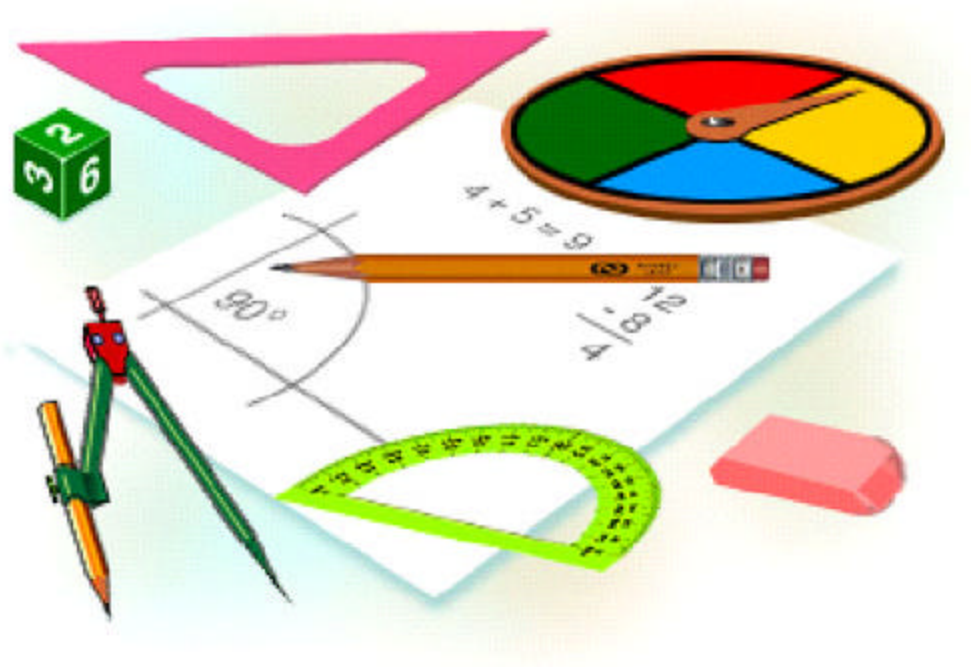
The Next Step

Mathematics Applications for Adults



Book 14018 – Graphs

OUTLINE

Mathematics - Book 14018

Graphs
Introduction To Graphs
answer questions about information contained in graphs.
construct a variety of graphs, given the necessary information.
write a table of values for any relation.
Problem Solving Using Graphs
solve multi-step problems requiring the performance of any combination of mathematical operations involving graphs, with or without a calculator.

THE NEXT STEP

Book 14018

Graphs

Introduction to Graphs

Plotting Information

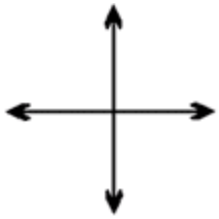
A ***graph*** is a kind of drawing or diagram that shows ***data***, or information, usually in numbers. In order to make a graph, you must first have data.

Making a Coordinate Graph

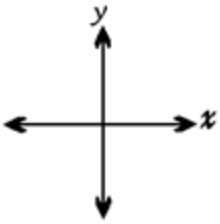
Many graphs show information on a ***grid***. The grid is made up of lines that intersect to create a screen pattern. The bottom line of the grid is called the ***horizontal axis*** and the vertical line on the left or right is called the ***vertical axis***.

The Plane

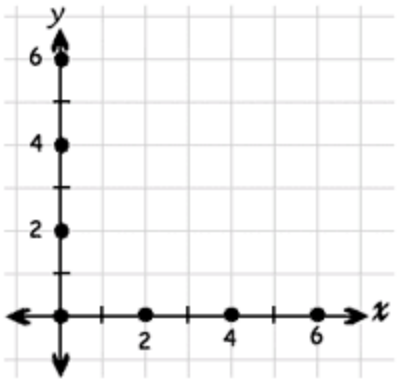
Here is a picture of a plane. Two lines are drawn inside the plane. Each of these lines is an axis. (Together they are called axes.) The axes are like landmarks that we can use to find different places in the plane.



We can label the axes to make them easier to tell apart. The axis that goes from side to side is the x-axis, and the axis that goes straight up and down is the y-axis.



Let's zoom in on one corner of the plane. (This corner is called the first quadrant.)



We have marked some of the points on each axis to make them easier to find. The point where the two axes cross has a special name: it is called the origin.

The gray lines will help us find points. When you make your own graphs, you can use the lines on your graph paper to help you.

Finding Points in the Plane

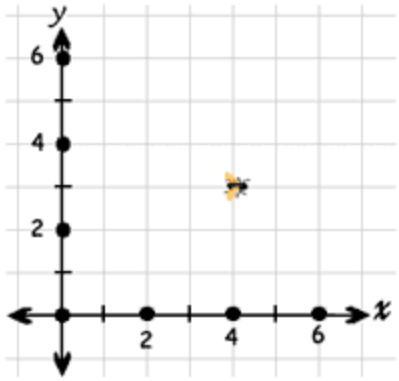
We can find every point in the plane using two numbers. These numbers are called coordinates. We write a point's coordinates inside parentheses, separated by a comma, like this: (5, 6). Sometimes coordinates written this way are called an ordered pair.

- **The first number in an ordered pair is called the** x-coordinate**. The x-coordinate tells us how far the point is along the x-axis.**

- **The second number is called the** y-coordinate**. The y-coordinate tells us how far the point is along the y-axis.**

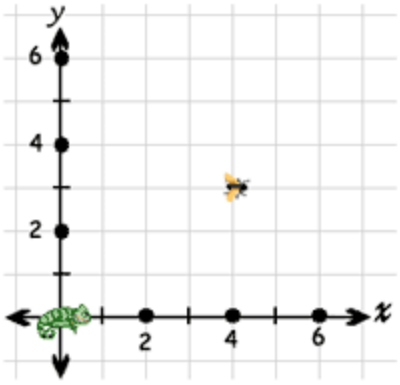
Let's try an example.

A fly is sitting in the plane.

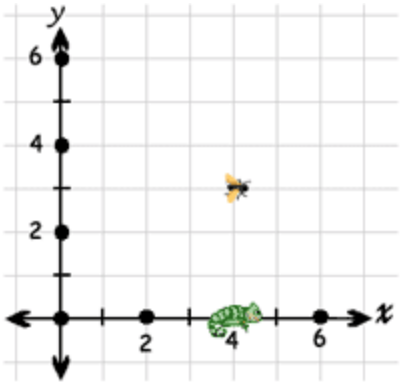


Sam knows that the fly is at point (4, 3). What should he do?

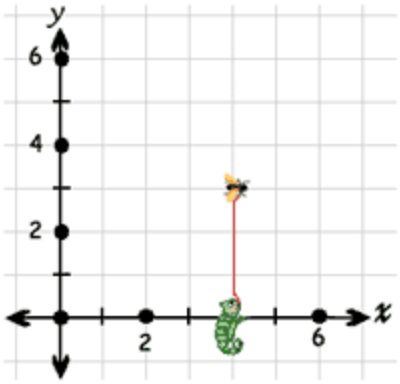
Sam starts at the origin. So far, he has not moved along the x-axis or the y-axis, so he is at point (0, 0).



Because he wants to find (4, 3), Sam moves four units along the x-axis.



Next, Sam turns around and shoots his tongue three units. Sam's tongue goes straight up, in the same direction that the y-axis travels.



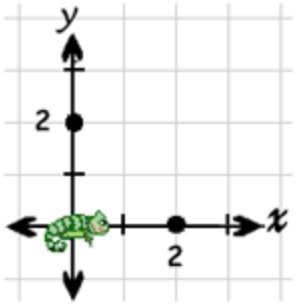
Sam has found point (4, 3). **He eats the fly happily**.

Graphing Points in the Plane

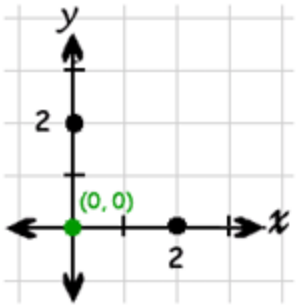
You can graph points the same way that Sam found the fly. Let's practice graphing different points in the plane.

We'll begin by graphing point (0, 0).

Sam starts at the origin and moves 0 units along the x-axis, then 0 units up. He has found (0,0) without going anywhere!



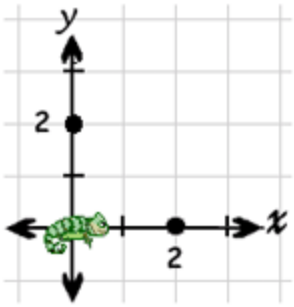
Sam marks the point with a green dot, and labels it with its coordinates.



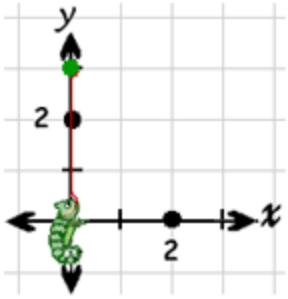
Sam has finished graphing point (0, 0).

Next, let's graph point (0, 3).

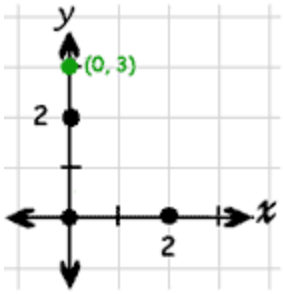
Sam starts at the origin, just like always. He moves 0 units along the x-axis, because the x-coordinate of the point he is trying to graph is 0.



Sam uses his tongue to move a green dot 3 units straight up.



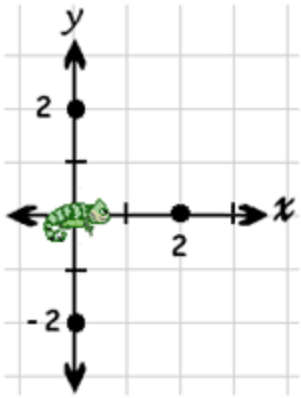
The final step is labeling the point.



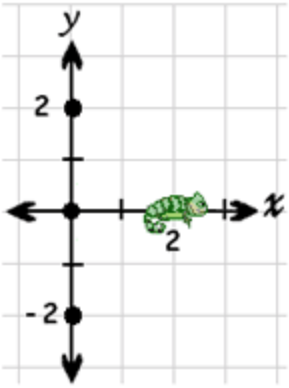
Notice that point (0, 3) is *on the y-axis* and its x-coordinate is 0. Every point on the y-axis has an x-coordinate of 0, because you don't need to move sideways to reach these points. Similarly, every point on the x-axis has a y-coordinate of 0.

Let's end with a more complicated example: graphing point (2, -2).

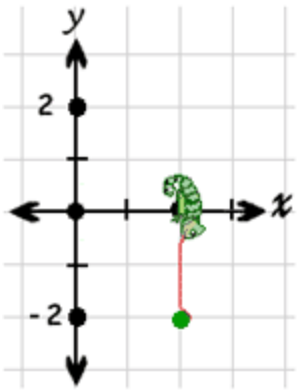
Sam begins at point (0, 0).



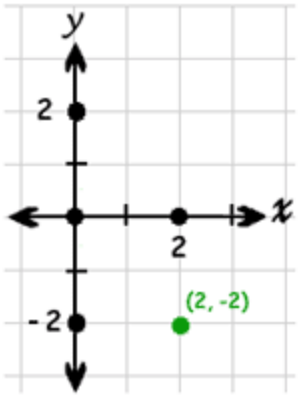
He moves 2 units along the x-axis.



The y-coordinate of the point Sam wants to graph is -2. Because the number is negative, Sam sticks his tongue down two units. This makes sense, because negative numbers are the opposite of positive numbers, and down is the opposite of up.



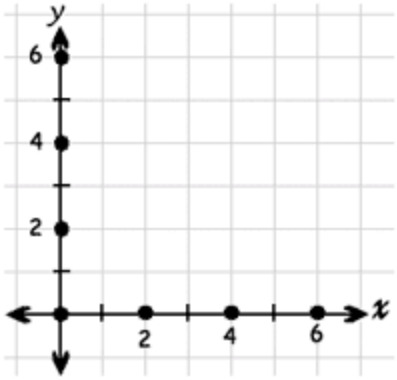
Before he leaves, Sam labels the point he graphed.



Scale

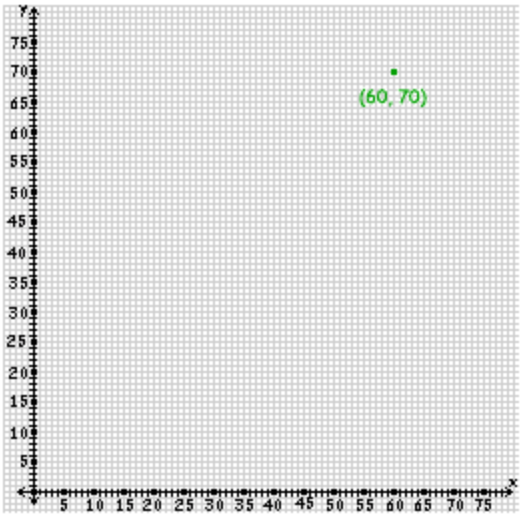
How would you graph the point (60, 70)?

We could start with this graph,



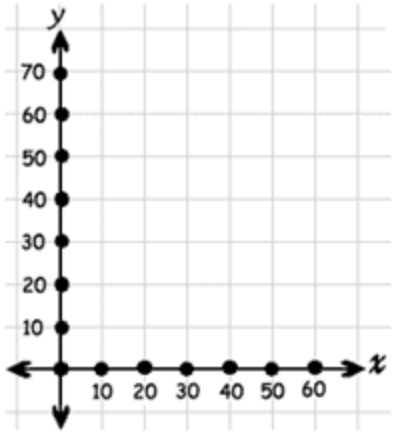
make the x and y axes much longer, and then graph our point. If we tried that, though, the graph would never fit on this screen.

We could try shrinking the axes, and then graphing the point:

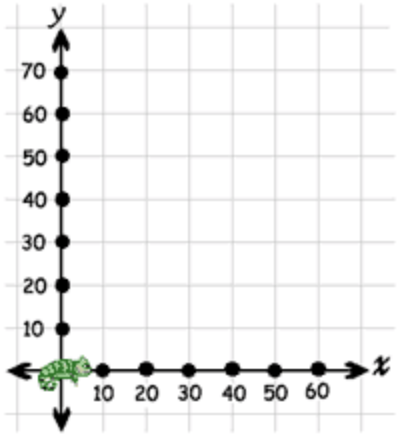


This graph is so small that it is hard to understand.

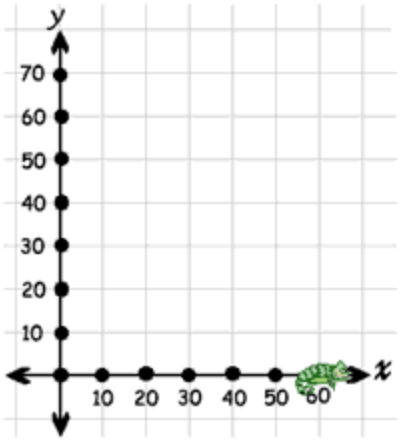
Instead of trying to mark every whole number on the axes, let's count by tens. When we change the distance between points on our graph like this, we say that we are changing the scale of the graph.



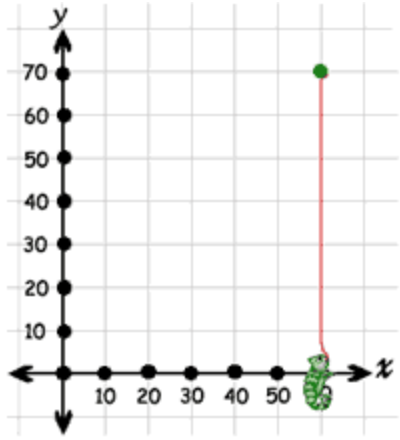
Now, let's watch Sam graph the point (60, 70) on this graph. Sam always starts at the origin.



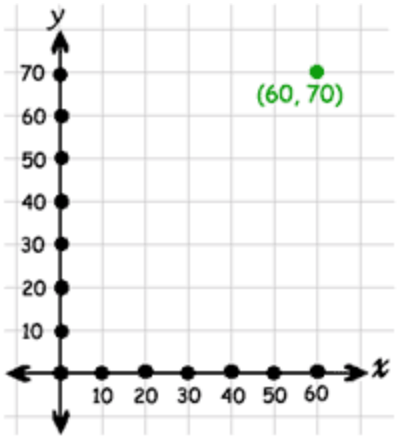
The x-coordinate of the point is 60, so Sam counts to 60 by tens.



Since the point's y-coordinate is 70, Sam must use his tongue to count to 70 by tens, moving straight up.



Before he leaves, Sam labels the point he graphed.



Practice Exercise

Graph the line segment using the following end points.

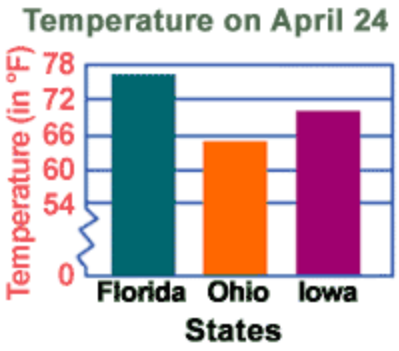
1. (4,-5) and (4,3)	2. (-8,-7) and (-2,-7)
3. (5,-2) and (-2,-2)	4. (-2,2) and (-2,4)
5. (7,2) and (7,-1)	6. (-4,9) and (-1,9)
7. (-1,8) and (2,8)	8. (-1,-2) and (7,-2)
9. (6,-7) and (6,-3)	10. (-2,6) and (-2,0)

11. (16,-17) and (-9,-17)	12. (-17,2) and (-17,18)
13. (-10,11) and (8,11)	14. (4,0) and (16,0)
15. (-8,-4) and (-8,-17)	16. (18,-8) and (18,19)
17. (-5,-19) and (-3,-19)	18. (-6,-10) and (-6,13)

Bar Graph

A graph that uses separate bars (rectangles) of different heights (lengths) to show and compare data. They are generally more complicated to read than other types of graphs.

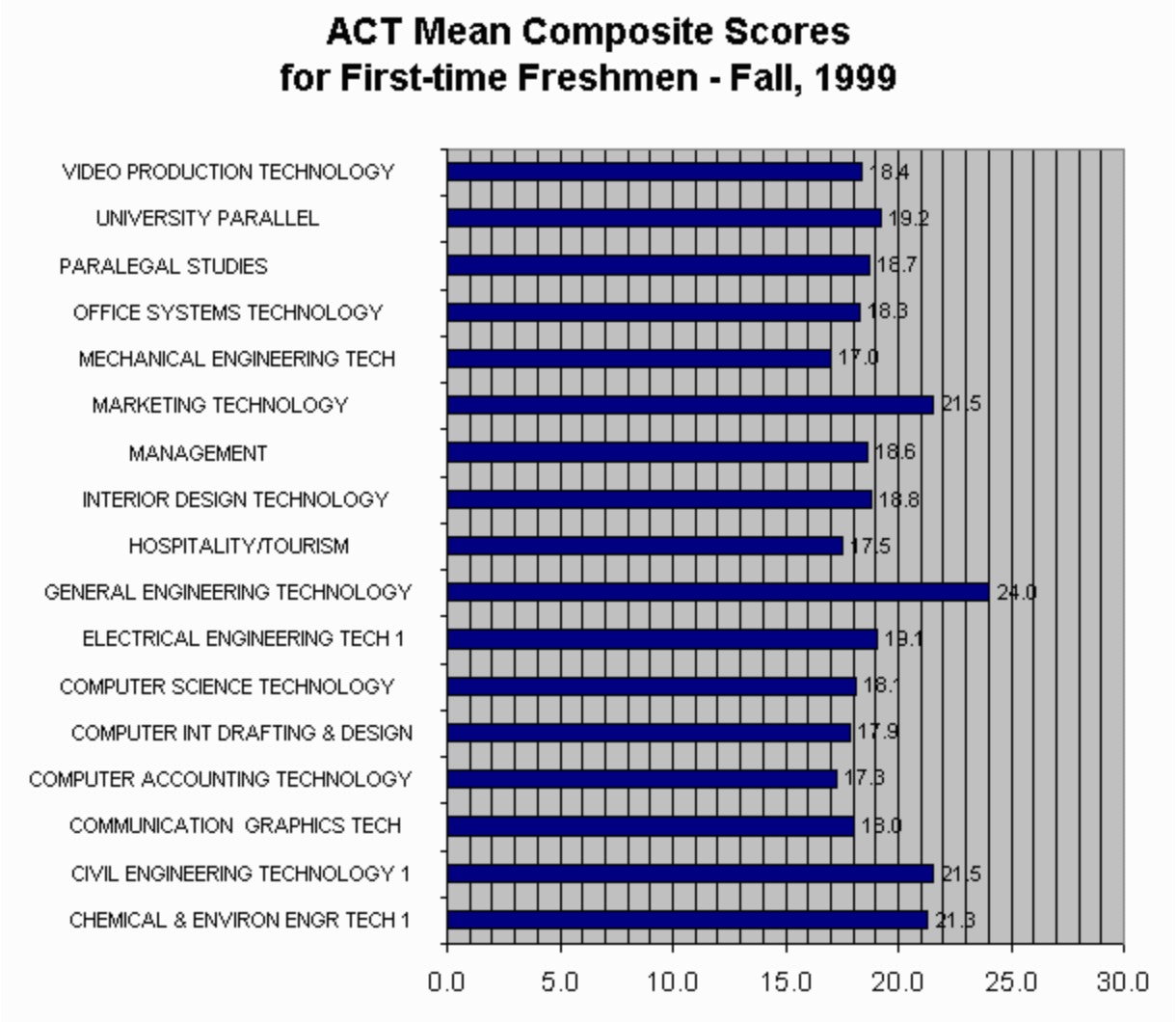
Example:



Bar graphs are usually drawn in one of two different directions:

1) With the bars ***running up and down*** like the graph above. The bars are placed at equal distances along the ***horizontal axis*** that runs across the bottom of the graph.

2) With the bars ***running from left to right*** like the graph on the next page. The bars are placed at equal distances along the ***vertical axis*** on the left side of the graph.



Bar graphs may also use a key to show additional information.

Sometimes, a graph may have a break in the vertical axis and an open space running across the graph. This means that some values have been left off to save space on the graph.

Line Graph

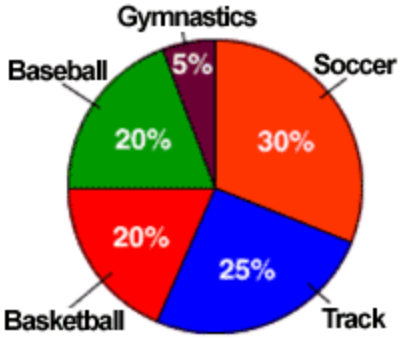
A graph in which line segments are used to show changes over time. Like the bar graph, a line graph is drawn using values along a horizontal and a vertical axis.

Example:

Circle Graph

A graph using a circle that is divided into pie-shaped sections showing percents or parts of the whole. A part of a circle graph is called a **segment** or a **section** and has its own name and value. The segments of a circle add up to a whole or 100% of the topic.

Example:

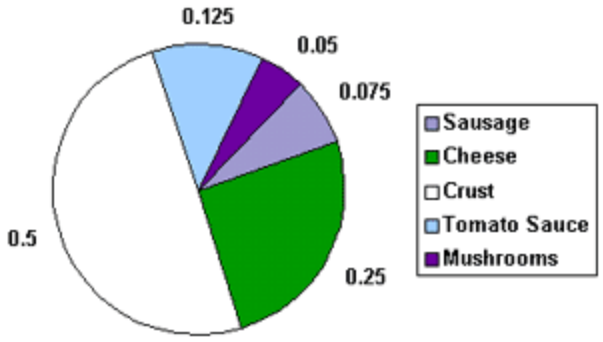


Circle graphs are often used to illustrate budgets and expenses.

Pie Charts

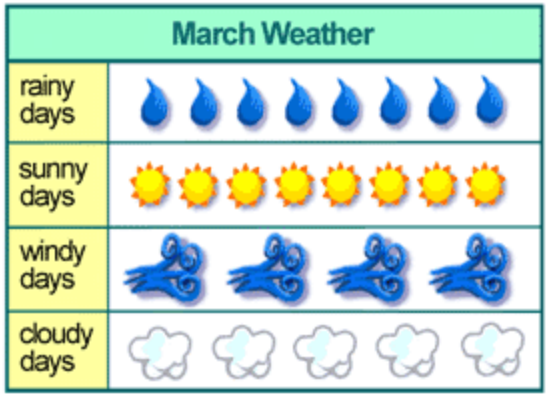
A pie chart is a circle graph divided into pieces, each displaying the size of some related piece of information. Pie charts are used to display the sizes of parts that make up some whole.

The pie chart below shows the ingredients used to make a sausage and mushroom pizza. The fraction of each ingredient by weight is shown in the pie chart below. We see that half of the pizza's weight comes from the crust. The mushrooms make up the smallest amount of the pizza by weight, since the slice corresponding to the mushrooms is smallest. Note that the sum of the decimal sizes of each slice is equal to 1 (the "whole" pizza").



Pictographs (picture graphs) are graphs that use pictures called ***icons*** to display data. Pictographs are used to show data in a small space. Pictographs, like bar graphs, compare data. Because pictographs use icons, however, they also include keys, or definitions of the icons. Parts of symbols are often used to represent a fractional amount of a quantity shown in the key.

Pictographs are often not as exact as other types of graphs, but they are the easiest to read. All you need to do is count the symbols on a line and compute their value.



How to Create Eye-catching, Information-packed Graphs

A woman stands up in a crowded city council meeting and reads the research. "We recently asked a random sampling of 250 citizens how often they use the new toll road. Five percent say they use it four or more times a week, eight percent say they use it one to three times a week, 12 percent say..." and continues on.

The point she would eventually get to, could have been stated in a simple declarative sentence, in half the time, with twice the effect: "We completed some eye-opening research this week--over one third of the people in the city don't use the new toll road because they can't afford it!"

The same is true on paper. Instead of getting mired in statistical detail, you can make your point with a simple, informative graph.

STEP-BY-STEP GRAPHS

Creating graphs is easy if you divide it into a few manageable steps.

STEP 1: *Gather and present accurate information*

You will need to seek out facts and figures from reputable sources. It is imperative, too, that your proportions be reasonably accurate. If, for example, you intentionally exaggerate a bar that represents 50% to look like 60%, you risk the reader dismissing your whole argument because of it. Be sure to add a caption line that credits your source.

Where possible, gather and present your information in a ***table of values***. This table will allow you to organize your data in rows and columns.

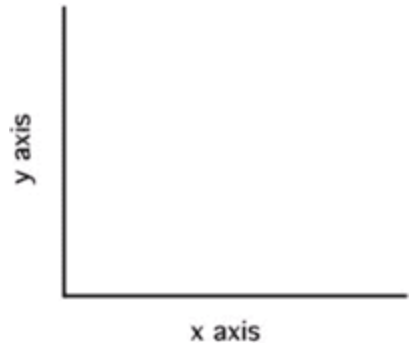
STEP 2: *Focus on a single point*
Don't make the mistake the speaker did. Sort through the details and decide on a single point to be made and organize everything around it. Simplify as much as you can: Consolidate several nonessential categories into one. Choose units of measure that are most easily understood. And round off values.

STEP 3: *Find the most relevant image*
Be obvious--you have just a moment to make the connection with your reader.

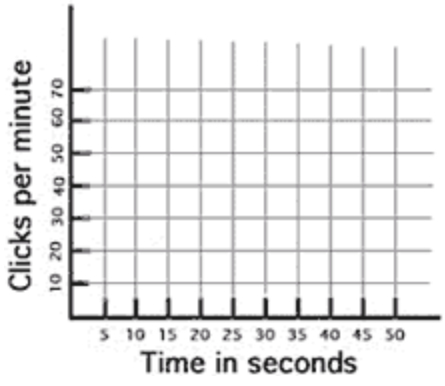
STEP 4: *Use words sparingly*
Your reader should get your point with as few words as possible. Use a title of five words or less to telegraph the theme, and a short subhead to fill in the details. Use labels economically and let the shapes, colors, and proportions do the work.

How to Construct a Line Graph.

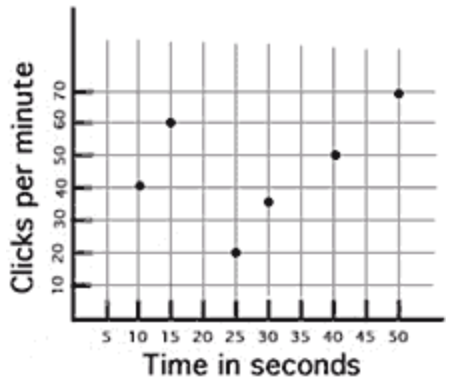
1. Draw a pair of axes (x-axis and y-axis).



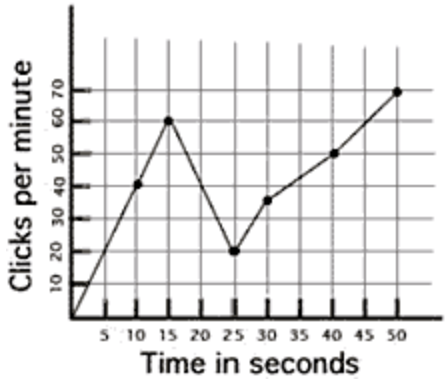
2. Label each axis with a scale.



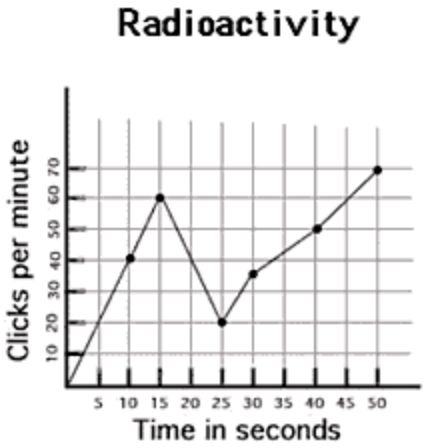
3. Plot the data points for each pair of data. First go over on the x-axis and then the y-axis.



4. After all the data points are plotted, connect them.

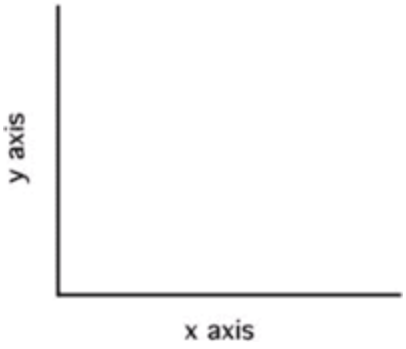


5. Give the graph a title.

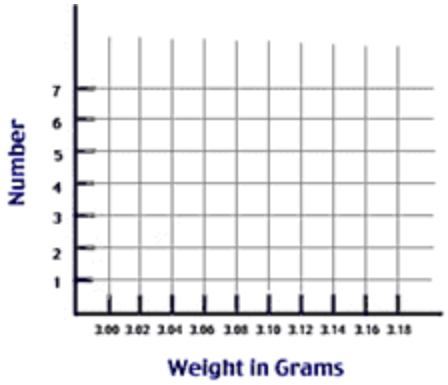


How to Construct a Bar Graph.

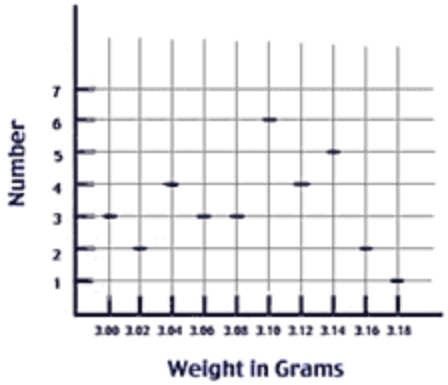
1. Draw a pair of axis (x-axis and y-axis).



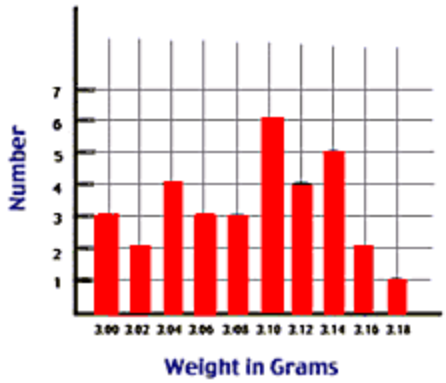
2. Label each axis with a scale.



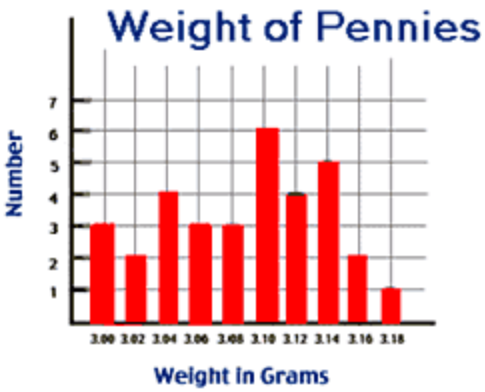
3. Plot the data points for each pair of data. First go over on the x-axis then up on the y-axis.



4. Draw a thick bar from the x-axis up to an imaginary point where the y-axis would intersect the bar.



5. Give the graph a title.



Constructing Circle Graphs

When constructing a circle graph, follow the steps below (NOTE: If the data is not already in a table, put it into tabular form. This will be your table of values.):

1. **Is the Data Suitable**--Determine if there is a "whole" for the data. Then determine what the different parts, or data groups, of the whole are.
2. **Calculate Percentages**--For data that is not already given as a percentage, convert the amounts for each part, or data group size, into a percentage of the whole.
3. **Draw the Graph**--Draw a circle and draw in a sector for each data group. Try to make the sector sizes look as close to the percentage of the circle as the percentage of the data group.
4. **Title and Label the Graph**--Label the sectors with the data group name and percentage. Then add a title to the graph. This is the same as the title of the table of values.

Example

Construct the circle graph for the data in the table of values on the next page.

Sneakers Sold for November 1997 at The Shoe Source

Brand Name	Number Sold
Adidas	150
Nike	192
Reebok	60
Asics	108
Other	90

1. **Is the Data Suitable:**

   Determine whether there is a "whole" for the data. Then determine what the different parts, or data groups, of the whole are.

   - Define the whole--In this table of values, the whole is the total number of sneakers sold for the month of November 1997.
   - How many different parts, or groups, are there--There are five parts to the whole. Each data group is a category of sneaker brands **(1)** Adidas, **(2)** Nike, **(3)** Reebok, **(4)** Asics, **(5)** Other.

   From the table we can calculate the whole, and we do have different parts. This means the data could be displayed in a circle graph.

2. Calculate Percentages

For data that is not already given as percentages, convert the amounts for each part, or data group, into a percentage of the whole.

- Calculate the whole--This total can be found by adding up the numbers sold for each type of sneaker.

  There are five different parts to our whole. The table of values lists the number sold in each part. To find the total sold we add up these parts. When we do this, we find the total number is 600.

150 + 192 + 60 + 108 + 90 = 600 **total shoes sold**

- Calculate the percentage for each part--This means we must calculate the percentage of the whole for each of the five data groups. Since we now have the total number of sneakers sold, and we have the amount of each category sold, we can calculate the percentage of sales for each data group.

  Once we find the total, we can convert each Number Sold into a percentage of the whole. Let's go through the calculation for Adidas shoes. If we look at Adidas shoes, 150 of the 600 shoes sold

are Adidas.

Brand Name	Number Sold
Adidas	150

- This means the fraction of shoes sold that are Adidas is 150/600. To convert this fraction to a decimal, we divide the numerator by the denominator and then multiply by 100.

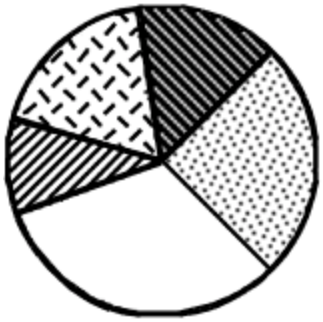
150/600 x 100 = 25

- So Adidas accounts for 25% of the sneakers sold in November 1997. The below has the percentages added for each category of sneakers

Brand Name	Number Sold	Percentage Sold
Adidas	150	25
Nike	192	32
Reebok	60	10
Asics	108	18
Other	90	15

3. **Draw the Graph**

First, using a compass, draw a circle. Then, use a protractor to draw in the sectors of the circle. We need to try to make each sector correspond to the percentage of the whole that it represents. For this circle our sectors need to be 32%, 25%, 18%, 15%, and 10%.

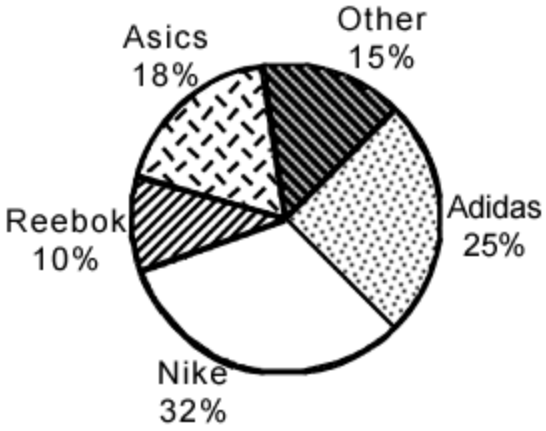


You can also add shading to the sectors. This helps to make them easier to distinguish.

4. **Title and Label the Graph**

Label the sectors with the data group name and percentage. Then add a title to the graph. This is the same as the title of the table of values.

Sneakers Sold for November 1997 at The Shoe Source



Now, we have the completed circle graph. This allows us to evaluate the relative sizes of each group quickly. We can see that Nike has the largest percentage of sales, and that, of the top four sellers, Reebok has the smallest, approximately 1/3 that of Nike.

Problem Solving Using Graphs

1. Given the table of values on the next page, create an accurate circle graph which represents the same information.

Shares of Stock Owned by an Investor

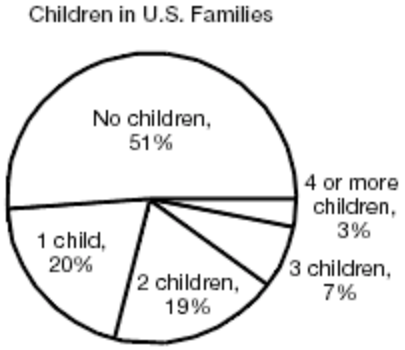
Type of Stock	Number of Shares
Coca-Cola	8
Pepsi	10
IBM	4
Exxon	8
General Motors	20

2. Given the table of values below, displaying the annual income of four employees, construct a bar graph that displays the same information.

Annual Income of Four Employees

Employee	Income (in dollars)
Sue	25,000
Brian	38,000
Dan	30,000
Nancy	35,000

Use the Children in U.S. Families graph to answer Exercises 3–4.



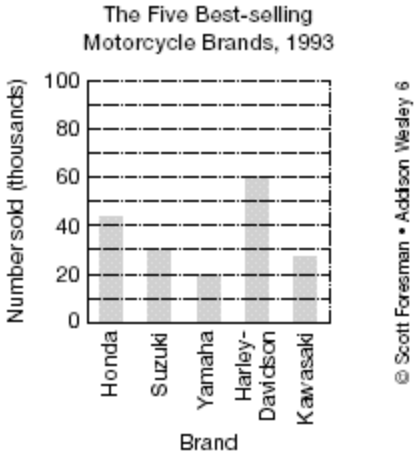
3. What percent of families include exactly 2 children?

_____

4. Of the categories shown, which is the largest?

_____

Use the graph of the Five Best-selling Motorcycle Brands to answer Exercises 5-8.



5. Which brand sold the most motorcycles?

_____

6. Which brand (of the five shown) sold the fewest?

_____

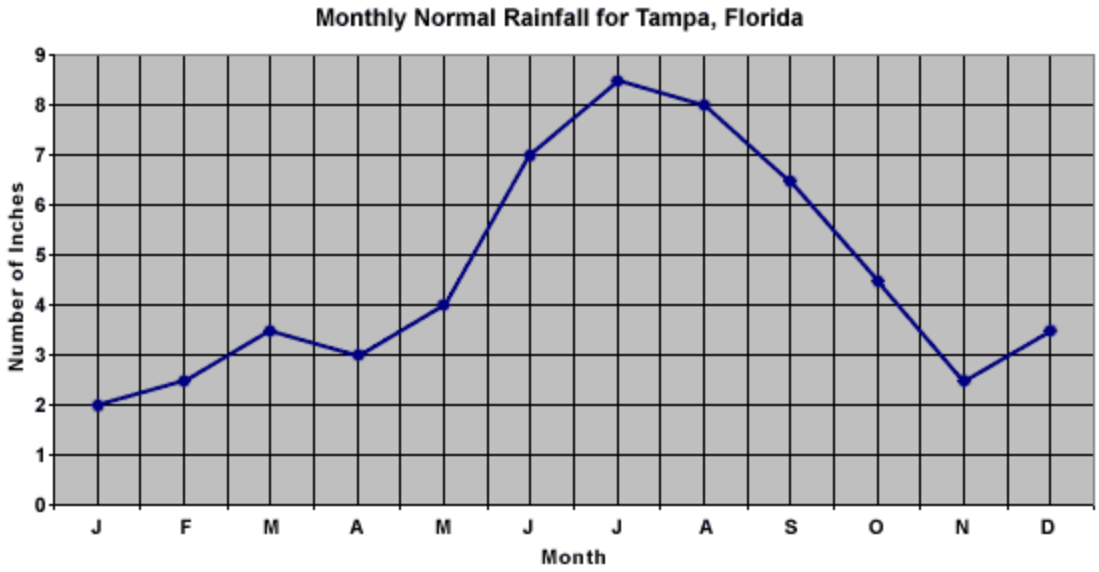
7. About how many Honda motorcycles were sold?

_____

8. Which brand sold more motorcycles, Kawasaki or Suzuki?

_____

Use the Monthly Normal Rainfall for Tampa graph to answer Exercises 9-14.



9. In which month is the amount of rainfall greatest?

_____

10. In which month is the amount of rainfall least?

_____

In which month is the amount of rainfall closest to each of the following months?

11. September _____

12. October _____

13. July _____

14. What is the normal amount of rainfall for the month of March?

    _____

15. John had read, “Chariot of the Gods” and decided to construct a large sign to indicate to travellers from space that we humans are friendly people. He intended to use a piece of twine as his unit length and with his house as the origin construct the sign by placing a large rock at each point and painting the rock a bright orange. He prepared the following diagram of his proposed sign on a sheet of grid paper. Plot the points and see what the sign said.

1. (-10, 2)	2. (-9, -4)	3. (4, 9)	4. (-8, -6)
5. (10, 2)	6. (-8, 6)	7. (9, -4)	8. (-6, -2)
9. (-2, -6)	10. (0, -10)	11. (-2, 10)	12. (-10, 0)
13. (-7, -7)	14. (6, -8)	15. (-2, 6)	16. (-3, 6)
17. (10, -2)	18. (-2, 5)	19. (-4, 9)	20. (-1, -10)
21. (-3, 3)	22. (2, -6)	23. (-4, 6)	24. (0, -6)
25. (-5, 5)	26. (7, 7)	27. (5, -4)	28. (-10, -2)
29. (8, 6)	30. (-4, 3)	31. (-4, -5)	32. (-5, 4)

33. (-2, 4)
34. (4, -5)
35. (2, 6)
36. (3, 6)
37. (-7, 7)
38. (2, 5)
39. (6, 8)
40. (10, 0)
41. (3, 3)
42. (7, -7)
43. (4, 6)
44. (4, -9)
45. (5, 5)
46. (-4, -9)
47. (-6, 8)
48. (-6, -8)
49. (9, 4)
50. (4, 3)
51. (2, 10)
52. (5, 4)
53. (2, 4)
54. (8, -6)
55. (-9, 4)
56. (0, 10)
57. (-5, -4)
58. (6, -2)
59. (1, -10)

Answer Key

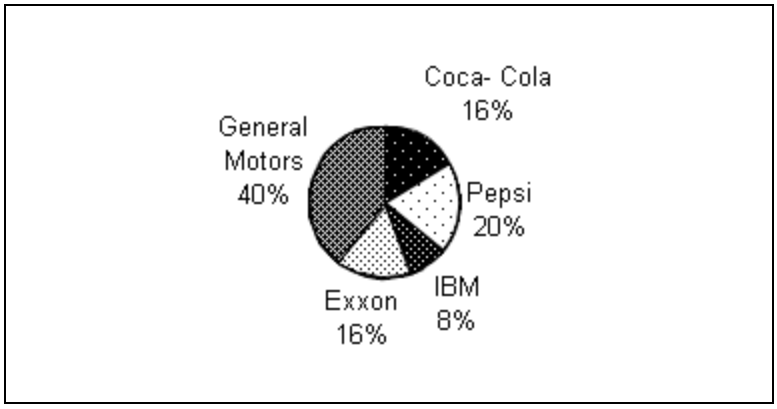
Book 14018 - Graphs

Page 16 **Make sure that all of the instructions are followed to graph the line segments in questions 1 – 18.**

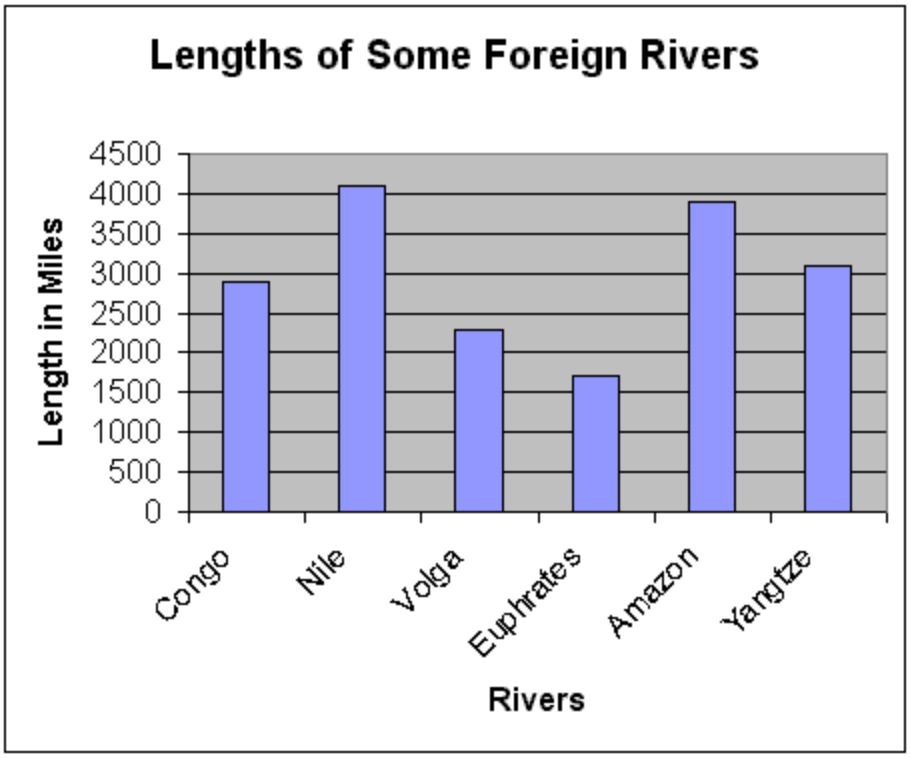
Page 35

1. Accept any reasonable answer.
(Example)

Shares of Stock Owned by an Investor



2. Accept any reasonable answer.
(Example)



3. 19% **4.** No children **5.** Harley-Davidson
6. Yamaha **7.** 42000 **8.** Suzuki **9.** July
10. January **11.** June **12.** May **13.** August
14. 3.5 inches **15. When the points have all been plotted correctly, the drawing should represent a smiling, happy face.**