Answers and Key Steps to Odd-Numbered Problems

CHAPTER 1

Section 1.1

1. (a) Response regarding frequency of eating at fast-food restaurants. (b) Qualitative. (c) Responses for *all* adults in the U.S.
3. (a) Student/faculty ratio at colleges. (b) Quantitative. (c) Student/faculty ratio at *all* colleges in the nation.
5. (a) Nitrogen concentration (mg nitrogen/l water). (b) Quantitative. (c) Nitrogen concentration (mg nitrogen/l water) in the entire lake.
7. (a) Ratio. (b) Interval. (c) Nominal. (d) Ordinal. (e) Ratio. (f) Ratio.
9. (a) Nominal. (b) Ratio. (c) Interval. (d) Ordinal. (e) Ratio. (f) Interval.

Section 1.2

1. See text.
3. Select a starting place in the table and group the digits in groups of four. Scan the table by rows and include the first six groups with numbers between 0001 and 8615.
5. (a) Yes, when a die is rolled several times, the same number may appear more than once. Outcome on the 4th roll is 2. (b) No, for a fair die, the outcomes are random.
7. Use a random-number table to select four distinct numbers corresponding to people in your class.
   (a) Reasons may vary. For instance, the first four students may make a special effort to get to class on time. (b) Reasons may vary. For instance, four students who come in late might all be nursing students enrolled in an anatomy and physiology class that meets the hour before in a far-away building. They may be more motivated than other students to complete a degree requirement. (c) Reasons may vary. For instance, four students sitting in the back row might be less inclined to participate in class discussions. (d) Reasons may vary. For instance, the tallest students might all be male.
9. Since there are five possible outcomes for each question, read single digits from a random-number table. Select a starting place, and proceed until you have 10 digits from 1 to 5. Repetition is required. The correct answer for each question will be the letter choice corresponding to the digit chosen for that question.
11. (a) Simple random sample. (b) Cluster sample. (c) Convenience sample. (d) Systematic sample. (e) Stratified sample.

Section 1.3

1. (a) Observational study. (b) Experiment. (c) Experiment. (d) Observational study.
3. (a) Use random selection to pick 10 calves to inoculate; test all calves; no placebo. (b) Use random selection to pick 9 schools to visit; survey all schools; no placebo. (c) Use random selection to pick 40 volunteers for skin patch with drug; survey all volunteers; placebo used.

Chapter 1 Review

1. Depends on article.
3. In the random-number table use groups of two digits. Select the first six distinct groups of two digits that fall in the range from 01 to 42. Choices vary according to the starting place in the random-number table.
5. (a) Observational study. (b) Experiment.
7. Possible directions on survey questions: Give height in inches, give age as of last birthday, give GPA to one decimal place, and so forth. Think about the types of responses you wish to have on each question.
9. (a) Experiment, since a treatment is imposed on one colony. (b) The control group receives normal daylight/darkness conditions. The treatment group has light 24 hours per day. (c) The number of fireflies living at the end of 72 hours. (d) Ratio.

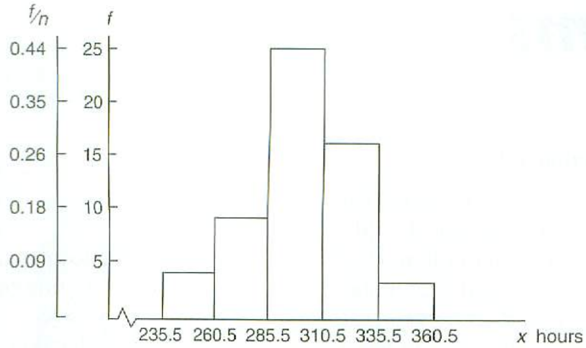
CHAPTER 2

Section 2.1

1. (a) Class width = 25.
   (b)

Class Limits	Boundaries	Midpoint	Frequency	Relative Frequency
236–260	235.5–260.5	248	4	0.07
261–285	260.5–285.5	273	9	0.16
286–310	285.5–310.5	298	25	0.44
311–335	310.5–335.5	323	16	0.28
336–360	335.5–360.5	348	3	0.05

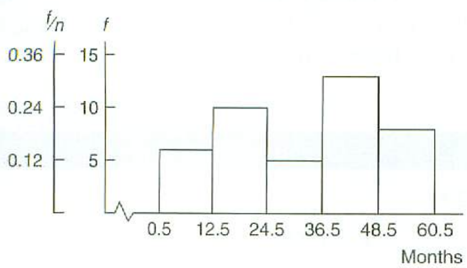
(c–d) Hours to Complete the Iditarod—Histogram, Relative-Frequency Histogram



3. (a) Class width = 12.
(b)

Class Limits	Boundaries	Midpoint	Frequency	Relative Frequency
1–12	0.5–12.5	6.5	6	0.14
13–24	12.5–24.5	18.5	10	0.24
25–36	24.5–36.5	30.5	5	0.12
37–48	36.5–48.5	42.5	13	0.31
49–60	48.5–60.5	54.5	8	0.19

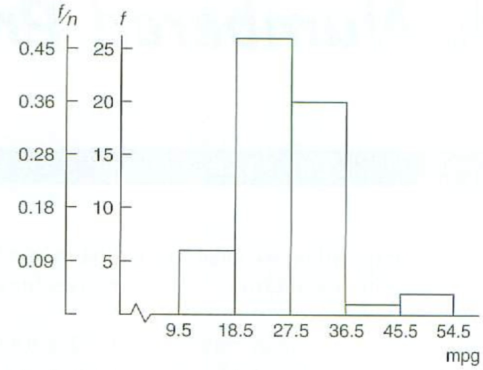
(c–d) Months *Before* Tumor Recurrence—Histogram, Relative-Frequency Histogram



5. (a) Class width = 9.
(b)

Class Limits	Boundaries	Midpoint	Frequency	Relative Frequency
10–18	9.5–18.5	14	6	0.11
19–27	18.5–27.5	23	26	0.47
28–36	27.5–36.5	32	20	0.36
37–45	36.5–45.5	41	1	0.02
46–54	45.5–54.5	50	2	0.04

(c–d) Fuel Consumption (mpg)—Histogram, Relative-Frequency Histogram

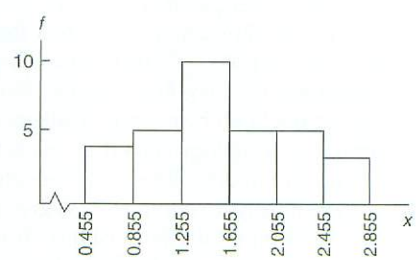


7. (a) Version 1 is skewed left; version 2 is uniform; version 3 is symmetrical; version 4 is bimodal; version 5 is skewed right. (b) Answers will vary.

9. (a) Clear the decimals.
(b, c) Class width = 0.40.

Class Limits	Boundaries	Midpoint	Frequency
0.46–0.85	0.455–0.855	0.655	4
0.86–1.25	0.855–1.255	1.055	5
1.26–1.65	1.255–1.655	1.455	10
1.66–2.05	1.655–2.055	1.855	5
2.06–2.45	2.055–2.455	2.255	5
2.46–2.85	2.455–2.855	2.655	3

(c) Tonnes of Wheat—Histogram

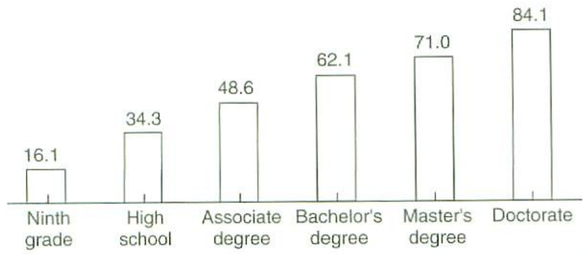


11. (a) One. (b) 5/51 or 9.8%. (c) Interval from 650 to 750.

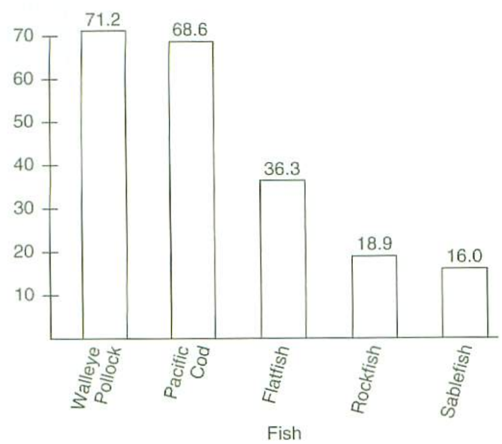
13. Dotplot for Months Before Tumor Recurrence

Section 2.2

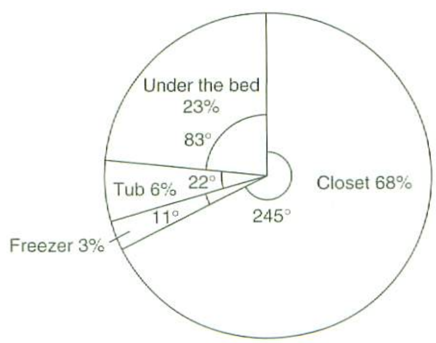
1. Highest Level of Education and Average Annual Household Income (in thousands of dollars)



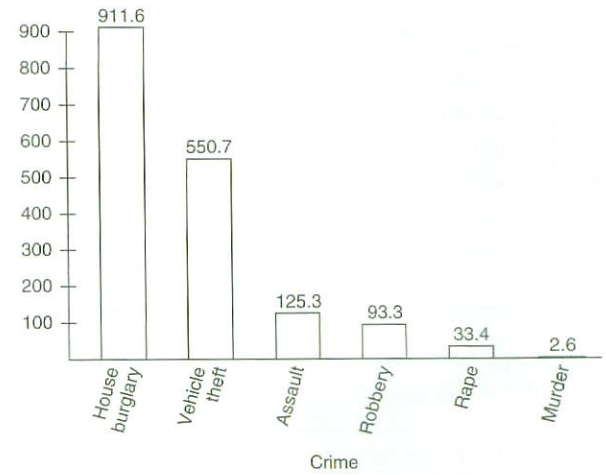
3. Annual Harvest (1000 Metric Tons)—Pareto Chart



5. Where We Hide the Mess

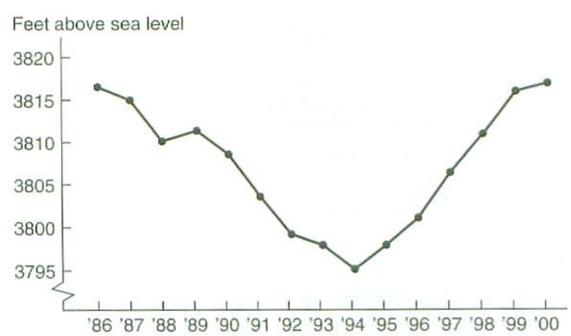


7. (a) Hawaii Crime Rate per 100,000 Population



(b) A circle graph is not appropriate because the data do not reflect all types of crime. Also, the same person may have been the victim of more than one crime.

9. Elevation of Pyramid Lake Surface—Time Plot



Section 2.3

1. (a) Longevity of Cowboys

4	7 = 47 years
4	7
5	2 7 8 8
6	1 6 6 8 8
7	0 2 2 3 3 5 6 7
8	4 4 4 5 6 6 7 9
9	0 1 1 2 3 7

(b) Yes, certainly these cowboys lived long lives.

3. Average Length of Hospital Stay

5 |	2 = 5.2 days
5	2 3 5 5 6 7
6	0 2 4 6 6 7 7 8 8 8 8 9 9
7	0 0 0 0 0 0 1 1 1 2 2 2 3 3 3 3 4 4 5 5 6 6 8
8	4 5 7
9	4 6 9
10	0 3
11	1

The distribution is skewed right.

5. (a) Minutes Beyond 2 Hours (1961–1980)

0 |	9 = 9 minutes past 2 hours
0	9 9
1	0 0 2 3 3 4
1	5 5 6 6 7 8 8 9
2	0 2 3 3

(b) Minutes Beyond 2 Hours (1981–2000)

0 |	7 = 7 minutes past 2 hours
0	7 7 7 8 8 8 8 9 9 9 9 9 9 9
1	0 0 1 1 4

(c) In more recent times, the winning times have been closer to 2 hours, with all the times between 7 and 14 minutes over two hours. In the earlier period, more than half the times were more than 2 hours and 14 minutes.

7. Milligrams of Tar per Cigarette

1 |	0 = 1.0 mg tar		
1	0	11	4
2		12	0 4 8
3		13	7
4	1 5	14	1 5 9
5		15	0 1 2 8
6		16	0 6
7	3 8	17	0
8	0 6 8		
9	0		
10		29	8

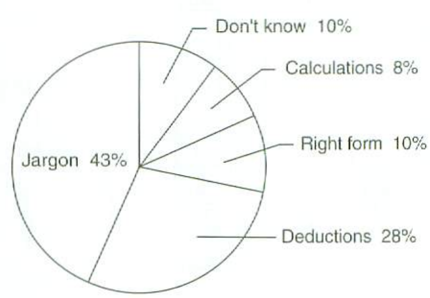
9. Milligrams of Nicotine per Cigarette

0 |	1 = 0.1 milligram
0	1 4 4
0	5 6 6 6 7 7 7 8 8 9 9 9
1	0 0 0 0 0 0 0 1 2
1	
2	0

Chapter 2 Review

1. (a) Yes, with lines used instead of bars. However, because of the perspective nature of the drawing, the lengths of the bars do not represent the mileages. The scale for each bar changes. (b) Yes. The scale does not change, and the viewer is not distracted by the graphic of the highway.

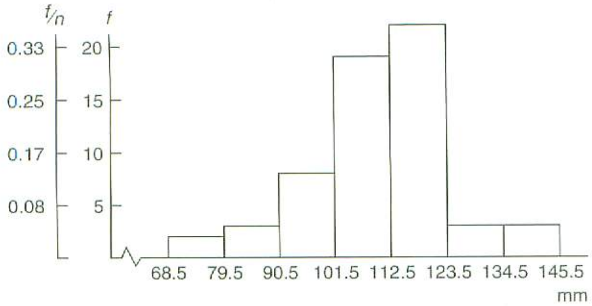
3. Problems with Tax Returns



5. (a) Class width = 11.

Class Limits	Boundaries	Midpoint	Frequency	Relative Frequency
69–79	68.5–79.5	74	2	0.03
80–90	79.5–90.5	85	3	0.05
91–101	90.5–101.5	96	8	0.13
102–112	101.5–112.5	107	19	0.32
113–123	112.5–123.5	118	22	0.37
124–134	123.5–134.5	129	3	0.05
135–145	134.5–145.5	140	3	0.05

(b–c) Trunk Circumference (mm)—Histogram, Relative-Frequency Histogram



7. (a) 1240s had 40 data. (b) 75. (c) From 1203 to 1212. Little if any repairs or new construction.

CHAPTER 3

Section 3.1

1. $\bar{x} \approx 167.3$ °F; median = 171 °F; mode = 178 °F.
3. (a) $\bar{x} \approx 3.27$; median = 3; mode = 3. (b) $\bar{x} \approx 4.21$; median = 2; mode = 1. (c) Lower Canyon mean is greater; median and mode are less. (d) Trimmed mean = 3.75 and is closer to Upper Canyon mean.
5. (a) $\bar{x}$ = \$136.15; median = \$66.50; mode = \$60. (b) 5% trimmed mean ≈ \$121.28; yes, but still higher than the median. (c) Median. The low and high prices would be useful.
7. (a) If the largest data value is *replaced* by a larger value, the mean will increase because the sum of the data values will increase, but the number of values will remain the same. The median will not change. The same value will still be in the eighth position when the data are ordered. (b) If the largest value is replaced by a value that is smaller (but still higher than the median), the mean will decrease because the sum of the data values will decrease. The median will not change. The same value will be in the eighth position in increasing order. (c) If the largest value is replaced by a value that is smaller than the median, the mean will decrease because the sum of the data values will decrease. The median also will decrease because the value formerly in the eighth position will move to the ninth position in increasing order. The median will be the new value in the eighth position.
9. $\Sigma wx = 85$; $\Sigma w = 10$; weighted average = 8.5.

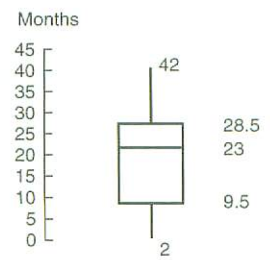
Section 3.2

1. (a) 15. (b) Use a calculator. (c) 37; 608. (d) 37; 6.08. (e) $\sigma^2 \approx 29.59$; $\sigma \approx 5.44$.
3. (a) 7.87. (b) Use a calculator. (c) $\bar{x} \approx 1.24$; $s^2 \approx 1.78$; $s \approx 1.33$. (d) CV ≈ 107%. The standard deviation of the time to failure is just slightly larger than the average time.
5. (a) Use a calculator. (b) $\bar{x} = 49$; $s^2 \approx 687.49$; $s \approx 26.22$. (c) $\bar{y} = 44.8$; $s^2 \approx 508.50$; $s \approx 22.55$. (d) Mallard nests, $CV \approx 53.5\%$; Canada goose nests, $CV \approx 50.3\%$. The CV gives the ratio of the standard deviation to the mean; the CV for mallard nests is slightly higher.
7. Since $CV = s/\bar{x}$, then $s = CV(\bar{x})$; $s = 0.033$.
9. Midpoints: 25.5, 35.5, 45.5; $\bar{x} \approx 35.80$; $s^2 \approx 61.1$; $s \approx 7.82$.
11. Midpoints: 10.55, 14.55, 18.55, 22.55, 26.55; $\bar{x} \approx 15.6$; $s^2 \approx 23.4$; $s \approx 4.8$.

Section 3.3

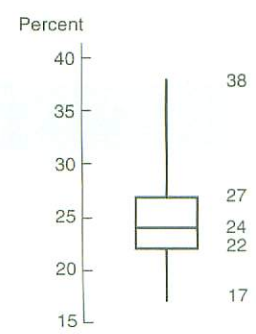
1. 82% or more of the scores were at or below Angela's score; 18% or fewer of the scores were above Angela's score.
3. No, the score 82 might have a percentile rank less than 70.
5. Low = 2; $Q_1 = 9.5$; median = 23; $Q_3 = 28.5$; high = 42; $IQR = 19$.

Nurses' Length of Employment (months)



7. (a) Low = 17; $Q_1 = 22$; median = 24; $Q_3 = 27$; high = 38; $IQR = 5$. (b) Third quartile, since it is between the median and Q_3.

Bachelor's Degree Percentage by State

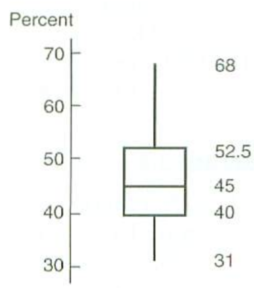


9. (a) California has the lowest premium. Pennsylvania has the highest. (b) Pennsylvania has the highest median premium. (c) California has the smallest range. Texas has the smallest interquartile range. (d) Part (a) is the five-number summary for Texas. It has the smallest IQR. Part (b) is the five-number summary for Pennsylvania. It has the largest minimum. Part (c) is the five-number summary for California. It has the lowest minimum.

Chapter 3 Review

1. (a) $\bar{x} = 109.5$; $s \approx 31.7$; $CV \approx 28.9\%$; range = 69.
   (b) $\bar{x} = 110.125$; $s \approx 7.2$; $CV \approx 6.5\%$; range = 20.
   (c) The first distribution is more spread than the second.
3. (a) Low = 31; $Q_1 = 40$; median = 45; $Q_3 = 52.5$; high = 68; $IQR = 12.5$.

Percentage of Democratic Vote by County



(b) Class width = 8.

Class	Midpoint	f
31–38	34.5	11
39–46	42.5	24
47–54	50.5	15
55–62	58.5	7
63–70	66.5	3

$\bar{x} \approx 46.1$; $s \approx 8.64$; 28.82 to 63.38.
(c) $\bar{x} = 46.15$; $s \approx 8.63$.
5. Mean weight = 156.25 lb.
7. (a) No. (b) \$23,478 to \$57,478. (c) \$7,775.
9. $\Sigma w = 16$, $\Sigma wx = 121$, average = 7.56.

CUMULATIVE REVIEW PROBLEMS CHAPTERS 1–3

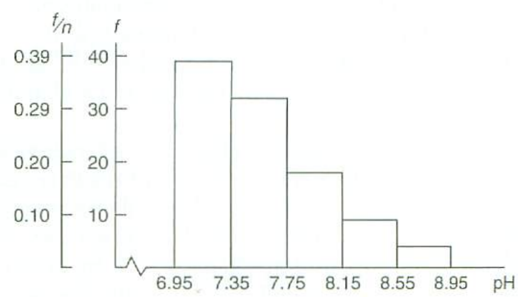
1. Assign consecutive numbers to all the wells in the study region. Then use a random number table, computer, or calculator to select 102 values that are less than or equal to the highest number assigned to a well in the study region. The sample consists of the wells with numbers corresponding to those selected.
2. Ratio.
3. 7 | 0 represents a pH level of 7.0

7	0000000001111111111
7	2222222222233333333333
7	444444444455555555
7	6666666666777777
7	8888899999
8	01111111
8	2222222
8	45
8	67
8	88

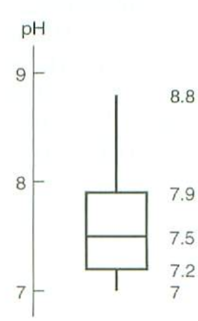
4. Clear the decimals. Then the highest value is 88 and the lowest is 70. The class width for the whole numbers is 4. For the actual data, the class width is 0.4.

Class Limits	Boundaries	Midpoint	Frequency	Relative Frequency
7.0–7.3	6.95–7.35	7.15	39	0.38
7.4–7.7	7.35–7.75	7.55	32	0.31
7.8–8.1	7.75–8.15	7.95	18	0.18
8.2–8.5	8.15–8.55	8.35	9	0.09
8.6–8.9	8.55–8.95	8.75	4	0.04

Levels of pH in West Texas Wells—Histogram, Relative-Frequency Histogram



5. Range = 1.8; $\bar{x} \approx 7.58$; median = 7.5; mode = 7.3.
6. (a) Use a calculator or computer.
   (b) $s^2 \approx 0.20$; $s \approx 0.45$; $CV \approx 5.9\%$.
7. 6.68 to 8.48.
8. Levels of pH in West Texas Wells



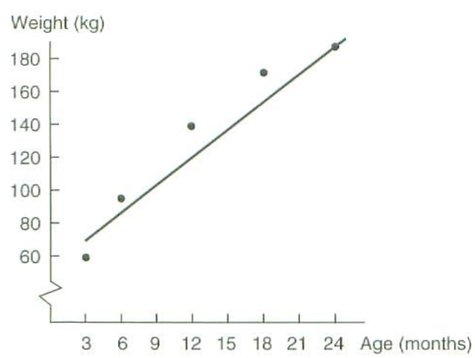
$IQR = 0.7$.

9. Skewed right. Lower values are more common.
10. No, there are no gaps in the plot, but only 6 out of 102, or about 6%, have pH levels at or above 8.4. Eight wells are neutral.
11. Half the wells have pH levels between 7.2 and 7.9. The data are skewed toward the high values, with the upper half of the pH levels spread out more than the lower half. The upper half ranges between 7.5 and 8.8, while the lower half is clustered between 7 and 7.5.
12. The report should emphasize the relatively low mean, median, and mode, and the fact that half the wells have a pH level less than 7.5. The data are clustered at the low end of the range.

CHAPTER 4

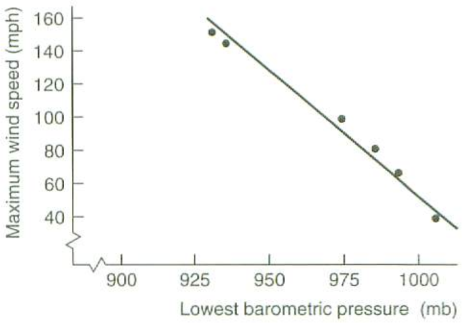
Section 4.1

1. (a) Moderate. (b) None. (c) High.
3. (a) No. (b) Increasing population might be a lurking variable causing both variables to increase.
5. (a) No. (b) One lurking variable responsible for average annual income increases is inflation. Better training might be a lurking variable responsible for shorter times to run the mile.
7. (a) Ages and Average Weights of Shetland Ponies



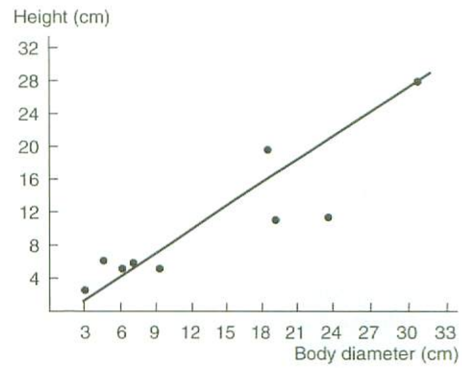
Line slopes upward.
(b) Strong; positive. (c) $r \approx 0.972$; increase.

9. (a) Lowest Barometric Pressure and Maximum Wind Speed for Tropical Cyclones



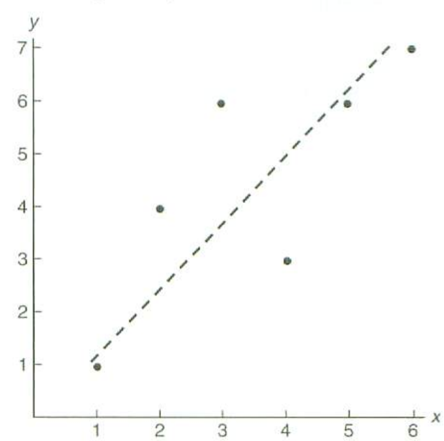
Line slopes downward.
(b) Strong; negative. (c) $r \approx -0.990$; decrease.

11. (a) Body Diameter and Height of Prehistoric Pottery

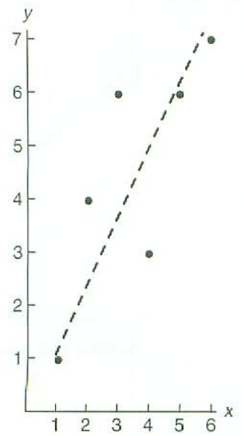


Line slopes upward.
(b) High; positive. (c) $r \approx 0.896$; increase.

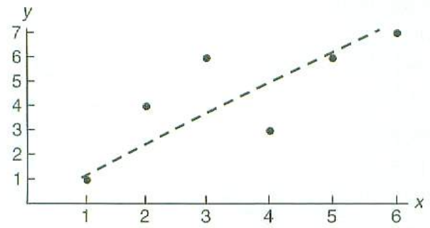
13. (a) Unit Length on y Same as That on x



(b) Unit Length on y Twice That on x



(c) Unit Length on y Half That on x

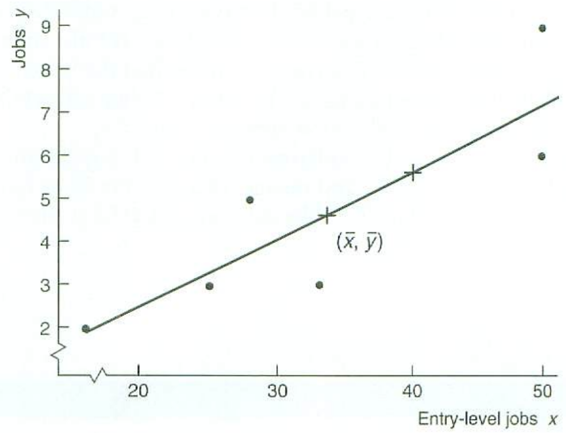


(d) The line in part b appears steeper than the line in part a, while the line in part c appears flatter than the line in part a. The slopes actually are all the same, but the lines look different because of the change in unit lengths on the y and x axes.

15. (a) $r \approx 0.972$ with $n = 5$ is significant for $\alpha = 0.05$. For this α, we conclude that age and weight of Shetland ponies are correlated. (b) $r \approx -0.990$ with $n = 6$ is significant for $\alpha = 0.01$. For this α, we conclude that lowest barometric pressure reading and maximum wind speed for cyclones are correlated.

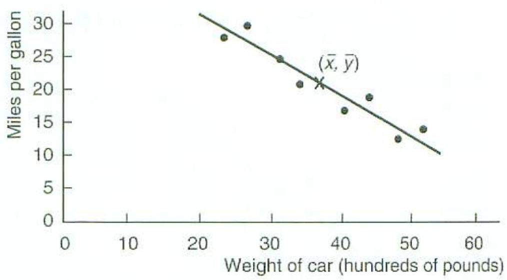
Section 4.2

1. (a) Total Number of Jobs and Number of Entry-Level Jobs



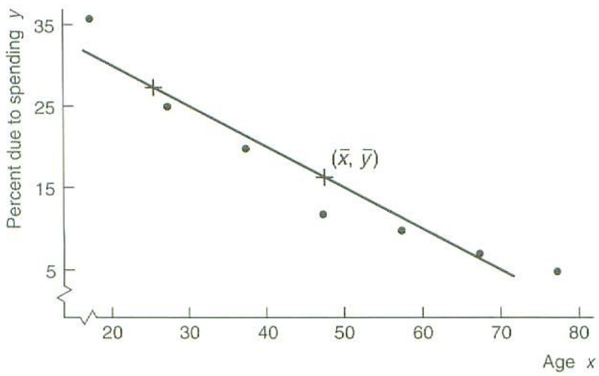
(b) Use a calculator. (c) $\bar{x} \approx 33.67$ jobs; $\bar{y} \approx 4.67$ entry-level jobs; $a \approx -0.748$; $b \approx 0.161$; $\hat{y} \approx -0.748 + 0.161x$. (d) See figure in part a. (e) $r^2 \approx 0.740$; 74.0% of variation explained and 26.0% unexplained. (f) 5.69 jobs.

3. (a) Weight of Cars and Gasoline Mileage



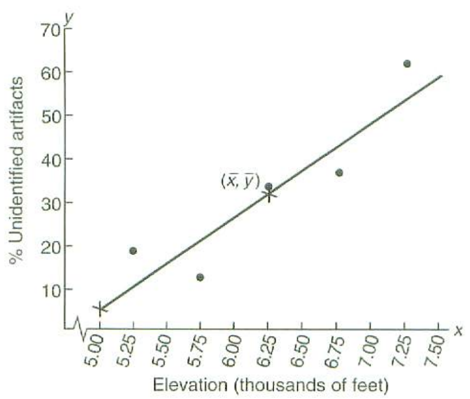
(b) Use a calculator. (c) $\bar{x} = 37.375$; $\bar{y} = 20.875$ mpg; $a \approx 43.326$; $b \approx -0.6007$; $\hat{y} \approx 43.326 - 0.6007x$. (d) See figure in part a. (e) $r^2 \approx 0.895$; 89.5% of variation explained and 10.5% unexplained. (f) 20.5 mpg.

5. (a) Age and Percentage of Fatal Accidents Due to Speeding



(b) Use a calculator. (c) $\bar{x} = 47$ years; $\bar{y} \approx 16.43\%$; $a \approx 39.761$; $b \approx -0.496$; $\hat{y} \approx 39.761 - 0.496x$.
(d) See figure of part a. (e) $r^2 \approx 0.920$; 92.0% of variation explained and 8.0% unexplained.
(f) 27.36%.

7. (a) Elevation of Archaeological Sites and Percentage of Unidentified Artifacts



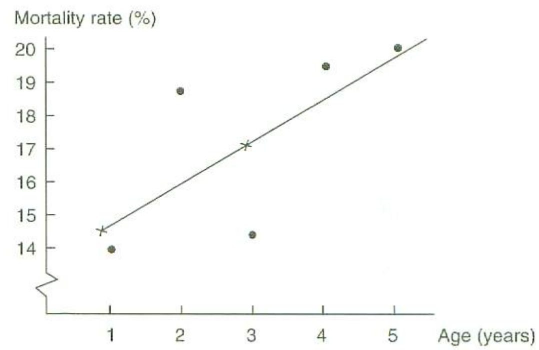
(b) Use a calculator. (c) $\bar{x} = 6.25$; $\bar{y} = 32.8$; $a = -104.7$; $b = 22$; $\hat{y} = -104.7 + 22x$. (d) See figure of part a. (e) $r^2 \approx 0.833$; 83.3% of variation explained, 16.7% unexplained. (f) 38.3.

9. (a) Yes. The pattern of residuals appears randomly scattered around the horizontal line at 0. (b) No. There do not appear to be any outliers.

11. (a) Result checks. (b) Result checks. (c) Yes. (d) The equation $x = 0.9337y - 0.1335$ does not match part b. (e) No. The least-squares equation changes depending on which variable is the explanatory variable and which is the response variable.

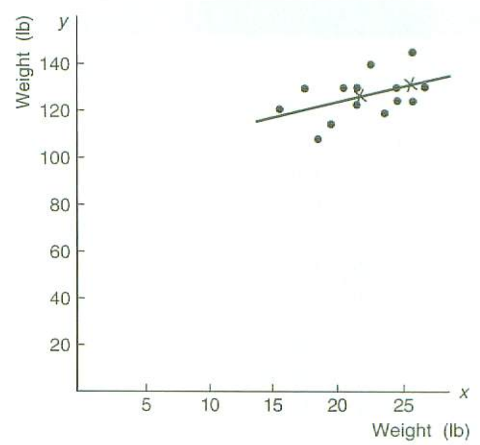
Chapter 4 Review

1. (a) Age and Mortality Rate for Bighorn Sheep



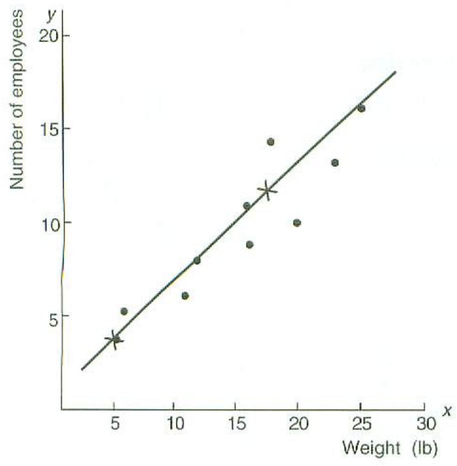
(b) $\bar{x} = 3$; $\bar{y} \approx 17.38$; $b \approx 1.27$; $\hat{y} \approx 13.57 + 1.27x$.
(c) $r \approx 0.685$; $r^2 \approx 0.469$; 46.9% explained.

3. (a) Weight of One-Year-Old versus Weight of Adult



(b) $\bar{x} \approx 21.43$; $\bar{y} \approx 126.79$; $b \approx 1.285$; $\hat{y} \approx 99.25 + 1.285x$. (c) $r \approx 0.468$; $r^2 \approx 0.219$; 21.9% explained.
(d) 124.95 lb. However, since r is low, this prediction may not be useful. Other lurking variables seem to have an effect on adult weight.

5. (a) Weight of Mail versus Number of Employees Required



(b) $\bar{x} \approx 16.38$; $\bar{y} \approx 10.13$; $b \approx 0.554$; $\hat{y} \approx 1.051 + 0.554x$. (c) $r \approx 0.913$; $r^2 \approx 0.833$; 83.3% explained. (d) 9.36.

CHAPTER 5

Section 5.1

1. See text.
3. b, since 4.1 is greater than 1; d, since −0.5 is less than 0; h, since 150% is greater than 100% or 1.
5. Answers vary. Probability as a relative frequency. One concern is whether the students in the class are more or less adept at wiggling their ears than people in the general population.
7. (a) $P(0) = 15/375$; $P(1) = 71/375$; $P(2) = 124/375$; $P(3) = 131/375$; $P(4) = 34/375$. (b) Yes, the listed numbers of similar preferences form the sample space.
9. (a) P(best idea 6 A.M.–12 noon) = 290/966 ≈ 0.30; P(best idea 12 noon–6 P.M.) = 135/966 ≈ 0.14; P(best idea 6 P.M.–12 midnight) = 319/966 ≈ 0.33; P(best idea 12 midnight–6 A.M.) = 222/966 ≈ 0.23. (b) The probabilities add up to 1. They should add up to 1 provided the intervals do not overlap and each inventor chose only one interval. The sample space is the set of four time intervals.
11. (a) P(enter if walks by) = 58/127 ≈ 0.46. (b) P(buy if entered) = 25/58 ≈ 0.43. (c) P(walk in and buy) = 25/127 ≈ 0.20. (d) P(not buy) = 1 − P(buy) ≈ 1 − 0.43 = 0.57.

Section 5.2

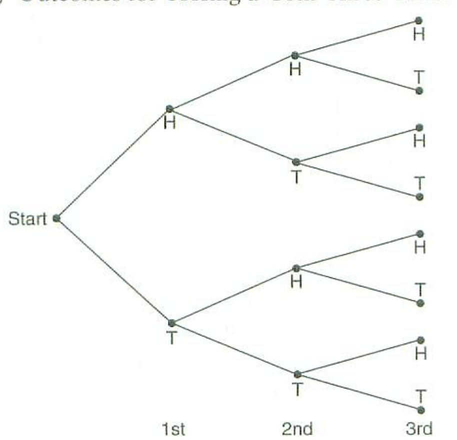
1. (a) 0.2; yes. (b) 0.4; yes. (c) 1.0 − 0.2 = 0.8.
3. (a) 0.332; yes. (b) 0.332; yes. (c) 1 (no purple).
5. (a) Yes. (b) P(5 on green *and* 3 on red) = $P(5) \cdot P(3)$ = (1/6)(1/6) = 1/36 ≈ 0.028. (c) P(3 on green *and* 5 on red) = $P(3) \cdot P(5)$ = (1/6)(1/6) = 1/36 ≈ 0.028. (d) P((5 on green *and* 3 on red) *or* (3 on green *and* 5 on red)) = (1/36) + (1/36) = 1/18 ≈ 0.056.
7. (a) P(sum of 6) = P(1 *and* 5) + P(2 *and* 4) + P(3 *and* 3) + P(4 *and* 2) + P(5 *and* 1) = (1/36) + (1/36) + (1/36) + (1/36) + (1/36) = 5/36. (b) P(sum of 4) = P(1 *and* 3) + P(2 *and* 2) + P(3 *and* 1) = (1/36) + (1/36) + (1/36) = 3/36 or 1/12. (c) P(sum of 6 *or* sum of 4) = P(sum of 6) + P(sum of 4) = (5/36) + (3/36) = 8/36 or 2/9; yes.
9. (a) No, after the first draw the sample space becomes smaller and probabilities for events on the second draw change. (b) P(ace on 1st *and* king on 2nd) = P(ace) · P(king, *given* ace) = (4/52)(4/51) = 4/663. (c) P(king on 1st *and* ace on 2nd) = P(king) · P(ace, *given* king) = (4/52)(4/51) = 4/663. (d) P(ace and king in either order) = P(ace on 1st *and* king on 2nd) + P(king on 1st *and* ace on 2nd) = (4/663) + (4/663) = 8/663.
11. (a) Yes, replacement of the card restores the sample space and all probabilities for the second draw remain unchanged, regardless of the outcome of the first card. (b) P(ace on 1st *and* king on 2nd) = P(ace) · P(king) = (4/52)(4/52) = 1/169. (c) P(king on 1st *and* ace on 2nd) = P(king) · P(ace) = (4/52)(4/52) = 1/169. (d) P(ace and king in either order) = P(ace on 1st *and* king on 2nd) + P(king on 1st *and* ace on 2nd) = (1/169) + (1/169) = 2/169.
13. (a) P(6 years old *or* older) = P(6–9) + P(10–12) + P(13 and over) = 0.27 + 0.14 + 0.22 = 0.63. (b) P(12 years old *or* younger) = P(2 and under) + P(3–5) + P(6–9) + P(10–12) = 0.15 + 0.22 + 0.27 + 0.14 = 0.78. (c) P(between 6 and 12) = P(6–9) + P(10–12) = 0.27 + 0.14 = 0.41. (d) P(between 3 and 9) = P(3–5) + P(6–9) = 0.22 + 0.27 = 0.49. The category 13 and over contains far more ages than the group 10–12. It is not surprising that more toys are purchased for this group, since there are more children in this group.
15. The information from James Burke can be viewed as conditional probabilities. P(report lie, *given* person is lying) = 0.72 and P(report lie, *given* person is not lying) = 0.07. (a) P(person is not lying) = 0.90; P(person is not

lying *and* polygraph reports lie) = P(person is not lying) × P(reports lie, *given* person not lying) = (0.90)(0.07) = 0.063 or 6.3%. (b) P(person is lying) = 0.10; P(person is lying *and* polygraph reports lie) = P(person is lying) × P(reports lie, *given* person is lying) = (0.10)(0.72) = 0.072 or 7.2%. (c) P(person is not lying) = 0.5; P(person is lying) = 0.5; P(person is not lying *and* polygraph reports lie) = P(person is not lying) × P(reports lie, *given* person not lying) = (0.50)(0.07) = 0.035 or 3.5%. P(person is lying *and* polygraph reports lie) = P(person is lying) × P(reports lie, *given* person is lying) = (0.50)(0.72) = 0.36 or 36%. (d) P(person is not lying) = 0.15; P(person is lying) = 0.85; P(person is not lying *and* polygraph reports lie) = P(person is not lying) × P(reports lie, *given* person is not lying) = (0.15)(0.07) = 0.0105 or 1.05%. P(person is lying *and* polygraph reports lie) = P(person is lying) × P(reports lie, *given* person is lying) = (0.85)(0.72) = 0.612 or 61.2%.

17. (a) 72/154. (b) 82/154. (c) 79/116. (d) 37/116. (e) 72/270. (f) 82/270.
19. (a) 932/1894. (b) 353/739. (c) 142/1894. (d) 22/224. (e) 1007/1894. (f) 39/66. (g) No; probabilities computed in parts (a) and (b) are not equal. (*Note*: More than once is two or more times.)

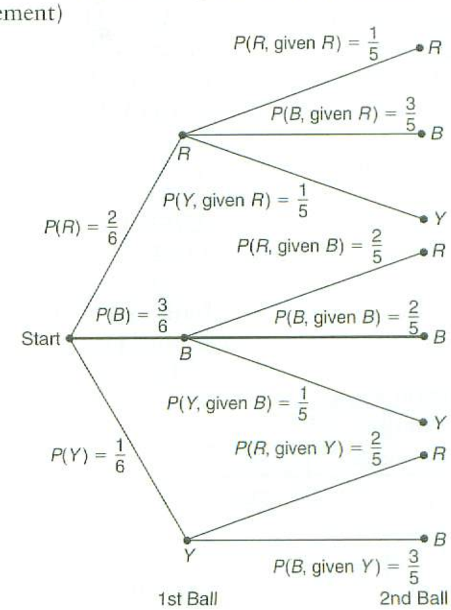
Section 5.3

1. (a) Outcomes for Tossing a Coin Three Times



(b) 3. (c) 3/8.

3. (a) Outcomes for Drawing Two Balls (without replacement)



(b) $P(R \text{ and } R) = 2/6 \cdot 1/5 = 1/15$.
$P(R \text{ 1st and } B \text{ 2nd}) = 2/6 \cdot 3/5 = 1/5$.
$P(R \text{ 1st and } Y \text{ 2nd}) = 2/6 \cdot 1/5 = 1/15$.
$P(B \text{ 1st and } R \text{ 2nd}) = 3/6 \cdot 2/5 = 1/5$.
$P(B \text{ 1st and } B \text{ 2nd}) = 3/6 \cdot 2/5 = 1/5$.
$P(B \text{ 1st and } Y \text{ 2nd}) = 3/6 \cdot 1/5 = 1/10$.
$P(Y \text{ 1st and } R \text{ 2nd}) = 1/6 \cdot 2/5 = 1/15$.
$P(Y \text{ 1st and } B \text{ 2nd}) = 1/6 \cdot 3/5 = 1/10$.

5. $4 \cdot 3 \cdot 2 \cdot 1 = 24$ ways.
7. $4 \cdot 3 \cdot 3 = 36$.
9. $P_{5,2} = (5!/3!) = 5 \cdot 4 = 20$.
11. $P_{7,7} = (7!/0!) = 7! = 5040$.
13. $C_{5,2} = (5!/(2!3!)) = 10$.
15. $C_{7,7} = (7!/(7!0!)) = 1$.
17. $P_{15,3} = 2730$.
19. $C_{15,5} = (15!/(5!10!)) = 3003$.
21. (a) $C_{12,6} = (12!/(6!6!)) = 924$.
(b) $C_{7,6} = (7!/(6!1!)) = 7$. (c) $7/924 \approx 0.008$.

Chapter 5 Review

1. $P(\text{asked}) = 24\%$; $P(\text{received, } \textit{given} \text{ asked}) = 45\%$; $P(\text{ask } \textit{and} \text{ receive}) = (0.24)(0.45) = 10.8\%$.
3. (a) If the first card is replaced, the outcomes are independent. Replacing the first card restores the original sample space. If the first card is not replaced, the outcomes are not independent, because removing the first card changes the sample space.
   (b) $P(\text{heart } \textit{and} \text{ heart}) = (13/52)(13/52) \approx 0.063$.
   (c) $P(\text{heart } \textit{and} \text{ heart}) = (13/52)(12/51) \approx 0.059$.
5. (a) Drop a fixed number of tacks and count how many land flat side down. Then form the ratio of the number landing flat side down to the total number dropped.
   (b) Up, down. (c) $P(\text{up}) = 160/500 = 0.32$; $P(\text{down}) = 340/500 = 0.68$.
7. (a) and (b)

Outcomes x	2	3	4	5	6
$P(x)$	0.028	0.056	0.083	0.111	0.139

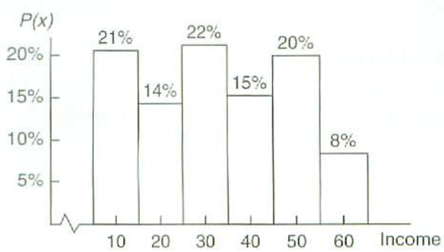
x	7	8	9	10	11	12
$P(x)$	0.167	0.139	0.111	0.083	0.056	0.028

9. $C_{8,2} = (8!/(2!6!)) = (8 \cdot 7/2) = 28$.
11. $3 \cdot 2 \cdot 1 \approx 6$.
13. $4 \cdot 4 \cdot 4 \cdot 4 \cdot 4 = 1024$ choices; $P(\text{all correct}) = 1/1024 \approx 0.00098$.

CHAPTER 6

Section 6.1

1. (a) Discrete. (b) Continuous. (c) Continuous. (d) Discrete. (e) Continuous.
3. (a) Yes. (b) No; probabilities total to more than 1.
5. (a) Yes, events are distinct and probabilities total to 1.
   (b) Income Distribution ($1000)



   (c) 32.3 thousand dollars. (d) 16.12 thousand dollars.
7. (a) 0.763; complement. (b) 0.368. (c) 0.016. (d) 1.25. (e) 0.97.
9. (a) 0.01191; $595.50. (b) $646; $698; $751.50; $806.50; $3497.50 total. (c) $4197.50. (d) $1502.50.

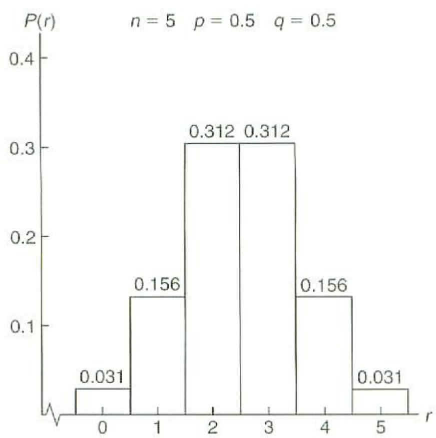
Section 6.2

1. A trial is one flip of a fair quarter. Success = coin shows heads. Failure = coin shows tails. $n = 3$; $p = 0.5$; $q = 0.5$. (a) $P(r = 3 \text{ heads}) = C_{3,3}p^3q^0 = 1(0.5)^3(0.5)^0 = 0.125$. To find this value in Table 2 of the Appendix, use the group in which $n = 3$, the column headed by $p = 0.5$, and the row headed by $r = 3$. (b) $P(r = 2 \text{ heads}) = C_{3,2}p^2q^1 = 3(0.5)^2(0.5)^1 = 0.375$. To find this value in Table 2 of the Appendix, use the group in which $n = 3$, the column headed by $p = 0.5$, and the row headed by $r = 2$. (c) $P(r \text{ is 2 or more}) = P(r = 2 \text{ heads}) + P(r = 3 \text{ heads}) = 0.375 + 0.125 = 0.500$.
   (d) The probability of getting three tails when you toss a coin three times is the same as getting zero heads. Therefore, $P(3 \text{ tails}) = P(r = 0 \text{ heads}) = C_{3,0}p^0q^3 = 1(0.5)^0(0.5)^3 = 0.125$. To find this value in Table 2 of the Appendix, use the group in which $n = 3$, the column headed by $p = 0.5$, and the row headed by $r = 0$.
3. (a) A trial is a man's response to the question, "Would you marry the same woman again?" Success = a positive response. Failure = a negative response. $n = 10$; $p = 0.80$; $q = 0.20$. Using values in Table 2 of the Appendix, $P(r \text{ is at least } 7) = P(r = 7) + P(r = 8) + P(r = 9) + P(r = 10) = 0.201 + 0.302 + 0.268 + 0.107 = 0.878$. $P(r \text{ is less than half of } 10) = P(r < 5) = P(r = 0) + P(r = 1) + P(r = 2) + P(r = 3) + P(r = 4) = 0.000 + 0.000 + 0.000 + 0.001 + 0.006 = 0.007$. (b) A trial is a woman's response to the question, "Would you marry the same man again?" Success = a positive response. Failure = a negative response. $n = 10$; $p = 0.5$; $q = 0.5$. Using values in Table 2 of the Appendix, $P(r \text{ is at least } 7) = P(r = 7) + P(r = 8) + P(r = 9) + P(r = 10) = 0.117 + 0.044 + 0.010 + 0.001 = 0.172$. $P(r \text{ is less than half of } 10) = P(r < 5) = P(r = 0) + P(r = 1) + P(r = 2) + P(r = 3) + P(r = 4) = 0.001 + 0.010 + 0.044 + 0.117 + 0.205 = 0.377$.
5. A trial consists of a woman's response regarding her mother-in-law. Success = dislike. Failure = like. $n = 6$; $p = 0.90$; $q = 0.10$. (a) $P(r = 6) = 0.531$. (b) $P(r = 0) = 0.000$ (to 3 digits). (c) $P(r \geq 4) = P(r = 4) + P(r = 5) + P(r = 6) = 0.098 + 0.354 + 0.531 = 0.983$. (d) $P(r \leq 3) = 1 - P(r \geq 4) \approx 1 - 0.983 = 0.017$ or 0.016 directly from table.
7. A trial is taking a polygraph exam. Success = pass. Failure = fail. $n = 9$; $p = 0.85$; $q = 0.15$. (a) $P(r = 9) = 0.232$. (b) $P(r \geq 5) = P(r = 5) + P(r = 6) + P(r = 7) + P(r = 8) + P(r = 9) = 0.028 + 0.107 + 0.260 + 0.368 + 0.232 = 0.995$. (c) $P(r \leq 4) = 1 - P(r \geq 5) \approx 1 - 0.995 = 0.005$ or 0.006 directly from table.
   (d) $P(r = 0) = 0.000$ (to 3 digits).

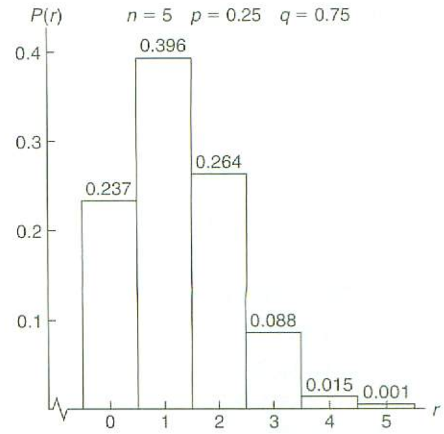
9. A trial is catching and releasing a pike. Success = pike dies. Failure = pike lives. $n = 16$; $p = 0.05$; $q = 0.95$. (a) $P(r = 0) = 0.440$. (b) $P(r < 3) = 0.957$. (c) $P(r = 0) = 0.440$ (all live is equivalent to none die). (d) Change success to live; $p = 0.95$; $P(r > 14) = 0.811$.
11. (a) A trial consists of using the Myers-Briggs instrument to determine if a person in marketing is an extrovert. Success = extrovert. Failure = not extrovert. $n = 15$; $p = 0.75$; $q = 0.25$. $P(r \geq 10) = 0.851$; $P(r \geq 5) = 0.999$; $P(r = 15) = 0.013$. (b) A trial consists of using the Myers-Briggs instrument to determine if a computer programmer is an introvert. Success = introvert. Failure = not introvert. $n = 5$; $p = 0.60$; $q = 0.40$. $P(r = 0) = 0.010$; $P(r \geq 3) = 0.683$; $P(r = 5) = 0.078$.
13. (a) $n = 10$; $p = 0.40$; $P(r = 0) = 0.006$. (b) $n = 10$; $p = 0.40$; $P(r < 5) = 0.633$. (c) $n = 10$; $p = 0.30$; $P(r \leq 2) = 0.382$. (d) $n = 10$; $p = 0.70$; $P(r \geq 6) = 0.849$.
15. $n = 8$; $p = 0.53$; $q = 0.47$. (a) 0.812515; yes, truncated at 5 digits. (b) 0.187486; 0.18749; yes, rounded to 5 digits.
17. (a) They are the same. (b) They are the same. (c) $r = 1$. (d) The one headed by $p = 0.80$.

Section 6.3

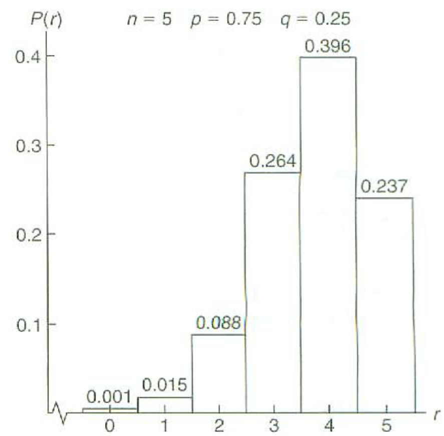
1. (a) Binomial Distribution
   The distribution is symmetrical.



(b) Binomial Distribution
The distribution is skewed right.

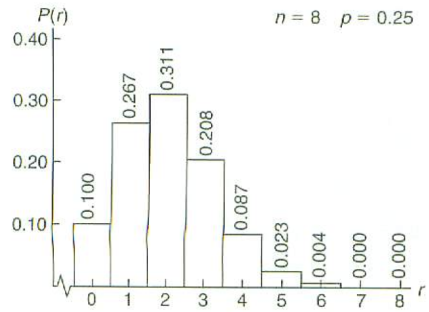


(c) Binomial Distribution
The distribution is skewed left.



(d) The distributions are mirror images of one another.
(e) The distribution would be skewed left for $p = 0.73$ because the more likely numbers of successes are to the right of the middle.

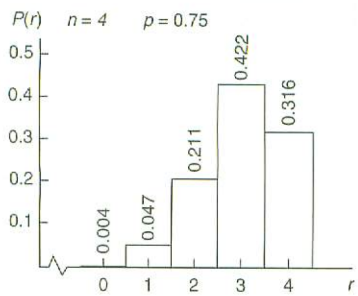
3. (a) Binomial Distribution for Number of Gullible Consumers



(b) $\mu = 2$; $\sigma \approx 1.225$.

5. (a) $P(r = 0) = 0.004$; $P(r = 1) = 0.047$; $P(r = 2) = 0.211$; $P(r = 3) = 0.422$; $P(r = 4) = 0.316$.

(b) Binomial Distribution for Number of Parolees Who Do Not Become Repeat Offenders



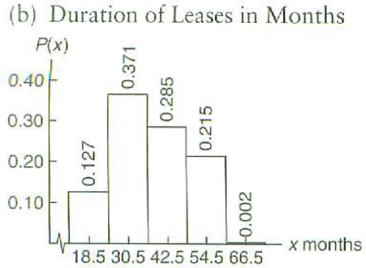
(c) $\mu = 3$; $\sigma \approx 0.866$.

7. $n = 12$; $p = 0.25$ do not serve; $p = 0.75$ serve.
(a) $P(r = 12 \text{ serve}) = 0.032$. (b) $P(r \geq 6 \text{ do not serve}) = 0.053$. (c) For serving, $\mu = 9$; $\sigma = 1.50$.

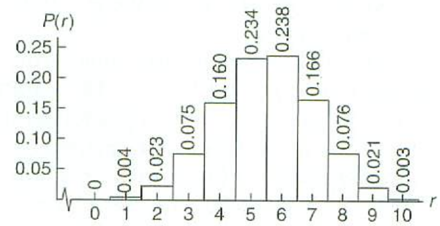
9. (a) $P(r = 7 \text{ guilty in U.S.}) = 0.028$; $P(r = 7 \text{ guilty in Japan}) = 0.698$. (b) For guilty in Japan, $\mu = 6.65$, $\sigma \approx 0.58$; for guilty in U.S., $\mu = 4.2$; $\sigma \approx 1.30$.

Chapter 6 Review

1. (a) 38; 11.6.
(b) Duration of Leases in Months



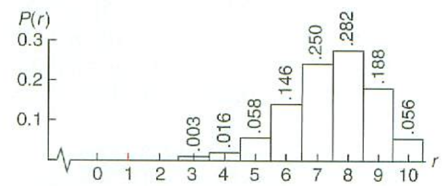
3. (a) Number of Claimants Under 25



(b) $P(r \geq 6) = 0.504$. (c) $\mu = 5.5$; $\sigma \approx 1.57$.

5. (a) 0.039. (b) 0.403. (c) 8.

7. (a) Number of Good Grapefruit



(b) 0.244, 0.999. (c) 7.5. (d) 1.37.

9. $P(r \leq 2) = 0.000$ (to 3 digits). The data seem to indicate that the percent favoring the increase in fees is less than 85%.

CUMULATIVE REVIEW PROBLEMS CHAPTERS 4–6

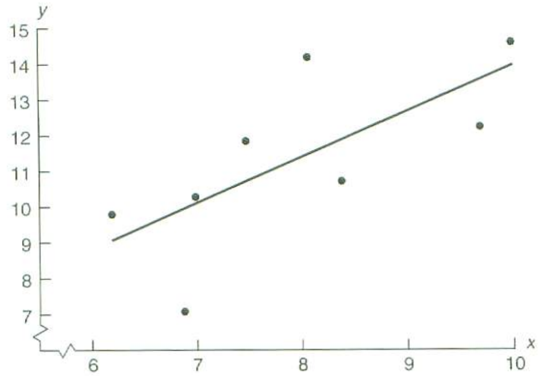
1. The specified ranges of readings are disjoint and cover all possible readings.
2. Essay.
3. Yes; the events constitute the entire sample space.
4. (a) 0.85. (b) 0.70. (c) 0.70. (d) 0.30. (e) 0.15. (f) 0.75. (g) 0.30. (h) 0.05.
5.

x	$P(x)$
5	0.25
15	0.45
25	0.15
35	0.10
45	0.05

$\mu \approx 17.5$; $\sigma \approx 10.9$.

6. (a) $p = 0.10$. (b) $\mu = 1.2$; $\sigma \approx 1.04$. (c) 0.718. (d) 0.889.

7. (a) Blood Glucose Level



(b) $\hat{y} \approx 1.135 + 1.279x$. (c) $r \approx 0.700$; $r^2 \approx 0.490$; 49% of the variance in y is explained by the model and the variance in x. (d) 12.65.

CHAPTER 7

Section 7.1

1. (a) No, the curve is skewed. (b) No, the curve crosses the horizontal axis. (c) No, the curve has three peaks. (d) No, the curve is not smooth.
3. Figure 7-9 has the larger standard deviation. The mean of Figure 7-9 is $\mu = 10$. The mean of Figure 7-10 is $\mu = 4$.
5. (a) 50%. (b) 68%. (c) 99.7%.
7. (a) 50%. (b) 50%. (c) 68%. (d) 95%.
9. (a) From 1207 to 1279. (b) From 1171 to 1315. (c) From 1135 to 1351.
11. (a) From 1.70 mA to 4.60 mA. (b) From 0.25 mA to 6.05 mA.

Section 7.2

1. (a) Robert, Juan, and Linda each scored above the mean. (b) Joel scored on the mean. (c) Susan and Jan scored below the mean. (d) Robert, 172; Juan, 184; Susan, 110; Joel, 150; Jan, 134; Linda, 182.
3. (a) $-4.00 < z < 4.00$. (b) $z < -1.6$. (c) $1.00 < z$. (d) $81.75°F < x$. (e) $x < 63.5°F$. (f) $64°F < x < 81.25°F$.
5. (a) $-1.77 < z$. (b) $z < 1.61$. (c) $-1.45 < z < 1.45$. (d) $3706 < x < 5907$. (e) $x < 5615$. (f) $6000 < x$. (g) A population of 2800 deer corresponds to a z value of -2.58. Data values this far below the mean occur less than 2.5% of the time. This would be an unusually low number. The population 6300 corresponds to a z value of 3.06. Fall deer populations are practically never so large. Such a population would be considered an unusually high population.
7. (a) $-1.00 < z$. (b) $z < -2.00$. (c) $-2.67 < z < 2.33$. (d) $x < 4.4$. (e) $5.2 < x$. (f) $4.1 < x < 4.5$. (g) A red blood cell count of 5.9 or higher corresponds to a standard z score of 3.67. Practically no data values occur this far above the mean. Such a count would be considered unusually high for a healthy female.
9. 0.5000. 11. 0.0934. 13. 0.6736. 15. 0.0643.
17. 0.8888. 19. 0.4993. 21. 0.4778. 23. 0.8953.
25. 0.3471. 27. 0.0306. 29. 0.5000. 31. 0.4483.
33. 0.8849. 35. 0.0885. 37. 0.8849. 39. 0.8808.
41. 0.3226. 43. 0.4474. 45. 0.2939. 47. 0.6704.

Section 7.3

1. $P(3 \le x \le 6) = P(-0.50 \le z \le 1.00) = 0.5328$.
3. $P(50 \le x \le 70) = P(0.67 \le z \le 2.00) = 0.2286$.
5. $P(8 \le x \le 12) = P(-2.19 \le z \le -0.94) = 0.1593$.
7. $P(x \ge 30) = P(z \ge 2.94) = 0.0016$.
9. $P(x \ge 90) = P(z \ge -0.67) = 0.7486$.
11. -1.555. 13. 0.13. 15. 1.41. 17. -0.92.
19. ± 2.33.
21. (a) $P(x > 60) = P(z > -1) = 0.8413$. (b) $P(x < 110) = P(z < 1) = 0.8413$. (c) $P(60 \le x \le 110) = P(-1.00 \le z \le 1.00) = 0.8413 - 0.1587 = 0.6826$. (d) $P(x > 140) = P(z > 2.20) = 0.0139$.
23. (a) $P(x > 675) = P(z > 1.75) = 0.0401$. (b) $P(x < 450) = P(z < -0.50) = 0.3085$. (c) $P(450 \le x \le 675) = P(-0.50 \le z \le 1.75) = 0.6514$. (d) $P(x > 28) = P(z > 1.67) = 0.0475$. (e) $P(x > 12) = P(z > -1.00) = 0.8413$. (f) $P(12 \le x \le 28) = P(-1.00 \le z \le 1.67) = 0.7938$.
25. (a) $P(x < 36 \text{ mo}) = P(z < -1.13) = 0.1292$. The company will replace 13% of its batteries. (b) $P(z < z_0) = 10\%$ for $z_0 = -1.28$; $x = -1.28(8) + 45 = 34.76$. Guarantee the batteries for 35 months.
27. (a) According to the empirical rule, about 95% of the data lies between $\mu - 2\sigma$ and $\mu + 2\sigma$. Since this interval is 4σ wide, we have $4\sigma \approx 6$ years, so $\sigma \approx 1.5$ years. (b) $P(x > 5) = P(z > -2.00) = 0.9772$. (c) $P(x < 10) = P(z < 1.33) = 0.9082$. (d) $P(z < z_0) = 0.10$ for $z_0 = -1.28$; $x = -1.28(1.5) + 8 = 6.08$ years. Guarantee the TVs for about 6.1 years.
29. (a) $P(z \ge z_0) = 0.99$ for $z_0 = -2.33$; $x = -2.33(3.7) + 90 \approx 81.38$ mo. Guarantee the microchips for 81 months. (b) $P(x \le 84) = P(z \le -1.62) = 0.0526$. (c) Expected loss = (50,000,000)(0.0526) = \$2,630,000. (d) Profit = \$370,000.

Section 7.4

1. A population is a set of measurements or counts either existing or conceptual. For example, the population of

ages of all people in Colorado; the population of weights of all students in your school; the population count of all antelope in Wyoming.

3. A population parameter is a numerical descriptive measure of a population, such as μ, the population mean; σ, the population standard deviation; or σ^2, the population variance.
5. A statistical inference is a conclusion about the value of a population parameter. We will do both estimation and testing.
7. They help us visualize the sampling distribution by using tables and graphs that approximately represent the sampling distribution.
9. We studied the sampling distribution of mean trout lengths based on samples of size 5. Other such sampling distributions abound.

Section 7.5

Note: Answers may differ slightly depending on the number of digits carried in the standard deviation.

1. (a) $\mu_{\bar{x}} = 15$; $\sigma_{\bar{x}} = 2.0$; $P(15 \le \bar{x} \le 17) = P(0 \le z \le 1.00) = 0.3413$. (b) $\mu_{\bar{x}} = 15$; $\sigma_{\bar{x}} = 1.75$; $P(15 \le \bar{x} \le 17) = P(0 \le z \le 1.14) = 0.3729$. (c) The standard deviation is smaller in part (b) because of the larger sample size. Therefore, the distribution about $\mu_{\bar{x}}$ is narrower in part (b).
3. (a) No; the sample size is only 9 and so is too small. (b) Yes; the $\bar{x}$ distribution also will be normal with $\mu_{\bar{x}} = 25$; $\sigma_{\bar{x}} = 3.5/3$; $P(23 \le \bar{x} \le 26) = P(-1.71 \le z \le 0.86) = 0.7615$.
5. (a) $P(x < 74.5) = P(z < -0.63) = 0.2643$. (b) $P(\bar{x} < 74.5) = P(z < -2.79) = 0.0026$. (c) No. If the weight of only one car were less than 74.5 tons, we could not conclude that the loader is out of adjustment. If the mean weight for a sample of 20 cars were less than 74.5 tons, we would suspect that the loader is malfunctioning. As we see in part (b), the probability of this happening is very low if the loader is correctly adjusted.
7. (a) $P(x < 40) = P(z < -1.80) = 0.0359$. (b) Since the x distribution is approximately normal, the $\bar{x}$ distribution is approximately normal with mean 85 and standard deviation 17.678. $P(\bar{x} < 40) = P(z < -2.55) = 0.0054$. (c) $P(\bar{x} < 40) = P(z < -3.12) = 0.0009$. (d) $P(\bar{x} < 40) = P(z < -4.02) < 0.0002$. (e) Yes; if the average value based on five tests were less than 40, the patient is almost certain to have excess insulin.
9. (a) $P(x < 54) = P(z < -1.27) = 0.1020$. (b) The expected number undernourished is 2200(0.1020), or about 224. (c) $P(\bar{x} \le 60) = P(z \le -2.99) = 0.0014$. (d) $P(\bar{x} < 64.2) = P(z < 1.20) = 0.8849$. Since the sample average is above the mean, it is quite unlikely that the doe population is undernourished.
11. (a) Since x itself represents a sample mean return based on a large (random) sample of stocks, x has a distribution that is approximately normal (central limit theorem). (b) $P(1\% \le \bar{x} \le 2\%) = P(-1.63 \le z \le 1.09) = 0.8105$. (c) $P(1\% \le \bar{x} \le 2\%) = P(-3.27 \le z \le 2.18) = 0.9849$. (d) Yes. The standard deviation decreases as the sample size increases. (e) $P(\bar{x} < 1\%) = P(z < -3.27) = 0.0005$. This is very unlikely if $\mu = 1.6\%$. One would suspect that μ has slipped below 1.6%.
13. (a) 30 or more. (b) No.

Section 7.6

Note: Answers may differ slightly depending on how many digits are carried in the computation of the standard deviation and z.

1. (a) $P(r \ge 50) = P(x \ge 49.5) = P(z \ge -27.53) \approx 1$ or almost certain. (b) $P(r \ge 50) = P(x \ge 49.5) = P(z \ge 7.78) \approx 0$ or almost impossible for a random sample.
3. (a) $P(r \ge 15) = P(x \ge 14.5) = P(z \ge -1.61) = 0.9463$. (b) $P(r \ge 28) = P(x \ge 27.5) = P(z \ge 1.49) = 0.0681$. (c) $P(15 \le r \le 28) = P(14.5 \le x \le 28.5) = P(-1.61 \le z \le 1.73) = 0.9045$. (d) $n = 125$; $p = 0.17$. Since both np and nq are larger than 5, the normal approximation is appropriate.
5. (a) $P(r \ge 15) = P(x \ge 14.5) = P(z \ge -2.35) = 0.9906$. (b) $P(r \ge 30) = P(x \ge 29.5) = P(z \ge 0.62) = 0.2676$. (c) $P(25 \le r \le 35) = P(24.5 \le x \le 35.5) = P(-0.37 \le z \le 1.81) = 0.6092$. (d) $P(r > 40) = P(r \ge 41) = P(x \ge 40.5) = P(z \ge 2.80) = 0.0026$.
7. (a) $P(r \ge 47) = P(x \ge 46.5) = P(z \ge -1.94) = 0.9738$. (b) $P(r \le 58) = P(x \le 58.5) = P(z \le 1.75) = 0.9599$. In parts c and d, let r be the number of products that succeed, and use $p = 1 - 0.80 = 0.20$. (c) $P(r \ge 15) = P(x \ge 14.5) = P(z \ge 0.40) = 0.3446$. (d) $P(r < 10) = P(r \le 9) = P(x \le 9.5) = P(z \le -1.14) = 0.1271$.
9. (a) $P(r > 280) = P(r \ge 281) = P(x > 280.5) = P(z \ge -2.16) = 0.9846$. (b) $P(r \ge 320) = P(x \ge 319.5) = P(z \ge 1.95) = 0.0256$. (c) $P(280 \le r \le 320) = P(279.5 \le x \le 320.5) = P(-2.26 \le z \le 2.05) = 0.9679$. (d) $n = 430$; $p = 0.70$; $q = 0.30$; np and nq are both greater than 5. These conditions mean that the normal approximation to the binomial is appropriate.
11. (a) $P(r \ge 540) = P(x \ge 539.5) = P(z \ge 3.81) \approx 0.000$. (b) $P(r \le 500) = P(x \le 500.5) = P(z \le 1.11) = 0.8665$. (c) $P(485 \le r \le 525) = P(484.5 \le x \le 525.5) = P(0 \le z \le 2.84) = 0.4977$.
13. (a) 0.94. (b) $P(r \le 255)$. (c) $P(r \le 255) = P(x \le 255.5) = P(z \le 1.16) = 0.8770$.

Chapter 7 Review

1. (a) 0.9821. (b) 0.3156. (c) 0.2977.
3. 1.645.
5. (a) 0.89. (b) 0. (c) 0.2514.
7. (a) 0.0166. (b) 0.975.
9. (a) 0.9772. (b) 17.3 hr.
11. (a) A normal distribution. (b) The mean μ of the x distribution. (c) $\sigma/\sqrt{n}$, where σ is the standard deviation of the x distribution. (d) They will both be approximately normal with the same mean, but the standard deviations will be $\sigma/\sqrt{50}$ and $\sigma/\sqrt{100}$, respectively.
13. $P(98 \le \bar{x} \le 102) = P(-1.33 \le z \le 1.33) = 0.8164$.

CHAPTER 8

Section 8.1

1. (a) 3.04 gm to 3.26 gm; 0.11 gm. (b) Distribution of weights is normal with known σ. (c) There is an 80% chance that the confidence interval is one of the intervals that contains the population average weight of Allen's hummingbirds in this region. (d) $n = 28$.
3. (a) 34.62 ml/kg to 40.38 ml/kg; 2.88 ml/kg. (b) The sample size is large (30 or more) and σ is known. (c) There is a 99% chance that the confidence interval is one of the intervals that contains the population average blood plasma level for male firefighters. (d) $n = 60$.
5. (a) 125.7 to 151.3 larceny cases; 12.8 larceny cases. (b) 123.3 to 153.7 larceny cases; 15.2 larceny cases. (c) 118.4 to 158.6 larceny cases; 20.1 larceny cases. (d) Yes. (e) Yes.
7. (a) \$53,871 to \$64,009; \$5069. (b) \$55,138 to \$62,742; \$3802. (c) \$56,175 to \$61,705; \$2765. (d) Yes. (e) Yes.
9. (a) The mean and standard deviation round to the values given. (b) Using the rounded values of part (a), the 75% interval is from 34.19 thousand to 37.81 thousand. (c) Yes. 30 thousand dollars is below the lower bound of the 75% confidence interval. We can say with 75% confidence that the mean lies between 34.19 thousand and 37.81 thousand. (d) Yes. 40 thousand is above the upper bound of the 75% confidence interval. (e) 33.41 thousand to 38.59 thousand. We can say with 90% confidence that the mean lies between 33.4 thousand and 38.6 thousand dollars. 30 thousand is below the lower bound and 40 thousand is above the upper bound.

Section 8.2

1. 2.110.
3. 1.721.
5. (a) The mean and standard deviation round to the values given. (b) Using the rounded values for the mean and standard deviation given in part (a), the interval is from 1249 to 1295.
7. (a) Use a calculator. (b) 74.7 lb to 107.3 lb.
9. (a) The mean and standard deviation round to the given values. (b) 8.41 to 11.49. (c) Since all values in the 99.9% confidence interval are above 6, we can be almost certain that this patient no longer has a calcium deficiency.
11. (a) Boxplots differ in length of interquartile box, location of median, and length of whiskers. The boxplots come from different samples. (b) Yes; yes; for 95% confidence intervals, we expect about 95% of the samples to generate intervals that contain the mean of the population.
13. (a) The mean and standard deviation round to the given values. (b) 21.6 to 28.8. (c) 19.4 to 31.0. (d) Using both confidence intervals, we can say that the P/E for Bank One is well below the population average. The P/E for AT&T Wireless is well above the population average. The P/E for Disney is within both confidence intervals. It appears that the P/E for Disney is close to the population average P/E. (e) By the central limit theorem, when n is large, the $\bar{x}$ distribution is approximately normal. In general, $n \ge 30$ is considered large.
15. (a) *d.f.* = 30; 43.59 to 46.82; 43.26 to 47.14; 42.58 to 47.81. (b) 43.63 to 46.77; 43.33 to 47.07; 42.74 to 47.66. (c) Yes; the respective intervals based on the Student's t distribution are slightly longer. (d) For Student's t, *d.f.* = 80; 44.22 to 46.18; 44.03 to 46.37; 43.65 to 46.75. For standard normal, 44.23 to 46.17; 44.05 to 46.35; 43.68 to 46.72. The intervals using the t distribution are still slightly longer than the corresponding intervals using the standard normal distribution. However, with a larger sample size, the differences between the two methods is less pronounced.

Section 8.3

1. (a) $\hat{p} = 39/62 = 0.6290$. (b) 0.51 to 0.75. If this experiment were repeated many times, about 95% of the intervals would contain p. (c) Both np and nq are greater than 5. If either is less than 5, the normal curve will not necessarily give a good approximation to the binomial.
3. (a) $\hat{p} = 1619/5222 = 0.3100$. (b) 0.29 to 0.33. If we repeat the survey with many different samples of 5222 dwellings, about 99% of the intervals will contain p. (c) Both np and nq are greater than 5. If either is less than 5, the normal curve will not necessarily give a good approximation to the binomial.

5. (a) $\hat{p} = 0.5420$. (b) 0.53 to 0.56. (c) Yes. Both np and nq are greater than 5.
7. (a) $\hat{p} = 0.0304$. (b) 0.02 to 0.05. (c) Yes. Both np and nq are greater than 5.
9. (a) $\hat{p} = 0.8603$. (b) 0.84 to 0.89. (c) A recent study showed that 86% of women shoppers remained loyal to their favorite supermarket last year. The margin of error was 2.5 percentage points.
11. (a) $\hat{p} = 0.25$. (b) 0.22 to 0.28. (c) A survey of 1000 large corporations has shown that 25% will choose a nonsmoking job candidate over an equally qualified smoker. The margin of error was 2.7%.
13. (a) 208. (b) 68.
15. (a) 666. (b) 662.

Chapter 8 Review

1. See text.
3. Interval for a mean; 176.91 to 180.49.
5. Interval for a mean.
   (a) Use a calculator. (b) 64.1 to 84.3.
7. Interval for a proportion; 0.50 to 0.54.
9. Interval for a proportion.
   (a) $\hat{p} = 0.4072$. (b) 0.333 to 0.482.

CHAPTER 9

Section 9.1

1. See text.
3. No, if we fail to reject the null hypothesis, we have not proven it beyond all doubt. We have only failed to find sufficient evidence to reject it.
5. (a) H_0: $\mu = 60$ kg. (b) H_1: $\mu < 60$ kg. (c) H_1: $\mu >$ 60 kg. (d) H_1: $\mu \neq 60$ kg. (e) For part b, the P-value area region is on the left. For part c, the P-value area is on the right. For part d, the P-value area is on both sides of the mean.
7. (a) H_0: $\mu = 16.4$ feet. (b) H_1: $\mu > 16.4$ feet. (c) H_1: $\mu < 16.4$ feet. (d) H_1: $\mu \neq 16.4$ feet. (e) For part b, the P-value area is on the right. For part c, the P-value area is on the left. For part d, the P-value area is on both sides of the mean.
9. (a) $\alpha = 0.01$; H_0: $\mu = 4.7\%$; H_1: $\mu > 4.7\%$; right-tailed. (b) Normal; $\bar{x} = 5.38$; $z \approx 0.90$. (c) P-value ≈ 0.1841; on standard normal curve, shade area to the right of 0.90. (d) P-value of $0.1841 > 0.01$ for α; fail to reject H_0. (e) Insufficient evidence at the 0.01 level to reject the claim that average yield for bank stocks equals average yield for all stocks.
11. (a) $\alpha = 0.01$; H_0: $\mu = 4.55$ gm; H_1: $\mu < 4.55$ gm; left-tailed. (b) Normal; $\bar{x} = 3.75$ gm; $z \approx -2.80$. (c) P-value ≈ 0.0026; on standard normal curve, shade area to the left of -2.80. (d) P-value of $0.0026 \leq 0.01$ for α; reject H_0. (e) The sample evidence is sufficient at the 0.01 level to justify rejecting H_0. It seems that the hummingbirds in the Grand Canyon region have a lower average weight.
13. (a) $\alpha = 0.01$; H_0: $\mu = 11\%$; H_1: $\mu \neq 11\%$; two-tailed. (b) Normal; $\bar{x} = 12.5\%$; $z = 1.20$. (c) P-value $= 2(0.1151) = 0.2302$; on standard normal curve, shade areas to the right of 1.20 and to the left of -1.20. (d) P-value of $0.2302 > 0.01$ for α; fail to reject H_0. (e) There is insufficient evidence at the 0.01 level to reject H_0. It seems that the average hail damage to wheat crops in Weld County matches the national average.

Section 9.2

1. (a) $\alpha = 0.01$; H_0: $\mu = 16.4$ ft; H_1: $\mu > 16.4$ ft. (b) Standard normal; $z \approx 1.54$. (c) P-value ≈ 0.0618; on standard normal curve shade area to the right of $z \approx 1.54$. (d) P-value of $0.0618 > 0.01$ for α; fail to reject H_0. (e) At the 1% level, there is insufficient evidence to say that the average storm level is increasing.
3. (a) $\alpha = 0.05$; H_0: $\mu = 41.7$; H_1: $\mu \neq 41.7$. (b) Standard normal; $z \approx -1.99$. (c) P-value $\approx 2(0.0233) \approx 0.0466$; on standard normal curve shade areas to the right of 1.99 and to the left of -1.99. (d) P-value of $0.0466 \leq 0.05$ for α; reject H_0. (e) At the 5% level, there is sufficient evidence to say that the average number of e-mails is different with the new priority system.
5. (a) $\alpha = 0.01$; H_0: $\mu = 1.75$ yr; H_1: $\mu > 1.75$ yr. (b) Student's t, $d.f. = 45$; $t \approx 2.481$. (c) $0.005 <$ P-value < 0.010; on t graph shade area to the right of 2.481. (d) Entire P-interval ≤ 0.01 for α; reject H_0. (e) At the 1% level of significance, the sample data indicate that the average age of the Minnesota region coyotes is higher than 1.75 years.
7. (a) $\alpha = 0.05$; H_0: $\mu = 19.4$; H_1: $\mu \neq 19.4$. (b) Student's t, $d.f. = 35$; $t \approx -1.731$. (c) $0.050 <$ P-value < 0.100; on t graph shade areas to the right of 1.731 and to the left of -1.731. (d) P-value interval > 0.05 for α; fail to reject H_0. (e) At the 5% level of significance, the sample evidence does not support rejecting the claim that the average P/E of socially responsible funds is different from that of the S&P stock index.
9. i. Use a calculator. Rounded values are used in part ii.
   ii. (a) $\alpha = 0.05$; H_0: $\mu = 4.8$; H_1: $\mu < 4.8$. (b) Student's t, $d.f. = 5$; $t \approx -3.499$. (c) $0.005 <$ P-value $<$ 0.010; on t graph shade area to the left of -3.499. (d) P-value interval ≤ 0.05 for α; reject H_0. (e) At the 5% level of significance, sample evidence supports the claim that the average RBC count for this patient is less than 4.8.

11. i. Use a calculator. Rounded values are used in part ii.
ii. (a) $\alpha = 0.01$; H_0: $\mu = 67$; H_1: $\mu \neq 67$. (b) Student's t, $d.f. = 15$; $t \approx -1.962$. (c) $0.050 < P\text{-value} < 0.100$; on t graph shade areas to the right of 1.962 and to the left of -1.962. (d) P-value interval > 0.01; fail to reject H_0. (e) At the 1% level of significance, the sample evidence does not support the claim that the average thickness of slab avalanches in Vail is different from that in Canada.

13. i. Use a calculator. Rounded values are used in part ii.
ii. (a) $\alpha = 0.05$; H_0: $\mu = 40$ beats per min; H_1: $\mu \neq 40$ beats per min. (b) Student's t, $d.f. = 5$; $t \approx -2.041$. (c) $0.050 < P\text{-value} < 0.100$; on t graph shade areas to the right of 2.041 and to the left of -2.041. (d) P-value interval > 0.05; fail to reject H_0. (e) At the 5% level of significance, the population average heart rate for the lion is not significantly different.

15. i. Use a calculator. Rounded values are used in part ii.
ii. (a) $\alpha = 0.05$; H_0: $\mu = 8.8$; H_1: $\mu \neq 8.8$. (b) Student's t, $d.f. = 13$; $t \approx -1.337$. (c) $0.200 < P\text{-value} < 0.250$; on t graph shade areas to the right of 1.337 and to the left of -1.337. (d) P-value interval > 0.05; fail to reject H_0. (e) At the 5% level of significance, we cannot conclude that the catch is different from 8.8 fish per day.

17. (a) The P-value of a one-tailed test is smaller. For a two-tailed test, the P-value is doubled because it includes the area in both tails. (b) Yes; the P-value of a one-tailed test is smaller, so it might be smaller than α, whereas the P-value of a two-tailed test is larger than α. (c) Yes; if the two-tailed P-value is less than α, the smaller one-tail area is also less than α. (d) Yes, the conclusions can be different. The conclusion based on the two-tailed test is more conservative in the sense that the sample data must be more extreme (differ more from H_0) in order to reject H_0.

19. (a) For $\alpha = 0.01$, confidence level $c = 0.99$; interval from 20.28 to 23.72; hypothesized $\mu = 20$ is not in the interval; reject H_0. (b) H_0: $\mu = 20$; H_1: $\mu \neq 20$; $z = 3.000$; $P\text{-value} \approx 0.0026$; P-value of $0.0026 \leq 0.01$ for α; reject H_0; conclusions are the same.

21. Critical value $z_0 = 2.33$; critical region is values to the right of 2.33; since the sample statistic $z = 1.54$ is not in the critical region, fail to reject H_0. At the 1% level, there is insufficient evidence to say that the average storm level is increasing. Conclusion is same as with P-value method.

23. Critical values $z_0 = \pm 1.96$; critical regions are values to the left of -1.96 together with values to the right of 1.96. Since the sample test statistic $z = -1.99$ is in the critical region, reject H_0. At the 5% level, there is sufficient evidence to say that the average number of e-mails is different with the new priority system. Conclusion is same as with P-value method.

25. Critical value is $t_0 = 2.412$ for one-tailed test with $d.f. = 45$; critical region is values to the right of 2.412. Since the sample test statistic $t = 2.481$ is in the critical region, reject H_0. At the 1% level, the sample data indicate that the average age of Minnesota region coyotes is higher than 1.75 yr. Conclusion is same as with P-value method.

Section 9.3

1. i. (a) $\alpha = 0.01$; H_0: $p = 0.301$; H_1: $p < 0.301$. (b) Standard normal; yes, $np \approx 64.7 > 5$ and $nq \approx 150.3 > 5$; $\hat{p} \approx 0.214$; $z \approx -2.78$. (c) $P\text{-value} \approx 0.0027$; on standard normal curve shade area to the left of -2.78. (d) P-value of $0.0027 \leq 0.01$ for α; reject H_0. (e) At the 1% level of significance, the sample data indicate that the population proportion of numbers with a leading "1" in the revenue file is less than the probability 0.301 predicted by Benford's Law.
ii. Yes; the revenue data file seems to include more numbers with higher first nonzero digits than Benford's Law predicts.
iii. We have not proved H_0 to be false. However, because our sample data led us to reject H_0 and to conclude that there are too few numbers with a leading digit of 1, more investigation is merited.

3. (a) $\alpha = 0.01$; H_0: $p = 0.70$; H_1: $p \neq 0.70$. (b) Standard normal; $\hat{p} = 0.75$; $z \approx 0.62$. (c) $P\text{-value} = 2(0.2676) = 0.5352$; on standard normal curve shade areas to the right of 0.62 and to the left of -0.62. (d) P-value of $0.5352 > 0.01$ for α; fail to reject H_0. (e) At the 1% level of significance, we cannot say that the population proportion of arrests of males aged 15 to 34 in Rock Springs is different from 70%.

5. (a) $\alpha = 0.01$; H_0: $p = 0.77$; H_1: $p < 0.77$. (b) Standard normal; $\hat{p} \approx 0.5556$; $z \approx -2.65$. (c) $P\text{-value} \approx 0.004$; on standard normal curve shade area to the left of -2.65. (d) P-value of $0.004 \leq 0.01$ for α; reject H_0. (e) At the 1% level of significance, the data show that the population proportion of driver fatalities related to alcohol is less than 77% in Kit Carson County.

7. (a) $\alpha = 0.01$; H_0: $p = 0.50$; H_1: $p < 0.50$. (b) Standard normal; $\hat{p} \approx 0.2941$; $z \approx -2.40$. (c) $P\text{-value} = 0.0082$; on standard normal curve shade region to the left of -2.40. (d) P-value of $0.0082 \leq 0.01$ for α; reject H_0. (e) At the 1% level of significance, the data indicate that the population proportion of female wolves is now less than 50% in the region.

9. (a) $\alpha = 0.01$; H_0: $p = 0.261$; H_1: $p \neq 0.261$. (b) Standard normal; $\hat{p} \approx 0.1924$; $z \approx -2.78$. (c) $P\text{-value} = 2(0.0027) = 0.0054$; on standard normal curve shade areas to the right of 2.78 and to the left of -2.78. (d) P-value of $0.0054 \leq 0.01$ for α; reject H_0. (e) At the 1% level of significance, the sample data indicate that the

population proportion of the five-syllable sequence is different from that of Plato's *Republic*.

11. (a) $\alpha = 0.01$; H_0: $p = 0.47$; H_1: $p > 0.47$. (b) Standard normal; $\hat{p} \approx 0.4871$; $z \approx 1.09$. (c) P-value $= 0.1379$; on standard normal curve shade area to the right of 1.09. (d) P-value of $0.1379 > 0.01$ for α; fail to reject H_0. (e) At the 1% level of significance, there is insufficient evidence to support the claim that the population proportion of customers loyal to Chevrolet is more than 47%.
13. (a) $\alpha = 0.05$; H_0: $p = 0.092$; H_1: $p > 0.092$. (b) Standard normal; $\hat{p} \approx 0.1480$; $z \approx 2.71$. (c) P-value $=$ 0.0034; on standard normal curve shade region to the right of 2.71. (d) P-value of $0.0034 \le 0.05$ for α; reject H_0. (e) At the 5% level of significance, the data indicate that the population proportion of students with hypertension during final exams week is higher than 9.2%.
15. (a) $\alpha = 0.01$; H_0: $p = 0.82$; H_1: $p \ne 0.82$. (b) Standard normal; $\hat{p} \approx 0.7671$; $z \approx -1.18$. (c) P-value $=$ $2(0.1190) = 0.2380$; on standard normal curve shade areas to the right of 1.18 and to the left of -1.18. (d) P-value of $0.2380 > 0.01$ for α; fail to reject H_0. (e) At the 1% level of significance, the evidence is insufficient to indicate that the population proportion of extroverts among college student government leaders is different from 82%.
17. (a) $\alpha = 0.01$; H_0: $p = 0.76$; H_1: $p \ne 0.76$. (b) Standard normal; $\hat{p} \approx 0.7966$; $z = 0.66$. (c) P-value $=$ $2(0.2546) = 0.5092$; on standard normal curve shade areas to the right of 0.66 and to the left of -0.66. (d) P-value of $0.5092 > 0.01$ for α; fail to reject H_0. (e) At the 1% level of significance, the evidence is insufficient to conclude that the population proportion of professors in Colorado who would choose the career again is different from the national rate of 76%.
19. Critical value is $z_0 = -2.33$. The critical region consists of values less than -2.33. The sample test statistic $z = -2.65$ is in the critical region, so we reject H_0. This result is consistent with the P-value conclusion.

Chapter 9 Review

1. (a) $\alpha = 0.05$; H_0: $\mu = 11.1$; H_1: $\mu \ne 11.1$. (b) Standard normal; $z = -3.00$. (c) P-value $=$ 0.0026; on standard normal curve shade areas to the right of 3.00 and to the left of -3.00. (d) P-value of $0.0026 \le 0.05$ for α; reject H_0. (e) At the 5% level of significance, the evidence is sufficient to say that the miles driven per vehicle in Chicago is different from the national average.
3. (a) $\alpha = 0.01$; H_0: $\mu = 0.8$; H_1: $\mu > 0.8$. (b) Student's t, $d.f. = 8$; $t \approx 4.390$. (c) $0.0005 < P\text{-value} < 0.005$; on t graph shade area to the right of 4.390. (d) P-value interval ≤ 0.01 for α; reject H_0. (e) At the 1% level of significance, the evidence is sufficient to say that the Toylot claim of 0.8 A is too low.
5. (a) $\alpha = 0.01$; H_0: $p = 0.60$; H_1: $p < 0.60$. (b) Standard normal; $z = -3.01$. (c) P-value $= 0.0013$; on standard normal curve shade area to the left of -3.01. (d) P-value of $0.0013 \le 0.01$ for α; reject H_0. (e) At the 1% level of significance, the evidence is sufficient to claim that the mortality rate has dropped.
7. (a) $\alpha = 0.01$; H_0: $p = 0.20$; H_1: $p > 0.20$. (b) Standard normal; $z = 3.18$. (c) P-value $= 0.0007$; on standard normal curve shade area to the right of 3.18. (d) P-value of $0.0007 \le 0.01$ for α; reject H_0. (e) At the 1% level of significance, the evidence is sufficient to claim that the population proportion of students who read the magazine is larger than 0.20.
9. (a) $\alpha = 0.05$; H_0: $\mu = 7$ oz; H_1: $\mu \ne 7$ oz. (b) Student's t, $d.f. = 7$; $t \approx 1.697$. (c) $0.100 < P\text{-value} < 0.150$; on t graph shade areas to the right of 1.697 and to the left of -1.697. (d) P-value interval > 0.05 for α; do not reject H_0. (e) At the 5% level of significance, the evidence is insufficient to claim that the population mean amount of coffee per cup is different from 7 oz.

CUMULATIVE REVIEW PROBLEMS CHAPTERS 7–9

1. (a) $\sigma \approx 1.7$. (b) 0.1314. (c) 0.1075.
2. (a) The normal approximation to the binomial is appropriate because np and nq are both greater than 5. (b) $\mu \approx 73.5$ and $\sigma \approx 5.6$. (c) $P(r \ge 65) \approx P(x \ge 64.5) \approx P(z \ge -1.61) \approx 0.9463$.
3. Essay based on material from Chapter 7 and Section 1.2.
4. (a) Because of the large sample size, the central limit theorem describes the $\bar{x}$ distribution (approximately). (b) $P(\bar{x} \le 6820) = P(z \le -2.75) = 0.0030$. (c) The probability that the average white blood cell count for 50 healthy adults is as low as or lower than 6820 is very small, 0.0030. Based on this result, it would be reasonable to gather additional facts.
5. (a)
   i. $\alpha = 0.01$; H_0: $\mu = 2.0$ ug/L; H_1: $\mu > 2.0$ ug/L.
   ii. Standard normal; $z = 2.53$.
   iii. P-value ≈ 0.0057; on standard normal curve shade area to the right of 2.53.
   iv. P-value of $0.0057 \le 0.01$ for α; reject H_0.
   v. At the 1% level of significance, the evidence is sufficient to say that the population mean discharge level of lead is higher.

   (b) 2.13 ug/L to 2.99 ug/L. (c) $n = 48$.
6. (a) Use rounded results to compute t in part (b).

   (b)
   i. $\alpha = 0.05$; H_0: $\mu = 10\%$; H_1: $\mu > 10\%$.
   ii. Student's t, $d.f. = 11$; $t \approx 1.248$.
   iii. $0.100 < P\text{-value} < 0.125$; on t graph shade area to the right of 1.248.
   iv. P-value interval > 0.05 for α; fail to reject H_0.

v. At the 5% level of significance, the evidence does not indicate that the patient is asymptomatic.

(c) 9.27% to 11.71%.

7. (a) i. $\alpha = 0.05$; H_0: $p = 0.10$; H_1: $p \neq 0.10$; yes, $np > 5$ and $nq > 5$; necessary to use normal approximation to the binominal.

ii. Standard normal; $\hat{p} \approx 0.147$; $z = 1.29$.

iii. P-value $= 2P(z > 1.29) \approx 0.1970$; on standard normal curve shade areas to the right of 1.29 and to the left of -1.29.

iv. P-value of $0.1970 > 0.05$ for α; fail to reject H_0.

v. At the 5% level of significance, the data do not indicate any difference from the national average for the population proportion of crime victims.

(b) 0.063 to 0.231. (c) From sample, $p \approx \hat{p} \approx 0.147$; $n = 193$.

8. (a) Essay. (b) Outline of study.

CHAPTER 10

Section 10.1

1. (a) $\alpha = 0.05$; H_0: $\mu_d = 0$; H_1: $\mu_d \neq 0$. (b) Student's t, $d.f. = 7$; $\bar{d} \approx 2.25$; $t \approx 0.818$. (c) $0.250 < P\text{-value} < 0.500$; on t graph shade areas to the left of -0.818 and to the right of 0.818. (d) P-value interval > 0.05 for α; fail to reject H_0. (e) At the 5% level of significance, the evidence is insufficient to claim a difference in population mean percentage increases for corporate revenue and CEO salary.

3. (a) $\alpha = 0.01$; H_0: $\mu_d = 0$; H_1: $\mu_d > 0$. (b) Student's t, $d.f. = 4$; $\bar{d} \approx 12.6$; $t \approx 1.243$. (c) $0.125 < P\text{-value} < 0.250$; on t graph shade area to the right of 1.243. (d) P-value interval > 0.01 for α; fail to reject H_0. (e) At the 1% level of significance, the evidence is insufficient to claim that the average peak wind gusts are higher in January.

5. (a) $\alpha = 0.05$; H_0: $\mu_d = 0$; H_1: $\mu_d > 0$. (b) Student's t, $d.f. = 7$; $\bar{d} \approx 6.125$; $t \approx 1.762$. (c) $0.050 < P\text{-value} < 0.075$; on t graph shade area to the right of 1.762. (d) P-value interval > 0.05 for α; fail to reject H_0. (e) At the 5% level of significance, the evidence is insufficient to indicate that the population average percentage of male wolves in winter is higher.

7. (a) $\alpha = 0.05$; H_0: $\mu_d = 0$; H_1: $\mu_d > 0$. (b) Student's t, $d.f. = 8$; $\bar{d} = 2.0$; $t \approx 1.333$. (c) $0.100 < P\text{-value} < 0.125$; on t graph shade area to the right of 1.333. (d) P-value interval > 0.05 for α; fail to reject H_0. (e) At the 5% level of significance, the evidence is insufficient to claim that the population score on the last round is higher than that on the first.

9. (a) $\alpha = 0.05$; H_0: $\mu_d = 0$; H_1: $\mu_d \neq 0$. (b) Student's t, $d.f. = 4$; $\bar{d} = 1.0$; $t \approx 0.427$. (c) P-value > 0.500 (note that the t value 0.427 is smaller than any entry in the $d.f. = 4$ row, so the P-value is larger than the largest value 0.500 in the two-tail area row); on t graph shade areas to the left of -0.427 and to the right of 0.427. (d) P-value interval > 0.05 for α; fail to reject H_0. (e) At the 5% level of significance, the evidence is insufficient to indicate a difference in the population mean number of service ware sherds in subarea 1 as compared with subarea 2.

11. For a two-tailed test with $\alpha = 0.05$ and $d.f. = 7$, the critical values are $\pm t_0 = \pm 2.365$. The sample test statistic $t = 0.818$ is between -2.365 and 2.365, so we do not reject H_0. This conclusion is the same as that reached by the P-value method.

Section 10.2

1. (a) (i) $\alpha = 0.01$; H_0: $\mu_1 = \mu_2$; H_1: $\mu_1 > \mu_2$. (ii) Standard normal; $\bar{x}_1 - \bar{x}_2 = 0.7$; $z \approx 2.57$. (iii) P-value $= P(z > 2.57) \approx 0.0051$; on standard normal curve shade area to the right of 2.57. (iv) P-value of $0.0051 \leq 0.01$ for α; reject H_0. (v) At the 1% level of significance, the evidence is sufficient to indicate that the population mean REM sleep time for children is more than that for adults. (b) 0.07 to 1.33; Interval contains values that are all positive. At the 98% confidence level, it appears that the population mean REM sleep time for children is greater than that for adults.

3. (a) (i) $\alpha = 0.05$; H_0: $\mu_1 = \mu_2$; H_1: $\mu_1 \neq \mu_2$. (ii) Standard normal; $\bar{x}_1 - \bar{x}_2 = 0.6$; $z \approx 2.16$. (iii) P-value $= 2P(z > 2.16) \approx 2(0.0154) = 0.0308$; on standard normal curve shade areas to the right of 2.16 and to the left of -2.16. (iv) P-value of $0.0308 \leq 0.05$ for α; reject H_0. (v) At the 5% level of significance, the evidence is sufficient to show that there is a difference between mean responses regarding preference for camping or fishing. (b) 0.06 to 1.14; Interval contains values that are all positive. At the 95% confidence level, it appears that the population mean response for camping is higher than that for fishing.

5. Use rounded results to compute t. (a) (i) $\alpha = 0.01$; H_0: $\mu_1 = \mu_2$; H_1: $\mu_1 < \mu_2$. (ii) Student's t, $d.f. = 9$; $\bar{x}_1 - \bar{x}_2 = -0.36$; $t \approx -0.965$. (iii) $0.125 < P\text{-value} < 0.250$; on t graph shade area to the left of -0.965. (iv) P-value interval > 0.01 for α; do not reject H_0. (v) At the 1% level of significance, the evidence is insufficient to indicate that violent crime in the Rocky Mountain region is higher than in New England. (b) $d.f. = 9$; $E \approx 1.05$; -1.41 to 0.69; Interval contains both negative and positive values. At the 98% confidence level, we cannot conclude that the population mean violent crime rate in the Rocky Mountain region is different from that in New England.

7. (a) (i) $\alpha = 0.05$; H_0: $\mu_1 = \mu_2$; H_1: $\mu_1 \neq \mu_2$. (ii) Student's t, $d.f. = 29$; $\bar{x}_1 - \bar{x}_2 = -9.7$; $t \approx -0.751$. (iii) $0.250 < P\text{-value} < 0.500$; on t graph shade areas to the right of 0.751 and to the left of -0.751. (iv) P-value interval > 0.05 for α; do not reject H_0. (v) At the 5% level of significance, the evidence is insufficient to indicate that there is a difference between the control and experimental groups in the mean score on the vocabulary portion of the test. (b) $d.f. = 29$; $E \approx 26.4$; -36.1 to 16.7; Interval contains both negative and positive values. At the 95% confidence level, we cannot conclude that the population mean vocabulary score was different between the two groups before instruction began.
9. Use rounded results to compute t. (a) (i) $\alpha = 0.05$; H_0: $\mu_1 = \mu_2$; H_1: $\mu_1 \neq \mu_2$. (ii) Student's t, $d.f. = 14$; $\bar{x}_1 - \bar{x}_2 = 0.82$; $t \approx 0.869$. (iii) $0.250 < P\text{-value} < 0.500$; on t graph shade areas to the right of 0.869 and to the left of -0.869. (iv) P-value interval > 0.05 for α; do not reject H_0. (v) At the 5% level of significance, the evidence is insufficient to indicate that there is a difference in the mean number of cases of fox rabies between the two regions. (b) $d.f. = 14$; $E \approx 2.02$; -1.2 to 2.84; Interval contains both negative and positive values. At the 95% confidence level, we cannot conclude that there is any difference in the population mean number of fox rabies cases in the two regions.
11. Use rounded results to compute t. (a) (i) $\alpha = 0.05$; H_0: $\mu_1 = \mu_2$; H_1: $\mu_1 \neq \mu_2$. (ii) Student's t, $d.f. = 6$; $\bar{x}_1 - \bar{x}_2 = -1.64$; $t \approx -1.041$. (iii) $0.250 < P\text{-value} < 0.500$; on t graph shade areas to the right of 1.041 and to the left of -1.041. (iv) P-value interval > 0.05 for α; do not reject H_0. (v) At the 5% level of significance, the evidence is insufficient to indicate that the mean time lost due to hot tempers is different from time lost due to technical workers' attitudes. (b) $d.f. = 6$; $E \approx 3.85$; -5.49 to 2.21; Interval contains both negative and positive values. At the 95% confidence level, we cannot conclude that there is any difference in the population mean time lost due to the two types of inappropriate behavior.
13. (a) $d.f. = 19.96$ (Some software will truncate this to 19.) (b) $d.f. = 9$; the convention of using the smaller of $n_1 - 1$ and $n_2 - 1$ leads to a $d.f.$ that is always less than or equal to that computed by Satterthwaite's formula.
15. H_0: $\mu_1 = \mu_2$; H_1: $\mu_1 < \mu_2$; for $d.f. = 9$, $\alpha = 0.01$ in the *one-tail area* row, the critical value $t_0 = -2.821$; sample test statistic $t = -0.965$ is not in the critical region; fail to reject H_0. This result is consistent with that obtained by the P-value method.

Section 10.3

1. (a) $\alpha = 0.05$; H_0: $p_1 = p_2$; H_1: $p_1 \neq p_2$. (b) Standard normal; $\bar{p} \approx 0.2911$; $\hat{p}_1 - \hat{p}_2 \approx -0.052$; $z \approx -1.13$. (c) $P\text{-value} \approx 2P(z < -1.13) \approx 2(0.1292) = 0.2584$; on standard normal curve shade areas to the right of 1.13 and to the left of -1.13. (d) P-value of $0.2584 > 0.05$ for α; fail to reject H_0. (e) At the 5% level of significance, there is insufficient evidence to conclude that the population proportion of women favoring more tax dollars for the arts is different from the proportion of men.
3. (a) $\alpha = 0.05$; H_0: $p_1 = p_2$; H_1: $p_1 < p_2$. (b) Standard normal; $\bar{p} \approx 0.2189$; $\hat{p}_1 - \hat{p}_2 \approx -0.074$; $z \approx -2.04$. (c) $P\text{-value} \approx P(z < -2.04) \approx 0.0207$; on standard normal curve shade area to the left of -2.04. (d) P-value of $0.0207 \leq 0.05$ for α; reject H_0. (e) At the 5% level of significance, there is sufficient evidence to conclude that the population proportion of trusting people in Chicago is higher for the older group.
5. (a) $\alpha = 0.01$; H_0: $p_1 = p_2$; H_1: $p_1 < p_2$. (b) Standard normal; $\bar{p} = 0.42$; $\hat{p}_1 - \hat{p}_2 = -0.10$; $z \approx -1.43$. (c) $P\text{-value} \approx P(z < -1.43) \approx 0.0764$; on standard normal curve shade area to the left of -1.43. (d) P-value of $0.0764 > 0.01$ for α; fail to reject H_0. (e) At the 1% level of significance, there is insufficient evidence to conclude that the population proportion of adults who believe in extraterrestrials and who attended college is higher than the proportion who did not attend college.
7. (a) $\alpha = 0.01$; H_0: $p_1 = p_2$; H_1: $p_1 < p_2$. (b) Standard normal; $\bar{p} \approx 0.5749$; $\hat{p}_1 - \hat{p}_2 \approx -0.1070$; $z \approx -3.19$. (c) $P\text{-value} \approx P(z < -3.19) \approx 0.0007$; on standard normal curve shade area to the left of -3.19. (d) P-value of $0.0007 \leq 0.01$ for α; reject H_0. (e) At the 1% level of significance, there is sufficient evidence to conclude that the population proportion of guests requesting nonsmoking rooms has increased.
9. For a two-tailed test with $\alpha = 0.05$, the critical values are $\pm z_0 = \pm 1.96$. The sample test statistic $z = -1.13$ is between -1.96 and 1.96, so we do not reject H_0. This conclusion is the same as that reached by the P-value method.
11. (a) $\hat{\sigma} = 0.0232$; $E = 0.0599$; the interval is from 0.67 to 0.79. (b) The confidence interval contains values that are all positive, so we can be 99% sure that $p_1 > p_2$.
13. (a) $\hat{p}_1 = 0.3095$; $\hat{p}_2 = 0.1184$; $\hat{\sigma} = 0.0413$; interval from 0.085 to 0.297. (b) The interval contains numbers that are all positive. A greater proportion of hogans occurs in Fort Defiance.

15. (a) Based on the same data, a 99% confidence interval is longer than a 95% confidence interval. Therefore, if the 95% confidence interval has both positive and negative values, so will the 99% confidence interval. However, for the same data, a 90% confidence interval is shorter than a 95% confidence interval. The 90% confidence interval might contain only positive or only negative values even if the 95% interval contains both. (b) Based on the same data, a 99% confidence interval is longer than a 95% confidence interval. Even if the 95% confidence interval contains values that are all positive, the longer 99% interval could contain both positive and negative values. Since, for the same data, a 90% confidence interval is shorter than a 95% confidence interval, if the 95% confidence interval contains only positive values, so will the 90% confidence interval.

Chapter 10 Review

1. Difference of means.
   (a) Use a calculator. (b) $d.f. \approx 71$; to use Table 4, round down to $d.f. \approx 70$; $E \approx 0.83$; interval from -0.06 to 1.6. (c) Because the interval contains both positive and negative values, we cannot conclude at the 95% confidence level that there is any difference in soil water content in the two fields. (d) Student's t distribution, because σ_1 and σ_2 are unknown. Both samples are large, so no assumptions about the original distributions are needed. (e) (i) $\alpha = 0.01$; H_0: $\mu_1 = \mu_2$; H_1: $\mu_1 > \mu_2$. (ii) Student's t; $d.f. = 71$ (use $d.f. = 70$ in Table 4 of the Appendix); $t \approx 1.841$. (iii) $0.025 < P\text{-value} < 0.050$; on t graph shade area to the right of 1.841. (iv) P-value interval > 0.01 for α; fail to reject H_0. At the 1% level of significance, the evidence does not show that the population mean soil water content of the first field is higher than that of the second.
3. Difference of means.
   (a) $d.f. \approx 17$; $E \approx 2.5$; interval from 5.5 to 10.5 lb.
   (b) Yes. The interval contains values that are all positive. At the 75% level of confidence, it appears that the average weight of adult male wolves from the Northwest Territories is greater. (c) (i) $\alpha = 0.01$; H_0: $\mu_1 = \mu_2$; H_1: $\mu_1 \neq \mu_2$. (ii) Student's t; $d.f. = 17$; $t \approx 3.743$.
   (iii) $0.001 < P\text{-value} < 0.010$; on t graph shade areas to the right of 3.743 and to the left of -3.743. (iv) P-value interval ≤ 0.01 for α; reject H_0. (v) At the 1% level of significance, the evidence is sufficient to conclude that the average weight of adult male wolves in the Northwest Territories is different from that of Alaska wolves.
5. Difference of proportions.
   (a) $\hat{p}_1 = 0.8495$; $\hat{p}_2 = 0.8916$; -0.1409 to 0.0567.
   (b) No. The interval contains both negative and positive numbers. We do not detect a difference in the proportions at the 95% confidence level. (c) (i) $\alpha = 0.05$; H_0: $p_1 = p_2$; H_1: $p_1 \neq p_2$. (ii) Normal distribution; $z \approx -0.83$. (iii) P-value $= 2(0.2033) = 0.4066$; on the normal graph, shade areas to the left of -0.83 and to the right of 0.83. (iv) P-value of $0.4066 > \alpha = 0.05$; fail to reject H_0. (v) At the 5% level of significance, there is insufficient evidence to conclude that the proportion of accurate responses from face-to-face interviews differs from the proportion for telephone interviews.
7. (a) $\alpha = 0.05$; H_0: $\mu_d = 0$; H_1: $\mu_d < 0$. (b) Student's t, $d.f. = 4$; $\bar{d} \approx -4.94$; $t = -2.832$. (c) $0.010 < P\text{-value} < 0.025$; on t graph shade area to the left of -2.832. (d) P-value interval ≤ 0.05 for α; reject H_0. (e) At the 5% level of significance, there is sufficient evidence to claim that the population average net sales improved.

CHAPTER 11

Section 11.1

1. (a) $\alpha = 0.05$; H_0: Myers-Briggs preference and profession are independent; H_1: Myers-Briggs preference and profession are not independent. (b) $\chi^2 = 8.649$; $d.f. = 2$. (c) $0.010 < P\text{-value} < 0.025$. (d) Reject H_0. (e) At the 5% level of significance, there is sufficient evidence to conclude that Myers-Briggs preference and profession are not independent.
3. (a) $\alpha = 0.01$; H_0: Site type and pottery type are independent; H_1: Site type and pottery type are not independent. (b) $\chi^2 = 0.5552$; $d.f. = 4$. (c) $0.950 < P\text{-value} < 0.975$. (d) Do not reject H_0. (e) At the 1% level of significance, there is insufficient evidence to conclude that site and pottery type are not independent.
5. (a) $\alpha = 0.05$; H_0: Age distribution and location are independent; H_1: Age distribution and location are not independent. (b) $\chi^2 = 0.6704$; $d.f. = 4$. (c) $0.950 < P\text{-value} < 0.975$. (d) Do not reject H_0. (e) At the 5% level of significance, there is insufficient evidence to conclude that age distribution and location are not independent.
7. (a) $\alpha = 0.05$; H_0: Age of young adult and movie preference are independent; H_1: Age of young adult and movie preference are not independent. (b) $\chi^2 = 3.6230$; $d.f. = 4$. (c) $0.100 < P\text{-value} < 0.900$. (d) Do not reject H_0. (e) At the 5% level of significance, there is insufficient evidence to conclude that age of young adult and movie preference are not independent.

9. (a) $\alpha = 0.05$; H_0: Stone tool construction material and site are independent; H_1: Stone tool construction material and site are not independent. (b) $\chi^2 = 11.15$; *d.f.* = 3. (c) $0.010 < P\text{-value} < 0.025$. (d) Reject H_0. (e) At the 5% level of significance, there is sufficient evidence to conclude that stone tool construction material and site are not independent.

Section 11.2

1. (a) $\alpha = 0.05$; H_0: The distributions are the same; H_1: The distributions are different. (b) Sample $\chi^2 = 11.788$; *d.f.* = 3. (c) $0.005 < P\text{-value} < 0.010$. (d) Reject H_0. (e) At the 5% level of significance, the evidence is sufficient to conclude that the age distribution of the Red Lake Village population does not fit the age distribution of the general Canadian population.
3. (a) $\alpha = 0.01$; H_0: The distributions are the same; H_1: The distributions are different. (b) Sample $\chi^2 = 0.1984$; *d.f.* = 4. (c) $P\text{-value} > 0.995$. (Note that as the χ^2 values decrease, the area in the right tail increases, so $\chi^2 < 0.207$ means that the corresponding $P\text{-value} > 0.995$.) (d) Do not reject H_0. (e) At the 1% level of significance, the evidence is insufficient to conclude that the regional distribution of raw materials does not fit the distribution at the current excavation site.
5. (i) Essay. (ii) (a) $\alpha = 0.01$; H_0: The distributions are the same; H_1: The distributions are different. (b) Sample $\chi^2 = 1.5693$; *d.f.* = 5. (c) $0.900 < P\text{-value} < 0.950$. (d) Do not reject H_0. (e) At the 1% level of significance, the evidence is insufficient to conclude that the average daily July temperature does not follow a normal distribution.
7. (a) $\alpha = 0.05$; H_0: The distributions are the same; H_1: The distributions are different. (b) Sample $\chi^2 = 9.333$; *d.f.* = 3. (c) $0.025 < P\text{-value} < 0.050$. (d) Reject H_0. (e) At the 5% level of significance, the evidence is sufficient to conclude that the current fish distribution is different than it was 5 years ago.
9. (a) $\alpha = 0.01$; H_0: The distributions are the same; H_1: The distributions are different. (b) Sample $\chi^2 = 13.70$; *d.f.* = 5. (c) $0.010 < P\text{-value} < 0.025$. (d) Do not reject H_0. (e) At the 1% level of significance, the evidence is insufficient to conclude that the census ethnic origin distribution and the ethnic origin distribution of city residents are different.

Section 11.3

1. (a) $\alpha = 0.05$; H_0: $\sigma^2 = 42.3$; H_1: $\sigma^2 > 42.3$. (b) $\chi^2 \approx 23.98$; *d.f.* = 22. (c) $0.100 < P\text{-value} < 0.900$. (d) Do not reject H_0. (e) At the 5% level of significance, there is insufficient evidence to conclude that the variance is greater in the new section.
3. (a) $\alpha = 0.01$; H_0: $\sigma^2 = 136.2$; H_1: $\sigma^2 < 136.2$. (b) $\chi^2 \approx 5.92$; *d.f.* = 7. (c) Right-tailed area between 0.900 and 0.100; $0.100 < P\text{-value} < 0.900$. (d) Do not reject H_0. (e) At the 1% level of significance, there is insufficient evidence to conclude that the variance for number of mountain-climber deaths is less than 136.2.
5. (a) $\alpha = 0.05$; H_0: $\sigma^2 = 9$; H_1: $\sigma^2 < 9$. (b) $\chi^2 \approx 8.82$; *d.f.* = 22. (c) Right-tail area is between 0.995 and 0.990; $0.005 < P\text{-value} < 0.010$. (d) Reject H_0. (e) At the 5% level of significance, there is sufficient evidence to conclude that the variance of protection times for the new typhoid shot is less than 9.
7. (a) $\alpha = 0.01$; H_0: $\sigma^2 = 0.18$; H_1: $\sigma^2 > 0.18$. (b) $\chi^2 = 90$; *d.f.* = 60. (c) $0.005 < P\text{-value} < 0.010$. (d) Reject H_0. (e) At the 1% level of significance, there is sufficient evidence to conclude that the variance of measurements for the fan blades is higher than the specified amount. The inspector is justified in claiming that the blades must be replaced.
9. (a) $\alpha = 0.05$; H_0: $\sigma^2 = 23$; H_1: $\sigma^2 \neq 23$. (b) $\chi^2 \approx 13.06$; *d.f.* = 21. (c) The area to the left of $\chi^2 = 13.06$ is less than 50%, so we double the left-tail area to find the P-value for the two-tailed test. The right-tail area is between 0.950 and 0.900. Subtracting each value from 1, we find that the left-tail area is between 0.050 and 0.100. Doubling the left-tail area for a two-tailed test gives $0.100 < P\text{-value} < 0.200$. (d) Do not reject H_0. (e) At the 5% level of significance, there is insufficient evidence to conclude that the variance of battery life is different from 23.

Section 11.4

1. (a) Use a calculator. (b) $\alpha = 0.05$; H_0: $\rho = 0$; H_1: $\rho > 0$; sample $t \approx 2.522$; *d.f.* = 4; $0.025 < P\text{-value} < 0.050$; reject H_0. There seems to be a positive correlation between x and y. (c) Use a calculator. (d) 45.36%. (e) Interval from 39.05 to 51.67. (f) $\alpha = 0.05$; H_0: $\beta = 0$; H_1: $\beta > 0$; sample $t \approx 2.522$; *d.f.* = 4; $0.025 < P\text{-value} < 0.050$; reject H_0. There seems to be a positive slope between x and y.
3. (a) Use a calculator. (b) $\alpha = 0.01$; H_0: $\rho = 0$; H_1: $\rho < 0$; sample $t \approx -10.06$; *d.f.* = 5; $P\text{-value} < 0.0005$; reject H_0. The sample evidence supports a negative correlation. (c) Use a calculator. (d) 2.39 hours. (e) Interval from 2.12 to 2.66 hours. (f) $\alpha = 0.01$; H_0: $\beta = 0$; H_1: $\beta < 0$; sample $t \approx -10.06$; *d.f.* = 5; $P\text{-value} < 0.0005$; reject H_0. The sample evidence supports a negative slope.

5. (a) Use a calculator. (b) $\alpha = 0.01$; H_0: $\rho = 0$; H_1: $\rho > 0$; sample $t \approx 6.534$; $d.f. = 4$; $0.0005 < P\text{-value} < 0.005$; reject H_0. The sample evidence supports a positive correlation. (c) Use a calculator. (d) \$12.577 thousand. (e) Interval from 12.247 to 12.907 (thousand dollars). (f) $\alpha = 0.01$; H_0: $\beta = 0$; H_1: $\beta > 0$; sample $t \approx 6.534$; $d.f. = 4$; $0.0005 < P\text{-value} < 0.005$; reject H_0. The sample evidence supports a positive slope.
7. (a) H_0: $\rho = 0$; H_1: $\rho \neq 0$; $d.f. = 4$; sample $t = 4.129$; $0.01 < P\text{-value} < 0.02$; do not reject H_0; r is not significant at the 0.01 level of significance. (b) H_0: $\rho = 0$; H_1: $\rho \neq 0$; $d.f. = 8$; sample $t = 5.840$; $P\text{-value} < 0.001$; reject H_0; r is significant at the 0.01 level of significance. (c) As n increases, the t value corresponding to r also increases, resulting in a smaller P-value.

Chapter 11 Review

1. Chi-square test of goodness of fit. (i) $\alpha = 0.01$; H_0: The distributions are the same; H_1: The distributions are different. (ii) $\chi^2 \approx 11.93$; $d.f. = 4$. (iii) $0.010 < P\text{-value} < 0.025$. (iv) Do not reject H_0. (v) At the 1% level of significance, there is insufficient evidence to claim that the age distribution of the population of Blue Valley has changed.
3. Chi-square test of σ^2. (i) $\alpha = 0.01$; H_0: $\sigma^2 = 1{,}040{,}400$; H_1: $\sigma^2 > 1{,}040{,}400$. (ii) $\chi^2 \approx 51.03$; $d.f. = 29$. (iii) $0.005 < P\text{-value} < 0.010$. (iv) Reject H_0. (v) At the 1% level of significance, there is sufficient evidence to conclude that the variance is greater than claimed.
5. Chi-square test of independence. (i) $\alpha = 0.01$; H_0: Student grade and teacher rating are independent; H_1: Student grade and teacher rating are not independent. (ii) $\chi^2 \approx 9.80$; $d.f. = 6$. (iii) $0.100 < P\text{-value} < 0.900$. (iv) Do not reject H_0. (v) At the 1% level of significance, there is insufficient evidence to claim that student grade and teacher rating are not independent.
7. (a) Use a calculator. (b) (i) $\alpha = 0.01$; H_0: $\rho = 0$; H_1: $\rho > 0$. (ii) $t \approx 6.665$; $d.f. = 5$. (iii) $0.0005 < P\text{-value} < 0.005$. (iv) Reject H_0. (v) At the 1% level of significance, there is evidence that ρ is positive. (c) (i) $\alpha = 0.01$; H_0: $\beta = 0$; H_1: $\beta > 0$. (ii) $t \approx 6.665$; $d.f. = 5$. (iii) $0.0005 < P\text{-value} < 0.005$. (iv) Reject H_0. (v) At the 1% level of significance, there is evidence that β is positive. (d) $\hat{y} \approx 5.98$; $E \approx 3.27$; 2.72 to 9.24.

CUMULATIVE REVIEW PROBLEMS CHAPTERS 10–11

1. (a) Use a calculator. (b) (i) $\alpha = 0.05$; H_0: $\rho = 0$; H_1: $\rho > 0$. (ii) Student's t, $d.f. = 6$; $t \approx 2.466$. (iii) $0.010 < P\text{-value} < 0.025$. On the t graph, shade area to the right of 2.466. (iv) P-value interval $< \alpha = 0.05$; reject H_0. (v) At the 5% level of significance, there is evidence of a positive correlation between age of a volcanic island in the Indian Ocean and distance of the island from the center of the midoceanic ridge. (c) (i) $\alpha = 0.05$; H_0: $\beta = 0$; H_1: $\beta > 0$. (ii) Student's t, $d.f. = 6$; $t \approx 2.466$. (iii) $0.010 < P\text{-value} < 0.025$. On the t graph, shade area to the right of 2.466. (iv) P-value interval $< \alpha = 0.05$; reject H_0. (v) At the 5% level of significance, there is evidence of a positive slope for the regression line for age of a volcanic island in the Indian Ocean and distance of the island from the center of the midoceanic ridge. (d) $\hat{y} \approx 16.5$ (units in 100 km); $d.f. = 6$; $t_{0.85} = 1.650$; $E \approx 11.4$; 5.1 to 27.9 (units in 100 km).
2. (i) $\alpha = 0.01$; H_0: Colorado major distribution is the same as national distribution; H_1: Colorado major distribution is different from national distribution. (ii) Chi-square; $d.f. = 5$; $\chi^2 \approx 10.196$. (iii) $0.050 < P\text{-value} < 0.100$; shade region to the right of 10.196. (iv) P-value interval $> \alpha = 0.01$; fail to reject H_0. At the 1% level of significance, the evidence is insufficient to claim that the distribution of college majors selected by Colorado students is different from the national distribution of college majors.
3. (i) $\alpha = 0.05$; H_0: Yield and fertilizer type are independent; H_1: Yield and fertilizer type are not independent. (ii) Chi-square distribution $\chi^2 \approx 5.005$; $d.f. = 4$. (iii) $0.100 < P\text{-value} < 0.900$. (iv) Do not reject H_0. (v) At the 5% level of significance, the evidence is insufficient to conclude that fertilizer type and yield are not independent.
4. (a) (i) $\alpha = 0.05$; H_0: $\sigma = 0.55$; H_1: $\sigma > 0.55$. (ii) Chi-square distribution $s \approx 0.602$; $d.f. = 9$; $\chi^2 \approx 10.78$. (iii) $0.100 < P\text{-value} < 0.900$. (iv) Do not reject H_0. (v) At the 5% level of significance, there is insufficient evidence to conclude that the standard deviation of petal lengths is greater than 0.55. (b) Interval from 0.44 to 0.99.
5. (i) $\alpha = 0.05$; H_0: $\mu_d = 0$; H_1: $\mu_d \neq 0$. (ii) Student's t, $d.f. = 6$; $\bar{d} \approx -0.0039$, $t \approx -0.771$. (iii) $0.250 < P\text{-value} < 0.500$; on t graph shade areas to the right of 0.771 and to the left of -0.771. (iv) P-value interval $>$ 0.05 for α; fail to reject H_0. (v) At the 5% level of significance, the evidence does not show a population mean difference in phosphorous reduction between the two methods.
6. (a) (i) $\alpha = 0.05$; H_0: $\mu_1 = \mu_2$; H_1: $\mu_1 \neq \mu_2$. (ii) Student's t, $d.f. = 15$; $t \approx 1.952$. (iii) $0.050 < P\text{-value} < 0.100$; on t graph shade areas to the right of 1.952 and to the left of -0.1952. (iv) P-value interval > 0.05 for α; fail to reject H_0. (v) At the 5% level of significance, the evidence does not show any difference in the

population mean proportion of on-time arrivals in summer versus winter. (b) −0.43% to 9.835%. (c) x_1 and x_2 distributions are approximately normal (mound-shaped and symmetric).

7. (a) (i) $\alpha = 0.05$; H_0: $p_1 = p_2$; H_1: $p_1 > p_2$. (ii) Standard normal; $\hat{p}_1 \approx 0.242$; $\hat{p}_2 \approx 0.207$; $\bar{p} \approx 0.2246$; $z \approx 0.58$. (iii) P-value ≈ 0.2810; on standard normal curve shade area to the right of 0.58. (iv) P-value interval > 0.05 for α; fail to reject H_0. (v) At the 5% level of significance, the evidence does not indicate that the population proportion of single men who go out dancing occasionally differs from the proportion of single women. Since $n_1\bar{p}$, $n_1\bar{q}$, $n_2\bar{p}$, and $n_2\bar{q}$ are all greater than 5, the normal approximation to the binomial is justified. (b) −0.065 to 0.139.