. Various Greek scholars—Eratosthenes, Hipparchus, and Ptolemy—created world maps that used reference lines similar to the lines of latitude and longitude we use today.

In the Cartesian system, each point on a two-dimensional plane is defined by its distance to a set of perpendicular axes that intersect at the **origin**. Each point is given as an **ordered pair** in the form (*x*, *y*). The *x* term gives the distance east or west of the origin; the *y* term gives the distance north or south of the origin. A negative *x*-value indicates that a point is west of the origin, and a negative *y*-value indicates that a point is south of the origin.



In the graph to the right, the coordinates of the four points are as follows:

Red point:	(3, 1)	Blue point:	(-4, 3)
Green point:	(2, -4)	Purple point:	(-3, -3)

By adding a third "*z*" axis, the Cartesian system can also be used to locate a point in three-dimensional space. The *z* coordinate indicates a point's position above or below the origin. (If you are looking down on a piece of paper with the *x*- and *y*-axes marked, you can imagine the *z*-axis pointing directly out of the paper toward your face, as well as through the paper and out the other side.)

Cartesian coordinates have many applications. They can be used to locate positions on a map, to define the vertices of a polygon, or to show the graph of an equation. Graphs are used extensively in many branches of mathematics including statistics, algebra, geometry, trigonometry, and calculus.

Selected Web Resources

Midtown Manhattan map: http://www.aaccessmaps.com/show/map/manhattan_midtown
Coordinates lesson plan: http://www.shodor.org/interactivate/lessons/CartesianCoordinate/
The story of the coordinate plane: http://mathforum.org/cgraph/history/intro.html
The Cartesian plane: http://www.purplemath.com/modules/plane.htm
Coordinate simulations/games:

- http://www.oswego.org/ocsd-web/games/BillyBug2/bug2.html
- http://www.learner.org/teacherslab/math/geometry/shape/taxicab/index.html
- http://www.shodor.org/interactivate/activities/SimpleCoordinates/?version=1.5.0_06&browser=MSIE&vendor=Sun_Microsystems_Inc.
- http://education.jlab.org/topquarkgame/index.html