Appendix D: Self-Test Solutions and Answers to Exercises

Chapter 1

2. a. Average number of rooms = 808/9 = 89.78, or approximately 90 rooms
b. Average overall score = 732.1/9 = 81.3
c. 2 of 9 are located in England; approximately 22%
d. 4 of 9 have a room rate of $$; approximately 44%

3. a. 9
b. 4
c. Qualitative: country and room rate
Quantitative: number of rooms and overall score
d. Country is nominal; room rate is ordinal; number of rooms is ratio; overall score is interval

5. a. 10
b. All brands of minisystems manufactured
c. $314
d. $314

6. a. 1005
b. Qualitative
c. Percentages
d. Approximately 291

7. a. All visitors to Hawaii
b. Yes
c. First and fourth questions provide quantitative data
Second and third questions provide qualitative data

11. a. Quantitative; ratio
b. Qualitative; nominal
c. Qualitative; ordinal
d. Quantitative; ratio
e. Qualitative; nominal

12. Questions a, c, and d provide quantitative data
Questions b and e provide qualitative data

13. a. Graph with a time series line for each manufacturer
b. Toyota surpasses General Motors in 2006 to become the leading auto manufacturer
c. A bar graph would show cross-sectional data for 2007; bar heights would be GM 8.8, Ford 7.9, DC 4.6, and Toyota 9.6

14. a. Earnings in billions of dollars are quantitative data
b. Time series for 1997 to 2005
c. Earnings for Volkswagen
d. Earnings are relatively low in 1997 to 1999, excellent growth occurs in 2000 and 2001, and decline happens in 2003 to 2005; the decline in earnings suggests the $600 million projected earnings for 2006 is reasonable
e. In July 2001, the earnings tread was positive; Volkswagen would have been a promising investment in 2001
f. Be careful when projecting time series data into the future, because trends in past data may or may not continue

15. a. Product taste tests and test marketing
b. Specially designed statistical studies

17. a. Correct
b. Incorrect
c. Correct
d. Incorrect
e. Incorrect

18. a. 43% of managers were bullish or very bullish, and 21% of managers expected health care to be the leading industry over the next 12 months
b. The average 12-month return estimate is 11.2% for the population of investment managers
c. The sample average of 2.5 years is an estimate of how long the population of investment managers think it will take to resume sustainable growth

21. a. All registered voters in California
b. Registered voters contacted by the Policy Institute
c. Too time consuming and costly to reach the entire population

22. a. 36%
b. 189
c. Qualitative

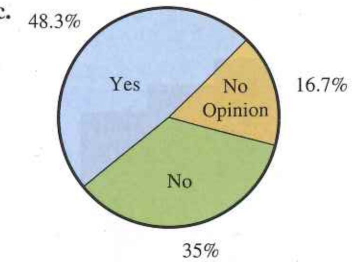
Chapter 2

2. a. .20
b. 40
c/d.

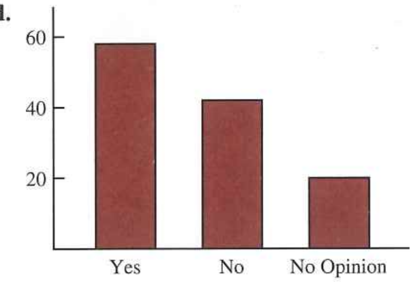
Class	Frequency	Percent Frequency
A	44	22
B	36	18
C	80	40
D	40	20
Total	200	100

3. a. 360° × 58/120 = 174°
b. 360° × 42/120 = 126°

c.



d.



4. a. Qualitative
b.

TV Show	Frequency	Percent Frequency
Law & Order	10	20%
CSI	18	36%
Without a Trace	9	18%
Desperate Housewives	13	26%
Total:	50	100%

d. *CSI* had the largest viewing audience; *Desperate Housewives* was in second place

6. a.

Network	Frequency	Percent Frequency
ABC	15	30
CBS	17	34
FOX	1	2
NBC	17	34

b. CBS and NBC tied for first; ABC is close with 15

7.

Rating	Frequency	Relative Frequency
Outstanding	19	.38
Very good	13	.26
Good	10	.20
Average	6	.12
Poor	2	.04

Management should be pleased with these results: 64% of the ratings are very good to outstanding, and 84% of the ratings are good or better; comparing these ratings to previous results will show whether the restaurant is making improvements in its customers' ratings of food quality

8. a.

Position	Frequency	Relative Frequency
P	17	.309
H	4	.073
1	5	.091
2	4	.073
3	2	.036
S	5	.091
L	6	.109
C	5	.091
R	7	.127
Totals	55	1.000

b. Pitcher
c. 3rd base
d. Right field
e. Infielders 16 to outfielders 18

10. a. The data are qualitative; they provide quality classifications
b.

Rating	Frequency	Relative Frequency
1 star	0	.000
2 star	3	.167
3 star	3	.167
4 star	10	.556
5 star	2	.111
	18	1.000

d. Very good overall, with 10 4-star ratings and 12 (66.7%) 4-star or 5-star ratings

12.

Class	Cumulative Frequency	Cumulative Relative Frequency
≤19	10	.20
≤29	24	.48
≤39	41	.82
≤49	48	.96
≤59	50	1.00

14. b/c.

Class	Frequency	Percent Frequency
6.0–7.9	4	20
8.0–9.9	2	10
10.0–11.9	8	40
12.0–13.9	3	15
14.0–15.9	3	15
Totals	20	100

15. a/b.

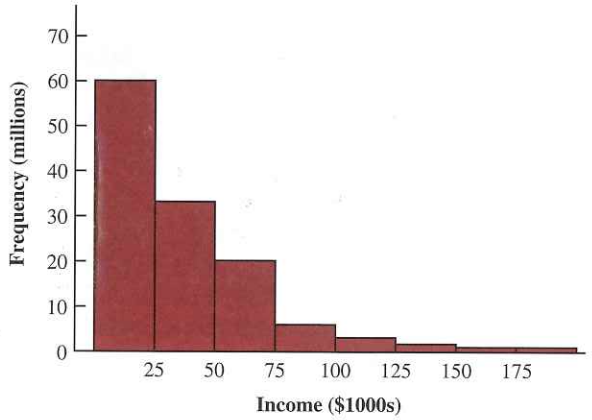
Waiting Time	Frequency	Relative Frequency
0–4	4	.20
5–9	8	.40
10–14	5	.25
15–19	2	.10
20–24	1	.05
Totals	20	1.00

c/d.

Waiting Time	Cumulative Frequency	Cumulative Relative Frequency
≤4	4	.20
≤9	12	.60
≤14	17	.85
≤19	19	.95
≤24	20	1.00

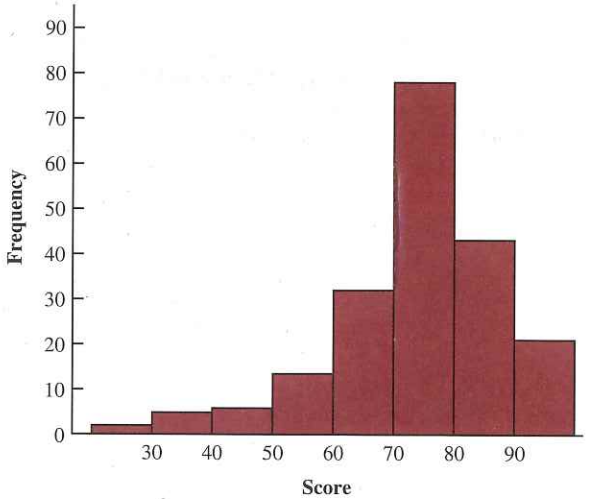
e. 12/20 = .60

16. a. Adjusted Gross Income



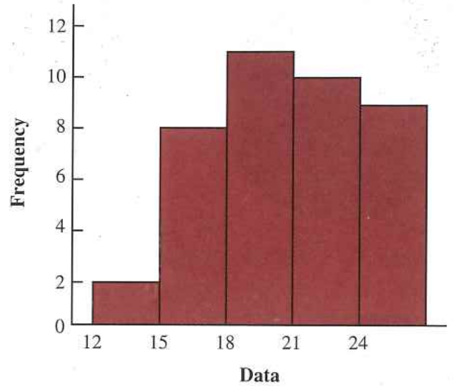
Histogram is skewed to the right

b. Exam Scores



Histogram is skewed to the left

c.



Histogram skewed slightly to the left

18. a. Lowest $180; highest $2050

b.

Spending	Frequency	Percent Frequency
$0–249	3	12
250–499	6	24
500–749	5	20
750–999	5	20
1000–1249	3	12
1250–1499	1	4
1500–1749	0	0
1750–1999	1	4
2000–2249	1	4
Total	25	100

c. The distribution shows a positive skewness

d. Majority (64%) of consumers spend between $250 and $1000; the middle value is about $750; and two high spenders are above $1750

20. a.

Price	Frequency	Percent Frequency
30–39.99	7	35
40–49.99	5	25
50–59.99	2	10
60–69.99	3	15
70–79.99	3	15
Total	20	100

c. Fleetwood Mac, Harper/Johnson

22.

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

23. Leaf unit = .1

6	3
7	5 5 7
8	1 3 4 8
9	3 6
10	0 4 5
11	3

24. Leaf unit = 10

11	6
12	0 2
13	0 6 7
14	2 2 7
15	5
16	0 2 8
17	0 2 3

25.

9	8 9
10	2 4 6 6
11	4 5 7 8 8 9
12	2 4 5 7
13	1 2
14	4
15	1

26. a.

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

b.

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

28. a.

2	14
2	67
3	011123
3	5677
4	003333344
4	6679
5	00022
5	5679
6	14
6	6
7	2

b. 40–44 with 9

c. 43 with 5

d. 10%; relatively small participation in the race

29. a.

		y: 1	y: 2	Total
x	A	5	0	5
	B	11	2	13
	C	2	10	12
	Total	18	12	30

b.

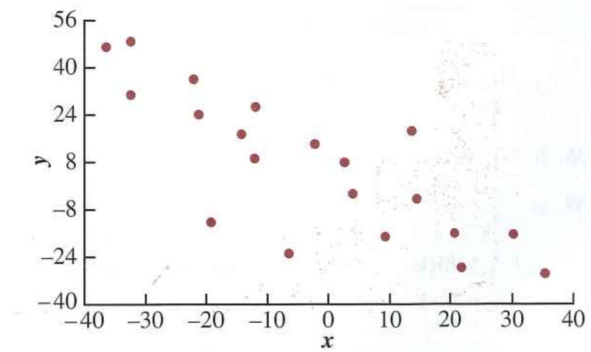
		y: 1	y: 2	Total
x	A	100.0	0.0	100.0
	B	84.6	15.4	100.0
	C	16.7	83.3	100.0

c.

		y: 1	y: 2
x	A	27.8	0.0
	B	61.1	16.7
	C	11.1	83.3
	Total	100.0	100.0

d. *A* values are always in $y = 1$
B values are most often in $y = 1$
C values are most often in $y = 2$

30. a.



b. A negative relationship between *x* and *y*; *y* decreases as *x* increases

32. a.

Education Level	Household Income ($1000s): Under 25	25.0–49.9	50.0–74.9	75.0–99.9	100 or more	Total
Not H.S. Graduate	32.70	14.82	8.27	5.02	2.53	15.86
H.S. Graduate	35.74	35.56	31.48	25.39	14.47	30.78
Some College	21.17	29.77	30.25	29.82	22.26	26.37
Bachelor's Degree	7.53	14.43	20.56	25.03	33.88	17.52
Beyond Bach. Deg.	2.86	5.42	9.44	14.74	26.86	9.48
Total	100.00	100.00	100.00	100.00	100.00	100.00

15.86% of the heads of households did not graduate from high school

b. 26.86%, 39.72%

c. Positive relationship between income and education level

34. a.

Sales/Margins/ROE	EPS Rating 0–19	20–39	40–59	60–79	80–100	Total
A				1	8	9
B		1	4	5	2	12
C	1		1	2	3	7
D	3	1		1		5
E		2	1			3
Total	4	4	6	9	13	36

b.

Sales/Margins/ROE	EPS Rating 0–19	20–39	40–59	60–79	80–100	Total
A				11.11	88.89	100
B		8.33	33.33	41.67	16.67	100
C	14.29		14.29	28.57	42.86	100
D	60.00	20.00		20.00		100
E		66.67	33.33			100

Higher EPS ratings seem to be associated with higher ratings on Sales/Margins/ROE

36. b. No apparent relationship

39. a.

Vehicle	Frequency	Percent Frequency
Accord	6	12
Camry	7	14
F-Series	14	28
Ram	10	20
Silverado	13	26

b. Ford F-Series and the Toyota Camry

41. a.

Response	Frequency	Percent Frequency
Accuracy	16	16
Approach shots	3	3
Mental approach	17	17
Power	8	8
Practice	15	15
Putting	10	10
Short game	24	24
Strategic decisions	7	7
Total	100	100

b. Poor short game, poor mental approach, lack of accuracy, and limited practice

43. a.

SAT Score	Frequency
750–849	2
850–949	5
950–1049	10
1050–1149	5
1150–1249	3
Total	25

b. Nearly symmetrical

c. 40% of the scores fall between 950 and 1049
A score below 750 or above 1249 is unusual
The average is near or slightly above 1000

45. a.

Population	Frequency	Percent Frequency
0.0–2.4	17	34
2.5–4.9	12	24
5.0–7.4	9	18
7.5–9.9	4	8
10.0–12.4	3	6
12.5–14.9	1	2
15.0–17.4	1	2
17.5–19.9	1	2
20.0–22.4	0	0
22.5–24.9	1	2
25.0–27.4	0	0
27.5–29.9	0	0
30.0–32.4	0	0
32.5–34.9	0	0
35.0–37.4	1	2
Total	50	100

c. High positive skewness

d. 17 (34%) with population less than 2.5 million
29 (58%) with population less than 5 million
8 (16%) with population greater than 10 million
Largest 35.9 million (California)
Smallest .5 million (Wyoming)

47. a. High Temperatures

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

b. Low Temperatures

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

c. The most frequent range for high is in 60s (9 of 20) with only one low temperature above 54
High temperatures range mostly from 41 to 68, while low temperatures range mostly from 21 to 47
Low was 11; high was 84

d.

High Temp	Frequency	Low Temp	Frequency
10–19	0	10–19	1
20–29	0	20–29	5
30–39	1	30–39	5
40–49	4	40–49	5
50–59	3	50–59	3
60–69	9	60–69	1
70–79	2	70–79	0
80–89	1	80–89	0
Total	20	Total	20

49. a.

Occupation	Satisfaction Score 30–39	40–49	50–59	60–69	70–79	80–89	Total
Cabinetmaker			2	4	3	1	10
Lawyer	1	5	2	1	1		10
Physical Therapist			5	2	1	2	10
Systems Analyst		2	1	4	3		10
Total	1	7	10	11	8	3	40

b.

Occupation	Satisfaction Score 30–39	40–49	50–59	60–69	70–79	80–89	Total
Cabinetmaker			20	40	30	10	100
Lawyer	10	50	20	10	10		100
Physical Therapist			50	20	10	20	100
Systems Analyst		20	10	40	30		100

c. Cabinetmakers seem to have the highest job satisfaction scores; lawyers seem to have the lowest

51. a. Row totals: 247; 54; 82; 121
Column totals: 149; 317; 17; 7; 14

b.

Year	Freq.	Fuel	Freq.
1973 or before	247	Elect.	149
1974–79	54	Nat. Gas	317
1980–86	82	Oil	17
1987–91	121	Propane	7
		Other	14
Total	504	Total	504

c. Crosstabulation of column percentages

Year Constructed	Fuel Type Elect.	Nat. Gas	Oil	Propane	Other
1973 or before	26.9	57.7	70.5	71.4	50.0
1974–1979	16.1	8.2	11.8	28.6	0.0
1980–1986	24.8	12.0	5.9	0.0	42.9
1987–1991	32.2	22.1	11.8	0.0	7.1
Total	100.0	100.0	100.0	100.0	100.0

d. Crosstabulation of row percentages

Year Constructed	Fuel Type Elect.	Nat. Gas	Oil	Propane	Other	Total
1973 or before	16.2	74.1	4.9	2.0	2.8	100.0
1974–1979	44.5	48.1	3.7	3.7	0.0	100.0
1980–1986	45.1	46.4	1.2	0.0	7.3	100.0
1987–1991	39.7	57.8	1.7	0.0	0.8	100.0

53. b. A positive relationship is demonstrated between market value and stockholders' equity

54. a. Crosstabulation of market value and profit

Market Value ($1000s)	Profit ($1000s) 0–300	300–600	600–900	900–1200	Total
0–8000	23	4			27
8000–16,000	4	4	2	2	12
16,000–24,000		2	1	1	4
24,000–32,000		1	2	1	4
32,000–40,000		2	1		3
Total	27	13	6	4	50

b. Crosstabulation of row percentages

Market Value ($1000s)	Profit ($1000s) 0–300	300–600	600–900	900–1200	Total
0–8000	85.19	14.81	0.00	0.00	100
8000–16,000	33.33	33.33	16.67	16.67	100
16,000–24,000	0.00	50.00	25.00	25.00	100
24,000–32,000	0.00	25.00	50.00	25.00	100
32,000–40,000	0.00	66.67	33.33	0.00	100

c. A positive relationship is indicated between profit and market value; as profit goes up, market value goes up

Chapter 3

2. 16, 16.5

3. Arrange data in order: 15, 20, 25, 25, 27, 28, 30, 34
$i = \frac{20}{100}(8) = 1.6$; round up to position 2
20th percentile $= 20$

$i = \frac{25}{100}(8) = 2$; use positions 2 and 3

25th percentile $= \frac{20 + 25}{2} = 22.5$

$i = \frac{65}{100}(8) = 5.2$; round up to position 6

65th percentile = 28

$i = \frac{75}{100}(8) = 6$; use positions 6 and 7

75th percentile $= \frac{28 + 30}{2} = 29$

4. 59.73, 57, 53

6. a. Marketing: 36.3, 35.5, 34.2
Accounting: 45.7, 44.7, no mode

b. Marketing: 34.2, 39.5
Accounting: 40.95, 49.8

c. Accounting salaries are approximately $9000 higher

8. a. $\bar{x} = \frac{\Sigma x_i}{n} = \frac{3200}{20} = 160$

Order the data from low 100 to high 360

Median: $i = \left(\frac{50}{100}\right)20 = 10$ Use 10th and 11th positions

Median $= \left(\frac{130 + 140}{2}\right) = 135$

Mode = 120 (occurs 3 times)

b. $i = \left(\frac{25}{100}\right)20 = 5$ Use 5th and 6th positions

$Q_1 = \left(\frac{115 + 115}{2}\right) = 115$

$i = \left(\frac{75}{100}\right)20 = 15$ Use 15th and 16th positions

$Q_3 = \left(\frac{180 + 195}{2}\right) = 187.5$

c. $i = \left(\frac{90}{100}\right)20 = 18$ Use 18th and 19th positions

90th percentile $= \left(\frac{235 + 255}{2}\right) = 245$

90% of the tax returns cost $245 or less

10. a. .4%, 3.5%

b. 2.3%, 2.5%, 2.7%

c. 2.0%, 2.8%

d. Optimistic

12. Disney: 3321, 255.5, 253, 169, 325
Pixar: 3231, 538.5, 505, 363, 631
Pixar films generate approximately twice as much box office revenue per film

14. 16, 4

15. Range = 34 − 15 = 19
Arrange data in order: 15, 20, 25, 25, 27, 28, 30, 34

$i = \frac{25}{100}(8) = 2$; $Q_1 = \frac{20 + 25}{2} = 22.5$

$i = \frac{75}{100}(8) = 6$; $Q_3 = \frac{28 + 30}{2} = 29$

IQR $= Q_3 - Q_1 = 29 - 22.5 = 6.5$

$\bar{x} = \frac{\Sigma x_i}{n} = \frac{204}{8} = 25.5$

x_i	$(x_i - \bar{x})$	$(x_i - \bar{x})^2$
27	1.5	2.25
25	−.5	.25
20	−5.5	30.25
15	−10.5	110.25
30	4.5	20.25
34	8.5	72.25
28	2.5	6.25
25	−.5	.25
		242.00

$$s^2 = \frac{\Sigma(x_i - \bar{x})^2}{n - 1} = \frac{242}{8 - 1} = 34.57$$

$$s = \sqrt{34.57} = 5.88$$

16. a. Range = 190 − 168 = 22

b. $\bar{x} = \frac{\Sigma x_i}{n} = \frac{1068}{6} = 178$

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

$$= \frac{4^2 + (-10)^2 + 6^2 + 12^2 + (-8)^2 + (-4)^2}{6 - 1}$$

$$= \frac{376}{5} = 75.2$$

c. $s = \sqrt{75.2} = 8.67$

d. $\frac{s}{\bar{x}}(100) = \frac{8.67}{178}(100\%) = 4.87\%$

18. a. 38, 97, 9.85

b. Eastern shows more variation

20. *Dawson:* range = 2, s = .67
Clark: range = 8, s = 2.58

22. a. 1285, 433
Freshmen spend more

b. 1720, 352

c. 404, 131.5

d. 367.04, 96.96

e. Freshmen have more variability

24. *Quarter-milers:* s = .0564, Coef. of Var. = 5.8%
Milers: s = .1295, Coef. of Var. = 2.9%

26. .20, 1.50, 0, −.50, −2.20

27. Chebyshev's theorem: *at least* $(1 - 1/z^2)$

a. $z = \frac{40 - 30}{5} = 2$; $1 - \frac{1}{(2)^2} = .75$

b. $z = \frac{45 - 30}{5} = 3$; $1 - \frac{1}{(3)^2} = .89$

c. $z = \frac{38 - 30}{5} = 1.6$; $1 - \frac{1}{(1.6)^2} = .61$

d. $z = \frac{42 - 30}{5} = 2.4$; $1 - \frac{1}{(2.4)^2} = .83$

e. $z = \frac{48 - 30}{5} = 3.6$; $1 - \frac{1}{(3.6)^2} = .92$

28. a. 95%

b. Almost all

c. 68%

29. a. z = 2 standard deviations

$1 - \frac{1}{z^2} = 1 - \frac{1}{2^2} = \frac{3}{4}$; at least 75%

b. z = 2.5 standard deviations

$1 - \frac{1}{z^2} = 1 - \frac{1}{2.5^2} = .84$; at least 84%

c. z = 2 standard deviations
Empirical rule: 95%

30. a. 68%

b. 81.5%

c. 2.5%

32. a. −.67

b. 1.50

c. Neither an outlier

d. Yes; z = 8.25

34. a. 76.5, 7

b. 16%, 2.5%

c. 12.2, 7.89; no

36. 15, 22.5, 26, 29, 34

38. Arrange data in order: 5, 6, 8, 10, 10, 12, 15, 16, 18

$i = \frac{25}{100}(9) = 2.25$; round up to position 3

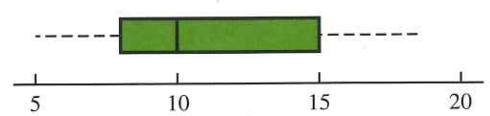
$Q_1 = 8$

Median (5th position) = 10

$i = \frac{75}{100}(9) = 6.75$; round up to position 7

$Q_3 = 15$

5-number summary: 5, 8, 10, 15, 18



40. a. 619, 725, 1016, 1699, 4450

b. Limits: 0, 3160

c. Yes

d. No

41. a. Arrange data in order low to high

$i = \frac{25}{100}(21) = 5.25$; round up to 6th position

$Q_1 = 1872$

Median (11th position) = 4019

$i = \frac{75}{100}(21) = 15.75$; round up to 16th position

$Q_3 = 8305$

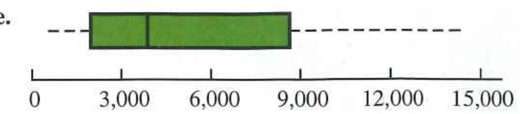
5-number summary: 608, 1872, 4019, 8305, 14,138

b. IQR $= Q_3 - Q_1 = 8305 - 1872 = 6433$
Lower limit: 1872 − 1.5(6433) = −7777.5
Upper limit: 8305 + 1.5(6433) = 17,955

c. No; data are within limits

d. 41,138 > 27,604; 41,138 would be an outlier; data value would be reviewed and corrected

e.



42. a. 66

b. 30, 49, 66, 88, 208

c. Yes; upper limit = 146.5

44. a. 18.2, 15.35

b. 11.7, 23.5

c. 3.4, 11.7, 15.35, 23.5, 41.3

d. Yes; Alger Small Cap 41.3

45. b. There appears to be a negative linear relationship between x and y

c.

x_i	y_i	$x_i - \bar{x}$	$y_i - \bar{y}$	$(x_i - \bar{x})(y_i - \bar{y})$
4	50	−4	4	−16
6	50	−2	4	−8
11	40	3	−6	−18
3	60	−5	14	−70
16	30	8	−16	−128
40	230	0	0	−240

$\bar{x} = 8$; $\bar{y} = 46$

$$s_{xy} = \frac{\Sigma(x_i - \bar{x})(y_i - \bar{y})}{n - 1} = \frac{-240}{4} = -60$$

The sample covariance indicates a negative linear association between x and y

d. $r_{xy} = \frac{s_{xy}}{s_x s_y} = \frac{-60}{(5.43)(11.40)} = -.969$

The sample correlation coefficient of −.969 is indicative of a strong negative linear relationship

46. b. There appears to be a positive linear relationship between x and y

c. $s_{xy} = 26.5$

d. $r_{xy} = .693$

48. −.91; negative relationship

50. b. .9098

c. Strong positive linear relationship; no

52. a. 3.69

b. 3.175

53. a.

f_i	M_i	f_iM_i
4	5	20
7	10	70
9	15	135
5	20	100
25		325

$$\bar{x} = \frac{\Sigma f_i M_i}{n} = \frac{325}{25} = 13$$

b.

f_i	M_i	$(M_i - \bar{x})$	$(M_i - \bar{x})^2$	$f_i(M_i - \bar{x})^2$
4	5	−8	64	256
7	10	−3	9	63
9	15	2	4	36
5	20	7	49	245
25				600

$$s^2 = \frac{\Sigma f_i(M_i - \bar{x})^2}{n-1} = \frac{600}{25-1} = 25$$

$$s = \sqrt{25} = 5$$

54. a.

Grade x_i	Weight w_i
4 (A)	9
3 (B)	15
2 (C)	33
1 (D)	3
0 (F)	0
	60 credit hours

$$\bar{x} = \frac{\Sigma w_i x_i}{\Sigma w_i} = \frac{9(4) + 15(3) + 33(2) + 3(1)}{9 + 15 + 33 + 3}$$

$$= \frac{150}{60} = 2.5$$

b. Yes

56. a. 3.49
b. .94

60. a. 215.9
b. 55%
c. 175.0, 628.3
d. 48.8, 175.0, 215.9, 628.3, 2325.0
e. Yes, any price over 1308.25
f. 482.1; prefer median

61. a. 60.68
b. $s^2 = 31.23$; $s = 5.59$

64. a. $670
b. $456
c. $z = 3$; yes
d. Save time and prevent a penalty cost

66. a. 2.3, 1.85
b. 1.90, 1.38
c. Altria Group 5%
d. −.51, below mean
e. 1.02, above mean
f. No

67. a. 817
b. 833

69. b. .9856, strong positive relationship

70. a. 1800, 1351
b. 387, 1710
c. 7280, 1323
d. 3,675,303, 1917
e. 9271.01, 96.29
f. High positive skewness
g. Using a box plot: 4135 and 7450 are outliers

Chapter 4

2. $\binom{6}{3} = \frac{6!}{3!3!} = \frac{6 \cdot 5 \cdot 4 \cdot 3 \cdot 2 \cdot 1}{(3 \cdot 2 \cdot 1)(3 \cdot 2 \cdot 1)} = 20$

ABC	ACE	BCD	BEF
ABD	ACF	BCE	CDE
ABE	ADE	BCF	CDF
ABF	ADF	BDE	CEF
ACD	AEF	BDF	DEF

4. b. (H,H,H), (H,H,T), (H,T,H), (H,T,T), (T,H,H), (T,H,T), (T,T,H), (T,T,T)
c. $\frac{1}{8}$

6. $P(E_1) = .40$, $P(E_2) = .26$, $P(E_3) = .34$
The relative frequency method was used

8. a. 4: Commission Positive—Council Approves
Commission Positive—Council Disapproves
Commission Negative—Council Approves
Commission Negative—Council Disapproves

9. $\binom{50}{4} = \frac{50!}{4!46!} = \frac{50 \cdot 49 \cdot 48 \cdot 47}{4 \cdot 3 \cdot 2 \cdot 1} = 230{,}300$

10. a. Use the relative frequency approach
P(California) = 1434/2374 = .60
b. Number not from four states
= 2374 − 1434 − 390 − 217 − 112
= 221
P(Not from 4 states) = 221/2374 = .09
c. P(Not in early stages) = 1 − .22 = .78
d. Estimate of number of Massachusetts companies in early stage of development = (.22)390 ≈ 86
e. If we assume the size of the awards did not differ by state, we can multiply the probability an award went to Colorado by the total venture funds disbursed to get an estimate
Estimate of Colorado funds = (112/2374)($32.4)
= $1.53 billion

Authors' Note: The actual amount going to Colorado was $1.74 billion

12. a. 3,478,761
b. 1/3,478,761
c. 1/146,107,962

14. a. $\frac{1}{4}$
b. $\frac{1}{2}$
c. $\frac{3}{4}$

15. a. S = {ace of clubs, ace of diamonds, ace of hearts, ace of spades}
b. S = {2 of clubs, 3 of clubs, . . . , 10 of clubs, J of clubs, Q of clubs, K of clubs, A of clubs}
c. There are 12; jack, queen, or king in each of the four suits
d. For (a): 4/52 = 1/13 = .08
For (b): 13/52 = 1/4 = .25
For (c): 12/52 = .23

16. a. 36
c. $\frac{1}{6}$
d. $\frac{5}{18}$
e. No; $P(\text{odd}) = P(\text{even}) = \frac{1}{2}$
f. Classical

17. a. (4, 6), (4, 7), (4, 8)
b. .05 + .10 + .15 = .30
c. (2, 8), (3, 8), (4, 8)
d. .05 + .05 + .15 = .25
e. .15

18. a. .022
b. .823
c. .104

20. a. .108
b. .096
c. .434

22. a. .40, .40, .60
b. .80, yes
c. $A^c = \{E_3, E_4, E_5\}$; $C^c = \{E_1, E_4\}$;
$P(A^c) = .60$; $P(C^c) = .40$
d. (E_1, E_2, E_5); .60
e. .80

23. a. $P(A) = P(E_1) + P(E_4) + P(E_6)$
$= .05 + .25 + .10 = .40$
$P(B) = P(E_2) + P(E_4) + P(E_7)$
$= .20 + .25 + .05 = .50$
$P(C) = P(E_2) + P(E_3) + P(E_5) + P(E_7)$
$= .20 + .20 + .15 + .05 = .60$
b. $A \cup B = \{E_1, E_2, E_4, E_6, E_7\}$;
$P(A \cup B) = P(E_1) + P(E_2) + P(E_4) + P(E_6) + P(E_7)$
$= .05 + .20 + .25 + .10 + .05$
$= .65$
c. $A \cap B = \{E_4\}$; $P(A \cap B) = P(E_4) = .25$
d. Yes, they are mutually exclusive
e. $B^c = \{E_1, E_3, E_5, E_6\}$;
$P(B^c) = P(E_1) + P(E_3) + P(E_5) + P(E_6)$
$= .05 + .20 + .15 + .10$
$= .50$

24. a. .05
b. .70

26. a. .30, .23
b. .17
c. .64

28. Let B = rented a car for business reasons
P = rented a car for personal reasons
a. $P(B \cup P) = P(B) + P(P) - P(B \cap P)$
$= .540 + .458 - .300$
$= .698$
b. P(Neither) = 1 − .698 = .302

30. a. $P(A \mid B) = \frac{P(A \cap B)}{P(B)} = \frac{.40}{.60} = .6667$
b. $P(B \mid A) = \frac{P(A \cap B)}{P(A)} = \frac{.40}{.50} = .80$
c. No, because $P(A \mid B) \neq P(A)$

32. a.

	Yes	No	Total
18 to 34	.375	.085	.46
35 and older	.475	.065	.54
Total	.850	.150	1.00

b. 46% 18 to 34; 54% 35 and older
c. .15
d. .1848
e. .1204
f. .5677
g. Higher probability of No for 18 to 34

33. a.

Reason for Applying

	Quality	Cost/ Convenience	Other	Total
Full-time	.218	.204	.039	.461
Part-time	.208	.307	.024	.539
Total	.426	.511	.063	1.000

b. A student is most likely to cite cost or convenience as the first reason (probability = .511); school quality is the reason cited by the second largest number of students (probability = .426)
c. P(quality | full-time) = .218/.461 = .473
d. P(quality | part-time) = .208/.539 = .386
e. For independence, we must have $P(A)P(B) = P(A \cap B)$; from the table
$P(A \cap B) = .218$, $P(A) = .461$, $P(B) = .426$
$P(A)P(B) = (.461)(.426) = .196$
Because $P(A)P(B) \neq P(A \cap B)$, the events are not independent

34. a.

	On Time	Late	Total
Southwest	.3336	.0664	.40
US Airways	.2629	.0871	.35
JetBlue	.1753	.0747	.25
Total	.7718	.2282	1.00

b. .40
c. .7718
d. Most likely is US Airways; least likely is Southwest

36. a. .7921
b. .9879
c. .0121
d. .3364, .8236, .1764
Don't foul Reggie Miller

38. a. .70
b. .30
c. .67, .33
d. .20, .10
e. .40
f. .20
g. No; $P(S \mid M) \neq P(S)$

39. a. Yes, because $P(A_1 \cap A_2) = 0$
b. $P(A_1 \cap B) = P(A_1)P(B \mid A_1) = .40(.20) = .08$
$P(A_2 \cap B) = P(A_2)P(B \mid A_2) = .60(.05) = .03$
c. $P(B) = P(A_1 \cap B) + P(A_2 \cap B) = .08 + .03 = .11$
d. $P(A_1 \mid B) = \frac{.08}{.11} = .7273$
$P(A_2 \mid B) = \frac{.03}{.11} = .2727$

40. a. .10, .20, .09
b. .51
c. .26, .51, .23

42. M = missed payment
D_1 = customer defaults
D_2 = customer does not default
$P(D_1) = .05, P(D_2) = .95, P(M \mid D_2) = .2, P(M \mid D_1) = 1$
a. $P(D_1 \mid M) = \frac{P(D_1)P(M \mid D_1)}{P(D_1)P(M \mid D_1) + P(D_2)P(M \mid D_2)}$
$= \frac{(.05)(1)}{(.05)(1) + (.95)(.2)}$
$= \frac{.05}{.24} = .21$
b. Yes, the probability of default is greater than .20

44. a. .47, .53, .50, .45
b. .4963
c. .4463
d. 47%, 53%

47. a. .40
b. .67

48. b. .2022
c. .4618
d. .4005

51. a.

	Young Adult	Older Adult	Total
Blogger	.0432	.0368	.08
Non-Blogger	.2208	.6992	.92
Total	.2640	.7360	1.00

b. .2640
c. .0432
d. .1636

52. a. .76
b. .24

55. a. .25
b. .125
c. .0125
d. .10
e. No

56. a. 315
b. .29
c. No
d. Republicans

59. a. .49
b. .44
c. .54
d. No
e. Yes

60. a. .68
b. 52
c. 10

Chapter 5

1. a. Head, Head (H, H)
Head, Tail (H, T)
Tail, Head (T, H)
Tail, Tail (T, T)
b. x = number of heads on two coin tosses
c.

Outcome	Values of x
(H, H)	2
(H, T)	1
(T, H)	1
(T, T)	0

d. Discrete; it may assume 3 values: 0, 1, and 2

2. a. x = time in minutes to assemble product
b. Any positive value: $x > 0$
c. Continuous

3. Let Y = position is offered
N = position is not offered
a. $S = \{(Y, Y, Y), (Y, Y, N), (Y, N, Y), (Y, N, N), (N, Y, Y), (N, Y, N), (N, N, Y), (N, N, N)\}$
b. Let N = number of offers made; N is a discrete random variable
c.

Experimental Outcome	(Y, Y, Y)	(Y, Y, N)	(Y, N, Y)	(Y, N, N)	(N, Y, Y)	(N, Y, N)	(N, N, Y)	(N, N, N)
Value of N	3	2	2	1	2	1	1	0

4. $x = 0, 1, 2, \ldots, 9$

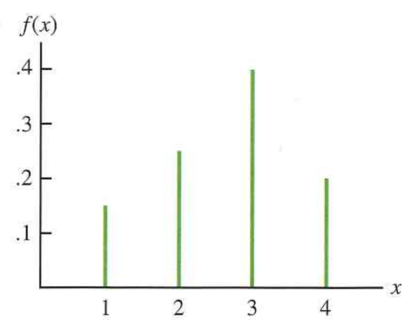
6. a. $0, 1, 2, \ldots, 20$; discrete
b. $0, 1, 2, \ldots$; discrete
c. $0, 1, 2, \ldots, 50$; discrete
d. $0 \leq x \leq 8$; continuous
e. $x > 0$; continuous

7. a. $f(x) \geq 0$ for all values of x
$\Sigma f(x) = 1$; therefore, it is a valid probability distribution
b. Probability $x = 30$ is $f(30) = .25$
c. Probability $x \leq 25$ is $f(20) + f(25) = .20 + .15 = .35$
d. Probability $x > 30$ is $f(35) = .40$

8. a.

x	$f(x)$
1	3/20 = .15
2	5/20 = .25
3	8/20 = .40
4	4/20 = .20
	Total 1.00

b.



c. $f(x) \geq 0$ for $x = 1, 2, 3, 4$
$\Sigma f(x) = 1$

10. a.

x	1	2	3	4	5
$f(x)$	.05	.09	.03	.42	.41

b.

x	1	2	3	4	5
$f(x)$	.04	.10	.12	.46	.28

c. .83
d. .28
e. Senior executives are more satisfied

12. a. Yes
b. .15
c. .10

14. a. .05
b. .70
c. .40

16. a.

y	$f(y)$	$yf(y)$
2	.20	.4
4	.30	1.2
7	.40	2.8
8	.10	.8
Totals	1.00	5.2

$E(y) = \mu = 5.2$

b.

y	$y - \mu$	$(y - \mu)^2$	$f(y)$	$(y - \mu)^2 f(y)$
2	−3.20	10.24	.20	2.048
4	−1.20	1.44	.30	.432
7	1.80	3.24	.40	1.296
8	2.80	7.84	.10	.784
			Total	4.560

$\text{Var}(y) = 4.56$
$\sigma = \sqrt{4.56} = 2.14$

18. a/b.

x	$f(x)$	$xf(x)$	$x - \mu$	$(x - \mu)^2$	$(x - \mu)^2 f(x)$
0	0.04	0.00	−1.84	3.39	0.12
1	0.34	0.34	−0.84	0.71	0.24
2	0.41	0.82	0.16	0.02	0.01
3	0.18	0.53	1.16	1.34	0.24
4	0.04	0.15	2.16	4.66	0.17
Total	1.00	1.84			0.79
		↑ $E(x)$			↑ $\text{Var}(x)$

c/d.

y	$f(y)$	$yf(y)$	$y - \mu$	$(y - \mu)^2$	$y - \mu^2 f(y)$
0	0.00	0.00	−2.93	8.58	0.01
1	0.03	0.03	−1.93	3.72	0.12
2	0.23	0.45	−0.93	0.86	0.20
3	0.52	1.55	0.07	0.01	0.00
4	0.22	0.90	1.07	1.15	0.26
Total	1.00	2.93			0.59
		↑ $E(y)$			↑ $\text{Var}(y)$

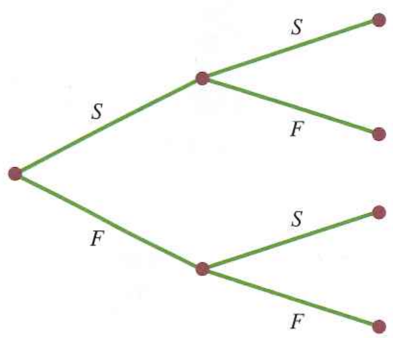
e. The number of bedrooms in owner-occupied houses is greater than in renter-occupied houses; the expected number of bedrooms is $2.93 - 1.84 = 1.09$ greater, and the variability in the number of bedrooms is less for the owner-occupied houses

20. a. 430
b. −90; concern is to protect against the expense of a big accident

22. a. 445
b. \$1250 loss

24. a. Medium: 145; large: 140
b. Medium: 2725; large: 12,400

25. a.



b. $f(1) = \binom{2}{1}(.4)^1(.6)^1 = \frac{2!}{1!1!}(.4)(.6) = .48$

c. $f(0) = \binom{2}{0}(.4)^0(.6)^2 = \frac{2!}{0!2!}(1)(.36) = .36$

d. $f(2) = \binom{2}{2}(.4)^2(.6)^0 = \frac{2!}{2!0!}(.16)(.1) = .16$

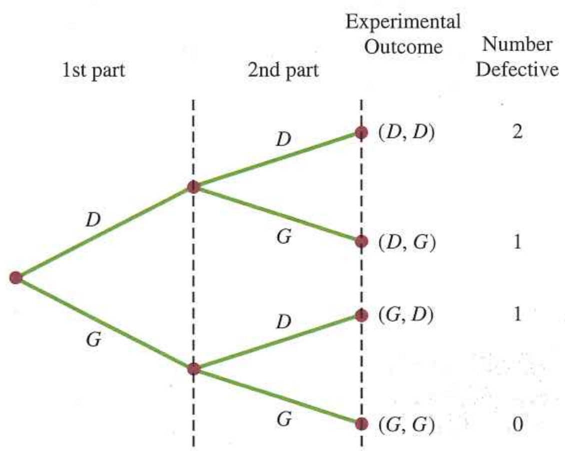
e. $P(x \geq 1) = f(1) + f(2) = .48 + .16 = .64$

f. $E(x) = np = 2(.4) = .8$
$\text{Var}(x) = np(1 - p) = 2(.4)(.6) = .48$
$\sigma = \sqrt{.48} = .6928$

26. a. $f(0) = .3487$
b. $f(2) = .1937$
c. .9298
d. .6513
e. 1
f. $\sigma^2 = .9000, \sigma = .9487$

28. a. .2789
b. .4181
c. .0733

30. a. Probability of a defective part being produced must be .03 for each part selected; parts must be selected independently
b. Let D = defective
G = not defective



c. Two outcomes result in exactly one defect
d. $P(\text{no defects}) = (.97)(.97) = .9409$
$P(1 \text{ defect}) = 2(.03)(.97) = .0582$
$P(2 \text{ defects}) = (.03)(.03) = .0009$

32. a. .90
b. .99
c. .999
d. Yes

34. a. .2262
b. .8355

36. a. .1897
b. .9757
c. Yes
d. 5

38. a. $f(x) = \frac{3^x e^{-3}}{x!}$
b. .2241
c. .1494
d. .8008

39. a. $f(x) = \frac{2^x e^{-2}}{x!}$
b. $\mu = 6$ for 3 time periods
c. $f(x) = \frac{6^x e^{-6}}{x!}$
d. $f(2) = \frac{2^2 e^{-2}}{2!} = \frac{4(.1353)}{2} = .2706$
e. $f(6) = \frac{6^6 e^{-6}}{6!} = .1606$
f. $f(5) = \frac{4^5 e^{-4}}{5!} = .1563$

40. a. $\mu = 48(5/60) = 4$
$f(3) = \frac{4^3 e^{-4}}{3!} = \frac{(64)(.0183)}{6} = .1952$
b. $\mu = 48(15/60) = 12$
$f(10) = \frac{12^{10} e^{-12}}{10!} = .1048$
c. $\mu = 48(5/60) = 4$; expect four callers to be waiting after 5 minutes
$f(0) = \frac{4^0 e^{-4}}{0!} = .0183$; the probability none will be waiting after 5 minutes is .0183
d. $\mu = 48(3/60) = 2.4$
$f(0) = \frac{2.4^0 e^{-2.4}}{0!} = .0907$; the probability of no interruptions in 3 minutes is .0907

42. a. $f(0) = \frac{7^0 e^{-7}}{0!} = e^{-7} = .0009$
b. probability $= 1 - [f(0) + f(1)]$
$f(1) = \frac{7^1 e^{-7}}{1!} = 7e^{-7} = .0064$
probability $= 1 - [.0009 + .0064] = .9927$

c. $\mu = 3.5$
$f(0) = \frac{3.5^0 e^{-3.5}}{0!} = e^{-3.5} = .0302$
probability $= 1 - f(0) = 1 - .0302 = .9698$

d.
$$\begin{aligned}\text{probability} &= 1 - [f(0) + f(1) + f(2) + f(3) + f(4)]\\ &= 1 - [.0009 + .0064 + .0223 + .0521 + .0912]\\ &= .8271\end{aligned}$$

44. a. $\mu = 1.25$
b. .2865
c. .3581
d. .3554

46. a. $f(1) = \frac{\binom{3}{1}\binom{10-3}{4-1}}{\binom{10}{4}} = \frac{\left(\frac{3!}{1!2!}\right)\left(\frac{7!}{3!4!}\right)}{\frac{10!}{4!6!}}$
$= \frac{(3)(35)}{210} = .50$

b. $f(2) = \frac{\binom{3}{2}\binom{10-3}{2-2}}{\binom{10}{2}} = \frac{(3)(1)}{45} = .067$

c. $f(0) = \frac{\binom{3}{0}\binom{10-3}{2-0}}{\binom{10}{2}} = \frac{(1)(21)}{45} = .4667$

d. $f(2) = \frac{\binom{3}{2}\binom{10-3}{4-2}}{\binom{10}{4}} = \frac{(3)(21)}{210} = .30$

48. a. .5250
b. .1833

50. $N = 60, n = 10$
a. $r = 20, x = 0$
$$\begin{aligned}f(0) &= \frac{\binom{20}{0}\binom{40}{10}}{\binom{60}{10}} = \frac{(1)\left(\frac{40!}{10!30!}\right)}{\frac{60!}{10!50!}}\\ &= \left(\frac{40!}{10!30!}\right)\left(\frac{10!50!}{60!}\right)\\ &= \frac{40 \cdot 39 \cdot 38 \cdot 37 \cdot 36 \cdot 35 \cdot 34 \cdot 33 \cdot 32 \cdot 31}{60 \cdot 59 \cdot 58 \cdot 57 \cdot 56 \cdot 55 \cdot 54 \cdot 53 \cdot 52 \cdot 51}\\ &\approx .01\end{aligned}$$
b. $r = 20, x = 1$
$$\begin{aligned}f(1) &= \frac{\binom{20}{1}\binom{40}{9}}{\binom{60}{10}} = 20\left(\frac{40!}{9!31!}\right)\left(\frac{10!50!}{60!}\right)\\ &\approx .07\end{aligned}$$
c. $1 - f(0) - f(1) = 1 - .08 = .92$
d. Same as the probability one will be from Hawaii; in part (b) it was equal to approximately .07

52. a. .5333
b. .6667
c. .7778
d. $n = 7$

53. a. .4667
b. .4667
c. .0667

56. a. .9510
b. .0480
c. .0490

57. a. .2240
b. .5767

60. a. .0596
b. .3585
c. 100
d. 9.75

61. .1912

64. a.

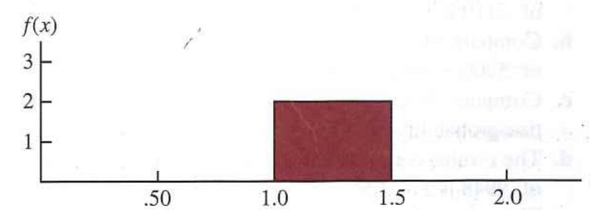
x	1	2	3	4	5
$f(x)$	.24	.21	.10	.21	.24

b. 3.00, 2.34
c. Bonds: $E(x) = 1.36$, $\text{Var}(x) = .23$
Stocks: $E(x) = 4$, $\text{Var}(x) = 1$

65. a. 240
b. 12.96
c. 12.96

Chapter 6

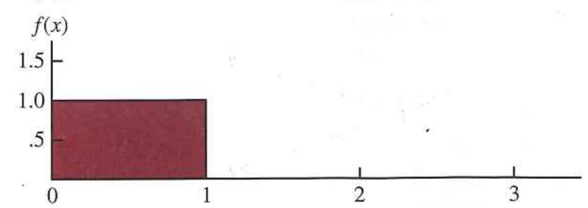
1. a.



b. $P(x = 1.25) = 0$; the probability of any single point is zero because the area under the curve above any single point is zero
c. $P(1.0 \leq x \leq 1.25) = 2(.25) = .50$
d. $P(1.20 < x < 1.5) = 2(.30) = .60$

2. b. .50
c. .60
d. 15
e. 8.33

4. a.



b. $P(.25 < x < .75) = 1(.50) = .50$
c. $P(x \leq .30) = 1(.30) = .30$
d. $P(x > .60) = 1(.40) = .40$

6. a. .125
b. .50
c. .25

10. a. .9332
b. .8413
c. .0919
d. .4938

12. a. .2967
b. .4418
c. .3300
d. .5910
e. .8849
f. .2389

13. a. $P(-1.98 \leq z \leq .49) = P(z \leq .49) - P(z < -1.98)$
$= .6879 - .0239 = .6640$
b. $P(.52 \leq z \leq 1.22) = P(z \leq 1.22) - P(z < .52)$
$= .8888 - .6985 = .1903$
c. $P(-1.75 \leq z \leq -1.04) = P(z \leq -1.04) - P(z < -1.75) = .1492 - .0401 = .1091$

14. a. $z = 1.96$
b. $z = 1.96$
c. $z = .61$
d. $z = 1.12$
e. $z = .44$
f. $z = .44$

15. a. The z-value corresponding to a cumulative probability of .2119 is $z = -.80$
b. Compute $.9030/2 = .4515$; the cumulative probability of $.5000 + .4515 = .9515$ corresponds to $z = 1.66$
c. Compute $.2052/2 = .1026$; z corresponds to a cumulative probability of $.5000 + .1026 = .6026$, so $z = .26$
d. The z-value corresponding to a cumulative probability of .9948 is $z = 2.56$
e. The area to the left of z is $1 - .6915 = .3085$, so $z = -.50$

16. a. $z = 2.33$
b. $z = 1.96$
c. $z = 1.645$
d. $z = 1.28$

18. $\mu = 30$ and $\sigma = 8.2$
a. At $x = 40$, $z = \dfrac{40 - 30}{8.2} = 1.22$
$P(z \leq 1.22) = .8888$
$P(x \geq 40) = 1.000 - .8888 = .1112$
b. At $x = 20$, $z = \dfrac{20 - 30}{8.2} = -1.22$
$P(z \leq -1.22) = .1112$
$P(x \leq 20) = .1112$
c. A z-value of 1.28 cuts off an area of approximately 10% in the upper tail
$x = 30 + 8.2(1.28)$
$= 40.50$
A stock price of \$40.50 or higher will put a company in the top 10%

20. a. .0885
b. 12.51%
c. 93.8 hours or more

22. a. .7193
b. \$35.59
c. .0233

24. a. 200, 26.04
b. .2206
c. .1251
d. 242.84 million

26. a. $\mu = np = 100(.20) = 20$
$\sigma^2 = np(1 - p) = 100(.20)(.80) = 16$
$\sigma = \sqrt{16} = 4$
b. Yes, because $np = 20$ and $n(1 - p) = 80$
c. $P(23.5 \leq x \leq 24.5)$
$z = \dfrac{24.5 - 20}{4} = 1.13 \qquad P(z \leq 1.13) = .8708$
$z = \dfrac{23.5 - 20}{4} = .88 \qquad P(z \leq .88) = .8106$
$P(23.5 \leq x \leq 24.5) = P(.88 \leq z \leq 1.13)$
$= .8708 - .8106 = .0602$
d. $P(17.5 \leq x \leq 22.5)$
$z = \dfrac{22.5 - 20}{4} = .63 \qquad P(z \leq .63) = .7357$
$z = \dfrac{17.5 - 20}{4} = -.63 \qquad P(z \leq -.63) = .2643$
$P(17.5 \leq x \leq 22.5) = P(-.63 \leq z \leq .63)$
$= .7357 - .2643 = .4714$
e. $P(x \leq 15.5)$
$z = \dfrac{15.5 - 20}{4} = -1.13 \qquad P(z \leq -1.13) = .1292$
$P(x \leq 15.5) = P(z \leq -1.13) = .1292$

28. a. In answering this part, we assume the exact numbers of Democrats and Republicans in the group are unknown
$\mu = np = 250(.47) = 117.5$
$\sigma^2 = np(1 - p) = 250(.47)(.53) = 62.275$
$\sigma = \sqrt{62.275} = 7.89$
Half the group is 125 people, so we want to find $P(x \geq 124.5)$
At $x = 124.5$, $z = \dfrac{124.5 - 117.5}{7.89} = .89$
$P(z \geq .89) = 1 - .8133 = .1867$
So $P(x \geq 124.5) = .1867$
We estimate a probability of .1867 that at least half the group is in favor of the proposal
b. For Republicans: $np = 150(.64) = 96$
For Democrats: $np = 100(.29) = 29$
Expected number in favor $= 96 + 29 = 125$
c. From part (b), we see that we can expect just as many in favor of the proposal as opposed

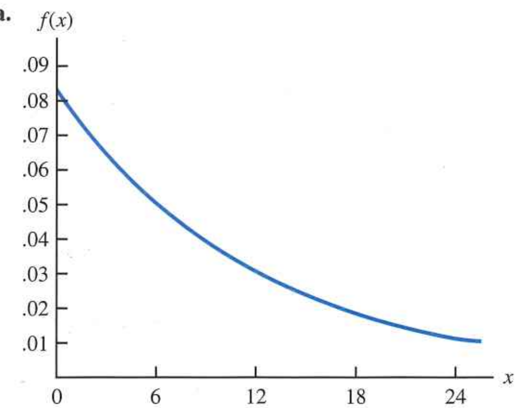
30. a. 220
b. .0392
c. .8962

32. a. .5276
b. .3935
c. .4724
d. .1341

33. a. $P(x \leq x_0) = 1 - e^{-x_0/3}$
b. $P(x \leq 2) = 1 - e^{-2/3} = 1 - .5134 = .4866$
c. $P(x \geq 3) = 1 - P(x \leq 3) = 1 - (1 - e^{-3/3})$
$= e^{-1} = .3679$
d. $P(x \leq 5) = 1 - e^{-5/3} = 1 - .1889 = .8111$
e. $P(2 \leq x \leq 5) = P(x \leq 5) - P(x \leq 2)$
$= .8111 - .4866 = .3245$

34. a. .5624
b. .1915
c. .2461
d. .2259

35. a.



b. $P(x \leq 12) = 1 - e^{-12/12} = 1 - .3679 = .6321$
c. $P(x \leq 6) = 1 - e^{-6/12} = 1 - .6065 = .3935$
d. $P(x \geq 30) = 1 - P(x < 30)$
$= 1 - (1 - e^{-30/12})$
$= .0821$

36. a. 50 hours
b. .3935
c. .1353

38. a. $f(x) = 5.5e^{-5.5x}$
b. .2528
c. .6002

40. a. \$3780 or less
b. 19.22%
c. \$8167.50

42. a. 3229
b. .2244
c. \$12,382 or more

44. a. .0228
b. \$50

46. a. 38.3%
b. 3.59% better, 96.41% worse
c. 38.21%

48. $\mu = 19.23$ ounces

50. a. Lose \$240
b. .1788
c. .3557
d. .0594

52. a. $\frac{1}{7}$ minute
b. $7e^{-7x}$
c. .0009
d. .2466

54. a. 2 minutes
b. .2212
c. .3935
d. .0821

Chapter 7

1. a. AB, AC, AD, AE, BC, BD, BE, CD, CE, DE
b. With 10 samples, each has a $\frac{1}{10}$ probability
c. E and C because 8 and 0 do not apply; 5 identifies E; 7 does not apply; 5 is skipped because E is already in the sample; 3 identifies C; 2 is not needed because the sample of size 2 is complete

2. 22, 147, 229, 289

3. 459, 147, 385, 113, 340, 401, 215, 2, 33, 348

4. a. Bell South, LSI Logic, General Electric
b. 120

6. 2782, 493, 825, 1807, 289

8. Maryland, Iowa, Florida State, Virginia, Pittsburgh, Oklahoma

10. a. finite; **b.** process; **c.** process; **d.** finite; **e.** process

11. a. $\bar{x} = \dfrac{\Sigma x_i}{n} = \dfrac{54}{6} = 9$
b. $s = \sqrt{\dfrac{\Sigma(x_i - \bar{x})^2}{n - 1}}$
$\Sigma(x_i - \bar{x})^2 = (-4)^2 + (-1)^2 + 1^2 + (-2)^2 + 1^2 + 5^2$
$= 48$
$s = \sqrt{\dfrac{48}{6 - 1}} = 3.1$

12. a. .50
b. .3667

13. a. $\bar{x} = \dfrac{\Sigma x_i}{n} = \dfrac{465}{5} = 93$
b.

	x_i	$(x_i - \bar{x})$	$(x_i - \bar{x})^2$
	94	+1	1
	100	+7	49
	85	−8	64
	94	+1	1
	92	−1	1
Totals	465	0	116

$s = \sqrt{\dfrac{\Sigma(x_i - \bar{x})^2}{n - 1}} = \sqrt{\dfrac{116}{4}} = 5.39$

14. a. .45
b. .15
c. .45

16. a. .10
b. 20
c. .72

18. a. 200
b. 5
c. Normal with $E(\bar{x}) = 200$ and $\sigma_{\bar{x}} = 5$
d. The probability distribution of $\bar{x}$

19. a. The sampling distribution is normal with
$E(\bar{x}) = \mu = 200$
$\sigma_{\bar{x}} = \sigma/\sqrt{n} = 50/\sqrt{100} = 5$
For ± 5, $195 \le \bar{x} \le 205$
Using the standard normal probability table:

$$\text{At } \bar{x} = 205,\ z = \frac{\bar{x} - \mu}{\sigma_{\bar{x}}} = \frac{5}{5} = 1$$

$P(z \le 1) = .8413$

$$\text{At } \bar{x} = 195,\ z = \frac{\bar{x} - \mu}{\sigma_{\bar{x}}} = \frac{-5}{5} = -1$$

$P(z < -1) = .1587$
$P(195 \le \bar{x} \le 205) = .8413 - .1587 = .6826$

b. For ± 10, $190 \le \bar{x} \le 210$
Using the standard normal probability table:

$$\text{At } \bar{x} = 210,\ z = \frac{\bar{x} - \mu}{\sigma_{\bar{x}}} = \frac{10}{5} = 2$$

$P(z \le 2) = .9772$

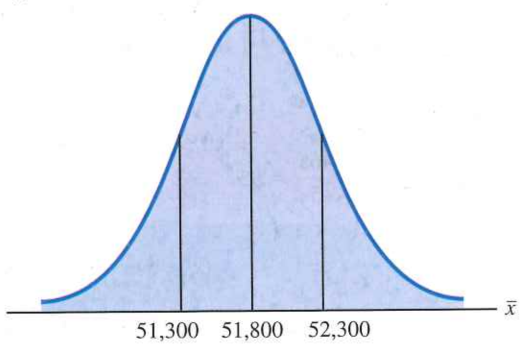
$$\text{At } \bar{x} = 190,\ z = \frac{\bar{x} - \mu}{\sigma_{\bar{x}}} = \frac{-10}{5} = -2$$

$P(z < -2) = .0228$
$P(190 \le \bar{x} \le 210) = .9722 - .0228 = .9544$

20. 3.54, 2.50, 2.04, 1.77
$\sigma_{\bar{x}}$ decreases as n increases

22. a. Normal with $E(\bar{x}) = 51{,}800$ and $\sigma_{\bar{x}} = 516.40$
b. $\sigma_{\bar{x}}$ decreases to 365.15
c. $\sigma_{\bar{x}}$ decreases as n increases

23. a.



$$\sigma_{\bar{x}} = \frac{\sigma}{\sqrt{n}} = \frac{4000}{\sqrt{60}} = 516.40$$

$$\text{At } \bar{x} = 52{,}300,\ z = \frac{52{,}300 - 51{,}800}{516.40} = .97$$

$P(\bar{x} \le 52{,}300) = P(z \le .97) = .8340$

$$\text{At } \bar{x} = 51{,}300,\ z = \frac{51{,}300 - 51{,}800}{516.40} = -.97$$

$P(\bar{x} < 51{,}300) = P(z < -.97) = .1660$
$P(51{,}300 \le \bar{x} \le 52{,}300) = .8340 - .1660 = .6680$

b.
$$\sigma_{\bar{x}} = \frac{\sigma}{\sqrt{n}} = \frac{4000}{\sqrt{120}} = 365.15$$

$$\text{At } \bar{x} = 52{,}300,\ z = \frac{52{,}300 - 51{,}800}{365.15} = 1.37$$

$P(\bar{x} \le 52{,}300) = P(z \le 1.37) = .9147$

$$\text{At } \bar{x} = 51{,}300,\ z = \frac{51{,}300 - 51{,}800}{365.15} = -1.37$$

$P(\bar{x} < 51{,}300) = P(z < -1.37) = .0853$
$P(51{,}300 \le \bar{x} \le 52{,}300) = .9147 - .0853 = .8294$

24. a. Normal with $E(\bar{x}) = 4260$ and $\sigma_{\bar{x}} = 127.28$
b. .95
c. .5704

26. a. .4246, .5284, .6922, .9586
b. Higher probability the sample mean will be close to population mean

28. a. Normal with $E(\bar{x}) = 95$ and $\sigma_{\bar{x}} = 2.56$
b. .7580
c. .8502
d. Part (c), larger sample size

30. a. $n/N = .01$; no
b. 1.29, 1.30; little difference
c. .8764

32. a. $E(\bar{p}) = .40$

$$\sigma_{\bar{p}} = \sqrt{\frac{p(1-p)}{n}} = \sqrt{\frac{(.40)(.60)}{200}} = .0346$$

Within $\pm .03$ means $.37 \le \bar{p} \le .43$

$$z = \frac{\bar{p} - p}{\sigma_{\bar{p}}} = \frac{.03}{.0346} = .87$$

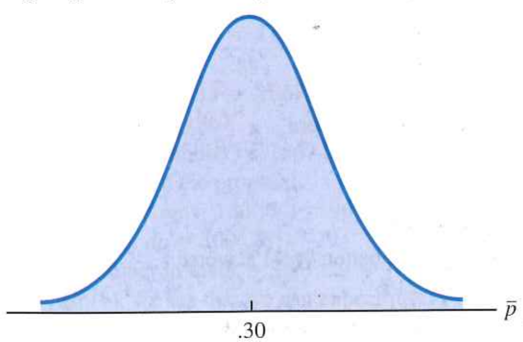
$$\begin{aligned} P(.37 \le \bar{p} \le .43) &= P(-.87 \le z \le .87) \\ &= .8078 - .1922 \\ &= .6156 \end{aligned}$$

b.
$$z = \frac{\bar{p} - p}{\sigma_{\bar{p}}} = \frac{.05}{.0346} = 1.44$$

$$\begin{aligned} P(.35 \le \bar{p} \le .45) &= P(-1.44 \le z \le 1.44) \\ &= .9251 - .0749 \\ &= .8502 \end{aligned}$$

34. a. .6156
b. .7814
c. .9488
d. .9942
e. Higher probability with larger n

35. a.



$$\sigma_{\bar{p}} = \sqrt{\frac{p(1-p)}{n}} = \sqrt{\frac{.30(.70)}{100}} = .0458$$

The normal distribution is appropriate because $np = 100(.30) = 30$ and $n(1-p) = 100(.70) = 70$ are both greater than 5

b. $P(.20 \le \bar{p} \le .40) = ?$

$$z = \frac{.40 - .30}{.0458} = 2.18$$

$$\begin{aligned} P(.20 \le \bar{p} \le .40) &= P(-2.18 \le z \le 2.18) \\ &= .9854 - .0146 \\ &= .9708 \end{aligned}$$

c. $P(.25 \le \bar{p} \le .35) = ?$

$$z = \frac{.35 - .30}{.0458} = 1.09$$

$$\begin{aligned} P(.25 \le \bar{p} \le .35) &= P(-1.09 \le z \le 1.09) \\ &= .8621 - .1379 \\ &= .7242 \end{aligned}$$

36. a. Normal with $E(\bar{p}) = .66$ and $\sigma_{\bar{p}} = .0273$
b. .8584
c. .9606
d. Yes, standard error is smaller in part (c)
e. .9616, the probability is larger because the increased sample size reduces the standard error

38. a. Normal with $E(\bar{p}) = .56$ and $\sigma_{\bar{p}} = .0248$
b. .5820
c. .8926

40. a. Normal with $E(\bar{p}) = .76$ and $\sigma_{\bar{p}} = .0214$
b. .8384
c. .9452

42. 112, 145, 73, 324, 293, 875, 318, 618

44. a. Normal with $E(\bar{x}) = 115.50$ and $\sigma_{\bar{x}} = 5.53$
b. .9298
c. $z = -2.80$, .0026

46. a. 775
b. .1075
c. .6372
d. .8030

48. a. 625
b. .7888

50. a. Normal with $E(\bar{p}) = .28$ and $\sigma_{\bar{p}} = .0290$
b. .8324
c. .5098

52. a. .8882
b. .0233

54. a. 48
b. Normal, $E(\bar{p}) = .25$, $\sigma_{\bar{p}} = .0625$
c. .2119

Chapter 8

2. Use $\bar{x} \pm z_{\alpha/2}(\sigma/\sqrt{n})$
a. $32 \pm 1.645(6/\sqrt{50})$
32 ± 1.4; 30.6 to 33.4
b. $32 \pm 1.96(6/\sqrt{50})$
32 ± 1.66; 30.34 to 33.66
c. $32 \pm 2.576(6/\sqrt{50})$
32 ± 2.19; 29.81 to 34.19

4. 54

5. a. $1.96\sigma/\sqrt{n} = 1.96(5/\sqrt{49}) = 1.40$
b. 24.80 ± 1.40; 23.40 to 26.20

6. 8.1 to 8.9

8. a. Population is at least approximately normal
b. 3.1
c. 4.1

10. a. \$113,638 to \$124,672
b. \$112,581 to \$125,729
c. \$110,515 to \$127,795
d. Width increases as confidence level increases

12. a. 2.179
b. -1.676
c. 2.457
d. -1.708 and 1.708
e. -2.014 and 2.014

13. a.
$$\bar{x} = \frac{\Sigma x_i}{n} = \frac{80}{8} = 10$$

b.
$$s = \sqrt{\frac{\Sigma(x_i - \bar{x})^2}{n-1}} = \sqrt{\frac{84}{7}} = 3.464$$

c.
$$t_{.025}\left(\frac{s}{\sqrt{n}}\right) = 2.365\left(\frac{3.46}{\sqrt{8}}\right) = 2.9$$

d.
$$\bar{x} \pm t_{.025}\left(\frac{s}{\sqrt{n}}\right)$$
10 ± 2.9 (7.1 to 12.9)

14. a. 21.5 to 23.5
b. 21.3 to 23.7
c. 20.9 to 24.1
d. A larger margin of error and a wider interval

15. $\bar{x} \pm t_{\alpha/2}(s/\sqrt{n})$
90% confidence: $df = 64$ and $t_{.05} = 1.669$

$$19.5 \pm 1.669\left(\frac{5.2}{\sqrt{65}}\right)$$

19.5 ± 1.08 (18.42 to 20.58)
95% confidence: $df = 64$ and $t_{.025} = 1.998$

$$19.5 \pm 1.998\left(\frac{5.2}{\sqrt{65}}\right)$$

19.5 ± 1.29 (18.21 to 20.79)

16. a. 1.69
b. 47.31 to 50.69
c. Fewer hours and higher cost for United

18. a. 3.8
b. .84
c. 2.96 to 4.64
d. Larger n next time

20. $\bar{x} = 22$; 21.48 to 22.52

22. a. 3.35
b. 2.40 to 4.30

24. a. Planning value of $\sigma = \frac{\text{Range}}{4} = \frac{36}{4} = 9$

b. $n = \frac{z_{.025}^2 \sigma^2}{E^2} = \frac{(1.96)^2(9)^2}{(3)^2} = 34.57$; use $n = 35$

c. $n = \frac{(1.96)^2(9)^2}{(2)^2} = 77.79$; use $n = 78$

25. a. Use $n = \frac{z_{\alpha/2}^2 \sigma^2}{E^2}$

$n = \frac{(1.96)^2(6.84)^2}{(1.5)^2} = 79.88$; use $n = 80$

b. $n = \frac{(1.645)^2(6.84)^2}{(2)^2} = 31.65$; use $n = 32$

26. a. 18
b. 35
c. 97

28. a. 328
b. 465
c. 803
d. n gets larger; no to 99% confidence

30. 81

31. a. $\bar{p} = \frac{100}{400} = .25$

b. $\sqrt{\frac{\bar{p}(1-\bar{p})}{n}} = \sqrt{\frac{.25(.75)}{400}} = .0217$

c. $\bar{p} \pm z_{.025}\sqrt{\frac{\bar{p}(1-\bar{p})}{n}}$

$.25 \pm 1.96(.0217)$

$.25 \pm .0424$; .2076 to .2924

32. a. .6733 to .7267
b. .6682 to .7318

34. 1068

35. a. $\bar{p} = \frac{281}{611} = .4599$ (46%)

b. $z_{.05}\sqrt{\frac{\bar{p}(1-\bar{p})}{n}} = 1.645\sqrt{\frac{.4599(1-.4599)}{611}} = .0332$

c. $\bar{p} \pm .0332$
$.4599 \pm .0332$ (.4267 to .4931)

36. a. .23
b. .1716 to .2884

38. a. .1790
b. .0738, .5682 to .7158
c. 354

39. a. $n = \frac{z_{.025}^2 p^*(1-p^*)}{E^2} = \frac{(1.96)^2(.156)(1-.156)}{(.03)^2}$

$= 562$

b. $n = \frac{z_{.005}^2 p^*(1-p^*)}{E^2} = \frac{(2.576)^2(.156)(1-.156)}{(.03)^2}$

$= 970.77$; use 971

40. .0267 (.8333 to .8867)

42. a. .0442
b. 601, 1068, 2401, 9604

44. a. 4.00
b. \$29.77 to \$37.77

46. a. 998
b. \$24,479 to \$26,455
c. \$93.5 million
d. Yes; \$21.4 (30%) over *Lost World*

48. a. 14 minutes
b. 13.38 to 14.62
c. 32 per day
d. Staff reduction

50. 37

52. 176

54. a. .2844 to .3356
b. .7987 to .8413
c. $\bar{p}$ closer to 1/2 in part (a)

56. a. .8273
b. .7957 to .8589

58. a. 1267
b. 1509

60. a. .3101
b. .2898 to .3304
c. 8219; no, this sample size is unnecessarily large

Chapter 9

2. a. $H_0: \mu \le 14$
$H_a: \mu > 14$
b. No evidence that the new plan increases sales
c. The research hypothesis $\mu > 14$ is supported; the new plan increases sales

4. a. $H_0: \mu \ge 220$
$H_a: \mu < 220$

5. a. Rejecting $H_0: \mu \le 56.2$ when it is true
b. Accepting $H_0: \mu \le 56.2$ when it is false

6. a. $H_0: \mu \le 1$
$H_a: \mu > 1$
b. Claiming $\mu > 1$ when it is not true
c. Claiming $\mu \le 1$ when it is not true

8. a. $H_0: \mu \ge 220$
$H_a: \mu < 220$
b. Claiming $\mu < 220$ when it is not true
c. Claiming $\mu \ge 220$ when it is not true

10. a. $z = \frac{\bar{x} - \mu_0}{\sigma/\sqrt{n}} = \frac{26.4 - 25}{6/\sqrt{40}} = 1.48$

b. Using normal table with $z = 1.48$: p-value $= 1.0000 - .9306 = .0694$
c. p-value $> .01$, do not reject H_0
d. Reject H_0 if $z \ge 2.33$
$1.48 < 2.33$, do not reject H_0

11. a. $z = \frac{\bar{x} - \mu_0}{\sigma/\sqrt{n}} = \frac{14.15 - 15}{3/\sqrt{50}} = -2.00$

b. p-value $= 2(.0228) = .0456$
c. p-value $\le .05$, reject H_0
d. Reject H_0 if $z \le -1.96$ or $z \ge 1.96$
$-2.00 \le -1.96$, reject H_0

12. a. .1056; do not reject H_0
b. .0062; reject H_0
c. ≈ 0; reject H_0
d. .7967; do not reject H_0

14. a. .3844; do not reject H_0
b. .0074; reject H_0
c. .0836; do not reject H_0

15. a. $H_0: \mu \ge 1056$
$H_a: \mu < 1056$

b. $z = \frac{\bar{x} - \mu_0}{\sigma/\sqrt{n}} = \frac{910 - 1056}{1600/\sqrt{400}} = -1.83$

p-value $= .0336$
c. p-value $\le .05$, reject H_0; the mean refund of "last-minute" filers is less than \$1056
d. Reject H_0 if $z \le -1.645$
$-1.83 \le -1.645$; reject H_0

16. a. $H_0: \mu \le 895$
$H_a: \mu > 895$
b. .1170
c. Do not reject H_0
d. Withhold judgment; collect more data

18. a. $H_0: \mu = 4.1$
$H_a: \mu \ne 4.1$
b. -2.21, .0272
c. Reject H_0

20. a. $H_0: \mu \ge 32.79$
$H_a: \mu < 32.79$
b. -2.73
c. .0032
d. Reject H_0

22. a. $H_0: \mu = 8$
$H_a: \mu \ne 8$
b. .1706
c. Do not reject H_0
d. 7.83 to 8.97; yes

24. a. $t = \frac{\bar{x} - \mu_0}{s/\sqrt{n}} = \frac{17 - 18}{4.5/\sqrt{48}} = -1.54$

b. Degrees of freedom $= n - 1 = 47$
Area in lower tail is between .05 and .10
p-value (two-tail) is between .10 and .20
Exact p-value $= .1303$
c. p-value $> .05$; do not reject H_0
d. With $df = 47$, $t_{.025} = 2.012$
Reject H_0 if $t \le -2.012$ or $t \ge 2.012$
$t = -1.54$; do not reject H_0

26. a. Between .02 and .05; exact p-value $= .0397$; reject H_0
b. Between .01 and .02; exact p-value $= .0125$; reject H_0
c. Between .10 and .20; exact p-value $= .1285$; do not reject H_0

27. a. $H_0: \mu \ge 238$
$H_a: \mu < 238$

b. $t = \frac{\bar{x} - \mu_0}{s/\sqrt{n}} = \frac{231 - 238}{80/\sqrt{100}} = -.88$

Degrees of freedom $= n - 1 = 99$
p-value is between .10 and .20
Exact p-value $= .1905$
c. p-value $> .05$; do not reject H_0
Cannot conclude mean weekly benefit in Virginia is less than the national mean
d. $df = 99$, $t_{.05} = -1.66$
Reject H_0 if $t \le -1.66$
$-.88 > -1.66$; do not reject H_0

28. a. $H_0: \mu \ge 9$
$H_a: \mu < 9$
b. Between .005 and .01
Exact p-value $= .0072$
c. Reject H_0

30. a. $H_0: \mu = 600$
$H_a: \mu \ne 600$
b. Between .20 and .40
Exact p-value $= .2491$
c. Do not reject H_0
d. A larger sample size

32. a. $H_0: \mu = 10{,}192$
$H_a: \mu \ne 10{,}192$
b. Between .02 and .05
Exact p-value $= .0304$
c. Reject H_0

34. a. $H_0: \mu = 2$
$H_a: \mu \ne 2$
b. 2.2
c. .52
d. Between .20 and .40
Exact p-value $= .2535$
e. Do not reject H_0

36. a. $z = \frac{\bar{p} - p_0}{\sqrt{\frac{p_0(1-p_0)}{n}}} = \frac{.68 - .75}{\sqrt{\frac{.75(1-.75)}{300}}} = -2.80$

p-value $= .0026$
p-value $\le .05$; reject H_0

b. $z = \frac{.72 - .75}{\sqrt{\frac{.75(1-.75)}{300}}} = -1.20$

p-value $= .1151$
p-value $> .05$; do not reject H_0

c. $z = \frac{.70 - .75}{\sqrt{\frac{.75(1-.75)}{300}}} = -2.00$

p-value $= .0228$
p-value $\le .05$; reject H_0

d. $z = \frac{.77 - .75}{\sqrt{\frac{.75(1-.75)}{300}}} = .80$

p-value = .7881
p-value > .05; do not reject H_0

38. a. $H_0: p = .64$
$H_a: p \neq .64$

b. $\bar{p} = 52/100 = .52$

$$z = \frac{\bar{p} - p_0}{\sqrt{\dfrac{p_0(1-p_0)}{n}}} = \frac{.52 - .64}{\sqrt{\dfrac{.64(1-.64)}{100}}} = -2.50$$

p-value = 2(.0062) = .0124

c. p-value ≤ .05; reject H_0
Proportion differs from the reported .64

d. Yes, because $\bar{p} = .52$ indicates that fewer believe the supermarket brand is as good as the name brand

40. a. .2702

b. $H_0: p \leq .22$
$H_a: p > .22$
p-value ≈ 0; reject H_0

c. Helps evaluate the effectiveness of commercials

42. a. $\bar{p} = .15$
b. .0718 to .2218
c. Yes, at $\alpha = .05$

44. a. $H_0: p \leq .51$
$H_a: p > .51$
b. $\bar{p} = .58$, p-value = .0026
c. Reject H_0

46. a. $H_0: \mu = 16$
$H_a: \mu \neq 16$
b. .0286; reject H_0
Readjust line
c. .2186; do not reject H_0
Continue operation
d. $z = 2.19$; reject H_0
$z = -1.23$; do not reject H_0
Yes, same conclusion

48. a. $H_0: \mu \leq 119{,}155$
$H_a: \mu > 119{,}155$
b. .0047
c. Reject H_0

50. $t = -.93$
p-value between .20 and .40
Exact p-value = .3596
Do not reject H_0

52. $t = 2.26$
p-value between .01 and .025
Exact p-value = .0155
Reject H_0

54. a. $H_0: p \leq .50$
$H_a: p > .50$
b. .64
c. .0026; reject H_0

56. a. $H_0: p \leq .80$
$H_a: p > .80$
b. .84
c. .0418
d. Reject H_0

58. $H_0: p \geq .90$
$H_a: p < .90$
p-value = .0808
Do not reject H_0

Chapter 10

1. a. $\bar{x}_1 - \bar{x}_2 = 13.6 - 11.6 = 2$

b. $z_{\alpha/2} = z_{.05} = 1.645$

$$\bar{x}_1 - \bar{x}_2 \pm 1.645\sqrt{\frac{\sigma_1^2}{n_1} + \frac{\sigma_2^2}{n_2}}$$

$$2 \pm 1.645\sqrt{\frac{(2.2)^2}{50} + \frac{(3)^2}{35}}$$

$2 \pm .98$ (1.02 to 2.98)

c. $z_{\alpha/2} = z_{.05} = 1.96$

$$2 \pm 1.96\sqrt{\frac{(2.2)^2}{50} + \frac{(3)^2}{35}}$$

2 ± 1.17 (.83 to 3.17)

2. a.
$$z = \frac{(\bar{x}_1 - \bar{x}_2) - D_0}{\sqrt{\dfrac{\sigma_1^2}{n_1} + \dfrac{\sigma_2^2}{n_2}}} = \frac{(25.2 - 22.8) - 0}{\sqrt{\dfrac{(5.2)^2}{40} + \dfrac{(6)^2}{50}}} = 2.03$$

b. p-value = 1.0000 − .9788 = .0212
c. p-value ≤ .05; reject H_0

4. a. $\bar{x}_1 - \bar{x}_2 = 2.04 - 1.72 = .32$

b.
$$z_{.025}\sqrt{\frac{\sigma_1^2}{n_1} + \frac{\sigma_2^2}{n_2}} = 1.96\sqrt{\frac{(.10)^2}{40} + \frac{(.08)^2}{35}} = .04$$

c. $.32 \pm .04$ (.28 to .36)

6. p-value = .015
Reject H_0; an increase

8. a. 1.08
b. .2802
c. Do not reject H_0; cannot conclude a difference exists

9. a. $\bar{x}_1 - \bar{x}_2 = 22.5 - 20.1 = 2.4$

b.
$$df = \frac{\left(\dfrac{s_1^2}{n_1} + \dfrac{s_2^2}{n_2}\right)^2}{\dfrac{1}{n_1 - 1}\left(\dfrac{s_1^2}{n_1}\right)^2 + \dfrac{1}{n_2 - 1}\left(\dfrac{s_2^2}{n_2}\right)^2}$$

$$= \frac{\left(\dfrac{2.5^2}{20} + \dfrac{4.8^2}{30}\right)^2}{\dfrac{1}{19}\left(\dfrac{2.5^2}{20}\right)^2 + \dfrac{1}{29}\left(\dfrac{4.8^2}{30}\right)^2} = 45.8$$

c. $df = 45$, $t_{.025} = 2.014$

$$t_{.025}\sqrt{\frac{s_1^2}{n_1} + \frac{s_2^2}{n_2}} = 2.014\sqrt{\frac{2.5^2}{20} + \frac{4.8^2}{30}} = 2.1$$

d. 2.4 ± 2.1 (.3 to 4.5)

10. a.
$$t = \frac{(\bar{x}_1 - \bar{x}_2) - 0}{\sqrt{\dfrac{s_1^2}{n_1} + \dfrac{s_2^2}{n_2}}} = \frac{(13.6 - 10.1) - 0}{\sqrt{\dfrac{5.2^2}{35} + \dfrac{8.5^2}{40}}} = 2.18$$

b.
$$df = \frac{\left(\dfrac{s_1^2}{n_1} + \dfrac{s_2^2}{n_2}\right)^2}{\dfrac{1}{n_1 - 1}\left(\dfrac{s_1^2}{n_1}\right)^2 + \dfrac{1}{n_2 - 1}\left(\dfrac{s_2^2}{n_2}\right)^2}$$

$$= \frac{\left(\dfrac{5.2^2}{35} + \dfrac{8.5^2}{40}\right)^2}{\dfrac{1}{34}\left(\dfrac{5.2^2}{35}\right)^2 + \dfrac{1}{39}\left(\dfrac{8.5^2}{40}\right)^2} = 65.7$$

Use $df = 65$

c. $df = 65$, area in tail is between .01 and .025;
two-tailed p-value is between .02 and .05
Exact p-value = .0329

d. p-value ≤ .05; reject H_0

12. a. $\bar{x}_1 - \bar{x}_2 = 22.5 - 18.6 = 3.9$ miles

b.
$$df = \frac{\left(\dfrac{s_1^2}{n_1} + \dfrac{s_2^2}{n_2}\right)^2}{\dfrac{1}{n_1 - 1}\left(\dfrac{s_1^2}{n_1}\right)^2 + \dfrac{1}{n_2 - 1}\left(\dfrac{s_2^2}{n_2}\right)^2}$$

$$= \frac{\left(\dfrac{8.4^2}{50} + \dfrac{7.4^2}{40}\right)^2}{\dfrac{1}{49}\left(\dfrac{8.4^2}{50}\right)^2 + \dfrac{1}{39}\left(\dfrac{7.4^2}{40}\right)^2} = 87.1$$

Use $df = 87$, $t_{.025} = 1.988$

$$3.9 \pm 1.988\sqrt{\frac{8.4^2}{50} + \frac{7.4^2}{40}}$$

3.9 ± 3.3 (.6 to 7.2)

14. a. $H_0: \mu_1 - \mu_2 \geq 0$
$H_a: \mu_1 - \mu_2 < 0$
b. −2.41
c. Using t table, p-value is between .005 and .01
Exact p-value = .009
d. Reject H_0; salaries of staff nurses are lower in Tampa

16. a. $H_0: \mu_1 - \mu_2 \leq 0$
$H_a: \mu_1 - \mu_2 > 0$
b. 38
c. $t = 1.80$, $df = 25$
Using t table, p-value is between .025 and .05
Exact p-value = .0420
d. Reject H_0; conclude higher mean score if college grad

18. a. $H_0: \mu_1 - \mu_2 \geq 120$
$H_a: \mu_1 - \mu_2 < 120$
b. −2.10
Using t table, p-value is between .01 and .025
Exact p-value = .0195
c. 32 to 118
d. Larger sample size

19. a. 1, 2, 0, 0, 2

b. $\bar{d} = \Sigma d_i / n = 5/5 = 1$

c.
$$s_d = \sqrt{\frac{\Sigma(d_i - \bar{d})^2}{n - 1}} = \sqrt{\frac{4}{5 - 1}} = 1$$

d.
$$t = \frac{\bar{d} - \mu}{s_d/\sqrt{n}} = \frac{1 - 0}{1/\sqrt{5}} = 2.24$$

$df = n - 1 = 4$
Using t table, p-value is between .025 and .05
Exact p-value = .0443
p-value ≤ .05; reject H_0

20. a. 3, −1, 3, 5, 3, 0, 1
b. 2
c. 2.08
d. 2
e. .07 to 3.93

21. $H_0: \mu_d \leq 0$
$H_a: \mu_d > 0$
$\bar{d} = .625$
$s_d = 1.30$

$$t = \frac{\bar{d} - \mu_d}{s_d/\sqrt{n}} = \frac{.625 - 0}{1.30/\sqrt{8}} = 1.36$$

$df = n - 1 = 7$
Using t table, p-value is between .10 and .20
Exact p-value = .1080
p-value > .05; do not reject H_0

22. \$.10 to \$.32

24. $t = 1.32$
Using t table, p-value is greater than .10
Exact p-value = .1142
Do not reject H_0

26. a. $t = -.60$
Using t table, p-value is greater than .40
Exact p-value = .5633
Do not reject H_0
b. −.103
c. .39; larger sample size

27. a. $\bar{\bar{x}} = (156 + 142 + 134)/3 = 144$

$$\text{SSTR} = \sum_{j=1}^{k} n_j(\bar{x}_j - \bar{\bar{x}})^2$$
$$= 6(156 - 144)^2 + 6(142 - 144)^2 + 6(134 - 144)^2$$
$$= 1488$$

b.
$$\text{MSTR} = \frac{\text{SSTR}}{k - 1} = \frac{1488}{2} = 744$$

c. $s_1^2 = 164.4$, $s_2^2 = 131.2$, $s_3^2 = 110.4$

$$\text{SSE} = \sum_{j=1}^{k} (n_j - 1)s_j^2$$
$$= 5(164.4) + 5(131.2) + 5(110.4)$$
$$= 2030$$

d.
$$\text{MSE} = \frac{\text{SSE}}{n_T - k} = \frac{2030}{18 - 3} = 135.3$$

e.

Source of Variation	Sum of Squares	Degrees of Freedom	Mean Square	F	p-value
Treatments	1488	2	744	5.50	.0162
Error	2030	15	135.3		
Total	3518	17			

f.
$$F = \frac{\text{MSTR}}{\text{MSE}} = \frac{744}{135.3} = 5.50$$

From the F table (2 numerator degrees of freedom and 15 denominator), p-value is between .01 and .025

Using Excel or Minitab, the p-value corresponding to $F = 5.50$ is .0162

Because p-value $\le \alpha = .05$, we reject the hypothesis that the means for the three treatments are equal

28.

Source of Variation	Sum of Squares	Degrees of Freedom	Mean Square	F	p-value
Treatments	300	4	75	14.07	.0000
Error	160	30	5.33		
Total	460	34			

30.

Source of Variation	Sum of Squares	Degrees of Freedom	Mean Square	F	p-value
Treatments	150	2	75	4.80	.0233
Error	250	16	15.63		
Total	400	18			

Reject H_0 because p-value $\le \alpha = .05$

32. Because p-value $= .0082$ is less than $\alpha = .05$, we reject the null hypothesis that the means of the three treatments are equal

34. $\bar{\bar{x}} = (79 + 74 + 66)/3 = 73$

$$\text{SSTR} = \sum_{j=1}^{k} n_j(\bar{x}_j - \bar{\bar{x}})^2 = 6(79 - 73)^2 + 6(74 - 73)^2 + 6(66 - 73)^2 = 516$$

$$\text{MSTR} = \frac{\text{SSTR}}{k - 1} = \frac{516}{2} = 258$$

$$s_1^2 = 34 \qquad s_2^2 = 20 \qquad s_3^2 = 32$$

$$\text{SSE} = \sum_{j=1}^{k} (n_j - 1)s_j^2 = 5(34) + 5(20) + 5(32) = 430$$

$$\text{MSE} = \frac{\text{SSE}}{n_T - k} = \frac{430}{18 - 3} = 28.67$$

$$F = \frac{\text{MSTR}}{\text{MSE}} = \frac{258}{28.67} = 9.00$$

Source of Variation	Sum of Squares	Degrees of Freedom	Mean Square	F	p-value
Treatments	516	2	258	9.00	.003
Error	430	15	28.67		
Total	946	17			

Using F table (2 numerator degrees of freedom and 15 denominator), p-value is less than .01

Using Excel or Minitab, the p-value corresponding to $F = 9.00$ is .003

Because p-value $\le \alpha = .05$, we reject the null hypothesis that the means for the three plants are equal; in other words, analysis of variance supports the conclusion that the population mean examination scores at the three NCP plants are not equal

36. p-value $= .0000$

Because p-value $\le \alpha = .05$, we reject the null hypothesis that the means for the three groups are equal

38. p-value $= .0003$

Because p-value $\le \alpha = .05$, we reject the null hypothesis that the mean miles per gallon ratings are the same for the three automobiles

40. **a.** H_0: $\mu_1 - \mu_2 = 0$
H_a: $\mu_1 - \mu_2 \ne 0$
$z = 2.79$
p-value $= .0052$
Reject H_0

42. **a.** H_0: $\mu_1 - \mu_2 \le 0$
H_a: $\mu_1 - \mu_2 > 0$
b. $t = .60$, $df = 57$
Using t table, p-value is greater than .20
Exact p-value $= .2754$
Do not reject H_0

44. **a.** 15 (or \$15,000)
b. 9.81 to 20.19
c. 11.5%

46. Significant; p-value $= .046$

48. Not significant; p-value $= .2455$

Chapter 11

1. **a.** $\bar{p}_1 - \bar{p}_2 = .48 - .36 = .12$

b. $\bar{p}_1 - \bar{p}_2 \pm z_{.05}\sqrt{\dfrac{\bar{p}_1(1-\bar{p}_1)}{n_1} + \dfrac{\bar{p}_2(1-\bar{p}_2)}{n_2}}$

$$.12 \pm 1.645\sqrt{\frac{.48(1 - .48)}{400} + \frac{.36(1 - .36)}{300}}$$

$.12 \pm .0614$ (.0586 to .1814)

c. $.12 \pm 1.96\sqrt{\dfrac{.48(1 - .48)}{400} + \dfrac{.36(1 - .36)}{300}}$

$.12 \pm .0731$ (.0469 to .1931)

2. **a.** .2333
b. .1498
c. Do not reject H_0

3. **a.** $\bar{p} = \dfrac{n_1\bar{p}_1 + n_2\bar{p}_2}{n_1 + n_2} = \dfrac{200(.22) + 300(.16)}{200 + 300} = .1840$

$$z = \frac{\bar{p}_1 - \bar{p}_2}{\sqrt{\bar{p}(1-\bar{p})\left(\dfrac{1}{n_1} + \dfrac{1}{n_2}\right)}} = \frac{.22 - .16}{\sqrt{.1840(1 - .1840)\left(\dfrac{1}{200} + \dfrac{1}{300}\right)}} = 1.70$$

p-value $= 1.0000 - .9554 = .0446$

b. p-value $\le .05$; reject H_0

4. **a.** .64; .58; professional
b. .06; professional 6% more
c. .02 to .10
from 2% to 10% more

6. **a.** H_0: $p_w \le p_m$
H_a: $p_w > p_m$
b. $\bar{p}_w = .3699$
c. $\bar{p}_m = .3400$
d. p-value $= .1093$
Do not reject H_0

8. **a.** H_0: $p_1 - p_2 = 0$
H_a: $p_1 - p_2 \ne 0$
b. .28
c. .26
d. .3078
Do not reject H_0

10. **a.** H_0: $p_1 - p_2 = 0$
H_a: $p_1 - p_2 \ne 0$
b. .13
c. p-value $= .0404$

11. **a.** Expected frequencies: $e_1 = 200(.40) = 80$
$e_2 = 200(.40) = 80$
$e_3 = 200(.20) = 40$

Actual frequencies: $f_1 = 60, f_2 = 120, f_3 = 20$

$$\chi^2 = \frac{(60 - 80)^2}{80} + \frac{(120 - 80)^2}{80} + \frac{(20 - 40)^2}{40} = \frac{400}{80} + \frac{1600}{80} + \frac{400}{40} = 5 + 20 + 10 = 35$$

Degrees of freedom: $k - 1 = 2$
$\chi^2 = 35$ shows p-value is less than .005
p-value $\le .01$; reject H_0

b. Reject H_0 if $\chi^2 \ge 9.210$
$\chi^2 = 35$; reject H_0

12. $\chi^2 = 15.33$, $df = 3$
p-value less than .005
Reject H_0

13. H_0: $p_{\text{ABC}} = .29, p_{\text{CBS}} = .28, p_{\text{NBC}} = .25, p_{\text{IND}} = .18$
H_a: The proportions are not $p_{\text{ABC}} = .29, p_{\text{CBS}} = .28, p_{\text{NBC}} = .25, p_{\text{IND}} = .18$
Expected frequencies: $300(.29) = 87$, $300(.28) = 84$
$300(.25) = 75$, $300(.18) = 54$
$e_1 = 87, e_2 = 84, e_3 = 75, e_4 = 54$
Actual frequencies: $f_1 = 95, f_2 = 70, f_3 = 89, f_4 = 46$

$$\chi^2 = \frac{(95 - 87)^2}{87} + \frac{(70 - 84)^2}{84} + \frac{(89 - 75)^2}{75} + \frac{(46 - 54)^2}{54} = 6.87$$

Degrees of freedom: $k - 1 = 3$
$\chi^2 = 6.87$, p-value between .05 and .10
Do not reject H_0

14. $\chi^2 = 29.51$, $df = 5$
p-value is less than .005
Reject H_0

16. **a.** $\chi^2 = 12.21$, $df = 3$
p-value is between .005 and .01
Conclude difference for 2003
b. 21%, 30%, 15%, 34%
Increased use of debit card
c. 51%

18. $\chi^2 = 16.31$, $df = 3$
p-value less than .005
Reject H_0

19. H_0: The column variable is independent of the row variable
H_a: The column variable is not independent of the row variable

Expected frequencies:

	A	B	C
P	28.5	39.9	45.6
Q	21.5	30.1	34.4

$$\chi^2 = \frac{(20 - 28.5)^2}{28.5} + \frac{(44 - 39.9)^2}{39.9} + \frac{(50 - 45.6)^2}{45.6} + \frac{(30 - 21.5)^2}{21.5} + \frac{(26 - 30.1)^2}{30.1} + \frac{(30 - 34.4)^2}{34.4} = 7.86$$

Degrees of freedom: $(2 - 1)(3 - 1) = 2$
$\chi^2 = 7.86$, p-value between .01 and .025
Reject H_0

20. $\chi^2 = 19.77$, $df = 4$
p-value less than .005
Reject H_0

21. H_0: Type of ticket purchased is independent of the type of flight

H_a: Type of ticket purchased is not independent of the type of flight

Expected frequencies:

$e_{11} = 35.59 \qquad e_{12} = 15.41$
$e_{21} = 150.73 \qquad e_{22} = 65.27$
$e_{31} = 455.68 \qquad e_{32} = 197.32$

Ticket	Flight	Observed Frequency (f_i)	Expected Frequency (e_i)	$(f_i - e_i)^2/e_i$
First	Domestic	29	35.59	1.22
First	International	22	15.41	2.82
Business	Domestic	95	150.73	20.61
Business	International	121	65.27	47.59
Full-fare	Domestic	518	455.68	8.52
Full-fare	International	135	197.32	19.68
Totals		920		$\chi^2 = 100.43$

Degrees of freedom: $(3 - 1)(2 - 1) = 2$
$\chi^2 = 100.43$, p-value is less than .005
Reject H_0

22. a. $\chi^2 = 7.95$, $df = 3$
p-value is between .025 and .05
Reject H_0
b. 18 to 24 use most

24. a. $\chi^2 = 10.60$, $df = 4$
p-value is between .025 and .05
Reject H_0; not independent
b. Higher negative effect on grades as hours increase

26. a. $\chi^2 = 7.85$, $df = 3$
p-value is between .025 and .05
Reject H_0
b. Pharmaceutical, 98.6%

28. $\chi^2 = 3.01$, $df = 2$
p-value is greater than .10
Do not reject H_0; 63.3%

30. a. p-value ≈ 0, reject H_0
b. .0468 to .1332

32. a. 163, 66
b. .0804 to .2196
c. Yes

34. $\chi^2 = 8.04$, $df = 3$
p-value between .025 and .05
Reject H_0

36. $\chi^2 = 4.64$, $df = 2$
p-value between .05 and .10
Do not reject H_0

38. $\chi^2 = 42.53$, $df = 4$
p-value is less than .005
Reject H_0

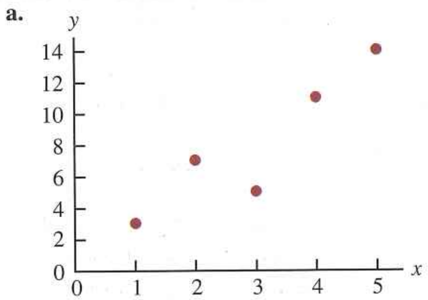
40. $\chi^2 = 23.37$, $df = 3$
p-value is less than .005
Reject H_0

42. a. $\chi^2 = 12.86$, $df = 2$
p-value is less than .005
Reject H_0
b. 66.9, 30.3, 2.9
54.0, 42.0, 4.0

44. $\chi^2 = 7.75$, $df = 3$
p-value is between .05 and .10
Do not reject H_0

Chapter 12

1. a.



b. There appears to be a positive linear relationship between x and y

c. Many different straight lines can be drawn to provide a linear approximation of the relationship between x and y; in part (d) we will determine the equation of a straight line that "best" represents the relationship according to the least squares criterion

d. Summations needed to compute the slope and y-intercept:

$$\bar{x} = \frac{\Sigma x_i}{n} = \frac{15}{5} = 3, \quad \bar{y} = \frac{\Sigma y_i}{n} = \frac{40}{5} = 8,$$

$$\Sigma(x_i - \bar{x})(y_i - \bar{y}) = 26, \quad \Sigma(x_i - \bar{x})^2 = 10$$

$$b_1 = \frac{\Sigma(x_i - \bar{x})(y_i - \bar{y})}{\Sigma(x_i - \bar{x})^2} = \frac{26}{10} = 2.6$$

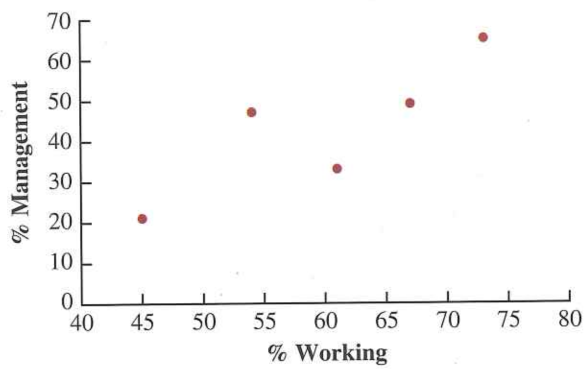
$$b_0 = \bar{y} - b_1\bar{x} = 8 - (2.6)(3) = 0.2$$

$$\hat{y} = 0.2 - 2.6x$$

e. $\hat{y} = .2 + 2.6x = .2 + 2.6(4) = 10.6$

2. b. There appears to be a negative linear relationship between x and y
d. $\hat{y} = 68 - 3x$
e. 38

4. a.



b. There appears to be a positive linear relationship between the percentage of women working in the five companies (x) and the percentage of management jobs held by women in those companies (y)

c. Many different straight lines can be drawn to provide a linear approximation of the relationship between x and y; in part (d) we will determine the equation of a straight line that "best" represents the relationship according to the least squares criterion

d. $\bar{x} = \frac{\Sigma x_i}{n} = \frac{300}{5} = 60 \quad \bar{y} = \frac{\Sigma y_i}{n} = \frac{215}{5} = 43$

$$\Sigma(x_i - \bar{x})(y_i - \bar{y}) = 624 \quad \Sigma(x_i - \bar{x})^2 = 480$$

$$b_1 = \frac{\Sigma(x_i - \bar{x})(y_i - \bar{y})}{\Sigma(x_i - \bar{x})^2} = \frac{624}{480} = 1.3$$

$$\hat{y} = -35 + 1.3x$$

e. $\hat{y} = -35 + 1.3x = -35 + 1.3(60) = 43\%$

6. c. $\hat{y} = 1.8395 + .0084x$
e. 11.9%

8. c. $\hat{y} = -6745.44 + 149.29x$
d. $4003

10. c. $\hat{y} = 359.2668 - 5.2772x$
d. $254

12. c. $\hat{y} = -8129.4439 + 22.4443x$
d. $8704

14. b. $\hat{y} = 28.30 - .0415x$
c. 26.2

15. a. $\hat{y}_i = .2 + 2.6x_i$ and $\bar{y} = 8$

x_i	y_i	$\hat{y}_i$	$y_i - \hat{y}_i$	$(y_i - \hat{y}_i)^2$	$y_i - \bar{y}$	$(y_i - \bar{y})^2$
1	3	2.8	.2	.04	−5	25
2	7	5.4	1.6	2.56	−1	1
3	5	8.0	−3.0	9.00	−3	9
4	11	10.6	.4	.16	3	9
5	14	13.2	.8	.64	6	36
				SSE = 12.40		SST = 80

$$SSR = SST - SSE = 80 - 12.4 = 67.6$$

b. $r^2 = \frac{SSR}{SST} = \frac{67.6}{80} = .845$

The least squares line provided a good fit; 84.5% of the variability in y has been explained by the least squares line

c. $r_{xy} = \sqrt{.845} = +.9192$

16. a. SSE = 230, SST = 1850, SSR = 1620
b. $r^2 = .876$
c. $r_{xy} = -.936$

18. a. The estimated regression equation and the mean for the dependent variable:

$$\hat{y} = 1790.5 + 581.1x, \quad \bar{y} = 3650$$

The sum of squares due to error and the total sum of squares:

$$SSE = \Sigma(y_i - \hat{y}_i)^2 = 85{,}135.14$$

$$SST = \Sigma(y_i - \bar{y})^2 = 335{,}000$$

Thus, SSR = SST − SSE
= 335,000 − 85,135.14 = 249,864.86

b. $r^2 = \frac{SSR}{SST} = \frac{249{,}864.86}{335{,}000} = .746$

The least squares line accounted for 74.6% of the total sum of squares

c. $r_{xy} = \sqrt{.746} = +.8637$

20. a. $\hat{y} = 12.0169 + .0127x$
b. $r^2 = .4503$
c. 53

22. a. $\hat{y} = -745.480627 + 117.917320x$
b. $r^2 = .7071$
c. $r_{xy} = +.84$

23. a. $s^2 = MSE = \frac{SSE}{n-2} = \frac{12.4}{3} = 4.133$

b. $s = \sqrt{MSE} = \sqrt{4.133} = 2.033$

c. $\Sigma(x_i - \bar{x})^2 = 10$

$$s_{b_1} = \frac{s}{\sqrt{\Sigma(x_i - \bar{x})^2}} = \frac{2.033}{\sqrt{10}} = .643$$

d. $t = \frac{b_1 - \beta_1}{s_{b_1}} = \frac{2.6 - 0}{.643} = 4.044$

From the t table (3 degrees of freedom), area in tail is between .01 and .025

p-value is between .02 and .05

Using Excel or Minitab, the p-value corresponding to $t = 4.04$ is .0272

Because p-value $\le \alpha$, we reject H_0: $\beta_1 = 0$

e. $MSE = \frac{SSR}{1} = 67.6$

$$F = \frac{MSR}{MSE} = \frac{67.6}{4.133} = 16.36$$

From the F table (1 numerator degree of freedom and 3 denominator), p-value is between .025 and .05

Using Excel or Minitab, the p-value corresponding to $F = 16.36$ is .0272

Because p-value $\le \alpha$, we reject H_0: $\beta_1 = 0$

Source of Variation	Sum of Squares	Degrees of Freedom	Mean Square	F	p-value
Regression	67.6	1	67.6	16.36	.0272
Error	12.4	3	4.133		
Total	80	4			

24. a. 76.6667
b. 8.7560
c. .6526
d. Significant; p-value = .0193
e. Significant; p-value = .0193

26. a. $s^2 = MSE = \frac{SSE}{n-2} = \frac{85{,}135.14}{4} = 21{,}283.79$

$$s = \sqrt{MSE} = \sqrt{21{,}283.79} = 145.89$$

$$\Sigma(x_i - \bar{x})^2 = .74$$

$$s_{b_1} = \frac{s}{\sqrt{\Sigma(x_i - \bar{x})^2}} = \frac{145.89}{\sqrt{.74}} = 169.59$$

$$t = \frac{b_1 - \beta_1}{s_{b_1}} = \frac{581.08 - 0}{169.59} = 3.43$$

From the t table (4 degrees of freedom), area in tail is between .01 and .025

p-value is between .02 and .05

Using Excel or Minitab, the p-value corresponding to $t = 3.43$ is .0266

Because p-value $\le \alpha$, we reject H_0: $\beta_1 = 0$

b. $MSR = \frac{SSR}{1} = \frac{249{,}864.86}{1} = 249{,}864.86$

$$F = \frac{MSR}{MSE} = \frac{249{,}864.86}{21{,}283.79} = 11.74$$

From the F table (1 numerator degree of freedom and 4 denominator), p-value is between .025 and .05

Using Excel or Minitab, the p-value corresponding to $F = 11.74$ is .0266

Because p-value $\le \alpha$, we reject H_0: $\beta_1 = 0$

c.

Source of Variation	Sum of Squares	Degrees of Freedom	Mean Square	F	p-value
Regression	29,864.86	1	29,864.86	11.74	.0266
Error	85,135.14	4	21,283.79		
Total	335,000	5			

28. They are related; p-value $= .000$

30. Significant; p-value $= .002$

32. a. $s = 2.033$

$\bar{x} = 3, \Sigma(x_i - \bar{x})^2 = 10$

$$s_{\hat{y}_p} = s\sqrt{\frac{1}{n} + \frac{(x_p - \bar{x})^2}{\Sigma(x_i - \bar{x})^2}}$$

$$= 2.033\sqrt{\frac{1}{5} + \frac{(4-3)^2}{10}} = 1.11$$

b. $\hat{y} = .2 + 2.6x = .2 + 2.6(4) = 10.6$

$\hat{y}_p \pm t_{\alpha/2}s_{\hat{y}_p}$

$10.6 \pm 3.182(1.11)$

10.6 ± 3.53, or 7.07 to 14.13

c. $$s_{\text{ind}} = s\sqrt{1 + \frac{1}{n} + \frac{(x_p - \bar{x})^2}{\Sigma(x_i - \bar{x})^2}}$$

$$= 2.033\sqrt{1 + \frac{1}{5} + \frac{(4-3)^2}{10}} = 2.32$$

d. $\hat{y}_p \pm t_{\alpha/2}s_{\text{ind}}$

$10.6 \pm 3.182(2.32)$

10.6 ± 7.38, or 3.22 to 17.98

34. Confidence interval: 8.65 to 21.15

Prediction interval: -4.50 to 41.30

35. a. $s = 145.89, \bar{x} = 3.2, \Sigma(x_i - \bar{x})^2 = .74$

$\hat{y} = 1790.5 + 581.1x = 1790.5 + 581.1(3)$

$= 3533.8$

$$s_{\hat{y}_p} = s\sqrt{\frac{1}{n} + \frac{(x_p - \bar{x})^2}{\Sigma(x_i - \bar{x})^2}}$$

$$= 145.89\sqrt{\frac{1}{6} + \frac{(3-3.2)^2}{.74}} = 68.54$$

$\hat{y}_p \pm t_{\alpha/2}s_{\hat{y}_p}$

$3533.8 \pm 2.776(68.54)$

3533.8 ± 190.27, or \$3343.53 to \$3724.07

b. $$s_{\text{ind}} = s\sqrt{1 + \frac{1}{n} + \frac{(x_p - \bar{x})^2}{\Sigma(x_i - \bar{x})^2}}$$

$$= 145.89\sqrt{1 + \frac{1}{6} + \frac{(3-3.2)^2}{.74}} = 161.19$$

$\hat{y}_p \pm t_{\alpha/2}s_{\text{ind}}$

$3533.8 \pm 2.776(161.19)$

3533.8 ± 447.46, or \$3086.34 to \$3981.26

36. a. \$201

b. 167.25 to 234.65

c. 108.75 to 293.15

38. a. \$5046.67

b. \$3815.10 to \$6278.24

c. Not out of line

40. a. 9

b. $\hat{y} = 20.0 + 7.21x$

c. 1.3626

d. SSE = SST − SSR = 51,984.1 − 41,587.3 = 10,396.8

MSE = 10,396.8/7 = 1485.3

$$F = \frac{\text{MSR}}{\text{MSE}} = \frac{41{,}587.3}{1485.3} = 28.0$$

From the F table (1 numerator degree of freedom and 7 denominator), p-value is less than .01

Using Excel or Minitab, the p-value corresponding to $F = 28.0$ is .0011

Because p-value $\leq \alpha = .05$, we reject H_0: $\beta_1 = 0$

e. $\hat{y} = 20.0 + 7.21(50) = 380.5$, or \$380,500

42. a. $\hat{y} = 80.0 + 50.0x$

b. 30

c. Significant; p-value $= .000$

d. \$680,000

44. b. Yes

c. $\hat{y} = 37.1 - .779x$

d. Significant; p-value $= 0.003$

e. $r^2 = .434$; not a good fit

f. \$12.27 to \$22.90

g. \$17.47 to \$39.05

45. a. $\bar{x} = \frac{\Sigma x_i}{n} = \frac{70}{5} = 14,\ \bar{y} = \frac{\Sigma y_i}{n} = \frac{76}{5} = 15.2,$

$\Sigma(x_i - \bar{x})(y_i - \bar{y}) = 200,\ \Sigma(x_i - \bar{x})^2 = 126$

$$b_1 = \frac{\Sigma(x_i - \bar{x})(y_i - \bar{y})}{\Sigma(x_i - \bar{x})^2} = \frac{200}{126} = 1.5873$$

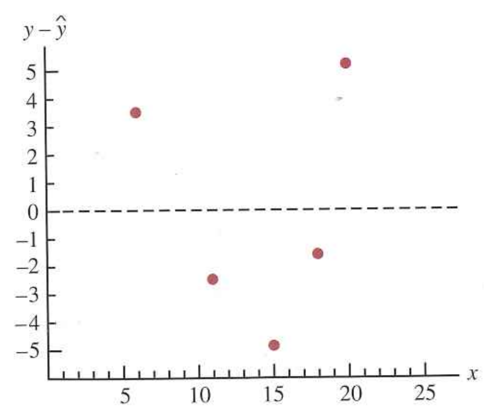
$b_0 = \bar{y} - b_1\bar{x} = 15.2 - (1.5873)(14) = -7.0222$

$\hat{y} = -7.02 + 1.59x$

b.

x_i	y_i	$\hat{y}_i$	$y_i - \hat{y}_i$
6	6	2.52	3.48
11	8	10.47	−2.47
15	12	16.83	−4.83
18	20	21.60	−1.60
20	30	24.78	5.22

c.



With only five observations, it is difficult to determine whether the assumptions are satisfied; however, the plot does suggest curvature in the residuals, which would indicate that the error term assumptions are not satisfied; the scatter diagram for these data also indicates that the underlying relationship between x and y may be curvilinear

46. a. $\hat{y} = 2.32 + .64x$

b. No; the variance does not appear to be the same for all values of x

47. a. Let x = advertising expenditures and y = revenue

$\hat{y} = 29.4 + 1.55x$

b. SST = 1002, SSE = 310.28, SSR = 691.72

$$\text{MSR} = \frac{\text{SSR}}{1} = 691.72$$

$$\text{MSE} = \frac{\text{SSE}}{n-2} = \frac{310.28}{5} = 62.0554$$

$$F = \frac{\text{MSR}}{\text{MSE}} = \frac{691.72}{62.0554} = 11.15$$

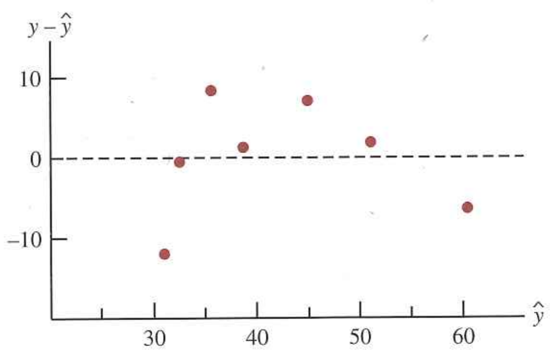
From the F table (1 numerator degree of freedom and 5 denominator), p-value is between .01 and .025

Using Excel or Minitab, p-value $= .0206$

Because p-value $\leq \alpha = .05$, we conclude that the two variables are related

c.

x_i	y_i	$\hat{y}_i = 29.40 + 1.55x_i$	$y_i - \hat{y}_i$
1	19	30.95	−11.95
2	32	32.50	−.50
4	44	35.60	8.40
6	40	38.70	1.30
10	52	44.90	7.10
14	53	51.10	1.90
20	54	60.40	−6.40



d. The residual plot leads us to question the assumption of a linear relationship between x and y; even though the relationship is significant at the $\alpha = .05$ level, it would be extremely dangerous to extrapolate beyond the range of the data

48. b. Yes

50. a. $\hat{y} = 9.26 + .711x$

b. Significant; p-value $= .001$

c. $r^2 = .744$; good fit

d. \$13.53

52. b. $\hat{y} = -182.11 + 133428$ DJIA

c. Significant; p-value $= .000$

d. Excellent fit; $r^2 = .956$

e. 1286

54. a. $\hat{y} = 22.2 - .148x$

b. Significant relationship; p-value $= .028$

c. Good fit; $r^2 = .739$

d. 12.294 to 17.271

56. a. $\hat{y} = 220 + 132x$

b. Significant; p-value $= .000$

c. $r^2 = .873$; very good fit

d. \$559.50 to \$933.90

58. a. Market beta $= .95$

b. Significant; p-value $= .029$

c. $r^2 = .470$; not a good fit

d. Texas Instruments has a higher risk

60. b. There appears to be a positive linear relationship between the two variables

c. $\hat{y} = 9.37 + 1.2875$ Top Five (%)

d. Significant; p-value $= .000$

e. $r^2 = .741$; good fit

f. $r_{xy} = .86$

Chapter 13

2. a. The estimated regression equation is

$\hat{y} = 45.06 + 1.94x_1$

An estimate of y when $x_1 = 45$ is

$\hat{y} = 45.06 + 1.94(45) = 132.36$

b. The estimated regression equation is

$\hat{y} = 85.22 + 4.32x_2$

An estimate of y when $x_2 = 15$ is

$\hat{y} = 85.22 + 4.32(15) = 150.02$

c. The estimated regression equation is

$\hat{y} = -18.37 + 2.01x_1 + 4.74x_2$

An estimate of y when $x_1 = 45$ and $x_2 = 15$ is

$\hat{y} = -18.37 + 2.01(45) + 4.74(15) = 143.18$

4. a. \$255,000

5. a. The Minitab output is shown in Figure D13.5a

b. The Minitab output is shown in Figure D13.5b

c. It is 1.60 in part (a) and 2.29 in part (b); in part (a) the coefficient is an estimate of the change in revenue due to a one-unit change in television advertising expenditures; in part (b) it represents an estimate of the change in revenue due to a one-unit change in television advertising expenditures when the amount of newspaper advertising is held constant

d. Revenue $= 83.2 + 2.29(3.5) + 1.30(1.8) = 93.56$ or \$93,560

6. a. Proportion Won $= .354 + .000888$ HR

b. Proportion Won $= .865 - .0837$ ERA

FIGURE D13.5a

```
The regression equation is
Revenue = 88.6 + 1.60 TVAdv

Predictor      Coef    SE Coef       T       p
Constant     88.638      1.582   56.02   0.000
TVAdv        1.6039     0.4778    3.36   0.015

S = 1.215    R-sq = 65.3%     R-sq(adj) = 59.5%

Analysis of Variance

SOURCE           DF       SS       MS       F       p
Regression        1   16.640   16.640   11.27   0.015
Residual Error    6    8.860    1.477
Total             7   25.500
```

FIGURE D13.5b

```
The regression equation is
Revenue = 83.2 + 2.29 TVAdv + 1.30 NewsAdv

Predictor      Coef    SE Coef       T       p
Constant     83.230      1.574   52.88   0.000
TVAdv        2.2902     0.3041    7.53   0.001
NewsAdv      1.3010     0.3207    4.06   0.010

S = 0.6426    R-sq = 91.9%     R-sq(adj) = 88.7%

Analysis of Variance

SOURCE           DF       SS       MS       F       p
Regression        2   23.435   11.718   28.38   0.002
Residual Error    5    2.065    0.413
Total             7   25.500
```

c. Proportion Won = .709 + .00140 HR − .103 ERA
d. 54.9%

8. a. Return = 247 − 32.8 Safety + 34.6 ExpRatio
b. 70.2

10. a. PCT = −1.22 + 3.96 FG%
b. Increase of 1% in FG% will increase PCT by .04
c. PCT = −1.23 + 4.82 FG% − 2.59 Opp 3 Pt% + .0344 Opp TO
d. Increase FG%; decrease Opp 3 Pt%; increase Opp TO
e. .638

12. a. $R^2 = \dfrac{\text{SSR}}{\text{SST}} = \dfrac{14{,}052.2}{15{,}182.9} = .926$

b. $R_a^2 = 1 - (1 - R^2)\dfrac{n-1}{n-p-1}$

$= 1 - (1 - .926)\dfrac{10-1}{10-2-1} = .905$

c. Yes; after adjusting for the number of independent variables in the model, we see that 90.5% of the variability in y has been accounted for

14. a. .75 **b.** .68

15. a. $R^2 = \dfrac{\text{SSR}}{\text{SST}} = \dfrac{23.435}{25.5} = .919$

$R_a^2 = 1 - (1 - R^2)\dfrac{n-1}{n-p-1}$

$= 1 - (1 - .919)\dfrac{8-1}{8-2-1} = .887$

b. Multiple regression analysis is preferred because both R^2 and R_a^2 show an increased percentage of the variability of y explained when both independent variables are used

16. a. No, $R^2 = .153$
b. Better fit with multiple regression

18. a. $R^2 = .564$, $R_a^2 = .511$
b. The fit is not very good

19. a. $\text{MSR} = \dfrac{\text{SSR}}{p} = \dfrac{6216.375}{2} = 3108.188$

$\text{MSE} = \dfrac{\text{SSE}}{n-p-1} = \dfrac{507.75}{10-2-1} = 72.536$

b. $F = \dfrac{\text{MSR}}{\text{MSE}} = \dfrac{3108.188}{72.536} = 42.85$

From the F table (2 numerator degrees of freedom and 7 denominator), p-value is less than .01

Using Excel or Minitab, the p-value corresponding to $F = 42.85$ is .0001

Because p-value $\le \alpha$, the overall model is significant

c. $t = \dfrac{b_1}{s_{b_1}} = \dfrac{.5906}{.0813} = 7.26$

p-value = .0002

Because p-value $\le \alpha$, β_1 is significant

d. $t = \dfrac{b_2}{s_{b_2}} = \dfrac{.4980}{.0567} = 8.78$

p-value = .0001

Because p-value $\le \alpha$, β_2 is significant

20. a. Significant; p-value = .000
b. Significant; p-value = .000
c. Significant; p-value = .002

22. a. SSE = 4000, $s^2 = 571.43$, MSR = 6000
b. Significant; p-value = .008

23. a. $F = 28.38$

p-value = .002

Because p-value $\le \alpha$, there is a significant relationship

b. $t = 7.53$

p-value = .001

Because p-value $\le \alpha$, β_1 is significant and x_1 should not be dropped from the model

c. $t = 4.06$

p-value = .010

Because p-value $\le \alpha$, β_2 is significant and x_2 should not be dropped from the model

24. a. $\hat{y} = -.682 + .0498$ Revenue + .0147 %Wins
b. Significant; p-value = .001
c. Both are significant; both p-values $< \alpha = .05$

26. a. Significant; p-value = .000
b. All significant; p-values are all $< \alpha = .05$

28. a. Using Minitab, the 95% confidence interval is 132.16 to 154.15
b. Using Minitab, the 95% prediction interval is 111.15 at 175.17

29. a. See Minitab output in Figure D13.5b.

$\hat{y} = 83.230 + 2.2902(3.5) + 1.3010(1.8) = 93.588$ or \$93,588

b. Minitab results: 92.840 to 94.335, or \$92,840 to \$94,335
c. Minitab results: 91.774 to 95.401, or \$91,774 to \$95,401

30. a. 46.758 to 50.646
b. 44.815 to 52.589

32. a. $E(y) = \beta_0 + \beta_1 x_1 + \beta_2 x_2$

where $x_2 = \begin{cases} 0 \text{ if level 1} \\ 1 \text{ if level 2} \end{cases}$

b. $E(y) = \beta_0 + \beta_1 x_1 + \beta_2(0) = \beta_0 + \beta_1 x_1$
c. $E(y) = \beta_0 + \beta_1 x_1 + \beta_2(1) = \beta_0 + \beta_1 x_1 + \beta_2$
d. $\beta_2 = E(y \mid \text{level 2}) - E(y \mid \text{level 1})$

β_1 is the change in $E(y)$ for a 1-unit change in x_1 holding x_2 constant

34. a. \$15,300
b. $\hat{y} = 10.1 - 4.2(2) + 6.8(8) + 15.3(0) = 56.1$

Sales prediction: \$56,100

c. $\hat{y} = 10.1 - 4.2(1) + 6.8(3) + 15.3(1) = 41.6$

Sales prediction: \$41,600

36. a. $\hat{y} = 1.86 + 0.291$ Months + 1.10 Type − 0.609 Person
b. Significant; p-value = .002
c. Person is not significant; p-value = .167

38. a. $\hat{y} = -91.8 + 1.08$ Age + .252 Pressure + 8.74 Smoker
b. Significant; p-value = .01
c. 95% prediction interval is 21.35 to 47.18 or a probability of .2135 to .4718; quit smoking and begin some type of treatment to reduce his blood pressure

40. a. $\hat{y} = -1.41 + .0235x_1 + .00486x_2$
b. Significant; p-value = .0001
c. $R^2 = .937$; $R_a^2 = 9.19$; good fit
d. Both significant

42. a. Score = 50.6 + 1.56 RecRes
b. $r^2 = .431$; not a good fit
c. Score = 33.5 + 1.90 RecRes + 2.61 Afford

Significant

$R_a^2 = .784$; much better fit

44. a. CityMPG = 24.1 − 2.10 Displace

Significant; p-value = .000

b. CityMPG = 26.4 − 2.44 Displace − 1.20 Drive4
c. Significant; p-value = .016
d. CityMPG = 33.3 − 4.15 Displace − 1.24 Drive4 + 2.16 EightCyl
e. Significant overall and individually