6.7

Box-and-Whisker Plots

GOAL 1 DRAWING A BOX-AND-WHISKER PLOT

A **box-and-whisker plot** is a data display that divides a set of data into four parts. The median or **second quartile** separates the set into two halves: the numbers that are below the median and the numbers that are above the median. The **first quartile** is the median of the lower half. The **third quartile** is the median of the upper half.

EXAMPLE 1 *Finding Quartiles*

Use this set of data: 11, 19, 5, 34, 9, 25, 28, 16, 17, 11, 12, 7.

a. Find the first, second, and third quartiles of the data.

b. Draw a box-and-whisker plot of the data.

SOLUTION

**a.** Begin by writing the numbers in increasing order. You must find the second quartile before you find the first and third quartiles.

Second quartile: $\dfrac{12 + 16}{2} = 14$

5, 7, 9, 11, 11, 12, 16, 17, 19, 25, 28, 34

First quartile: $\dfrac{9 + 11}{2} = 10$ Third quartile: $\dfrac{19 + 25}{2} = 22$
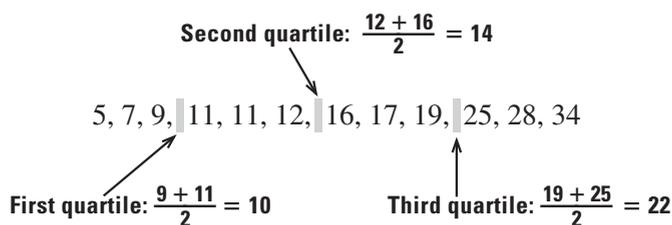
b. *Draw* a number line that includes the least number and the greatest number in the data set.

Plot the least number, the first quartile, the second quartile, the third quartile, and the greatest number. Draw a line from the least number to the greatest number below your number line. Plot the same points on that line.

The "box" extends from the first to the third quartile. Draw a vertical line in the box at the second quartile. The "whiskers" connect the box to the least and greatest numbers.
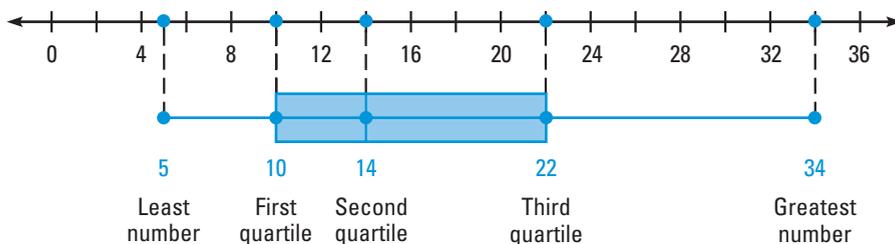
EXAMPLE 2 *Organizing Data*

Retail Prices

You found the following prices of 24 different brands of backpacks.

a. Draw a stem-and-leaf plot to order the data.

b. Draw a box-and-whisker plot of the data.

c. Describe the results.

$15	$25	$50	$42	$29
$50	$33	$27	$35	$32
$40	$35	$28	$40	$40
$35	$35	$75	$40	$40
$25	$50	$35	$50	

backpacks

Navy

Tan

School Days
Style 44302 $35.00
Size: 18" x 13" x 9"
Colors: Black, Navy

Ultimate Pack
Style 44336 $50.00
Size: 15" x 24" x 13"
Colors: Black, Navy, Tan

SOLUTION

a. Draw an ordered stem-and-leaf plot.

```
1 | 5
2 | 5  5  7  8  9
3 | 2  3  5  5  5  5  5
4 | 0  0  0  0  0  2
5 | 0  0  0  0
6 |
7 | 5
```

Key: 5 | 0 = 50

STUDENT HELP

▶ **Study Tip**
A stem with no leaves shows that there are no data in the set that begin with that stem number.
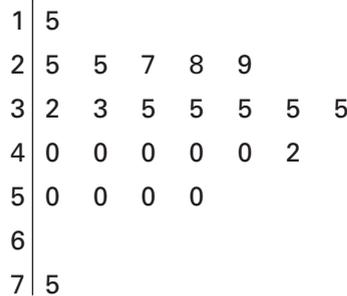
From this plot, you can order the data.

$15	$25	$25	$27	$28	$29	$32	$33
$35	$35	$35	$35	$35	$40	$40	$40
$40	$40	$42	$50	$50	$50	$50	$75

b. Use the ordered data to find the quartiles.

Second quartile: $\dfrac{35 + 35}{2} = 35$

First quartile: $\dfrac{29 + 32}{2} = 30.5$

Third quartile: $\dfrac{40 + 42}{2} = 41$

15	30.50	35	41	75
Least number	First quartile	Second quartile	Third quartile	Greatest number
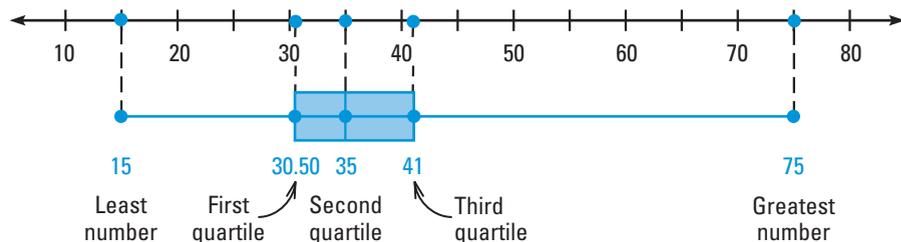
c. One half of the prices are between $30.50 and $41. The median price is $35. Three fourths of the backpacks cost $41 or less. The least price is $15 and the greatest price is $75.

You can use a box-and-whisker plot to see how data are grouped within a set of data. You can also use a box-and-whisker plot to compare two different sets of data.

Meteorology

EXAMPLE 3 *Interpreting a Box-and-Whisker Plot*

The box-and-whisker plots below show the annual precipitation (in inches) in Chicago, Illinois, and in San Diego, California, recorded over the last 30 years.

Precipitation in Chicago, Illinois

26.6   32.0   36.2   40.1   49.4
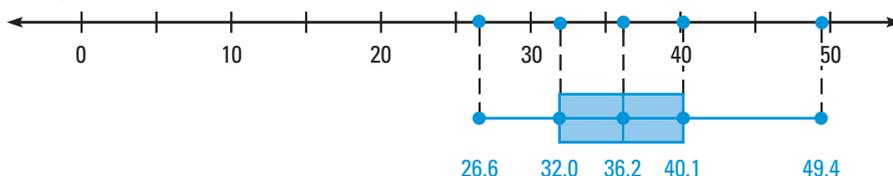
Precipitation in San Diego, California

3.7   8.1 10.3 12.8 19.4
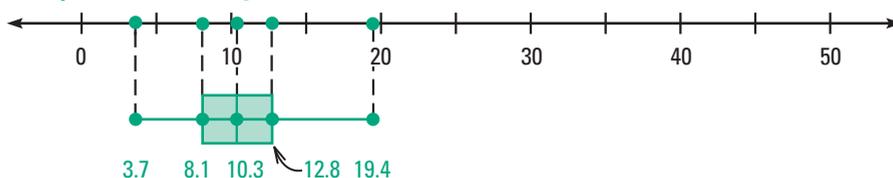
a. What is the median amount of precipitation in Chicago? in San Diego?

b. Which city has had more precipitation in the last 30 years?

c. *Writing* How else do the data sets differ?

SOLUTION

a. The median amount of precipitation in Chicago is about 36.2 inches. The median amount of precipitation in San Diego is about 10.3 inches.

b. Chicago has had more precipitation than San Diego. The lowest "whisker" in the Chicago plot represents a greater amount than the highest "whisker" in the San Diego plot.

c.

Chicago has had between 26.6 inches and 49.4 inches of precipitation. San Diego has had between 3.7 inches and 19.4 inches of precipitation. The difference between the extremes of precipitation in Chicago is about 22.8 inches. The difference between the extremes of precipitation in San Diego is about 15.7 inches.

In about half of the years, Chicago had a precipitation between 32 inches and 40 inches. In about half of the years, San Diego had a precipitation between 8 inches and 13 inches.
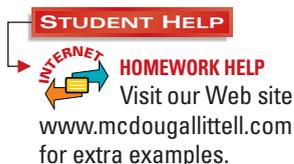
GUIDED PRACTICE

Vocabulary Check ✓

1. Another expression for the median of an ordered set of numbers is ? .

Concept Check ✓

2. Describe the "box" of a box-and-whisker plot. What does it represent?

3. Describe the "whiskers" of a box-and-whisker plot. What do they represent?

Skill Check ✓

In Exercises 4–7, find the first, second, and third quartiles of the data.

4. 1, 2, 3, 1, 2, 1, 2, 1, 2

5. 5, 6, 7, 2, 1, 3, 4

6. 12, 30, 19, 15, 18, 22

7. 4, 20, 14, 6, 8, 18, 2, 10, 12, 16

8. Draw a box-and-whisker plot of the following ages of horses in a stable.

2, 5, 12, 3, 18, 23, 7, 8, 11, 24, 4, 10, 3, 5, 12

9. Tell which set of data is shown by the box-and-whisker plot.
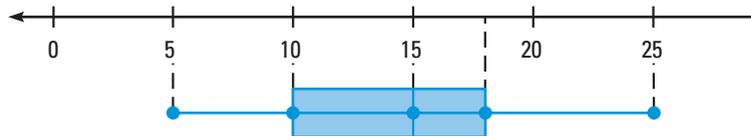
A. 0, 10, 15, 18, 25   **B.** 5, 10, 15, 18, 30   **C.** 5, 10, 15, 18, 25

10. Use the box-and-whisker plots in Example 3. Is it true that 50% of the yearly precipitation in San Diego is less than 8.1 inches? Explain.

PRACTICE AND APPLICATIONS

FINDING QUARTILES Find the first, second, and third quartiles of the data.

11. 12, 5, 3, 8, 10, 7, 6, 5

12. 20, 73, 31, 53, 22, 64, 47

13. 1, 12, 6, 5, 4, 7, 5, 10, 3, 4

14. 2.3, 5.6, 3.4, 4.5, 3.8, 1.2, 9.7

DRAWING BOX-AND-WHISKER PLOTS In Exercises 15–22, draw a box-and-whisker plot of the data.

15. 6, 7, 10, 6, 2, 8, 7, 7, 8

16. 10, 5, 9, 50, 10, 3, 4, 15, 20, 6

17. 12, 13, 7, 6, 25, 25, 5, 10, 15, 10, 16, 14, 29

18. 8, 8, 10, 10, 1, 12, 8, 6, 5, 1, 9, 10

19. Number of days of rainfall in a year: 39, 46, 26, 12, 34, 57, 38, 37, 69, 15, 44, 47, 38, 58, 75, 29, 40, 35, 22, 69, 22, 37, 51, 55, 46, 27, 19, 36, 72, 49

20. Dogs' weights (in pounds): 88, 23, 75, 46, 77, 22, 83, 75, 97, 89, 46, 79, 69, 72, 91, 20, 75, 78, 83, 35, 39, 98, 59, 77, 84, 69, 82, 79, 57, 91

21. Attendance at early showing of a movie: 48, 60, 40, 68, 51, 47, 57, 41, 65, 61, 20, 65, 49, 34, 63, 53, 52, 35, 45, 35, 65, 65, 48, 36, 24, 53, 64, 48, 40

22. Weekly tips earned (in dollars): 167, 191, 190, 154, 188, 174, 192, 166, 180, 155, 157, 161, 163, 172, 169, 167, 182, 184, 158, 160, 176

CREATING DATA SETS Create a collection of 16 numbers that could be represented by the box-and-whisker plot.

23.

10 13   19   27   38

24.

106   124   150 162   193
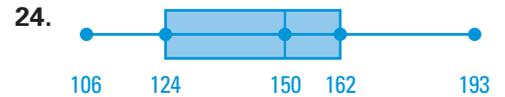
CELLULAR TELEPHONES In Exercises 25–29, use the table that lists the weights (in ounces) and operating times (in minutes) for 10 cellular telephones.

25. Make a stem-and-leaf plot to order the weights of the phones.

26. Draw a box-and-whisker plot of the weights of the phones.

27. Make a stem-and-leaf plot to order the operating times of the phones.

28. Draw a box-and-whisker plot of the operating times of the phones.

29. *Writing* Using the plot in Exercise 28, describe the distribution of the operating time data. What does this mean in terms of operating time?

Weight	Operating Time
8.8	140
7.7	80
4.8	90
7.0	90
7.1	90
8.4	70
3.8	60
3.6	260
6.7	75
6.2	135

DATA UPDATE Visit our Web site
www.mcdougallittell.com

30. **MILK PRODUCTION** To increase the amount of milk produced by the herd, a dairy farmer changes the cows' feed. The data show the average daily milk yield (in pints) for 10 cows before the feed change and one month after the feed change. Did the feed change increase the average daily milk yield of a cow? Use box-and-whisker plots to support your answer.

Before	39	42	43	44	39	40	42	51	40	47
After	52	53	50	46	39	49	50	49	51	44

COMMUTING In Exercises 31–33, use the box-and-whisker plot that shows the lengths (in hours) of commuters' trips to work.
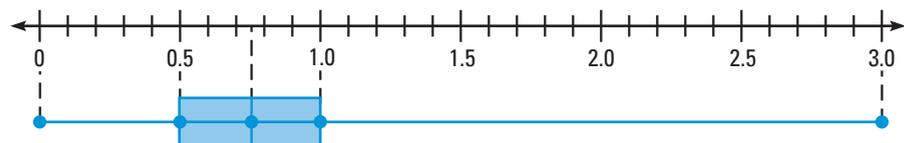
31. How long is the median trip to work?

32. Compare the number of people whose trip is 0–0.5 hour long to the number of people whose trip is 1–3 hours long. Explain your reasoning.

**33.** Do more people travel 1–3 hours than travel 0.5–1 hour? Explain.

**DRAWING BOX-AND-WHISKER PLOTS** Draw a box-and-whisker plot of the data.

34.

35.
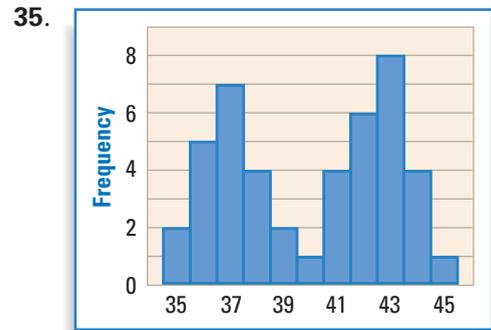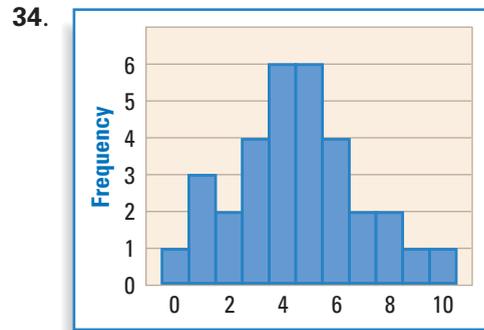
36. **MULTI-STEP PROBLEM** The heights (in meters) of some of the world's tallest skyscrapers are given in the table below.

Skyscraper, location	Height (m)
One Liberty Place, Philadelphia	288
Columbia Seafirst Center, Seattle	287
First Interstate World Center, Los Angeles	310
Society Tower, Cleveland	289
One Peachtree Center, Atlanta	275
Texas Commerce Tower, Houston	305
Two Prudential Center, Chicago	274
First Interstate Plaza, Houston	300
Bank of China, Hong Kong	305
Citicorp Center, New York City	279
Empire State, New York City	381
John Hancock Center, Chicago	343
Overseas Union Bank, Singapore	280
Aon Center, Chicago	346

a. Make a stem-and-leaf plot of the heights. List the heights from largest to smallest.

b. Draw a box-and-whisker plot of the heights.

c. **CRITICAL THINKING** Explain which type of plot you would prefer to use to answer this question: What is the median height of the skyscrapers that are listed in the table?

★ **Challenge**

37. **ANALYZING DATA** In Exercises 36(a) and 36(b) you made a stem-and-leaf plot and a box-and-whisker plot. Compare the types of plots. Include a discussion of how to find the measures of central tendency with each plot. Also include an explanation of the types of conclusions you can draw from the plots.

MIXED REVIEW

FUNCTIONS Rewrite the equation so that *x* is a function of *y*. Then use the result to find *x* when *y* = −2, −1, 0, and 1. **(Review 3.7)**

38. $3x + y = 7$

39. $4x - y = 4$

40. $3(2 - y) = -9x + 8$

41. $6y - 4(x + 3) = -2$

UNIT RATES Find the unit rate. **(Review 3.8)**

42. 12 ounces for 4 servings

43. $420 for 40 hours

FINDING POINTS Decide whether the given ordered pair is a solution of the equation. **(Review 4.2 for 7.1)**

44. $3x - 2y = 2$; $(1, 3)$

45. $5x + 4y = 6$; $(-2, 4)$

46. $-2x - 2y = -6$; $(4, -1)$

47. $x = 3$; $(-3, 3)$

🌎 **UNITED STATES HOUSEHOLDS** Use the table that shows the number of households in the United States from 1970 to 1995. **(Review 5.5)**

Years since 1970	Households (in thousands)
0	63,401
5	71,120
10	80,776
15	86,789
20	93,347
25	98,990

▶ Source: *Statistical Abstract of the United States*

48. Find the year in the table in which the number of households first exceeded 80,000,000.

49. Write a linear model for the number of households in the United States.

50. Use the linear model to estimate the number of households in 2005.

QUIZ 3

Make a stem-and-leaf plot for the data. Use the result to list the data in increasing order. **(Lesson 6.6)**

1. 23, 16, 24, 31, 38, 10, 32, 29, 5, 25, 37, 7, 20

2. 33, 59, 27, 44, 47, 12, 61, 46, 18, 33, 42, 26

Find the mean, the median, and the mode of the data. **(Lesson 6.6)**

3. 9, 9, 5, 10, 7, 10, 6

4. 42, 43, 50, 20, 30, 40

Find the first, second, and third quartiles of the data. Then draw a box-and-whisker plot of the data. **(Lesson 6.7)**

5. 13, 10, 16, 25, 5, 12, 20, 7, 15

6. 50, 70, 75, 60, 30, 10, 40, 80, 15, 20

7. 57, 48, 9, 27, 8, 80, 56, 55, 6, 33

8. 2, 6, 11, 16, 10, 7, 3, 12, 20, 5, 1, 14

9. 🌎 **BASKETBALL WINS** The data represent the number of wins by some NBA basketball teams for the 1996–1997 season. Find the mean, the median, and the mode of the data to the nearest whole number. **(Lesson 6.6)**

64, 57, 24, 20, 14, 40, 21, 15, 61, 57, 22, 26, 45, 44, 57, 30, 34, 56, 49