Answers to Selected Exercises

Chapter 1

1.1 **a.** the student **b.** the exam **c.** the patient **d.** the plant **e.** the car

1.3 **a.** discrete **b.** continuous **c.** continuous **d.** discrete

1.5 **a.** vehicles **b.** type (qualitative); make (qualitative); carpool (qualitative); distance (quantitative continuous); age (quantitative continuous) **c.** multivariate

1.7 The population is the set of voter preferences for all voters in the state. Voter preferences may change over time.

1.9 **a.** score on the reading test; quantitative **b.** the student **c.** the set of scores for all deaf students who hypothetically might take the test

1.11 **a.** a pair of jeans **b.** the state in which the jeans are produced; qualitative **e.** 8/25 **f.** California **g.** The three states produce roughly the same numbers of jeans.

1.13 **a.** no; add a category called "Other"

1.15 **a.** no **b.** not quite **c.** the bar chart

1.17 Answers will vary.

1.19 **a.** eight to ten class intervals **c.** 43/50 **d.** 33/50 **e.** yes

1.21 **b.** .30 **c.** .70 **d.** .30 **e.** relatively symmetric; no

1.25 **b.** centered at 75; two peaks (bimodal) **c.** Scores are divided into two groups according to student abilities.

1.27 **a.** pie chart, bar chart

1.29 **c.** the Pareto chart

1.31 **a.** skewed right; several outliers

1.33 **b.**

```
Stem-and-leaf of Ages N = 37
 Leaf Unit = 1.0
   2    4  69
   3    5  3
   7    5  6678
  13    6  003344
 (6)    6  567778
  18    7  0111234
  11    7  7889
   7    8  013
   4    8  58
   2    9  00
```

relatively symmetric **c.** Kennedy, Garfield, and Lincoln were assassinated.

1.35 **b.** 0.05

1.37 **a.** number of hazardous waste sites (discrete) **b.** skewed right **c.** size of the state; amount of industrial activity

1.39 **a.** skewed **b.** symmetric **c.** symmetric **d.** symmetric **e.** skewed **f.** skewed

1.41 **a.** continuous **b.** continuous **c.** discrete **d.** discrete **e.** discrete

1.43

```
 7 | 8 9
 8 | 0 1 7
 9 | 0 1 2 4 4 5 6 6 6 8 8
10 | 1 7 9
11 | 2
```

1.45 **c.** skewed right

1.49 **a.** no **b.** roughly mound-shaped

1.51 **a.** skewed right **c.** yes; large states

1.53 **a.** Popular vote is skewed right; percent vote is relatively symmetric. **b.** yes **c.** Once the size of the state is removed, each state will be measured on an equal basis.

1.55 **d.** Answers will vary.

1.57 **a.** no

1.59 **b.** bimodal distribution, outliers; different kiln sites **c.** yes

1.63 **a.** Stem-and-Leaf Display: Percent

```
Stem-and-leaf of Percent N = 51
Leaf Unit = 1.0
  1    0   8
  3    1   00
  3    1
  5    1   44
 10    1   66777
 20    1   8888889999
(11)   2   00000000011
 20    2   233333
 14    2   444555
  8    2   67
  6    2   89
  4    3   01
  2    3   22
```

b. roughly mound-shaped
c. three somewhat low—Alaska, Georgia, and New Jersey

1.65 Use a pie chart or a bar chart.

1.67 **a.** approximately mound-shaped
b. bar centered at 100.8
c. slightly above the center

1.69 **a.** somewhat mound-shaped **b.** .2

1.73 **a–b.** skewed left **c.** 8 and 11

Chapter 2

2.1 **b.** $\bar{x} = 2$; $m = 1$; mode = 1 **c.** skewed

2.3 **a.** 5.8 **b.** 5.5 **c.** 5 and 6

2.5 **a.** slightly skewed right **c.** $\bar{x} = 1.08$; $m = 1$; mode = 1

2.7 2.5 is an average number calculated (or estimated) for all families in a particular category.

2.9 The median, because the distribution is highly skewed to the right.

2.11 **a.** $\bar{x} = 4.72$; $m = 3.50$; mode = 1
b. skewed right **c.** yes

2.13 **a.** 2.4 **b.** 2.8 **c.** 1.673

2.15 **a.** 3 **b.** 2.125 **c.** $s^2 = 1.2679$; $s = 1.126$

2.17 **a.** 1.11 **b.** $s^2 = .19007$, $s = .436$
c. $R \approx 2.5s$

2.19 **a.** $s \approx 1.67$ **b.** $s = 1.75$ **c.** no
d. yes **e.** no

2.21 **a.** approximately .68 **b.** approximately .95
c. approximately .815 **d.** approximately .16

2.23 **a.** $s \approx .20$ **b.** $\bar{x} = .76$; $s = .165$

2.25 **a.** approximately .68 **b.** approximately .95
c. approximately .003

2.27 **a.** ≈ 4.5 **b.** ≈ 2.25 **c.** $\bar{x} = 4.586$; $s = 2.892$

2.29 **a.** skewed right **b.** 0 to 104 days

2.31 **b.** $\bar{x} = 7.729$ **c.** $s = 1.985$

k	$\bar{x} \pm ks$	Actual	Tchebysheff	Empirical Rule
1	(5.744, 9.714)	.71	At least 0	Approx. .68
2	(3.759, 11.699)	.96	At least 3/4	Approx. .95
3	(1.774, 13.684)	1.00	At least 8/9	Approx. .997

2.33 **a.** 42 **b.** $s \approx 10.5$ **c.** $s = 13.10$
d. 1.00; 1.00; yes

2.35 **a.** $s \approx .444$ **b.** $s = .436$

2.37 **a–b.** $\bar{x} = 1.4$; $s^2 = 1.4$

2.39 **a.** $\bar{x} = 2.04$; $s = 2.806$

b–c.

k	$\bar{x} \pm ks$	Actual	Tchebysheff	Empirical Rule
1	(−.766, 4.846)	.84	At least 0	Approx. .68
2	(−3.572, 7.652)	.92	At least 3/4	Approx. .95
3	(−6.378, 10.458)	1.00	At least 8/9	Approx. .997

2.41

Sorted Data Set	Position of Q_1	Measurements Above and Below	Q_1	Position of Q_3	Measurements Above and Below	Q_3
1, 1.5, 2, 2, 2.2	1.5	1 and 1.5	1.25	4.5	2 and 2.2	2.1
0, 1.7, 1.8, 3.1, 3.2, 7, 8, 8.8, 8.9, 9, 10	3	None	1.8	9	None	8.9
.23, .30, .35, .41, .56, .58, .76, .80	2.25	.30 and .35	.3125	6.75	.58 and .76	.7150

2.43 min = 0, $Q_1 = 6$, $m = 10$, $Q_3 = 14$, max = 19; IQR = 8

2.45 lower and upper fences: −2.25 and 15.25; $x = 22$ is an outlier

2.47 **a.** min = 1.70, $Q_1 = 130.5$, $m = 246.5$, $Q_3 = 317.5$, max = 485
b. lower and upper fences: −150 and 598
c–d. No, but there are four extremely small observations, not identified by the box plot as outliers.

2.49 **a.**

Variable	Minimum	Q1	Median	Q3	Maximum
Favre	5.00	19.25	22.00	24.75	31.00
Manning	14.00	20.25	23.50	26.75	32.00

b. *Favre:* lower and upper fences: 11 and 33; one outlier ($x = 5$); relatively symmetric, except for the outlier. *Manning:* upper and lower fences: 10.5 and 36.5; no outliers, relatively symmetric.

2.51 **a.** skewed left **b.** $\bar{x} = 108.15$; $m = 123.5$; mean < median implies skewed left **c.** lower and upper fences: −43.125 and 259.875; skewed left, no outliers.

2.53 Female temperatures have a higher center (median) and are more variable; three outliers in the female group.

2.55 **a.** *Generic:* $m = 26$, $Q_1 = 25$, $Q_3 = 27.25$, IQR = 2.25; *Sunmaid:* $m = 26$, $Q_1 = 24$, $Q_3 = 28$, IQR = 4 **b.** *Generic:* lower and upper fences: 21.625 and 30.625; *Sunmaid:* lower and upper fences: 18 and 34 **c.** yes **d.** The average size is nearly the same; individual raisin sizes are more variable for Sunmaid raisins.

2.57 **a.** R = 32.1 **b.** $s \approx 8.025$ **c.** $s = 7.671$

2.59 $m = 6.35$, $Q_1 = 2.325$, $Q_3 = 12.825$; lower and upper fences: −13.425 and 28.575; one outlier ($x = 32.3$).

2.61 **a, b.**

k	$\bar{x} \pm ks$	Tchebysheff	Empirical Rule
1	(.16, .18)	At least 0	Approx. .68
2	(.15, .19)	At least 3/4	Approx. .95
3	(.14, .20)	At least 8/9	Approx. .997

c. No, distribution of $n = 4$ measurements cannot be mound-shaped.

2.63 68%; 95%

2.65 **a.** 27; 20.2; 6.8 **b.** slightly skewed left **c.** 23.96; 1.641 **d.** largest $x = 27$, z-score = 1.85; smallest $x = 20.2$, z-score = −2.29; no **e.** 24.3 **f.** 22.95 and 24.85

2.67 **a.** $s \approx 7.75$ **b.** $\bar{x} = 59.2$; $s = 10.369$ **c.** $m = 60$, $Q_1 = 51.25$, $Q_3 = 69.75$; lower and upper fences: 23.5 and 97.5; no outliers.

2.69 $\sigma \approx 100$

2.71 **a.** 16% **b.** 81.5%

2.73 **a.** .9735 **b.** .16

2.75 **a.** .025 **b.** .84

2.77 **a.** At least 3/4 have between 145 and 205 teachers. **b.** .16

2.81 **a.** 8.36 **b.** 4 **c.** skewed right **d.** lower and upper fences: −24.375 and 42.625; no; yes

2.83 **b.** yes **c.** more than 2 or 3 standard deviations from the mean

2.85 **a.** 2.5, 3.75, 4.2, 4.75, 5.7 **b.** lower and upper fences: 2.25 and 6.25 **c.** no **d.** mound-shaped; yes

2.87 **b.** the sample mean gets smaller **d.** $5 \le m \le 10$

2.89 **c.** The standard deviation when dividing by $n - 1$ is closer to σ.

2.91 **b–c.** skewed left with one outlier to the right of the other observations ($x = 520$)

Chapter 3

3.3 **a.** comparative pie charts; side-by-side or stacked bar charts **c.** Proportions spent in all four categories are substantially different for men and women.

3.5 **a.** *Population:* responses to free time question for all parents and children in the United States. *Sample:* responses for the 398 people in the survey. **b.** bivariate data, measuring relationship (qualitative) and response (qualitative) **c.** the number of people who fall into that relationship-opinion category **e.** stacked or side-by-side bar charts

3.9

x	y	xy	Calculate:	Covariance
1	6	6	$n = 3$	$s_{xy} = \dfrac{\Sigma xy - \dfrac{(\Sigma x)(\Sigma y)}{n}}{n-1} = -2$
3	2	6	$s_x = 1$	
2	4	8	$s_y = 2$	Correlation Coefficient
$\Sigma x = 6$	$\Sigma y = 12$	$\Sigma xy = 20$		$r = \dfrac{s_{xy}}{s_x s_y} = -1$

3.11 **b.** As x increases, y increases. **c.** .903 **d.** $y = 3.58 + .815x$; yes

3.13 **b.** As x increases, y decreases. **c.** −.987

3.15 **a.** $y = 56.11 + 23.83x$ **c.** $199.06; no

3.17 **b.** slight positive trend **c.** $r = .760$

3.19 **a.** price = dependent variable; size = independent variable **b.** yes

3.21 **b.** The professor's productivity appears to increase, with less time required to write later books; no.

3.23 **a.** age of the soldier (quantitative), status of soldier—enlisted or officer (qualitative), branch of service (qualitative) **b.** the population of responses for all soldiers in the U.S. Army and the U.S. Marine Corps; population at a fixed moment in time **c.** side-by-side bar charts; stacked bar charts

3.27 **a.** .882 (.886 using Minitab printout) **b.** x = weeks in release, y = gross to date **c.** .148; −.642

3.29 **a.** no **b.** $r = -.039$; yes **c.** Large cluster in lower left corner shows no apparent relationship; 7 to 10 states form a cluster with a negative linear trend **d.** local environmental regulations; population per square mile; geographic region

3.31 **a.** aluminum oxide (quantitative), site (qualitative) **b.** higher levels of aluminum oxide at Ashley Rails and Island Thorns

3.33 **a.** year (quantitative), number of home networks (quantitative), type of network (qualitative) **c.** Wireless networking will increase and wired networks will decrease.

3.35 **a.** strong positive linear relationship **b.** .946 **c.** $b \approx 1$ **d.** $y = 12.221 + .815x$

3.37 **b.** strong positive linear relationship

3.39 **b.** weak negative linear relationship **c.** yes; Juneau, AK **d.** stronger negative relationship

3.43 **a.** .635

3.45 **a.** 0.5 **b.** increase **c.** 2.0; the y-intercept **d.** 3.25; 4

Chapter 4

4.1 **a.** {1, 2, 3, 4, 5, 6} **c.** 1/6 **e.** $P(A) = 1/6$; $P(B) = 1/2$; $P(C) = 2/3$; $P(D) = 1/6$; $P(E) = 1/2$; $P(F) = 0$

4.3 $P(E_1) = .45$; $P(E_2) = .15$; $P(E_i) = .05$ for $i = 3, 4, \ldots, 10$

4.5 **a.** {NDQ, NDH, NQH, DQH} **b.** 3/4 **c.** 3/4

4.9 **a.** .58 **b.** .14 **c.** .46

4.11 **a.** randomly selecting three people and recording their gender **b.** {FFF, FMM, MFM, MMF, MFF, FMF, FFM, MMM} **c.** 1/8 **d.** 3/8 **e.** 1/8

4.13 **a.** rank *A, B, C* **b.** {*ABC, ACB, BAC, BCA, CAB, CBA*} **d.** 1/3, 1/3

4.15 **a.** .467 **b.** .513 **c.** .533

4.17 80

4.19 **a.** 60 **b.** 3,628,800 **c.** 720 **d.** 20

4.21 6720

4.23 216

4.25 120

4.27 720

4.29 **a.** 140,608 **b.** 132,600 **c.** .00037 **d.** .943

4.31 **a.** 2,598,960 **b.** 4 **c.** .000001539

4.33 $5.720645 \times (10^{12})$

4.35 **a.** 49 **b.** 1/49 **c.** 2/7

4.37 1/56

4.39 $\dfrac{4!(3!)^4}{12!}$

4.41

$P(A)$	$P(B)$	Conditions for Events A and B	$P(A \cap B)$	$P(A \cup B)$	$P(A\|B)$
.3	.4	Mutually exclusive	0	.7	0
.3	.4	Independent	.12	.58	.3
.1	.5	Independent	.05	.55	.1
.2	.5	Mutually exclusive	0	.7	0

4.43 **a.** 3/5 **b.** 4/5

4.45 **a.** 1 **b.** 1/5 **c.** 1/5

4.47 **a.** 1 **b.** 1 **c.** 1/3 **d.** 0 **e.** 1/3 **f.** 0 **g.** 0 **h.** 1 **i.** 5/6

4.49 **a.** .08 **b.** .52

4.51 **a.** .3 **b.** no **c.** yes

4.53 **a.** no, since $P(A \cap B) \neq 0$ **b.** no, since $P(A) \neq P(A|B)$

4.55 **a.** .14 **b.** .56 **c.** .30

4.59 **a.** $P(A) = .9918$; $P(B) = .0082$ **b.** $P(A) = .9836$; $P(B) = .0164$

4.61 .05

4.63 **a.** .99 **b.** .01

4.65 **a.** 154/256 **b.** 155/256 **c.** 88/256 **d.** 88/154 **e.** 44/67 **f.** 23/35 **g.** 12/101 **h.** 189/256

4.67 **a.** .64 **b.** .4982 **c.** .011236

4.69 **a.** .23 **b.** .6087; .3913

4.71 .38

4.73 .012

4.75 **a.** .6585 **b.** .3415 **c.** left

4.77 .3130

4.79 **a.** $P(D) = .10$; $P(D^C) = .90$; $P(N \mid D^C) = .94$; $P(N \mid D) = .20$ **b.** .023 **c.** .023 **d.** .056 **e.** .20 **f.** false negative

4.81 **a.** continuous **b.** continuous **c.** discrete **d.** discrete **e.** continuous

4.83 **a.** .2 **c.** $\mu = 1.9$; $\sigma^2 = 1.29$; $\sigma = 1.136$ **d.** .3 **e.** .9

4.85 1.5

4.87 **a.** {S, FS, FFS, FFFS} **b.** $p(1) = p(2) = p(3) = p(4) = 1/4$

4.89 **a.** $p(0) = 3/10$; $p(1) = 6/10$; $p(2) = 1/10$

4.91 **a.** .1; .09; .081 **b.** $p(x) = (.9)^{x-1}(.1)$

4.93 **a.** 4.0656 **b.** 4.125 **c.** 3.3186

4.95 $1500

4.97 **a.** .28 **b.** .18 **c.** $\mu = 1.32$; $\sigma = 1.199$ **d.** .94

4.99 $20,500

4.101 .0713

4.103 $P(A) = 1/2$; $P(B) = 2/3$; $P(A \cap B) = 1/3$; $P(A \cup B) = 5/6$; $P(C) = 1/6$; $P(A \cap C) = 0$; $P(A \cup C) = 2/3$

4.105 2/7

4.107 $p(0) = .0256$; $p(1) = .1536$; $p(2) = .3456$; $p(3) = .3456$; $p(4) = .1296$; .4752

4.109 **a.** .4565 **b.** .2530 **c.** .3889

4.111 3/10; 6/10

4.113 **a.** .73 **b.** .27

4.115 .999999

4.117 8

4.119 **a.** .3582 **b.** .4883 **c.** .4467

4.121 **a.** 1/8 **b.** 1/64 **c.** Not necessarily; they could have studied together, and so on.

4.123 **a.** 5/6 **b.** 25/36 **c.** 11/36

4.125 **a.** .8 **b.** .64 **c.** .36

4.127 .0256; .1296

4.129 .2; .1

4.131 **a.** .5182 **b.** .1136 **c.** .7091 **d.** .3906

4.133 **a.** .0625 **b.** .25

4.135 **a.**

x	0	1	2
$p(x)$	6/15	8/15	1/15

b. $\mu = 2/3$; $\sigma^2 = 16/45$

4.137 **a.** $p(2) = p(12) = 1/36$, $p(3) = p(11) = 2/36$, $p(4) = p(10) = 3/36$, $p(5) = p(9) = 4/36$, $p(6) = p(8) = 5/36$, $p(7) = 6/36$

4.139 **a.** $p(0) = .5$, $p(1) = .5$

Chapter 5

5.1

k	0	1	2	3	4	5	6	7	8
$P(x \leq k)$	.000	.001	.011	.058	.194	.448	.745	.942	1.000

The Problem	List the Values of x	Write the Probability	Rewrite the Probability	Find the Probability
3 or less	0, 1, 2, 3	$P(x \leq 3)$	not needed	.058
3 or more	3, 4, 5, 6, 7, 8	$P(x \geq 3)$	$1 - P(x \leq 2)$	.989
More than 3	4, 5, 6, 7, 8	$P(x > 3)$	$1 - P(x \leq 3)$	.942
Fewer than 3	0, 1, 2	$P(x < 3)$	$P(x \leq 2)$	.011
Between 3 and 5 (inclusive)	3, 4, 5	$P(3 \leq x \leq 5)$	$P(x \leq 5) - P(x \leq 2)$	.437
Exactly 3	3	$P(x = 3)$	$P(x \leq 3) - P(x \leq 2)$	.047

5.3 not binomial; dependent trials; p varies from trial to trial.

5.5 **a.** .2965 **b.** .8145 **c.** .1172 **d.** .3670

5.7 **a.** .097 **b.** .329 **c.** .671 **d.** 2.1 **e.** 1.212

5.9 $p(0) = .000$; $p(1) = .002$; $p(2) = .015$; $p(3) = .082$; $p(4) = .246$; $p(5) = .393$; $p(6) = .262$

5.11 **a.** .251 **b.** .618 **c.** .367 **d.** .633 **e.** 4 **f.** 1.549

5.13 **a.** .901 **b.** .015 **c.** .002 **d.** .998

5.15 **a.** .748 **b.** .610 **c.** .367 **d.** .966 **e.** .656

5.17 **a.** 1; .99 **b.** 90; 3 **c.** 30; 4.58 **d.** 70; 4.58 **e.** 50; 5

5.19 **a.** .9568 **b.** .957 **c.** .9569 **d.** $\mu = 2$; $\sigma = 1.342$ **e.** .7455; .9569; .9977 **f.** yes; yes

5.21 no; the variable is not the number of successes in n trials. Instead, the number of trials n is variable.

5.23 **a.** 1.000 **b.** .997 **c.** .086

5.25 **a.** .098 **b.** .991 **c.** .098 **d.** .138 **e.** .430 **f.** .902

5.27 **a.** .0081 **b.** .4116 **c.** .2401

5.29 **a.** $\mu = 10$ **b.** 4 to 16 **c.** If this unlikely value were actually observed, it might be possible that the trials (fields) are not independent.

5.31 **a.** .016796 **c.** .98320

5.33 **a.** .107 **b.** .762

5.35

Probability	Formula	Calculated Value
$P(x = 0)$	$\frac{\mu^k e^{-\mu}}{k!} = \frac{2.5^0 e^{-2.5}}{0!}$	.082085
$P(x = 1)$	$\frac{\mu^k e^{-\mu}}{k!} = \frac{2.5^1 e^{-2.5}}{1!}$	.205212
$P(x = 2)$	$\frac{\mu^k e^{-\mu}}{k!} = \frac{2.5^2 e^{-2.5}}{2!}$	.256516
P(2 or fewer successes)	$P(x = 0) + P(x = 1)$	.543813

5.37

k	0	1	2	3	4	5	6	7	8	9	10
$P(x \le k)$	.055	.199	.423	.647	.815	.916	.966	.988	.996	.999	1.000

The Problem	List the Values of x	Write the Probability	Rewrite the Probability	Find the Probability
3 or less	0, 1, 2, 3	$P(x \le 3)$	not needed	.647
3 or more	3, 4, 5, . . .	$P(x \ge 3)$	$1 - P(x \le 2)$	.577
More than 3	4, 5, 6, . . .	$P(x > 3)$	$1 - P(x \le 3)$	.353
Fewer than 3	0, 1, 2	$P(x < 3)$	$P(x \le 2)$	.423
Between 3 and 5 (inclusive)	3, 4, 5	$P(3 \le x \le 5)$	$P(x \le 5) - P(x \le 2)$	.493
Exactly 3	3	$P(x = 3)$	$P(x \le 3) - P(x \le 2)$	.224

5.39 **a.** .135335 **b.** .27067 **c.** .593994 **d.** .036089

5.41 **a.** .677 **b.** .6767 **c.** yes

5.43 **a.** .0067 **b.** .1755 **c.** .560

5.45 **a.** .271 **b.** .594 **c.** .406

5.47 $P(x > 5) = .017$; unlikely.

5.49 **a.** .6 **b.** .5143 **c.** .0714

5.51 **a.** $p(0) = .36; p(1) = .48; p(2) = .15; p(3) = .01$ **c.** $\mu = .8, \sigma^2 = .50286$ **d.** .99; .99; yes

5.53 $p(0) = .2; p(1) = .6; p(2) = .2$

5.55 **a.** hypergeometric **b.** .1786 **c.** .01786 **d.** .2857

5.61 **a.** $p(0) = .729; p(1) = .243; p(2) = .027; p(3) = .001$ **c.** .3; .520 **d.** .729; .972

5.63 **a.** .234 **b.** .136 **c.** Claim is not unlikely.

5.65 **a.** .228 **b.** no indication that people are more likely to choose middle numbers

5.67 **a.** $\mu = 280$ **b.** $\sigma = 9.165$ **c.** 261.67 to 298.33 **d.** yes; $x = 225$ lies 6 standard deviations below the mean.

5.69 **a.** 20 **b.** 4 **c.** .006 **d.** Psychiatrist is incorrect.

5.71 **a.** $\mu = 50; \sigma = 6.124$ **b.** The value $x = 35$ lies 2.45 standard deviations below the mean. It is somewhat unlikely that the 25% figure is representative of this campus.

5.73 **a.** .5 **b.** $\mu = 12.5; \sigma = 2.5$ **c.** There is a preference for the second design.

5.75 **a.** yes; $n = 10; p = .25$ **b.** .2440 **c.** .0000296 **d.** Yes; genetic model is not behaving as expected.

5.77 **a.** yes **b.** 1/8192 = .00012

5.79 **a.** hypergeometric, or approximately binomial **b.** Poisson **c.** approximately .85; .72; .61

5.81 **a.** .015625 **b.** .421875 **c.** .25

5.83 **a.** $p = 1/3$ **b.** .3292 **c.** .8683

5.85 **a.** 14 **b.** 2.049 **c.** no; $x = 10$ is only 1.95 standard deviations below the mean

5.87 **a.** .135335 **b.** .676676

5.89 .655

5.91 **a.** .794 **b.** .056 **c.** −0.82 to 3.82 or 0 to 3

5.93 **a.** 36 **b.** 4.8 **c.** Yes, since $x = 49$ lies 2.71 standard deviations above the mean.

5.95 **a.** .00006 **b.** .042 **c.** .0207 **d.** .5948 **e.** 1

5.99 **a.** .0176 **b.** .9648 **c.** .9648

Chapter 6

6.1

The Interval	Write the Probability	Rewrite the Probability (if needed)	Find the Probability
Less than −2	$P(z < -2)$	not needed	.0228
Greater than 1.16	$P(z > 1.16)$	$1 - P(z \le 1.16)$	.1230
Greater than 1.645	$P(z > 1.645)$	$1 - P(z \le 1.645)$	.0500
Between −2.33 and 2.33	$P(-2.33 < z < 2.33)$	$P(z \le 2.33) - P(z \le -2.33)$	.9802
Between 1.24 and 2.58	$P(1.24 < z < 2.58)$	$P(z \le 2.58) - P(z \le 1.24)$	.1026
Less than or equal to 1.88	$P(z \le 1.88)$	not needed	.9699

6.3 **a.** .9452 **b.** .9664 **c.** .8159 **d.** 1.0000

6.5 **a.** .6753 **b.** .2401 **c.** .2694 **d.** .0901 **e.** ≈ 0

6.7 **a.** 1.96 **b.** 1.44

6.9 **a.** 1.65 **b.** -1.645

6.11 **a.** 1.28 **b.** 1.645 **c.** 2.05 **d.** 2.33

6.13 **a.** .1596 **b.** .1151 **c.** .1359

6.15 58.3

6.17 $\mu = 8$; $\sigma = 2$

6.19 **a.** .1949 **b.** .4870 **c.** no **d.** yes; $y = 18$ lies 3.82 standard deviations above the mean.

6.21 **a.** .4586 **b.** .0526 **c.** .0170

6.23 .1562; .0012

6.25 **a.** .0475 **b.** .00226 **c.** 29.12 to 40.88 **d.** 38.84

6.27 **a.** .1056 **b.** .2676

6.29 .0475

6.31 63,550

6.33 **a.** .3085 **b.** .2417 **c.** .0045

6.35 **a.** 15; 10 **b.** yes **c.** 15; 2.449 **d.** 10, 11, . . . , 25 **e.** 10; 9.5 **f.** $z = -2.25$ **g.** -2.25; .0122; .9878

6.37 **a.** yes **b.** $\mu = 7.5$; $\sigma = 2.291$ **c.** .6156 **d.** .618

6.39 **a.** .2676 **b.** .3520 **c.** .3208 **d.** .9162

6.41 **a.** .178 **b.** .392

6.43 **a.** .245 **b.** .2483

6.45 **a.** .0446 **b.** .0104 **c.** .0446

6.47 .9441

6.49 **a.** .5000 **b.** They do not consider height when casting their ballot.

6.51 **a.** .0050 **b.** .8394 **c.** .9767 **d.** yes; Pepsi's market share is higher than claimed.

6.53 **a.** 31 **b.** 3.432 **c.** no; $x = 25$ is only 1.75 standard deviations below the mean.

6.55 **a.** .3227 **b.** .1586

6.57 $z_0 = 0$

6.59 $z_0 = .67$; the 25th and 75th percentiles

6.61 no

6.63 5.065 months

6.65 .0336

6.67 85.36 minutes

6.69 no; $x = 184$ lies only 1.26 standard deviations below the mean.

6.71 7.301 ounces

6.73 **a.** 141 **b.** .0401

6.75 .9474

6.77 .3557

6.79 **a.** $Q_1 = 269.96$; $Q_3 = 286.04$ **b.** yes; $x = 180$ lies 8.17 standard deviations below the mean.

6.81 **a.** ≈ 0 **b.** .6026 **c.** Sample is not random; results will be biased.

6.83 **a.** $\pm.52$ standard deviations **b.** ±1.28 standard deviations

6.85 **a.** .3085 **b.** 99.92 degrees

6.87 **a.** .9544 **b.** .0561

6.89 **a.** $z_0 = -1.96$ **b.** $z_0 = .36$

6.91 **a.** .9651 **b.** .1056 **c.** .0062

6.93 **a.** .0442 **b.** .0445

6.95 **a.** 1.273 **b.** .1016

6.97 .1244 (exact probability = .1236)

Chapter 7

7.1 1/500

7.11 **a.** convenience sample **c.** Yes, but only if the students behave like a random sample from the general population of Native American youth.

7.13 **a.** first question **b.** Percent favoring the program decreased, perhaps due to the "spending billions of dollars" wording in the question.

7.15 normal; 53; 3

7.17 normal; 100; 3.16

7.19 **a.** $\mu = 10$; $\sigma/\sqrt{n} = .5$ **b.** $\mu = 5$; $\sigma/\sqrt{n} = .2$ **c.** $\mu = 120$; $\sigma/\sqrt{n} = .3536$

7.21 **c.** roughly mound-shaped

7.23 **a.** 1 **b.** .707 **c.** .500 **d.** .333 **e.** .250 **f.** .200 **g.** .100

7.25 **a.** 106; 2.4 **b.** .0475 **c.** .9050

7.27 **b.** a large number of replications

7.31 **a.** 1890; 69.282 **b.** .0559

7.33 **a.** ≈ 0 **b.** yes; the value $\bar{x} = 98.25$ is almost 5 standard deviations below the assumed mean, $\mu = 98.6$.

7.35 normal; .7; .0648

7.37 **a.** $p = .3$; $SE = .0458$ **b.** $p = .1$; $SE = .015$ **c.** $p = .6$; $SE = .0310$

7.39 **a.** .7019 **b.** .5125

7.41 **a.** .0099 **b.** .03 **c.** .0458 **d.** .05 **e.** .0458 **f.** .03 **g.** .0099

7.43 **a.** yes; $p = .19$; SE = .03923 **b.** .0630 **c.** .0604 **d.** The value is unusual because $\hat{p} = .30$ lies 2.80 standard deviations above the mean $p = .19$.

7.45 **a.** approximately normal with mean .13 and standard deviation .0453 **b.** .9382 **c.** ≈ 0 **d.** .04 to .22

7.47 **a.** approximately normal with mean .75 and standard deviation .0306 **b.** .0516 **c.** .69 to .81

7.49 **a.** LCL = 150.13; UCL = 161.67

7.51 **a.** LCL = 0; UCL = .090

7.53 **a.** LCL = 8598.7; UCL = 12,905.3

7.55 LCL = .078; UCL = .316

7.57 LCL = .0155; UCL = .0357

7.59 mean too large at hours 2, 3, and 4

7.63 **a.** ≈ 12.5 **b.** .9986 **c.** They are probably correct.

7.65 **c.** no

7.71 **a.** cluster sample **b.** 1-in-10 systematic sample **c.** stratified sample **d.** 1-in-10 systematic sample **e.** simple random sample

7.73 **a.** 131.2; 3.677 **b.** yes **c.** .1515

7.75 **a.** LCL = 0; UCL = .0848 **b.** $\hat{p} > .0848$

7.77 yes

7.81 **a.** approximately normal with mean 288 and standard deviation .9798 **b.** .0207 **c.** .0071

7.83 UCL = .2273; LCL = −.0273

7.85 **a.** 3.5; 1.208

7.87 **a.** 3.5; .854

7.89 **a.** .4938 **b.** .0062 **c.** .0000

Chapter 8

8.3 **a.** .160 **b.** .339 **c.** .438

8.5 **a.** .554 **b.** .175 **c.** .055

8.7 **a.** .179 **b.** .098 **c.** .049 **d.** .031

8.9 **a.** .0588 **b.** .0898 **c.** .098 **d.** .0898 **e.** .0588 **f.** $p = .5$

8.11 $\hat{p} = .728$; margin of error (MOE) = .029

8.13 $\bar{x} = 39.8$; MOE = 4.768

8.15 $\bar{x} = 7.2\%$; MOE = .776

8.17 **a.** $\hat{p} = .51$; MOE = .0327 **b.** $1.96\sqrt{\frac{.5(.5)}{900}}$

8.19 **a.** no **b.** nothing; no

8.21 Point estimate is $\bar{x} = 19.3$ with margin of error = 1.86.

8.23 **a.** (.797, .883) **b.** (21.469, 22.331) **c.** Intervals constructed in this way enclose the true value of μ 90% of the time in repeated sampling.

8.25 (.846, .908)

8.27 **a.** 3.92 **b.** 2.772 **c.** 1.96

8.29 **a.** 3.29 **b.** 5.16 **c.** The width increases.

8.31 (3.496, 3.904); random sample

8.33 **a.** (.932, 1.088) **c.** no; $\mu = 1$ is a possible value for the population mean

8.35 **a.** (.106, .166) **b.** Increase the sample size and/or decrease the confidence level.

8.37 **a.** $98.085 < \mu < 98.415$ **b.** no; perhaps the value 98.6 is not the true average body temperature for healthy people.

8.39 **a.** (4.61, 5.99) **b.** yes

8.41 (15.463, 36.937)

8.43 **a.** (17.676, 19.324) **b.** (15.710, 17.290) **c.** (.858, 3.142) **d.** yes

8.45 **a.** $\bar{x}_1 - \bar{x}_2 = 2617$; MOE = 902.08 **b.** yes

8.47 **a.** (3.333, 16.667) **b.** (−22.040, −7.960) **c.** no **d.** yes; yes

8.49 **a.** (−.528, − .032); yes, since $\mu_1 - \mu_2 = 0$ is not in the interval.

8.51 **a.** (−.203, −.117) **b.** random and independent samples from binomial distributions

8.53 **a.** (−.221, .149) **b.** no

8.55 **a.** (−.118, −.002) **b.** Yes, since $p_1 - p_2 = 0$ is not in the interval.

8.57 **a.** (.095, .445) **b.** yes

8.59 (.061, .259)

8.61 **a.** (−.082, .022) **b.** No, since $p_1 - p_2 = 0$ is in the interval.

8.63 $1.96\sqrt{\frac{pq}{n}}$; $1.96\sqrt{\frac{.5(.5)}{n}}$; 385; quantitative; one; $1.96\frac{10}{\sqrt{n}}$; 97

8.65 **a.** $\mu < 76.63$ **b.** $\mu < 1.89$

8.67 $\mu_1 - \mu_2 < 4$

8.69 505

8.71 $n_1 = n_2 = 1086$

8.73 **b.** 9604

8.75 $n_1 = n_2 = 360$

8.77 97

8.79 $n_1 = n_2 = 136$

8.81 $n_1 = n_2 = 98$

8.83 **a.** $\bar{x} = 29.1$; MOE = .9555 **b.** (28.298, 29.902) **c.** $\mu > 28.48$ **d.** 234

8.85 $n_1 = n_2 = 224$

8.87 1083

8.89 $n_1 = n_2 = 925$

8.91 **a.** $\hat{p}_W = .5$; $\hat{p}_M = .75$ **b.** $-.313 < p_W - p_M < -.187$ **c.** There is a difference in the two proportions.

8.93 (8.087, 11.313)

8.95 97

8.97 (33.41, 34.59)

8.99 **a.** MOE = .029 **b.** 6147

8.101 **a.** (.522, .578) **b.** (.035, .145); yes.

8.103 at least 1825

8.105 .3874; .651

8.107 **a.** (2.837, 3.087) **b.** 276

8.109 ($10.52, $12.38); no

8.111 (2.694, 2.716)

8.113 (.161, .239)

8.115 at least 97

8.117 **b.** Widths are the same.

8.119 **a.** 9.702 **b.** (746.298, 765.702) **c.** yes

8.121 **b.** The standard error and the width of the interval decrease.

Chapter 9

9.1

Test Statistic	Significance Level	One or Two-Tailed Test?	Critical Value	Rejection Region	Conclusion
$z = 0.88$	$\alpha = .05$	Two-tailed	1.96	$\|z\| > 1.96$	Do not reject H_0
$z = -2.67$	$\alpha = .05$	One-tailed (lower)	1.645	$z < -1.645$	Reject H_0
$z = 5.05$	$\alpha = .01$	Two-tailed	2.58	$\|z\| > 2.58$	Reject H_0
$z = -1.22$	$\alpha = .01$	One-tailed (lower)	2.33	$z < -2.33$	Do not reject H_0

9.3 **a.** $z > 2.33$ **b.** $|z| > 1.96$ **c.** $z < -2.33$ **d.** $|z| > 2.58$

9.5 **a.** Do not reject H_0; results are not statistically significant. **b.** Reject H_0; results are highly significant. **c.** Reject H_0; results are statistically significant.

9.7 **a.** .0207 **b.** Reject H_0; results are statistically significant. **c.** yes

9.9 p-value = .0644; do not reject H_0; results are not statistically significant.

9.11 **a.** H_0: $\mu = 1$; H_a: $\mu \neq 1$ **b.** p-value = .7414; do not reject H_0 **c.** There is no evidence to indicate that the average weight is different from 1 pound.

9.13 **a.** H_0: $\mu = 80$ **b.** H_a: $\mu \neq 80$ **c.** $z = -3.75$; reject H_0

9.15 **a.** $z = 2.63$; p-value = .0043; reject H_0 at the 1% and 5% levels of significance

9.17 yes; $z = 10.94$

9.19 no; $z = -1.334$ with p-value = .0918; do not reject H_0

9.21 **a.** H_0: $\mu_1 - \mu_2 = 0$; H_a: $\mu_1 - \mu_2 > 0$; one-tailed **b.** $z = 2.074$; reject H_0

9.23 **a.** $z = -2.26$; p-value = .0238; reject H_0 **b.** $(-3.55, -.25)$ **c.** no

9.25 **a.** H_0: $\mu_1 - \mu_2 = 0$; H_a: $\mu_1 - \mu_2 \neq 0$ **b.** yes; $z = 8.77$ **c.** p-value ≈ 0

9.27 **a.** yes; $z = -3.18$; p-value = .0014 **b.** $(-3.01, -.71)$; yes

9.29 **a.** $z = -2.22$ with p-value = .0264 **b.** significant at the 5% but not the 1% level.

9.31 H_0: $p = .4$; H_a: $p \neq .4$ **b.** p-value = .093; not statistically significant **c.** no

9.33 **a.** H_0: $p = .15$; H_a: $p < .15$ **b.** Reject H_0; $z = -4.53$. **c.** ≈ 0

9.35 **a.** H_0: $p = 2/3$ **b.** H_a: $p > 2/3$ **c.** yes; $z = 4.6$ **d.** p-value < .0002

9.37 no; $z = -.90$

9.39 no; $z = -1.06$

9.41 no; $z = -.71$

9.43 **a.** H_0: $p_1 - p_2 = 0$; H_a: $p_1 - p_2 < 0$ **b.** one-tailed **c.** Do not reject H_0; $z = -.84$

9.45 **a.** yes; $z = -2.40$ **b.** $(-.43, -.05)$

9.47 Do not reject H_0; $z = -.39$; there is insufficient evidence to indicate a difference in the two population proportions.

9.49 $p_1 - p_2 > .001$; the risk is at least 1/1000 higher when taking *Prempro.*

9.51 Reject H_0; $z = 3.14$ with p-value $= .0008$; researcher's conclusions are confirmed.

9.55 The power increases.

9.57 **a.** p-value $< .0002$ **b.** Reject H_0; $z = 4.47$

9.59 **a.** H_0: $\mu = 7.5$; H_a: $\mu < 7.5$ **b.** one-tailed **d.** $z = -5.477$; reject H_0

9.61 **a.** H_0: $\mu_1 - \mu_2 = 0$; H_a: $\mu_1 - \mu_2 \neq 0$ **b.** two-tailed **c.** no; $z = -.954$

9.63 no; do not reject H_0; $z = 1.684$

9.65 **a.** no, $z = .16$ **b.** .4364 **c.** Do not reject H_0.

9.67 yes; $z = 4$; reject H_0

9.69 yes; $z = 4.00$

9.71 **a.** yes; $z = 4.33$ **b.** (7.12, 18.88)

9.73 **a.** no; $z = -.92$ **b.** no; $z = -.42$ **c.** no

9.75 no; $z = 2.19$

9.77 yes; $z = -2.08$

9.79 yes; $z = 3.32$

9.81 **a.** (1447.49. 4880.51) **b.** between 1500 and 5000 more meters per week; they only have one stroke to practice.

9.83 **a.** H_0: $\mu = 94$; H_a: $\mu \neq 94$ **b.** $z = -1.331$ **c.** .1832 **d.** Do not reject H_0. **e.** no

9.85 **a.** .7422 **b.** .9783 **c.** power increases

Chapter 10

10.1 **a.** 2.015 **b.** 2.306 **c.** 1.330 **d.** 1.96

10.3 **a.** $.02 < p$-value $< .05$ **b.** p-value $< .005$ **c.** p-value $> .20$ **d.** p-value $< .005$

10.5 **a.** $\bar{x} = 7.05$; $s = .4994$ **b.** (7.496) **c.** Reject H_0; $t = -2.849$ **d.** Yes.

10.7 no; $t = -1.195$

10.9 **a.** yes; $t = -3.044$ **b.** 98.316

10.11 (3.652, 3.912)

10.13 **a.** Reject H_0; $t = -4.31$. **b.** (23.23, 29.97) **c.** The pretreatment mean looks smaller than the other two means.

10.17 (233.98, 259.94)

10.19 **a.** 3.775 **b.** 21.2258

10.21 **a.** H_0: $\mu_1 - \mu_2 = 0$; H_a: $\mu_1 - \mu_2 \neq 0$ **b.** $|t| > 2.771$ **c.** $t = 2.795$ **d.** p-value $< .01$ **e.** Reject H_0

10.23 **a.** yes; larger s^2/smaller $s^2 = 1.36$ **b.** $t = .06$ with p-value $= .95$ **c.** 19.1844 **d.** Do not reject H_0. **e.** (−5.223, 5.503); yes

10.25 **a.** no; $t = -1.16$ **b.** p-value $= .260$ **c.** yes; larger s^2/smaller $s^2 = 2.88$

10.27 **a.** no; larger s^2/smaller $s^2 = 16.22$ **b.** yes; $t = -2.412$; $.02 < p$-value $< .05$

10.29 **a.** yes **b.** no; larger s^2/smaller $s^2 = 3.72$ **c.** Do not reject H_0; $t = .10$ with p-value $> .20$.

10.31 Do not reject H_0; $t = 0.24$ with p-value $> .10$.

10.33 **a.** Do not reject H_0; $t = -.93$. **b.** (−5.81, 2.18), using $df = 29$; yes

10.35 **a.** Reject H_0; $t = 2.372$ with $.02 < p$-value. $< .05$ **b.** (.014, .586) **c.** 62 pairs

10.37 **a.** Do not reject H_0; $t = 1.177$. **b.** p-value $> .20$ **c.** (−.082, .202) **d.** random sample from normal distribution

10.39 **a.** Do not reject H_0; $t = 1.984$; (−7.28, 170.94). **b.** Reject H_0; $t = 2.307$; (6.867, 208.433). **c.** Reject H_0; $t = 4.38$. **d.** (−1.6, 8.2); yes

10.41 **b.** yes; $t = 9.150$ with p-value $< .01$ **c.** (80.472, 133.328)

10.43 **a.** yes; $t = -4.326$; reject H_0. **b.** (−2.594, −.566) **c.** at least 65 pairs

10.45 **a.** yes; $t = 2.82$; reject H_0. **b.** 1.488 **d.** yes

10.47 Do not reject H_0; $t = 1.03$ with p-value $> .10$; do not proceed with the installation.

10.49 (.190, .685)

10.51 Reject H_0; $\chi^2 = 22.449$.

10.53 **a.** no; $t = -.232$ **b.** yes; $\chi^2 = 20.18$

10.55 **a.** no **b.** yes; $z = 3.262$

10.57 no; $\chi^2 = 29.433$

10.59 (.667, 4.896)

10.61 $F = 1.057$ with p-value $> .20$; do not reject H_0: $\sigma_1^2 = \sigma_2^2$.

10.63 (1.544, 4.003)

10.65 Rest: $F = 1.03$ with p-value $> .20$; 80% maximal O_2: $F = 2.01$ with p-value $> .20$; maximal O_2: $F = 14.29$ with p-value $< .01$; use the unpooled t-test for maximal O_2.

10.71 (9.860, 12.740)

10.73 yes, $t = 5.985$; reject H_0; (28.375, 33.625).

10.75 yes, $F = 3.268$

10.77 72

10.79 (22.578, 26.796)

10.81 at least 136 **b.** Lower the confidence level; redesign the experiment as a paired difference test.

10.83 **a.** yes **b.** $F = 19.516$; there is a difference in the population variances.

10.85 **a.** random independent samples from normal distributions with equal variances; no **b.** yes; $t = 3.237$ with p-value $< .01$ **c.** yes; $t = 60.36$ with p-value $< .01$

10.87 no; $t = 2.2$ with p-value $> .10$

10.89 no; $t = -.177$ with p-value $> .20$

10.91 no, $t = -1.712$

10.93 unpaired: $(-1.69, .19)$; paired: $(-1.49, -.01)$; paired interval is slightly narrower.

10.95 **a.** no, $t = 2.571$ **b.** (.000, .020)

10.97 **a.** two-tailed; H_a: $\sigma_1^2 \neq \sigma_2^2$ **b.** lower-tailed; H_a: $\sigma_1^2 < \sigma_2^2$ **c.** upper-tailed; H_a: $\sigma_1^2 > \sigma_2^2$

10.99 **a.** no, $\chi^2 = 7.008$ **b.** (.185, 2.465)

10.101 Reject H_0; $t = 2.425$; drug increases average reaction time.

10.103 yes, $t = -2.945$

10.105 no

10.107 no, $t = 1.86$ with p-value $= .112$

10.109 Use pooled t-test; $t = -1.82$ with p-value $> .10$; results are nonsignificant.

10.111 **a.** (5.814, 7.886) **b.** random sample; sampled population is normal.

10.113 Reject H_0; $t = 4.57$; yes.

10.115 **a.** Reject H_0; $t = 4.38$; yes. **b.** p-value $< .01$; yes

10.117 **a.** $t > 1.8$ **b.** $|t| > 2.37$ **c.** $t < -2.6$

10.121 Do not reject H_0; $t = -1.438$ with p-value $= .1782$

10.123 yes; $t = -3.33$ with p-value $= .0030$

Chapter 11

11.1

Source	*df*
Treatments	5
Error	54
Total	59

11.3 **a.** (2.731, 3.409) **b.** (.07, 1.03)

11.5 **a.**

Source	*df*	SS	MS	F
Treatments	3	339.8	113.267	16.98
Error	20	133.4	6.67	
Total	23			

b. $df_1 = 3$ and $df_2 = 20$ **c.** $F > 3.10$ **d.** yes, $F = 16.98$ **e.** p-value $< .005$; yes

11.7 **a.** CM $= 103.142857$; Total SS $= 26.8571$ **b.** SST $= 14.5071$; MST $= 7.2536$ **c.** SSE $= 12.3500$; MSE $= 1.1227$ **d.**

```
Analysis of Variance
Source   DF    SS    MS    F     P
Trts      2  14.51  7.25  6.46  0.014
Error    11  12.35  1.12
Total    13  26.86
```

f. $F = 6.46$; reject H_0 with $.01 < p$-value $< .025$.

11.9 **a.** (1.95, 3.65) **b.** (.27, 2.83)

11.11 **a.** (67.86, 84.14) **b.** (55.82, 76.84) **c.** $(-3.629, 22.963)$ **d.** No, they are not independent.

11.13 **a.** Each observation is the mean length of 10 leaves. **b.** yes, $F = 57.38$ with p-value $= .000$ **c.** Reject H_0; $t = 12.09$. **d.** (1.810, 2.924)

11.15

```
Analysis of Variance for Percent
Source   DF        SS          MS          F      P
Method    2   0.0000041   0.0000021   16.38 0.000
Error    12   0.0000015   0.0000001
Total    14   0.0000056
```

11.17 **a.** completely randomized design

b.

```
Source   DF      SS       MS       F       P
State     3   3272.2   1090.7   26.44   0.000
Error    16    660.0     41.3
Total    19   3932.2
```

c. $F = 26.44$; reject H_0 with p-value $= .000$.

11.19 Sample means must be independent; equal sample sizes.

11.21 **a.** $1.878s$ **b.** $2.1567s$

11.23 $\underline{\bar{x}_1 \quad \bar{x}_2 \quad \bar{x}_3} \quad \bar{x}_4$

11.25 **a.** no; $F = .60$ with p-value $= .562$ **b.** no differences

11.27 **a.** yes; $F = 8.55$, p-value $= .005$ **b.** $(-157.41, -28.59)$ **c.** $\underline{\bar{x}_3 \quad \bar{x}_1} \quad \bar{x}_2$

11.29

Source	*df*	SS	MS	*F*
Treatments	2	11.4	5.70	4.01
Blocks	5	17.1	3.42	2.41
Error	10	14.2	1.42	
Total	17	42.7		

11.31 (−3.833, −.767)

11.33 **a.** yes; $F = 19.19$ **b.** yes; $F = 135.75$
c. $\bar{x}_1 \quad \bar{x}_3 \quad \bar{x}_4 \quad \bar{x}_2$ **d.** (−5.332, −2.668)
e. yes

11.35 **a.** 7 **b.** 7 **c.** 5 **e.** yes; $F = 9.68$
f. yes; $F = 8.59$

11.37

Two-way ANOVA: y versus Blocks, Chemicals

Analysis of Variance for y

Source	DF	SS	MS	F	P
Blocks	2	7.1717	3.5858	40.21	0.000
Chemical	3	5.2000	1.7333	19.44	0.002
Error	6	0.5350	0.0892		
Total	11	12.9067			

11.39 **a.** yes; $F = 10.06$ **b.** yes; $F = 10.88$
c. $\omega = 4.35$ **d.** (1.12, 5.88)

11.41

Two-way ANOVA: Cost versus Estimator, Job

Analysis of Variance for Cost

Source	DF	SS	MS	F	P
Estimator	2	10.862	5.431	7.20	0.025
Job	3	37.607	12.536	16.61	0.003
Error	6	4.528	0.755		
Total	11	52.997			

11.43 **a.** Blocks are items; treatments are stores.
b. yes, $F = 14.79$; p-value = .000
c. yes, $F = 19.39$; p-value = .000

11.45 **a.** 20 **b.** 60 **c.**

Source	*df*
A	3
B	4
AB	12
Error	40
Total	59

11.47 (−1.11, 5.11)

11.49 **a.** strong interaction present
b. $F = 37.85$ with p-value = .000; yes **d.** no

11.51 **b.** yes **c.** Since the interaction is significant, attention should be focused on means for the individual factor-level combinations.
d. Training: $.05 < p\text{-value} < .10$; ability: $p\text{-value} < .005$; interaction: $.01 < p\text{-value} < .025$

11.53 **a.** 2 × 4 factorial; students; gender at two levels, schools at four levels **c.** no; $F = 1.19$ **e.** Main effect for schools is significant; $F = 27.75$; Tukey's $\omega = 82.63$.

11.55 **a.**

Source	DF	SS	MS	F	P
Training	1	4489.00	4489.00	117.49	0.000
Situation	1	132.25	132.25	3.46	0.087
Interaction	1	56.25	56.25	1.47	0.248
Error	12	458.50	38.21		
Total	15	5136.00			

b. No. $F = 1.47$; p-value = .248. **c.** no
$F = 3.46$; p-value = .087. **d.** yes
$F = 117.49$; p-value = .000.

11.57 significant differences between treatments A and C, B and C, C and E and D and E

11.59 **a.** significant difference in treatment means; $F = 27.78$ **b.** Tukey's $\omega = .190$
c. yes; $F = 6.59$

11.61

One-way ANOVA: Sales versus Program

Analysis of Variance for Sales

Source	DF	SS	MS	F	P
Program	3	1385.8	461.9	9.84	0.000
Error	23	1079.4	46.9		
Total	26	2465.2			

11.63 **a.** no; $F = 1.40$ **b.** p-value > .10
c. yes; $F = 6.51$ **d.** yes; $F = 7.37$

11.65 **a.** 2 × 3 factorial experiment **b.** no; $F = .45$ with p-value = .642
d. (−22.56, −5.84)

11.67 **a.** randomized block design
b.

Two-way ANOVA: Total versus Week, Store

Analysis of Variance for Total

Source	DF	SS	MS	F	P
Week	3	571.7	190.6	8.27	0.003
Store	4	684.6	171.2	7.43	0.003
Error	12	276.4	23.0		
Total	19	1532.7			

c. yes; $F = 7.43$ **d.** $\omega = 10.82$

11.69 **a.** factorial experiment **b.** yes; $F = 7.61$
c. $\omega = 2.67$

11.71 **a.** completely randomized design
b. Yes, there is a significant difference.
$F = 126.85$, p-value = .000

Source	DF	SS	MS	F	P
Site	2	132.277	66.139	126.85	0.000
Error	21	10.950	0.521		
Total	23	143.227			

11.73 There is no evidence of non-normality. There appears to be slightly larger error variation for the smaller values compared to the larger values of y.

Chapter 12

12.1 y-intercept = 1, slope = 2

12.3 $y = 3 - x$

12.7 **a.** $\hat{y} = 6.00 - .557x$ **c.** 4.05
d. Analysis of Variance

Source	DF	SS	MS
Regression	1	5.4321	5.4321
Residual Error	4	0.1429	0.0357
Total	5	5.5750	

12.9 **a.** $S_{xx} = 21066.82$; $S_{yy} = .374798$; $S_{xy} = 88.80003$ **b.** $\hat{y} = .0187 + .00422x$
d. .44
e. Analysis of Variance

Source	DF	SS	MS
Regression	1	0.37431	0.37431
Residual Error	7	0.00049	0.00007
Total	8	0.37480	

12.11 **a.** y = API; x = ELL **b.** yes **c.** $\hat{y} = 731.277 - 3.040x$ **d.** yes

12.13 **a.** yes **b.** $\hat{y} = -11.665 + .755x$ **c.** $\hat{y} = 52.51$

12.15 **a.** strong positive linear relationship **b.** approximately 1 **c.** $\hat{y} = 12.221 + .815x$ **d.** $\hat{y} = 62.75$

12.17 **a.** yes, $t = 5.20$ **b.** $F = 27.00$ **c.** $t_{.025} = 3.182$; $F_{.05} = 10.13$

12.19 **a.** yes, $F = 152.10$ with p-value = .000 **b.** $r^2 = .974$

12.21 **a.** y = cost, x = distance **b.** $\hat{y} = 128.58 + .12715x$ **d.** $t = 6.09$; $r^2 = .699$

12.23 **a.** yes; $t = 3.79$ and $F = 14.37$ with p-value = .005 **b.** no **c.** $r^2 = .642$ **d.** MSE = 5.025 **e.** (.186, .764)

12.25 **a.** yes **b.** $\hat{y} = -26.82 + 1.2617x$ **c.** yes; $t = 7.49$ and $F = 56.05$ with p-value = .000 **d.** (.7768, 1.7466)

12.27 **a.** yes; reject H_0, $t = 7.15$ **b.** (.5362, 1.0944) **c.** yes; the value $\beta = 1$ is contained in the interval.

12.29 plot residuals versus fit; random scatter of points, free of patterns

12.31 no

12.33 **a.** slight curve **b.** 95.9% of overall variation explained by the straight-line model **c.** strong curvilinear pattern indicates relationship may be curvilinear

12.35 **a.** fairly strong positive relationship **b.** yes; Toshiba 37HLX95 **c.** yes; no

12.37 **a.** (4.6006, 5.1708) **b.** (4.2886, 5.4829) **c.** $x = 8$; extrapolation

12.39 **a.** slight curve **b.** 95.7% of overall variation is explained by the straight-line model. **c.** Pattern indicates relationship may be curvilinear.

12.41 **a.** (2.01, 3.74) **b.** (−.77, 3.02) **c.** $\bar{x} = 0$

12.43 **a.** (198.178, 244.254) **b.** (126.235, 316.197) **c.** no

12.47 **a.** positive **b.** $r = .9487$; $r^2 = .9000$

12.49 **b.** $r = .982$ **c.** 96.5%

12.51 **a.** positive **b.** $r = .760$; yes, $t = 2.615$

12.53 yes; $t = 3.158$ with p-value $< .01$

12.55 **a.** correlation analysis **b.** $r = .981$

12.57 **a.** possibly **b.** $r = .658$; yes, $t = 2.140$

12.59 **a.** yes **b.** $\hat{y} = 80.85 + 270.82x$ **c.** yes; $t = 3.96$ with p-value = .003 **d.** (112.1, 157.9)

12.61 **a.** $r = .980$ **b.** $r^2 = .961$ **c.** $\hat{y} = 21.9 + 15.0x$ **d.** Variance is not constant for all x.

12.63

Regression Analysis: API versus ELL

```
The regression equation is
API = 731 - 3.04 ELL
```

Predictor	Coef	StDev	T	P
Constant	731.28	22.81	32.06	0.000
ELL	-3.0399	0.7551	-4.03	0.007

S = 33.72 R-Sq = 73.0% R-Sq(adj) = 68.5%

Analysis of Variance

Source	DF	SS	MS	F	P
Regression	1	18422	18422	16.21	0.007
Residual Error	6	6820	1137		
Total	7	25242			

12.65 **a.** no; $t = 2.066$ with p-value $> .05$ **b.** $r^2 = .299$

12.67 no; variance is not constant for all x.

12.69 **a.** strong positive relationship **b.** $r^2 = .778$; 77.8% **c.** $\hat{y} = -14.150 + 21.430x$; yes, $t = 5.30$ **d.** yes

12.71 at the extremes of the experimental region

12.73 **a.** $\hat{y} = 20.47 - .758x$
b.

Source	DF	SS	MS	F	P
Regression	1	287.28	287.28	493.40	0.000
Residual Error	8	4.66	0.58		
Total	9	291.94			

c. Reject H_0, $t = -22.21$ **d.** (−.86, −.66) **e.** (9.296, 10.420) **f.** $r^2 = .984$

12.77 **a.** y-intercept = 3; slope = −0.5

Chapter 13

13.1 **b.** parallel lines

13.3 **a.** yes, $F = 57.44$ with p-value $< .005$ **b.** $R^2 = .94$

13.5 **a.** quadratic **b.** $R^2 = .815$; relatively good fit **c.** yes, $F = 37.37$ with p-value = .000

13.7 **a.** $b_0 = 10.5638$ **b.** yes, $t = 15.20$ with p-value $= .000$

13.9 **b.** $t = -8.11$ with p-value $= .000$; reject H_0: $\beta_2 = 0$ in favor of H_a: $\beta_2 < 0$.

13.11 **a.** $R^2 = .9955$ **b.** $R^2(\text{adj}) = 99.3\%$ **c.** The quadratic model fits slightly better.

13.13 **a.** Use variables x_2, x_3, and x_4. **b.** no

13.15 **a.** $\hat{y} = -8.177 + 292x_1 + 4.434x_2$ **b.** Reject H_0, $F = 16.28$ with p-value $= .002$. The model contributes significant information for the prediction of y. **c.** yes, $t = 5.54$ with p-value $= .001$ **d.** $R^2 = .823$; 82.3%

13.17 **a.** quantitative **b.** quantitative **c.** qualitative; $x_1 = 1$ if plant B, 0 otherwise; $x_2 = 1$ if plant C, 0 otherwise **d.** quantitative **e.** qualitative; $x_1 = 1$ if day shift, 0 if night shift

13.19 **a.** x_2 **b.** $\hat{y} = 12.6 + 3.9x_2^2$ or $\hat{y} = 13.14 - 1.2x_2 + 3.9x_2^2$

13.21 **a.** $y = \beta_0 + \beta_1x_1 + \beta_2x_2 + \beta_3x_1x_2 + \epsilon$ with $x_2 = 1$ if cucumber, 0 if cotton **c.** No, the test for interaction yields $t = .63$ with p-value $= .533$. **d.** yes

13.23 $y = \beta_0 + \beta_1x_1 + \beta_2x_1^2 + \beta_3x_2 + \beta_4x_1x_2 + \beta_5x_1^2x_2 + \varepsilon$

13.25 **a.** $\hat{y} = 8.585 + 3.8208x - 0.21663x^2$ **b.** $R^2 = .944$ **c.** yes; $F = 33.44$ **d.** yes; $t = -4.93$ with p-value $= .008$ **e.** no

13.27 **b.** $\hat{y} = 4.10 + 1.04x_1 + 3.53x_2 + 4.76x_3 - 0.43x_1x_2 - 0.08x_1x_3$ **c.** yes; $t = -2.61$ with p-value $= .028$ **d.** no; $F = 3.86$; consider eliminating the interaction terms.

13.29 **a.** $y = \beta_0 + \beta_1x_1 + \beta_2x_2 + \beta_3x_1^2 + \beta_4x_1x_2 + \beta_5x_1^2x_2 + \epsilon$ **b.** $F = 25.85$; $R^2 = .768$ **c.** $\hat{y} = 4.51 + 6.394x_1 + .1318x_1^2$ **d.** $\hat{y} = -46.34 + 23.458x_1 - .3707x_1^2$ **e.** no; $t = .78$ with p-value $= .439$

13.31 **a.** no; x_1, x_2, x_3 **b.** $y = \beta_0 + \beta_1x_1 + \beta_2x_2 + \beta_3x_3 + \beta_4x_4 + \beta_5x_5 + \epsilon$ **c.** $R^2 = 91.4\%$ and $R^2(\text{adj}) = 88.7\%$; yes. **d.** x_1, x_2, and possibly x_4; $y = \beta_0 + \beta_1x_1 + \beta_2x_2 + \beta_3x_4 + \epsilon$; $R^2(\text{adj}) = 89.8\%$; the reduced model is better than the full model.

13.35 **a.** 99.9% **b.** yes; $F = 1676.61$ with p-value $= .000$ **c.** yes; $t = -2.65$ with p-value $= .045$ **d.** yes; $t = 15.14$ with p-value $= .000$ **e.** Linear: $R^2(\text{adj}) = 91.9\%$, quadratic: $R^2(\text{adj}) = 99.8\%$, quadratic term is significant. **f.** Quadratic term is missing.

Chapter 14

14.3 **a.** $X^2 > 12.59$ **b.** $X^2 > 21.666$ **c.** $X^2 > 29.8194$ **d.** $X^2 > 5.99$

14.5 **a.** H_0: $p_1 = p_2 = p_3 = p_4 = p_5 = 1/5$ **b.** 4 **c.** 9.4877 **d.** $X^2 = 8.00$ **e.** Do not reject H_0.

14.7 Yes, $X^2 = 24.48$; drivers tend to prefer the inside lanes.

14.9 no, $X^2 = 3.63$

14.11 no, $X^2 = 13.58$

14.13 yes; do not reject H_0; $X^2 = 1.247$

14.15 yes; reject H_0; $X^2 = 28.386$

14.17 8

14.19 Reject H_0; $X^2 = 18.352$ with p-value $= .000$.

14.21 **a.** yes; $X^2 = 7.267$ **b.** $.025 < p\text{-value} < .05$

14.23 **a.** yes; reject H_0; $X^2 = 20.937$ **b.** no; $X^2 = 1.255$

14.25 **a.** no; do not reject H_0; $X^2 = 6.447$ **b.** p-value $> .10$; yes

14.27 **a.** $X^2 = 10.597$ **b.** $X^2 > 13.2767$ **c.** Do not reject H_0. **d.** $.025 < p\text{-value} < .05$

14.29 yes; $X^2 = 24.31$

14.31 **a.** Each care type represents a binomial population in which we measure the presence or absence of EMI services. **b.** yes; $X^2 = 18.446$

14.33 Yes, reject H_0; $X^2 = 36.499$.

14.35 no, $X^2 = 4.4$ with p-value $> .10$

14.37 no, $X^2 = 1.89$ with p-value $> .10$

14.39 **a.** no, $X^2 = 1.815$ **b.** p-value $> .10$

14.43 no; do not reject H_0; $X^2 = 1.311$.

14.45 **a.** Reject H_0; $X^2 = 18.527$. **b.** Reject H_0; $z = 4.304$; yes.

14.49 yes, $X^2 = 7.488$ with $.005 < p\text{-value} < .01$

14.51 yes, $X^2 = 6.190$ with $.025 < p\text{-value} < .05$; (.347, .483)

14.53 **a.** no; $X^2 = 3.259$ with p-value $= .196$ **b.** no; $X^2 = 1.054$ with p-value $= .788$ **c.** yes

14.55 no, $X^2 = 3.953$ with p-value $= .139$

14.57 **a.** Do not reject H_0; $X^2 = 3.660$ with p-value $= .454$; yes.

14.59 **a.** yes; $X^2 = 11.690$ with p-value $= .003$ **b.** The susceptibility to a cold seems to decrease as the number of relationships increases.

14.61 Yes, reject H_0; $X^2 = 16.535$.

14.63 **a.** 27.69 **b.** 5.99

14.65 Consumers have a preference; $X^2 = 18.5$ with p-value $= .0001$.

14.69 no; $X_2 = 2.87$ with p-value $= .2378$

Chapter 15

15.1 **a.** T_1^* **b.** $T \leq 31$ **c.** $T \leq 27$

15.3 **a.** H_0: population distributions are identical; H_a: population 1 shifted to the left of population 2. **b.** $T_1 = 16$; $T_1^* = 39$ **c.** $T \leq 19$ **d.** yes; reject H_0

15.5 Do not reject H_0; $z = -1.59$.

15.7 Do not reject H_0; $T = 102$.

15.9 yes; reject H_0; $T = 45$

15.11 yes; reject H_0; $T = 44$

15.13 **b.** $\alpha = .002, .007, .022, .054, .115$

15.15 one-tailed: **n = 10:** $\alpha = .001, .011, .055$; **n = 15:** $\alpha = .004, .018, .059$; **n = 20:** $\alpha = .001, .006, .021, .058, .132$; two-tailed: **n = 10:** $\alpha = .002, .022, .110$; **n = 15:** $\alpha = .008, .036, .118$; **n = 20:** $\alpha = .002, .012, .042, .116$

15.17 **a.** H_0: $p = \frac{1}{2}$; H_a: $p \neq \frac{1}{2}$; rejection region: $\{0, 1, 7, 8\}$; $x = 6$; do not reject H_0 at $\alpha = .07$; p-value $= .290$.

15.19 $z = 3.15$; reject H_0.

15.21 **b.** $T = \min\{T^+, T^-\}$ **c.** $T \leq 137$ **d.** Do not reject H_0.

15.23 Do not reject H_0; $z = -.34$.

15.25 **a.** Reject H_0; $T = 1.5$ **b.** Results do not agree.

15.27 **a.** no; $T = 6.5$

15.29 **a.** Do not reject H_0; $x = 8$. **b.** Do not reject H_0; $T = 14.5$.

15.31 **a.** paired difference test, sign test, Wilcoxon signed-rank test **b.** Reject H_0 with both tests; $x = 0$ and $T = 0$.

15.33 yes, $H = 13.90$

15.35 **a.** no; $H = 2.63$ **b.** p-value $> .10$ **c.** p-value $> .10$

15.37 no; $H = 2.54$ with p-value $> .10$

15.39 **a.** Reject H_0; $F_r = 21.19$. **b.** p-value $< .005$ **d.** $F = 75.43$ **e.** p-value $< .005$ **f.** Results are identical.

15.41 **a.** Do not reject H_0; $F_r = 5.81$. **b.** $.05 < p$-value $< .10$

15.43 **a.** $r_s \geq .425$ **b.** $r_s \geq .601$

15.45 **a.** $|r_s| \geq .400$ **b.** $|r_s| \geq .526$

15.47 **a.** $-.593$ **b.** yes

15.49 **a.** $r_s = .811$ **b.** yes

15.51 yes

15.53 yes, $r_s = .9118$

15.55 **a.** Do not reject H_0; $x = 2$. **b.** Do not reject H_0; $t = -1.646$.

15.57 **a.** Do not reject H_0; $x = 7$. **b.** Do not reject H_0; $x = 7$.

15.59 Do not reject H_0 with the Wilcoxon rank sum test ($T = 77$) or the paired difference test ($t = .30$).

15.61 Do not reject H_0 using the sign test ($x = 2$); no.

15.63 yes; $r_s = -.845$

15.65 Reject H_0; $T = 14$.

15.67 **a.** Reject H_0; $F_r = 20.13$. **b.** The results are the same.

15.69 **a.** Reject H_0; $H = 9.08$. **b.** $.025 < p$-value $< .05$ **c.** The results are the same.

15.71 **a.** no **b.** significant differences among the responses to the three rates of application; $F_r = 10.33$ with p-value $= .006$

15.73 $T = 19$. $T_{.05} = 21$ ($T_{.01} = 18$.) Reject H_0.

15.75 $z = 1.18 < z_{.05} = 1.645$; lighting not effective

15.77 $H = 7.43$ $df = 3$ p-value $= 0.059$; no significant difference

15.79 **a.** $r_s = .738$. **b.** p-value $= .025 < .05$; yes, positive correlation

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