APPENDIX D: ANSWERS TO SELF-REVIEW

CHAPTER 1

1.1 **a.** Inferential statistics, because a sample was used to draw a conclusion about how all consumers in the population would react if the chicken dinner were marketed.

b. On the basis of the sample of 1,960 consumers, we estimate that, if it is marketed, 60% of all consumers will purchase the chicken dinner: $(1{,}176/1{,}960) \times 100 = 60\%$.

1.2 **a.** Age is a ratio-scale variable. A 40-year-old is twice as old as someone 20 years old.

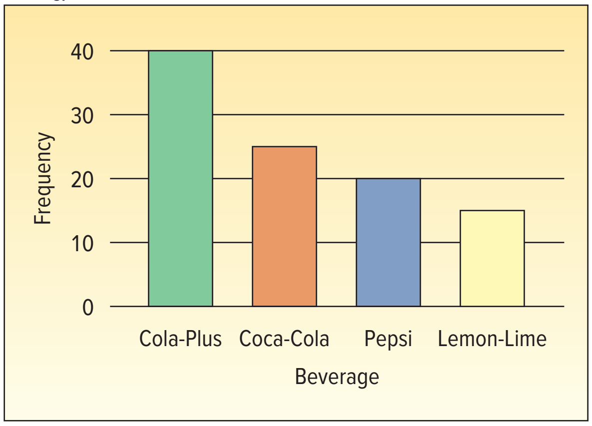
b. The two variables are: (1) if a person owns a luxury car, and (2) the state of residence. Both are measured on a nominal scale.

CHAPTER 2

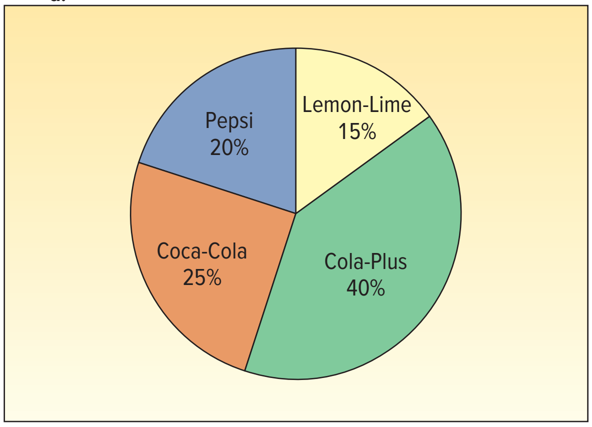
2.1 **a.** Qualitative data, because the customers' response to the taste test is the name of a beverage.

b. Frequency table. It shows the number of people who prefer each beverage.

c.



d.



2.2 **a.** The raw data or ungrouped data.

b.

Commission	Number of Salespeople
$1,400 up to $1,500	2
1,500 up to 1,600	5
1,600 up to 1,700	3
1,700 up to 1,800	1
Total	11

c. Class frequencies.

d. The largest concentration of commissions is $1,500 up to $1,600. The smallest commission is about $1,400 and the largest is about $1,800. The typical amount earned is $1,550.

2.3 **a.** $2^6 = 64 < 73 < 128 = 2^7$, so seven classes are recommended.

b. The interval width should be at least $(488 - 320)/7 = 24$. Class intervals of either 25 or 30 are reasonable.

c. Assuming a class interval of 25 and beginning with a lower limit of 300, eight classes are required. If we use an interval of 30 and begin with a lower limit of 300, only 7 classes are required. Seven classes is the better alternative.

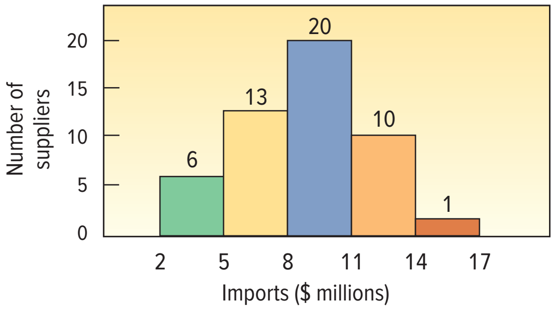
Distance Classes	Frequency	Percent
300 up to 330	2	2.7%
330 up to 360	2	2.7
360 up to 390	17	23.3
390 up to 420	27	37.0
420 up to 450	22	30.1
450 up to 480	1	1.4
480 up to 510	2	2.7
Grand Total	73	100.00

d. 17

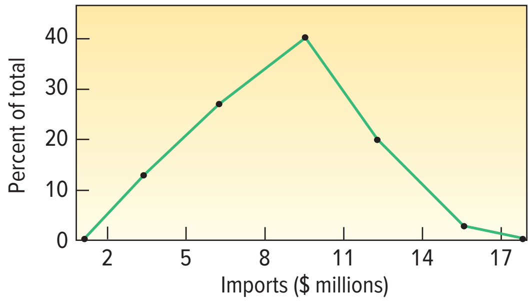
e. 23.3%, found by 17/73

f. 71.2%, found by $(27 + 22 + 1 + 2)/73$

2.4 **a.**



b.



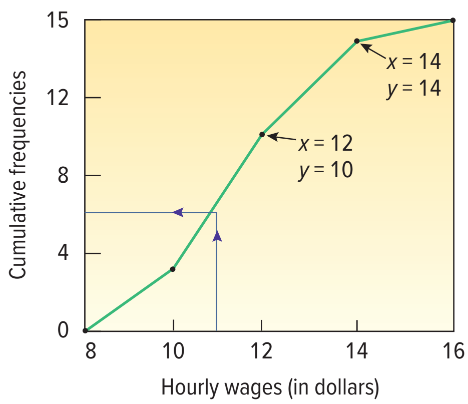
The plots are: (3.5, 12), (6.5, 26), (9.5, 40), (12.5, 20), and (15.5, 2).

c. The smallest annual volume of imports by a supplier is about $2 million, the largest about $17 million. The highest frequency is between $8 million and $11 million.

2.5 **a.** A frequency distribution.

b.

Hourly Wages	Cumulative Number
Less than $8	0
Less than $10	3
Less than $12	10
Less than $14	14
Less than $16	15



c. About seven employees earn $11.00 or less.

CHAPTER 3

3–1 **1. a.** $\bar{x} = \dfrac{\Sigma x}{n}$

b. $\bar{x} = \dfrac{\$267{,}100}{4} = \$66{,}775$

c. Statistic, because it is a sample value.

d. $66,775. The sample mean is our best estimate of the population mean.

2. a. $\mu = \dfrac{\Sigma x}{N}$

b. $\mu = \dfrac{498}{6} = 83$

c. Parameter, because it was computed using all the population values.

3–2 **1. a.** $878

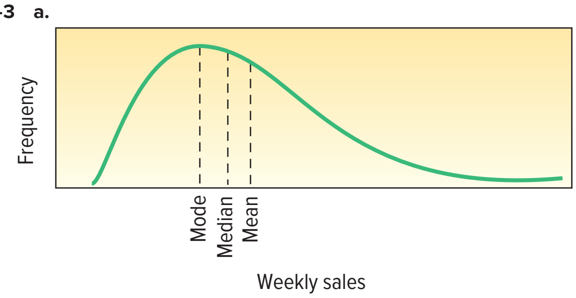
b. 3, 3

2. a. 17, found by (15 + 19)/2 = 17

b. 5, 5

c. There are 3 values that occur twice: 11, 15, and 19. There are three modes.

3–3 **a.**



b. Positively skewed, because the mean is the largest average and the mode is the smallest.

3–4 **a.** $237, found by:

$$\frac{(95 \times \$400) + (126 \times \$200) + (79 \times \$100)}{95 + 126 + 79} = \$237.00$$

b. The profit per suit is $12, found by $237 – $200 cost – $25 commission. The total profit for the 300 suits is $3,600, found by 300 × $12.

3–5 **1. a.** About 9.9%, found by $\sqrt[4]{1.458602236}$, then 1.099 – 1.00 = .099

b. About 10.095%

c. Greater than, because 10.095 > 9.9

2. 8.63%, found by $\sqrt[20]{\dfrac{120{,}520}{23{,}000}} - 1 = 1.0863 - 1$

3–6 **a.** 22 thousands of pounds, found by 112 – 90

b. $\bar{x} = \dfrac{824}{8} = 103$ thousands of pounds

c. Variance $= \dfrac{373}{8} = 46.625$

3–7 **a.** $\mu = \dfrac{\$16{,}900}{5} = \$3{,}380$

b. $\sigma^2 = \dfrac{(3{,}536 - 3{,}380)^2 + \cdots + (3{,}622 - 3{,}380)^2}{5}$

$$= \frac{(156)^2 + (-207)^2 + (68)^2 + (-259)^2 + (242)^2}{5}$$

$$= \frac{197{,}454}{5} = 39{,}490.8$$

c. $\sigma = \sqrt{39{,}490.8} = 198.72$

d. There is more variation in the Pittsburgh office because the standard deviation is larger. The mean is also larger in the Pittsburgh office.

3–8 2.33, found by:

$$\bar{x} = \frac{\Sigma x}{n} = \frac{28}{7} = 4$$

$$s^2 = \frac{\Sigma(x - \bar{x})^2}{n - 1}$$

$$= \frac{14}{7 - 1}$$

$$= 2.33$$

$$s = \sqrt{2.33} = 1.53$$

3–9 **a.** $k = \dfrac{14.15 - 14.00}{.10} = 1.5$

$k = \dfrac{13.85 - 14.0}{.10} = -1.5$

$1 - \dfrac{1}{(1.5)^2} = 1 - .44 = .56$

b. 13.8 and 14.2

3–10 **a.** Frequency distribution.

b. $\bar{x} = \dfrac{\Sigma fM}{M} = \dfrac{\$244}{20} = \$12.20$

c. $s = \sqrt{\dfrac{303.20}{20 - 1}} = \$3.99$

CHAPTER 4

4–1 **1. a.** 79, 105

b. 15

c. From 88 to 97; 75% of the stores are in this range.

4–2 **a.** 7.9

b. $Q_1 = 7.76$, $Q_3 = 8.015$

4–3 The smallest value is 10 and the largest 85; the first quartile is 25 and the third 60. About 50% of the values are between 25 and 60. The median value is 40. The distribution is positively skewed. There are no outliers.

4–4 **a.** $\bar{x} = \dfrac{407}{5} = 81.4$,

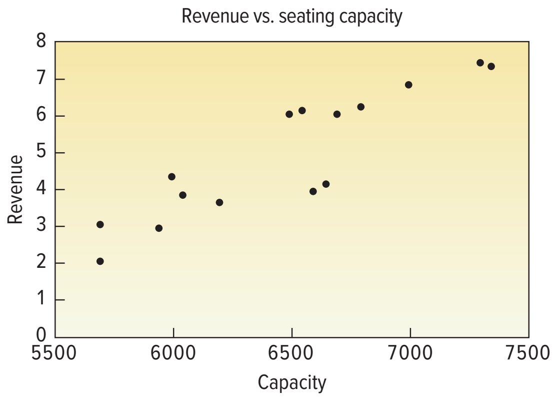
$s = \sqrt{\dfrac{923.2}{5 - 1}} = 15.19$, Median = 84

b. $sk = \dfrac{3(81.4 - 84.0)}{15.19} = -0.51$

c. $sk = \dfrac{5}{(4)(3)}[-1.3154] = -0.5481$

d. The distribution is somewhat negatively skewed.

4–5 **a.**



b. The correlation coefficient is 0.90.
c. \$7,500
d. Strong and positive. Revenue is positively related to seating capacity.

CHAPTER 5

5–1 **a.** Count the number who think the new game is playable.
b. Seventy-three players found the game playable. Many other answers are possible.
c. No. Probability cannot be greater than 1. The probability that the game, if put on the market, will be successful is 65/80, or .8125.
d. Cannot be less than 0. Perhaps a mistake in arithmetic.
e. More than half of the players testing the game liked it. (Of course, other answers are possible.)

5–2 **1.** $\frac{\text{4 queens in deck}}{\text{52 cards total}} = \frac{4}{52} = .0769$ Classical.

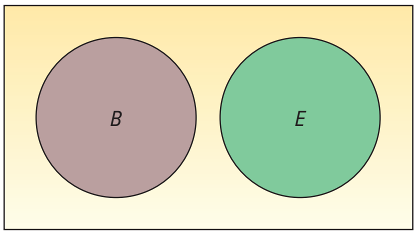
2. $\frac{182}{539} = .338$ Empirical.

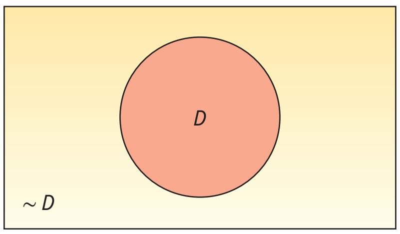
3. The probability of the outcome is estimated by applying the subjective approach to estimating a probability. If you think that it is likely that you will save \$1 million, then your probability should be between .5 and 1.0.

5–3 **a.** **i.** $\frac{(50 + 68)}{2{,}000} = .059$

ii. $1 - \frac{302}{2{,}000} = .849$

b.



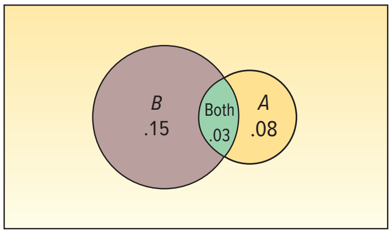


c. They are not complementary, but are mutually exclusive.

5–4 **a.** Need for corrective shoes is event *A*. Need for major dental work is event *B*.

$$P(A \text{ or } B) = P(A) + P(B) - P(A \text{ and } B) = .08 + .15 - .03 = .20$$

b. One possibility is:



5–5 (.95)(.95)(.95)(.95) = .8145

5–6 **a.** .002, found by:

$$\left(\frac{4}{12}\right)\left(\frac{3}{11}\right)\left(\frac{2}{10}\right)\left(\frac{1}{9}\right) = \frac{24}{11{,}880} = .002$$

b. .14, found by:

$$\left(\frac{8}{12}\right)\left(\frac{7}{11}\right)\left(\frac{6}{10}\right)\left(\frac{5}{9}\right) = \frac{1{,}680}{11{,}880} = .1414$$

c. No, because there are other possibilities, such as three women and one man.

5–7 **a.** $P(B_2) = \frac{225}{500} = .45$

b. The two events are mutually exclusive, so apply the special rule of addition.

$$P(B_1 \text{ or } B_2) = P(B_1) + P(B_2) = \frac{100}{500} + \frac{225}{500} = .65$$

c. The two events are not mutually exclusive, so apply the general rule of addition.

$$P(B_1 \text{ or } A_1) = P(B_1) + P(A_1) - P(B_1 \text{ and } A_1) = \frac{100}{500} + \frac{75}{500} - \frac{15}{500} = .32$$

d. As shown in the example/solution, movies attended per month and age are not independent, so apply the general rule of multiplication.

$$P(B_1 \text{ and } A_1) = P(B_1)P(A_1 \mid B_1) = \left(\frac{100}{500}\right)\left(\frac{15}{100}\right) = .03$$

5–8 **a.** $P(\text{visited often}) = \frac{80}{195} = .41$

b. $P(\text{visited a store in an enclosed mall}) = \frac{90}{195} = .46$

c. The two events are not mutually exclusive, so apply the general rule of addition.

P(visited often or visited a Sears in an enclosed mall)
= *P*(often) + *P*(enclosed mall) − *P*(often and enclosed mall)

$$= \frac{80}{195} + \frac{90}{195} - \frac{60}{195} = .56$$

d. *P*(visited often | went to a Sears in an enclosed mall)

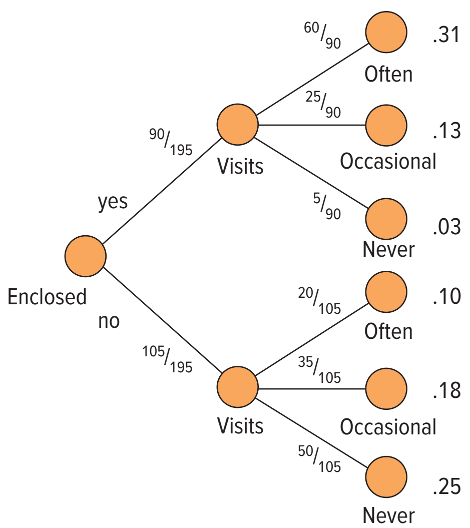
$$= \frac{60}{90} = .67$$

e. Independence requires that $P(A \mid B) = P(A)$. One possibility is: *P*(visit often | visited an enclosed mall) = *P*(visit often). Does 60/90 = 80/195? No, the two variables are not independent. Therefore, any joint probability in the table must be computed by using the general rule of multiplication.

f. As shown in part (e), visits often and enclosed mall are not independent, so apply the general rule of multiplication.

$$P(\text{often and enclosed mall}) = P(\text{often})P(\text{enclosed} \mid \text{often}) = \left(\frac{80}{195}\right)\left(\frac{60}{80}\right) = .31$$

g.



5–9 **a.** $P(A_3 \mid B_2) = \dfrac{P(A_3)P(B_2 \mid A_3)}{P(A_1)P(B_2 \mid A_1) + P(A_2)P(B_2 \mid A_2) + P(A_3)P(B_2 \mid A_3)}$

b. $= \dfrac{(.50)(.96)}{(.30)(.97) + (.20)(.95) + (.50)(.96)}$

$= \dfrac{.480}{.961} = .499$

5–10 **1.** $(5)(4) = 20$

2. $(3)(2)(4)(3) = 72$

5–11 **1.** **a.** 60, found by (5)(4)(3).

b. 60, found by:

$\dfrac{5!}{(5-3)!} = \dfrac{5 \cdot 4 \cdot 3 \cdot \cancel{2 \cdot 1}}{\cancel{2 \cdot 1}}$

2. 5,040, found by:

$\dfrac{10!}{(10-4)!} = \dfrac{10 \cdot 9 \cdot 8 \cdot 7 \cdot \cancel{6 \cdot 5 \cdot 4 \cdot 3 \cdot 2 \cdot 1}}{\cancel{6 \cdot 5 \cdot 4 \cdot 3 \cdot 2 \cdot 1}}$

3. **a.** 35 is correct, found by:

${}_7C_3 = \dfrac{n!}{r!(n-r)!} = \dfrac{7!}{3!(7-3)!} = 35$

b. Yes. There are 21 combinations, found by:

${}_7C_5 = \dfrac{n!}{r!(n-r)!} = \dfrac{7!}{5!(7-5)!} = 21$

4. **a.** ${}_{50}P_3 = \dfrac{50!}{(50-3)!} = 117{,}600$

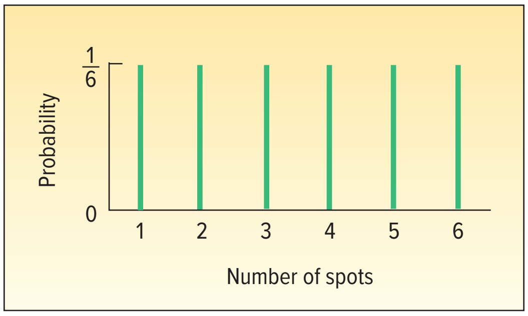
b. ${}_{50}C_3 = \dfrac{50!}{3!\,(50-3)!} = 19{,}600$

CHAPTER 6

6–1 **a.**

Number of Spots	Probability
1	$\frac{1}{6}$
2	$\frac{1}{6}$
3	$\frac{1}{6}$
4	$\frac{1}{6}$
5	$\frac{1}{6}$
6	$\frac{1}{6}$
Total	$\frac{6}{6} = 1.00$

b.



c. $\frac{6}{6}$ or 1.

6–2 **a.** It is discrete because the values \$1.99, \$2.49, and \$2.89 are clearly separated from each other. Also the sum of the probabilities is 1.00, and the outcomes are mutually exclusive.

b.

x	$P(x)$	$xP(x)$
1.99	.30	0.597
2.49	.50	1.245
2.89	.20	0.578
		Sum is 2.42

Mean is 2.42

c.

x	$P(x)$	$(x - \mu)$	$(x - \mu)^2 P(x)$
1.99	.30	−0.43	0.05547
2.49	.50	0.07	0.00245
2.89	.20	0.47	0.04418
			0.10210

The variance is 0.10208, and the standard deviation is 31.95 cents.

6–3 **a.** It is reasonable because each employee either uses direct deposit or does not; employees are independent; the probability of using direct deposit is 0.95 for all; and we count the number using the service out of 7.

b. $P(7) = {}_7C_7\,(.95)^7\,(.05)^0 = .6983$

c. $P(4) = {}_7C_4\,(.95)^4\,(.05)^3 = .0036$

d. Answers are in agreement.

6–4 **a.** $n = 8,\ \pi = .40$

b. $P(x = 3) = .2787$

c. $P(x > 0) = 1 - P(x = 0) = 1 - .0168 = .9832$

6–5 $P(3) = \dfrac{{}_8C_3\,{}_4C_2}{{}_{12}C_5} = \dfrac{\left(\frac{8!}{3!5!}\right)\left(\frac{4!}{2!2!}\right)}{\frac{12!}{5!7!}}$

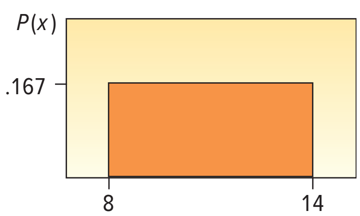
$= \dfrac{(56)(6)}{792} = .424$

6–6 $\mu = 4{,}000(.0002) = 0.8$

$P(1) = \dfrac{0.8^1 e^{-0.8}}{1!} = .3595$

CHAPTER 7

7–1 **a.**



b. $P(x) = \text{(height)(base)}$

$$= \left(\frac{1}{14-8}\right)(14-8)$$
$$= \left(\frac{1}{6}\right)(6) = 1.00$$

c. $\mu = \frac{a+b}{2} = \frac{14+8}{2} = \frac{22}{2} = 11$

$$\sigma = \sqrt{\frac{(b-a)^2}{12}} = \sqrt{\frac{(14-8)^2}{12}} = \sqrt{\frac{36}{12}} = \sqrt{3}$$
$$= 1.73$$

d. $P(10 < x < 14) = \text{(height)(base)}$

$$= \left(\frac{1}{14-8}\right)(14-10)$$
$$= \frac{1}{6}(4)$$
$$= .667$$

e. $P(x < 9) = \text{(height)(base)}$

$$= \left(\frac{1}{14-8}\right)(9-8)$$
$$= 0.167$$

7–2 a. $z = (64 - 48)/12.8 = 1.25$. This person's difference of 16 ounces more than average is 1.25 standard deviations above the average.

b. $z = (32 - 48)/12.8 = -1.25$. This person's difference of 16 ounces less than average is 1.25 standard deviations below the average.

7–3 a. \$46,400 and \$48,000, found by \$47,200 ± 1(\$800).

b. \$45,600 and \$48,800, found by \$47,200 ± 2(\$800).

c. \$44,800 and \$49,600, found by \$47,200 ± 3(\$800).

d. \$47,200. The mean, median, and mode are equal for a normal distribution.

e. Yes, a normal distribution is symmetrical.

7–4 a. Computing z:

$$z = \frac{154-150}{5} = 0.80$$

Referring to Appendix B.3, the area is .2881. So $P(150 < \text{temp} < 154) = .2881$.

b. Computing z:

$$z = \frac{164-150}{5} = 2.80$$

Referring to Appendix B.3, the area is .4974. So $P(164 > \text{temp}) = .5000 - .4974 = .0026$

7–5 a. Computing the z-values:

$$z = \frac{146-150}{5} = -0.80 \quad \text{and} \quad z = \frac{156-150}{5} = 1.20$$

$$P(146 < \text{temp} < 156) = P(-0.80 < z < 1.20)$$
$$= .2881 + .3849 = .6730$$

b. Computing the z-values:

$$z = \frac{162-150}{5} = 2.40 \quad \text{and} \quad z = \frac{156-150}{5} = 1.20$$

$$P(156 < \text{temp} < 162) = P(1.20 < z < 2.40)$$
$$= .4918 - .3849 = .1069$$

7–6 85.24 (instructor would no doubt make it 85). The closest area to .4000 is .3997; z is 1.28. Then:

$$1.28 = \frac{x-75}{8}$$
$$10.24 = x - 75$$
$$x = 85.24$$

7–7 a. .0465, found by $\mu = n\pi = 200(.80) = 160$, and $\sigma^2 = n\pi(1-\pi) = 200(.80)(1-.80) = 32$. Then,

$$\sigma = \sqrt{32} = 5.66$$
$$z = \frac{169.5-160}{5.66} = 1.68$$

Area from Appendix B.3 is .4535. Subtracting from .5000 gives .0465.

b. .9686, found by .4686 + .5000. First calculate z:

$$z = \frac{149.5-160}{5.66} = -1.86$$

Area from Appendix B.3 is .4686.

7–8 a. .7769, found by:

$$P(\text{Arrival} < 15) = 1 - e^{-\frac{1}{10}(15)}$$
$$= 1 - .2231 = .7769$$

b. .0821, found by:

$$P(\text{Arrival} > 25) = e^{-\frac{1}{10}(25)} = .0821$$

c. .1410, found by

$$P(15 < x < 25) = P(\text{Arrival} < 25) - P(\text{Arrival} < 15)$$
$$= .9179 - .7769 = .1410$$

d. 16.09 minutes, found by:

$$.80 = 1 - e^{-\frac{1}{10}(x)}$$
$$-\ln 0.20 = \frac{1}{10}x$$
$$x = -(-1.609)(10) = 1.609(10) = 16.09$$

CHAPTER 8

8–1 a. Students selected are Lehman, Edinger, Nickens, Chontos, St. John, and Kemp.

b. Answers will vary.

c. Skip it and move to the next random number.

8–2 The students selected are Berry, Francis, Kopp, Poteau, and Swetye.

8–3 a. 10, found by:

$$_5C_2 = \frac{5!}{2!(5-2)!}$$

b.

	Service	Sample Mean
Snow, Tolson	20, 22	21
Snow, Kraft	20, 26	23
Snow, Irwin	20, 24	22
Snow, Jones	20, 28	24
Tolson, Kraft	22, 26	24
Tolson, Irwin	22, 24	23
Tolson, Jones	22, 28	25
Kraft, Irwin	26, 24	25
Kraft, Jones	26, 28	27
Irwin, Jones	24, 28	26

c.

Mean	Number	Probability
21	1	.10
22	1	.10
23	2	.20
24	2	.20
25	2	.20
26	1	.10
27	1	.10
	10	1.00

d. Identical: population mean, μ, is 24, and mean of sample means, is also 24.

e. Sample means range from 21 to 27. Population values go from 20 to 28.

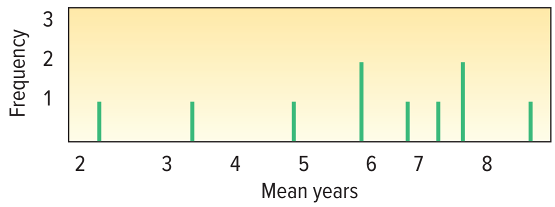
f. No, the population is uniformly distributed.

g. Yes.

8–4 The answers will vary. Here is one solution.

	Sample Number									
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
	8	2	2	19	3	4	0	4	1	2
	19	1	14	9	2	5	8	2	14	4
	8	3	4	2	4	4	1	14	4	1
	0	3	2	3	1	2	16	1	2	3
	2	1	7	2	19	18	18	16	3	7
Total	37	10	29	35	29	33	43	37	24	17
$\bar{x}$	7.4	2	5.8	7.0	5.8	6.6	8.6	7.4	4.8	3.4

Mean of the 10 sample means is 5.88.



8–5 $z = \dfrac{31.08 - 31.20}{0.4/\sqrt{16}} = -1.20$

The probability that z is greater than −1.20 is .5000 + .3849 = .8849. There is more than an 88% chance the filling operation will produce bottles with at least 31.08 ounces.

CHAPTER 9

9–1 **a.** Unknown. This is the value we wish to estimate.

b. The sample mean of $20,000 is the point estimate of the population mean daily franchise sales.

c. $\$20{,}000 \pm 1.960 \dfrac{\$3{,}000}{\sqrt{40}} = \$20{,}000 \pm \$930$

d. The estimate of the population mean daily sales for the Bun-and-Run franchises is between $19,070 and $20,930. About 95% all possible samples of 40 Bun-and-Run franchises would include the population mean.

9–2 **a.** $\bar{x} = \dfrac{18}{10} = 1.8 \qquad s = \sqrt{\dfrac{11.6}{10 - 1}} = 1.1353$

b. The population mean is not known. The best estimate is the sample mean, 1.8 days.

c. $1.80 \pm 2.262 \dfrac{1.1353}{\sqrt{10}} = 1.80 \pm 0.81$

The endpoints are 0.99 and 2.61.

d. t is used because the population standard deviation is unknown.

e. The value of 0 is not in the interval. It is unreasonable to conclude that the mean number of days of work missed is 0 per employee.

9–3 **a.** $p = \dfrac{420}{1{,}400} = .30$

b. $.30 \pm 2.576\,(.0122) = .30 \pm .03$

c. The interval is between .27 and .33. About 99% of the similarly constructed intervals would include the population mean.

9–4 $n = \left(\dfrac{2.576(.279)}{.05}\right)^2 = 206.6$. The sample should be rounded to 207.

9–5 $.375 \pm 1.96\sqrt{\dfrac{.375(1 - .375)}{40}}\sqrt{\dfrac{250 - 40}{250 - 1}} =$

$.375 \pm 1.96(.0765)(.9184) = .375 \pm .138$

CHAPTER 10

10–1 **a.** H_0: $\mu = 16.0$; H_1: $\mu \neq 16.0$

b. .05

c. $z = \dfrac{\bar{x} - \mu}{\sigma/\sqrt{n}}$

d. Reject H_0 if $z < -1.96$ or $z > 1.96$.

e. $z = \dfrac{16.017 - 16.0}{0.15/\sqrt{50}} = \dfrac{0.0170}{0.0212} = 0.80$

f. Do not reject H_0.

g. We cannot conclude the mean amount dispensed is different from 16.0 ounces.

10–2 **a.** H_0: $\mu \leq 16.0$; H_1: $\mu > 16.0$

b. Reject H_0 if $z > 1.645$.

c. The sampling error is 16.04 − 16.00 = 0.04 ounce.

d. $z = \dfrac{16.040 - 16.0}{0.15/\sqrt{50}} = \dfrac{.0400}{.0212} = 1.89$

e. Reject H_0.

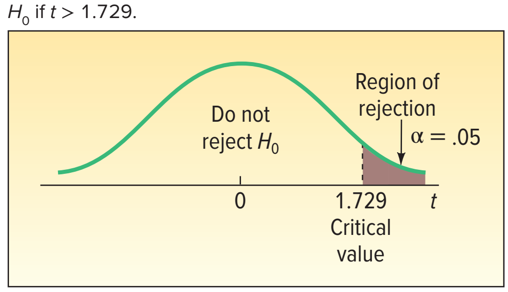
f. The mean amount dispensed is more than 16.0 ounces.

g. p-value = .5000 − .4706 = .0294. The p-value is less than α (.05), so H_0 is rejected. It is the same conclusion as in part (d).

10–3 **a.** H_0: $\mu \leq 305$; H_1: $\mu > 305$

b. $df = n - 1 = 20 - 1 = 19$

The decision rule is to reject H_0 if $t > 1.729$.



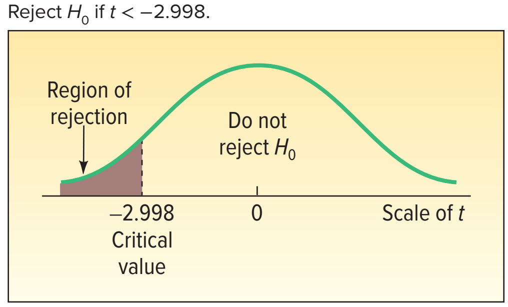
c. $t = \dfrac{\bar{X} - \mu}{s/\sqrt{n}} = \dfrac{311 - 305}{12/\sqrt{20}} = 2.236$

Reject H_0 because 2.236 > 1.729. The modification increased the mean battery life to more than 305 days.

10–4 **a.** H_0: $\mu \geq 9.0$; H_1: $\mu < 9.0$

b. 7, found by $n - 1 = 8 - 1 = 7$

c. Reject H_0 if $t < -2.998$.



d. $t = -2.494$, found by:

$$s = \sqrt{\frac{0.36}{8 - 1}} = 0.2268$$

$$\bar{x} = \frac{70.4}{8} = 8.8$$

Then

$$t = \frac{8.8 - 9.0}{0.2268/\sqrt{8}} = -2.494$$

Since −2.494 lies to the right of −2.998, H_0 is not rejected. We have not shown that the mean is less than 9.0.

e. The p-value is between .025 and .010.

10–5 .0054, found by determining the area under the curve between 10,078 and 10,180.

$$z = \frac{\bar{x}_c - \mu_1}{\sigma/\sqrt{n}}$$

$$= \frac{10{,}078 - 10{,}180}{400/\sqrt{100}} = -2.55$$

The area under the curve for a z of −2.55 is .4946 (Appendix B.3), and .5000 − .4946 = .0054.

CHAPTER 11

11–1 **a.** H_0: $\mu_W \le \mu_M$ H_1: $\mu_W > \mu_M$
The subscript W refers to the women and M to the men.
b. Reject H_0 if $z > 1.645$.
c. $$z = \frac{\$1{,}500 - \$1{,}400}{\sqrt{\frac{(\$250)^2}{50} + \frac{(\$200)^2}{40}}} = 2.11$$
d. Reject the null hypothesis.
e. p-value = .5000 − .4826 = .0174
f. The mean amount sold per day is larger for women.

11–2 **a.** H_0: $\mu_d = \mu_a$ H_1: $\mu_d \ne \mu_a$
b. $df = 6 + 8 - 2 = 12$
Reject H_0 if $t < -2.179$ or $t > 2.179$.
c. $$\bar{x}_1 = \frac{42}{6} = 7.00 \quad s_1 = \sqrt{\frac{10}{6-1}} = 1.4142$$
$$\bar{x}_2 = \frac{80}{8} = 10.00 \quad s_2 = \sqrt{\frac{36}{8-1}} = 2.2678$$
$$s_p^2 = \frac{(6-1)(1.4142)^2 + (8-1)(2.2678)^2}{6+8-2} = 3.8333$$
$$t = \frac{7.00 - 10.00}{\sqrt{3.8333\left(\frac{1}{6} + \frac{1}{8}\right)}} = -2.837$$
d. Reject H_0 because −2.837 is less than the critical value.
e. The p-value is less than .02.
f. The mean number of defects is not the same on the two shifts.
g. Independent populations, populations follow the normal distribution, populations have equal standard deviations.

11–3 **a.** H_0: $\mu_c \ge \mu_a$ H_1: $\mu_c < \mu_a$
b. $$df = \frac{[(356^2/10) + (857^2/8)]^2}{\frac{(356^2/10)^2}{10-1} + \frac{(857^2/8)^2}{8-1}} = 8.93$$
so $df = 8$
c. Reject H_0 if $t < -1.860$.
d. $$t = \frac{\$1{,}568 - \$1{,}967}{\sqrt{\frac{356^2}{10} + \frac{857^2}{8}}} = \frac{-399.00}{323.23} = -1.234$$
e. Do not reject H_0.
f. There is no difference in the mean account balance of those who applied for their card or were contacted by a telemarketer.

11–4 **a.** H_0: $\mu_d \ge 0$, H_1: $\mu_d > 0$
b. Reject H_0 if $t > 2.998$.
c.

Name	Before	After	d	$(d - \bar{d})$	$(d - \bar{d})^2$
Hunter	155	154	1	−7.875	62.0156
Cashman	228	207	21	12.125	147.0156
Mervine	141	147	−6	−14.875	221.2656
Massa	162	157	5	−3.875	15.0156
Creola	211	196	15	6.125	37.5156
Peterson	164	150	14	5.125	26.2656
Redding	184	170	14	5.125	26.2656
Poust	172	165	7	−1.875	3.5156
			71		538.8750

$$\bar{d} = \frac{71}{8} = 8.875$$

$$s_d = \sqrt{\frac{538.875}{8-1}} = 8.774$$
$$t = \frac{8.875}{8.774/\sqrt{8}} = 2.861$$
d. p-value = .0122
e. Do not reject H_0. We cannot conclude that the students lost weight.
f. The distribution of the differences must be approximately normal.

CHAPTER 12

12–1 Let Mark's assemblies be population 1, then H_0: $\sigma_1^2 \le \sigma_2^2$; H_1: $\sigma_1^2 > \sigma_2^2$; $df_1 = 10 - 1 = 9$; and df_2 also equals 9. H_0 is rejected if $F > 3.18$.
$$F = \frac{(2.0)^2}{(1.5)^2} = 1.78$$
H_0 is not rejected. The variation is the same for both employees.

12–2 **a.** H_0: $\mu_1 = \mu_2 = \mu_3$
H_1: At least one treatment mean is different.
b. Reject H_0 if $F > 4.26$.
c. $$\bar{x} = \frac{240}{12} = 20$$
$$\text{SS total} = (18-20)^2 + \cdots + (32-20)^2 = 578$$
$$\text{SSE} = (18-17)^2 + (14-17)^2 + \cdots + (32-29)^2 = 74$$
$$\text{SST} = 578 - 74 = 504$$
d.

Source	Sum of Squares	Degrees of Freedom	Mean Square	F
Treatment	504	2	252	30.65
Error	74	9	8.22	
Total	578	11		

The F-test statistic, 30.65.
e. H_0 is rejected. There is a difference in the mean number of bottles sold at the various locations.

12–3 **a.** H_0: $\mu_1 = \mu_2 = \mu_3$
H_1: Not all means are equal.
b. H_0 is rejected if $F > 3.98$.
c.

ANOVA: Single Factor

Groups	Count	Sum	Average	Variance
Northeast	5	205	41	1
Southeast	4	155	38.75	0.916667
West	5	184	36.8	0.7

ANOVA

Source of Variation	SS	df	MS	F	p-Value
Between Groups	44.16429	2	22.08214	25.43493	7.49E-05
Within Groups	9.55	11	0.868182		
Total	53.71429	13			

d. H_0 is rejected. The treatment means differ.
e. $(41 - 36.8) \pm 2.201\sqrt{0.8682(\frac{1}{5} + \frac{1}{5})} = 4.2 \pm 1.3 = 2.9$ *and* 5.50. The means are significantly different. Zero is not in the interval.
These treatment means differ because both endpoints of the confidence interval are of the same sign.

12–4 **a.** For types:
H_0: $\mu_1 = \mu_2 = \mu_3$
H_1: The treatment means are not equal.
Reject H_0 if $F > 4.46$.
For months:
H_0: $\mu_1 = \mu_2 = \mu_3 = \mu_4 = \mu_5$
H_1: The block means are not equal.

b. Reject H_0 if $F > 3.84$.
c. The analysis of variance table is as follows:

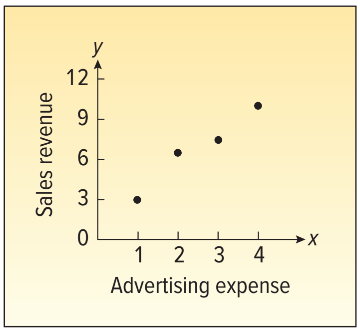
Source	*df*	SS	MS	*F*	*p*-value
Types	2	3.60	1.80	0.39	0.2397
Months	4	31.73	7.93	1.71	0.6902
Error	8	37.07	4.63		
Total	14	72.40			

d. Fail to reject both hypotheses. The *p*-values are more than .05.
e. There is no difference in the mean sales among types or months.

12–5 a. There are four levels of Factor A. The *p*-value is less than .05, so Factor A means differ.
b. There are three levels of Factor B. The *p*-value is less than .05, so the Factor B means differ.
c. There are three observations in each cell. There is an interaction between Factor A and Factor B means because the *p*-value is less than .05.

CHAPTER 13

13–1 a. Advertising expense is the independent variable, and sales revenue is the dependent variable.
b.



c.

x	y	$(x-\bar{x})$	$(x-\bar{x})^2$	$(y-\bar{y})$	$(y-\bar{y})^2$	$(x-\bar{x})(y-\bar{y})$
2	7	−0.5	.25	0	0	0
1	3	−1.5	2.25	−4	16	6
3	8	0.5	.25	1	1	0.5
4	10	1.5	2.25	3	9	4.5
10	28		5.00		26	11.0

$$\bar{x} = \frac{10}{4} = 2.5 \qquad \bar{y} = \frac{28}{4} = 7$$

$$s_x = \sqrt{\frac{5}{3}} = 1.2910$$

$$s_y = \sqrt{\frac{26}{3}} = 2.9439$$

$$r = \frac{\Sigma(X-\bar{X})(y-\bar{y})}{(n-1)s_x s_y} = \frac{11}{(4-1)(1.2910)(2.9439)}$$

$$= 0.9648$$

d. There is a strong correlation between the advertising expense and sales.

13–2 $H_0: \rho \le 0$, $H_1: \rho > 0$. H_0 is rejected if $t > 1.714$.

$$t = \frac{.43\sqrt{25-2}}{\sqrt{1-(.43)^2}} = 2.284$$

H_0 is rejected. There is a positive correlation between the percent of the vote received and the amount spent on the campaign.

13–3 a. See the calculations in Self-Review 13–1, part (c).

$$b = \frac{rs_y}{s_x} = \frac{(0.9648)(2.9439)}{1.2910} = 2.2$$

$$a = \frac{28}{4} - 2.2\left(\frac{10}{4}\right) = 7 - 5.5 = 1.5$$

b. The slope is 2.2. This indicates that an increase of $1 million in advertising will result in an increase of $2.2 million in sales. The intercept is 1.5. If there was no expenditure for advertising, sales would be $1.5 million.
c. $\hat{Y} = 1.5 + 2.2(3) = 8.1$

13–4 $H_0: \beta_1 \le 0$; $H_1: \beta > 0$. Reject H_0 if $t > 3.182$.

$$t = \frac{2.2-0}{0.4243} = 5.1850$$

Reject H_0. The slope of the line is greater than 0.

13–5 a.

y	$\hat{y}$	$(y-\hat{y})$	$(y-\hat{y})^2$
7	5.9	1.1	1.21
3	3.7	−0.7	.49
8	8.1	−0.1	.01
10	10.3	−0.3	.09
			1.80

$$s_{y \cdot x} = \sqrt{\frac{\Sigma(y-\hat{y})^2}{n-2}}$$

$$= \sqrt{\frac{1.80}{4-2}} = .9487$$

b. $r^2 = (.9648)^2 = .9308$
c. Ninety-three percent of the variation in sales is accounted for by advertising expense.

13–6 6.58 and 9.62, since for an x of 3 is 8.1, found by $\hat{y} = 1.5 + 2.2(3) = 8.1$, then $\bar{x} = 2.5$ and $\Sigma(x-\bar{x})^2 = 5$. t from Appendix B.5 for $4 - 2 = 2$ degrees of freedom at the .10 level is 2.920.

$$\hat{y} \pm t(s_{y \cdot x})\sqrt{\frac{1}{n} + \frac{(x-\bar{x})^2}{\Sigma(x-\bar{x})^2}}$$

$$= 8.1 \pm 2.920(0.9487)\sqrt{\frac{1}{4} + \frac{(3-2.5)^2}{5}}$$

$$= 8.1 \pm 2.920(0.9487)(0.5477)$$

$$= 6.58 \text{ and } 9.62 \text{ (in \$ millions)}$$

CHAPTER 14

14–1 a. $389,500 or 389.5 (in $000); found by
$2.5 + 3(40) + 4(72) - 3(10) + .2(20) + 1(5) = 3{,}895$
b. The b_2 of 4 shows profit will go up $4,000 for each extra hour the restaurant is open (if none of the other variables change). The b_3 of −3 implies profit will fall $3,000 for each added mile away from the central area (if none of the other variables change).

14–2 a. The total degrees of freedom $(n - 1)$ is 25. So the sample size is 26.
b. There are 5 independent variables.
c. There is only 1 dependent variable (profit).
d. $S_{Y.12345} = 1.414$, found by $\sqrt{2}$. Ninety-five percent of the residuals will be between −2.828 and 2.828, found by $\pm 2(1.414)$.
e. $R^2 = .714$, found by 100/140. 71.4% of the deviation in profit is accounted for by these five variables.
f. $R^2_{adj} = .643$, found by

$$1 - \left[\frac{40}{(26-(5+1))}\right] \Big/ \left[\frac{140}{(26-1)}\right]$$

14–3 a. $H_0: \beta_1 = \beta_2 = \beta_3 = \beta_4 = \beta_5 = 0$
H_1: Not all of the βs are 0.
The decision rule is to reject H_0 if $F > 2.71$. The computed value of F is 10, found by 20/2. So, you reject H_0, which indicates at least one of the regression coefficients is different from zero.

Based on *p*-values, the decision rule is to reject the null hypothesis if the *p*-value is less than .05. The computed value of F is 10, found by 20/2, and has a *p*-value of .000. Thus, we reject the null hypothesis, which indicates that at least one of the regression coefficients is different from zero.

b. For variable 1: H_0: $\beta_1 = 0$ and H_1: $\beta_1 \neq 0$
The decision rule is to reject H_0 if $t < -2.086$ or $t > 2.086$. Since 2.000 does not go beyond either of those limits, we fail to reject the null hypothesis. This regression coefficient could be zero. We can consider dropping this variable. By parallel logic, the null hypothesis is rejected for variables 3 and 4.

For variable 1, the decision rule is to reject H_0: $\beta_1 = 0$ if the *p*-value is less than .05. Because the *p*-value is .056, we cannot reject the null hypothesis. This regression coefficient could be zero. Therefore, we can consider dropping this variable. By parallel logic, we reject the null hypothesis for variables 3 and 4.

c. We should consider dropping variables 1, 2, and 5. Variable 5 has the smallest absolute value of *t* or largest *p*-value. So delete it first and compute the regression equation again.

14–4 a. $\hat{y} = 15.7625 + 0.4415x_1 + 3.8598x_2$
$\hat{y} = 15.7625 + 0.4415(30) + 3.8598(1)$
$= 32.87$

b. Female agents make $3,860 more than male agents.

c. H_0: $\beta_3 = 0$
H_1: $\beta_3 \neq 0$
$df = 17$; reject H_0 if $t < -2.110$ or $t > 2.110$

$$t = \frac{3.8598 - 0}{1.4724} = 2.621$$

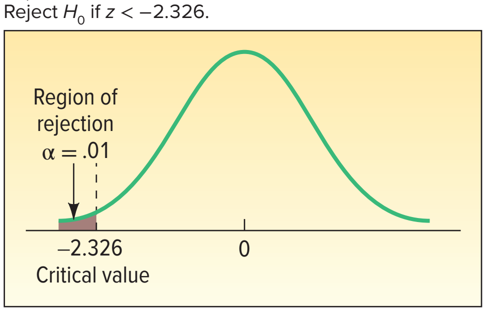
The *t*-statistic exceeds the critical value of 2.110. Also, the *p*-value = .0179 and is less than .05. Reject H_0. Gender should be included in the regression equation.

CHAPTER 15

15–1 a. Yes, because both $n\pi$ and $n(1 - \pi)$ exceed 5: $n\pi = 200(.40) = 80$, and $n(1 - \pi) = 200(.60) = 120$.

b. H_0: $\pi \geq .40$
H_1: $\pi < .40$

c. Reject H_0 if $z < -2.326$.



d. $z = -0.87$, found by:

$$z = \frac{.37 - .40}{\sqrt{\frac{.40(1 - .40)}{200}}} = \frac{-.03}{\sqrt{.0012}} = -0.87$$

Do not reject H_0.

e. The *p*-value is .1922, found by .5000 − .3078.

15–2 a. H_0: $\pi_a = \pi_{ch}$
H_1: $\pi_a \neq \pi_{ch}$

b. .10

c. Two-tailed

d. Reject H_0 if $z < -1.645$ or $z > 1.645$.

e. $$p_c = \frac{87 + 123}{150 + 200} = \frac{210}{350} = .60$$

$$p_a = \frac{87}{150} = .58 \qquad p_{ch} = \frac{123}{200} = .615$$

$$z = \frac{.58 - .615}{\sqrt{\frac{.60(.40)}{150} + \frac{.60(.40)}{200}}} = -0.66$$

f. Do not reject H_0.

g. *p*-value = 2(.5000 − .2454) = .5092
There is no difference in the proportion of adults and children that liked the proposed flavor.

15–3 a. Observed frequencies

b. Six (six days of the week)

c. 10. Total observed frequencies ÷ 6 = 60/6 = 10.

d. 5; $k - 1 = 6 - 1 = 5$

e. 15.086 (from the chi-square table in Appendix B.7).

f. $$\chi^2 = \Sigma\left[\frac{(f_o - f_e)^2}{f_e}\right] = \frac{(12 - 10)^2}{10} + \cdots + \frac{(9 - 10)^2}{10} = 0.8$$

g. Do not reject H_0.

h. Evidence fails to show a difference in the proportion of absences by day of the week.

15–4 H_0: $P_C = .60$, $P_L = .30$, and $P_U = .10$.
H_1: Distribution is not as above.
Reject H_0 if $\chi^2 > 5.991$.

Category	f_o	f_e	$\frac{(f_o - f_e)^2}{f_e}$
Current	320	300	1.33
Late	120	150	6.00
Uncollectible	60	50	2.00
	500	500	9.33

Reject H_0. The accounts receivable data do not reflect the national average.

15–5 a. Contingency table

b. H_0: There is no relationship between income and whether the person played the lottery. H_1: There is a relationship between income and whether the person played the lottery.

c. Reject H_0 if $\chi^2 > 5.991$.

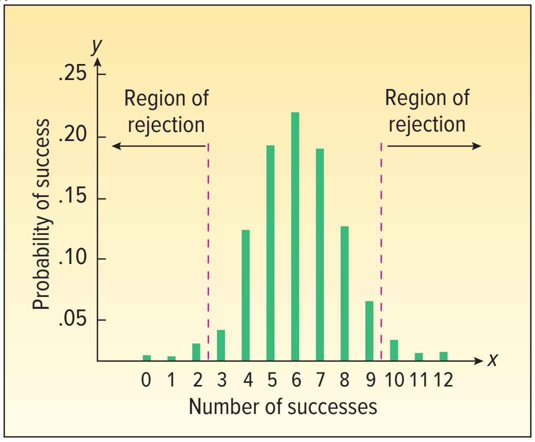
d. $$\chi^2 = \frac{(46 - 40.71)^2}{40.71} + \frac{(28 - 27.14)^2}{27.14} + \frac{(21 - 27.14)^2}{27.14} + \frac{(14 - 19.29)^2}{19.29} + \frac{(12 - 12.86)^2}{12.86} + \frac{(19 - 12.86)^2}{12.86}$$
$$= 6.544$$

e. Reject H_0. There is a relationship between income level and playing the lottery.

CHAPTER 16

16–1 a. Two-tailed because H_1 does not state a direction.

b.



Adding down, .000 + .003 + .016 = .019. This is the largest cumulative probability up to but not exceeding .050, which is half the level of significance. The decision rule is to reject H_0 if the number of plus signs is 2 or less or 10 or more.

c. Reject H_0; accept H_1. There is a preference.

16–2 H_0: median = $3,000, H_1: median ≠ $3,000
Binomial distribution with n = 20, and $\pi = 0.5$

x	*P*(*x*)	Cumulative probabilities in the tails
0	0.000	
1	0.000	0.000
2	0.000	0.000
3	0.001	0.001
4	0.005	0.006
5	0.015	0.019
6	0.037	0.052
7	0.074	
8	0.120	
9	0.160	
10	0.176	
11	0.160	
12	0.120	
13	0.074	
14	0.037	0.052
15	0.015	0.019
16	0.005	0.006
17	0.001	0.001
18	0.000	0.000
19	0.000	0.000
20	0.000	

Reject H_0: median = $3,000 if number of successes is 5 or less, or the number of success is 15 or more. In this example, the number of successes is 13. Therefore, fail to reject H_0.

16–3 **a.** $n = 10$ (because there was no change for A. A.)

b.

Before	After	Difference	Absolute Difference	Rank	R^-	R^+
17	18	−1	1	1.5	1.5	
21	23	−2	2	3.0	3.0	
25	22	3	3	5.0		5.0
15	25	−10	10	8.0	8.0	
10	28	−18	18	10.0	10.0	
16	16	—	—	—	—	—
10	22	−12	12	9.0	9.0	
20	19	1	1	1.5		1.5
17	20	−3	3	5.0	5.0	
24	30	−6	6	7.0	7.0	
23	26	−3	3	5.0	5.0	
					48.5	6.5

H_0: Production is the same.
H_1: Production has increased.

The sum of the positive signed ranks is 6.5; the negative sum is 48.5. From Appendix B.8, one-tailed test, $n = 10$, the critical value is 10. Since 6.5 is less than 10, reject the null hypothesis and accept the alternate. New procedures did increase production.

c. No assumption regarding the shape of the distribution is necessary.

16–4 H_0: There is no difference in the distances traveled by the XL-5000 and by the D2.
H_1: There is a difference in the distances traveled by the XL-5000 and by the D2.

Do not reject H_0 if the computed z is between 1.96 and −1.96 (from Appendix B.3); otherwise, reject H_0 and accept H_1. $n_1 = 8$, the number of observations in the first sample.

XL-5000		D2	
Distance	Rank	Distance	Rank
252	4	262	9
263	10	242	2
279	15	256	5
273	14	260	8
271	13	258	7
265	11.5	243	3
257	6	239	1
280	16	265	11.5
Total	89.5		46.5

$W = 89.5$

$$z = \frac{89.5 - \frac{8(8 + 8 + 1)}{2}}{\sqrt{\frac{(8)(8)(8 + 8 + 1)}{12}}} = \frac{21.5}{9.52} = 2.26$$

Reject H_0; accept H_1. There is evidence of a difference in the distances traveled by the two golf balls.

16–5

Ranks			
Englewood	West Side	Great Northern	Sylvania
17	5	19	7
20	1	9.5	11
16	3	21	15
13	5	22	9.5
5	2	14	8
18			12

$\Sigma R_1 = 89$ $\Sigma R_2 = 16$ $\Sigma R_3 = 85.5$ $\Sigma R_4 = 62.5$
$n_1 = 6$ $n_2 = 5$ $n_3 = 5$ $n_4 = 6$

H_0: The population distributions are identical.
H_1: The population distributions are not identical.

$$H = \frac{12}{22(22 + 1)}\left[\frac{(89)^2}{6} + \frac{(16)^2}{5} + \frac{(85.5)^2}{5} + \frac{(62.5)^2}{6}\right] - 3(22 + 1)$$
$= 13.635$

The critical value of chi-square for $k - 1 = 4 - 1 = 3$ degrees of freedom is 11.345. Since the computed value of 13.635 is greater than 11.345, the null hypothesis is rejected. We conclude that the number of transactions is not the same.

16–6 **a.**

		Rank			
x	*y*	*x*	*y*	*d*	d^2
805	23	5.5	1	4.5	20.25
777	62	3.0	9	−6.0	36.00
820	60	8.5	8	0.5	0.25
682	40	1.0	4	−3.0	9.00
777	70	3.0	10	−7.0	49.00
810	28	7.0	2	5.0	25.00
805	30	5.5	3	2.5	6.25
840	42	10.0	5	5.0	25.00
777	55	3.0	7	−4.0	16.00
820	51	8.5	6	2.5	6.25
				0	193.00

$$r_s = 1 - \frac{6(193)}{10(99)} = -.170$$

b. H_0: $\rho = 0$; H_1: $\rho \neq 0$. Reject H_0 if $t < -2.306$ or $t > 2.306$.

$$t = -.170\sqrt{\frac{10-2}{1-(-0.170)^2}} = -0.488$$

H_0 is not rejected. We have not shown a relationship between the two tests.

CHAPTER 17

17–1 **1.**

Country	Amount	Index (Based=US)
China	831.7	1026.8
Japan	104.7	129.3
United States	81	100.0
India	101.5	125.3
Russia	71.5	88.3

China produced 926.8% more steel than the U.S.

2. a.

Year	Average Hourly Earnings	Index (1995 = Base)
2010	22.76	100.0
2012	23.73	104.3
2014	24.65	108.3
2016	25.93	113.9
2018	27.53	121.0

The 2018 average increased 21.0% from 2010.

b.

Year	Average Hourly Earnings	Index (1995 – 2000 = Base)
2010	22.76	97.9
2012	23.73	102.1
2014	24.65	106.0
2016	25.93	111.6
2018	27.53	118.4

The 2018 average increased 18.4% from the average of 2010 and 2012.

17–2 **1. a.** $P_1 = (\$85/\$75)(100) = 113.3$

$P_2 = (\$45/\$40)(100) = 112.5$

$P = (113.3 + 112.5)/2 = 112.9$

b. $P = (\$130/\$115)(100) = 113.0$

c. $$P = \frac{\$85(500) + \$45(1{,}200)}{\$75(500) + \$40(1{,}200)}(100)$$

$$= \frac{\$96{,}500}{85{,}500}(100) = 112.9$$

d. $$P = \frac{\$85(520) + \$45(1{,}300)}{\$75(520) + \$40(1{,}300)}(100)$$

$$= \frac{\$102{,}700}{\$91{,}000}(100) = 112.9$$

e. $P = \sqrt{(112.9)(112.9)} = 112.9$

17–3 **a.** $$P = \frac{\$4(9{,}000) + \$5(200) + \$8(5{,}000)}{\$3(10{,}000) + \$1(600) + \$10(3{,}000)}(100)$$

$$= \frac{\$77{,}000}{60{,}600}(100) = 127.1$$

b. The value of sales went up 27.1% from 2010 to 2018.

17–4 **a.**

For 2015	
Item	**Weight**
Cotton	(\$0.25/\$0.20)(100)(.10) = 12.50
Autos	(1,200/1,000)(100)(.30) = 36.00
Money turnover	(90/80)(100)(.60) = 67.50
Total	116.00

For 2018	
Item	**Weight**
Cotton	(\$0.50/\$0.20)(100)(.10) = 25.00
Autos	(900/1,000)(100)(.30) = 27.00
Money turnover	(75/80)(100)(.60) = 56.25
Total	108.25

b. Business activity decreased 7.75% from 2015 to 2018.

17–5 In terms of the base period, Jon's salary was \$14,637 in 2000 and \$23,894 in 2018. This indicates that take-home pay increased at a faster rate than the rate of prices paid for food, transportation, etc.

17–6 \$0.37, round by (\$1.00/272.776)(100). The purchasing power has declined by \$0.63.

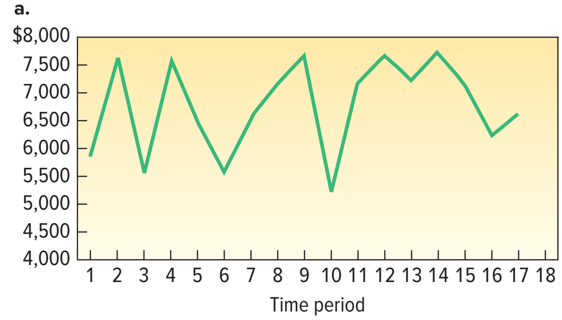
17–7

Year	IPI	PPI
2007	109.667	93.319
2008	97.077	92.442
2009	94.330	96.386
2010	100.000	100.000
2011	102.840	104.710
2012	105.095	106.134
2013	107.381	107.612
2014	110.877	107.010
2015	106.289	104.107
2016	107.150	106.079
2017	110.906	109.474
2018	115.027	111.008

The Industrial Production Index (IPI) increased 15.027% from 2010 to 2018. The Producer Price Index (PPI) increased 11.008%.

CHAPTER 18

18–1 **a.**



b. Over the 18 months, the graph of the time series does not show any trend or seasonal patterns.

c. Because the graph does not show any trend or seasonal patterns, the pattern is random and stationary. Therefore, the best time series forecasting method is an averaging method, such as a simple moving average.

d. and **e.** The MAD, or estimate of forecasting error is 751.7885.

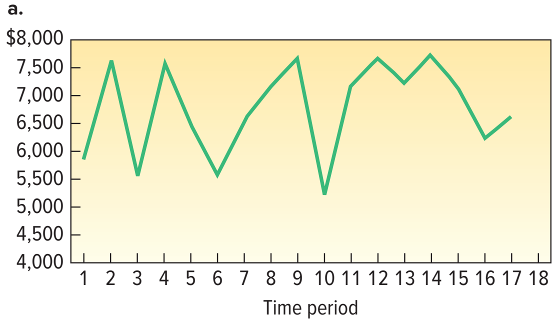
Period	Revenue	4-Month	ABS (error)	Bias
March	$5,874			
April	7,651			
May	5,546			
June	7,594			
July	6,450	$6,666.25	216.25	−216.25
August	5,580	6,810.25	1230.25	−1230.25
September	6,560	6,292.50	267.50	267.50
October	7,209	6,546.00	663.00	663.00
November	7,679	6,449.75	1229.25	1229.25
December	5,192	6,757.00	1565.00	−1565.00
January	7,177	6,660.00	517.00	517.00
February	7,693	6,814.25	878.75	878.75
March	7,232	6,935.25	296.75	296.75
April	7,742	6,823.50	918.50	918.50
May	7,142	7,461.00	319.00	−319.00
June	6,227	7,452.25	1225.25	−1225.25
July	6,639	7,085.75	446.75	−446.75
August		6,937.50	MAD	Bias
			751.7885	−231.75

f. The 8-month moving average MAD is 808.5278.

Period	Revenue	8-Month	ABS (error)	Bias
March	$5,874			
April	7,651			
May	5,546			
June	7,594			
July	6,450			
August	5,580			
September	6,560			
October	7,209			
November	7,679	$6,558.000	1121.000	1121.000
December	5,192	6,783.625	1591.625	−1591.625
January	7,177	6,476.250	700.750	700.750
February	7,693	6,680.125	1012.875	1012.875
March	7,232	6,692.500	539.500	539.500
April	7,742	6,790.250	951.750	951.750
May	7,142	7,060.500	81.500	81.500
June	6,227	7,133.250	906.250	−906.250
July	6,639	7,010.500	371.500	−371.500
August		6,880.500	MAD	Bias
			808.5278	1538.000

g. Based on the comparison of the MADs, the 4-month moving average has the lower MAD and would be preferred over the 8-month average.

18–2 a.



b. Over the 18 months, the graph of the time series does not show any trend or seasonal patterns.

c. Because the graph does not show any trend or seasonal patterns, the pattern is random and stationary. Therefore, the best time series forecasting method is an averaging method. Simple exponential smoothing is a good choice.

d. and **e.** The forecast for August is $6,849.7643. The error of the forecast is the MAD, 823.3141.

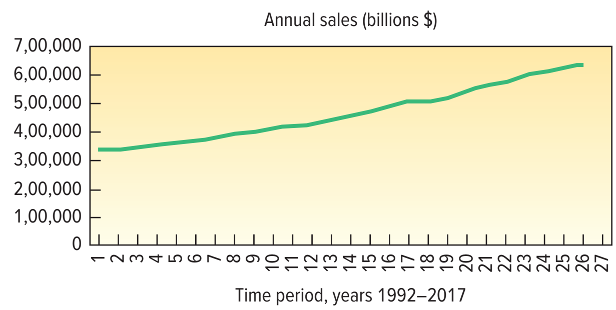
Period	Revenue	Forecast (0.2)	ABS (error)	Bias
March	$5,874			
April	7,651	$5874.0000	1777.0000	1777.0000
May	5,546	6229.4000	683.4000	−683.4000
June	7,594	6092.7200	1501.2800	1501.2800
July	6,450	6392.9760	57.0240	57.0240
August	5,580	6404.3808	824.3808	−824.3808
September	6,560	6239.5046	320.4954	320.4954
October	7,209	6303.6037	905.3963	905.3963
November	7,679	6484.6830	1194.3170	1194.3170
December	5,192	6723.5464	1531.5464	−1531.5464
January	7,177	6417.2371	759.7629	759.7629
February	7,693	6569.1897	1123.8103	1123.8103
March	7,232	6793.9517	438.0483	438.0483
April	7,742	6881.5614	860.4386	860.4386
May	7,142	7053.6491	88.3509	88.3509
June	6,227	7071.3193	844.3193	−844.3193
July	6,639	6902.4554	263.4554	−263.4554
August		6,849.7643	MAD	Bias
			823.3141	4878.8217

f. Using an alpha = 0.7, the forecast for August is $6,610.2779. The error of the forecast is the MAD, 977.1302.

Period	Revenue	Forecast (0.7)	ABS (error)	Bias
March	$5,874			
April	7,651	$5874.0000	1777.0000	1777.0000
May	5,546	7117.9000	1571.9000	−1571.9000
June	7,594	6017.5700	1576.4300	1576.4300
July	6,450	7121.0710	671.0710	−671.0710
August	5,580	6651.3213	1071.3213	−1071.3213
September	6,560	5901.3964	658.6036	658.6036
October	7,209	6362.4189	846.5811	846.5811
November	7,679	6955.0257	723.9743	723.9743
December	5,192	7461.8077	2269.8077	−2269.8077
January	7,177	5872.9423	1304.0577	1304.0577
February	7,693	6785.7827	907.2173	907.2173
March	7,232	7420.8348	188.8348	−188.8348
April	7,742	7288.6504	453.3496	453.3496
May	7,142	7605.9951	463.9951	−463.9951
June	6,227	7281.1985	1054.1985	−1054.1985
July	6,639	6543.2596	95.7404	95.7404
August		6,610.2779	MAD	Bias
			977.1302	1051.8255

g. Based on the comparison of the MADs, the exponential smoothing model with alpha of 0.2 is preferred because it as has a lower MAD than the exponential smoothing model with alpha of 0.7.

18–3 a.



b. The time series graph shows a gradual increase in U.S. total grocery store annual sales between 1992 and 2017.

c. A trend model is appropriate because we would like to estimate the average annual increase shown by the trend pattern in the time series graph.

d. Sales = 298,829.3723 + 12,426.7986 (time period). The MAD is 10,932.39. Notice that the error as a percent of the forecast is very small.

SUMMARY OUTPUT

Regression Statistics	
Multiple R	0.9906
R Square	0.9812
Adjusted R Square	0.9804
Standard Error	13424.0404
Observations	26

ANOVA

	df	*SS*	*MS*	*F*	*p-value*
Regression	1	2.25847E+11	2.26E+11	1253.279	0.0000
Residual	24	4324916631	1.8E+08		
Total	25	2.30172E+11			

	Coefficients	*Standard Error*	*t Stat*	*P-value*
Intercept	298829.3723	5421.0012	55.1244	0.0000
Time Period	12426.7986	351.0228	35.4017	0.0000

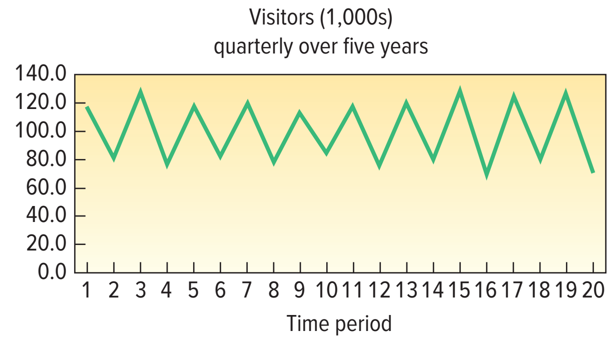
Period	Total Sales	Forecast	ABS Error
1	$337,370	311,256.17	26,113.83
2	341,318	323,682.97	17,635.03
3	350,523	336,109.77	14,413.23
4	356,409	348,536.57	7,872.43
5	365,547	360,963.37	4,583.63
6	372,570	373,390.16	820.16
7	378,188	385,816.96	7,628.96
8	394,250	398,243.76	3,993.76
9	402,515	410,670.56	8,155.56
10	418,127	423,097.36	4,970.36
11	419,813	435,524.16	15,711.16
12	427,987	447,950.96	19,963.96
13	441,136	460,377.75	19,241.75
14	457,667	472,804.55	15,137.55
15	471,699	485,231.35	13,532.35
16	491,360	497,658.15	6,298.15
17	511,222	510,084.95	1,137.05
18	510,033	522,511.75	12,478.75
19	520,750	534,938.55	14,188.55
20	547,476	547,365.34	110.66
21	563,645	559,792.14	3,852.86
22	574,547	572,218.94	2,328.06
23	599,603	584,645.74	14,957.26
24	613,159	597,072.54	16,086.46
25	625,295	609,499.34	15,795.66
26	639,161	621,926.14	17,234.86
			MAD
			10,932.39

e. The predicted annual change in total U.S. grocery sales dollars is $12,426.7986 million.

f. Sales = 298,829.3723 + 12,426.7986 (time period). The next three years–2018, 2019, and 2020–are periods 27, 28, and 29.

2018 sales = 298,829.3723 + 12,426.7986 (27) = 634,352.94
2019 sales = 298,829.3723 + 12,426.7986 (28) = 646.779.73
2020 sales = 298,829.3723 + 12,426.7986 (29) = 659.206.53

18–4 a.



b. The pattern in the time series is clearly seasonality. During a 4-quarter time span, winter and summer are always the highest number of visitors; spring and fall are always the lowest number of visitors.

c. In this time series, there is virtually no trend. So using the overall average as the base of the seasonal indexes would be a logical choice.

d. Computing the indexes by dividing each period's visitors by 100 shows the following results.

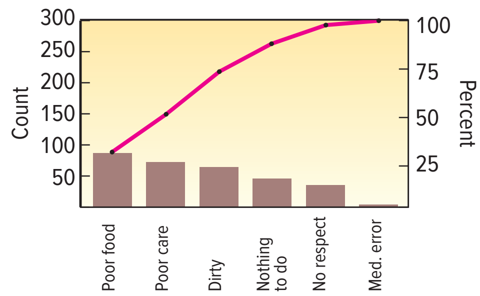
Season	Time Period	Visitors	Indexes (Base = 100)
Winter	1	117.0	1.17
Spring	2	80.7	0.807
Summer	3	129.6	1.296
Fall	4	76.1	0.761
Winter	5	118.6	1.186
Spring	6	82.5	0.825
Summer	7	121.4	1.214
Fall	8	77.0	0.77
Winter	9	114.0	1.14
Spring	10	84.3	0.843
Summer	11	119.1	1.191
Fall	12	75.0	0.75
Winter	13	120.7	1.207
Spring	14	79.6	0.796
Summer	15	129.9	1.299
Fall	16	69.5	0.695
Winter	17	125.2	1.252
Spring	18	80.2	0.802
Summer	19	127.6	1.276
Fall	20	72.0	0.72

Quarter	Seasonal Index
Winter	1.191
Spri ng	0.8146
Summer	1.2552
Fall	0.7392

e. The winter index is 1.191. It means that on average, the number of visitors is 19.1% above the quarterly average of 100,000 visitors, or 191,100 (100,000 × 1.191) visitors. In the spring, the number of visitors is 18.54% below the quarterly average of 100,000 visitors, or 81,460 (100,000 × 0.8146) visitors. The summer index is 1.2552. It means that on average, the number of visitors is 25.52% above the quarterly average of 100,000 visitors, or 125,520 (100,000 × 1.2552) visitors. In the spring, the number of visitors is 26.08% below the quarterly average of 100,000 visitors, or 73,920 (100,000 × 0.7392) visitors.

CHAPTER 19

19–1



Count	84	71	63	45	35	2
Percent	28	24	21	15	12	0
Cum. %	28	52	73	88	100	100

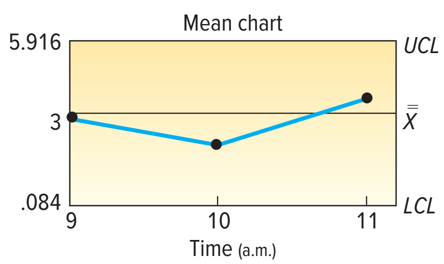
Seventy-three percent of the complaints involve poor food, poor care, or dirty conditions. These are the factors the administrator should address.

19–2 **a.**

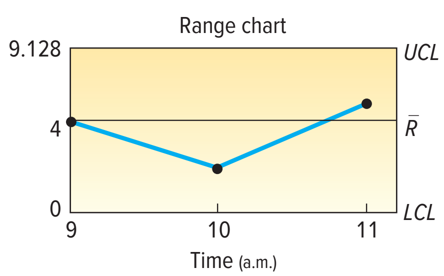
Sample Times						
1	**2**	**3**	**4**	**Total**	**Average**	**Range**
1	4	5	2	12	3	4
2	3	2	1	8	2	2
1	7	3	5	16	4	6
					9	12

$$\bar{\bar{x}} = \frac{9}{3} = 3 \qquad \bar{R} = \frac{12}{3} = 4$$

$$UCL \text{ and } LCL = \bar{\bar{x}} \pm A_2\bar{R}$$
$$= 3 \pm 0.729(4)$$
$$UCL = 5.916 \qquad LCL = 0.084$$



$$LCL = D_3\bar{R} = 0(4) = 0$$
$$UCL = D_4\bar{R} = 2.282(4) = 9.128$$



b. Yes. Both the mean chart and the range chart indicate that the process is in control.

19–3 $\bar{c} = \frac{25}{12} = 2.083$

$$UCL = 2.083 + 3\sqrt{2.083} = 6.413$$
$$LCL = 2.083 - 3\sqrt{2.083} = -2.247$$

Because LCL is a negative value, we set $LCL = 0$. The shift with seven defects is out of control.

19–4 $P(x \leq 2 \mid \pi = .30 \text{ and } n = 20) = .036$

CHAPTER 20

20–1

Event	Payoff	Probability of Event	Expected Value
Market rise	$2,200	.60	$1,320
Market decline	1,100	.40	440
			$1,760

20–2 **a.** Suppose the investor purchased Rim Homes stock, and the value of the stock in a bear market dropped to $1,100 as anticipated (Table 20–1). Instead, had the investor purchased Texas Electronics and the market declined, the value of the Texas Electronics stock would be $1,150. The difference of $50, found by $1,150 − $1,100, represents the investor's regret for buying Rim Homes stock.

b. Suppose the investor purchased Texas Electronics stock, and then a bull market developed. The stock rose to $1,900, as anticipated (Table 20–1). However, had the investor bought Kayser Chemicals stock and the market value increased to $2,400 as anticipated, the difference of $500 represents the extra profit the investor could have made by purchasing Kayser Chemicals stock.

20–3

Event	Payoff	Probability of Event	Expected Opportunity Value
Market rise	$500	.60	$300
Market decline	0	.40	0
			$300

20–4 **a.**

Event	Payoff	Probability of Event	Expected Value
Market rise	$1,900	.40	$ 760
Market decline	1,150	.60	690
			$1,450

b.

Event	Payoff	Probability of Event	Expected Value
Market rise	$2,400	.50	$1,200
Market decline	1,000	.50	500
			$1,700

20–5 For probabilities of a market rise (or decline) down to .333, Kayser Chemicals stock would provide the largest expected profit. For probabilities .333 to .143, Rim Homes would be the best buy. For .143 and below, Texas Electronics would give the largest expected profit. Algebraic solutions:

Kayser: $2{,}400p + (1 - p)1{,}000$
Rim: $2{,}200p + (1 - p)1{,}100$

$1{,}400p + 1{,}000 = 1{,}100p + 1{,}100$
$p = .333$

Rim: $2{,}200p + (1 - p)1{,}100$
Texas: $1{,}900p + (1 - p)1{,}150$

$1{,}100p + 1{,}100 = 750p + 1{,}150$
$p = .143$