19.2 teacher notes

Objectives

- Interpret line graphs.
- Interpret bar graphs.
- Interpret circle graphs.

Vocabulary

- Line graph
- Bar graph
- Circle graph
- Slope (Lesson 7-2)
- Statistics (Lesson 19-1)
- Mean (Lesson 19-1)
- Median (Lesson 19-1)
- Mode (Lesson 19-1)
- Pie chart

Prerequisites

Plotting points on a coordinate grid

Interpreting the slope of a line

Finding the mean, median, and mode of a data set

Using a protractor to draw angles

Calculating the percent of a number

Get Started

- Write the months of the year on post-it notes, one month per post-it. Align the post-its in a straight row on the top of a table or desk.
- Give each student one block or other stackable object.
- One at a time, students should place their block behind the post-it with the month of their birth. If a student has already placed a block at a given month, the next student with a birthday in the same month should stack their block on top of the previous one.
- After all students have placed their blocks on the table, tell the students that the stacks of blocks are like the bars in a bar graph. Ask comparison questions such as "Which month has the most students' birthdays?"

Section 1

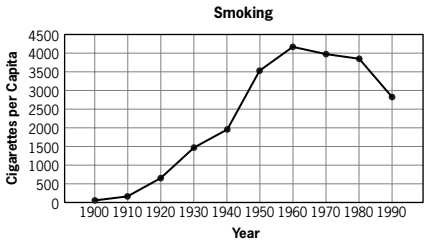
Expand Their Horizons

In Section 1, students will read and interpret line graphs. A line graph is a graph in which data points are connected by line segments. A line graph is used to show changes in data over a period of time. Points are graphed as on a rectangular coordinate system. However, the *x*-axis will be labeled with units of time, while the *y*-axis will be labeled with data units. Since time typically has positive values, only the positive side of the horizontal axis is usually necessary. Likewise, the data being represented on the vertical axis often contains only positive values, so the positive side of this axis is usually all that is shown. As a result, most line graphs show only Quadrant I. Quadrant IV is included for graphs with positive and negative values, like profit and loss.

Recall the slope of a line, or line segment, is the vertical change divided by the horizontal change, also known as rise over run. A positive slope, indicated by a line segment that slants up from left to right, indicates an increase. A negative slope, indicated by a line segment which slants down from left to right, indicates a decrease. Steeper line segments indicate greater changes. A horizontal line segment, which has a slope of zero, indicates no change. In addition to changes indicated by individual line segments, one may look for overall trends.

Graphs of real statistical data are the most interesting to students because they demonstrate applications of statistics in the real world. Good sources for statistical data include the U.S. Department of Labor, the National Center for Education Statistics, and other government or non-profit organizations such as the American Lung Association. These were used for some of the graphs within these Teachers Notes. Also, newspapers and magazines often contain various graphs which can be used in the classroom.

Consider the line graph below. The per capita annual consumption of cigarettes, for persons over the age of 18 years, is given in ten-year intervals from 1900 to 1990.



Many observations can be made from this line graph. When did the number of cigarettes per capita begin to decrease? The period from 1960 to 1970 showed the first, though slight, decrease, which continued through 1990. Notice that the segments between these points have a negative slope. When was the sharpest change in the number of cigarettes per capita? The period from 1940 to 1950 shows the steepest slope, indicating the sharpest change. Did this period mark an increase or decrease in cigarettes per capita? The period from 1940 to 1950 shows the line segment slanting up from left to right, indicating a positive slope and thus, an increase in cigarettes per capita. What was the *overall* trend from 1900 through 1960? Although the actual slopes vary significantly, the slope of the line segments connecting these periods are positive, so the overall trend was an increase in cigarettes per capita. However, even if a single segment in that time frame had a negative slope, the overall trend would still be an increase. Estimate the number of cigarettes smoked per capita in 1920 and 1980. In 1920, the number of cigarettes was between 500 and 1,000, slightly less than halfway between these values. A good estimate for 1920 is 700 cigarettes per capita. In 1980, the number of cigarettes was slightly more than half-way between 3,500 and 4,000, which would make 3,800 a good estimate. Estimate the maximum

number of cigarettes per capita during this graphed period. The maximum is found at the highest point on the graph, which is at 1960. This value is between 4,000 and 4,500, with the value being slightly closer to 4,000; therefore, a good estimate of this maximum would be 4,200 cigarettes. Some line graphs lend themselves to more accurate readings. However, most of the values in this graph can only be estimated.

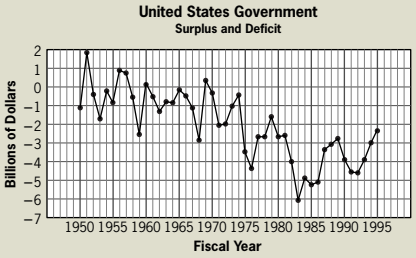
The line graph below shows the progress Newt's father is making on his diet. Use it to answer Questions 1 and 2.

1 **What is the maximum weight displayed on the graph?** Newt's father was at his maximum weight when he started the diet; that is, at zero months. At this point his weight was slightly less than half-way between 200 and 300 pounds. Since 250 is exactly half-way between these values, a good estimate is 245 pounds. Other values close to this should be accepted.

2 **What trends are displayed on the line graph?** Overall, the graph slants downward from left to right, indicating a decrease in weight throughout the three months. The steepest line segment is between zero months and one month, indicating Newt's father lost the most weight during the first month. The remaining line segments are less steep, indicating he lost weight at a slower rate. Emphasize the one on the horizontal scale represents the end of the first month, the two represents the end of the second month, etc. So, each point on the graph represents a weight at a particular moment in time.

Additional Examples

1. **The line graph to the right represents the difference in receipts and outlays for the U.S. Government from 1950 through 1995 in billions of dollars. Positive values indicate a surplus, while negative values indicate a deficit. In the 45-year period, in what year was the surplus greatest, and what was the approximate surplus? In what year was the deficit greatest, and what was the approximate deficit?**



The greatest surplus is the greatest positive value and is indicated by the highest point on the graph. In 1951, the surplus was $2 billion. The greatest deficit is indicated by the lowest point on the graph. In 1983, the deficit was $6 billion.

2. **Discuss the trend demonstrated by the graph from Example 1.**

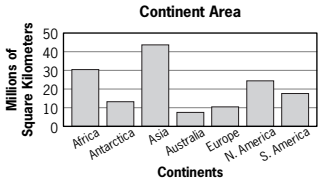
From 1950 to 1995, the overall trend was a decreasing surplus or an increasing deficit.

Section 2

Expand Their Horizons

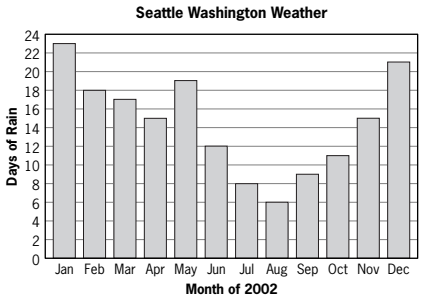
In Section 2, students will read and interpret bar graphs. Using horizontal or vertical bars to represent the data, a bar graph is a graph used to compare amounts. The units of the horizontal axis are often such that no positive or negative values can be assigned, such as countries or teams. The units of the vertical axis may have both positive and negative values.

Consider the bar graph below. The approximate area, in millions of square kilometers, is given for each of the seven continents.



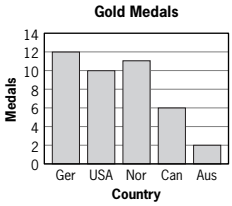
Many comparisons can be made from this bar graph. What are the largest and smallest continents? The largest continent, indicated by the bar that is the highest, is Asia. Asia is approximately 44 million square kilometers. The smallest continent, indicated by the bar that is the lowest, is Australia, whose area is about eight million square kilometers. Compare the areas of Europe and North America. The North American continent is more than twice the area of the European Continent, with North America covering approximately 24 million square kilometers and Europe covering about 10 million square kilometers. Which continent is nearly three times the area of the European continent? Europe is slightly more than 10 million kilometers in area. Three times this would be 30 million square kilometers—the approximate area of Africa. As with line graphs, some bar graphs lend themselves to more accurate readings than other bar graphs. However, for this bar graph, data values can only be estimated.

For bar graphs that allow for accurate readings, the mean, median, and mode can also be found. Consider the bar graph below. The number of days of rain for each month of 2002 is given for Seattle, Washington.



The mode can be determined by an inspection of the graph. The only value represented more than once is 15 days, for both April and November. So, the mode is 15. The mean is found by adding all the days of rain and dividing by 12, the number of months. The days of rain for January through December are 23, 18, 17, 15, 19, 12, 8, 6, 9, 11, 15, and 21. The sum of these values is 174. The sum divided by 12 yields a mean of 14.5. To find the median value, the data must be arranged in order: 6, 8, 9, 11, 12, 15, 15, 17, 18, 19, 21, 23. Since there is an even number of values in this data set, the median is found by averaging the two middle values. The two middle values are 15 and 15, whose average is 15, which makes 15 the median. With all three measures of central tendency being 15, or close to 15, it is safe to say that 15 days is a good representation for the number of days of rain during a month in Seattle, Washington.

Use the gold medal graph below to answer Guided Notes Problem 3.



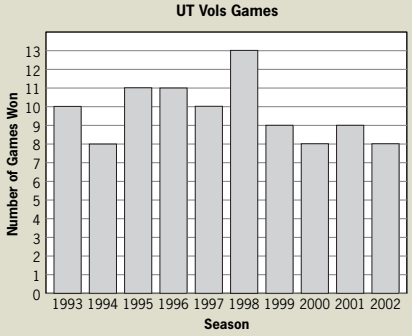
3 **List the countries, in order, from most gold medals won to least gold medals won.** The country with the most gold medals is indicated by the tallest bar and

the bar representing Germany is highest. Germany had 12 gold medals. Following Germany, the next highest is Norway, with 11 gold medals, and then the USA, with 10 gold medals. Next to last is Canada, with six gold medals, and finally Australia, with two gold medals. Note that the answer can be determined just by comparing the heights of the bars. Finding the exact number of medals is not necessary.

Additional Examples

1. **Create a bar graph for this information: The University of Tennessee Vols won the following number of games in each season from 1993 to 2002: 10, 8, 11, 11, 10, 13, 9, 8, 9, 8.**

   Across the horizontal axis, each bar will be labeled with the years: 1993, 1994, 1995, etc. Along the vertical axis, each gridline will be labeled with the number of games won: 1 through 13. The vertical axis must go at least as high as the greatest value in the data set. Be sure to label the graph, as well as both axes. The graph can be labeled "UT Vols Games." The horizontal axis can be labeled "Season," and the vertical axis can be labeled "Number of Games Won." Then, one rectangle is drawn for each season and usually shaded to represent the number of games won. The graph should look like this.



2. **Find the most games won, the least games won, and the mode, for the 10-year period using the data from the previous example.**

   The season with the most games won is represented by the highest bar. This occurs for 1998, when the Vols won 13 games. The season with the least games won is represented by the lowest bar. In this graph, there are three bars that are equally low. They occur during 1994, 2000, and 2002 and reach a height of eight. Therefore, eight games is the least games won during this 10-year period. Since eight games is the most frequent bar height, it is also the mode.

Section 3

Expand Their Horizons

In Section 3, students will read and interpret circle graphs. Circle graphs are also called pie charts. A circle graph compares the parts to the whole, with the entire circle representing the whole and each sector representing a part of the whole. To create a circle graph, percents for the parts are calculated and then, displayed as the same percent of the circle. Recall that a circle is a total of 360° around. So half, or 50% of the circle, is 50% of 360° or 180°. One-quarter, or 25% of the circle, is 25% of 360° or 90°. Real life applications of circle graphs can be applied to student situations for added interest and understanding. For example, if a circle graph illustrates that 10% of a teenager's day is spent playing video games and watching television, students might calculate the number of hours represented by this (a little less than two and a half) and discuss whether or not this amount of time is accurate for them.

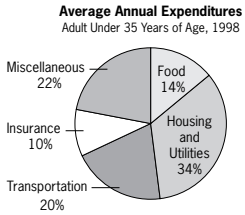
Connections

Since graphs are visual representations of data, they are a quick and clear way to illustrate information. Not only might it be necessary to create such graphs in various careers from business to education, reading these graphs is a necessary part of daily life. News programs, newspapers, and magazines utilize line, bar, and circle graphs to present information quickly and concisely. Being able to read and interpret the information provided by these graphs is a part of being a responsible, well-informed citizen.

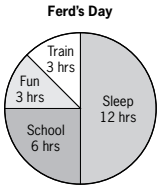
Consider the average annual expenditures for an adult less than 35 years of age in 1998. Those expenditures included food at $4,138, housing and utilities at $10,300, transportation costs at $5,974, insurance and pension payments at $2,895, and miscellaneous expenses at $6,985. To create a circle graph to represent this information, first find the total expenditures. The total expenditures are $30,292. Then, calculate the percent spent in each category. To find the percent spent on food, divide $4,138 by $30,292 and multiply by 100. Rounded to the nearest percent, the answer is 14%. Next, find 14% of the circle, by multiplying 0.14 by 360°. Rounded to the nearest degree, the answer is 50°. The food portion of this graph would be a sector enclosed by a 50° angle. Calculations for the other categories are made in the same manner to obtain these results:

Food	$4,138	14%	50° sector of circle
Housing and Utilities	$10,300	34%	122° sector of circle
Transportation	$5,974	20%	72° sector of circle
Insurance	$2,895	10%	36° sector of circle
Miscellaneous	$6,985	22%	79° sector of circle

Due to rounding, percents may not total exactly 100% and degrees may not total exactly 360°. Here is the resulting circle graph.



Use the circle graph below to answer Guided Notes 4 and 5.



4 **What fraction of the circle represents sleep?** Of the 24-hour day, 12 hours were spent sleeping. The fraction $\frac{12}{24}$ is $\frac{1}{2}$, so half the circle represents sleep. This is also easy to determine visually, as sleep makes up one-half of the circle graph.

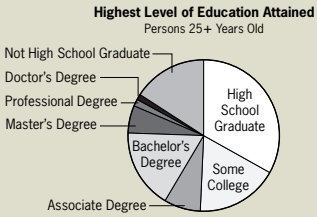
5 **Which two activities together make up twenty-five percent of the circle?**
Visually, it can be determined that fun and training make up one-quarter or 25% of the circle. This can also be determined by finding 25% of 24 hours and by seeing which two activities, together, make this amount. Twenty-five per cent of 24 hours is 0.25 times 24 hours or six hours. Fun and training are three hours each, so together they are six hours.

Look Beyond

In statistics courses, data is analyzed and summarized in a variety of ways. In Lesson 19-1, data sets were analyzed by finding the mean, median, and mode and by creating a stem-and-leaf plot. Line, bar, and circle graphs were used as visual representations of data in this lesson. In future statistical studies, the frequency of various values will be represented by a special bar graph called a histogram or line graph called a frequency polygon. These concepts will build easily from those learned here.

Additional Examples

1. The circle graph below represents, on average, the highest level of education attained by persons in the United States, 25 years and older. Use this graph to estimate what percent of the U.S. population over age 25 did not graduate from high school.



The portion of the circle graph representing persons who did not graduate from high school is about $\frac{1}{8}$ of the circle. Since $\frac{1}{8}$ is 12.5%, it could be estimated that 12.5% of this population did not graduate from high school.

2. Use to the circle graph in Example 1. Estimate what percent of the population attended at least some college. Given that the total number of persons age 25 and older in the U.S. was 175.2 million, determine approximately how many people attended at least some college.

Because one must attend college to receive a degree, this percent includes those that attended some college as well as all those who received various degrees, ranging from associates to doctorates. Approximately half of the circle is taken up with these categories, therefore, about 50% of those persons 25 years of age and older attended at least some college. Given the population was 175.2 million people, this meant that approximately 87.6 million persons attended at least some college since this was 50% or half of the given population.