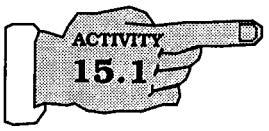


OBJECTIVE: **Illustrate a coordinate system on a square lattice**

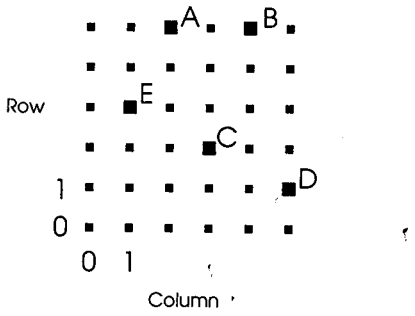
1. In previous chapters you have worked with a geoboard or with a square lattice. The points in an array like the one pictured can also be identified using coordinates.

   First, number the columns from left to right.

   Then, number the rows beginning with the bottom row.

   A point can be identified by giving its column number and its row number, in that order.

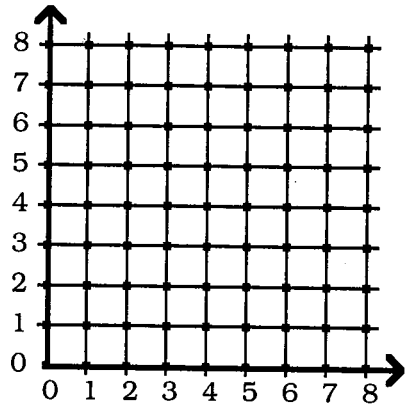
   For example, point A has coordinates (2, 5).



   Find the coordinates of the following points.

   a. B b. C c. D d. E

2. Connecting the dots in each row and column yields the grid pattern to the right. The grid could be extended to include more points as illustrated.



   a. Plot the points A (2, 1), B (6, 1), C (6, 2), D (5, 3), E (5, 6), F (4, 8), G (3, 6), H (3, 3), and I (2, 2).

   b. Connect A to B, B to C, . . . , and I to A. What type of polygon have you drawn?

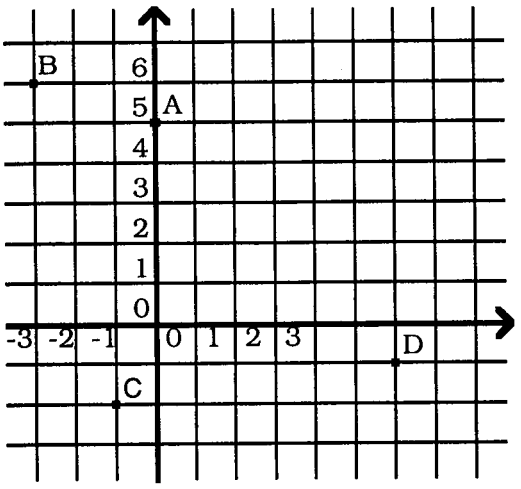
3. Point A has coordinates (0, 5).

   We could extend the grid to the left and label it with integers. Then we see point B has coordinates (-3, 6).

   A similar extension of the grid allows us to find coordinates for points such as C and D.

   What are the coordinates of points C and D?

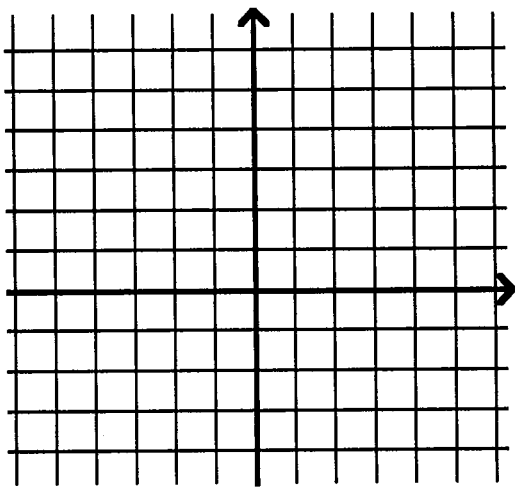
   C = (,) D = (,)



4. The grid system we now have is called the **Cartesian coordinate system**, in honor of the mathematician René Descartes.

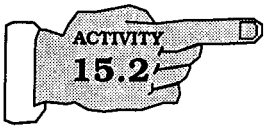
   The two darkened lines that are perpendicular to each other are called the **axes** (singular is axis). Here we call the horizontal line the ***x*-axis** and the vertical line the ***y*-axis**. They meet at the point called the **origin**, which has coordinates (0, 0).

   a. Plot the points A (5, 2), B (3, -1), C (-2, 5), D (1, -4), E (-3, -4), and F (-6, -2).



   b. The axes divide the plane into 4 regions, called **quadrants**. These are numbered I to IV, counterclockwise, beginning in the upper right-hand region. Identify the quadrant that each of the points A through F is in.

   c. In quadrant I all coordinates are positive. What do the coordinates of all the points in quadrant II have in common? in quadrant III? in quadrant IV?



OBJECTIVE: **Practice plotting points**

You Will Need: Materials Card 15.2 or graph paper

1. Place the origin at the lower left corner.

2. Locate these points on your coordinate plane.

A (12, 12)	B (12, 20)	C (20, 20)	D (20, 12)
E (16, 24)	F (24, 24)	G (24, 16)	H (16, 16)

Make solid line segments $\overline{AB}$, $\overline{AD}$, $\overline{AH}$, $\overline{BE}$, $\overline{EF}$, $\overline{EH}$, $\overline{DG}$, $\overline{FG}$, $\overline{GH}$. Make dashed line segments $\overline{BC}$, $\overline{CF}$, $\overline{CD}$. Do you see a cube? _____
Which face looks closer to you, face ABCD or face EFGH?

3. Divide each coordinate in A, B, C, D, E, F, G, H by 2 to get new points A', B', C', D', E', F', G', H'. Complete the following.

A' (6, 6)	B' (,)	C' (,)	D' (,)
E' (,)	F' (,)	G' (,)	H' (,)

4. Locate A', B', C', D', E', F', G', H' on your graph. Make similar solid and dashed lines as you did in part 2. Do you see a cube? ____

5. Now divide the coordinates in A', B', C', D', E', F', G', H', by 2 to get points A", B", C", D", E", F", G", H". Complete the following.

A" (3, 3)	B" (,)	C" (,)	D" (,)
E" (,)	F" (,)	G" (,)	H" (,)

6. Locate the points in part 5 on your graph. Make similar solid and dashed lines as you did in parts 2 and 4.

7. Draw a straight line connecting B, B', and B". Draw another line connecting C, C', and C". Draw another line connecting D, D', and D". Extend your three lines so that they intersect. Do they meet at the origin? ____

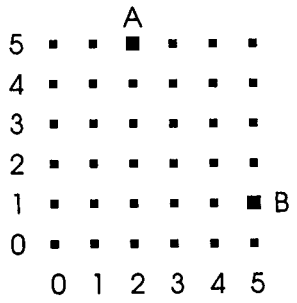
8. Turn your paper half-way around. What do you see? Would the title "The Shrinking Cube" be appropriate for this activity?

9. Can you draw another cube that lines up with the three you have drawn and is smaller than all the others? Draw it.

The next activities explore the concepts of **distance** and **slope** in the Cartesian coordinate system.

OBJECTIVE: **Develop the idea of distance in the plane**

1. a. Points A and B are shown to the right on a portion of a square lattice. What are their coordinates?
   A (,) B (,)



   b. Form a right triangle with segment $\overline{AB}$ as the hypotenuse. Draw the vertical line through A and the horizontal line through B. Name the point where these lines intersect point C. What are the coordinates of point C? C (,)

   c. What is the length of segment $\overline{AC}$? of $\overline{BC}$?

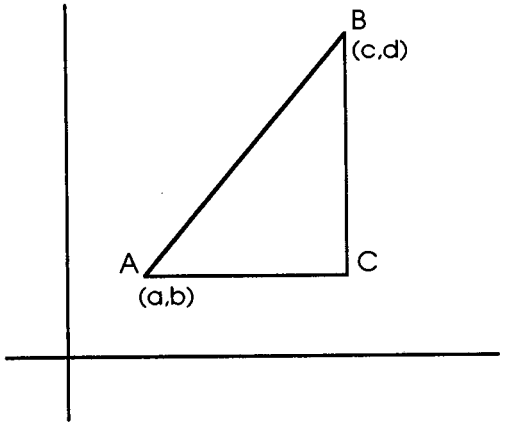
   d. Use the Pythagorean theorem to find the length of segment $\overline{AB}$; AB = _____

2. On the following coordinate grid, points A and B are given with their coordinates.

   a. Point C is located at the intersection of the horizontal line through A and vertical line through B. What are the coordinates of C? _____

   b. What is the distance between A and C? _____
   between B and C?_____

   c. Use the Pythagorean theorem to find the distance between A and B.

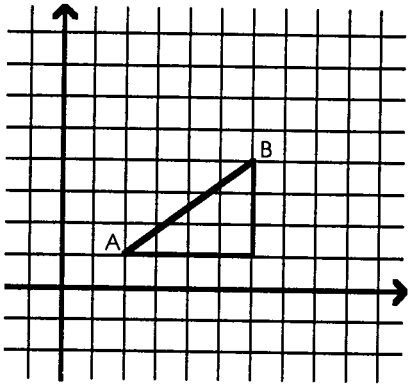


Summarize: If A is the point (a, b) and B is the point (c, d), then the distance from A to B is

This result is known as the **coordinate distance formula**.

ACTIVITY 15.4

OBJECTIVE: **Investigate the slope of a line**



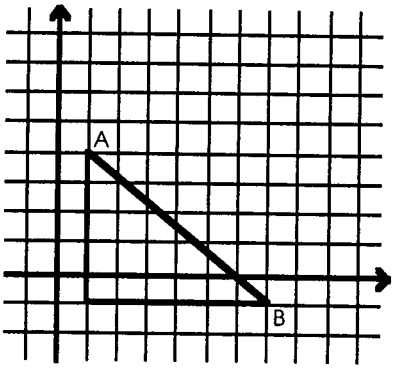
1. The **slope** of a line segment $\overline{AB}$ is defined as the ratio of rise/run where rise is the vertical change from A to B and run is the horizontal change from A to B.

   Imagine that segment $\overline{AB}$ is a road up a hill.

   a. What is the vertical change from A to B? ____

   b. What is the horizontal change from A to B? ____

   c. What is the ratio of rise/run?



2. Sometimes, the 'rise' may be negative.

   a. What is the vertical change from A to B? ____

   b. What is the horizontal change from A to B? ____

   c. What is the slope of segment $\overline{AB}$? ____

3. On the grid to the right are points A and B with their coordinates *(a, b)* and *(c, d)*, respectively.

   a. What is the vertical change from A to B? ____

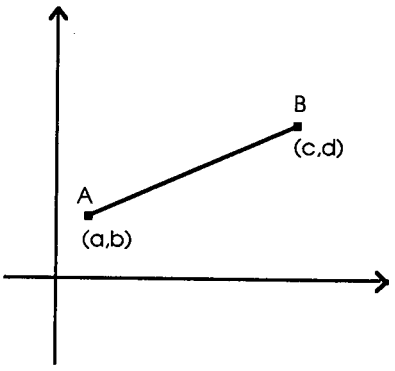
   b. What is the horizontal change from A to B? ____

   c. What is the slope of segment $\overline{AB}$? ____

   d. What is the vertical change from B to A? ____

   e. What is the horizontal change from B to A? ____

   f. What is the slope of the segment $\overline{BA}$? ____



   g. Compare your results in parts (c) and (f). What to you observe?

Summarize: If A is the point *(a, b)* and B is the point *(c , d)*, then the slope of line segment $\overline{AB}$ (where $a \neq c$) is

This result is known as the **slope formula** for a line segment.