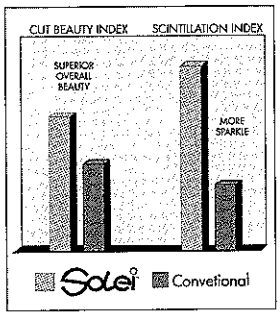
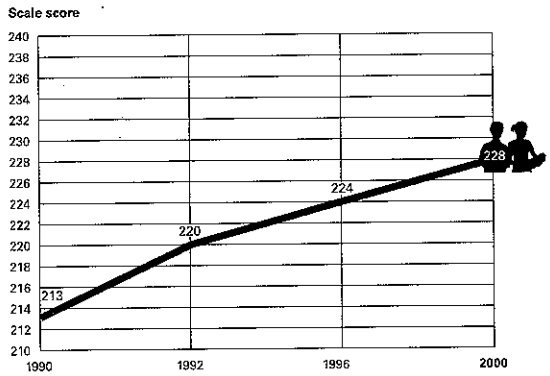
PROBLEM SET 8.3

1. A jewelry catalog advertising Solei diamonds displayed the following bar graph to demonstrate that Solei diamonds have superior overall beauty and more sparkle. Explain what is misleading about the graph.



Source: Permission courtesy of VisionCut™, New York, NY.

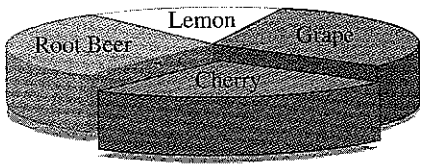
2. The following line graph is from the 2002 Brown Center Report published by the Brookings Institute. It shows fourth-grade math scores from 1990 through 2000. Explain what is misleading about the graph.



Source: From 2002 Brown Center Report on American Education by Tom Loveless. The Brookings Institution Press, Washington, D.C.

3. Suppose a beverage company conducts a taste test and includes the following pie chart in its advertising.

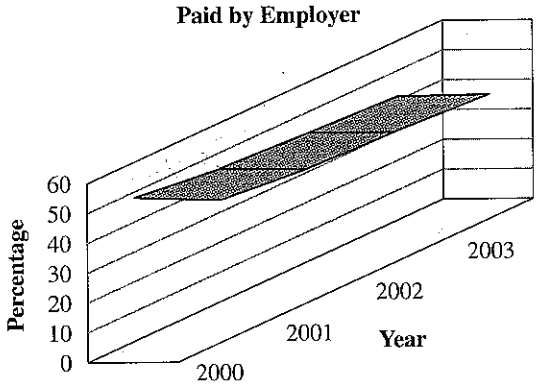
Soda Preferences



   a. Which type of soda do you think the company produces?
   b. In the actual taste test, 15% of consumers preferred lemon, 25% preferred cherry, and equal numbers preferred grape and root beer. The sectors in the pie chart are drawn using the correct degree measures. Explain what makes this pie chart misleading.

4. Suppose that during contract negotiations, management presents the workers with the following graph showing the percentage of health-care premiums paid by the employer.

Percentage of Health-Care Premium Paid by Employer

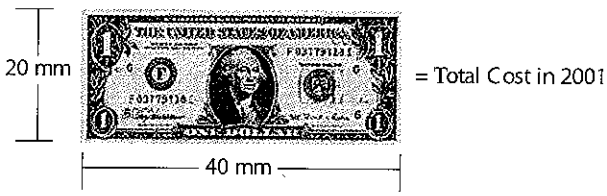


   a. Why do you think management presented the graph in this way?
   b. Estimate the percentages for each of the 4 years given in the graph and describe the trend. Explain what makes this graph misleading.

5. To see whether bar heights in a bar graph are proportional to the numerical values they represent, create ratios of bar heights, compare them to ratios of the corresponding quantities, and see if they are equal. For each case below, determine whether the bar heights and the numeric values they represent are proportional.
   a. Bar 1: height, 1 cm; value, $700
      Bar 2: height, 8.5 cm; value, $5950
   b. Bar 1: height, 1.3 inches; value, 52%
      Bar 2: height, 0.4 inch; value, 15%
   c. Bar 1: height, 3 mm; value, 1250 people
      Bar 2: height, 27 mm; value, 11,250 people
      Bar 3: height, 35 mm; value, 14,950 people

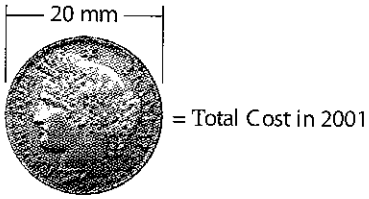
6. To see whether bar heights in a bar graph are proportional to the numerical values they represent, create ratios of bar heights, compare them to ratios of the corresponding quantities, and see if they are equal. For each case below, determine whether the bar heights and the numeric values they represent are proportional.
   a. Bar 1: height, 5 cm; value, $8000
      Bar 2: height, 5.2 cm; value, $8320
   b. Bar 1: height, 0.6 inch; value, 22%
      Bar 2: height, 2.2 inches; value, 91%
   c. Bar 1: height, 18 mm; value, 9000 people
      Bar 2: height, 15 mm; value, 7500 people
      Bar 3: height, 2.5 mm; value, 1250 people

7. In a pictograph, pictures, symbols, or icons represent quantities. Suppose the area of a dollar bill with length 40 mm and width 20 mm will represent the total cost of an item in the year 2001.



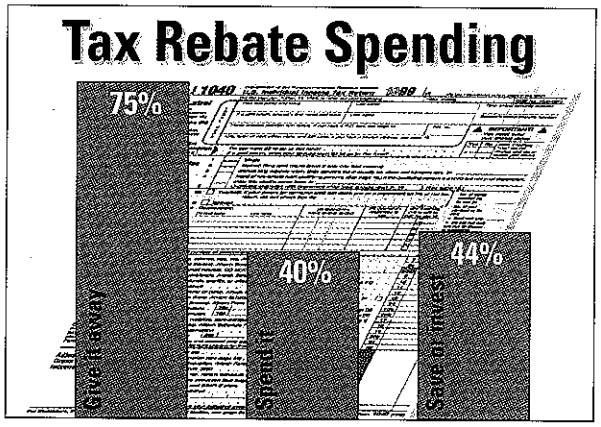
   a. In the year 2002, suppose that the total cost for the item tripled. Represent the total cost of the item in 2002 in a way that is not misleading without changing the size of the dollar bill.
   b. Suppose that in the year 2001, an item cost $5000, and in the year 2002, the same item cost $4000. Represent the total cost of the item in 2002 in a way that is not misleading by changing only the length of the dollar bill. What is the length of the dollar bill that must be used for the year 2002?
   c. Suppose that in the year 2002, the total cost for the item doubled. Represent the total cost of the item in 2002 in a way that is not misleading by changing both the length and the width of the dollar bill. In the original dollar bill, the length was twice the width. Maintain that relationship when creating the dollar bill for the year 2002. Find the length and width of the dollar bill, rounded to the nearest tenth of a millimeter, to use for the year 2002.

8. In a pictograph, pictures, symbols, or icons represent quantities. Suppose the area of a coin with diameter 20 mm will represent the total cost of an item in the year 2001.



   a. In the year 2002, suppose that the total cost for the item quadrupled. Represent the total cost of the item in 2002 in a way that is not misleading without changing the size of the coin.
   b. Suppose that in the year 2001, an item cost $0.50, and in the year 2002, the same item cost $0.75. Represent the total cost of the item in 2002 in a way that is not misleading without changing the size of the coin.
   c. Suppose that in the year 2002, the total cost for the item doubled. Represent this in a way that is not misleading by changing the diameter of the coin. In the original coin, the diameter was 20 mm. Find the diameter of the coin, rounded to the nearest tenth of a millimeter, to be used for the year 2002.

9. In 2001, most Americans received a rebate check from the federal government. The following graph shows the percentage of Americans who said they would use their rebate money in a certain way.



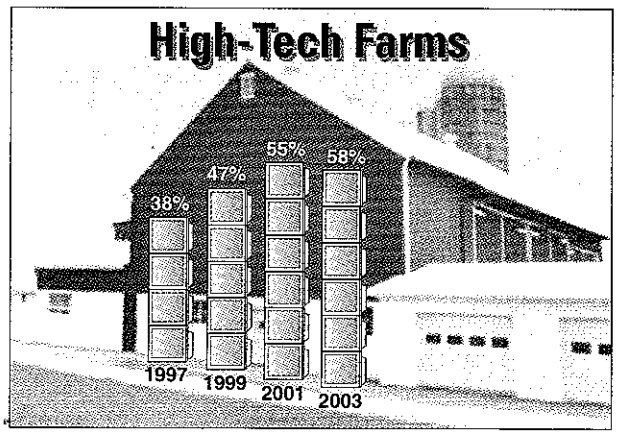
   a. Measure each bar height to the nearest tenth of a centimeter, and determine if the bar heights are proportional to the percentages they represent.
   b. If the bar that represents the 40% of Americans who would spend their rebate money was drawn 5 cm tall, find the heights that should be used for the other two bars so that bar heights are proportional to the percentages they represent. Round heights to the nearest tenth of a centimeter.

10. WALTHAM, a leading authority on pet care and nutrition, conducted a survey and found that pet owners humanize pets in several ways. The following graph summarizes some of the responses of pet owners from Los Angeles, San Francisco, Washington D.C., and Atlanta.

a. Measure each bar (dog collar) to the nearest tenth of a centimeter and determine if the bar lengths are proportional to the percentages they represent.

b. If the bar that represents the 28% of respondents who think of pets 5-10 times a day was drawn 3 cm long, find the lengths that should be used for the other two bars so that bar lengths are proportional to the percentages they represent. Round lengths to the nearest tenth of a centimeter.

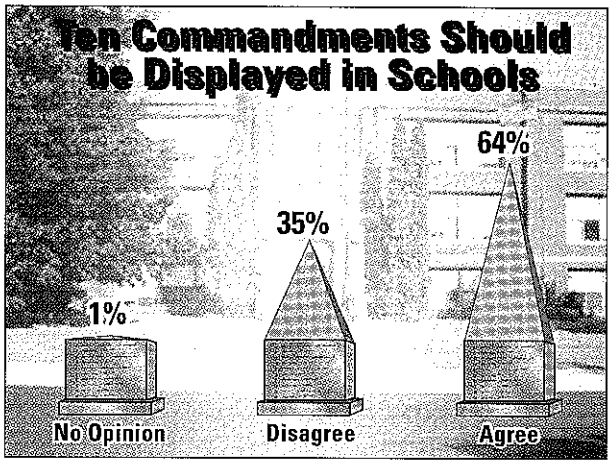
11. Farmers increasingly have access to computers in their businesses. The following pictograph gives the percentage of farms that had access to computers from 1997 to 2003.



a. Each computer monitor represents how many percentage points in the 1997 bar? Answer the same question for each of the other three bars. What do you notice?

b. Summarize what is misleading about this graph.

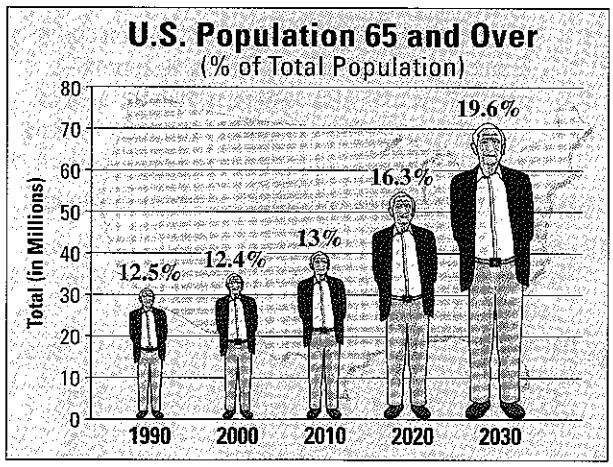
12. In a May 2005 free-speech survey, the majority of Americans polled supported displaying the Ten Commandments in schools as shown in the following graph.



a. What part of each monument is used to represent the results of the survey, and are the heights proportional to the percentages they represent?

b. Summarize what is misleading about this graph.

13. The U.S. population 65 years old and over, in millions, is given in the following graph for the years 1990 and 2000 and is predicted for the years 2010, 2020, and 2030.



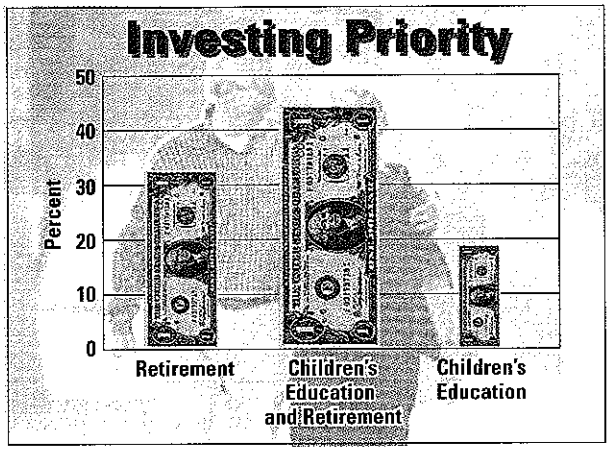
a. What does the height of each figure represent?

b. Approximately how many millions of people in the U.S. were 65 years old or over in 1990? Approximately how many millions are predicted to be 65 years old or over in 2030? The predicted 2030 value is how many times taller than the 1990 value?

c. The area of the 2030 figure is how many times larger than the area of the 1990 figure? Is the area of a figure meaningful in this graph?

d. Summarize what is misleading about this graph.

14. In a July 2005 Allstate survey, people with children were asked if investing in retirement is a higher priority, investing in children's education and retirement is of equal importance, or investing in children's education is a higher priority. The following graph summarizes the results.



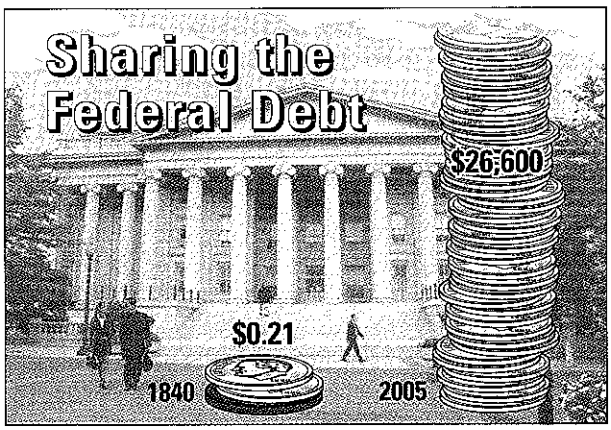
a. What does the height of each dollar represent?

b. Approximately what percent of respondents felt investing in their children's education was a higher priority? Approximately what percent of respondents felt investing in their children's education and retirement was of equal importance?

c. The area of the dollar that represents those who felt investing in their children's education and retirement was of equal importance is approximately how many times greater than the area of the dollar that represents those who felt investing in their children's education was a higher priority?

d. Summarize what is misleading about this graph.

15. In 1840, the cost of the federal debt was $0.21 per person. The cost grew to $26,600 per person in 2005, as shown in the following graph.

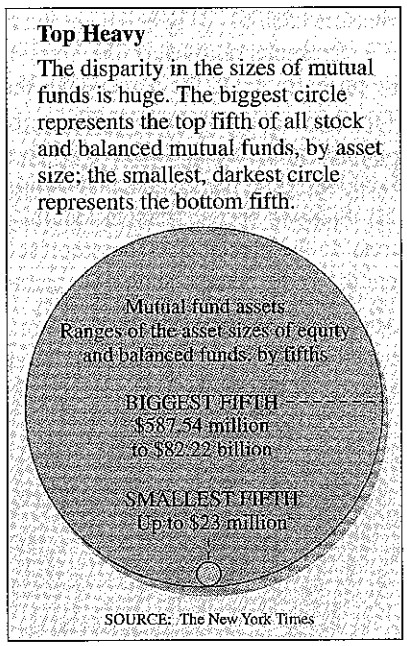


a. There are two dimes and a penny in the stack of coins that accurately represents the federal debt per person in 1840. If stack that represents the federal debt per person in 2005 contains only dimes, then how many dimes should be in the stack?

b. Suppose the stack of coins that represents the federal debt per person in 1840 was drawn 0.5 cm tall. How tall should the stack of coins that represents the federal debt per person in 2005 be if stack heights are proportional to the amounts they represent? Round to the nearest centimeter.

c. Summarize what is misleading about this graph.

16. Small, independent mutual funds attract investors even though there is no guarantee that investors will make more money with small funds rather than large funds. The following graph illustrates the relationship between the mutual funds with large asset size and those with small asset size.



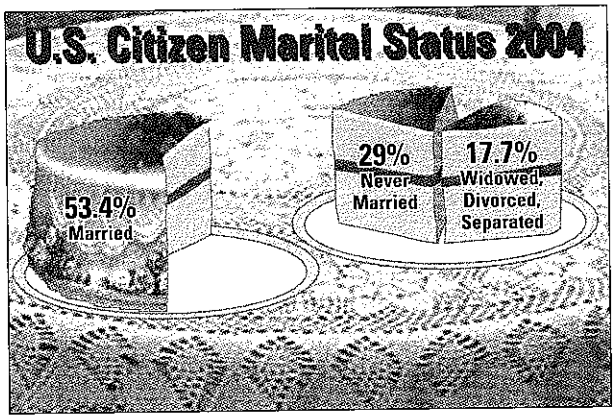
Source: Adapted from The New York Times

a. If the area of the largest circle represents the top fifth of all stock and balanced mutual funds with assets of $82.22 billion, and the circle used has a radius of 2 inches, what must the radius be for the circle that represents the smallest fifth, with assets of $23 million, assuming that area is proportional to assets?

b. If the area of the smallest circle is used to represent assets of $23 million dollars and measures 2 mm in radius, what must the radius be for the largest circle if it represents assets of $82.22 billion, assuming that area is proportional to assets?

c. Summarize what is misleading about this graph.

17. The U.S. Census Bureau classifies citizens who are at least 15 years old according to marital status. The following graph gives the percentages in each of three categories in 2004.



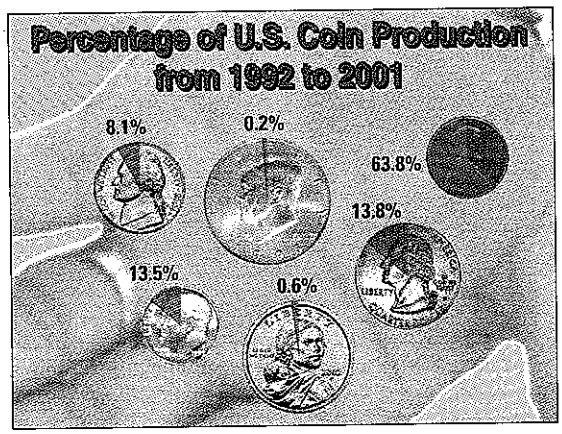
a. If you would create a single pie chart using the percentages given in the graph, what degree measure would be associated with each sector? Round to the nearest degree.

b. Using a protractor, measure the angles of each sector in the graph and compare the angles to the degree measures you found in part (a). How do they compare?

c. Summarize what is misleading about this graph.

d. Create a single pie chart using the degree measures you found in part (a).

18. There are six coins currently in circulation in the United States: penny, nickel, dime, quarter, half dollar, and dollar. The percentage of the U.S. coin production for each of these circulating coins is given in the following graph.



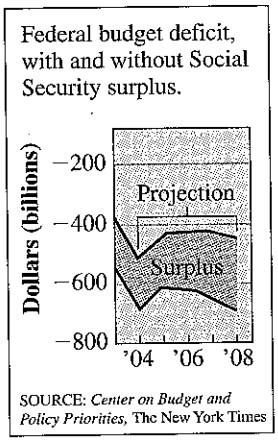
a. If you would create a single pie chart using the percentages given in the graph, what degree measure would be associated with each sector? Round to the nearest degree.

b. Using a protractor, measure the angles of each sector in the graph and compare the angles to the degree measures you found in part (a). How do they compare?

c. Summarize what is misleading about this graph.

d. Create a single pie chart using the degree measures you found in part (a).

19. The following double-line graph shows the actual federal budget deficit, with or without the Social Security surplus, along with projections for the next few years. The federal budget deficit without the Social Security surplus is represented by the lower line. The federal budget deficit with the Social Security surplus is represented by the upper line.



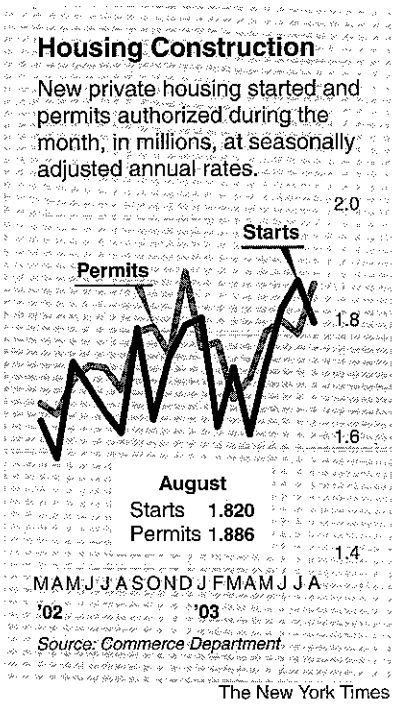
a. At first glance, what overall impression does the graph give?

b. How is the vertical scale labeled? Explain how this graph is misleading.

c. Estimate the value of the federal budget deficit with and without the Social Security surplus for the years from 2003 to 2008, and use them to create a new double-line graph, but begin the vertical scale at zero. Plot deficit values above the horizontal axis, using positive values along the vertical axis.

d. For the graph constructed in part (c), describe the trend in the federal budget deficit with or without the Social Security surplus.

20. The following double-line graph is designed to show the trends in private housing permits issued and actual housing starts from May 2002 to October 2003.



http://www.nytimages.com/portal/wieck_preview_page_116740.

a. At first glance, what overall impression does the graph give?

b. Explain how this graph is misleading.

c. Estimate permit values and housing-start values from the graph, and use them to create a new double-line graph, but begin the vertical scale at zero and expand the horizontal scale.

d. For the graph constructed in part (c), describe the overall impression the graph gives in private housing permits and new housing starts.

21. The dropout rates for grades 9 through 12 for Georgia and Nevada are given in the following table. The dropout rate for a school is found by dividing the number of dropouts by the total number of students enrolled in the school at the beginning of the school year, writing the result as a percentage.

a. Create a double-line graph to represent the data, and choose a vertical scale that downplays the differences in dropout rates for the two states.

b. Create a double-line graph to represent the data, and choose a vertical scale that emphasizes the differences in dropout rates for the two states.

State	'95–'96	'96–'97	'97–'98	'98–'99	'99–'00	'00–'01
Georgia	8.5	8.2	7.3	7.4	7.2	7.2
Nevada	9.6	10.2	10.1	7.9	6.2	5.2

Source: http://www.necs.ed.gov.

22. The following table gives the results of a survey in which people of different ethnic groups were asked whether they suffered from some common conditions in the past six months.

Ailment	Hispanic	Non-Hispanic
Cough, cold, flu	59%	24%
Heartburn	49%	14%
Frequent headaches	33%	13%
Back, neck, joint pain	45%	29%

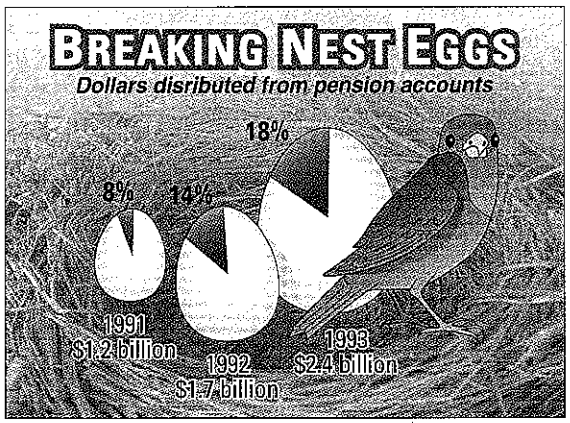
Source: http://www.acnielsen.com.

a. Create a double-bar graph to represent the data, and choose a vertical scale that downplays the differences in percentages.

b. Create a double-bar graph to represent the data, and choose a vertical scale that emphasizes the differences in percentages.

Problems 23 and 24

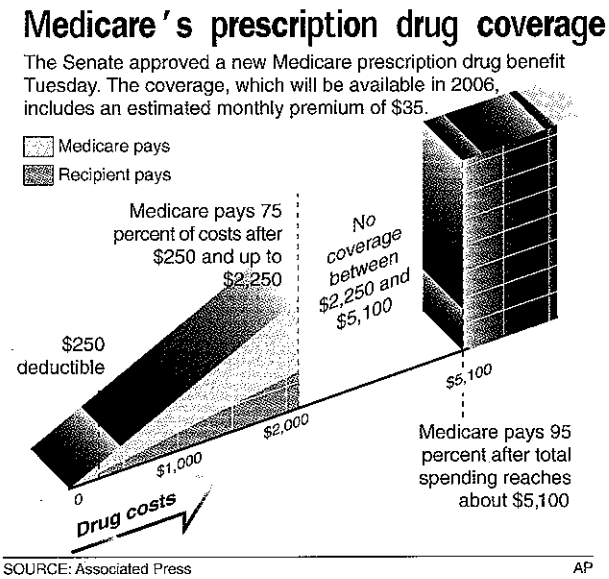
In the following pictograph, the ovals that represent the "nest eggs" have heights that are proportional to the total amounts in the pension accounts. For example, notice that the 1991 egg represents $1.2 billion and is half as tall as the 1993 egg, which represents $2.4 billion. The percentages given represent the percentages of the total pension funds that are distributed in that year.



23. Comment about how the use of an egg is misleading in the pictograph provided. Create a set of three pie charts based on the data from the pictograph. Make all the circles the same size. How does making the circles the same size affect a reader's impression of the amounts involved?

24. Comment about how the use of the tree and leaves is misleading in the pictograph provided. Create a set of three pie charts based on the data from the pictograph. Make the area of each circle proportional to the amount in the pension fund; that is, the area of the circle for 1993 should be twice the area of the circle for 1991. How does this representation affect a reader's impression of the amounts involved?

25. The U.S. Senate approved a new Medicare prescription-drug benefit on November 25, 2003. Consider the following misleading three-dimensional graph intended to explain the new system. It compares the percentage of drug costs covered by Medicare to the percentage that must be paid by the senior citizen as drug costs increase.



AP/Wide World Photos

a. What quantity is represented by the horizontal axis of the graph?

b. What do the darker shaded region and lighter shaded region represent? Consider the region between drug costs of $250 and $2000 and comment on the slant of the graph and the misleading features.

c. What does the thickness of the graph represent?

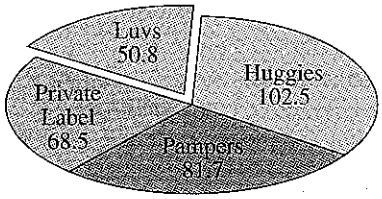
d. Notice that the portion of the graph between $0 and $250 is labeled as the deductible. A deductible is not paid by Medicare. What color should the portion of the graph between $0 and $250 be?

e. If there is "no coverage" between $2250 and $5100, as indicated, then who must pay and what color should that portion of the graph be?

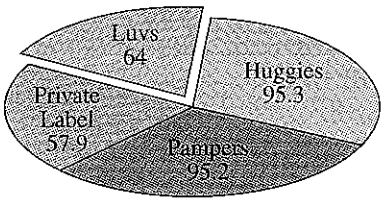
f. Create a proportional bar graph (see Section 8.2) using the information in this graph. Compare the proportional bar graph to the three-dimensional graph and comment on the differences in ease of interpretation.

26. Using perspective with pie charts can result in a graph that is deceptive. Consider the following examples, which compare sales of various brands of disposable diapers for two different years.

Diaper Sales
(Millions of Units)



52 weeks ending Dec 11, 1993



52 weeks ending Jun 13, 1992

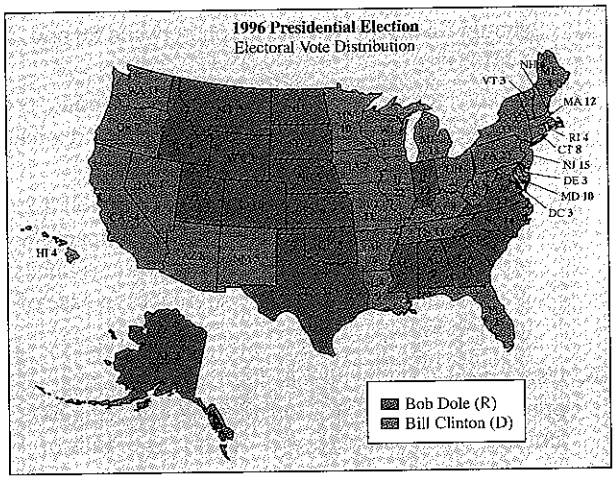
a. For each company, find the change in sales, in millions of units, from 1992 to 1993.

b. Notice how the sector for Luvs brand diapers is colored and raised up out of the pie charts. Suppose these pie charts were used in an investors' guide or in a company report for Luvs. Explain why the pie charts were presented in this manner and why they are misleading.

c. Construct a double-bar graph that emphasizes the differences in sales from 1992 to 1993.

d. How might investors in Luvs react to the double-bar graph from part (c)?

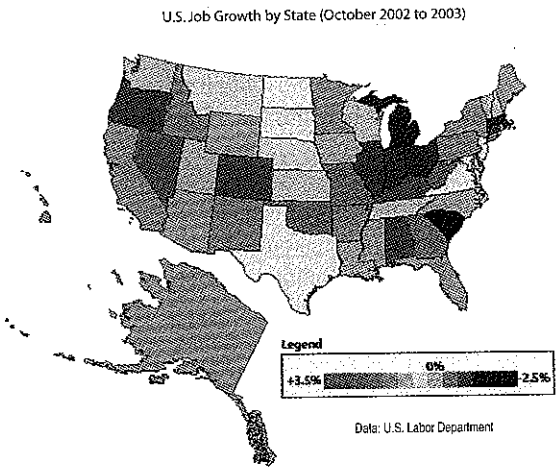
27. The following graphical map displays the electoral vote distribution of the 1996 Presidential election.



a. Based on land area alone, roughly estimate what fraction of the United States appears to have supported each candidate? What geographic regions of the country supported each candidate?

b. Bill Clinton received 379 electoral votes while Bob Dole received 159 electoral votes. Is area proportional to the1996 vote totals?

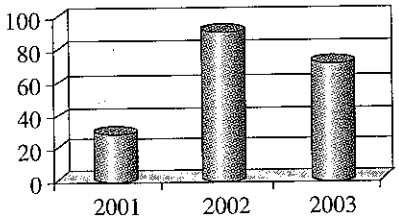
28. The following geographic map displays job growth for the United States for the year beginning October 2002.



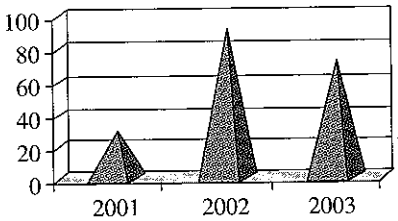
a. Based on land area alone, roughly estimate what fraction of the United States appears to have experienced zero or negative job growth?

b. What area(s) of the United States experienced the most dramatic job loss? What area(s) experienced the most dramatic job growth?

Three-Dimensional Graph Using Cylinders



Three-Dimensional Graph Using Pyramids



29. Three-dimensional graphs, such as the preceding examples, are much easier to create using a computer program such as Microsoft Excel than to do so by hand. Use the following guidelines to explore the three-dimensional graph options in Microsoft Excel.

a. Using the rebate percentages from problem 9, create a three-dimensional graph in Microsoft Excel. Discuss any aspects of this graph that might mislead a reader.

b. Using the pet percentages from problem 10, create a three-dimensional graph in Microsoft Excel. Discuss any aspects of this graph that might mislead a reader.

c. Using the percentages for computer use in farming from problem 11, create a three-dimensional graph in Microsoft Excel. Discuss any aspects of this graph that might mislead a reader.

d. Using the percentages for displaying the Ten Commandments in schools from problem 12, create a three-dimensional graph in Microsoft Excel. Discuss any aspects of this graph that might mislead a reader.

30. *USA Today* regularly includes graphical representations called "Snapshots" to emphasize statistics or survey results about money, life, sports, or news. These snapshots are colorful, eye-catching pictographs or bar charts designed to convey a message quickly. Go to the *USA Today* website at http://www.usatoday.com/news/snapshot.htm and look at the collection of snapshots. From them, select two examples of misleading graphs that each use different techniques discussed in this chapter. For each graph you select, summarize the features that are misleading.

31. Graphing in three dimensions is a common, attractive way to display data. However, as we have discussed, a three-dimensional bar graph can be misleading. A new method, called the "diamond graph" method, is designed to avoid the misleading aspects of the three-dimensional bar graph. This new type of graph was created by Dr. Alvaro Muñoz, who is a professor of epidemiology at the Johns Hopkins Bloomberg School of Public Health. What shape does the diamond graph use rather than parallel, three-dimensional bars? Why was this shape chosen? Find or create an example of this type of graph. Research the diamond graph by using search keywords "new diamond graph method" on the Internet. Summarize your findings in a report.

32. In 1861, a French engineer, Charles Minard, created a graphical presentation of Napoleon's Russian campaign of 1812. This display is considered by some to be the greatest statistical graphic ever created before the advent of computer graphics. Research the graph by Minard. What techniques were used to make the graph? What made the graph so effective? Was there anything misleading about the graph? One source of information on this and other graphs is Edward Tufte's book, *The Visual Display of Quantitative Information* (Cheshire, CT: Graphics Press). On the Internet, search keywords, "Charles Minard." Write a report of your findings about Minard's graph.

33. Compare the graphs used in different media publications such as the *New York Times,* the *Wall Street Journal, Time* magazine, or other diverse sources. From at least three different sources, find examples of misleading bar graphs, line graphs, three-dimensional graphs, pie charts, or pictographs. Which types of graphs seem to be used most commonly? How does the target audience of a publication influence the choice of the graphics used? What is the most common misleading feature of graphs used in the media? For each graph you selected, write a paragraph describing the misleading feature of the graph and explaining why a misleading graph might have been printed.

34. Research recent lawsuits over misleading advertising claims. Some of the companies that have been involved in misleading advertising lawsuits over the past few years are Aleve pain reliever, Claritin, Kaiser Permanente, Nike, Pepsi, Grey Goose Vodka, McDonald's, Burger King, and Kentucky Fried Chicken. Research claims against these companies or research lawsuits filed against other companies. What was considered misleading about the advertisement? Were any graphs involved? How was the lawsuit resolved? Write a report to summarize your findings.