APPENDIX D

Selected Answers*

Chapter 1

Exercises 1–1

1. Statistics is the science of conducting studies to collect, organize, summarize, analyze, and draw conclusions from data.

3. In a census, the researchers collect data from all subjects in the population.

5. Descriptive statistics consists of the collection, organization, summarization, and presentation of data while inferential statistics consists of generalizing from samples to populations, performing estimations and hypothesis testing, determining relationships among variables, and making predictions.

7. Samples are used more than populations both because populations are usually large and because researchers are unable to use every subject in the population.

9. This is inferential because a generalization is being made about the population.

11. This is a descriptive statistic since it describes the weight loss for a specific group of subjects; i.e., those teenagers at Boston University.

13. This is an inferential statistic since a generalization was made about a population.

15. This is an inferential statistic since a generalization was made about a population.

17. This is an inferential statistic since it is a generalization made from data obtained from a sample.

19. Answers will vary.

Exercises 1–2

1. Qualitative variables are variables that can be placed in distinct categories according to some characteristic or attribute and cannot be ranked, while quantitative variables are numerical in nature and can be ordered or counted.

3. Continuous variables need to be rounded because of the limits of the measuring device.

5. Qualitative **7.** Quantitative

9. Quantitative **11.** Discrete

13. Continuous **15.** Discrete

17. 23.5–24.5 feet **19.** 142.5–143.5 miles

21. 200.65–200.75 miles **23.** Nominal

25. Ratio **27.** Ordinal **29.** Ratio

Exercises 1–3

1. Data can be collected by using telephone surveys, mail questionnaire surveys, personal interview surveys, by taking a look at records, or by direct observation methods.

3. Random numbers are used in sampling so that every subject in the population has an equal chance of being selected for a sample. Random numbers can be generated by computers or calculators; however, there are other ways of generating random numbers such as using a random number table or rolling dice.

5. The population could be all people in the United States who earn over $200,000 a year. A sample could have been created by selecting at random 500 people from an accounting firm that prepares income taxes. Answers will vary.

7. The population could be all households in the United States. A sample could be selected using 1000 households in the United States. Answers will vary.

9. The population could be all adults in the United States who develop diabetes. The sample could be surveying patient records of these people to see if they have been taking statins. Again, the privacy rights must be considered. Answers will vary.

11. Systematic **13.** Random **15.** Cluster

Exercises 1–4

1. In an observational study, the researcher observes what is happening and tries to draw conclusions based on the observations. In an experimental study, the researcher manipulates one of the variables and tries to determine how this influences the other variables.

3. One advantage of an observational study is that it can occur in a natural setting. In addition, researchers can look at past instances of statistics and draw conclusions from these situations. Another advantage is that the researcher can use variables, such as drugs, that he or she cannot manipulate. One disadvantage is that since the variable cannot be manipulated, a definite cause-and-effect situation cannot be shown. Another disadvantage is that these studies can be expensive and time-consuming. These studies can also be influenced by confounding variables. Finally, in these studies, the researcher sometimes needs to rely on data collected by others.

5. In an experimental study, the researcher has control of the assignment of subjects to the groups, whereas in a quasi-experimental study, the researcher uses intact groups.

7. In research studies, a treatment group subject receives a specific treatment and those in the control group do not receive a treatment or are given a placebo.

9. A confounding variable is one that can influence the results of the research study when no precautions were taken to eliminate it from the study.

11. Blinding is used to help eliminate the placebo effect. Here the subjects are given a sugar pill that looks like the real medical pill. The subjects do not know which pill they are

*Answers may vary due to rounding or use of technology.

getting. When double blinding occurs, neither the subjects nor the researchers are told who gets the real treatment or the placebo.

13. In a completely randomized design, the subjects are assigned to the groups randomly, whereas in a matched-pair design, subjects are matched on some variable. Then one subject is randomly assigned to one group, and the other subject is assigned to the other group. In both types of studies, the treatments can be randomly assigned to the groups.

15. Observational

17. Experimental

19. Independent variable—minutes exercising
Dependent variable—catching a cold

21. Independent variable— happy face on check
Dependent variable—amount of the tip

23. Age, income, socioeconomic status. Answers will vary.

25. Income, number of hours worked, type of boss. Answers will vary.

27. How is a perfect body defined statistically?

29. How can 24 hours of pain relief be measured?

31. How much weight, if any, will be lost?

33. Only 20 people were used in the study.

35. It is meaningless since there is no definition of "the road less traveled." Also, there is no way to know that for *every* 100 women, 91 would say that they have taken "the road less traveled."

37. There is no mention of how this conclusion was obtained.

39. Since the word *may* is used, there is no guarantee that the product will help fight cancer and heart disease.

41. No. There are many other factors that contribute to criminal behavior.

43. Answers will vary.

45. Answers will vary.

Review Exercises

1. Inferential **3.** Descriptive
5. Inferential **7.** Descriptive
9. Ratio **11.** Interval
13. Ratio **15.** Ordinal
17. Ratio **19.** Qualitative
21. Quantitative **23.** Quantitative
25. Quantitative **27.** Discrete
29. Discrete **31.** Continuous
33. Continuous **35.** 55.5–56.5 yards
37. 72.55–72.65 tons **39.** Cluster
41. Random **43.** Stratified
45. Experimental **47.** Observational

49. Independent variable—habitat of the animal
Dependent variable—weight of the animal

51. Independent variable—thyme
Dependent variable—antioxidants

53. A telephone survey won't contact all the types of people who shop online. Answers will vary.

55. It depends on where the survey was taken. Some places in the United States get very little or no snow at all during the winter.

57. It depends on how the Internet is used. How can the Internet raise IQ? Answers will vary.

Chapter Quiz

1. True **2.** True

3. False. The difference between a sampling measure and a population measure is called a sampling error.

4. False. This sample is called a stratified sample.

5. True **6.** True

7. False. The boundary is 5.5-6.5 inches.

8. *c*

9. *b* **10.** *d*

11. *a* **12.** *c*

13. *a* **14.** Descriptive, inferential

15. Gambling, insurance. Answers can vary.

16. Population

17. Sample

18. *a.* Saves time
b. Saves money
c. Use when population is infinite

19. *a.* Random *c.* Cluster
b. Systematic *d.* Stratified

21. Random

22. *a.* Descriptive *d.* Inferential
b. Inferential *e.* Inferential
c. Descriptive

23. *a.* Nominal *d.* Interval
b. Ratio *e.* Ratio
c. Ordinal

24. *a.* Continuous *d.* Continuous
b. Discrete *e.* Discrete
c. Continuous

25. *a.* 31.5–32.5 minutes
b. 0.475–0.485 millimeters
c. 6.15–6.25 inches
d. 18.5–19.5 pounds
e. 12.05–12.15 quarts

Chapter 2

Exercises 2–1

1. To organize data in a meaningful way, to determine the shape of the distribution, to facilitate computational procedures for statistics, to make it easier to draw charts and graphs, to make comparisons among different sets of data

3. 5–20; class width should be an odd number so that the midpoints of the classes are in the same place value as the data.

5. 60; 5

7. 17.405; 2.12

9. Class width is not uniform.

11. A class has been omitted.

13.

Class	Tally	Frequency	Percent
V	𝍸 /	6	12
C	𝍸 //	7	14
M	𝍸 𝍸 𝍸 𝍸 //	22	44
H	///	3	6
P	𝍸 𝍸 //	12	24
	Total	50	100

The mocha flavor class the most data values and the hazelnut class has the least number of data values.

15.

Limits	Boundaries	Tally	*f*
0	−0.5–0.5	/ /	2
1	0.5–1.5	𝍸	5
2	1.5–2.5	𝍸 𝍸 𝍸 𝍸////	24
3	2.5–3.5	𝍸 ///	8
4	3.5–4.5	𝍸 /	6
5	4.5–5.5	////	4
6	5.5–6.5		0
7	6.5–7.5	/	1
		Total	50

	cf
Less than −0.5	0
Less than 0.5	2
Less than 1.5	7
Less than 2.5	31
Less than 3.5	39
Less than 4.5	45
Less than 5.5	49
Less than 6.5	49
Less than 7.5	50

The category “twice a week” has more values than any other category.

17.

Limits	Boundaries	cf
48–54	47.5–54.5	3
55–61	54.5–61.5	2
62–68	61.5–68.5	9
69–75	68.5–75.5	13
76–82	75.5–82.5	8
83–89	82.5–89.5	3
90–96	89.5–96.5	2
		Total 40

	cf
Less than 47.5	0
Less than 54.5	3
Less than 61.5	5
Less than 68.5	14
Less than 75.5	27
Less than 82.5	35
Less than 89.5	38
Less than 96.5	40

19.

Limits	Boundaries	*f*
27–33	26.5–33.5	7
34–40	33.5–40.5	14
41–47	40.5–47.5	15
48–54	47.5–54.5	11
55–61	54.5–61.5	3
62–68	61.5–68.5	3
69–75	68.5–75.5	2
		Total 55

	cf
Less than 26.5	0
Less than 33.5	7
Less than 40.5	21
Less than 47.5	36
Less than 54.5	47
Less than 61.5	50
Less than 68.5	53
Less than 75.5	55

21.

Limits	Boundaries	*f*
12–20	11.5–20.5	7
21–29	20.5–29.5	7
30–38	29.5–38.5	3
39–47	38.5–47.5	3
48–56	47.5–56.5	4
57–65	56.5–65.5	3
66–74	65.5–74.5	0
75–83	74.5–83.5	2
84–92	83.5–92.5	1
		Total 30

	cf
Less than 11.5	0
Less than 20.5	7
Less than 29.5	14
Less than 38.5	17
Less than 47.5	20
Less than 56.5	24
Less than 65.5	27
Less than 74.5	27
Less than 83.5	29
Less than 92.5	30

23.

Limits	Boundaries	*f*
14–20	13.5–20.5	10
21–27	20.5–27.5	11
28–34	27.5–34.5	6
35–41	34.5–41.5	8
42–48	41.5–48.5	4
49–55	48.5–55.5	1
		Total 40

	cf
Less than 13.5	0
Less than 20.5	10
Less than 27.5	21
Less than 34.5	27
Less than 41.5	35
Less than 48.5	39
Less than 55.5	40

25.

Limits	Boundaries	*f*
6.2–7.0	6.15–7.05	1
7.1–7.9	7.05–7.95	7
8.0–8.8	7.95–8.85	9
8.9–9.7	8.85–9.75	7
9.8–10.6	9.75–10.65	8
10.7–11.5	10.65–11.55	4
11.6–12.4	11.55–12.45	4
	Total	40

	cf
Less than 6.15	0
Less than 7.05	1
Less than 7.95	8
Less than 8.85	17
Less than 9.75	24
Less than 10.65	32
Less than 11.55	36
Less than 12.45	40

27. The percents sum to 101. They should sum to 100% unless rounding was used.

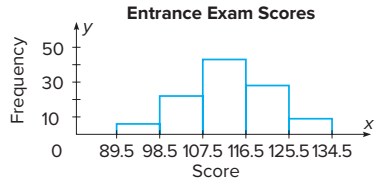
Exercises 2–2

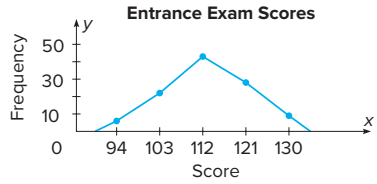
1.

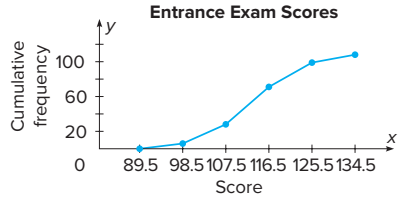
Limits	Boundaries	*f*	Midpoints
90–98	89.5–98.5	6	94
99–107	98.5–107.5	22	103
108–116	107.5–116.5	43	112
117–125	116.5–125.5	28	121
126–134	125.5–134.5	9	130
	Total	108	

	cf
Less than 89.5	0
Less than 98.5	6
Less than 107.5	28
Less than 116.5	71
Less than 125.5	99
Less than 134.5	108

Eighty applicants do not need to enroll in the developmental programs.





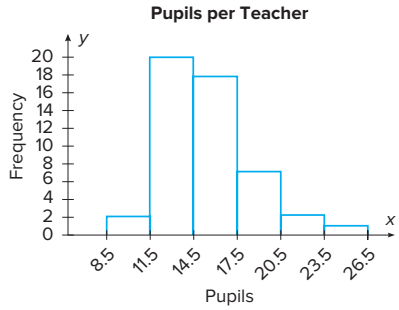


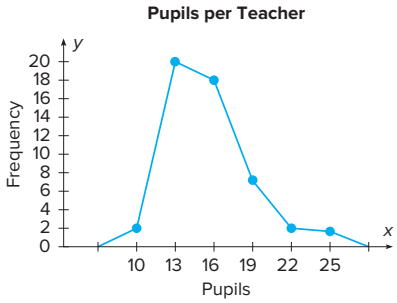
3.

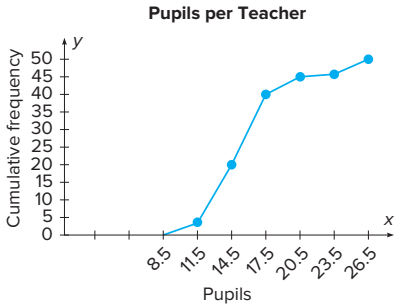
Limits	Boundaries	*f*	Midpoints
9–11	8.5–11.5	2	10
12–14	11.5–14.5	20	13
15–17	14.5–17.5	18	16
18–20	17.5–20.5	7	19
21–23	20.5–23.5	2	22
24–26	23.5–26.5	1	25
	Total	50	

	cf
Less than 8.5	0
Less than 11.5	2
Less than 14.5	22
Less than 17.5	40
Less than 20.5	47
Less than 23.5	49
Less than 26.5	50

The distribution is positively skewed with a peak at the class of 11.5–14.5.





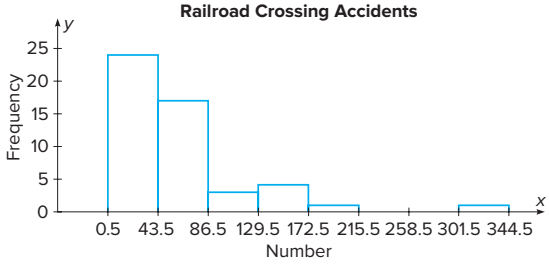


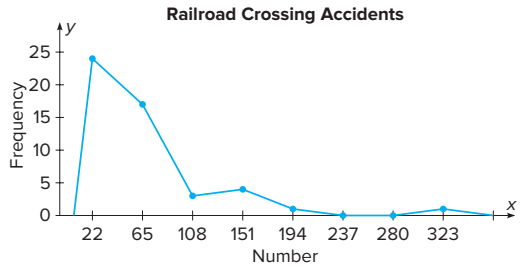
5.

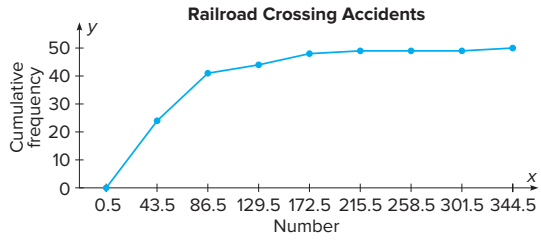
Limits	Boundaries	*f*	Midpoints
1–43	0.5–43.5	24	22
44–86	43.5–86.5	17	65
87–129	86.5–129.5	3	108
130–172	129.5–172.5	4	151
173–215	172.5–215.5	1	194
216–258	215.5–258.5	0	237
259–301	258.5–301.5	0	280
302–344	301.5–344.5	1	323
	Total	50	

	cf
Less than 0.5	0
Less than 43.5	24
Less than 86.5	41
Less than 129.5	44
Less than 172.5	48
Less than 215.5	49
Less than 258.5	49
Less than 301.5	49
Less than 344.5	50

The distribution is positively skewed.





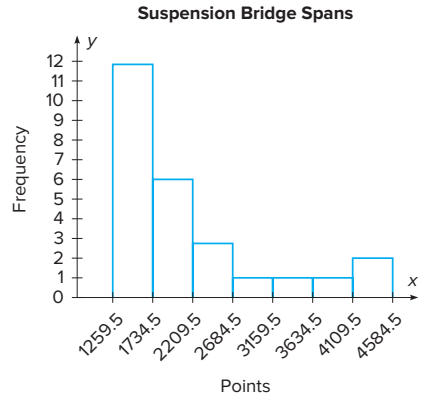


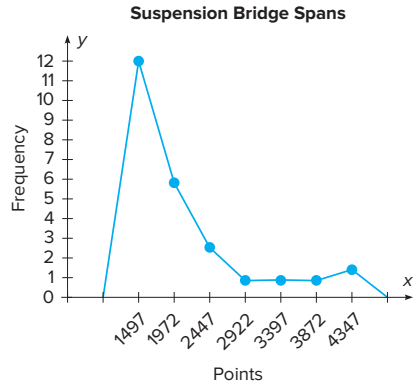
7.

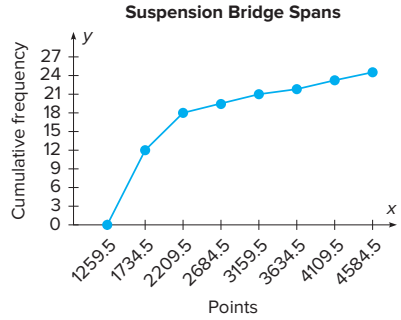
Limits	Boundaries	*f*	Midpoints
1260–1734	1259.5–1734.5	12	1497
1735–2209	1734.5–2209.5	6	1972
2210–2684	2209.5–2684.5	3	2447
2685–3159	2684.5–3159.5	1	2922
3160–3634	3159.5–3634.5	1	3397
3635–4109	3634.5–4109.5	1	3872
4110–4584	4109.5–4584.5	2	4347

	cf
Less than 1259.5	0
Less than 1734.5	12
Less than 2209.5	18
Less than 2684.5	21
Less than 3159.5	22
Less than 3634.5	23
Less than 4109.5	24
Less than 4584.5	26

The distribution is positively skewed. The class with the most frequencies is 1259.5–1734.5.



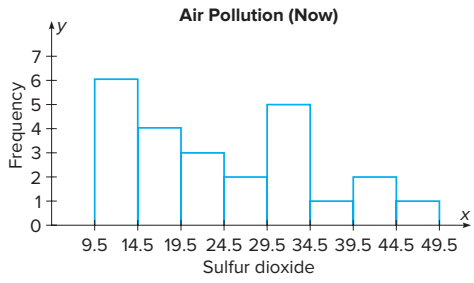


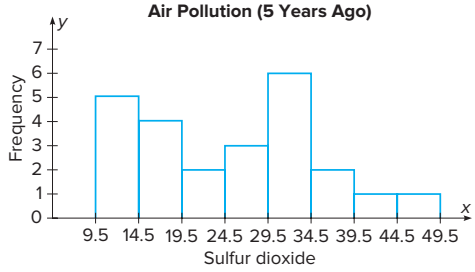


9.

Limits	Boundaries	*f* (now)	*f* (5 years ago)
10–14	9.5–14.5	6	5
15–19	14.5–19.5	4	4
20–24	19.5–24.5	3	2
25–29	24.5–29.5	2	3
30–34	29.5–34.5	5	6
35–39	34.5–39.5	1	2
40–44	39.5–44.5	2	1
45–49	44.5–49.5	1	1
		Total 24	Total 24

With minor differences, the histograms are fairly similar.



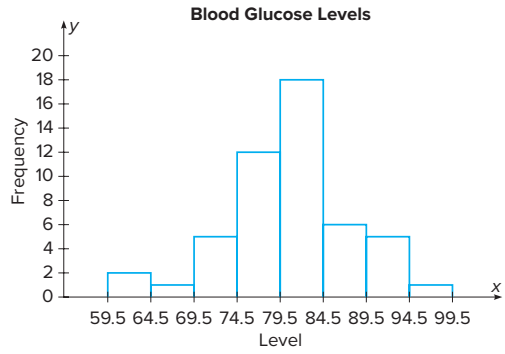


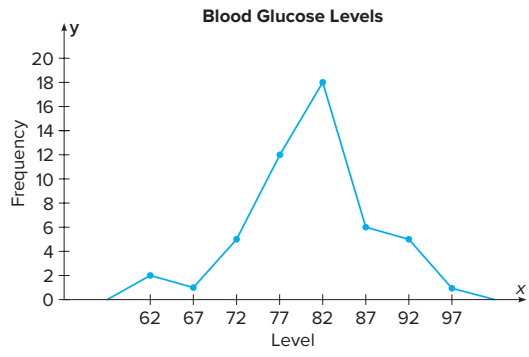
11.

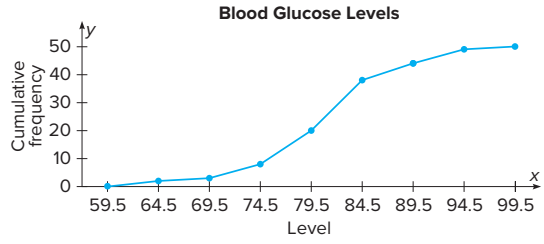
Limits	Boundaries	*f*	Midpoints
60–64	59.5–64.5	2	62
65–69	64.5–69.5	1	67
70–74	69.5–74.5	5	72
75–79	74.5–79.5	12	77
80–84	79.5–84.5	18	82
85–89	84.5–89.5	6	87
90–94	89.5–94.5	5	92
95–99	94.5–99.5	1	97
	Total	50	

	cf
Less than 59.5	0
Less than 64.5	2
Less than 69.5	3
Less than 74.5	8
Less than 79.5	20
Less than 84.5	38
Less than 89.5	44
Less than 94.5	49
Less than 99.5	50

Most patients fell into the 75–84 range.





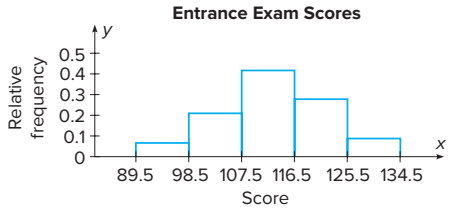


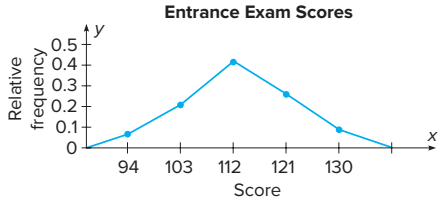
13.

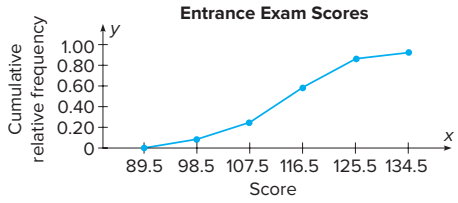
Boundaries	rf	Midpoints
89.5–98.5	0.06	94
98.5–107.5	0.20	103
107.5–116.5	0.40	112
116.5–125.5	0.26	121
125.5–134.5	0.08	130
Total	1.00	

	crf
Less than 89.5	0
Less than 98.5	0.06
Less than 107.5	0.26
Less than 116.5	0.66
Less than 125.5	0.92
Less than 134.5	1.00

The proportion of applicants who do not need to enroll in the developmental program is about 0.74.



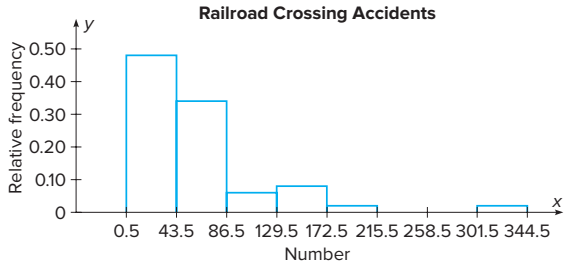


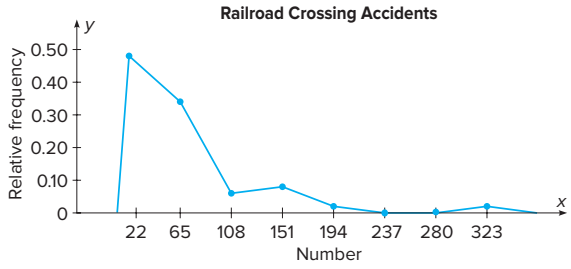


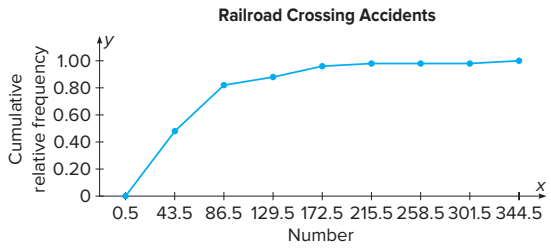
15.

Boundaries	rf	Midpoints
0.5–43.5	0.48	22
43.5–86.5	0.34	65
86.5–129.5	0.06	108
129.5–172.5	0.08	151
172.5–215.5	0.02	194
215.5–258.5	0.00	237
258.5–301.5	0.00	280
301.5–344.5	0.02	323
Total	1.00	

	rcf
Less than 0.5	0
Less than 43.5	0.48
Less than 86.5	0.82
Less than 129.5	0.88
Less than 172.5	0.96
Less than 215.5	0.98
Less than 258.5	0.98
Less than 301.5	0.98
Less than 344.5	1.00





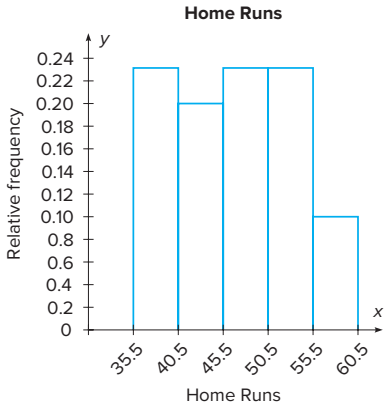


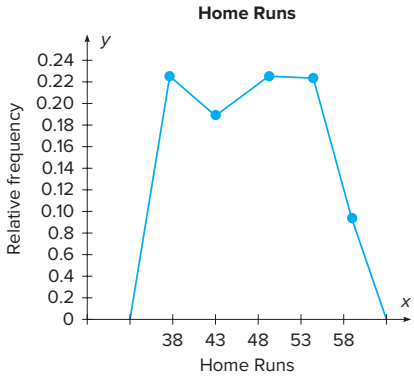
17.

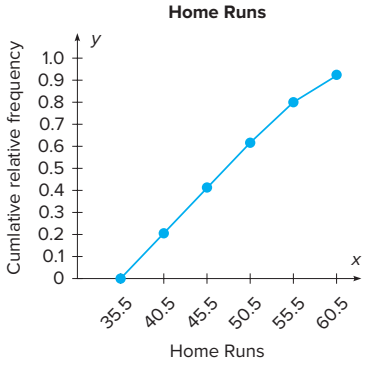
Class boundaries	rf	Midpoints
35.5–40.5	0.23	38
40.5–45.5	0.20	43
45.5–50.5	0.23	48
50.5–55.5	0.23	53
55.5–60.5	0.10	58
	0.99	

	crf
Less than 35.5	0.00
Less than 40.5	0.23
Less than 45.5	0.43
Less than 50.5	0.66
Less than 55.5	0.89
Less than 60.5	0.99

The graph is fairly uniform except for the last class in which the relative frequency drops significantly.





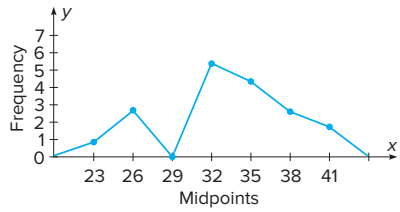


19. *a.*

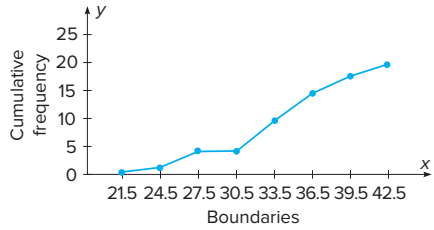
Limits	Boundaries	Midpoints	*f*
22–24	21.5–24.5	23	1
25–27	24.5–27.5	26	3
28–30	27.5–30.5	29	0
31–33	30.5–33.5	32	6
34–36	33.5–36.5	35	5
37–39	36.5–39.5	38	3
40–42	39.5–42.5	41	2

	cf
Less than 21.5	0
Less than 24.5	1
Less than 27.5	4
Less than 30.5	4
Less than 33.5	10
Less than 36.5	15
Less than 39.5	18
Less than 42.5	20

b.

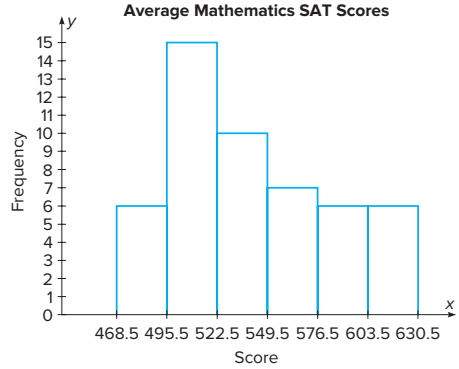


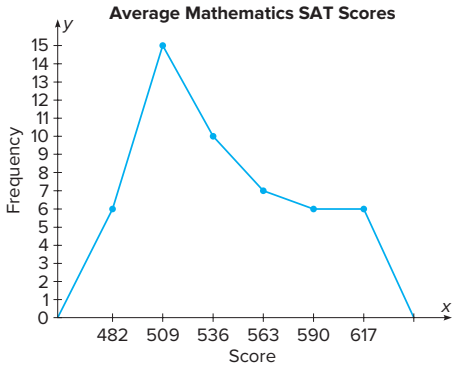
c.



21.

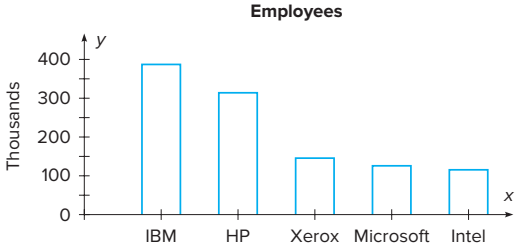
Boundaries	*f*	Midpoints
468.5–495.5	6	482
495.5–522.5	15	509
522.5–549.5	10	536
549.5–576.5	7	563
576.5–603.5	6	590
603.5–630.5	6	617
	Total 50	

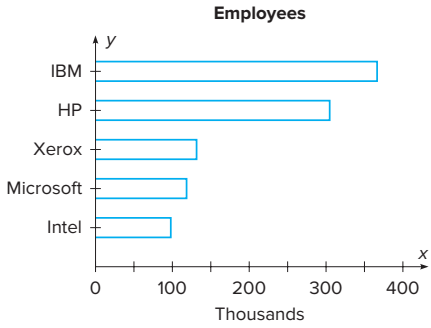




Exercises 2–3

1.





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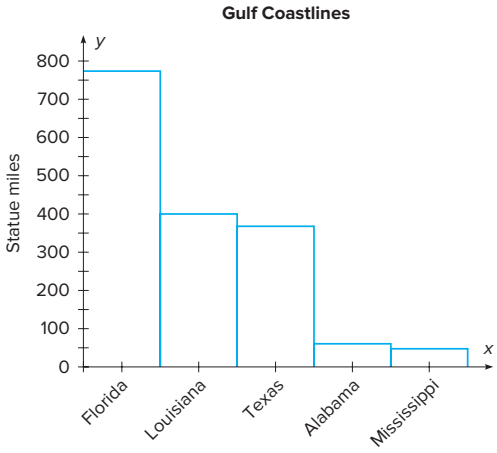
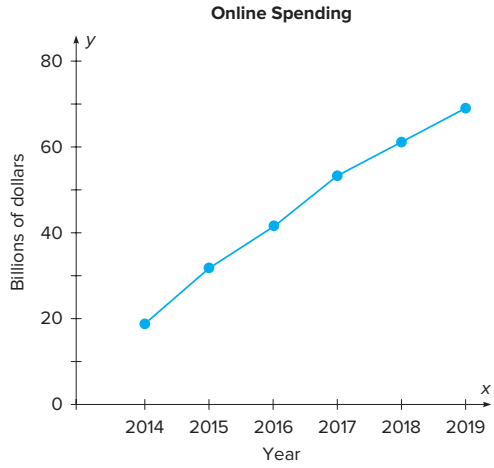
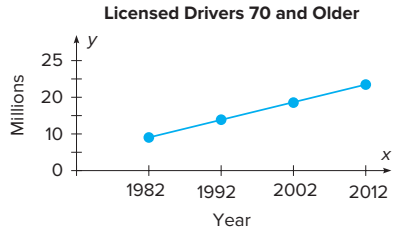


5.

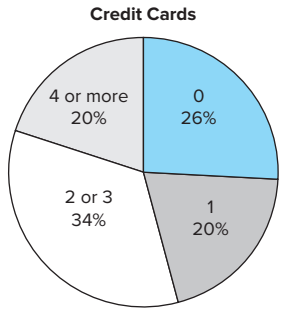


There is an increase over the years.

7.

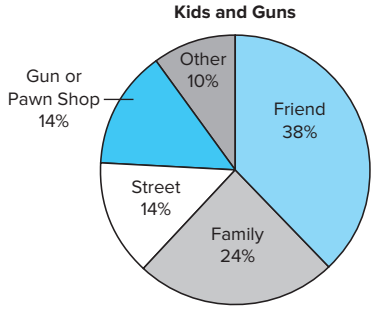


9.

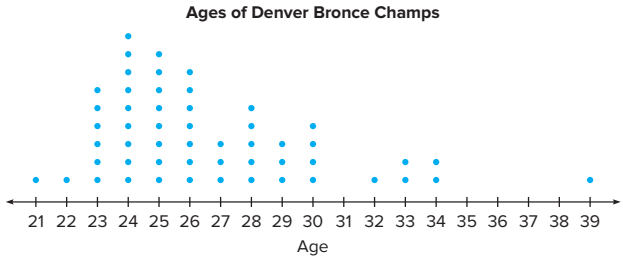


Most people have at least two credit cards.

11.

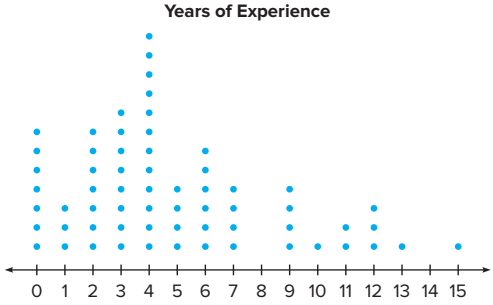


13.



The dotplot is somewhat positively skewed with most players being between the ages of 21 and 30 years old. There are 2 peaks. They are 24 and 25 years with 9 players being 24 years old and 8 players being 25 years old. The dot plot is positively skewed with a gap between 34 and 39.

15. The distribution is positively skewed. The class of 4 has more values than any other class, followed by the class with 3 years of experience.



17. **The 50-Home Run Club**

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

Most players in the club have hit from 50 to 54 home runs in one season. The greatest number of home runs hit is 73.

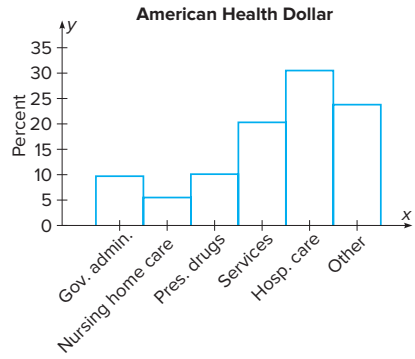
19. **Lengths of Major Rivers**

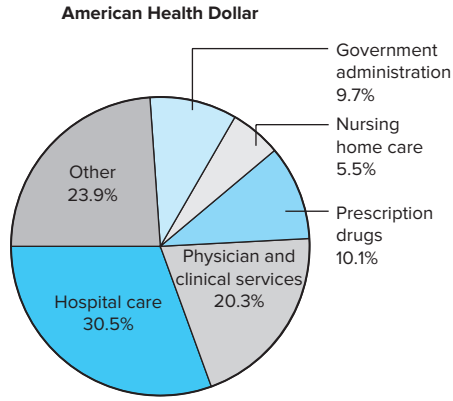
South America		Europe
2	0	3 4 4 5 5 5 5 6 6 6 6 6 7 8 8 9
4 2 1 0 0 0 0 0 0 0	1	1 2 3 4
7 6 5 5	1	8
1	2	
5	2	
	3	
9	3	

The majority of rivers are longer in South America.

21. *a.* Pareto chart
b. Pareto chart
c. Pie graph
d. Time series graph
e. Pareto chart
f. Time series graph

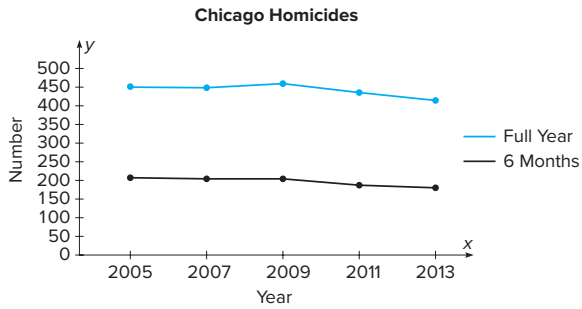
23.





25. The bottle for 2011 is much bigger in area than the bottle for 1988. So your eyes compare areas rather than heights, making the difference appear to be much greater than it is.

27.



There's no way to tell if the crime rate is decreasing by looking at the graph.

Review Exercises

1.

Class	*f*	Percent
Newspaper	10	20
Television	16	32
Radio	12	24
Internet	12	24
	Total 50	100

3.

Class	*f*
11	1
12	2
13	2
14	2
15	1
16	2
17	4
18	2
19	2
20	1
21	0
22	1
Total	20

	cf
Less than 10.5	0
Less than 11.5	1
Less than 12.5	3
Less than 13.5	5
Less than 14.5	7
Less than 15.5	8
Less than 16.5	10
Less than 17.5	14
Less than 18.5	16
Less than 19.5	18
Less than 20.5	19
Less than 21.5	19
Less than 22.5	20

5.

Class limits	Class boundaries	*f*
53–185	52.5–185.5	8
186–318	185.5–318.5	11
319–451	318.5–451.5	2
452–584	451.5–584.5	1
585–717	584.5–717.5	4
718–850	717.5–850.5	2
	Total	28

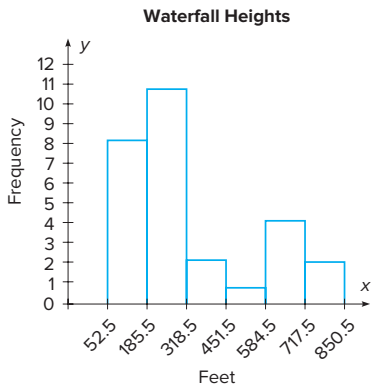
	cf
Less than 52.5	0
Less than 185.5	8
Less than 318.5	19
Less than 451.5	21
Less than 584.5	22
Less than 717.5	26
Less than 850.5	28

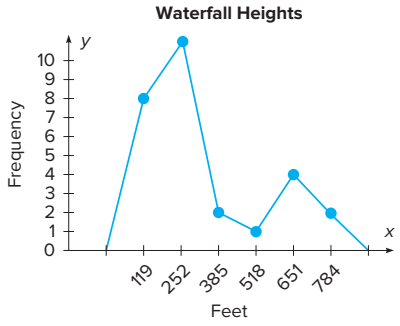
7.

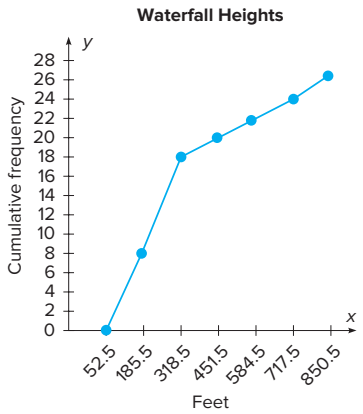
Class limits	Class boundaries	rf
53–185	52.5–185.5	0.29
186–318	185.5–318.5	0.39
319–451	318.5–451.5	0.07
452–584	451.5–584.5	0.04
585–717	584.5–717.5	0.14
718–850	717.5–850.5	0.07

	crf
Less than 52.5	0.00
Less than 185.5	0.29
Less than 318.5	0.68
Less than 451.5	0.75
Less than 584.5	0.79
Less than 717. 5	0.93
Less than 850.5	1.00

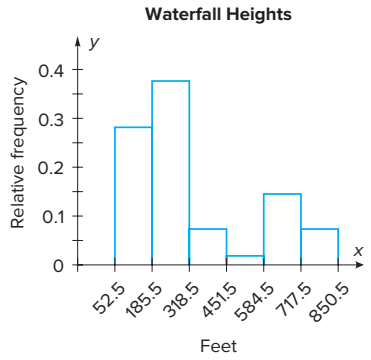
9.

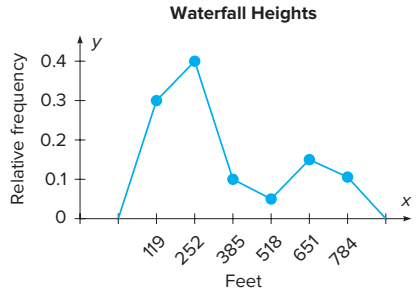


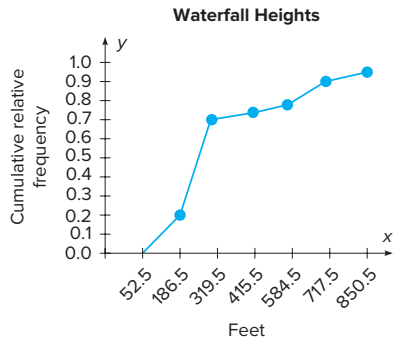




11.







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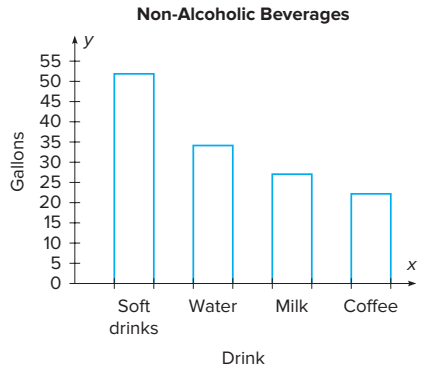
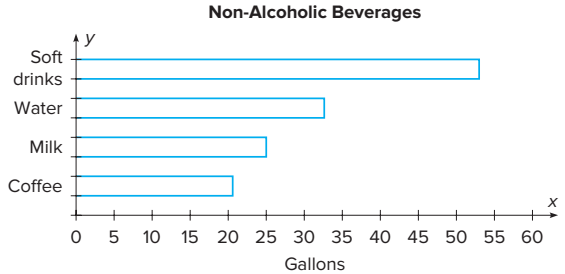
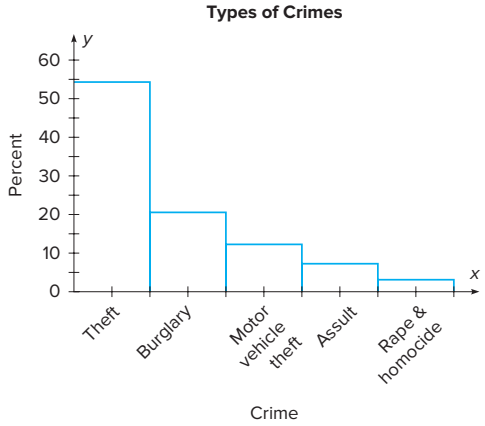
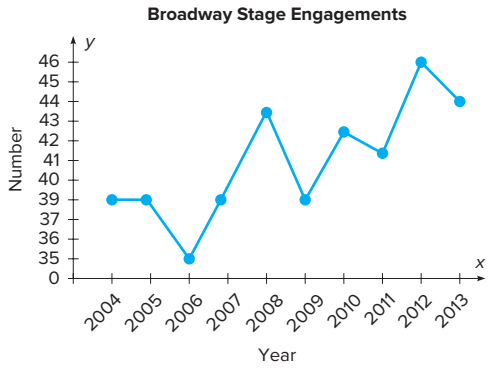




15.

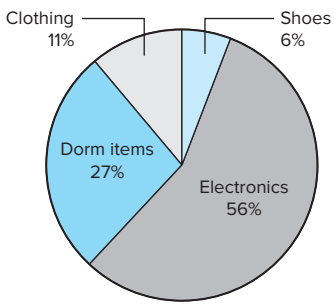


17.

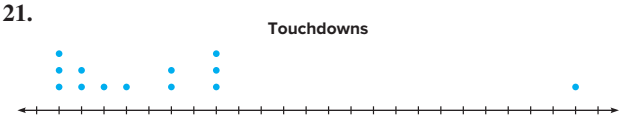


The number of new Broadway productions decreased between 2005 and 2006 before consistently increasing until 2008. At that point it alternated between decreasing and increasing every year until 2013.

19.



21.



The graph shows almost all but one of the touchdowns per season for Manning's career were between 26 and 33.

23.

20	2 3 6
21	3 5 8 9 9
22	0 1 3 3 4 7
23	0 2 3 3 5 8 9
24	6 8 9
25	4 4 6 8
26	2 3

25. There are no numbers on the x and y axes. So it is impossible to tell the times of the pain relief.

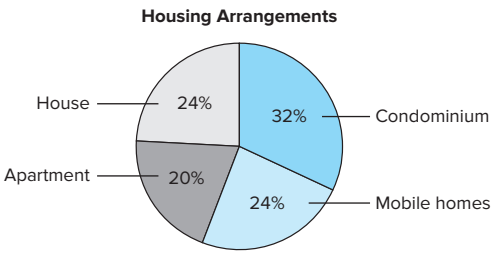
Chapter Quiz

1. False
2. True
3. False
4. True
5. True
6. False
7. False
8. *c*
9. *c*
10. *b*
11. *b*
12. Categorical, ungrouped, grouped
13. 5, 20
14. Categorical
15. Time series
16. Stem and leaf plot
17. Vertical or y

18.

Class	*f*	Percent
H	6	24
A	5	20
M	6	24
C	8	32
Total	25	100

19.

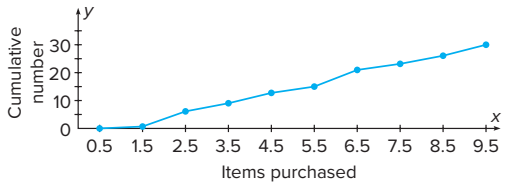


20.

Class limits	Class boundaries	*f*
1	0.5–1.5	1
2	1.5–2.5	5
3	2.5–3.5	3
4	3.5–4.5	4
5	4.5–5.5	2
6	5.5–6.5	6
7	6.5–7.5	2
8	7.5–8.5	3
9	8.5–9.5	4
	Total	30

	cf
Less than 0.5	0
Less than 1.5	1
Less than 2.5	6
Less than 3.5	9
Less than 4.5	13
Less than 5.5	15
Less than 6.5	21
Less than 7.5	23
Less than 8.5	26
Less than 9.5	30

21.

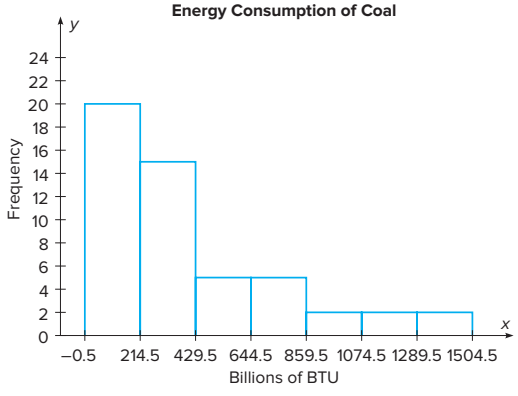


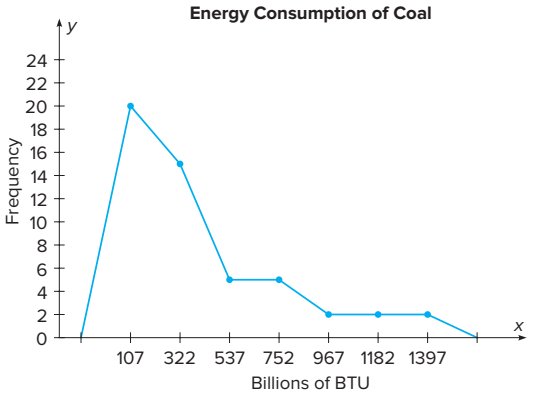
22.

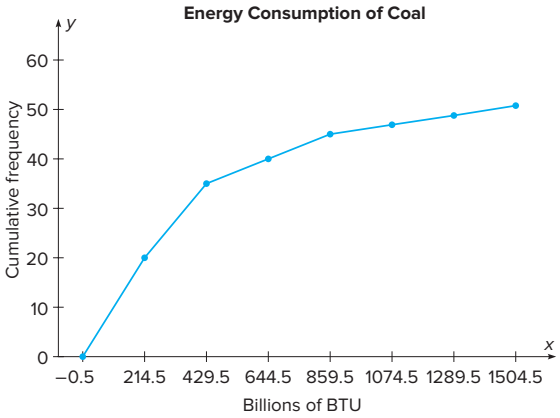
Limits	Boundaries	*f*	rf	Midpoints
0–214	–0.5–214.5	20	0.39	107
215–429	214.5–429.5	15	0.29	322
430–644	429.5–644.5	5	0.10	537
645–859	644.5–859.5	5	0.10	752
860–1074	859.5–1074.5	2	0.04	967
1075–1289	1074.5–1289.5	2	0.04	1182
1290–1504	1289.5–1504.5	2	0.04	1397
	Total	51	1.00	

	cf	crf
Less than 0	0	0
Less than 214.5	20	0.39
Less than 429.5	35	0.69
Less than 644.5	40	0.78
Less than 859.5	45	0.88
Less than 1074.5	47	0.92
Less than 1289.5	49	0.96
Less than 1504.5	51	1.00

23.







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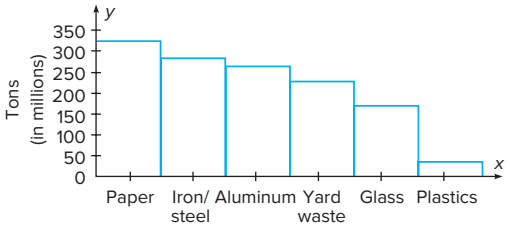

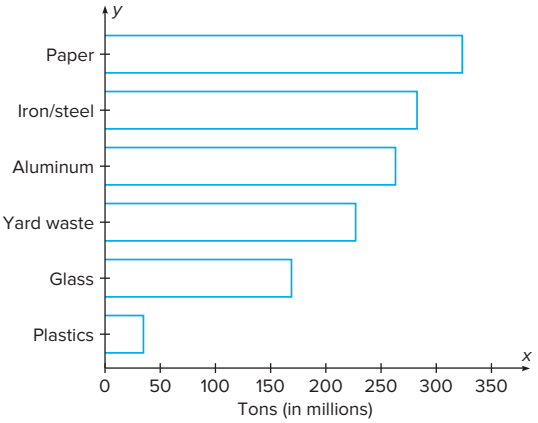

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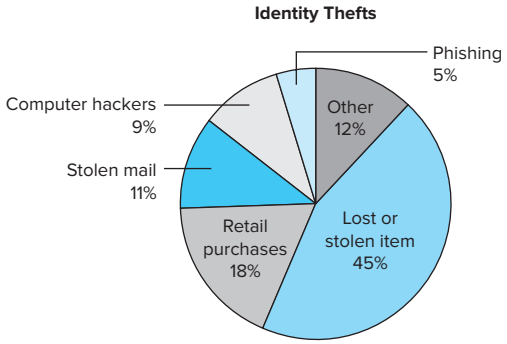
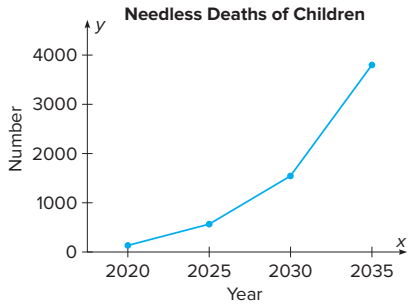


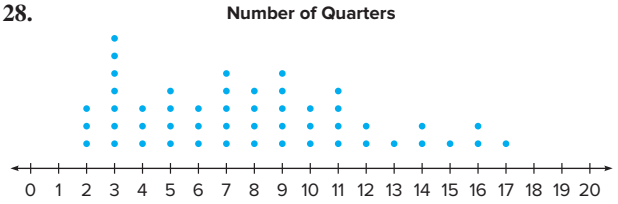
26.



27.

1	5 9
2	6 8
3	1 5 8 8 9
4	1 7 8
5	3 3 4
6	2 3 7 8
7	6 9
8	6 8 9
9	8

28.



29. The bottles have different diameters, so your eyes will compare areas instead of heights.

Chapter 3

Exercises 3–1

1. 104.1; 102; 105; 50, 95, and 102

3. 218.7; 221; 215.5; no mode

5. 1,067,130; 1,155,000; 1,340,000; 1,149,000

7. 26.3; 28; 24; 30

9. 30.6; 10; 73.5; no mode

11. 37.4; 33.7; none; 46.15

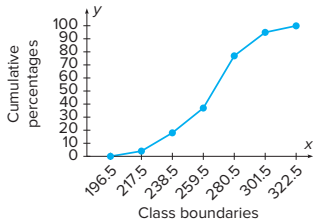
13. 71.65; 68.5–75.5 **15.** 28.9; 21–27
17. 26.66; 24.2–28.6 **19.** 34.1; 0.5–19.5
21. 3.2; 2 **23.** $9866.67
25. 35.4% **27.** 83.2
29. *a.* Mode *c.* Median *e.* Mean
b. Median *d.* Mode *f.* Median
31. Roman letters, $\overline{X}$; Greek letters, μ
33. 320
35. *a.* 40 *b.* 20 *c.* 300 *d.* 3
e. The results will be the same as if you add, subtract, multiply, and divide the mean by 10.
37. *a.* 25.5% *b.* 5.7% *c.* 8.4% *d.* 3.2%
39. 4.36

Exercises 3–2

1. The square root of the variance is the standard deviation.
3. σ^2; σ
5. When the population is large and the sample is small (usually less than 30), dividing the sum of the squares of the deviations by n will underestimate the population variance. So we must divide by $n - 1$ instead, giving a slighty larger value and an unbiased estimate of the population variance.
7. 90.7; 891.88; 29.86
9. Silver: 27.9; 86.756; 9.314
Tin: 10.92; 13.502; 3.674
Silver is more valuable since the range, variance, and standard deviation are larger.
11. Triplets: 1233; 198,612.7; 445.7
Quadruplets: 167; 3952.9; 62.9
Quintuplets: 45; 180.8; 13.4
The data for the triplets are the most variable.
13. $s \approx R/4$ so $s \approx 5$ years.
15. 297; 8373.6; 91.5 **17.** 130; 1156.7; 34.0
19. 9.2; 3.0 **21.** 27,941.8; 167.2
23. 167.2; 12.9 **25.** 47,732.2; 218.5
27. CVar = 20.9%; CVar = 22.5%. The factory workers' data are more variable.
29. CVar = 13.1%; CVar = 15.2%. The waiting time for people who are discharged is more variable.
31. *a.* 75% *b.* 56%
33. At least 93.75%
35. Between 84 and 276 minutes
37. Between $161,100 and $355,100
39. At least 84% **41.** 490–586; About 2.5%
43. $345; $52 **45.** $6.51; $1.65
47. $\overline{X} = 215.0$ and $s = 20.8$. All the data values fall within 2 standard deviations of the mean. This agrees with Chebyshev's theorem, which states that at least 75% of the data values will fall within 2 standard deviations of the mean.
49. 56%; 75%; 84%; 89%; 92%
51. 4.36
53. It must be an incorrect data value, since it is beyond the range using the formula $s\sqrt{n-1}$.

Exercises 3–3

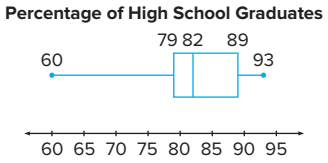
1. A z score tells how many standard deviations a data value is above or below the mean.
3. A percentile is a relative measurement of position; a percentage is an absolute measure of the part to the total.
5. $Q_1 = P_{25}$; $Q_2 = P_{50}$; $Q_3 = P_{75}$
7. $D_1 = P_{10}$; $D_2 = P_{20}$; $D_3 = P_{30}$; etc.
9. Canada −0.40, Italy 1.47, United States −1.91
11. *a.* 0.75 *b.* −0.8125 *c.* 2 *d.* −2.0625 *e.* 0.4375
13. Geography test $z = 1.83$. Accounting test $z = 1.71$.
The geography test score is relatively higher than the accounting test score.
15. *a.* 0.55 *c.* 19,690; 12,340, 14,090
b. −1.17
17. *a.* 21 *e.* 57
b. 43 *f.* 72
c. 97 *g.* 80
d. 19 *h.* 87
19. *a.* 6 *c.* 68 *e.* 94 *g.* 251 *i.* 274
b. 24 *d.* 76 *f.* 234 *h.* 263 *j.* 284



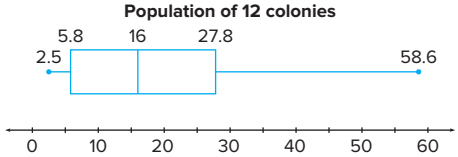
21. 94th; 72nd; 61st; 17th; 83rd; 50th; 39th; 28th; 6th; 597
23. 5th; 15th; 25th; 35th; 45th; 55th; 65th; 75th; 85th; 95th; 2.15
25. $Q_1 = 11$; $Q_3 = 32$; IQR = 21
27. $Q_1 = 19.7$; $Q_3 = 78.8$; IQR = 59.1
29. *a.* None *b.* 65 *c.* None
31. *a.* 12; 20.5; 32; 22; 20 *b.* 62; 94; 99; 80.5; 37
33. Tom, Harry, Dick. Find the z score for Tom, and it is less than Harry's z score; and both z scores are less than the 98th percentile.

Exercises 3–4

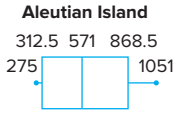
1. 6, 8, 19, 32, 54; 24
3. 188, 192, 339, 437, 589; 245
5. 14.6, 15.05, 16.3, 19, 19.8; 3.95
7. 11, 3, 8, 5, 9, 4
9. 95, 55, 70, 65, 90, 25
11. The distribution is slightly left-skewed.

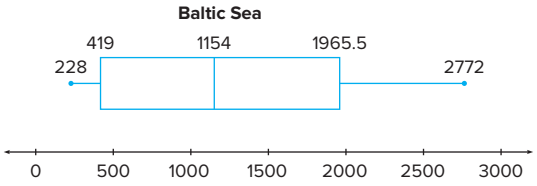


13. No, the distribution is not symmetric. The distribution is slightly right-skewed.

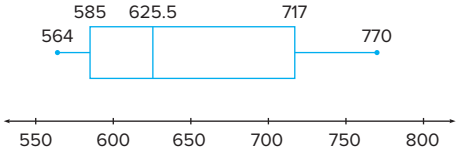


15. The areas of the islands in the Baltic Sea are more variable than the ones in the Aleutian Islands. Also, they are in general larger in area.

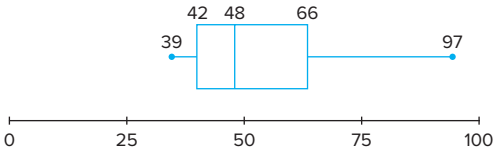




17. Lowest value = 564 $Q_1 = 585$ Median = 625.5
$Q_3 = 717$ Highest value = 770 IQR = 132



19.

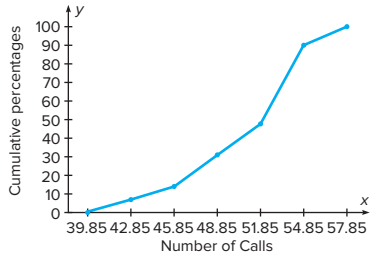


There are no outliers.

Review Exercises

1. 36.5; 11; 78.5; 0, 3, and 4.
3. 120; 120–124; and 125–129
5. 1.43 viewers
7. 175; 2597.0; 51.0 **9.** 566.1; 23.8 **11.** 6
13. Books CVar = 31.25%; Ages CVar = 18.6%; the number of books is more variable
15. \$0.26–\$0.38
17. 56% **19.** \$17–\$25
21. *a.* −0.27 *b.* 0.78 *c* 1.53

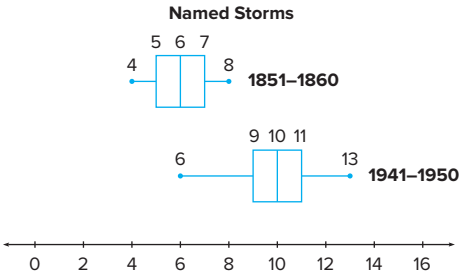
23. *a.*



b. 50, 53, 55
c. 10th; 26th; 78th

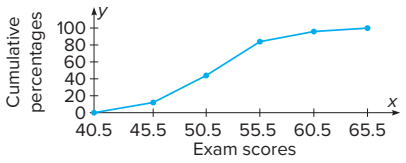
25. *a.* 400 *b.* None

27. The variability for the named storms for the period 1941–1950 is about the same as for the period of 1851–1860. The range for the storms for 1941–1950 is larger.



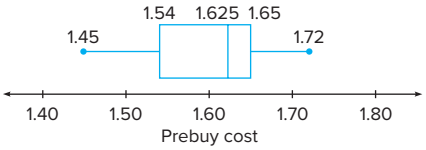
Chapter Quiz

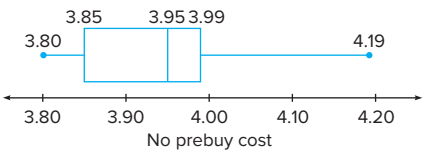
1. True **2.** True
3. False. A single, extremely large value affects the mean more than the median.
4. False. The median has this property, not the mode.
5. False. There can be more than one mode.
6. False. The midrange is not a measure of variation.
7. False. The median is unique.
8. False. They are both measures of central tendency.
9. False. The score being the 75th percentile means that the score is above 75 percent of the scores on that exam.
10. *c* **11.** *c* **12.** *a* and *b*
13. *b* **14.** *d* **15.** *b* **16.** Statistic
17. Parameters, statistics **18.** Standard deviation
19. σ **20.** Midrange
21. Positively **22.** Outlier
23. *a.* 15.3 *c.* 15, 16, and 17 *e.* 6 *g.* 1.9
b. 15.5 *d.* 15 *f.* 3.6
24. *a.* 6.4 *b.* 6–8 *c.* 11.6 *d.* 3.4
25. 4.5
26. The number of newspapers sold in a convenience store is more variable.
27. 88.89% **28.** 16%; 97.5%
29. 4.5 **30.** −0.75; −1.67; science
31. *a.*



b. 47; 55; 64
c. 56th, 6th, 99th percentiles

32. The cost of prebuy gas is much less than that of the return without filling gas. The variability of the return without filling gas is larger than the variability of the prebuy gas.





Chapter 4

Exercises 4–1

1. A probability experiment is a chance process that leads to well-defined outcomes.

3. An outcome is the result of a single trial of a probability experiment, but an event can consist of more than one outcome.

5. The range of values is 0 to 1 inclusive.

7. 0

9. 0.80 Since the probability that it won't rain is 80%, you could leave your umbrella at home and be fairly safe.

11. *a.* Empirical *c.* Empirical
b. Classical *d.* Classical

13. *a.* 0 *b.* $\frac{1}{2}$ *c.* 1 *d.* $\frac{1}{2}$

15. *a.* $\frac{1}{9}$ *b.* $\frac{7}{36}$ *c.* $\frac{1}{6}$

17. *a.* $\frac{1}{13}$ *c.* $\frac{1}{52}$ *e.* $\frac{6}{13}$
b. $\frac{1}{4}$ *d.* $\frac{2}{13}$

19. *a.* 0.1 *b.* 0.2 *c.* 0.8

21. *a.* 12% *b.* 48% *c.* 57%

23. *a.* 0.96 *b.* 0.48 *c.* 0.24

25. *a.* $\frac{1}{16}$ *b.* $\frac{3}{8}$ *c.* $\frac{15}{16}$ *d.* $\frac{7}{8}$

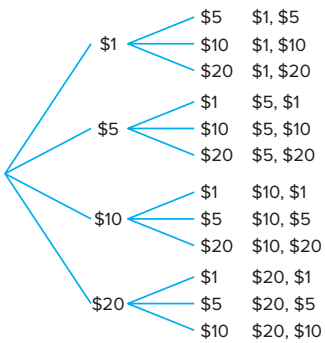
27. $\frac{1}{3}$

29. *a.* 27% *c.* 67%
b. 33% *d.* 14%

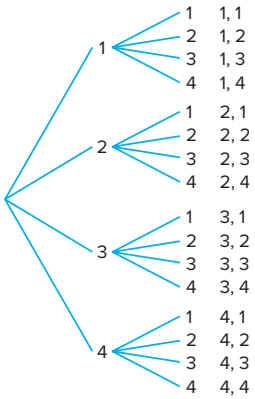
31. 0.11; 0.92

33. 0.285, 0.725

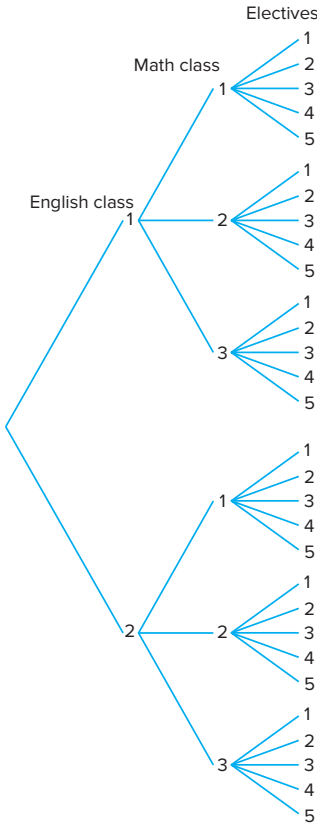
35.



37.



39.



41. *a.* 0.08 *b.* 0.01 *c.* 0.35 *d.* 0.36

43. The statement is probably not based on empirical probability and is probably not true.

45. Answers will vary. However they should be approximately $\frac{1}{8}, \frac{3}{8}, \frac{3}{8}, \frac{1}{8}$.

47. *a.* 1:5, 5:1 *d.* 1:1, 1:1 *g.* 1:1, 1:1
b. 1:1, 1:1 *e.* 1:12, 12:1
c. 1:3, 3:1 *f.* 1:3, 3:1

Exercises 4–2

1. Two events are mutually exclusive if they cannot occur at the same time (i.e., they have no outcomes in common). Examples will vary.

3. *a.* Not mutually exclusive. You can get the 6 of spades.
b. Yes, they are mutually exclusive.
c. Mutually exclusive
d. Not mutually exclusive. Some sophomore students are male.

5. *a.* 0.707 *b.* 0.589 *c.* 0.011 *d.* 0.731

7. *a.* $\frac{7}{38} = 0.184$ *b.* $\frac{35}{38} = 0.921$

9. $\frac{5}{8}$

11. *a.* $\frac{3}{10} = 0.3$ *b.* $\frac{6}{40} = \frac{3}{20} = 0.15$ *c.* $\frac{17}{20} = 0.85$

13. *a.* 0.058 *b.* 0.942 *c.* 0.335

15. *a.* 0.056 *b.* 0.004 *c.* 0.076

17. *a.* 0.789 *b.* 0.154 *c.* 0.057

19. *a.* $\frac{1}{15}$ *c.* $\frac{5}{6}$ *e.* $\frac{1}{3}$
b. $\frac{1}{3}$ *d.* $\frac{5}{6}$

21. *a.* $\frac{2}{15}$ *b.* $\frac{5}{6}$ *c.* $\frac{7}{15}$ *d.* $\frac{5}{6}$ *e.* $\frac{1}{6}$
23. *a.* $\frac{3}{13}$ *b.* $\frac{19}{52}$ *c.* $\frac{11}{26}$ *d.* $\frac{7}{13}$ *e.* $\frac{15}{26}$
25. 0.491 **27.** 0.06 **29.** 0.30
31. $(m + n)/(2m + n)$

Exercises 4–3

1. *a.* Independent *c.* Dependent
b. Dependent *d.* Dependent
3. *a.* 0.009 *b.* 0.227
5. 0.002 The event is highly unlikely since the probability is small.
7. *a.* 0.07656 *b.* 0.13362 *c.* 0.92344
9. 0.016
11. *a.* 0.166375 *b.* 0.091125 *c.* 0.833625
13. *a.* $\frac{1}{270{,}725}$ *b.* $\frac{46}{833}$ *c.* $\frac{11}{4165}$
15. *a.* $\frac{1}{221}$ *b.* $\frac{4}{17}$ *c.* $\frac{1}{17}$
17. $\frac{1}{66} \approx 0.015$ highly unlikely
19. *a.* 0.167 *b.* 0.406 *c.* 0.691
21. 0.03 **23.** 0.071
25. 0.656; 0.438 **27.** 0.2
29. 68.4%
31. *a.* 0.06 *b.* 0.435 *c.* 0.35 *d.* 0.167
33. *a.* 0.198 *b.* 0.188 *c.* 0.498
35. *a.* 0.020 *b.* 0.611
37. *a.* 0.172 *b.* 0.828
39. 0.5431
41. 0.987
43. $\frac{7411}{9520}$
45. *a.* 0.4308 *b.* 0.5692
47. 0.875, likely
49. $\frac{11}{36} = 0.306$
51. 0.319
53. No, since $P(A \text{ and } B) = 0$ and does not equal $P(A) \cdot P(B)$.
55. Enrollment and meeting with DW and meeting with MH are dependent. Since meeting with MH has a low probability and meeting with LP has no effect, all students, if possible, should meet with DW.
57. No; no; 0.072; 0.721; 0.02
59. 5

Exercises 4–4

1. 100,000; 30,240
3. 5040 ways
5. 100,000; 30,240
7. 7776
9. 120
11. 3,991,680; 8064
13. *a.* 39,916,800 *c.* 1 *e.* 360 *g.* 5040 *i.* 72
b. 362,880 *d.* 1 *f.* 19,958,400 *h.* 1 *j.* 990
15. 24 **17.** 504 **19.** 840 **21.** 151,200
23. 5,527,200 **25.** 495; 11,880 **27.** 210
29. 1260 **31.** 18,480
33. *a.* 10 *b.* 56 *c.* 35 *d.* 15 *e.* 15
35. 2,118,760
37. 495
39. 1800
41. 6400
43. 495; 210; 420
45. 350
47. 106
49. ${}_7C_2$ is 21 combinations + 7 double tiles = 28
51. 27,720
53. 9000
55. 125,970
57. 126
59. 136
61. 165
63. 200
65. 336
67. 11
69. *a.* 48 *b.* 60 *c.* 72
71. $(x + 2)(x + 1)/2$

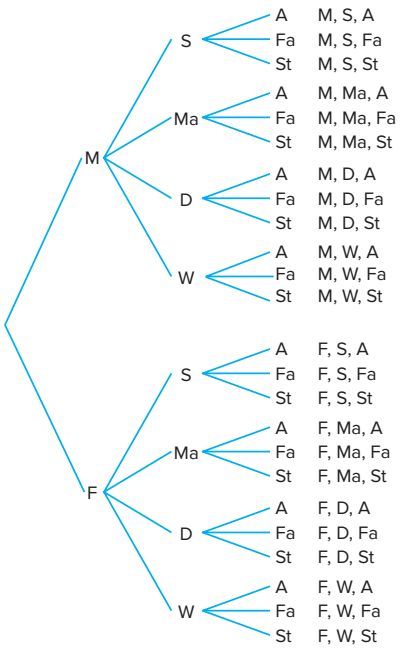
Exercises 4–5

1. $\frac{11}{221}$
3. *a.* $\frac{5}{42}$ *b.* $\frac{1}{21}$ *c.* $\frac{10}{21}$ *d.* $\frac{5}{14}$
5. *a.* 0.192 *b.* 0.269 *c.* 0.538 *d.* 0.013
7. $\frac{1}{15}$ **9.** 0.917; 0.594; 0.001
11. *a.* 0.322 *b.* 0.164 *c.* 0.515
d. It probably got lost in the wash!
13. $\frac{10}{216}$ **15.** $\frac{1}{60}$ **17.** 0.727

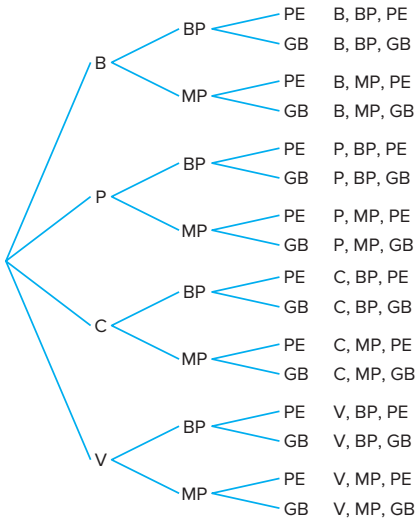
Review Exercises

1. *a.* 0.125 *b.* 0.375 *c.* 0.50
3. *a.* 0.7 *b.* 0.5
5. 0.33
7. 0.2 **9.** 0.9
11. *a.* 0.0001 *b.* 0.402 *c.* 0.598
13. *a.* $\frac{2}{17}$ *b.* $\frac{11}{850}$ *c.* $\frac{1}{5525}$
15. *a.* 0.603 *b.* 0.340 *c.* 0.324 *d.* 0.379
17. 0.4
19. 0.507
21. 0.573 or 57.3%
23. *a.* $\frac{19}{44}$ *b.* $\frac{1}{4}$
25. 0.99999984
27. 676,000; 468,000; 650,000
29. 350 **31.** 6188
33. 100! (Answers may vary regarding calculator.)
35. 495
37. 60
39. 5765760
41. 676,000; 0.2
43. 0.097

45.



48.



49. 120,120 **50.** 210

Chapter Quiz

1. False **2.** False
3. True **4.** False
5. False **6.** False
7. True **8.** False
9. *b* **10.** *d*
11. *d* **12.** *b*
13. *c* **14.** *b*
15. *d* **16.** *b*
17. *b* **18.** Sample space
19. 0, 1 **20.** 0
21. 1 **22.** Mutually exclusive
23. *a.* $\frac{1}{13}$ *b.* $\frac{1}{13}$ *c.* $\frac{4}{13}$
24. *a.* $\frac{1}{4}$ *b.* $\frac{4}{13}$ *c.* $\frac{1}{52}$
d. $\frac{1}{13}$ *e.* $\frac{1}{2}$
25. *a.* $\frac{12}{31}$ *b.* $\frac{12}{31}$ *c.* $\frac{27}{31}$ *d.* $\frac{24}{31}$
26. *a.* $\frac{11}{36}$ *b.* $\frac{5}{18}$ *c.* $\frac{11}{36}$
d. $\frac{1}{3}$ *e.* 0 *f.* $\frac{11}{12}$
27. 0.68 **28.** 0.002
29. *a.* $\frac{253}{9996}$ *b.* $\frac{33}{66{,}640}$ *c.* 0
30. 0.538 **31.** 0.533
32. 0.814 **33.** 0.056
34. *a.* $\frac{1}{2}$ *b.* $\frac{3}{7}$
35. 0.992 **36.** 0.518
37. 0.9999886 **38.** 2646
39. 40,320 **40.** 1365
41. 1,188,137,600; 710,424,000
42. 720 **43.** 33,554,432
44. 56 **45.** $\frac{1}{4}$
46. $\frac{3}{14}$ **47.** $\frac{12}{55}$

Chapter 5

Exercises 5–1

1. A random variable is a variable whose values are determined by chance. Three examples of random variables are the number of heads when two coins are tossed, the outcome of a single die roll, and the time it takes to have a medical physical exam. (Examples will vary.)

3. The number of commercials a radio station plays during each hour. The number of times a student uses his or her calculator during a mathematics exam. The number of leaves on a specific type of tree. (Answers will vary.)

5. Examples: Continuous variables: length of home run, length of game, temperature at game time, pitcher's ERA, batting average

Discrete variables: number of hits, number of pitches, number of seats in each row, etc.

7. No. Probabilities cannot be negative.

9. Yes

11. No. The sum of the probabilities is greater than 1.

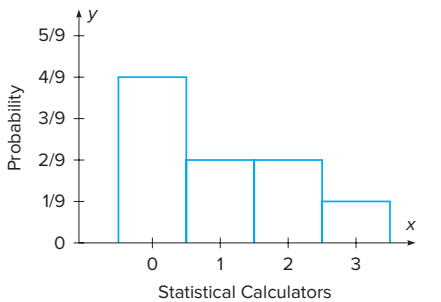
13. Discrete

15. Continuous

17. Discrete

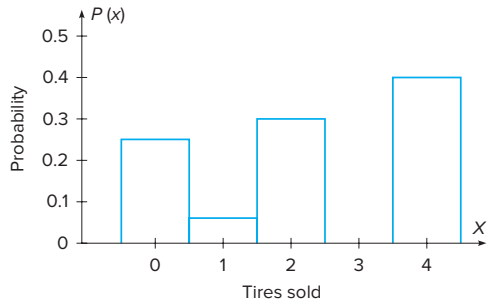
19.

X	0	1	2	3
P(*X*)	$\frac{4}{9}$	$\frac{2}{9}$	$\frac{2}{9}$	$\frac{1}{9}$



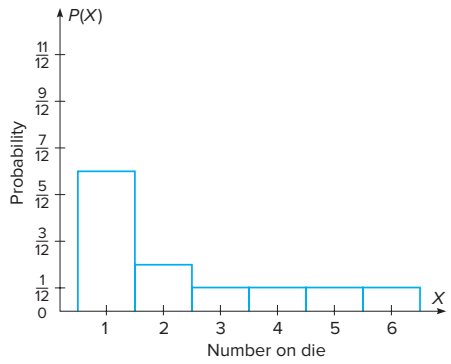
21.

X	0	1	2	3	4
$P(X)$	0.25	0.05	0.30	0.00	0.40



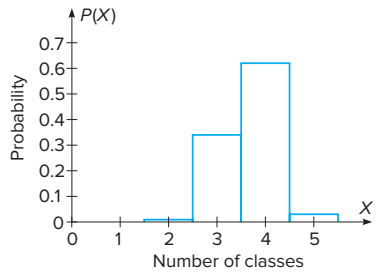
23.

X	1	2	3	4	5	6
$P(X)$	$\frac{1}{2}$	$\frac{1}{6}$	$\frac{1}{12}$	$\frac{1}{12}$	$\frac{1}{12}$	$\frac{1}{12}$



25.

X	2	3	4	5
$P(X)$	0.01	0.34	0.62	0.03

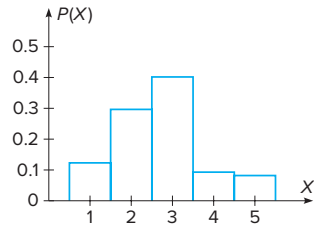


27.

X	4	7	9	11	13	16	18	21	22	24	25	27	31	36
$P(X)$	$\frac{1}{15}$	$\frac{1}{15}$	$\frac{1}{15}$	$\frac{1}{15}$	$\frac{1}{15}$	$\frac{2}{15}$	$\frac{1}{15}$	$\frac{1}{15}$	$\frac{1}{15}$	$\frac{1}{15}$	$\frac{1}{15}$	$\frac{1}{15}$	$\frac{1}{15}$	$\frac{1}{15}$

29.

X	1	2	3	4	5
$P(X)$	0.124	0.297	0.402	0.094	0.083



31.

X	1	2	3
$P(X)$	$\frac{1}{6}$	$\frac{1}{3}$	$\frac{1}{2}$

Yes

33.

X	3	4	7
$P(X)$	$\frac{3}{6}$	$\frac{4}{6}$	$\frac{7}{6}$

No, the sum of the probabilities is greater than 1.

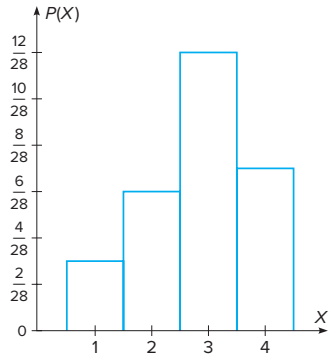
35.

X	1	2	4
$P(X)$	$\frac{1}{7}$	$\frac{2}{7}$	$\frac{4}{7}$

Yes

37.

X	1	2	3	4
$P(X)$	$\frac{3}{28}$	$\frac{6}{28}$	$\frac{12}{28}$	$\frac{7}{28}$



Exercises 5–2

1. 1.04, 0.858, 0.926
3. 0.84; 0.71; 0.85
5. 7.05; 0.75; 0.86
7. 2.0; 1.2; 1.1
9. 2.1; 0.8; 0.9
11. $E(X) = -\$0.30$
13. \$0.83
15. −\$1.00
17. −\$0.50; −\$0.52

19. *a.* −5.26 cents *c.* −5.26 cents *e.* −5.26 cents
b. −5.26 cents *d.* −5.26 cents
21. 10.5
23. $P(4) = 0.345$; $P(6) = 0.23$
$\overline{X} = 3.485$; $\sigma^2 = 3.820$; $\sigma = 1.954$
25. Answers will vary.
27.

X	2	3	4	5	6	8	9	11	14
$P(X)$	0.1	0.1	0.1	0.1	0.1	0.2	0.1	0.1	0.1

$\mu = 7$; $\sigma^2 = 12.6$; $\sigma = 3.55$

Exercises 5–3

1. *a.* Yes *b.* Yes *c.* Yes *d.* No *e.* No
3. *a.* 0.420 *b.* 0.346 *c.* 0.590 *d.* 0.251 *e.* 0.000
5. *a.* 0.0005 *b.* 0.131 *c.* 0.342
7. *a.* 0.264 *b.* 0.251 *c.* 0.387
9. *a.* 0.028 *b.* 0.006 *c.* 0.200
11. 0.117
13. *a.* 0.230 *b.* 0.990 *c.* 0.317 *d.* 0.337
15. *a.* 0.242 *b.* 0.547 *c.* 0.306
17. *a.* 75; 18.8; 4.3 *c.* 10; 5; 2.2
b. 90; 63; 7.9 *d.* 8; 1.6; 1.3
19. 75; 56.25; 7.5 **21.** 52.1; 6.8; 2.6
23. 210; 165.9; 12.9 **25.** 0.199
27. 0.559 **29.** 0.104
31. 0.246

33.

X	0	1	2	3
$P(X)$	0.125	0.375	0.375	0.125

35. $\mu = 0q^3 + 3pq^2 + 6p^2q + 3p^3 = 3p(q^2 + 2pq + p^2)$
$= 3p(1) = 3p$

Exercises 5–4

1. *a.* 0.135 *b.* 0.0324 *c.* 0.0096
3. 0.0025 **5.** 0.0048
7. *a.* 0.1042 *b.* 0.0842 *c.* 0.0216
9. *a.* 0.0183 *b.* 0.0733 *c.* 0.1465 *d.* 0.7619
11. 0.0521 **13.** 0.0498
15. 0.1563 **17.** 0.117
19. 0.0909 **21.** 0.597 **23.** 0.099
25. 0.144 **27.** 12
29. 17.33 or 18 **31.** 1.25; 0.559
33. 5; 4.472

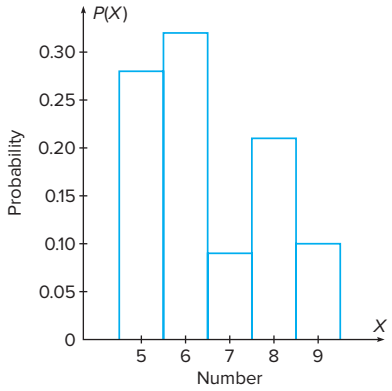
Review Exercises

1. Yes
3. No. The sum of the probabilities is greater than 1.
5. *a.* 0.35 *b.* 1.55; 1.808; 1.344
7.

9. 7.2; 2.2; 1.5
11. 1.4; 0.9; 0.95. Two people at most should be employed.
13. \$2.15
15. *a.* 0.008 *b.* 0.724 *c.* 0.0002 *d.* 0.276
17. 145; 60.9; 7.8 **19.** 0.886 **21.** 0.190
23. 0.026 **25.** 0.012
27. *a.* 0.5543 *b.* 0.8488 *c.* 0.4457
29. 0.274 **31.** 0.086 **33.** 0.105

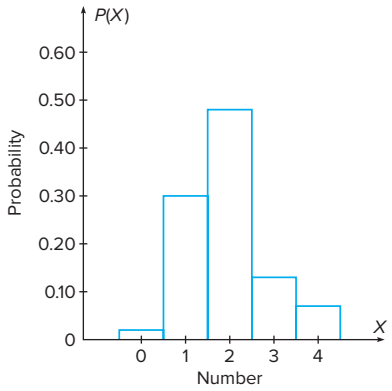
Chapter Quiz

1. True **2.** False
3. False **4.** True
5. Chance **6.** $n \cdot p$
7. 1 **8.** *c*
9. *c* **10.** *d*
11. No, since $\Sigma P(X) > 1$ **12.** Yes
13. Yes **14.** Yes
15.



16.

X	0	1	2	3	4
$P(X)$	0.02	0.3	0.48	0.13	0.07



17. 2.0; 1.3; 1.1 **18.** 32.2; 1.1; 1.0
19. 5.2 **20.** \$9.65
21. 0.124
22. *a.* 0.075 *b.* 0.872 *c.* 0.126
23. 240; 48; 6.9 **24.** 9; 7.9; 2.8
25. 0.008 **26.** 0.0003
27. 0.061 **28.** 0.122

29. *a.* 0.5470 *b.* 0.9862 *c.* 0.453
30. 0.128
31. *a.* 0.160 *b.* 0.42 *c.* 0.07
32. 0.033 **33.** 0.007

Chapter 6

Exercises 6–1

1. The characteristics of the normal distribution are as follows:
a. It is bell-shaped.
b. It is symmetric about the mean.
c. Its mean, median, and mode are equal.
d. It is continuous.
e. It never touches the x axis.
f. The area under the curve is equal to 1.
g. It is unimodal.
h. About 68% of the area lies within 1 standard deviation of the mean, about 95% within 2 standard deviations, and about 99.7% within 3 standard deviations of the mean.

3. 1 or 100%
5. 68%; 95%; 99.7%
7. 0.3577 **9.** 0.4732
11. 0.3557 **13.** 0.0307
15. 0.1043 **17.** 0.0337
19. 0.0482 **21.** 0.8686
23. 0.5714 **25.** 0.3574
27. 0.5714 **29.** 0.4162
31. 0.0099 **33.** 0.0655
35. 0.9507 **37.** 0.0428
39. 0.9222 **41.** −1.39 (TI: −1.3885)
43. −2.08 (TI: −2.0792)
45. −1.26 (TI: −1.2602)
47. *a.* −2.28 (TI: −2.2801)
b. −0.92 (TI: −0.91995)
c. −0.27 (TI: −0.26995)
49. *a.* $z = +1.96$ and $z = -1.96$ (TI: ±1.95996)
b. $z = +1.65$ and $z = -1.65$, approximately (TI: ±1.64485)
c. $z = +2.58$ and $z = -2.58$, approximately (TI: ±2.57583)
51. 0.6827; 0.9545; 0.9973; they are very close.
53. 2.10 **55.** −1.45 and 0.11
57. $y = \dfrac{e^{-X^2/2}}{\sqrt{2\pi}}$
59. 1.00

Exercises 6–2

1. 0.0104
3. *a.* 0.2005 (TI: 0.2007) *b.* 0.4315 (TI: 0.4316)
5. *a.* 0.3023 *b.* 0.0062
7. *a.* 0.0764 *b.* 0.1711
9. 0.0262; 0.0003; would want to know why it had only been driven less than 6000 miles (TI: 0.0260; 0.0002)
11. *a.* 0.9803 (TI: 0.9801)
b. 0.2514 (TI: 0.2511)
c. 0.3434 (TI: 0.3430)
13. *a.* 0.0082 *b.* 0.1587 *c.* 0.5403
15. *a.* 0.6568 *b.* 0.2514 *c.* 0.8413
17. 0.4435
19. The maximum size is 1927.76 square feet; the minimum size is 1692.24 square feet.
(TI: 1927.90 maximum, 1692.10 minimum)
21. 0.006; $821
23. 117.3 – 122.7
25. 6.7; 4.05 (TI: for 10%, 6.657; for 30%, 4.040)
27. $18,840.48 (TI: $18,869.48)
29. 18.6 months
31. *a.* $\mu = 120, \sigma = 20$ *c.* $\mu = 30, \sigma = 5$
b. $\mu = 15, \sigma = 2.5$
33. 7.29 **35.** $1175.54
37. 0.1075 **39.** Somewhat positively skewed
41. Not normal
43. Answers will vary.

Exercises 6–3

1. The distribution is called the sampling distribution of sample means.
3. The mean of the sample means is equal to the population mean.
5. The distribution will be approximately normal when the sample size is large.
7. 0.8945
9. *a.* 0.9699 *b.* 0.0301 *c.* 0.4699
11. 0.9927
13. 0.9990
15. 0.2358; less than 0.0001
17. 0.4176 (TI: 0.4199)
19. 0.1254 (TI: 0.12769)
21. *a.* 0.3300 *b.* 0.0838
c. yes *d.* yes, but not as likely.
23. *a.* 0.3707 (TI: 0.3694) *b.* 0.0475 (TI: 0.04779)
25. Approximately 60
27. 0.0143 **29.** $\sigma_{\bar{X}} = 1.5, n = 25$

Exercises 6–4

1. When p is approximately 0.5, as n increases, the shape of the binomial distribution becomes similar to that of the normal distribution.
3. The correction is necessary because the normal distribution is continuous and the binomial distribution is discrete.

5. *a.* 0.0811 *b.* 0.0516 *c.* 0.1052
7. *a.* Yes *b.* No *c.* No
9. 0.9893 **11.** 0.8900
13. 0.0949 **15.** 0.7054
17. 0.7734; This is likely to occur **19.** 0.3936
21. 0.0087
23. *a.* $n \geq 50$ *c.* $n \geq 10$ *e.* $n \geq 50$
b. $n \geq 17$ *d.* $n \geq 25$

Review Exercises

1. *a.* 0.4803 *c.* 0.0629 *e.* 0.2158
b. 0.2019 *d.* 0.7945
3. *a.* 0.4871 *c.* 0.8841 *e.* 0.6151
b. 0.4599 *d.* 0.0728
5. 0.1131; \$4872 and \$5676
(TI: \$4869.31 minimum, \$5678.69 maximum)
7. *a.* 0.3621 or 36.21% *c.* 0.0606 or 6.06%
b. 0.1190 or 11.9%
9. \$130.92
11. Not normal
13. *a.* 0.0143 (TI: 0.0142) *b.* 0.9641
15. *a.* 0.3859 (TI: 0.3875) *b.* 0.1841 (TI: 0.1831)
c. Individual values are more variable than means.
17. 0.5234 **19.** 0.7123; 0.9999 (TI: 0.7139)
21. 0.2090

Chapter Quiz

1. False **2.** True
3. True **4.** True
5. False **6.** False
7. *a* **8.** *a*
9. *b* **10.** *b*
11. *c* **12.** 0.5
13. sampling error
14. the population mean
15. standard error of the mean
16. 5 **17.** 5%
18. *a.* 0.4332 *d.* 0.1029 *g.* 0.0401 *j.* 0.9131
b. 0.3944 *e.* 0.2912 *h.* 0.8997
c. 0.0344 *f.* 0.8284 *i.* 0.017
19. *a.* 0.4846 *d.* 0.0188 *g.* 0.0089 *j.* 0.8461
b. 0.4693 *e.* 0.7461 *h.* 0.9582
c. 0.9334 *f.* 0.0384 *i.* 0.9788
20. *a.* 0.7734 *b.* 0.0516 *c.* 0.3837
d. Any rainfall above 65 inches could be considered an extremely wet year since this value is 2 standard deviations above the mean.
21. *a.* 0.0668 *b.* 0.0228 *c.* 0.4649 *d.* 0.0934
22. *a.* 0.4525 *b.* 0.3707 *c.* 0.3707 *d.* 0.019
23. *a.* 0.0013 *b.* 0.5 *c.* 0.0081 *d.* 0.5511
24. *a.* 0.0037 *b.* 0.0228 *c.* 0.5 *d.* 0.3232
25. 8.804 centimeters
26. 121.24 is the lowest acceptable score.
27. 0.015 **28.** 0.9738
29. 0.0495; no **30.** 0.0455 or 4.55%
31. 0.0618 **32.** 0.0495
33. Approximately normal **34.** Approximately normal

Chapter 7

Exercises 7–1

1. A point estimate of a parameter specifies a particular value, such as $\mu = 87$; an interval estimate specifies a range of values for the parameter, such as $84 < \mu < 90$. The advantage of an interval estimate is that a specific confidence level (say 95%) can be selected, and one can be 95% confident that the interval contains the parameter that is being estimated.
3. The margin of error is the maximum likely difference between the point estimate of a parameter and the actual parameter itself.
5. A good estimator should be unbiased, consistent, and relatively efficient.
7. *a.* 2.58 *c.* 1.96 *e.* 1.88
b. 2.33 *d.* 1.65
9. $26.6 < \mu < 29.6$
11. *a.* 30 pounds
b. $28.9 < \mu < 31.1$
c. $28.6 < \mu < 31.4$
d. The 99% confidence interval is larger because an interval needs to contain more values to be confident about.
13. $295.2 < \mu < 397.3$
15. $56.1 < \mu < 60.3$
17. $739 < \mu < 759$ The fact that the person uses 803 gallons per year is not believable unless the person is a delivery person, truck driver, etc. since it is well above the upper limit of 759 gallons. (TI answer: $739 < \mu < 759$.)
19. $59.5 < \mu < 62.9$ **21.** 55 people
23. 49 people **25.** 21 days

Exercises 7–2

1. The characteristics of the t distribution are as follows: It is bell-shaped, it is symmetric about the mean, and it approaches, but never touches the x axis. The mean, median, and mode are equal to 0 and are located at the center of the distribution. The variance is greater than 1. The t distribution is a family of curves based on degrees of freedom. As a sample size increases, the t distribution approaches the standard normal distribution.
3. *a.* 2.898 *c.* 2.624 *e.* 2.093
b. 2.074 *d.* 1.833
5. $43 < \mu < 45.4$
7. $\overline{X} = 33.4$; $s = 28.7$; $21.2 < \mu < 45.6$; the point estimate is 33.4, and it is close to 32. Also, the interval does indeed contain $\mu = 32$. The data value 132 is unusually large

(an outlier). The mean may not be the best point estimate in this case.

9. $226.3 < \mu < 260.1$

11. $12{,}282 < \mu < 12{,}318$

13. $95 < \mu < 101$

15. $105 < \mu < 113$

17. $32.0 < \mu < 71.0$

19. $22.828 < \mu < 58.160$

21. $\overline{X} = 2.175$; $s = 0.585$; $\mu >$ \$1.95 means one can be 95% confident that the mean revenue is greater than \$1.95; $\mu <$ \$2.40 means one can be 95% confident that the mean revenue is less than \$2.40.

Exercises 7–3

1. *a.* 0.5, 0.5 *c.* 0.46, 0.54 *e.* 0.42, 0.58
b. 0.45, 0.55 *d.* 0.25, 0.75

3. $0.301 < p < 0.359$

5. $0.603 < p < 0.757$

7. $0.797 < p < 0.883$

9. $0.596 < p < 0.704$

11. $0.510 < p < 0.850$

13. $0.812 < p < 0.908$

15. 385; 601

17. 801 homes; 1068 homes

19. 994 **21.** 95%

Exercises 7–4

1. Chi-square

3. *a.* 3.816; 21.920 *d.* 0.412; 16.750
b. 10.117; 30.144 *e.* 26.509; 55.758
c. 13.844; 41.923

5. $56.6 < \sigma^2 < 236.3$; $7.5 < \sigma < 15.4$

7. $1.48 < \sigma^2 < 5.46$; $1.22 < \sigma < 2.34$ Yes, the estimate is reasonable.

9. $8628.44 < \sigma^2 < 31{,}100.99$
\$92.89 $< \sigma <$ \$176.35

11. $1115.2 < \sigma^2 < 13{,}028.76$
\$33.39 $< \sigma <$ \$114.14

13. $17.3 < \sigma < 38.4$

15. $31.5 < \sigma < 67.9$

Review Exercises

1. $24 < \mu < 26$

3. 16 female students

5. $76.9 < \mu < 88.3$

7. $0.311 < p < 0.369$

9. $0.474 < p < 0.579$

11. 407

13. $0.22 < \sigma < 0.43$. Yes. It seems that there is a large standard deviation.

15. $5.1 < \sigma^2 < 18.3$

Chapter Quiz

1. True **2.** True

3. False **4.** True

5. *b* **6.** *a*

7. *d*

8. Unbiased, consistent, relatively efficient

9. Margin of error

10. Point **11.** 90; 95; 99

12. \$121.60; \$119.85 $< \mu <$ \$123.35

13. \$44.80; \$43.15 $< \mu <$ \$46.45

14. 4150; $3954 < \mu < 4346$

15. $45.7 < \mu < 51.5$ **16.** $418 < \mu < 458$

17. $26 < \mu < 36$ **18.** 180

19. 25 **20.** $0.374 < p < 0.486$

21. $0.295 < p < 0.425$ **22.** $0.342 < p < 0.547$

23. 545 **24.** $7 < \sigma < 13$

25. $30.9 < \sigma^2 < 78.2$ **26.** $1.8 < \sigma < 3.2$
$5.6 < \sigma < 8.8$

Chapter 8

Note: For Chapters 8–13, specific *P*-values are given in parentheses after the *P*-value intervals. When the specific *P*-value is extremely small, it is not given.

Exercises 8–1

1. The null hypothesis states that there is no difference between a parameter and a specific value or that there is no difference between two parameters. The alternative hypothesis states that there is a specific difference between a parameter and a specific value or that there is a difference between two parameters. Examples will vary.

3. A statistical test uses the data obtained from a sample to make a decision about whether the null hypothesis should be rejected.

5. The critical region is the range of values of the test statistic that indicates that there is a significant difference and the null hypothesis should be rejected. The noncritical region is the range of values of the test statistic that indicates that the difference was probably due to chance and the null hypothesis should not be rejected.

7. α, β

9. A one-tailed test should be used when a specific direction, such as greater than or less than, is being hypothesized; when no direction is specified, a two-tailed test should be used.

11. *a.* ± 1.65 *c.* -2.58 *e.* $+1.65$
b. 2.33 *d.* -2.33

13. *a.* H_0: $\mu = 15.6$ and H_1: $\mu \neq 15.6$
b. H_0: $\mu = 10.8$ and H_1: $\mu > 10.8$
c. H_0: $\mu = 390$ and H_1: $\mu < 390$
d. H_0: $\mu = 12{,}603$ and H_1: $\mu \neq 12{,}603$
e. H_0: $\mu =$ \$24 and H_1: $\mu <$ \$24

Exercises 8–2

1. H_0: $\mu = 305$; H_1: $\mu > 305$ (claim); C.V. = 1.65; $z = 4.69$; reject. There is enough evidence to support the claim that the mean depth is greater than 305 feet. It might be due to warmer temperatures or more rainfall.

3. H_0: $\mu = \$24$ billion and H_1: $\mu > \$24$ billion (claim); C.V. = 1.65; $z = 1.85$; reject. There is enough evidence to support the claim that the average revenue is greater than \$24 billion.

5. H_0: $\mu = 5$; H_1: $\mu > 5$ (claim); C.V. = 2.33; $z = 2.83$; reject. There is enough evidence to support the claim that the mean number of sick days a person takes per year is greater than 5.

7. H_0: $\mu = 29$ and H_1: $\mu \neq 29$ (claim); C.V. = ±1.96; $z = 0.944$; do not reject. There is not enough evidence to say that the average height differs from 29 inches.

9. H_0: $\mu = 2.8$; H_1: $\mu > 2.8$ (claim); C.V. = 2.33; $z = 2.05$; do not reject. There is not enough evidence to support the claim that the mean number of telephone calls a person makes is greater than 2.8. Yes, the null hypothesis could be rejected at $\alpha = 0.05$.

11. H_0: $\mu = 7$, H_1: $\mu < 7$ (claim); C.V. = −2.33; $z = -1.57$; fail to reject. There is not enough evidence to support the claim that newborn babies lose less than 7 ounces in the first 2 days of life.

13. H_0: $\mu = 15$; H_1: $\mu \neq 15$ (claim); C.V. = ±1.96; $z = -2.59$; reject. There is enough evidence to support the claim that the mean number of dress shirts a man owns is not 15.

15. *a.* Do not reject. *d.* Reject.
b. Reject. *e.* Reject.
c. Do not reject.

17. H_0: $\mu = 264$ and H_1: $\mu < 264$ (claim); $z = -2.53$; P-value = 0.0057; reject. There is enough evidence to support the claim that the average stopping distance is less than 264 ft. (TI: P-value = 0.0056)

19. H_0: $\mu = 7.8$; H_1: $\mu > 7.8$ (claim); C.V. = 2.33; $z = 2.05$; do not reject. There is not enough evidence to support the claim that the mean number of medical schools to which a premed student sends applications is greater than 7.8.

21. H_0: $\mu = 444$; H_1: $\mu \neq 444$ (claim); $z = -1.70$; P-value = 0.0892; do not reject H_0. There is insufficient evidence at $\alpha = 0.05$ to conclude that the average size differs from 444 acres. (TI: P-value = 0.0886)

23. H_0: $\mu = 30{,}000$ (claim) and H_1: $\mu \neq 30{,}000$; $z = 1.71$; P-value = 0.0872; reject. There is enough evidence to reject the claim that the customers are adhering to the recommendation. Yes, the 0.10 level is appropriate. (TI: P-value = 0.0868)

25. H_0: $\mu = 10$ and H_1: $\mu < 10$ (claim); $z = -8.67$; P-value < 0.0001; since P-value < 0.05, reject. Yes, there is enough evidence to support the claim that the average number of days missed per year is less than 10.(TI: P-value = 0)

27. H_0: $\mu = 8.65$ (claim) and H_1: $\mu \neq 8.65$; C.V. = ±1.96; $z = -1.27$; do not reject. Yes; there is not enough evidence to reject the claim that the average hourly wage of the employees is \$8.65.

Exercises 8–3

1. It is bell-shaped, it is symmetric about the mean, and it approaches, but never touches the x axis. The mean, median, and mode are all equal to 0, and they are located at the center of the distribution. The t distribution differs from the standard normal distribution in that it is a family of curves and the variance is greater than 1; and as the degrees of freedom increase, the t distribution approaches the standard normal distribution.

3. *a.* −2.718 *d.* +2.228
b. +1.753 *e.* ±2.262
c. ±1.943

5. Specific P-values are in parentheses.
a. 0.01 < P-value < 0.025 (0.018)
b. 0.05 < P-value < 0.10 (0.062)
c. P-value > 0.10 (0.123)
d. 0.10 < P-value < 0.20 (0.138)

7. H_0: $\mu = 31$, H_1: $\mu < 31$ (claim); C.V. = −1.833; d.f. = 9; $t = -3.514$; reject. There is enough evidence to support the claim that the mean number of cigarettes that smokers smoke is less than 31 per day.

9. H_0: $\mu = 700$ (claim) and H_1: $\mu < 700$; C.V. = −2.262; d.f. = 9; $t = -2.710$; reject. There is enough evidence to reject the claim that the average height of the buildings is at least 700 feet.

11. H_0: $\mu = 58$; H_1: $\mu > 58$ (claim); C.V. = 2.821; d.f. = 9; $t = 5.27$; reject. There is enough evidence to support the claim that the average is greater than the national average.

13. H_0: $\mu = 7.2$; H_1: $\mu \neq 7.2$ (claim); C.V. = ±2.145; d.f. = 14; $t = 3.550$; reject. There is enough evidence to support the claim that the mean number of hours that college students sleep on Friday night to Saturday morning is not 7.2 hours.

15. H_0: $\mu = \$50.07$; H_1: $\mu > \$50.07$ (claim); C.V. = 1.833; d.f. = 9; $t = 2.74$; reject. There is enough evidence to support the claim that the average phone bill has increased.

17. H_0: $\mu = 211$, H_1: $\mu < 211$ (claim); C.V. = −1.345; d.f. = 14; $t = -2.242$; reject. There is enough evidence that the mean number of operations that the surgeons perform per year is less than 211. No. The claim would not be rejected at $\alpha = 0.01$.

19. H_0: $\mu = 25.4$ and H_1: $\mu < 25.4$ (claim); C.V. = −1.318; d.f. = 24; $t = -3.11$; reject. Yes. There is enough evidence to support the claim that the average commuting time is less than 25.4 minutes.

21. H_0: $\mu = 5.8$ (claim) and H_1: $\mu \neq 5.8$; d.f. = 19; $t = -3.462$; P-value < 0.01; reject. There is enough evidence to support the claim that the mean number of times has changed. (TI: P-value = 0.0026)

23. H_0: $\mu = 123$ and H_1: $\mu \neq 123$ (claim); d.f. = 15; $t = -3.019$; P-value < 0.01 (0.0086); reject. There is enough evidence to support the hypothesis that the mean has changed. The *Old Farmer's Almanac* figure may have changed.

Exercises 8–4

1. Answers will vary.

3. $np \geq 5$ and $nq \geq 5$

5. H_0: $p = 0.46$, H_1: $p \neq 0.46$ (claim); C.V. = ±1.65; $z = -1.32$; do not reject. There is not enough evidence to support the claim that the percentage has changed.

7. H_0: $p = 0.11$ (claim); H_1: $p \neq 0.11$; C.V. = ±2.33; $z = 2.26$; do not reject. There is not enough evidence to reject the claim that 11% of individuals eat takeout food every day. Yes, the claim would be rejected at $\alpha = 0.05$.

9. H_0: $p = 0.58$; H_1: $p > 0.58$ (claim); C.V. = 1.65; $z = 2.31$; reject. There is enough evidence to support the claim that the percentage of runaways who are female is greater than 58%.

11. H_0: $p = 0.76$; H_1: $p < 0.76$ (claim); C.V. = −2.33; $z = -1.43$; do not reject. There is not enough evidence to support the claim that the percentage of individuals who prefer American-made automobiles is less than 76%.

13. H_0: $p = 0.54$ (claim) and H_1: $p \neq 0.54$; $z = 0.93$; P-value = 0.3524; do not reject. There is not enough evidence to reject the claim that the proportion is 0.54. Yes, a healthy snack should be made available for children to eat after school. (TI: P-value = 0.3511)

15. H_0: $p = 0.18$ and H_1: $p < 0.18$ (claim); $z = -0.60$; P-value = 0.2739; since P-value > 0.05, do not reject. There is not enough evidence to support the claim that less than 18% of all high school students smoke at least a pack of cigarettes a day. (TI: P-value = 0.2739)

17. H_0: $p = 0.67$ and H_1: $p \neq 0.67$ (claim); C.V. = ±1.96; $z = 3.19$; reject. Yes. There is enough evidence to support the claim that the percentage is not 67%.

19. H_0: $p = 0.576$ and H_1: $p < 0.576$ (claim); C.V. = −1.65; $z = -1.26$; do not reject. There is not enough evidence to support the claim that the proportion is less than 0.576.

21. No, since $p = 0.508$.

23. $z = \dfrac{X - \mu}{\sigma}$

$z = \dfrac{X - np}{\sqrt{npq}}$ since $\mu = np$ and $\sigma = \sqrt{npq}$

$z = \dfrac{X/n - np/n}{\sqrt{npq}/n}$

$z = \dfrac{X/n - np/n}{\sqrt{npq/n^2}}$

$z = \dfrac{\hat{p} - p}{\sqrt{pq/n}}$ since $\hat{p} = X/n$

Exercises 8–5

1. *a.* H_0: $\sigma^2 = 225$ and H_1: $\sigma^2 \neq 225$; C.V. = 22.362 and 5.892, d.f. = 13

b. H_0: $\sigma^2 = 225$ and H_1: $\sigma^2 > 225$; C.V. = 38.885, d.f. = 26

c. H_0: $\sigma^2 = 225$ and $\sigma^2 < 225$; C.V. = 1.646; d.f. = 8

d. H_0: $\sigma^2 = 225$ and $\sigma^2 > 225$; C.V. = 26.296; d.f. = 16

3. *a.* $0.01 < P$-value < 0.025 (0.015)

b. $0.005 < P$-value < 0.01 (0.006)

c. $0.01 < P$-value < 0.02 (0.012)

d. P-value < 0.005 (0.003)

5. H_0: $\sigma = 8.6$ (claim) and H_1: $\sigma \neq 8.6$; C.V. = 21.920 and 3.816; d.f. = 11; $\chi^2 = 12.864$; do not reject. There is not enough evidence to reject the claim that the standard deviation of the ages is 8.6 years.

7. H_0: $\sigma = 1.2$ (claim) and H_1: $\sigma > 1.2$; $\alpha = 0.01$; d.f. = 14; $\chi^2 = 31.5$; P-value < 0.005 (0.0047); since P-value < 0.01, reject. There is enough evidence to reject the claim that the standard deviation is less than or equal to 1.2 minutes.

9. H_0: $\sigma = 2$ and H_1: $\sigma > 2$ (claim); C.V. = 12.017; d.f. = 7; $\chi^2 = 12.178$; reject. There is enough evidence to support the claim that the standard deviation is greater than 2.

11. H_0: $\sigma = 35$ and H_1: $\sigma < 35$ (claim); C.V. = 3.940; d.f. = 10; $\chi^2 = 8.359$; do not reject. There is not enough evidence to support the claim that the standard deviation is less than 35.

13. H_0: $\sigma^2 = 0.638$ (claim) and H_1: $\sigma^2 \neq 0.638$; C.V. = 39.364 and 12.401; d.f. = 24; $\chi^2 = 34.984$; do not reject. There is not enough evidence to reject the claim that the variance is equal to 0.638.

15. H_0: $\sigma = 0.52$; H_1: $\sigma > 0.52$ (claim); C.V. = 30.144; d.f. = 19; $\chi^2 = 22.670$; do not reject H_0. There is insufficient evidence to conclude that the standard deviation is outside the guidelines.

17. H_0: $\sigma = 60$ (claim) and H_1: $\sigma \neq 60$; C.V. = 8.672; 27.587; d.f. = 17; $\chi^2 = 19.707$; do not reject. There is not enough evidence to reject the claim that the standard deviation is 60.

19. H_0: $\sigma = 679.5$; H_1: $\sigma \neq 679.5$ (claim); C.V. = 5.009; 24.736; d.f. = 13; $\chi^2 = 16.723$; do not reject. There is not enough evidence to support the claim that the sample standard deviation differs from the estimated standard deviation.

Exercises 8–6

1. H_0: $\mu = 25.2$; H_1: $\mu \neq 25.2$ (claim); C.V. = ±2.032; $t = 4.50$; $27.1 < \mu < 30.3$; reject. There is enough evidence to support the claim that the average age is not 25.2 years. The confidence interval does not contain 25.2.

3. H_0: $\mu = \$19{,}150$; H_1: $\mu \neq \$19{,}150$ (claim); C.V. = ±1.96; $z = -3.69$; $15{,}889 < \mu < 18{,}151$; reject. There is enough evidence to support the claim that the mean differs from \$19,150. Yes, the interval supports the results because it does not contain the hypothesized mean \$19,150.

5. H_0: $\mu = 19$; H_1: $\mu \neq 19$ (claim); C.V. = ±2.145; d.f. = 14; $t = 1.37$; do not reject H_0. There is insufficient evidence to conclude that the mean number of

hours differs from 19. 95% C.I.: $17.7 < \mu < 24.9$. Because the mean ($\mu = 19$) is in the interval, there is no evidence to support the idea that a difference exists.

7. The power of a statistical test is the probability of rejecting the null hypothesis when it is false.

9. The power of a test can be increased by increasing α or selecting a larger sample size.

Review Exercises

1. H_0: $\mu = 18$ and H_1: $\mu \neq 18$ (claim); C.V. = ±2.33; $z = 2.02$; do not reject. There is not enough evidence to support the claim that the average lifetime of a $1.00 bill is not 18 months.

3. H_0: $\mu = 18{,}000$; H_1: $\mu < 18{,}000$ (claim); C.V. = −2.33; test statistic $z = -3.58$; reject H_0. There is sufficient evidence to conclude that the mean debt is less than $18,000.

5. H_0: $\mu = 22$ and H_1: $\mu > 22$ (claim); C.V. = 1.65; $z = 1.95$; reject. There is enough evidence to support the claim that the average number of items purchased is greater than 22.

7. H_0: $\mu = 10$; H_1: $\mu < 10$ (claim); C.V. = −1.782; d.f. = 12; $t = -2.227$; reject. There is enough evidence to support the claim that the mean weight is less than 10 ounces.

9. H_0: $p = 0.25$ and H_1: $p < 0.25$ (claim); C.V. = −1.65; $z = -1.39$; do not reject. There is not enough evidence to support the claim that the percentage of doctors who received their medical degrees from a foreign school is less than 25%.

11. H_0: $p = 0.593$; H_1: $p < 0.593$ (claim); C.V. = −2.33; $z = -2.57$; reject H_0. There is sufficient evidence to conclude that the proportion of free and reduced-cost lunches is less than 59.3%.

13. H_0: $p = 0.204$; H_1: $p \neq 0.204$ (claim); C.V. = ±1.96; $z = -1.03$; do not reject. There is not enough evidence to support the claim that the proportion is different from the national proportion.

15. H_0: $\sigma = 4.3$ and H_1: $\sigma < 4.3$ (claim); d.f. = 19; $\chi^2 = 6.95$; $0.005 < P\text{-value} < 0.01$ (0.006); since P-value < 0.05, reject. Yes, there is enough evidence to reject the claim that the standard deviation is greater than or equal to 4.3 miles per gallon.

17. H_0: $\sigma^2 = 40$; H_1: $\sigma^2 \neq 40$ (claim); C.V. = 2.700 and 19.023; test statistic $\chi^2 = 9.675$; do not reject H_0. There is insufficient evidence to conclude that the variance in the number of games played differs from 40.

19. H_0: $\mu = 4$ and H_1: $\mu \neq 4$ (claim); C.V. = ±2.58; $z = 1.49$; $3.85 < \mu < 4.55$; do not reject. There is not enough evidence to support the claim that the growth has changed. Yes, the results agree. The hypothesized mean is contained in the interval.

Chapter Quiz

1. True **2.** True

3. False **4.** True

5. False **6.** *b*

7. *d* **8.** *c*

9. *b* **10.** Type I

11. β

12. Statistical hypothesis

13. Right **14.** $n - 1$

15. H_0: $\mu = 28.6$ (claim) and H_1: $\mu \neq 28.6$; $z = 2.09$; C.V. = ±1.96; reject. There is enough evidence to reject the claim that the average age of the mothers is 28.6 years.

16. H_0: $\mu = \$6500$ (claim) and H_1: $\mu \neq \$6500$; $z = 5.27$; C.V. = ±1.96; reject. There is enough evidence to reject the agent's claim.

17. H_0: $\mu = 8$ and H_1: $\mu > 8$ (claim); $z = 6$; C.V. = 1.65; reject. There is enough evidence to support the claim that the average is greater than 8.

18. H_0: $\mu = 500$ (claim) and H_1: $\mu \neq 500$; d.f. = 6; $t = -0.571$; C.V. = ±3.707; do not reject. There is not enough evidence to reject the claim that the mean is 500.

19. H_0: $\mu = 67$ and H_1: $\mu < 67$ (claim); $t = -3.1568$; P-value < 0.005 (0.003); since P-value < 0.05, reject. There is enough evidence to support the claim that the average height is less than 67 inches.

20. H_0: $\mu = 12.4$ (claim) and H_1: $\mu < 12.4$; $t = -2.324$; C.V. = −1.345; reject. There is enough evidence to support the claim that the average is less than the company claimed.

21. H_0: $\mu = 63.5$ and H_1: $\mu > 63.5$ (claim); $t = 0.47075$; P-value > 0.10 (0.322); since P-value > 0.05, do not reject. There is not enough evidence to support the claim that the average is greater than 63.5.

22. H_0: $\mu = 26$ (claim) and H_1: $\mu \neq 26$; $t = -1.5$; C.V. = ±2.492; do not reject. There is not enough evidence to reject the claim that the average is 26.

23. H_0: $p = 0.39$ (claim) and H_1: $p \neq 0.39$; C.V. = ±1.96; $z = -0.62$; do not reject. There is not enough evidence to reject the claim that 39% took supplements.

24. H_0: $p = 0.55$ (claim) and H_1: $p < 0.55$; $z = -0.8989$; C.V. = −1.28; do not reject. There is not enough evidence to reject the survey's claim.

25. H_0: $p = 0.35$ (claim) and H_1: $p \neq 0.35$; C.V. = ±2.33; $z = 0.67$; do not reject. There is not enough evidence to reject the claim that the proportion is 35%.

26. H_0: $p = 0.75$ (claim) and H_1: $p \neq 0.75$; $z = 2.6833$; C.V. = ±2.58; reject. There is enough evidence to reject the claim.

27. P-value = 0.0358

28. P-value < 0.0002

29. H_0: $\sigma = 6$ and H_1: $\sigma > 6$ (claim); $\chi^2 = 54$; C.V. = 36.415; reject. There is enough evidence to support the claim.

30. H_0: $\sigma = 8$ (claim) and $H_1 = \sigma \neq 8$; $\chi^2 = 33.2$; C.V. = 34.770, 90.715; reject. There is enough evidence to reject the claim that $\sigma = 8$. $P = 0.0053$

31. H_0: $\sigma = 2.3$ and H_1: $\sigma < 2.3$ (claim); $\chi^2 = 13$; C.V. = 10.117; do not reject. There is not enough

evidence to support the claim that the standard deviation is less than 2.3.

32. H_0: $\sigma = 9$ (claim) and H_1: $\sigma \neq 9$; $\chi^2 = 13.4$; P-value > 0.20 (0.2870); since P-value > 0.05, do not reject. There is not enough evidence to reject the claim that $\sigma = 9$.

33. $28.9 < \mu < 31.2$; no

34. $\$6562.81 < \mu < \$6637.19$; no

Chapter 9

Exercises 9–1

1. Testing a single mean involves comparing a population mean to a specific value such as $\mu = 100$; testing the difference between two means involves comparing the means of two populations, such as $\mu_1 = \mu_2$.

3. Both samples are random samples. The populations must be independent of each other, and they must be normally or approximately normally distributed.

5. H_0: $\mu_1 = \mu_2$; H_1: $\mu_1 \neq \mu_2$ (claim); C.V. = ±1.65; $z = -3.51$; reject. There is enough evidence to support the claim that the mean number of hours that families with and without children participate in recreational activities are different.

7. H_0: $\mu_1 = \mu_2$; H_1: $\mu_1 \neq \mu_2$ (claim); C.V. = ±1.96; $z = -3.65$; reject. There is sufficient evidence at $\alpha = 0.05$ to conclude that the commuting times differ in the winter.

9. H_0: $\mu_1 = \mu_2$; H_1: $\mu_1 > \mu_2$ (claim); C.V. = 2.33; $z = 3.75$; reject. There is sufficient evidence at $\alpha = 0.01$ to conclude that the average hospital stay for men is longer.

11. H_0: $\mu_1 = \mu_2$; H_1: $\mu_1 \neq \mu_2$ (claim); C.V. = ±2.58; $z = -2.69$; reject.

13. H_0: $\mu_1 = \mu_2$; H_1: $\mu_1 \neq \mu_2$ (claim); C.V. = ±1.96; $z = 0.66$; do not reject. There is not enough evidence to support the claim that there is a difference in the means.

15. H_0: $\mu_1 = \mu_2$ and H_1: $\mu_1 \neq \mu_2$ (claim); $z = 1.01$; P-value = 0.3124; do not reject. There is not enough evidence to support the claim that there is a difference in self-esteem scores. (TI: P-value = 0.3131)

17. $5.3 < \mu_1 - \mu_2 < 8.7$

19. $-59.5 < \mu_1 - \mu_2 < -10.5$. The interval provides evidence to reject the claim that there is no difference in mean scores because the interval for the difference is entirely negative. That is, 0 is not in the interval.

21. H_0: $\mu_1 = \mu_2$, H_1: $\mu_1 > \mu_2$ (claim); C.V. = 2.33; $z = 3.43$; reject. There is enough evidence to support the claim that women watch more television than men.

23. H_0: $\mu_1 = \mu_2$, H_1: $\mu_1 \neq \mu_2$ (claim); $z = -2.47$; P-value = 0.0136; do not reject. There is not enough evidence to support the claim that there is a significant difference in the mean daily sales of the two stores.

25. H_0: $\mu_1 - \mu_2 = 8$ (claim) and H_1: $\mu_1 - \mu_2 > 8$; C.V. = 1.65; $z = -0.73$; do not reject. There is not enough evidence to reject the claim that private school students have exam scores that are at most 8 points higher than those of students in public schools.

27. H_0: $\mu_1 - \mu_2 = \$30{,}000$; H_1: $\mu_1 - \mu_2 \neq \$30{,}000$ (claim); C.V. = ±2.58; $z = 1.22$; do not reject. There is not enough evidence to support the claim that the difference in income is not $30,000.

Exercises 9–2

1. H_0: $\mu_1 = \mu_2$; H_1: $\mu_1 \neq \mu_2$ (claim); C.V. = ±1.860; d.f. = 8; $t = 0.209$; do not reject. There is not enough evidence to support the claim that the mean heights are different.

3. H_0: $\mu_1 = \mu_2$; H_1: $\mu_1 \neq \mu_2$ (claim); C.V. = ±2.093; d.f. = 19; $t = 3.811$; reject. There is enough evidence to support the claim that the mean noise levels are different.

5. H_0: $\mu_1 = \mu_2$; H_1: $\mu_1 \neq \mu_2$ (claim); C.V. = ±1.812; d.f. = 10; $t = -1.220$; do not reject. There is not enough evidence to support the claim that the means are not equal.

7. H_0: $\mu_1 = \mu_2$; H_1: $\mu_1 \neq \mu_2$ (claim); d.f. = 9; $t = 5.103$; the P-value for the t test is P-value < 0.001; reject. There is enough evidence to support the claim that the means are different.

9. $-338.3 < \mu_1 - \mu_2 < 424.1$

11. H_0: $\mu_1 = \mu_2$; H_1: $\mu_1 \neq \mu_2$ (claim); C.V. = ±2.977; d.f. = 14; $t = 2.601$; do not reject. There is insufficient evidence to conclude a difference in viewing times.

13. H_0: $\mu_1 = \mu_2$ and H_1: $\mu_1 > \mu_2$ (claim); C.V. = 3.365; d.f. = 5; $t = 1.057$; do not reject. There is not enough evidence to support the claim that the average number of students attending cyber charter schools in Allegheny County is greater that the average number of students attending cyber charter schools in surrounding counties. One reason why caution should be used is that cyber charter schools are a relatively new concept.

15. H_0: $\mu_1 = \mu_2$ (claim) and H_1: $\mu_1 \neq \mu_2$; d.f. = 15; $t = 2.385$. The P-value for the t test is $0.02 < P$-value < 0.05 (0.026). Do not reject since P-value > 0.01. There is not enough evidence to reject the claim that the means are equal. $-0.1 < \mu_1 - \mu_2 < 0.9$ (TI: Interval $-0.07 < \mu_1 - \mu_2 < 0.87$)

17. $9.9 < \mu_1 - \mu_2 < 219.6$ (TI: Interval $13.23 < \mu_1 - \mu_2 < 216.24$)

19. H_0: $\mu_1 = \mu_2$, H_1: $\mu_1 < \mu_2$ (claim); $t = -0.7477$; P-value = 0.238; do not reject. There is not enough evidence to say that the cost of gasoline in 2011 was less than in 2015.

21. H_0: $\mu_1 = \mu_2$; H_1: $\mu_1 \neq \mu_2$ (claim); C.V. = ±1.796; d.f.= 11; $t = -0.451$; do not reject. There is not enough evidence to support the claim that the mean number of home runs for the two leagues are different.

Exercises 9–3

1. *a.* Dependent *b.* Dependent *c.* Independent *d.* Dependent *e.* Independent

3. H_0: $\mu_D = 0$ and H_1: $\mu_D < 0$ (claim); C.V. = -1.397; d.f. = 8; $t = -2.818$; reject. There is enough evidence to support the claim that the seminar increased the number of hours students studied.

5. H_0: $\mu_D = 0$ and H_1: $\mu_D > 0$ (claim); C.V. = 2.015; d.f. = 5; $t = 3.58$; reject. There is enough evidence to support the claim that the film motivated the people to reduce their cholesterol levels by eating a better diet.

7. H_0: $\mu_D = 0$ and H_1: $\mu_D > 0$ (claim); C.V. = 2.571; d.f. = 5; $t = 2.236$; do not reject. There is not enough evidence to support the claim that the errors have been reduced.

9. H_0: $\mu_D = 0$ and H_1: $\mu_D \neq 0$ (claim); d.f. = 7; $t = 0.978$; P-value > 0.20 (0.361). Do not reject since P-value > 0.01. There is not enough evidence to support the claim that there is a difference in the pulse rates. $-3.2 < \mu_D < 5.7$

11. H_0: $\mu_D = 0$ and H_1: $\mu_D > 0$ (claim); C.V. = 1.943; d.f. = 6; $t = 3.104$; reject. There is enough evidence to support the claim that the program reduced the mean difference in spelling errors.

13. $$\overline{X_1 - X_2} = \sum \frac{X_1 - X_2}{n} = \sum \left(\frac{X_1}{n} - \frac{X_2}{n}\right)$$
$$= \sum \frac{X_1}{n} - \sum \frac{X_2}{n} = \overline{X}_1 - \overline{X}_2$$

Exercises 9–4

1. *a.* $\hat{p} = 0.615$, $\hat{q} = 0.385$ *d.* $\hat{p} = 0.17$, $\hat{q} = 0.83$
b. $\hat{p} = 0.825$, $\hat{q} = 0.175$ *e.* $\hat{p} = 0.3125$, $\hat{q} = 0.6875$
c. $\hat{p} = 0.33$, $\hat{q} = 0.67$

3. *a.* 144 *c.* 312 *e.* 70
b. 64 *d.* 40

5. *a.* $\overline{p} = 0.394$; $\overline{q} = 0.606$
b. $\overline{p} = 0.457$; $\overline{q} = 0.543$
c. $\overline{p} = 0.133$; $\overline{q} = 0.867$
d. $\overline{p} = 0.53$; $\overline{q} = 0.47$
e. $\overline{p} = 0.25$; $\overline{q} = 0.75$

7. $\hat{p}_1 = 0.83$; $\hat{p}_2 = 0.75$; $\overline{p} = 0.79$; $\overline{q} = 0.21$; H_0: $p_1 = p_2$ (claim) and H_1: $p_1 \neq p_2$; C.V. = ±1.96; $z = 1.39$; do not reject. There is not enough evidence to reject the claim that the proportions are equal. $-0.032 < p_1 - p_2 < 0.192$

9. $\hat{p}_1 = 0.55$; $\hat{p}_2 = 0.46$; $\overline{p} = 0.5$; $\overline{q} = 0.5$; H_0: $p_1 = p_2$ and H_1: $p_1 \neq p_2$ (claim); C.V. = ±2.58; $z = 1.23$; do not reject. There is not enough evidence to support the claim that the proportions are different. ($-0.104 < p_1 - p_2 < 0.293$)

11. $\hat{p}_1 = 0.28$; $\hat{p}_2 = 0.35$; $\overline{p} = 0.318$; $\overline{q} = 0.682$; H_0: $p_1 = p_2$ and H_1: $p_1 < p_2$ (claim); C.V. = -1.65; $z = -0.785$; do not reject. There is not enough evidence to say that the proportion of cat owners is less than the proportions of dog owners.

13. $\hat{p}_1 = 0.3$; $\hat{p}_2 = 0.12$; $\overline{p} = 0.231$; $\overline{q} = 0.769$; H_0: $p_1 = p_2$ and H_1: $p_1 > p_2$ (claim); C.V. = 1.28; $z = 2.37$; reject. There is enough evidence to support the claim that the proportion of women who were attacked by relatives is greater than the proportion of men who were attacked by relatives.

15. $0.164 < p_1 - p_2 < 0.402$

17. $\hat{p}_1 = 0.4$; $\hat{p}_2 = 0.295$; $\overline{p} = 0.3475$; $\overline{q} = 0.6525$; H_0: $p_1 = p_2$; H_1: $p_1 \neq p_2$ (claim); C.V. = ±2.58; $z = 2.21$; do not reject. There is not enough evidence to support the claim that the proportions are different.

19. $-0.0667 < p_1 - p_2 < 0.0631$. It does agree with the *Almanac* statistics stating a difference of -0.042 since -0.042 is not contained in the interval.

21. $\hat{p}_1 = 0.80$; $\hat{p}_2 = 0.60$; $\overline{p} = 0.69$; $\overline{q} = 0.31$; H_0: $p_1 = p_2$ and H_1: $p_1 \neq p_2$ (claim); C.V. = ±2.58; $z = 5.05$; reject. There is enough evidence to support the claim that the proportions are different.

23. $\hat{p}_1 = 0.6$, $\hat{p}_2 = 0.533$; $\overline{p} = 0.563$, $\overline{q} = 0.437$. H_0: $p_1 = p_2$ and H_1: $p_1 \neq p_2$ (claim); C.V. = ±2.58; $z = 1.10$; do not reject. There is not enough evidence to support the claim that the proportion of males who commit interview errors is different from the proportion of females who commit interview errors.

25. $\hat{p}_1 = 0.733$, $\hat{p}_2 = 0.56$; $\overline{p} = 0.671$, $\overline{q} = 0.329$; H_0: $p_1 = p_2$ and H_1: $p_1 > p_2$ (claim); $z = 2.96$; P-value < 0.002; reject. There is enough evidence to support the claim that the proportion of couponing women is greater than the couponing men. (Note: TI says P-value = 0.00154.)

27. $\hat{p}_1 = 0.065$; $\hat{p}_2 = 0.08$; $\overline{p} = 0.0725$; $\overline{q} = 0.9275$; H_0: $p_1 = p_2$; H_1: $p_1 \neq p_2$ (claim); C.V. = ±1.96; $z = -0.58$; do not reject. There is insufficient evidence to conclude a difference.

Exercises 9–5

1. The variance in the numerator should be the larger of the two variances.

3. One degree of freedom is used for the variance associated with the numerator, and one is used for the variance associated with the denominator.

5. *a.* d.f.N. = 24; d.f.D. = 13; C.V. = 2.89
b. d.f.N. = 15; d.f.D. = 11; C.V. = 2.17
c. d.f.N. = 20; d.f.D. = 17; C.V. = 3.16

7. Specific P-values are in parentheses.
a. 0.025 < P-value < 0.05 (0.033)
b. 0.05 < P-value < 0.10 (0.072)
c. P-value = 0.05
d. 0.005 < P-value < 0.01 (0.006)

9. H_0: $\sigma_1^2 = \sigma_2^2$; H_1: $\sigma_1^2 \neq \sigma_2^2$ (claim); C.V. = 3.43; d.f.N. = 12; d.f.D. = 11; $F = 2.08$; do not reject. There is not enough evidence to support the claim that the variances are different.

11. H_0: $\sigma_1^2 = \sigma_2^2$ and H_1: $\sigma_1^2 \neq \sigma_2^2$ (claim); C.V. = 4.99; d.f.N. = 7; d.f.D. = 7; $F = 1.00$; do not reject. There is not enough evidence to support the claim that there is a difference in the variances.

13. H_0: $\sigma_1^2 = \sigma_2^2$; H_1: $\sigma_1^2 > \sigma_2^2$ (claim); C.V. = 4.950; d.f.N. = 6; d.f.D. = 5; $F = 9.80$; reject. There is sufficient evidence at $\alpha = 0.05$ to conclude that the variance in area is greater for Eastern cities. C.V. = 10.67; do not reject. There is insufficient evidence to conclude the variance is greater at $\alpha = 0.01$.

15. H_0: $\sigma_1^2 = \sigma_2^2$ and H_1: $\sigma_1^2 \neq \sigma_2^2$ (claim); C.V. = 4.03; d.f.N. = 9; d.f.D. = 9; $F = 1.10$; do not reject. There is not enough evidence to support the claim that the variances are not equal.

17. H_0: $\sigma_1^2 = \sigma_2^2$ (claim) and H_1: $\sigma_1^2 \neq \sigma_2^2$; C.V. d.f.N. = 6; d.f.D. = 7; $F = 3.31$; do not reject. $F = 3.31$. There is not enough evidence to support the claim that the variance of the heights of the buildings in Denver is greater than the variance of the heights of the building in Nashville.

19. H_0: $\sigma_1^2 = \sigma_2^2$ (claim) and H_1: $\sigma_1^2 \neq \sigma_2^2$; $F = 5.32$; d.f.N. = 14; d.f.D. = 14; P-value < 0.01 (0.004); reject. There is enough evidence to reject the claim that the variances of the weights are equal. The variance for men is 2.363 and the variance for women is 0.444.

21. H_0: $\sigma_1^2 = \sigma_2^2$ and H_1: $\sigma_1^2 \neq \sigma_2^2$ (claim); C.V. = 4.67; d.f.N. = 12; d.f.D. = 7; $F = 3.45$; do not reject. There is not enough evidence to support the claim that the variances of ages of dog owners in Miami and Boston are different.

23. H_0: $\sigma_1^2 = \sigma_2^2$; H_1: $\sigma_1^2 > \sigma_2^2$ (claim); C.V. = 2.54; d.f.N. = 10; d.f.D. = 15; $F = 1.31$; do not reject. There is not enough evidence to support the claim that the students' exam who took the online course is greater than the variances of the students' exams who took the classroom course.

Review Exercises

1. H_0: $\mu_1 = \mu_2$ and H_1: $\mu_1 > \mu_2$ (claim); C.V. = 2.33; $z = 0.59$; do not reject. There is not enough evidence to support the claim that single drivers do more pleasure driving than married drivers.

3. H_0: $\mu_1 = \mu_2$, H_1: $\mu_1 \neq \mu_2$ (claim); C.V. = ±2.861; $t = -0.901$; do not reject. There is not enough evidence to support the claim that the means are different.

5. H_0: $\mu_1 = \mu_2$ and H_1: $\mu_1 \neq \mu_2$ (claim); C.V. = ±2.624; d.f. = 14; $t = 6.540$; reject. Yes, there is enough evidence to support the claim that there is a difference in the teachers' salaries. $\$3447.80 < \mu_1 - \mu_2 < \$8068.20$

7. H_0: $\mu_D = 10$; H_1: $\mu_D > 10$ (claim); C.V. = 2.821; d.f. = 9; $t = 3.249$; reject. There is sufficient evidence to conclude that the difference in temperature is greater than 10 degrees.

9. $\hat{p}_1 = 0.245$, $\hat{p}_2 = 0.31$, $\overline{p} = 0.2775$, $\overline{q} = 0.7225$; H_0: $p_1 = p_2$; H_1: $p_1 \neq p_2$ (claim); C.V. = ±1.96; $z = -1.45$; do not reject. There is not enough evidence to support the claim that the proportions are different.

11. H_0: $\sigma_1 = \sigma_2$ and H_1: $\sigma_1 \neq \sigma_2$ (claim); C.V. = 2.77; $\alpha = 0.10$; d.f.N. = 23; d.f.D. = 10; $F = 10.37$; reject. There is enough evidence to support the claim that there is a difference in the standard deviations.

13. H_0: $\sigma_1^2 = \sigma_2^2$; H_1: $\sigma_1^2 \neq \sigma_2^2$ (claim); C.V. = 5.42; d.f.N. = 11; d.f.D. = 11; $F = 1.11$; do not reject. There is not enough evidence to support the claim that the variances are not equal.

Chapter Quiz

1. False
2. False
3. True
4. False
5. *d*
6. *a*
7. *c*
8. *a*
9. $\mu_1 = \mu_2$
10. *t*
11. Normal
12. Negative
13. $F = \dfrac{s_1^2}{s_2^2}$

14. H_0: $\mu_1 = \mu_2$ and H_1: $\mu_1 \neq \mu_2$ (claim); $z = -3.69$; C.V. = ±2.58; reject. There is enough evidence to support the claim that there is a difference in the cholesterol levels of the two groups. $-10.19 < \mu_1 - \mu_2 < -1.81$

15. H_0: $\mu_1 = \mu_2$ and H_1: $\mu_1 > \mu_2$ (claim); C.V. = 1.28; $z = 1.61$; reject. There is enough evidence to support the claim that the average rental fees for the apartments in the East are greater than the average rental fees for the apartments in the West.

16. H_0: $\mu_1 = \mu_2$ and H_1: $\mu_1 \neq \mu_2$ (claim); $t = 11.094$; d.f. = 11; C.V. = ±3.106; reject. There is enough evidence to support the claim that the average prices are different. $0.29 < \mu_1 - \mu_2 < 0.51$ (TI: Interval $0.2995 < \mu_1 - \mu_2 < 0.5005$)

17. H_0: $\mu_1 = \mu_2$ and H_1: $\mu_1 < \mu_2$ (claim); C.V. = −2.132; d.f. = 4; $t = -4.046$; reject. There is enough evidence to support the claim that accidents have increased.

18. H_0: $\mu_1 = \mu_2$ and H_1: $\mu_1 \neq \mu_2$ (claim); $t = 9.807$; d.f. = 11; C.V. = ±2.718; reject. There is enough evidence to support the claim that the salaries are different. $\$6653.91 < \mu_1 - \mu_2 < \$11,756.09$ (TI: Interval $\$6919 < \mu_1 - \mu_2 < \$11,491$)

19. H_0: $\mu_1 = \mu_2$ and H_1: $\mu_1 > \mu_2$ (claim); d.f. = 10; $t = 0.874$; $P = 0.198$; do not reject since P-value > 0.05. There is not enough evidence to support the claim that the incomes of city residents are greater than the incomes of rural residents.

20. H_0: $\mu_D = 0$ and H_1: $\mu_D < 0$ (claim); $t = -4.172$; d.f. = 9; C.V. = −2.821; reject. There is enough evidence to support the claim that the sessions improved math skills.

21. H_0: $\mu_D = 0$ and H_1: $\mu_D < 0$ (claim); $t = -1.714$; d.f. = 9; C.V. = −1.833; do not reject. There is not enough evidence to support the claim that egg production was increased.

22. $\hat{p}_1 = 0.05$, $\hat{p}_2 = 0.08$, $\overline{p} = 0.0615$, $\overline{q} = 0.9385$; H_0: $p_1 = p_2$ and H_1: $p_1 \neq p_2$ (claim); $z = -0.69$; C.V. = ±1.65; do not reject. There is not enough evidence to support the claim that the proportions are different. $-0.105 < p_1 - p_2 < 0.045$

23. $\hat{p}_1 = 0.04$, $\hat{p}_2 = 0.03$, $\overline{p} = 0.035$, $\overline{q} = 0.965$; H_0: $p_1 = p_2$ and H_1: $p_1 \neq p_2$ (claim); C.V. = ±1.96; $z = 0.54$; do not reject. There is not enough evidence to support the claim that the proportions have changed. $-0.026 < p_1 - p_2 < 0.046$. Yes, the confidence interval contains 0; hence, the null hypothesis is not rejected.

24. H_0: $\sigma_1^2 = \sigma_2^2$ and H_1: $\sigma_1^2 \neq \sigma_2^2$ (claim); $F = 1.64$; d.f.N. = 17; d.f.D. = 14; P-value > 0.20 (0.357). Do not reject since P-value > 0.05. There is not enough evidence to support the claim that the variances are different.

25. H_0: $\sigma_1^2 = \sigma_2^2$ and H_1: $\sigma_1^2 \neq \sigma_2^2$ (claim); $F = 1.30$; C.V. = 1.90; do not reject. There is not enough evidence to support the claim that the variances are different.

Chapter 10

Exercises 10–1

1. Two variables are related when a discernible pattern exists between them.

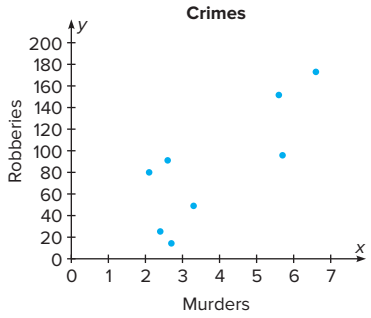
3. r, ρ (rho)

5. A positive relationship means that as x increases, y increases. A negative relationship means that as x increases, y decreases.

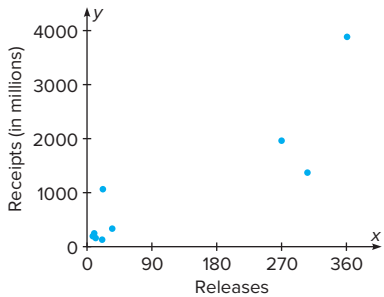
7. The diagram is called a scatter plot. It shows the nature of the relationship.

9. t test

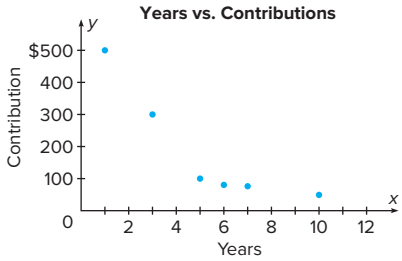
11. H_0: $\rho = 0$; H_1: $\rho \neq 0$; $r = 0.804$; C.V. = ±0.707; reject. There is sufficient evidence to say that there is a linear relationship between the number of murders and the number of robberies per 100,000 people for a random selection of states in the United States.



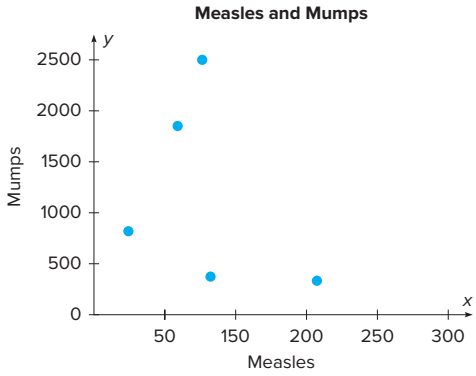
13. H_0: $\rho = 0$; H_1: $\rho \neq 0$; $r = 0.880$; C.V. = ±0.666; reject. There is sufficient evidence to conclude that a significant linear relationship exists between the number of releases and gross receipts.



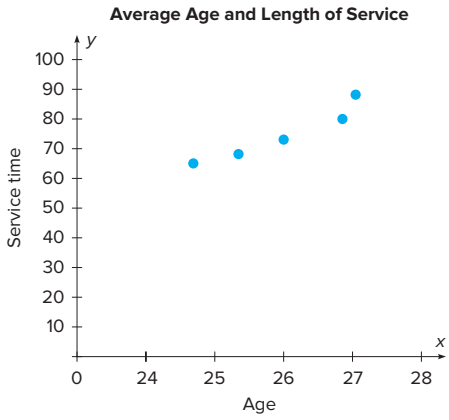
15. H_0: $\rho = 0$; H_1: $\rho \neq 0$; $r = -0.883$; C.V. = ±0.811; reject. There is a significant linear relationship between the number of years a person has been out of school and his or her contribution.



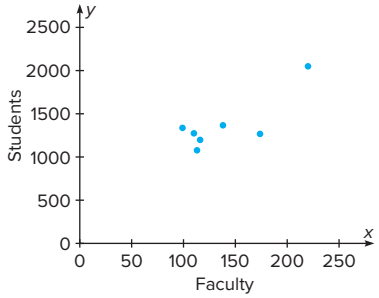
17. H_0: $\rho = 0$; H_1: $\rho \neq 0$; $r = -0.632$; C.V. = ±0.878; fail to reject. There is not sufficient evidence to conclude that a significant linear relationship exists between the number of cases of measles and mumps.



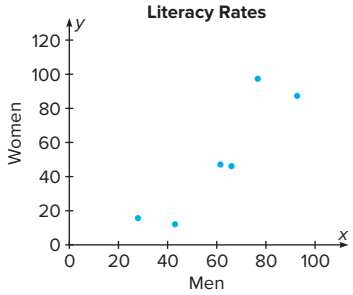
19. H_0: $\rho = 0$; H_1: $\rho \neq 0$; $r = 0.978$; C.V. = ±0.878; reject. There is sufficient evidence to conclude that a significant linear relationship exists between age and length of service.



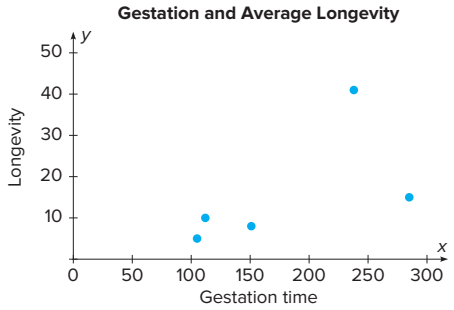
21. H_0: $\rho = 0$; H_1: $\rho \neq 0$; $r = 0.812$; C.V. = ±0.754; reject. There is a significant linear relationship between the number of faculty and the number of students at small colleges. When the values for x and y are switched, the results are identical. The independent variable is most likely the number of students.



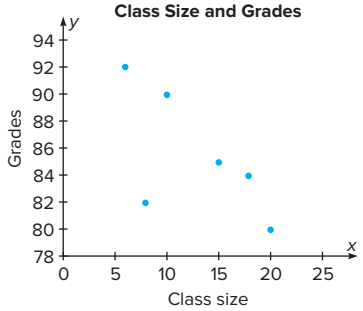
23. H_0: $\rho = 0$; H_1: $\rho \neq 0$; $r = 0.908$; C.V. = ±0.811; reject. There is a significant linear relationship between the literacy rates of men and women for various countries.



25. H_0: $\rho = 0$; H_1: $\rho \neq 0$; $r = 0.605$; C.V. = ±0.878; fail to reject. There is not enough evidence to support the claim that there is a significant relationship between the gestation time and the longevity of the animals.



27. H_0: $\rho = 0$; H_1: $\rho \neq 0$; $r = -0.673$; C.V. = ±0.811; do not reject. There is not enough evidence to say that there is a significant linear relationship between class size and average grades for students.



29. $r = 1.00$: All points fall in a straight line. $r = 1.00$: The value of r between x and y is the same when x and y are interchanged.

Exercises 10–2

1. A scatter plot should be drawn, and the value of the correlation coefficient should be tested to see whether it is significant.

3. $y' = a + bx$

5. It is the line that is drawn on a scatter plot such that the sum of the squares of the vertical distances from each point to the line is a minimum.

7. When r is positive, b will be positive. When r is negative, b will be negative.

9. The closer r is to +1 or −1, the more accurate the predicted value will be.

11. $y' = -13.151 + 25.333x$; $y' = 100.848$ robberies

13. $y' = 181.661 + 7.319x$; $y' = 1645.5$ (million $)

15. $y' = 453.176 - 50.439x$; $251.42

17. Since r is not significant, no regression should be done.

19. $y' = -167.012 + 9.309x$; 82.5 months

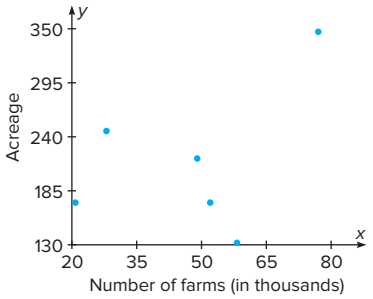
21. $y' = -14.974 + 0.111x$

23. $y' = -33.261 + 1.367x$; $y' = 76.1\%$

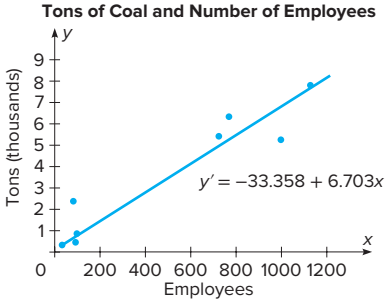
25. Since r is not significant, no regression should be done.

27. Since r is not significant, no regression should be done.

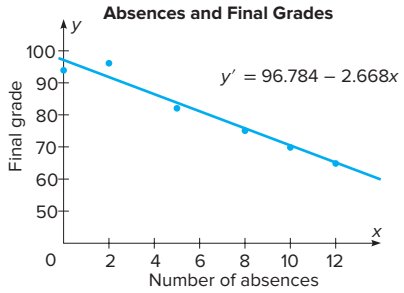
29. H_0: $\rho = 0$; H_1: $\rho \neq 0$; $r = 0.429$; C.V. = ±0.811; do not reject. There is insufficient evidence to conclude a relationship exists between number of farms and acreage.



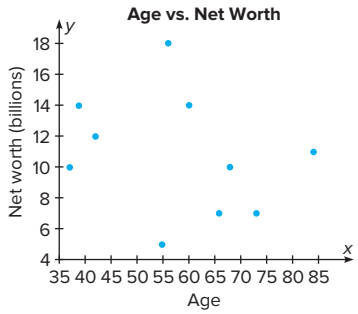
31. H_0: $\rho = 0$; H_1: $\rho \neq 0$; $r = 0.970$; C.V. = ±0.707; reject; $y' = -33.358 + 6.703x$; when $x = 500$, $y' = 3318.142$, or about 3318 tons. There is a significant relationship between number of employees and tons of coal produced.



33. H_0: $\rho = 0$; H_1: $\rho \neq 0$; $r = -0.981$; C.V. = ± 0.811; reject. There is a significant linear relationship between the number of absences and the final grade; $y' = 96.784 - 2.668x$.



35. H_0: $\rho = 0$; H_1: $\rho \neq 0$; $r = -0.265$; d.f. = 8; $t = -0.777$; P-value > 0.05 (0.459); do not reject. There is no significant linear relationship between the ages of billionaires and their net worth. No regression should be done.



37. 453.173; regression should not be done.

Exercises 10–3

1. Explained variation is the variation due to the relationship. It is computed by $\Sigma(y' - \bar{y})^2$.

3. Total variation is the sum of the squares of the vertical distances of the points from the mean. It is computed by $\Sigma(y - \bar{y})^2$.

5. The coefficient of determination is found by squaring the value of the correlation coefficient.

7. The coefficient of nondetermination is found by subtracting r^2 from 1.

9. $r^2 = 0.1936$; 19.36% of the variation of y is due to the variation of x; 80.64% is due to chance.

11. $r^2 = 0.9409$; 94.09% of the variation of y is due to the variation of x; 5.91% is due to chance.

13. $r^2 = 0.0225$; 2.25% of the variation of y is due to the variation of x; 97.75% is due to chance.

15. 629.49

17. 94.22*

19. $387.48 < y < 2903.52$*

21. $\$41.43 < y < \$461.37$*

*Answers may vary due to rounding.

Exercises 10–4

1. Simple regression has one dependent variable and one independent variable. Multiple regression has one dependent variable and two or more independent variables.

3. The relationship would include all variables in one equation.

5. They will all be smaller.

7. 7.5

9. 85.75 (grade) or 86

11. R is the strength of the relationship between the dependent variable and all the independent variables.

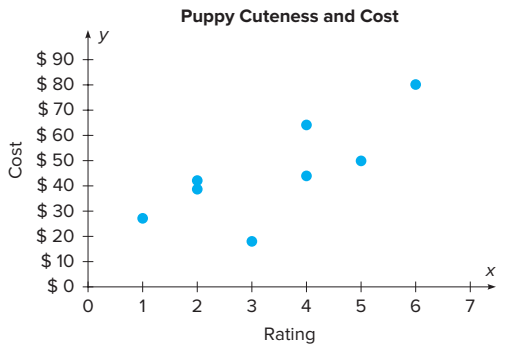
13. R^2 is the coefficient of multiple determination. R^2_{adj} is adjusted for sample size and number of predictors.

15. F test

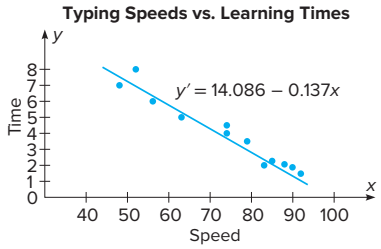
Review Exercises

1. H_0: $\rho = 0$; H_1: $\rho \neq 0$; $r = 0.864$; C.V. = ± 0.917; d.f. = 4; do not reject. There is not a significant linear relationship between the rating and the amount that they spent. No regression analysis should be done. $P = 0.0263$

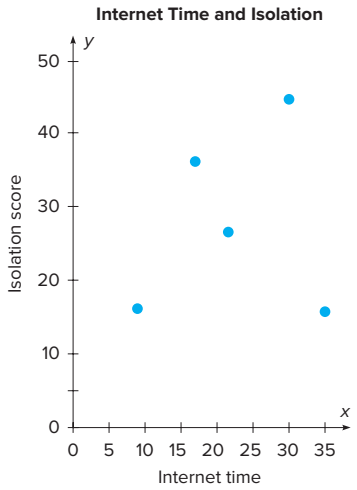
3. H_0: $\rho = 0$; H_1: $\rho \neq 0$; $r = 0.761$; C.V. = ± 0.834; d.f. = 6; do not reject. There is not a significant linear relationship between the rating and the cost. No regression analysis should be done. $P = 0.0284$



5. H_0: $\rho = 0$; H_1: $\rho \neq 0$; $r = -0.974$; C.V. = ± 0.708; d.f. = 10; reject. There is a significant linear relationship between speed and time; $y' = 14.086 - 0.137x$; $y' = 4.2$ hours.



7. H_0: $\rho = 0$; H_1: $\rho \neq 0$; $r = 0.510$; C.V. = ± 0.959; d.f. = 3 do not reject. There is not a significant linear relationship between Internet use and isolation. No regression should be done since r is not significant.



9. 0.513*

11. $3.25 < y < 5.19$*

13. 22.01*

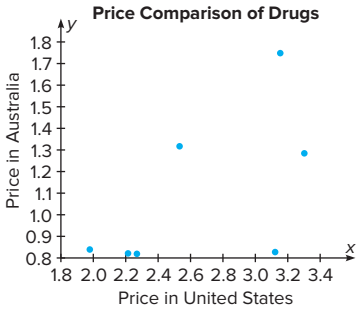
15. $R^2_{adj} = 0.643$*

*Answers may vary due to rounding.

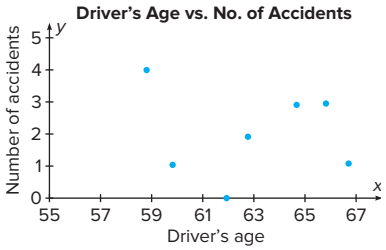
Chapter Quiz

1. False	**2.** True	**3.** True
4. False	**5.** False	**6.** False
7. *a*	**8.** *a*	**9.** *d*
10. *c*	**11.** *b*	**12.** Scatter plot
13. Independent	**14.** −1, +1	
15. *b* (slope)		
16. Line of best fit		
17. +1, −1		

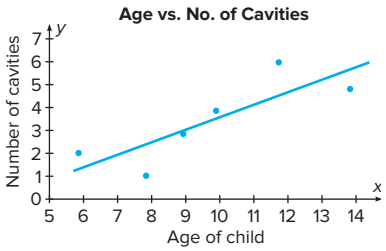
18. H_0: $\rho = 0$; H_1: $\rho \neq 0$; d.f. = 5; $r = 0.600$; C.V. = ± 0.754; do not reject. There is no significant linear relationship between the price of the same drugs in the United States and in Australia. No regression should be done.



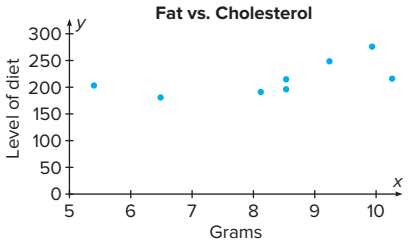
19. H_0: $\rho = 0$; H_1: $\rho \neq 0$; d.f. = 5; $r = -0.078$; C.V. = ± 0.754; do not reject. No regression should be done.



20. H_0: $\rho = 0$; H_1: $\rho \neq 0$; $r = 0.842$; d.f. = 4; C.V. = ± 0.811; reject. $y' = -1.918 + 0.551x$; 4.14 or 4



21. H_0: $\rho = 0$; H_1: $\rho \neq 0$; $r = 0.602$; d.f. = 6; C.V. = ± 0.707; do not reject. No regression should be done.



22. 1.129*

23. 29.5* For calculation purposes only. No regression should be done.

24. $-0.72 < y < 4.6$ or $0 < y < 5$*

25. 217.5 (average of y values is used since there is no significant relationship)

26. 119.9*

27. $R = 0.729$*

28. $R^2_{adj} = 0.439$*

*These answers may vary due to the method of calculation or rounding.

Chapter 11

Exercises 11–1

1. The variance test compares a sample variance with a hypothesized population variance; the goodness-of-fit test compares a distribution obtained from a sample with a hypothesized distribution.

3. The expected values are computed on the basis of what the null hypothesis states about the distribution.

5. H_0: The students show no preference for class times. H_1: The students show a preference for class times (claim). C.V. = 11.345; d.f. = 3; $\alpha = 0.01$; $\chi^2 = 2.552$; do not reject. There is not enough evidence to support the claim that the students show a preference for class times.

7. H_0: The distribution is as follows: 45% favor extending the school year, 47% do not want the school year extended, and 8% have no opinion. H_1: The distribution is not the same as stated in the null hypothesis (claim). C.V. = 5.991; $\alpha = 0.05$; $\chi^2 = 2.554$; do not reject. There is not enough evidence to support the claim that the percentages are different from the ones stated in the null hypothesis.

9. H_0: 35% feel that genetically modified food is safe to eat, 52% feel that genetically modified food is not safe to eat, and 13% have no opinion. H_1: The distribution is not the same as stated in the null hypothesis (claim). C.V. = 9.210; d.f. = 2; $\alpha = 0.01$; $\chi^2 = 1.429$; do not reject. There is not enough evidence to support the claim that the proportions are different from those reported in the poll.

11. H_0: Employee absences are equally distributed over the five-day workweek. H_1: Employee absences are not equally distributed over the five-day workweek (claim). C.V. = 9.488; d.f. = 4; $\alpha = 0.05$; $\chi^2 = 8.235$; do not reject. There is not enough evidence to say that the absences are not equally distributed during the week.

13. H_0: 10% of the annual deaths from firearms occurred at birth to age 19 years, 50% were from ages 20–44, and 40% were ages 45 years and over. H_1: The distribution is not the same as stated in the null hypothesis (claim). C.V. = 5.991; d.f. = 2; $\alpha = 0.05$; $\chi^2 = 9.405$; reject. There is enough evidence to support the claim that the proportions are different from those stated by the National Safety Council.

15. H_0: The proportion of Internet users is the same for the groups. H_1: The proportion of Internet users is not the same for the groups (claim). C.V. = 5.991; d.f. = 2; $\alpha = 0.05$; $\chi^2 = 0.208$; do not reject. There is insufficient evidence to conclude that the proportions differ.

17. H_0: The distribution of the ways people pay for their prescriptions is as follows: 60% use personal funds, 25% use insurance, and 15% use Medicare (claim). H_1: The distribution is not the same as stated in the null hypothesis. The d.f. = 2; $\alpha = 0.05$; $\chi^2 = 0.667$; do not reject since P-value > 0.10. There is not enough evidence to reject the claim that the distribution is the same as stated in the null hypothesis. An implication of the results is that the majority of people are using their own money to pay for medications. Maybe the medication should be less expensive to help out these people. (TI: P-value = 0.717)

19. H_0: The coins are balanced and randomly tossed (claim). H_1: The coins are not balanced or are not randomly tossed. C.V. = 7.815; d.f. = 3; $\chi^2 = 139.407$; reject the null hypothesis. There is enough evidence to reject the claim that the coins are balanced and randomly tossed.

Exercises 11–2

1. The independence test and the goodness-of-fit test both use the same formula for computing the test value. However, the independence test uses a contingency table, whereas the goodness-of-fit test does not.

3. H_0: The variables are independent (or not related). H_1: The variables are dependent (or related).

5. The expected values are computed as (row total × column total) ÷ grand total.

7. H_0: The living arrangement of a person is independent of the gender of the person. H_1: The living arrangement of a person is dependent upon the gender of the person (claim). C.V. = 7.815; d.f. = 3; $\alpha = 0.05$; $\chi^2 = 1.674$; do not reject. There is not enough evidence to support the claim that the living arrangement is dependent on the gender of the individual.

9. H_0: Pet ownership is independent of the number of persons living in the household. H_1: Pet ownership is dependent on the number of persons living in the household (claim). C.V. = 6.251; d.f. = 3; $\alpha = 0.10$; $\chi^2 = 2.235$; do not reject. There is not enough evidence to support the claim that pet ownership is dependent on the number of persons living in the household.

11. H_0: The types of violent crimes committed are independent of the cities where they are committed. H_1: The types of violent crimes committed are dependent upon the cities where they are committed (claim). C.V. = 12.592; d.f. = 6; $\alpha = 0.05$; $\chi^2 = 43.890$; reject. There is enough evidence to support the claim that the types of violent crimes are dependent upon the cities where they are committed.

13. H_0: The length of unemployment time is independent of the type of industry where the worker is employed. H_1: The length of unemployment time is dependent upon the type of industry where the worker is employed (claim). C.V. = 9.488; d.f. = 4; $\alpha = 0.05$; $\chi^2 = 4.974$; do not reject. There is not enough evidence to support the claim that the length of unemployment time is dependent upon the type of industry where the worker is employed.

15. H_0: The program of study of a student is independent of the type of institution. H_1: The program of study of a student is dependent upon the type of institution (claim). C.V. = 7.815; d.f. = 3; $\alpha = 0.05$; $\chi^2 = 13.702$; reject. There is sufficient evidence to conclude that there is a relationship between program of study and type of institution.

17. H_0: The type of automobile owned by a person is independent of the gender of the individual. H_1: The type of automobile owned by a person is dependent on the gender of the individual (claim). C.V. = 6.251; d.f. = 3; $\alpha = 0.10$; $\chi^2 = 7.337$; reject. There is enough evidence to support the claim that the type of automobile is related to the gender of the owner.

19. H_0: The type of vitamin pill preferred by an individual is independent on the age of the person taking the pill.

H_1: The type of vitamin pill preferred by the individual is dependent on the age of the individual (claim). C.V. = 7.779; d.f. = 4; $\alpha = 0.10$; $\chi^2 = 18.860$; reject. There is enough evidence to support the claim that the type of vitamin pill preferred is dependent upon the age of the individual.

21. H_0: $p_1 = p_2 = p_3$ (claim). H_1: At least one proportion is different from the others. C.V. = 4.605; d.f. = 2; $\alpha = 0.10$; $\chi^2 = 5.749$; reject. There is enough evidence to reject the claim that the proportions are equal.

23. H_0: $p_1 = p_2 = p_3 = p_4$ (claim). H_1: At least one proportion is different. C.V. = 7.815; d.f. = 3; $\alpha = 0.05$; $\chi^2 = 5.317$; do not reject. There is not enough evidence to reject the claim that the proportions are equal.

25. H_0: $p_1 = p_2 = p_3$ (claim). H_1: At least one proportion is different from the others. C.V. = 5.991; d.f. = 2; $\alpha = 0.05$; $\chi^2 = 2.625$; do not reject. There is not enough evidence to reject the claim that the proportions are equal.

27. H_0: $p_1 = p_2 = p_3 = p_4 = p_5$ (claim). H_1: At least one proportion is different. C.V. = 9.488; d.f. = 4; $\alpha = 0.05$; $\chi^2 = 12.028$; reject. There is sufficient evidence to conclude that the proportions differ.

29. H_0: $p_1 = p_2 = p_3 = p_4$ (claim). H_1: At least one proportion is different. The d.f. = 3; $\chi^2 = 1.735$; $\alpha = 0.05$; do not reject since P-value > 0.05. There is not enough evidence to reject the claim that the proportions are equal. (TI: P-value = 0.6291)

31. H_0: $p_1 = p_2 = p_3$ (claim). H_1: At least one proportion is different from the others. C.V. = 7.779; d.f. = 4; $\alpha = 0.10$; $\chi^2 = 5.781$; do not reject. There is not enough evidence to reject the claim that the proportions are equal.

33. $\chi^2 = 1.064$

Review Exercises

1. H_0: The distribution of traffic fatalities was as follows: used seat belt, 31.58%; did not use seat belt, 59.83%; status unknown, 8.59%. H_1: The distribution is not as stated in the null hypothesis (claim). C.V. = 5.991; d.f. = 2; $\alpha = 0.05$; $\chi^2 = 1.819$; do not reject. There is not enough evidence to support the claim that the distribution differs from the one stated in the null hypothesis.

3. H_0: The distribution of denials for gun permits is as follows: 75% for criminal history, 11% for domestic violence, and 14% for other reasons (claim). H_1: The distribution is not the same as stated in the null hypothesis. C.V. = 4.605; d.f. = 2; $\alpha = 0.10$; $\chi^2 = 27.753$; reject. There is enough evidence to reject the claim that the distribution is as stated in the null hypothesis. Yes, the distribution may vary in different geographic locations.

5. H_0: The type of investment is independent of the age of the investor. H_1: The type of investment is dependent on the age of the investor (claim). C.V. = 9.488; d.f. = 4; $\alpha = 0.05$; $\chi^2 = 27.998$; reject. There is enough evidence to support the claim that the type of investment is dependent on the age of the investor.

7. H_0: $p_1 = p_2 = p_3$ (claim). H_1: At least one proportion is different. $\alpha = 0.01$; $\chi^2 = 4.912$; d.f. = 2; 0.05 < P-value < 0.10 (0.086); do not reject since P-value > 0.01. There is not enough evidence to reject the claim that the proportions are equal.

9. H_0: $p_1 = p_2 = H_1$: At least one proportion is different from the others (claim). C.V. = 7.815; d.f. = 3; $\alpha = 0.05$; $\chi^2 = 8.357$; reject. There is enough evidence to support the claim that at least one proportion is different from the others.

Chapter Quiz

1. False **2.** True
3. False **4.** *c*
5. *b* **6.** *d*
7. 6 **8.** Independent
9. Right **10.** At least 5

11. H_0: The reasons why people lost their jobs are equally distributed (claim). H_1: The reasons why people lost their jobs are not equally distributed. C.V. = 5.991; d.f. = 2; $\chi^2 = 2.333$; do not reject. There is not enough evidence to reject the claim that the reasons why people lost their jobs are equally distributed. The results could have been different 10 years ago since different factors of the economy existed then.

12. H_0: Takeout food is consumed according to the following distribution: 53% at home, 19% in the car, 14% at work, and 14% at other places (claim). H_1: The distribution is different from that stated in the null hypothesis. C.V. = 11.345; d.f. = 3; $\chi^2 = 5.27$; do not reject. There is not enough evidence to reject the claim that the distribution is as stated. Fast-food restaurants may want to make their advertisements appeal to those who like to take their food home to eat.

13. H_0: College students show the same preference for shopping channels as those surveyed. H_1: College students show a different preference for shopping channels (claim). C.V. = 7.815; d.f. = 3; $\alpha = 0.05$; $\chi^2 = 21.789$; reject. There is enough evidence to support the claim that college students show a different preference for shopping channels.

14. H_0: The proportion of commuters is distributed as follows: 76.6%, alone; 9.7%, carpooling; 4.9%, public transportation; 2.8%, walking; 1.7%, other; and 4.3%, working at home. H_1: The proportion of workers using each type of transportation differs from the stated proportions (claim). C.V. = 11.071; d.f. = 5; $\chi^2 = 69.224$; reject. There is enough evidence to support the claim that the distribution is different from the one stated in the null hypothesis.

15. H_0: Ice cream flavor is independent of the gender of the purchaser (claim). H_1: Ice cream flavor is dependent upon the gender of the purchaser. C.V. = 7.815; d.f. = 3; $\chi^2 = 7.198$; do not reject. There is not enough evidence to reject the claim that ice cream flavor is independent of the gender of the purchaser.

16. H_0: The type of pizza ordered is independent of the age of the individual who purchases it. H_1: The type of pizza ordered is dependent on the age of the individual who purchases it (claim). $\chi^2 = 107.3$; d.f. = 9; $\alpha = 0.10$; P-value < 0.005; reject since P-value < 0.10.

There is enough evidence to support the claim that the pizza purchased is related to the age of the purchaser.

17. H_0: The color of the pennant purchased is independent of the gender of the purchaser (claim). H_1: The color of the pennant purchased is dependent on the gender of the purchaser. $\chi^2 = 5.632$; d.f. = 2; C.V. = 4.605; reject. There is enough evidence to reject the claim that the color of the pennant purchased is independent of the gender of the purchaser.

18. H_0: The opinion of the children on the use of the tax credit is independent of the gender of the children. H_1: The opinion of the children on the use of the tax credit is dependent upon the gender of the children (claim). C.V. = 4.605; d.f. = 2; $\chi^2 = 1.535$; do not reject. There is not enough evidence to support the claim that the opinion of the children on the use of the tax credit is dependent on their gender.

19. H_0: $p_1 = p_2$ (claim). H_1: At least one proportion is different from the others. C.V. = 4.605; d.f. = 2; $\chi^2 = 6.711$; reject. There is enough evidence to reject the claim that the proportions are equal. It seems that more women are undecided about their jobs. Perhaps they want better income or greater chances of advancement.

Chapter 12

Exercises 12–1

1. The analysis of variance using the F test can be employed to compare three or more means.

3. The populations from which the samples were obtained must be normally or approximately normally distributed. The samples must be independent of one another. The variances of the populations must be equal, and the samples should be random.

5. H_0: $\mu_1 = \mu_2 = \cdots = \mu_n$. H_1: At least one mean is different from the others.

7. H_0: $\mu_1 = \mu_2 = \mu_3 = \mu_4$. H_1: At least one mean is different from the others (claim); C.V. = 3.01; d.f.N. = 3; d.f.D. = 24; $\alpha = 0.05$; $F = 1.10$; do not reject. There is not enough evidence to support the claim that at least one mean is different from the others.

9. H_0: $\mu_1 = \mu_2 = \mu_3$. H_1: At least one of the means differs from the others. C.V. = 4.26; d.f.N. = 2; d.f.D. = 9; $\alpha = 0.05$; $F = 14.15$; reject. There is sufficient evidence to conclude at least one mean is different from the others.

11. H_0: $\mu_1 = \mu_2 = \mu_3$. H_1: At least one mean is different from the others (claim); C.V. = 3.89; d.f.N. = 2; d.f.D. = 12; $\alpha = 0.05$; $F = 1.89$; do not reject. There is not enough evidence to support the claim that at least one mean is different from the others.

13. H_0: $\mu_1 = \mu_2 = \mu_3$. H_1: At least one mean is different from the others (claim). C.V. = 3.68; d.f.N. = 2; d.f.D. = 15; $\alpha = 0.05$; $F = 8.14$; reject. There is enough evidence to support the claim that at least one mean is different from the others.

15. H_0: $\mu_1 = \mu_2 = \mu_3$. H_1: At least one mean is different from the others (claim); C.V. = 2.64; d.f.N. = 2; d.f.D. = 17; $\alpha = 0.10$; $F = 14.90$; reject. There is enough evidence to support the claim that at least one mean is different from the others.

17. H_0: $\mu_1 = \mu_2 = \mu_3$. H_1: At least one mean is different from the others (claim). d.f.N. = 2; d.f.D. = 19; $\alpha = 0.10$; $F = 10.12$; P-value = 0.00102; reject. There is enough evidence to conclude that at least one mean is different from the others.

19. H_0: $\mu_1 = \mu_2 = \mu_3$. H_1: At least one mean is different from the others (claim). C.V. = 3.01; d.f.N. = 2; d.f.D. = 9; $\alpha = 0.10$; $F = 3.62$; reject. There is enough evidence to support the claim that at least one mean is different from the others.

Exercises 12–2

1. The Scheffé and Tukey tests are used.

3. $F_{1\times 2} = 2.10$; $F_{2\times 3} = 17.64$; $F_{1\times 3} = 27.923$. Scheffé test: C.V. = 8.52. There is sufficient evidence to conclude a difference in mean cost to drive 25 miles between hybrid cars and hybrid trucks and between hybrid SUVs and hybrid trucks.

5. Tukey test: C.V. = 3.67; $\overline{X}_1 = 7.0$; $\overline{X}_2 = 8.12$; $\overline{X}_3 = 5.23$; $\overline{X}_1$ versus $\overline{X}_2$, $q = -2.20$; $\overline{X}_1$ versus $\overline{X}_3$, $q = 3.47$; $\overline{X}_2$ versus $\overline{X}_3$, $q = 5.67$. There is a significant difference between $\overline{X}_2$ and $\overline{X}_3$. One reason for the difference might be that the students are enrolled in cyber schools with different fees.

7. Scheffé test: C.V. = 8.20; $\overline{X}_1$ versus $\overline{X}_2$, $F_3 = 0.94$; $\overline{X}_1$ versus $\overline{X}_3$, $F = 15.56$; $\overline{X}_2$ versus $\overline{X}_3$, $F = 26.27$. There is a significant difference between $\overline{X}_1$ and $\overline{X}_3$ and between $\overline{X}_2$ and $\overline{X}_3$.

9. H_0: $\mu_1 = \mu_2 = \mu_3$. H_1: At least one mean is different from the others (claim). C.V. = 3.68; d.f.N. = 2; d.f.D. = 15; $F = 3.76$; reject. There is enough evidence to support the claim that at least one mean differs from the others. Tukey test: C.V. = 3.67; $\overline{X}_1 = 32.33$; $\overline{X}_2 = 27.83$; $\overline{X}_3 = 22.5$; $\overline{X}_1$ versus $\overline{X}_2$, $q = 1.77$; $\overline{X}_2$ versus $\overline{X}_3$, $q = 2.10$; $\overline{X}_1$ versus $\overline{X}_3$, $q = 3.87$. There is a significant difference between $\overline{X}_1$ and $\overline{X}_3$.

11. H_0: $\mu_1 = \mu_2 = \mu_3$. H_1: At least one mean is different from the others (claim). C.V. = 3.47; $\alpha = 0.05$; d.f.N. = 2; d.f.D. = 21; $F = 1.99$; do not reject. There is not enough evidence to support the claim that at least one mean is different from the others.

13. H_0: $\mu_1 = \mu_2 = \mu_3$. H_1: At least one mean differs from the others (claim). C.V. = 3.68; d.f.N. = 2; d.f.D. = 15; $F = 17.17$; reject. There is enough evidence to support the claim that at least one mean differs from the others. Tukey test: C.V. = 3.67; $\overline{X}_1$ versus $\overline{X}_2$, $q = -8.17$; $\overline{X}_1$ versus $\overline{X}_3$, $q = -2.91$; $\overline{X}_2$ versus $\overline{X}_3$, $q = 5.27$. There is a significant difference between $\overline{X}_1$ and $\overline{X}_2$ and between $\overline{X}_2$ and $\overline{X}_3$.

Exercises 12–3

1. The two-way ANOVA allows the researcher to test the effects of two independent variables and a possible interaction effect. The one-way ANOVA can test the effects of only one independent variable.

3. The mean square values are computed by dividing the sum of squares by the corresponding degrees of freedom.

5. *a.* For factor A, d.f.$_A = 2$ *c.* d.f.$_{A\times B} = 2$
b. For factor B, d.f.$_B = 1$ *d.* d.f.$_{\text{within}} = 24$

7. The two types of interactions that can occur are ordinal and disordinal.

9. *Interaction:* H_0: There is no interaction between the amount of glycerin additive and the soap concentration. H_1: There is an interaction between the amount of glycerin additives.

Glycerin additives: H_0: There is no difference in the means of the glycerin additives. H_1: There is a difference in the means of the glycerin additives.

Soap concentrations: H_0: There is no difference in the means of the soap concentrations. H_1: There is a difference in the means of the soap concentrations.

ANOVA Summary Table

Source of variation	SS	d.f.	MS	*F*
Soap additive	100.00	1	100.00	5.39
Glycerin concentration	182.25	1	182.25	9.83
Interaction	272.25	1	272.25	14.68
Within	222.5	12	18.54	
Total	777.0	15		

The critical value at $\alpha = 0.05$ with d.f.N. = 1 and d.f.D. = 12 is 4.75. There is a significant difference at $\alpha = 0.05$ for the interaction and a significant difference for the soap additive and the glycerin concentration. However, since the interaction is significant, the main effects should not be examined individually.

11. *Interaction:* H_0: There is no interaction effect between the temperature and the level of humidity. H_1: There is an interactive effect between the temperature and the level of humidity. *Humidity:* H_0: There is no difference in mean length of effectiveness with respect to humidity. H_1: There is a difference in mean length of effectiveness with respect to humidity. *Temperature:* H_0: There is no difference in the mean length of effectiveness based on temperature. H_1: There is a difference in mean length of effectiveness based on temperature.

C.V. = 5.32; d.f.N. = 1; d.f.D. = 8; $F = 18.38$ for humidity. There is sufficient evidence to conclude a difference in mean length of effectiveness based on the humidity level. The temperature and interaction effects are not significant.

ANOVA Summary Table for Exercise 11

Source of variation	SS	d.f.	MS	*F*	*P*-value
Humidity	280.3333	1	280.3333	18.383	0.003
Temperature	3	1	3	0.197	0.669
Interaction	65.33333	1	65.33333	4.284	0.0722
Within	122	8	15.25		
Total	470.6667	11			

13. *Interaction:* H_0: There is no interaction effect on the durability rating between the dry additives and the solution-based additives. H_1: There is an interaction effect on the durability rating between the dry additives and the solution-based additives. *Solution-based additive:* H_0: There is no difference in the mean durability rating with respect to the solution-based additives. H_1: There is a difference in the mean durability rating with respect to the solution-based additives. *Dry additive:* H_0: There is no difference in the mean durability rating with respect to the dry additive. H_1: There is a difference in the mean durability rating with respect to the dry additive. C.V. = 4.75; d.f.N. = 1; d.f.D. = 12. There is not a significant interaction effect. Neither the solution additive nor the dry additive has a significant effect on mean durability.

ANOVA Summary Table for Exercise 13

Source	SS	d.f.	MS	*F*	*P*-value
Solution additive	1.563	1	1.563	0.50	0.494
Dry additive	0.063	1	0.063	0.020	0.890
Interaction	1.563	1	1.563	0.50	0.494
Within	37.750	12	3.146		
Total	40.939	15			

15. H_0: There is no interaction effect between the ages of the salespeople and the products they sell on the monthly sales. H_1: There is an interaction effect between the ages of the salespeople and the products they sell on the monthly sales.

H_0: There is no difference in the means of the monthly sales of the two age groups. H_1: There is a difference in the means of the monthly sales of the two age groups.

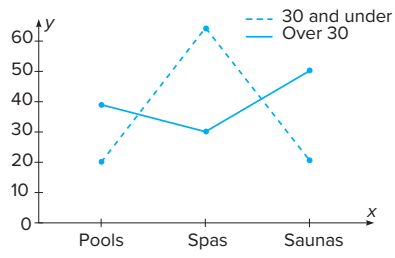
H_0: There is no difference among the means of the sales for the different products. H_1: There is a difference among the means of the sales for the different products.

ANOVA Summary Table

Source	SS	d.f.	MS	*F*
Age	168.033	1	168.033	1.57
Product	1,762.067	2	881.034	8.22
Interaction	7,955.267	2	3,977.634	37.09
Within	2,574.000	24	107.250	
Total	12,459.367	29		

At $\alpha = 0.05$, the critical values are as follows: for age, d.f.N. = 1, d.f.D. = 24, C.V. = 4.26; for product and interaction, d.f.N. = 2, d.f.D. = 24, C.V. = 3.40. There is a significant interaction between the age of the salesperson and the type of product sold, so no main effects should be interpreted without further study.

Age \ Product	Pools	Spas	Saunas
Over 30	38.8	28.6	55.4
30 and under	21.2	68.6	18.8



Since the lines cross, there is a disordinal interaction; hence, there is an interaction effect between the ages of salespeople and the type of products sold.

Review Exercises

1. H_0: $\mu_1 = \mu_2 = \mu_3$ (claim). H_1: At least one mean is different from the others. C.V. = 5.39; d.f.N. = 2; d.f.D. = 33; $\alpha = 0.01$; $F = 6.94$; reject. Tukey test: C.V. = 4.45; $\overline{X}_1$ versus $\overline{X}_2$: $q = 0.34$; $\overline{X}_1$ versus $\overline{X}_3$: $q = 4.72$; $\overline{X}_2$ versus $\overline{X}_3$: $q = 4.38$. There is a significant difference between $\overline{X}_1$ and $\overline{X}_3$.

3. H_0: $\mu_1 = \mu_2 = \mu_3$. H_1: At least one mean is different from the others (claim). C.V. = 3.55; $\alpha = 0.05$; d.f.N. = 2; d.f.D. = 18; $F = 0.04$; do not reject. There is not enough evidence to support the claim that at least one mean is different from the others.

5. H_0: $\mu_1 = \mu_2 = \mu_3$. H_1: At least one mean is different from the others (claim). C.V. = 2.61; $\alpha = 0.10$; d.f.N. = 2; d.f.D. = 19; $F = 0.49$; do not reject. There is not enough evidence to support the claim that at least one mean is different from the others.

7. H_0: $\mu_1 = \mu_2 = \mu_3 = \mu_4$. H_1: At least one mean is different from the others (claim). C.V. = 3.59; $\alpha = 0.05$; d.f.N. = 3; d.f.D. = 11; $F = 0.18$; do not reject. There is not enough evidence to support the claim that at least one mean is different from the others.

9. *Interaction:* H_0: There is no interaction effect between type of formula delivery system and review organization. H_1: There is an interaction effect between type of formula delivery system and review organization. *Review:* H_0: There is no difference in mean scores based on who leads the review. H_1: There is a difference in mean scores based on who leads the review. *Formulas:* H_0: There is no difference in mean scores based on who provides the formulas. H_1: There is a difference in mean scores based on who provides the formulas.

C.V. = 4.49; d.f.N. = 1; d.f.D. = 16; $F = 5.244$ for review organization. There is sufficient evidence to conclude a difference in mean scores based on who leads the review. The formula and interaction effects are not significant.

ANOVA Summary Table for Exercise 9

Source of variation	SS	d.f.	MS	*F*	*P*-value
Sample	288.8	1	288.8	5.24	0.036
Columns	51.2	1	51.2	0.93	0.349
Interaction	5	1	5	0.09	0.767
Within	881.2	16	55.075		
Total	1226.2	19			

Chapter Quiz

1. False
2. False
3. False
4. True
5. *d*
6. *a*
7. *a*
8. *c*
9. ANOVA
10. Tukey

11. H_0: $\mu_1 = \mu_2 = \mu_3$. H_1: At least one mean is different from the others (claim). C.V. = 8.02; d.f.N. = 2; d.f.D. = 9; $F = 77.69$; reject. There is enough evidence to support the claim that at least one mean is different from the others. Tukey test: C.V. = 5.43; $\overline{X}_1 = 3.195$; $\overline{X}_2 = 3.633$; $\overline{X}_3 = 3.705$; $\overline{X}_1$ versus $\overline{X}_2$, $q = -13.99$; $\overline{X}_1$ versus $\overline{X}_3$, $q = -16.29$; $\overline{X}_2$ versus $\overline{X}_3$, $q = -2.30$. There is a significant difference between $\overline{X}_1$ and $\overline{X}_2$ and between $\overline{X}_1$ and $\overline{X}_3$.

12. H_0: $\mu_1 = \mu_2 = \mu_3 = \mu_4$. H_1: At least one mean is different from the others (claim). C.V. = 3.49; $\alpha = 0.05$; d.f.N. = 3; d.f.D. = 12; $F = 3.23$; do not reject. There is not enough evidence to support the claim that there is a difference in the means.

13. H_0: $\mu_1 = \mu_2 = \mu_3$. H_1: At least one mean is different from the others (claim). C.V. = 6.93; $\alpha = 0.01$; d.f.N. = 2; d.f.D. = 12; $F = 3.49$; do not reject. There is not enough evidence to support the claim that at least one mean is different from the others. Writers would want to target their material to the age group of the viewers.

14. H_0: $\mu_1 = \mu_2 = \mu_3$. H_1: At least one mean differs from the others (claim). C.V. = 4.26; d.f.N. = 2; d.f.D. = 9; $F = 10.03$; reject. There is enough evidence to conclude that at least one mean differs from the others. Tukey test: C.V. = 3.95; $\overline{X}_1$ versus $\overline{X}_2$, $q = -1.28$; $\overline{X}_1$ versus $\overline{X}_3$, $q = 4.74$; $\overline{X}_2$ versus $\overline{X}_3$, $q = 6.02$. There is a significant difference between $\overline{X}_1$ and $\overline{X}_3$ and between $\overline{X}$ and $\overline{X}_3$.

15. H_0: $\mu_1 = \mu_2 = \mu_3$. H_1: At least one mean differs from the others (claim). C.V. = 4.46; d.f.N. = 2; d.f.D. = 8; $F = 6.65$; reject. Scheffé test: C.V. = 8.92; $\overline{X}$ versus $\overline{X}_2$, $F_s = 9.32$; $\overline{X}_1$ versus $\overline{X}_3$, $F_s = 10.13$; $\overline{X}_2$ versus $\overline{X}_3$, $F_s = 0.13$. There is a significant difference between $\overline{X}_1$ and $\overline{X}_2$ and between $\overline{X}_1$ and $\overline{X}_3$.

16. H_0: $\mu_1 = \mu_2 = \mu_3 = \mu_4$. H_1: At least one mean is different from the others (claim). C.V. = 3.07; $\alpha = 0.05$; d.f.N. = 3; d.f.D. = 21; $F = 0.46$; do not reject. There is not enough evidence to support the claim that at least one mean is different from the others.

17. *a.* Two-way ANOVA

b. Diet and exercise program

c. 2

d. H_0: There is no interaction effect between the type of exercise program and the type of diet on a person's weight loss. H_1: There is an interaction effect between the type of exercise program and the type of diet on a person's weight loss.

H_0: There is no difference in the means of the weight losses of people in the exercise programs. H_1: There is a difference in the means of the weight losses of people in the exercise programs.

H_0: There is no difference in the means of the weight losses of people in the diet programs. H_1: There is a difference in the means of the weight losses of people in the diet programs.

e. Diet: $F = 21.0$, significant; exercise program: $F = 0.429$, not significant; interaction: $F = 0.429$, not significant.

f. Reject the null hypothesis for the diets.

Chapter 13

Exercises 13–1

1. *Nonparametric* means hypotheses other than those using population parameters can be tested; *distribution-free* means no assumptions about the population distributions have to be satisfied.

3. Nonparametric methods have the following advantages:

a. They can be used to test population parameters when the variable is not normally distributed.

b. They can be used when data are nominal or ordinal.

c. They can be used to test hypotheses other than those involving population parameters.

d. The computations are easier in some cases than the computations of the parametric counterparts.

e. They are easier to understand.

f. There are fewer assumptions that have to be met, and the assumptions are easier to verify.

5. Distribution-free means the samples can be selected from populations that are not normally distributed.

7.

Data	25	36	36	39	63	68	74
Rank	1	2.5	2.5	4	5	6	7

9.

Data	2.1	6.2	11.4	12.7	18.6	20.7	22.5
Rank	1	2	3	4	5	6	7

11.

Data	12	22	22	38	44	50	54	56	56	62	73	88
Rank	1	2.5	2.5	4	5	6	7	8.5	8.5	10	11	12

Exercises 13–2

1. The sign test uses only positive or negative signs.

3. The smaller number of positive or negative signs

5. H_0: median = 27 and H_1: median ≠ 27 (claim); test value = 5; C.V. = 3; do not reject. There is not enough evidence to support the claim that the median age is not 27 years.

7. H_0: median = \$35,642 and H_1: median > \$35,642 (claim); test value = 6; C.V. = 3; do not reject. There is not enough evidence to support the claim that the median is greater than \$35,642.

9. H_0: median = 25 and H_1: median > 25 (claim); C.V. = 1.65; $z = 1.56$; do not reject. There is not enough evidence to support the claim that more than 50% of the students favor the summer institute.

11. H_0: median number of faculty = 150 (claim) and H_1: median ≠ 150; C.V. = ±1.96; $z = -2.70$; reject. There is sufficient evidence at the 0.05 level of significance to reject the claim that the median number of faculty is 150.

13. H_0: median = 50 (claim) and H_1: median ≠ 50; $z = -2.53$; P-value = 0.0114; reject. There is enough evidence to reject the claim that 50% of the students are against extending the school year.

15. H_0: The number of sessions will not be reduced. H_1: The number of sessions will be reduced (claim). C.V. = 1; test value = 2; do not reject. There is not enough evidence to support the claim that the number of sessions was reduced.

17. H_0: The number of soft drinks will not change. H_1: The number of soft drinks will decrease (claim). C.V. = 1; test value = 3; do not reject. There is not enough evidence to support the claim that the number of soft drinks was reduced.

19. H_0: The number of viewers is the same as last year (claim) and H_1: The number of viewers is not the same as last year; C.V. = 0; test value = 2; do not reject. There is not enough evidence to reject the claim that the number of viewers is the same as last year.

21. $6 \leq \text{median} \leq 22$

23. $4.7 \leq \text{median} \leq 9.3$

25. $17 \leq \text{median} \leq 33$

Exercises 13–3

1. n_1 and n_2 are each greater than or equal to 10.

3. H_0: There is no difference in the speed skating times of the students at the two universities (claim) and H_1: There is a difference in the speed skating times of the students at the two universities; C.V. = ±1.96; $z = -0.26$; do not reject. There is not enough evidence to reject the claim that there is no difference in the times.

5. H_0: There is no difference in the number of credits transferred; H_1: There is a difference in the number of credits transferred (claim); C.V. = ±1.96; $z = -0.57$; do not reject. There is not enough evidence to support the claim that there is a difference in the number of credits transferred.

7. H_0: There is no difference between the stopping distances of the two types of automobiles (claim) and H_1: There is a difference between the stopping distances of the two types of automobiles; C.V. = ±1.65; $z = -2.72$; reject. There is enough evidence to reject the claim that there is no difference in the stopping distances of the automobiles. In this case, midsize cars have a smaller stopping distance.

9. H_0: There is no difference in the number of hunting accidents in the two geographic areas and H_1: There is a difference in the number of hunting accidents (claim); C.V. = ±1.96; $z = 2.58$ reject. There is enough evidence to support the claim that there is a difference in the number of accidents in the two areas. The number of accidents may be related to the number of hunters in the areas.

11. H_0: There is no difference in job satisfaction; H_1: There is a difference in job satisfaction (claim); C.V. = ±1.65; $z = 1.12$; reject. There is not enough evidence to support the claim that there is a difference in job satisfaction between the two groups.

Exercises 13–4

1. The t test for dependent samples

3. The sum of the minus ranks is 9. The sum of the plus ranks is 19. The test value is 9.

5. C.V. = 16; reject

7. C.V. = 60; do not reject

9. H_0: The human dose is equal to the animal dose and H_1: The human dose is more than the animal dose (claim); C.V. = 6; $w_s = 2$; reject. There is enough evidence to support the claim that the human dose costs more than the equivalent animal dose. One reason is that some people might not be inclined to pay a lot of money for their pets' medication.

11. H_0: The amount spent on lottery tickets does not change; H_1: The amount spent on lottery tickets is reduced (claim); C.V. = 6, $w_s = 5$; reject. There is enough evidence to support the claim that the workshop reduced the amount the participants spent on lottery tickets.

13. H_0: The prices of prescription drugs in the United States are equal to the prices in Canada and H_1: The drugs sold in Canada are cheaper (claim); C.V. = 11; $w_s = 3$; reject. There is enough evidence to support the claim that the drugs are less expensive in Canada.

Exercises 13–5

1. H_0: There is no difference in the results of the questionnaires among the three groups; H_1: There is a difference in the results of the questionnaires among the three groups (claim); C.V. = 5.991; H = 4.891; do not reject. There is not enough evidence to support the claim that there is a difference in the results of the questionnaire.

3. H_0: There is no difference in the scores on the questionnaire; H_1: There is a difference in the scores on the questionnaire (claim); C.V. = 4.605; H = 3.254; do not reject. There is not enough evidence to support the claim that there is a difference in the results of the questionnaire.

5. H_0: There is no difference in the sugar content of the three different types of candy bars and H_1: There is a difference in the sugar content of the three different types of candy bars (claim); C.V. = 5.991; H = 10.389; reject. There is enough evidence to support the claim that the sugar content of the three of candy bars is different.

7. H_0: There is no difference in spending between regions and H_1: There is a difference in spending between regions (claim); $H = 0.740$; C.V. = 5.991; do not reject. There is insufficient evidence to conclude a difference in spending.

9. H_0: There is no difference in the number of crimes in the five precincts and H_1: There is a difference in the number of crimes in the five precincts (claim); C.V. = 13.277; $H = 20.753$; reject. There is enough evidence to support the claim that there is a difference in the number of crimes in the five precincts.

11. H_0: There is no difference in speeds and H_1: There is a difference in speeds (claim); $H = 3.815$; C.V. = 5.991; do not reject. There is insufficient evidence to conclude a difference in speeds.

Exercises 13–6

1. 0.392 **3.** 0.783

5. $r_s = 0.964$; H_0: $\rho = 0$ and H_1: $\rho \neq 0$. C.V. = ±0.786; reject. There is a significant relationship between math achievement scores for 4th and 8th graders.

7. $r_s = 0.817$; H_0: $\rho = 0$ and H_1: $\rho \neq 0$; C.V. = ±0.700; reject. There is a significant relationship between the number of new releases and the gross receipts.

9. $r_s = 0.048$; H_0: $\rho = 0$ and H_1: $\rho \neq 0$; C.V. = ±0.738; do not reject. There is not enough evidence to say that a significant correlation exists between calories and the cholesterol amounts in fast-food sandwiches.

11. $r_s = 0.714$; H_0: $\rho = 0$ and H_1: $\rho \neq 0$; C.V. = 0.786; do not reject. There is not enough evidence to say that there is a relationship in the rankings of the textbook between the instructors and the students.

13. $r_s = -0.100$; H_0: $\rho = 0$ and H_1: $\rho \neq 0$; C.V. = ±0.900; do not reject. There is no significant relationship between the number of cyber school students and the cost per pupil. In this case, the cost per pupil is different in each district.

15. H_0: The number of cavities in a person occurs at random (claim) and H_1: The number of cavities in a person does not occur at random. There are 21 runs; the expected number of runs is between 10 and 22. There is not enough evidence to reject the hypothesis that the number of cavities in a person occurs at random.

17. H_0: The types of admissions occur at random (claim) and H_1: The types of admissions do not occur at random. There is not enough evidence to reject the hypothesis that the integers occur at random.

19. H_0: The ups and downs in the stock market occur at random (claim) and H_1: The ups and downs in the stock market do not occur at random. There are eight runs. Since the expected number of runs is between 5 and 15, do not reject. There is not enough evidence to reject the hypothesis that the ups and downs of the stock market occur at random.

21. H_0: The number of absences of employees occurs at random over a 30-day period (claim) and H_1: The number of absences of employees does not occur at random. There are only 6 runs, and this value does not fall within the 9-to-21 range. Hence, the null hypothesis is rejected; the absences do not occur at random.

23. H_0: The number of on-demand movie rentals occurs at random (claim) and H_1: The number of on-demand movie rentals does not occur at random. The number of runs is 10. Do not reject the null hypothesis since the number of runs is between 6 and 16. There is not enough evidence to reject the hypothesis that the number of rentals at random.

25. H_0: The gender of the patients at a medical center occurs at random (claim) and H_1: The gender of patients does not occur at random; C.V. = ±1.96; $z = -1.64$; do not reject. There is not enough evidence to reject the claim that the sequence is random.

27. H_0: The patients who were treated for an accident or illness occur at random (claim) and H_1: The patients who were treated for an accident or illness do not occur at random; C.V. = ±1.96; $z = 1.14$; do not reject. There is not enough evidence to reject the claim that the sequence occurs at random.

29. ±0.28 **31.** ±0.400 **33.** ±0.413

Review Exercises

1. H_0: median = \$9.00 (claim) and H_1: median < \$9.00; $z = -2.01$; C.V. = ±1.65; reject. There is enough evidence to reject the claim that the median price is \$9.00.

3. H_0: There is no difference in prices and H_1: There is a difference in prices (claim); test value = 1; C.V. = 0; do not reject. There is insufficient evidence to conclude a difference in prices. Comments: Examine what affects the result of this test.

5. H_0: There is no difference in the hours worked and H_1: There is a difference in the hours worked (claim); $z = -1.76$; C.V. = ±1.645; reject. There is sufficient evidence to conclude a difference in the hours worked. C.V. = ±1.96; do not reject.

7. H_0: There is no difference in the amount spent and H_1: There is a difference in the amount spent (claim); $w_s = 1$; C.V. = 2; reject. There is sufficient evidence of a difference in amount spent at the 0.05 level of significance.

9. H_0: There is no difference in beach temperatures and H_1: There is a difference in temperatures (claim); $H = 15.524$; C.V. = 7.815; reject. There is sufficient evidence to conclude a difference in beach temperatures. (Without the Southern Pacific: $H = 3.661$; C.V. = 5.991; do not reject.)

11. $r_s = 0.679$; H_0: $\rho = 0$ and H_1: $\rho \neq 0$; C.V. = ±0.786; do not reject. There is not a significant relationship between the number of pages and the number of references.

13. H_0: The grades of students who finish the exam occur at random (claim) and H_1: The grades do not occur at random. Since there are 8 runs and this value does not fall in the 9-to-21 interval, the null hypothesis is rejected. The grades do not occur at random.

Chapter Quiz

1. False **2.** False

3. True **4.** True

5. *a* **6.** *c*

7. *d* **8.** *b*

9. Nonparametric, distribution-free

10. Nominal, ordinal

11. Sign **12.** Sensitive

13. H_0: median = \$230,500; H_1: median ≠ \$230,500 (claim); C.V. = 2; test value = 3; do not reject. There is not enough evidence to say that the median is not \$230,500.

14. H_0: median = 1200 and H_1: median ≠ 1200 (claim); C.V. = 6, test value = 10; do not reject. Since 6 is less than the test value of 10, reject the null hypothesis. There is enough evidence to support the claim that the median is not 1200.

15. H_0: There will be no change in the weight of the turkeys after the special diet and H_1: The turkeys will weigh more after the special diet (claim). There is 1 plus sign; hence, the null hypothesis is rejected, since the critical value is zero. There is enough evidence to support the claim that the turkeys gained weight on the special diet.

16. H_0: There is no difference in the amounts of money received by the teams and H_1: There is a difference in the amounts of money each team received (claim); C.V. = ±1.96; $z = -0.79$; do not reject. There is not enough evidence to say that the amounts differ.

17. H_0: The distributions are the same and H_1: The distributions are different (claim); $z = -0.14$; C.V. = ±1.65; do not reject the null hypothesis. There is not enough evidence to support the claim that the distributions are different.

18. H_0: There is no difference in the GPA of the students before and after the workshop and H_1: There is a difference in the GPA of the students before and after the workshop (claim); test statistic = 0; C.V. = 2; reject the null hypothesis. There is enough evidence to support the claim that there is a difference in the GPAs of the students.

19. H_0: There is no difference in the amounts of sodium in the three sandwiches and H_1: There is a difference in the amounts of sodium in the sandwiches (claim); C.V. = 5.991; $H = 11.795$; reject. There is enough evidence to conclude that there is a difference in the amounts of sodium in the sandwiches.

20. H_0: There is no difference in the reaction times of the monkeys and H_1: There is a difference in the reaction times of the monkeys (claim); $H = 6.85$; $0.025 < P\text{-value} < 0.05$ (0.032); reject the null hypothesis. There is enough evidence to support the claim that there is a difference in the reaction times of the monkeys.

21. $r_s = 0.633$; H_0: $\rho = 0$ and H_1: $\rho \neq 0$; C.V. = ±0.600; reject. There is enough evidence to say that there is a significant relationship between the drug prices.

22. $r_s = 0.943$; H_0: $\rho = 0$ and H_1: $\rho \neq 0$; C.V. = ±0.829; reject. There is a significant relationship between the amount of money spent on Head Start and the number of students enrolled in the program.

23. H_0: The births of babies occur at random according to gender (claim) and H_1: The births according to gender do not occur at random. There are 10 runs, and since this is between 8 and 19, the null hypothesis is not rejected. There is not enough evidence to reject the null hypothesis that gender occurs at random.

24. H_0: There is no difference in the rpm of the motors before and after the reconditioning and H_1: There is a difference in the rpm of the motors before and after the reconditioning (claim); test statistic = 0; C.V. = 8; do not reject the null hypothesis. There is not enough evidence to support the claim that there is a difference in the rpm of the motors before and after reconditioning.

25. H_0: The numbers occur at random (claim) and H_1: The numbers do not occur at random. There are 16 runs, and since this is between 9 and 20, the null hypothesis is not rejected. There is not enough evidence to reject the null hypothesis that the numbers occur at random.

26. H_0: The showing of the type of movie (black and white or color) occurs at random (claim). H_1: The showing of the type of movie does not occur at random. C.V. $= \pm 1.96$; $z = -5.54$; reject. There is enough evidence to reject the claim that the showing of the type of movie occurs at random.

Chapter 14

Exercises 14–1

1. Random, systematic, stratified, cluster

3. A sample must be randomly selected.

5. Talking to people on the street, calling people on the phone, and asking your friends are three incorrect ways of obtaining a sample.

7. Random sampling has the advantage that each unit of the population has an equal chance of being selected. One disadvantage is that the units of the population must be numbered; if the population is large, this could be somewhat time-consuming.

9. An advantage of stratified sampling is that it ensures representation for the groups used in stratification; however, it is virtually impossible to stratify the population so that all groups are represented.

11, 13, 15, 17, 19. Answers will vary.

21. Sampling or selection bias occurs when some subjects are more likely to be included in a study than others.

23. Nonresponse bias occurs when subjects who do not respond to a survey question would answer the question differently than the subjects who responded to the survey question.

25. Response or interview bias occurs when the subject does not give his or her true opinion and gives an opinion that he or she feels is politically correct.

27. Volunteer bias occurs when people volunteer to participate in a study because they are interested in the study or survey.

Exercises 14–2

1. Flaw—biased; it's confusing.

3. Flaw—the question is too broad.

5. Flaw—confusing words. How many hours did you study for this exam?

7. Flaw—confusing words. If a plane were to crash on the border of New York and New Jersey, where should the victims be buried?

9. Flaw—The word *vaguely* is too general.

11. The word *family* could mean different things to the respondent, for example, in cases of separated families.

13. The word *regularly* is vague.

15. A person might not know of the situation four years ago.

17. This question assumes the subject feels texting while driving is bad. Not all people will agree with this.

19. Here the question limits the response to "repeated" tours. Subjects might not be in favor of any tour.

21. Answers will vary.

Exercises 14–3

1. Simulation involves setting up probability experiments that mimic the behavior of real-life events.

3. John Von Neumann and Stanislaw Ulam

5. The steps are as follows:

a. List all possible outcomes.

b. Determine the probability of each outcome.

c. Set up a correspondence between the outcomes and the random numbers.

d. Conduct the experiment by using random numbers.

e. Repeat the experiment and tally the outcomes.

f. Compute any statistics and state the conclusions.

7. When the repetitions increase, there is a higher probability that the simulation will yield more precise answers.

9. Use three-digit random numbers; numbers 001 through 681 mean that the mother is in the labor force.

11. Select 100 two-digit random numbers. Numbers 00 to 34 mean the household has at least one set with premium cable service. Numbers 35 to 99 mean the household does not have the service.

13. Let an odd number represent heads and an even number represent tails. Then each person selects a digit at random.

15, 17, 19, 21, 23, 25. Answers will vary.

Review Exercises

1, 3, 5, 7. Answers will vary.

9. Flaw—asking a biased question. Have you ever driven through a red light?

11. Flaw—asking a double-barreled question. Do you think all automobiles should have heavy-duty bumpers?

13. Use one-digit random numbers 1 through 4 for a strikeout, and 5 through 9 and 0 represent anything other than a strikeout.

15. The first person selects a two-digit random number. Any two-digit random number that has a 7, 8, 9, or 0 is ignored, and another random number is selected. Player 1 selects a one-digit random number; any random number that is not 1 through 6 is ignored, and another one is selected.

17, 19, 21. Answers will vary.

Chapter Quiz

1. True
2. True
3. False
4. True
5. *a*
6. *c*
7. *c*
8. Larger

9. Biased **10.** Cluster

11–14. Answers will vary.

15. Use two-digit random numbers: 01 through 45 means the player wins. Any other two-digit random number means the player loses.

16. Use two-digit random numbers: 01 through 05 means a cancellation. Any other two-digit random number means the person shows up.

17. The random numbers 01 through 10 represent the 10 cards in hearts. The random numbers 11 through 20 represent the 10 cards in diamonds. The random numbers 21 through 30 represent the 10 spades, and 31 through 40 represent the 10 clubs. Any number over 40 is ignored.

18. Use two-digit random numbers to represent the spots on the face of the dice. Ignore any two-digit random numbers with 7, 8, 9, or 0. For cards, use two-digit random numbers between 01 and 13.

19. Use two-digit random numbers. The first digit represents the first player, and the second digit represents the second player. If both numbers are odd or even, player 1 wins. If a digit is odd and the other digit is even, player 2 wins.

20–24. Answers will vary.

25. Here *regularly* is vague.

26. *Bad weather* means different things to different people.

27. What is meant by *readable*?

28. Smoking a lot means different things to different people.

29. Some respondents might not know much about herbal medicine.

30. Almost everybody would answer “No” to this question.