

## QUICK QUIZ

Choose the best answer to each of the following questions. Explain your reasoning with one or more complete sentences.

- Consider Figure 5.16. Notice that the red segment of the second bar from the left starts higher up than the red segment of the first bar (at far left). This fact tells us that
  - books and supplies cost more at public 4-year institutions than at public 2-year institutions.
  - room and board cost more at public 4-year institutions than at public 2-year institutions.
  - the sum of tuition and fees, plus room and board, is greater at public 4-year institutions than at public 2-year institutions.
- Consider Figure 5.17. According to this graph, the approximate death rate from tuberculosis in 1950 was
  - 2 per 100,000.
  - 20 per 100,000.
  - 200 per 100,000.
- Consider Figure 5.18. According to this graph, what is per capita energy use in Oregon (OR)?
  - between 200 and 299 million BTUs
  - between 300 and 399 million BTUs
  - more than 400 million BTUs
- Consider the Figure 5.19. According to this map, the temperature in Iowa (IA) was
  - 30°F.
  - 40°F.
  - between 30°F and 40°F.
- Consider the tan regions in Figure 5.19, such as the region including northern Texas and eastern Colorado. What can you say about temperatures within those tan regions?
  - They were 40°F.
  - They were higher than 40°F but lower than 50°F.
  - They could have been anything above 40°F.
- Suppose you are given a contour map showing elevation (altitude) for the state of Vermont. The region with the most closely spaced contours represents
  - the highest altitude.
  - the lowest altitude.
  - the steepest terrain.
- Consider Figure 5.22. Approximately how many women participated in the 1948 Olympics?
  - 19
  - 9.4
  - 450
- Consider Figure 5.24a. The way the graph is drawn
  - makes the graph completely invalid.
  - makes the changes from one decade to the next appear larger than they really were.
  - makes it more difficult to see the upward and downward trends that have occurred over time.
- Consider Figure 5.25a. Moving one tick mark up the vertical axis represents an increase in computer speed of
  - 1 billion calculations per second.
  - a factor of 2.
  - a factor of 10.
- Consider Figure 5.26. In years where the graph slopes downward with time,
  - college costs decreased.
  - the cost of college rose, but by a lower percentage than in previous years.
  - the cost of college rose, but the new cost represented a lower proportion of the average person's income.

## Exercises 5D

### REVIEW QUESTIONS

- Briefly describe the construction and use of multiple bar graphs and stack plots.
- What are geographical data? Briefly describe at least two ways to display geographical data. Be sure to explain the meaning of contours on a contour map.
- What are three-dimensional graphics? Explain the difference between graphics that only appear three-dimensional and those that show truly three-dimensional data.
- Describe how perceptual distortions can arise in graphics and how they can be misleading.
- How can graphics be misleading when the scales do not go all the way to zero? Why are such graphics sometimes useful?
- What is an exponential scale? When is an exponential scale useful?
- Explain how a graph that shows percentage change can show descending bars (or a descending line) even when the variable of interest is increasing.
- What is a pictograph? How can a pictograph enhance a graph? How can it make a graph misleading?

### DOES IT MAKE SENSE?

Decide whether each of the following statements makes sense (or is clearly true) or does not make sense (or is clearly false). Explain your reasoning.

- My bar chart contains more information than yours, because I made my bars three-dimensional.
- I used an exponential scale because the data values for my categories ranged from 7 to 450,000.
- There's been only a very slight rise in our stock price over the past few months, but I wanted to make it look dramatic so

I started the vertical scale from the lowest price rather than from zero.

12. A graph showing the yearly rate of increase in the number of computer users has a slight downward trend, even though the actual number of users is rising.

**BASIC SKILLS & CONCEPTS**

13. **Net Grain Production.** Net grain production is the difference between the amount of grain a country produces and the amount of grain its citizens consume. It is positive if the country produces more than it consumes, and negative if the country consumes more than it produces. Figure 5.29 shows the net grain production of four countries in 1990 and projected for 2030.

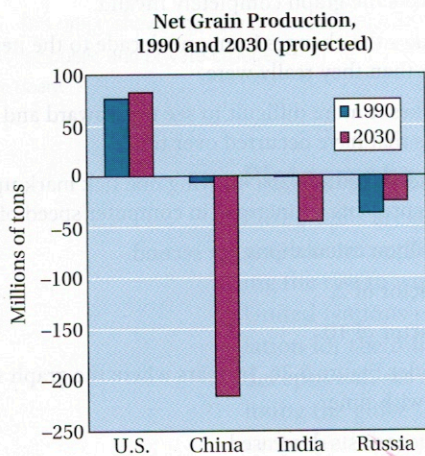


FIGURE 5.29

- a. Which of the four countries had to import grain to meet its needs in 1990?  
 b. Which of the four countries are expected to need to import grain to meet needs in 2030?  
 c. Given that India and China are the world's two most populous countries, what does this graph tell you about how world agriculture will have to change between now and 2030?
14. **Education and Earnings.** Examine Figure 5.15, which shows the unemployment rate and the median weekly earnings for eight different levels of education.
- a. Briefly describe how earnings vary with educational attainment.  
 b. Briefly describe how unemployment varies with educational attainment.  
 c. What is the percentage increase in weekly earnings when a professional degree is compared to a bachelor's degree?  
 d. How much more likely is a high school dropout to be unemployed than a worker with a bachelor's degree?  
 e. On average, people spend about 45 years in the work force before retiring. Based on the data in Figure 5.15, how much more would the average college graduate (bachelor's degree) earn during these 45 years than the average high school graduate?

15. **Stack Plot.** Answer the following based on Figure 5.17.
- a. State whether the death rate for each of the four diseases individually decreased or increased between 1900 and 2004.  
 b. When was the death rate due to cardiovascular diseases the greatest, and what was the rate?  
 c. What was the death rate due to cancer in 2000?  
 d. Based on the trends in the graph, speculate on which of these four diseases will be responsible for the most deaths in 2050. Explain.

16. **College Costs Stack Plot.** Answer the following questions based on Figure 5.16.
- a. Which cost category varies the most among the different types of institutions? by how much?  
 b. Which cost category varies the least among the different types of institutions? Can you explain why this category varies so little?  
 c. The general trend is for everything to cost more as you go from left to right across the different types of institutions, but one category is an exception and actually shows declines from left to right. Which category? Can you explain why?

17. **College Degrees.** Figure 5.30 shows the numbers of college degrees awarded to men and women over time.

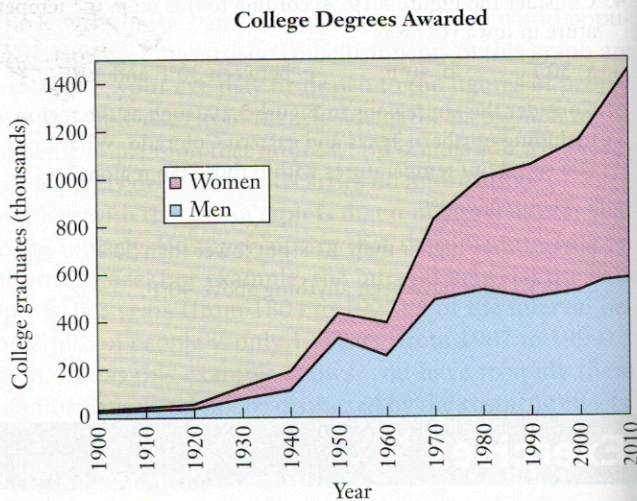


FIGURE 5.30

- a. Estimate the numbers of college degrees awarded to men and to women (separately) in 1930 and in 2010.  
 b. Did men or women earn more degrees in 1980? Did men or women earn more degrees in 2010?  
 c. During what decade did the total number of degrees awarded increase the most?  
 d. Compare the total numbers of degrees awarded in 1950 and 2010.  
 e. Do you think the stack plot is an effective way to display these data? Briefly discuss other ways that might have been used instead.
18. **Federal Spending.** Figure 5.31 shows the major spending categories of the federal budget over the last 50 years. (*Payments to*

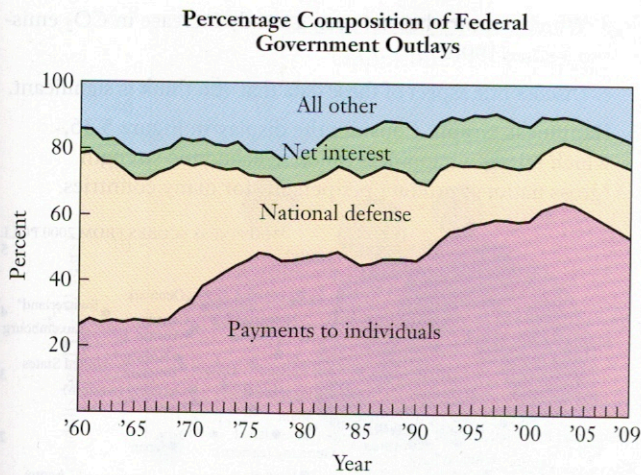


FIGURE 5.31 Source: Office of Management and Budget.

individuals includes Social Security and Medicare; net interest represents interest payments on the national debt; all other represents non-defense discretionary spending.)

Interpret the stack plot and discuss some of the trends it reveals.

- Find the percentage of the budget that went to net interest in 1990, 1995, and 2005.
  - Find the percentage of the budget that went to defense in 1960, 1980, and 2005.
  - Find the percentage of the budget that went to payments to individuals in 1980, 2000, and 2005.
19. **School Segregation.** One way of measuring segregation is to determine the likelihood that a black student will have white classmates. A *New York Times* study found that, by this measure, segregation increased significantly in the 1990s. Figure 5.32 shows the probability, by county, that a black student had white classmates

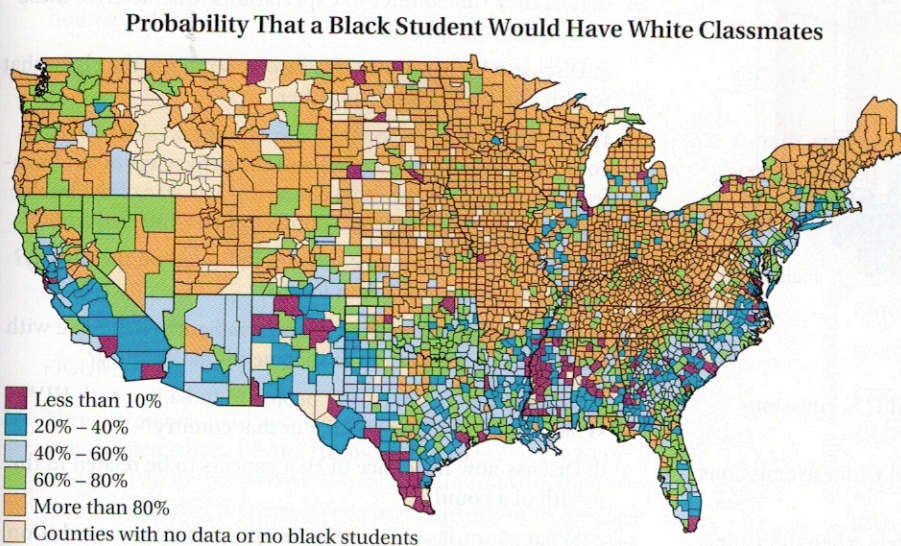


FIGURE 5.32 Source: *New York Times*, April 2, 2000.

during the 1997–1998 academic year. Do there appear to be any significant regional differences? Can you pick out any differences between urban and rural areas? Discuss possible explanations for a few of the trends that you see in the figure.

20. **Contour Maps.** Consider the contour map in Figure 5.33, which has six points marked on it. Assume that points A and B correspond to summits, and that the contour lines have 40-foot intervals.

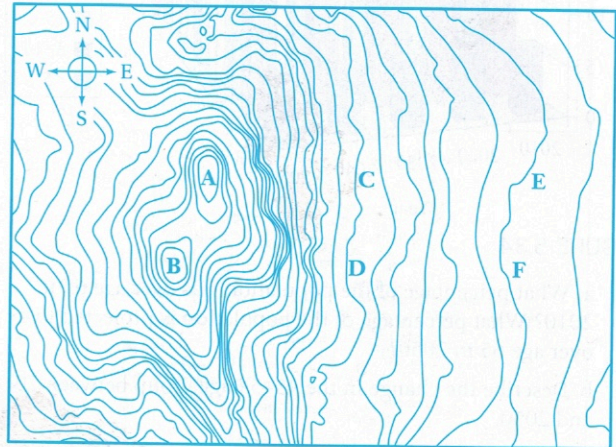


FIGURE 5.33

- If you walk from A to C, do you walk uphill or downhill?
- Does your elevation change more in walking from B to D or from D to F?
- If you walk directly from E to F, does your elevation increase, decrease, or remain the same?
- What is your net elevation change if you walk from A to C to D to A?

21. **U.S. Age Distribution: 3D Plot.** Figure 5.34 shows projections of the age distribution of the U.S. population from 2010 through 2050. Use this graph to answer the following questions.

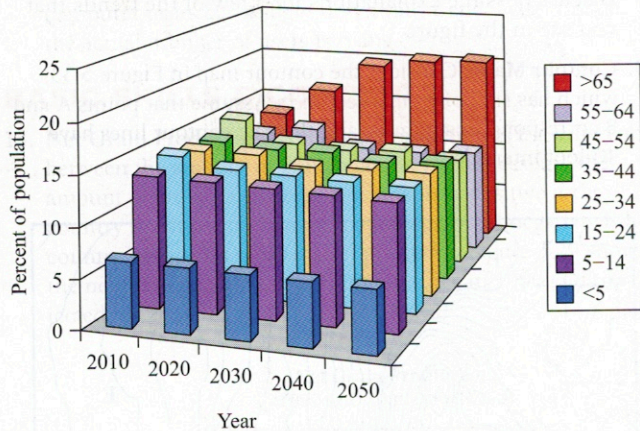


FIGURE 5.34

- What percentage of the population was over age 65 in 2010? What percentage of the population is projected to be over age 65 in 2050?
- Describe the change in the 45–54 age group between 2010 and 2050.
- Does the under-25 segment of the population increase or decrease in size between 2010 and 2050?
- In what year did (will) 45- to 54-year-olds comprise the largest percentage of the population?
- Discuss any significant trends that you see in the data.

22. **CO<sub>2</sub> Emitters.** Figure 5.35 shows the carbon dioxide output (in terms of the total weight of the gas) of the world's leading emitters over the past 20 years. (Values for 2005 and 2010 were still estimates at the time this graph was created.)

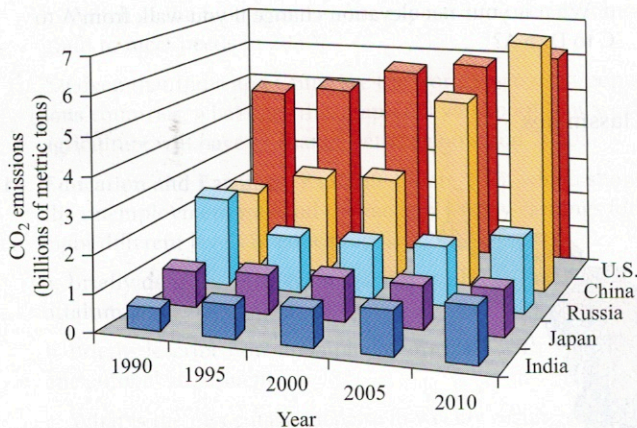
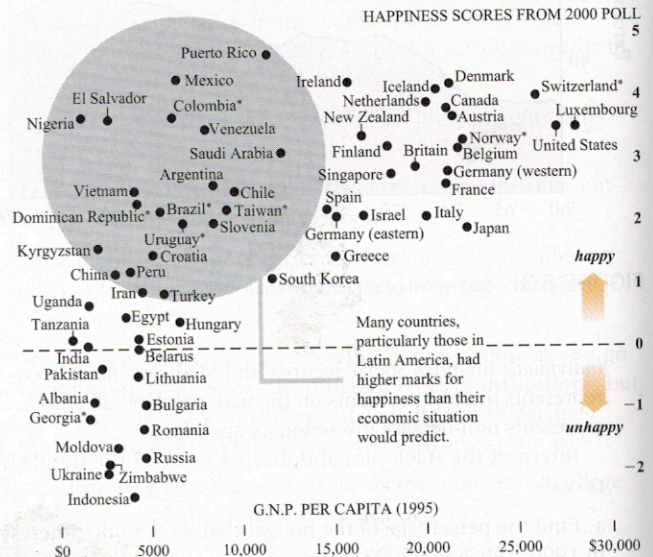


FIGURE 5.35 Source: U.S. Department of Energy.

- By approximately what percentage did U.S. emissions increase between 1990 and 2010?
- By approximately what percentage did Chinese emissions increase between 1990 and 2010?
- Based on these estimates, approximately when did China overtake the United States as the leading emitter?

- Which country has *not* seen a steady increase in CO<sub>2</sub> emissions since 1990?
- Discuss one aspect of these data that you think is significant.

23. **Happiness Graph.** Consider the display in Figure 5.36, which relates a happiness index to economic strength (gross national product per person) for many countries.



\*Poll results for these countries were from 1995.  
Source: Ronald Inglehart, "Human Beliefs and Values: A Cross-Cultural Sourcebook Based on the 1999–2002 Values Surveys"

FIGURE 5.36 Source: *New York Times*.

- What kind of variable is the happiness index (qualitative or quantitative)? What does zero on the happiness scale mean?
  - Are there any countries with a low happiness index despite good economic strength?
  - Characterize geographically the countries with high happiness and high economic strength.
  - The display suggests that certain countries are anomalous; that is, they run counter to expectations. Characterize these countries geographically.
  - Discuss whether or not this display supports the claim that wealth and happiness go together.
24. **HIV Distribution.** Figure 5.37 displays the wealth of various countries (per capita income) and the percentage of adults infected with HIV in the same countries. The size of the bubble is proportional to the actual number of HIV-infected adults.
- How is the location of countries indicated on the display? On what continent is Benin located?
  - Approximately how many people in South Africa live with HIV? What is the per capita income in that country?
  - Approximately how many people in India live with HIV? What is the per capita income in that country?
  - Discuss how incidence of HIV appears to be related to the wealth of a country.
  - What countries are notable exceptions to your conclusion in part d?

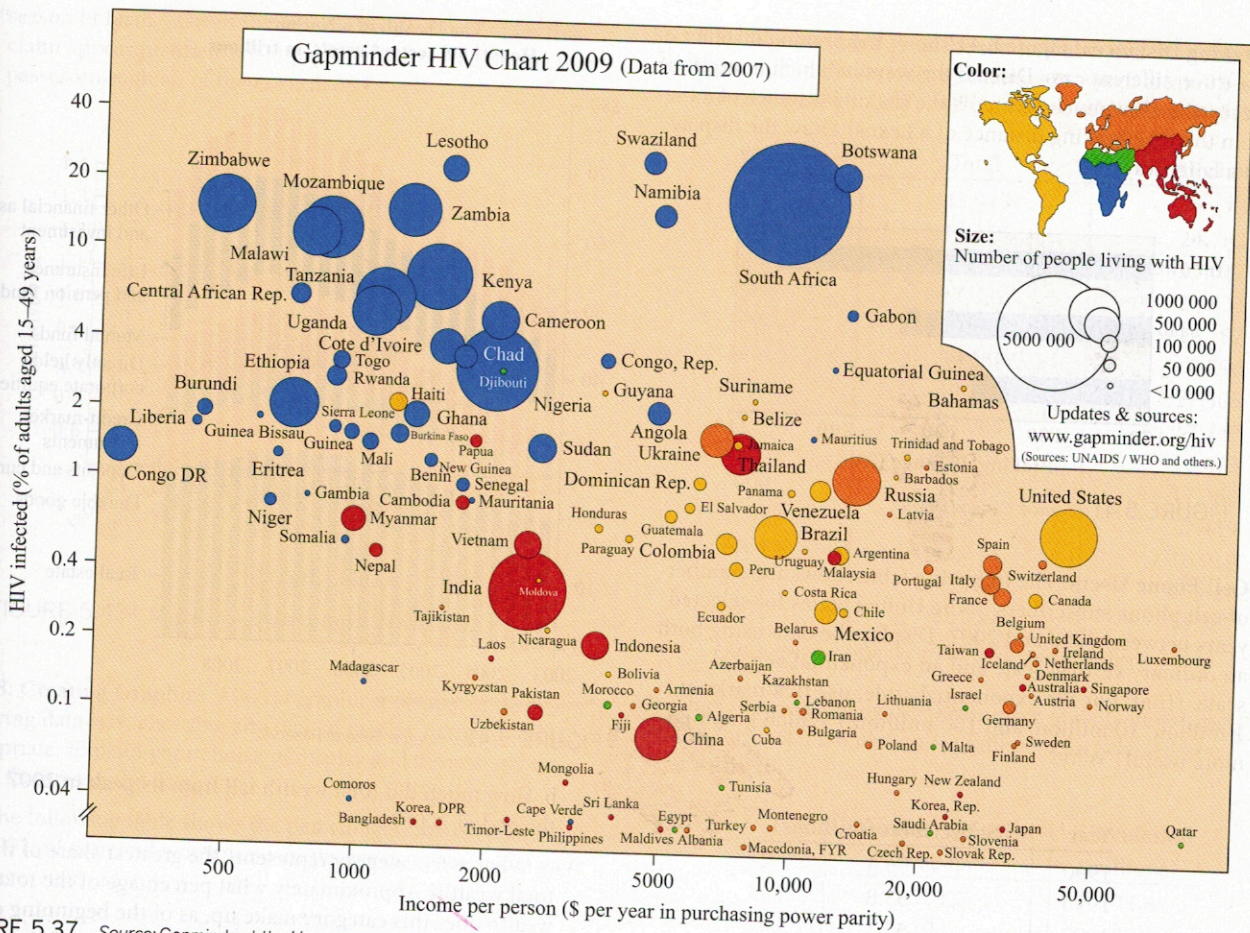


FIGURE 5.37 Source: Gapminder, <http://www.gapminder.org/>.

25. **Volume Distortion.** Figure 5.38 uses television sets to represent the numbers of homes with cable in 1980 and 2008. Note that the heights of the TVs represent the numbers of homes. Briefly explain how the graph creates a perceptual distortion that exaggerates the true change in the number of homes with cable.

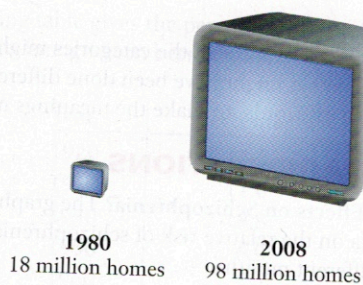


FIGURE 5.38

26. **Three-Dimensional Pies.** The pie charts in Figure 5.39 represent the percentage of Americans in three age categories in 1990 and 2050 (projected). Briefly explain how the three-dimensional effects create a perceptual distortion in this case. Why would flat pies (without the three-dimensional effects) give a more accurate representation of the data?

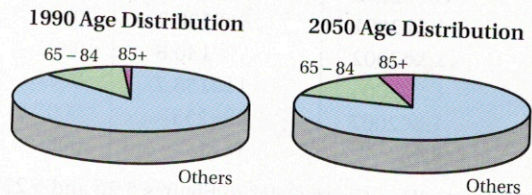


FIGURE 5.39 Source: U.S. Census Bureau.

27. **Comparing Earnings.** Figure 5.40 compares the average weekly earnings of men and women. Identify any misleading aspects of the display. Draw the display in a fairer way.

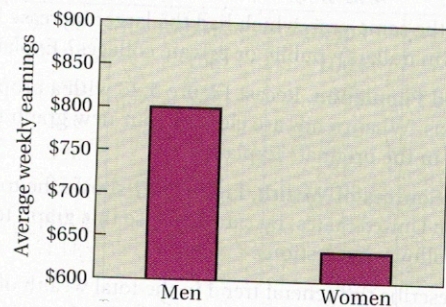


FIGURE 5.40 Source: U.S. Census Bureau.

28. **Braking Distances.** Figure 5.41 shows the braking distance for three different cars. Discuss the ways in which it might be deceptive. How much greater is the braking distance of a Lincoln than the braking distance of a Lexus? Draw the display in a fairer way.

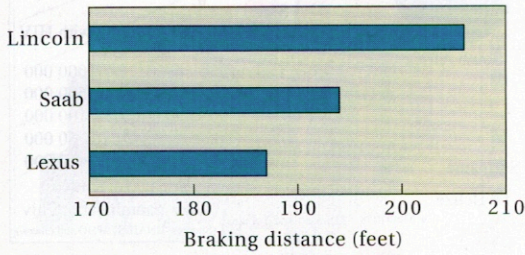


FIGURE 5.41 Source: Car and Driver.

29. **Cell Phone Users.** The following table shows the number of cell phone subscribers in the United States for selected years between 1990 and 2007. Display the data using both an ordinary vertical scale and an exponential vertical scale. (Hint: For the exponential scale, use tick marks at 1 million, 10 million, and 100 million.) Which graph is more useful? Why?

Year	Subscribers (millions)
1990	5.3
1995	33.8
1997	55.3
1998	69.2
1999	86.0
2000	109.5
2001	128.3
2002	140.8
2003	158.7
2007	255

30. **Rising College Costs.** Refer to Figures 5.26 and 5.27 to answer the following questions.

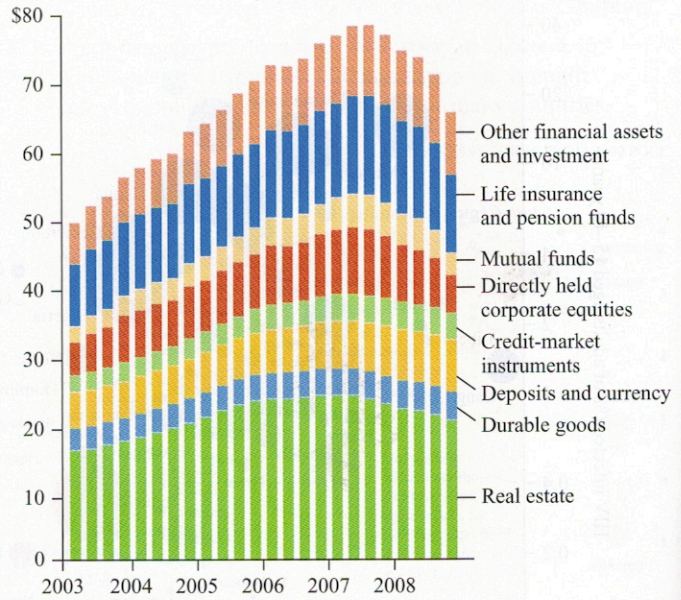
- In what academic year did public college costs rise by the largest percentage? What was the percentage increase?
- In the same year (as part a), what was the percentage increase in private college costs?
- In the same year, which had the larger increase in actual cost (in dollars): public or private colleges? Explain.

31. **World Population.** Recast Figure 5.28 with a proper horizontal axis. What trends are clear in your new graph that are not clear in the original? Explain.

32. **U.S. Sources of Wealth.** Figure 5.42 shows the total wealth of the United States, by category. Use this graph to answer the following questions.

- Describe the general trend in the total wealth of households in the United States from 2003 to 2008.

The Wealth of a Nation:  
Household sector\* assets, in trillions



\*Households and nonprofit organizations.

FIGURE 5.42 Source: Federal Reserve.

b. How much did total wealth fall from its peak in 2007 to the end of 2008?

c. What asset category represents the greatest share of the total wealth? Approximately what percentage of the total wealth does this category make up, as of the beginning of 2009?

d. The category “directly held corporate equities” represents investments in the stock market. How did the value of stock investments change between mid-2007 and the end of 2008?

e. Based on what has happened to the economy since the beginning of 2009, how do you think total wealth has changed since that time? What category (or categories) would you expect to have changed the most? Explain your reasoning.

f. The meanings of some of the categories might be somewhat mysterious. What might have been done differently, either visually or with words, to make the meanings more clear?

**FURTHER APPLICATIONS**

33. **Seasonal Effects on Schizophrenia?** The graph in Figure 5.43 shows data on the relative risk of schizophrenia among people born in different months.

- Note that the scale of the vertical axis does not include zero. Sketch the same risk curve using an axis that includes zero. Comment on the effect of this change.
- Each value of the relative risk is shown with a dot at its most likely value and with an “error bar” indicating the range in which the data value probably lies. The study concludes that “the risk was also significantly associated with the

season of birth.” Given the size of the error bars, does this claim appear justified? (Is it possible to draw a flat line that passes through all of the error bars?)

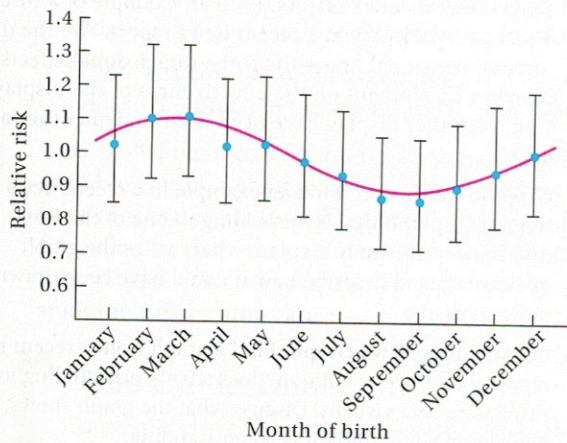


FIGURE 5.43 Source: *New England Journal of Medicine*.

36. The following table gives the total number of automobile fatalities and the number of fatalities in which alcohol was involved for 1982 to 2007. All figures are in thousands of deaths.

Year	Total	Alcohol
1982	43,945	26,173
1984	44,257	24,762
1986	46,087	25,017
1988	47,087	23,833
1990	44,599	22,587
1992	39,250	18,290
1994	40,716	17,308
1996	42,065	17,749
1998	41,501	16,673
2000	41,945	17,380
2002	42,815	17,419
2004	42,643	16,919
2006	42,708	15,829
2007	41,059	15,387

Source: National Highway Traffic Safety Administration.

34–38: **Creating Graphics.** Make a graphical display of the following data sets, choosing any type of display that you feel is appropriate. Explain your choice of display and discuss any interesting features in the data.

34. The following table shows the percentages, for 1970 and 2007, of men and women in various age categories who were never married.

Women	1970	2007	Men	1970	2007
20–24	35.8	75.3	20–24	54.7	86.7
25–29	10.5	43.1	25–29	19.1	57.4
30–34	6.2	24.0	30–34	9.4	33.4
35–39	5.4	16.7	35–39	7.2	23.3
40–44	4.9	13.1	40–44	6.3	18.5

Source: U.S. Census Bureau.

37. The following table gives the number of daily newspapers and their total circulation (in millions) for selected years since 1920.

Year	Number of Daily Newspapers	Circulation (millions)
1920	2042	27.8
1930	1942	39.6
1940	1878	41.1
1950	1772	53.9
1960	1763	58.8
1970	1748	62.1
1980	1747	62.2
1990	1611	62.3
2000	1485	56.1
2006	1437	52.3

Source: Newspaper Association of America.

35. The following table gives the percentage of the U.S. population that was foreign born between 1920 and 2006.

Year	Percentage
1920	13.2
1930	11.6
1940	8.8
1950	6.9
1960	5.4
1970	4.7
1980	6.2
1990	8.0
2000	10.4
2006	12.1

Source: U.S. Census Bureau.

38. The following table summarizes deaths due to firearms in different nations in a recent year.

Country	Total	Homicides	Suicides	Fatal Accidents
U.S.	35,563	15,835	18,503	1225
Germany	1197	168	1004	25
Canada	1189	176	975	38
Australia	536	96	420	20
Spain	396	76	219	101
U.K.	277	72	193	12
Sweden	200	27	169	4
Vietnam	131	85	16	30
Japan	93	34	49	10

Source: Coalition to Stop Gun Violence.