Appendix D: Self-Test Solutions and Answers to Even-Numbered Exercises

Chapter 1

2. a. 9
   b. 4
c. Categorical: 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

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

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

6. Questions a, c, and d provide quantitative data
   Questions b and e provide categorical data

8. a. 1005
   b. Categorical
c. Percentages
d. Approximately 291

10. a. Quantitative; ratio
    b. Categorical; nominal
c. Categorical; ordinal
d. Quantitative; ratio
e. Categorical; nominal

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

13. 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 trend 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

14. 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 chart would show cross-sectional data for 2007; bar heights would be GM 8.8, Ford 7.9, DC 4.6, and Toyota 9.6

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

18. a. 36%
    b. 189
c. Categorical

20. 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

22. 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

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

Chapter 2

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

3. a. \( 360^\circ \times \frac{58}{120} = 174^\circ \)
    b. \( 360^\circ \times \frac{42}{120} = 126^\circ \)
Appendix D  Self-Test Solutions and Answers to Even-Numbered Exercises

4. a. Categorical
   b.
<table>
<thead>
<tr>
<th>TV Show</th>
<th>Frequency</th>
<th>Percent Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>L&amp;O</td>
<td>10</td>
<td>20</td>
</tr>
<tr>
<td>CSI</td>
<td>18</td>
<td>36</td>
</tr>
<tr>
<td>Trace</td>
<td>9</td>
<td>18</td>
</tr>
<tr>
<td>DH</td>
<td>13</td>
<td>26</td>
</tr>
<tr>
<td>Total</td>
<td>50</td>
<td>100</td>
</tr>
</tbody>
</table>

d. CSI had the largest; DH was second

6. a.
<table>
<thead>
<tr>
<th>Network</th>
<th>Frequency</th>
<th>Percent Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>ABC</td>
<td>15</td>
<td>30</td>
</tr>
<tr>
<td>CBS</td>
<td>17</td>
<td>34</td>
</tr>
<tr>
<td>FOX</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>NBC</td>
<td>17</td>
<td>34</td>
</tr>
</tbody>
</table>
   b. CBS and NBC tied for first; ABC is close with 15

7. | Rating       | Frequency | Relative Frequency |
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Outstanding</td>
<td>19</td>
<td>.38</td>
</tr>
<tr>
<td>Very good</td>
<td>13</td>
<td>.26</td>
</tr>
<tr>
<td>Good</td>
<td>10</td>
<td>.20</td>
</tr>
<tr>
<td>Average</td>
<td>6</td>
<td>.12</td>
</tr>
<tr>
<td>Poor</td>
<td>2</td>
<td>.04</td>
</tr>
</tbody>
</table>

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.
<table>
<thead>
<tr>
<th>Position</th>
<th>Frequency</th>
<th>Relative Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>P</td>
<td>17</td>
<td>.309</td>
</tr>
<tr>
<td>H</td>
<td>4</td>
<td>.073</td>
</tr>
<tr>
<td>I</td>
<td>5</td>
<td>.091</td>
</tr>
<tr>
<td>2</td>
<td>4</td>
<td>.073</td>
</tr>
<tr>
<td>3</td>
<td>2</td>
<td>.036</td>
</tr>
<tr>
<td>S</td>
<td>5</td>
<td>.091</td>
</tr>
<tr>
<td>L</td>
<td>6</td>
<td>.109</td>
</tr>
<tr>
<td>C</td>
<td>5</td>
<td>.091</td>
</tr>
<tr>
<td>R</td>
<td>7</td>
<td>.127</td>
</tr>
</tbody>
</table>
   Totals  | 55        | 1.000              |

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

10. a. The data are categorical; they provide quality classifications
   b.
<table>
<thead>
<tr>
<th>Rating</th>
<th>Frequency</th>
<th>Relative Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 star</td>
<td>0</td>
<td>.000</td>
</tr>
<tr>
<td>2 star</td>
<td>3</td>
<td>.167</td>
</tr>
<tr>
<td>3 star</td>
<td>3</td>
<td>.167</td>
</tr>
<tr>
<td>4 star</td>
<td>10</td>
<td>.556</td>
</tr>
<tr>
<td>5 star</td>
<td>2</td>
<td>.111</td>
</tr>
</tbody>
</table>
   Totals | 18        | 1.000              |

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

12.
<table>
<thead>
<tr>
<th>Class</th>
<th>Cumulative Frequency</th>
<th>Cumulative Relative Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>≤19</td>
<td>10</td>
<td>.20</td>
</tr>
<tr>
<td>≤29</td>
<td>24</td>
<td>.48</td>
</tr>
<tr>
<td>≤39</td>
<td>41</td>
<td>.82</td>
</tr>
<tr>
<td>≤49</td>
<td>48</td>
<td>.96</td>
</tr>
<tr>
<td>≤59</td>
<td>50</td>
<td>1.00</td>
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</table>

14. b/c.
<table>
<thead>
<tr>
<th>Class</th>
<th>Frequency</th>
<th>Percent Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>6.0–7.9</td>
<td>4</td>
<td>20</td>
</tr>
<tr>
<td>8.0–9.9</td>
<td>2</td>
<td>10</td>
</tr>
<tr>
<td>10.0–11.9</td>
<td>8</td>
<td>40</td>
</tr>
<tr>
<td>12.0–13.9</td>
<td>3</td>
<td>15</td>
</tr>
<tr>
<td>14.0–15.9</td>
<td>3</td>
<td>15</td>
</tr>
</tbody>
</table>
   Totals | 20        | 100               |
15. a/b. 

<table>
<thead>
<tr>
<th>Waiting Time</th>
<th>Frequency</th>
<th>Relative Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>0–4</td>
<td>4</td>
<td>.20</td>
</tr>
<tr>
<td>5–9</td>
<td>8</td>
<td>.40</td>
</tr>
<tr>
<td>10–14</td>
<td>5</td>
<td>.25</td>
</tr>
<tr>
<td>15–19</td>
<td>2</td>
<td>.10</td>
</tr>
<tr>
<td>20–24</td>
<td>1</td>
<td>.05</td>
</tr>
<tr>
<td>Totals</td>
<td>20</td>
<td>1.00</td>
</tr>
</tbody>
</table>

c/d. 

<table>
<thead>
<tr>
<th>Waiting Time</th>
<th>Cumulative Frequency</th>
<th>Cumulative Relative Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>≤4</td>
<td>4</td>
<td>.20</td>
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<tr>
<td>≤9</td>
<td>12</td>
<td>.60</td>
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<tr>
<td>≤14</td>
<td>17</td>
<td>.85</td>
</tr>
<tr>
<td>≤19</td>
<td>19</td>
<td>.95</td>
</tr>
<tr>
<td>≤24</td>
<td>20</td>
<td>1.00</td>
</tr>
</tbody>
</table>

e. 12/20 = .60

16. a. Adjusted Gross Income

- Histogram is skewed to the right

b. Exam Scores

- Histogram skewed slightly to the left

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

18. a. Lowest $180; highest $2050

b. 

<table>
<thead>
<tr>
<th>Spending</th>
<th>Frequency</th>
<th>Percent Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>$0–249</td>
<td>3</td>
<td>12</td>
</tr>
<tr>
<td>250–499</td>
<td>6</td>
<td>24</td>
</tr>
<tr>
<td>500–749</td>
<td>5</td>
<td>20</td>
</tr>
<tr>
<td>750–999</td>
<td>5</td>
<td>20</td>
</tr>
<tr>
<td>1000–1249</td>
<td>3</td>
<td>12</td>
</tr>
<tr>
<td>1250–1499</td>
<td>1</td>
<td>4</td>
</tr>
<tr>
<td>1500–1749</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>1750–1999</td>
<td>1</td>
<td>4</td>
</tr>
<tr>
<td>2000–2249</td>
<td>1</td>
<td>4</td>
</tr>
<tr>
<td>Total</td>
<td>25</td>
<td>100</td>
</tr>
</tbody>
</table>

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. 

<table>
<thead>
<tr>
<th>Price</th>
<th>Frequency</th>
<th>Percent Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>30–39.99</td>
<td>7</td>
<td>35</td>
</tr>
<tr>
<td>40–49.99</td>
<td>5</td>
<td>25</td>
</tr>
<tr>
<td>50–59.99</td>
<td>2</td>
<td>10</td>
</tr>
<tr>
<td>60–69.99</td>
<td>3</td>
<td>15</td>
</tr>
<tr>
<td>70–79.99</td>
<td>3</td>
<td>15</td>
</tr>
<tr>
<td>Total</td>
<td>20</td>
<td>100</td>
</tr>
</tbody>
</table>

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  1  3
| 7  5  5  7
| 8  1  3  4  8
| 9  3  6
| 10  0  4  5
| 11  3
24. Leaf unit = 10

<table>
<thead>
<tr>
<th>11</th>
<th>6</th>
</tr>
</thead>
<tbody>
<tr>
<td>12</td>
<td>2</td>
</tr>
<tr>
<td>13</td>
<td>0 6 7</td>
</tr>
<tr>
<td>14</td>
<td>2 2 7</td>
</tr>
<tr>
<td>15</td>
<td>5</td>
</tr>
<tr>
<td>16</td>
<td>0 2 8</td>
</tr>
<tr>
<td>17</td>
<td>0 2 3</td>
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</table>

25. 9 8 9

<table>
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<tr>
<th>10</th>
<th>2 4 6 6</th>
</tr>
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<tbody>
<tr>
<td>11</td>
<td>4 5 7 8 8 9</td>
</tr>
<tr>
<td>12</td>
<td>2 4 5 7</td>
</tr>
<tr>
<td>13</td>
<td>1 2</td>
</tr>
<tr>
<td>14</td>
<td>4</td>
</tr>
<tr>
<td>15</td>
<td>1</td>
</tr>
</tbody>
</table>

26. a. 1 0 3 7 7

<table>
<thead>
<tr>
<th>2 4 5 5</th>
</tr>
</thead>
<tbody>
<tr>
<td>3 0 0 5 5 9</td>
</tr>
<tr>
<td>4 0 0 0 5 5 8</td>
</tr>
<tr>
<td>5 0 0 0 4 5 5</td>
</tr>
</tbody>
</table>

b. 0 5 7

<table>
<thead>
<tr>
<th>1 0 1 1 3 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 5 5 5 8</td>
</tr>
<tr>
<td>2 0 0 0 0 0 0</td>
</tr>
<tr>
<td>2 5 5</td>
</tr>
<tr>
<td>3 0 0 0</td>
</tr>
<tr>
<td>3 6</td>
</tr>
<tr>
<td>4</td>
</tr>
<tr>
<td>4</td>
</tr>
<tr>
<td>5</td>
</tr>
<tr>
<td>5</td>
</tr>
<tr>
<td>6 3</td>
</tr>
</tbody>
</table>

c. A values are always in y = 1

<table>
<thead>
<tr>
<th>100.0 0.0</th>
</tr>
</thead>
<tbody>
<tr>
<td>84.6 15.4</td>
</tr>
<tr>
<td>16.7 83.3</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>100.0</td>
</tr>
</tbody>
</table>

d. A values are always in y = 1

<table>
<thead>
<tr>
<th>B values are most often in y = 1</th>
</tr>
</thead>
<tbody>
<tr>
<td>C values are most often in y = 2</td>
</tr>
</tbody>
</table>

28. a. 2 14

<table>
<thead>
<tr>
<th>2 67</th>
</tr>
</thead>
<tbody>
<tr>
<td>3 111123</td>
</tr>
<tr>
<td>3 5677</td>
</tr>
<tr>
<td>4 00333344</td>
</tr>
<tr>
<td>4 6679</td>
</tr>
<tr>
<td>5 00022</td>
</tr>
<tr>
<td>5 5679</td>
</tr>
<tr>
<td>6 14</td>
</tr>
<tr>
<td>6 6</td>
</tr>
<tr>
<td>7 2</td>
</tr>
</tbody>
</table>

b. 40–44 with 9

c. 43 with 5

d. 10%; relatively small participation in the race

29. a.

<table>
<thead>
<tr>
<th>x</th>
<th>1</th>
<th>2</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>5</td>
<td>0</td>
<td>5</td>
</tr>
<tr>
<td>B</td>
<td>11</td>
<td>2</td>
<td>13</td>
</tr>
<tr>
<td>C</td>
<td>2</td>
<td>10</td>
<td>12</td>
</tr>
<tr>
<td>Total</td>
<td>18</td>
<td>12</td>
<td>30</td>
</tr>
</tbody>
</table>

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

c. 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
Appendix D  Self-Test Solutions and Answers to Even-Numbered Exercises

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

36. b. No apparent relationship

38. a. Ford F-Series and the Toyota Camry

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

42. a. Nearly symmetrical

b. 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

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)
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. 

<table>
<thead>
<tr>
<th>High Temp</th>
<th>Frequency</th>
<th>Low Temp</th>
<th>Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>10–19</td>
<td>0</td>
<td>10–19</td>
<td>1</td>
</tr>
<tr>
<td>20–29</td>
<td>0</td>
<td>20–29</td>
<td>5</td>
</tr>
<tr>
<td>30–39</td>
<td>1</td>
<td>30–39</td>
<td>5</td>
</tr>
<tr>
<td>40–49</td>
<td>4</td>
<td>40–49</td>
<td>5</td>
</tr>
<tr>
<td>50–59</td>
<td>3</td>
<td>50–59</td>
<td>3</td>
</tr>
<tr>
<td>60–69</td>
<td>9</td>
<td>60–69</td>
<td>1</td>
</tr>
<tr>
<td>70–79</td>
<td>2</td>
<td>70–79</td>
<td>0</td>
</tr>
<tr>
<td>80–89</td>
<td>1</td>
<td>80–89</td>
<td>0</td>
</tr>
<tr>
<td>Total</td>
<td>20</td>
<td>Total</td>
<td>20</td>
</tr>
</tbody>
</table>

48. a.

**Satisfaction Score**

<table>
<thead>
<tr>
<th>Occupation</th>
<th>30–40</th>
<th>40–49</th>
<th>50–60</th>
<th>60–70</th>
<th>70–80</th>
<th>80–90</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cabinetmaker</td>
<td>2</td>
<td>4</td>
<td>3</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>10</td>
</tr>
<tr>
<td>Lawyer</td>
<td>1</td>
<td>5</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>10</td>
</tr>
<tr>
<td>Physical Therapist</td>
<td>5</td>
<td>2</td>
<td>2</td>
<td>1</td>
<td>2</td>
<td>1</td>
<td>10</td>
</tr>
<tr>
<td>Systems Analyst</td>
<td>2</td>
<td>1</td>
<td>4</td>
<td>3</td>
<td>1</td>
<td>1</td>
<td>10</td>
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<tr>
<td>Total</td>
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<td>7</td>
<td>10</td>
<td>11</td>
<td>8</td>
<td>3</td>
<td>40</td>
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b.

**Satisfaction Score**

<table>
<thead>
<tr>
<th>Occupation</th>
<th>30–40</th>
<th>40–49</th>
<th>50–60</th>
<th>60–70</th>
<th>70–80</th>
<th>80–90</th>
<th>Total</th>
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<tbody>
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<td>Cabinetmaker</td>
<td>20</td>
<td>40</td>
<td>30</td>
<td>10</td>
<td>10</td>
<td>10</td>
<td>100</td>
</tr>
<tr>
<td>Lawyer</td>
<td>10</td>
<td>50</td>
<td>20</td>
<td>10</td>
<td>10</td>
<td>10</td>
<td>100</td>
</tr>
<tr>
<td>Physical Therapist</td>
<td>50</td>
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<td>10</td>
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<td>100</td>
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<td>Systems Analyst</td>
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<td>10</td>
<td>40</td>
<td>30</td>
<td>10</td>
<td>10</td>
<td>100</td>
</tr>
<tr>
<td>Total</td>
<td>20</td>
<td>10</td>
<td>40</td>
<td>30</td>
<td>10</td>
<td>10</td>
<td>100</td>
</tr>
</tbody>
</table>

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

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

b.

<table>
<thead>
<tr>
<th>Year Constructed</th>
<th>Fuel Type</th>
<th>Elect.</th>
<th>Nat. Gas</th>
<th>Oil</th>
<th>Propane</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>1973 or before</td>
<td>247</td>
<td>149</td>
<td>57.7</td>
<td>70.5</td>
<td>71.4</td>
<td>50.0</td>
</tr>
<tr>
<td>1974–1979</td>
<td>54</td>
<td>317</td>
<td>8.2</td>
<td>11.8</td>
<td>28.6</td>
<td>0.0</td>
</tr>
<tr>
<td>1980–1986</td>
<td>82</td>
<td>17</td>
<td>12.0</td>
<td>5.9</td>
<td>0.0</td>
<td>42.9</td>
</tr>
<tr>
<td>1987–1991</td>
<td>121</td>
<td>7</td>
<td>1.9</td>
<td>5.9</td>
<td>0.0</td>
<td>71.7</td>
</tr>
<tr>
<td>Total</td>
<td>504</td>
<td>Total</td>
<td>100.0</td>
<td>100.0</td>
<td>100.0</td>
<td>100.0</td>
</tr>
</tbody>
</table>

c. Crosstabulation of column percentages

d. Crosstabulation of row percentages.

52. a. Crosstabulation of market value and profit

<table>
<thead>
<tr>
<th>Market Value ($1000s)</th>
<th>Profit ($1000s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0–8000</td>
<td>85.19</td>
</tr>
<tr>
<td>8000–16,000</td>
<td>33.33</td>
</tr>
<tr>
<td>16,000–24,000</td>
<td>33.33</td>
</tr>
<tr>
<td>24,000–32,000</td>
<td>33.33</td>
</tr>
<tr>
<td>32,000–40,000</td>
<td>33.33</td>
</tr>
</tbody>
</table>

b. Crosstabulation of row percentages

<table>
<thead>
<tr>
<th>Market Value ($1000s)</th>
<th>Profit ($1000s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0–8000</td>
<td>14.81</td>
</tr>
<tr>
<td>8000–16,000</td>
<td>16.67</td>
</tr>
<tr>
<td>16,000–24,000</td>
<td>16.67</td>
</tr>
<tr>
<td>24,000–32,000</td>
<td>50.00</td>
</tr>
<tr>
<td>32,000–40,000</td>
<td>66.67</td>
</tr>
</tbody>
</table>

54. b. A positive relationship is demonstrated between market value and stockholders’ equity.

Chapter 3

2. 16, 16.5

3. Arrange data in order: 15, 20, 25, 25, 27, 28, 30, 34
   \[i = \frac{20}{100} = 0.2\]
   20th percentile = 20
i = 25 / 100 (8) = 2; use positions 2 and 3
25th percentile = 20 + 25 / 2 = 22.5

i = 65 / 100 (8) = 5.2; round up to position 6
65th percentile = 28

i = 75 / 100 (8) = 6; use positions 6 and 7
75th percentile = 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. \( \bar{x} = \frac{\sum x_i}{n} = \frac{3200}{20} = 160 \)
   Median (10th and 11th positions) \( \frac{130 + 140}{2} = 135 \)
   Mode = 120 (appears three times)
b. \( i = 25 / 100 (20) = 5; \) use 5th and 6th positions
   \( Q_1 = \frac{115 + 115}{2} = 115 \)
   \( i = 75 / 100 (20) = 15; \) use 15th and 16th positions
   \( Q_3 = \frac{180 + 195}{2} = 187.5 \)
c. \( i = 90 / 100 (20) = 18; \) use 18th and 19th positions
   90th percentile = \( \frac{235 + 255}{2} = 245 \)
   90% of the tax returns cost $245 or less. 10% of the tax returns cost $245 or more.

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
    \( i = 25 / 100 (8) = 2; \) \( Q_1 = \frac{20 + 25}{2} = 22.5 \)
    \( i = 75 / 100 (8) = 6; \) \( Q_3 = \frac{28 + 30}{2} = 29 \)

IQR = \( Q_3 - Q_1 = 29 - 22.5 = 6.5 \)
\( \bar{x} = \frac{\sum x_i}{n} = \frac{204}{8} = 25.5 \)

16. a. Range = 190 - 168 = 22
   b. \( \bar{x} = \frac{\sum x_i}{n} = \frac{1068}{6} = 178 \)
   \( s^2 = \frac{\sum(x_i - \bar{x})^2}{n - 1} = \frac{42}{6 - 1} = 178 \)
   \( s = \sqrt{178} = 8.67 \)
   c. \( s = \sqrt{75.2} = 8.67 \)
   d. \( \frac{s}{\bar{x}} (100) = \frac{8.67}{178} = 4.87% \)
   e. Freshmen

20. Dawson: range = 2, \( s = .67 \)
    Clark: range = 8, \( s = 2.58 \)

22. a. Freshmen: $1285; Seniors: $433; Yes
   b. Freshmen: $1720; Seniors: $352
   c. Freshmen: $404; Seniors: $134.5
   d. Freshmen: $367.04; Seniors: $96.96
   e. Freshmen

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

26. 20, 1.50, 0, -0.5, -2.20

27. Chebyshev’s theorem: \( at least (1 - 1/x^2) \)
   a. \( x = 40 - 30 / 5 = 2; 1 - (2)^2 = .75 \)
   b. \( x = 45 - 30 / 5 = 3; 1 - (3)^2 = .89 \)
   c. \( x = 38 - 30 / 5 = 1.6; 1 - (1.6)^2 = .61 \)
   d. \( x = 42 - 30 / 5 = 2.4; 1 - (2.4)^2 = .83 \)
Appendix D  Self-Test Solutions and Answers to Even-Numbered Exercises

28. a. 95%
   b. Almost all
   c. 68%

29. a. \( z = 2 \text{ standard deviations} \)
   \[ 1 - \frac{1}{z^2} = 1 - \frac{1}{2^2} = \frac{3}{4}; \] at least 75%
   b. \( z = 2.5 \text{ standard deviations} \)
   \[ 1 - \frac{1}{z^2} = 1 - \frac{1}{2.5^2} = .84; \] at least 84%
   c. \( z = 2 \text{ standard deviations} \)
   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
   \[ i = \frac{25}{100} (9) = 2.25; \text{ round up to position 3} \]
   \( Q_1 = 8 \)
   Median (5th position) = 10
   \[ i = \frac{75}{100} (9) = 6.75; \text{ round up to position 7} \]
   \( Q_3 = 15 \)
   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
   \[ i = \frac{25}{100} (21) = 5.25; \text{ round up to 6th position} \]
   \( Q_1 = 1872 \)
   Median (11th position) = 4019
   \[ i = \frac{75}{100} (21) = 15.75; \text{ round up to 16th position} \]
   \( Q_3 = 8305 \)
   5-number summary: 608, 1872, 4019, 8305, 14138
   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

42. a. 66
   b. 30, 49, 66, 88, 208
   c. Yes; upper limit = 146.5

44. a. 18.2, 15.35
   b. 1.7, 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. \[ r_{xy} = \frac{\sum(x_i - \bar{x})(y_i - \bar{y})}{n - 1} = \frac{-240}{4} = -60 \]

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. \[ f_i \quad M_i \quad f_i M_i \]
   \[ 4 \quad 5 \quad 20 \]
   \[ 7 \quad 10 \quad 70 \]
   \[ 9 \quad 15 \quad 135 \]
   \[ 5 \quad 20 \quad 100 \]
   \[ 25 \]
   \[ \bar{x} = \frac{\sum f_i M_i}{n} = \frac{325}{25} = 13 \]
Appendix D  Self-Test Solutions and Answers to Even-Numbered Exercises

b. 

<table>
<thead>
<tr>
<th>f_i</th>
<th>M_i</th>
<th>(M_i - x̄)^2</th>
<th>f_i(M_i - x̄)^2</th>
</tr>
</thead>
<tbody>
<tr>
<td>4</td>
<td>5</td>
<td>-8</td>
<td>64</td>
</tr>
<tr>
<td>7</td>
<td>10</td>
<td>-3</td>
<td>9</td>
</tr>
<tr>
<td>9</td>
<td>15</td>
<td>2</td>
<td>4</td>
</tr>
<tr>
<td>5</td>
<td>20</td>
<td>7</td>
<td>49</td>
</tr>
<tr>
<td>25</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

\[ s^2 = \frac{\sum f_i(M_i - x̄)^2}{n - 1} = \frac{600}{25 - 1} = 25 \]

\[ s = \sqrt{25} = 5 \]

54. a.

<table>
<thead>
<tr>
<th>Grade x_i</th>
<th>Weight w_i</th>
</tr>
</thead>
<tbody>
<tr>
<td>4 (A)</td>
<td>9</td>
</tr>
<tr>
<td>3 (B)</td>
<td>15</td>
</tr>
<tr>
<td>2 (C)</td>
<td>33</td>
</tr>
<tr>
<td>1 (D)</td>
<td>3</td>
</tr>
<tr>
<td>0 (F)</td>
<td>0</td>
</tr>
</tbody>
</table>

\[ \bar{x} = \frac{\sum w_i x_i}{\sum w_i} = \frac{9(4) + 15(3) + 33(2) + 3(1)}{150} = \frac{150}{60} = 2.5 \]

56. 3.49, .94

58. 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

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

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

64. 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

66. b. .9856, strong positive relationship

68. a. 817
   b. 833

70. a. 60.68
   b. \( s^2 = 31.23; s = 5.59 \)

Chapter 4

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

<table>
<thead>
<tr>
<th>ABC</th>
<th>ACE</th>
<th>BCD</th>
<th>BEF</th>
</tr>
</thead>
<tbody>
<tr>
<td>ABD</td>
<td>ACF</td>
<td>BCE</td>
<td>CDE</td>
</tr>
<tr>
<td>ABE</td>
<td>ADE</td>
<td>BCF</td>
<td>CDF</td>
</tr>
<tr>
<td>ABF</td>
<td>ADF</td>
<td>BDE</td>
<td>CEF</td>
</tr>
<tr>
<td>ACD</td>
<td>AEF</td>
<td>BDF</td>
<td>DEF</td>
</tr>
</tbody>
</table>

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
    \( P(\text{California}) = 1.434/2,374 = .60 \)
   b. Number not from four states
    \( P(\text{Not from 4 states}) = 221/2374 = .09 \)
   c. \( P(\text{Not in early stages}) = 1 - .22 = .78 \)
   d. Estimate of number of Massachusetts companies in early stage of development = 112(2374)/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
    \( \text{Estimate of Colorado funds} = (112/2374) \times (32.4) = \$1.53 \text{ billion} \)

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. \( S = \{ \text{ace of clubs, ace of diamonds, ace of hearts, ace of spades} \} \)
   b. \( S = \{ \text{2 of clubs, 3 of clubs, . . . , 10 of clubs, J of clubs, Q of clubs, K of clubs, A of clubs} \} \)
23. a. 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

24. a. \( \frac{5}{6} \)
   b. \( \frac{5}{6} \)
   c. No; \( P(\text{odd}) = P(\text{even}) = \frac{1}{2} \)
   d. Classical

25. 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. \(\frac{1}{4}\)

26. a. \(\frac{1}{10}\)
   b. \(\frac{1}{10}\)
   c. \(0.34\)

27. a. \(0.40, 0.40, 0.60\)
   b. \(0.80\)
   c. \(A' = \{E_1, E_2, E_4, E_5\}; C' = \{E_1, E_4\}\)
   \(P(A') = 0.60; P(C') = 0.40\)
   d. \(E_1, E_2, E_5\)
   e. \(0.80\)

28. Let \(B =\) rented a car for business reasons
   \(P =\) rented a car for personal reasons
   a. \(P(B \cup P) = P(B) + P(P) - P(B \cap P) = 0.40 + 0.45 - 0.30 = 0.540\)
   \(= 0.98\)
   b. \(P(\text{Neither}) = 1 - 0.698 = 0.302\)

30. a. \(P(A \mid B) = \frac{P(A \cap B)}{P(B)} = \frac{0.40}{0.60} = 0.6667\)
   b. \(P(B \mid A) = \frac{P(A \cap B)}{P(A)} = \frac{0.40}{0.50} = 0.80\)
   c. No, because \(P(A \mid B) \neq P(A)\)

32. a.

<table>
<thead>
<tr>
<th></th>
<th>Yes</th>
<th>No</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>18 to 34</td>
<td>.375</td>
<td>.085</td>
<td>.46</td>
</tr>
<tr>
<td>35 and older</td>
<td>.475</td>
<td>.065</td>
<td>.54</td>
</tr>
<tr>
<td>Total</td>
<td>.850</td>
<td>.150</td>
<td>1.00</td>
</tr>
</tbody>
</table>

b. 46% 18 to 34; 54% 35 and older

33. a.

<table>
<thead>
<tr>
<th>Reason for Applying</th>
<th>Cost/Quality</th>
<th>Convenience</th>
<th>Other</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Full-time</td>
<td>.218</td>
<td>.204</td>
<td>.039</td>
<td>.461</td>
</tr>
<tr>
<td>Part-time</td>
<td>.208</td>
<td>.307</td>
<td>.024</td>
<td>.539</td>
</tr>
<tr>
<td>Total</td>
<td>.426</td>
<td>.511</td>
<td>.063</td>
<td>1.00</td>
</tr>
</tbody>
</table>

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. \(P(\text{quality} \mid \text{full-time}) = \frac{0.218}{0.461} = 0.473\)

d. \(P(\text{quality} \mid \text{part-time}) = \frac{0.208}{0.539} = 0.386\)

e. For independence, we must have \(P(A)P(B) = P(A \cap B)\); from the table
\(P(\text{A} \cap \text{B}) = 0.218, P(\text{A}) = 0.461, P(\text{B}) = 0.426\)
\(P(A)P(B) = (0.461)(0.426) = 0.196\)
Because \(P(A)P(B) \neq P(A \cap B)\), the events are not independent

34. a.

<table>
<thead>
<tr>
<th></th>
<th>On Time</th>
<th>Late</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Southwest</td>
<td>.3336</td>
<td>.0664</td>
<td>.40</td>
</tr>
<tr>
<td>US Airways</td>
<td>.2629</td>
<td>.0871</td>
<td>.35</td>
</tr>
<tr>
<td>JetBlue</td>
<td>.1753</td>
<td>.0747</td>
<td>.25</td>
</tr>
<tr>
<td>Total</td>
<td>.7718</td>
<td>.2282</td>
<td>1.00</td>
</tr>
</tbody>
</table>

b. Southwest Airlines

c. .7718

d. US Airways, Southwest

36. a. .7921

b. .9879

c. .0121

d. .3364,.8236,.764

Don’t foul Reggie Miller
58. a. 

<table>
<thead>
<tr>
<th>Outcome</th>
<th>Values of $x$</th>
</tr>
</thead>
<tbody>
<tr>
<td>$(H, H)$</td>
<td>2</td>
</tr>
<tr>
<td>$(H, T)$</td>
<td>1</td>
</tr>
<tr>
<td>$(T, H)$</td>
<td>1</td>
</tr>
<tr>
<td>$(T, T)$</td>
<td>0</td>
</tr>
</tbody>
</table>

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

60. a. .40
b. .67

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. 

<table>
<thead>
<tr>
<th>Outcome</th>
<th>Values of $x$</th>
</tr>
</thead>
<tbody>
<tr>
<td>$(H, H)$</td>
<td>2</td>
</tr>
<tr>
<td>$(H, T)$</td>
<td>1</td>
</tr>
<tr>
<td>$(T, H)$</td>
<td>1</td>
</tr>
<tr>
<td>$(T, T)$</td>
<td>0</td>
</tr>
</tbody>
</table>

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. $S = \{(Y, Y, Y), (Y, Y, N), (Y, N, Y), (Y, N, N), (Y, Y, Y), (N, Y, N), (N, N, Y), (N, N, N)\}$
   b. Let $N =$ number of offers made; $N$ is a discrete random variable

<table>
<thead>
<tr>
<th>Outcome</th>
<th>Values of $N$</th>
</tr>
</thead>
<tbody>
<tr>
<td>$F (Y, Y, Y)$</td>
<td>3</td>
</tr>
<tr>
<td>$(F, Y, N)$</td>
<td>2</td>
</tr>
<tr>
<td>$(F, N, Y)$</td>
<td>2</td>
</tr>
<tr>
<td>$(F, N, N)$</td>
<td>1</td>
</tr>
<tr>
<td>$Y$</td>
<td>0</td>
</tr>
</tbody>
</table>

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 $f(35) = .40$
Appendix D  Self-Test Solutions and Answers to Even-Numbered Exercises

8. a.

\[
\begin{array}{c|c}
 x & f(x) \\
\hline
 1 & 3/20 = .15 \\
 2 & 5/20 = .25 \\
 3 & 8/20 = .40 \\
 4 & 4/20 = .20 \\
\hline
\text{Total} & 1.00 \\
\end{array}
\]

b. 

\[
\begin{array}{c|c|c|c|c|c|c|c|c|c}
 x & 1 & 2 & 3 & 4 & 5 \\
\hline
 f(x) & .05 & .09 & .03 & .42 & .41 \\
\hline
\end{array}
\]

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

\( \sum f(x) = 1 \)

10. a.

\[
\begin{array}{c|c|c|c|c|c}
 x & 1 & 2 & 3 & 4 & 5 \\
\hline
 f(x) & .04 & .10 & .12 & .46 & .28 \\
\hline
\end{array}
\]

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.

\[
\begin{array}{c|c|c|c}
 y & f(y) & yf(y) \\
\hline
 2 & .20 & .4 \\
 4 & .30 & 1.2 \\
 7 & .40 & 2.8 \\
 8 & .10 & .8 \\
\hline
\text{Totals} & 1.00 & 5.2 \\
\end{array}
\]

\( E(y) = \mu = 5.2 \)

b. 

\[
\begin{array}{c|c|c|c|c|c}
 y & y - \mu & (y - \mu)^2 & f(y) & (y - \mu)^2f(y) \\
\hline
 2 & -3.20 & 10.24 & .20 & 2.048 \\
 4 & -1.20 & 1.44 & .30 & .432 \\
 7 & 1.80 & 3.24 & .40 & 1.296 \\
 8 & 2.80 & 7.84 & .10 & .784 \\
\hline
\text{Total} & & & 4.560 \\
\end{array}
\]

\( \text{Var}(y) = 4.56 \)

\( \sigma = \sqrt{4.56} = 2.14 \)

18. a/b.

\[
\begin{array}{c|c|c|c|c|c|c|c|c|c}
 x & f(x) & xf(x) & x - \mu & (x - \mu)^2 & (x - \mu)^2f(x) \\
\hline
 0 & 0.04 & 0.00 & -1.84 & 3.39 & 0.12 \\
 1 & 0.34 & 0.34 & -0.84 & 0.71 & 0.24 \\
 2 & 0.41 & 0.82 & 0.16 & 0.02 & 0.01 \\
 3 & 0.18 & 0.53 & 1.16 & 1.34 & 0.24 \\
 4 & 0.04 & 0.15 & 2.16 & 4.66 & 0.17 \\
\hline
\text{Total} & 1.00 & 1.84 & 0.79 & & \\
\end{array}
\]

\( \uparrow \)

\( E(x) \)

\( \text{Var}(x) \)

c/d.

\[
\begin{array}{c|c|c|c|c|c|c|c|c|c}
 y & f(y) & yf(y) & y - \mu & (y - \mu)^2 & y - \mu^2f(y) \\
\hline
 0 & 0.00 & 0.00 & -2.93 & 8.58 & 0.01 \\
 1 & 0.03 & 0.03 & -1.93 & 3.72 & 0.12 \\
 2 & 0.23 & 0.46 & -0.93 & 0.86 & 0.20 \\
 3 & 0.52 & 1.55 & 0.07 & 0.01 & 0.00 \\
 4 & 0.22 & 0.90 & 1.07 & 1.15 & 0.26 \\
\hline
\text{Total} & 1.00 & 2.93 & 0.59 & & \\
\end{array}
\]

\( \uparrow \)

\( E(y) \)

\( \text{Var}(y) \)

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. 

\[ S \]

\[ F \]

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

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

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

<table>
<thead>
<tr>
<th>1st part</th>
<th>2nd part</th>
<th>Experimental Outcome</th>
<th>Number Defective</th>
</tr>
</thead>
<tbody>
<tr>
<td>D</td>
<td>D</td>
<td>(D, D)</td>
<td>2</td>
</tr>
<tr>
<td>G</td>
<td>D</td>
<td>(D, G)</td>
<td>1</td>
</tr>
<tr>
<td>D</td>
<td>G</td>
<td>(G, D)</td>
<td>1</td>
</tr>
<tr>
<td>G</td>
<td>G</td>
<td>(G, G)</td>
<td>0</td>
</tr>
</tbody>
</table>

c. Two outcomes result in exactly one defect

d. P(no defects) = (.97)(.97) = .9409
P(1 defect) = 2(.03)(.97) = .0582
P(2 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. \( f(x) = \frac{3xe^{-3}}{x!} \)
b. .2241
c. .1494
d. .8008

39. a. \( f(x) = \frac{2xe^{-2}}{x!} \)

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

42. a. \( f(0) = \frac{7^0e^{-7}}{0!} = e^{-7} = .0009 \)
b. probability = \( 1 - [f(0) + f(1)] \)
f(1) = \( \frac{7^1e^{-7}}{1!} = 7e^{-7} = .0064 \)
probability = \( 1 - [.0009 + .0064] = .9927 \)
c. \( \mu = 3.5 \)
f(0) = \( \frac{3.5^0e^{-3.5}}{0!} = e^{-3.5} = .0302 \)
probability = \( 1 - f(0) = 1 - .0302 = .9698 \)
d. probability = \( 1 - [f(0) + f(1) + f(2) + f(3) + f(4)] \)
= \( 1 - [.0009 + .0064 + .0223 + .0521 + .0912] = .8271 \)

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

46. a. \( f(1) = \frac{3}{10} \frac{10 - 3}{4 - 1} = \frac{(3)(7!)(3!)}{10!(34)!} = \frac{3!(35)(10 - 3)}{210} = .50 \)
b. \( f(2) = \frac{3}{10} \frac{10 - 2}{2 - 2} = \frac{(3)(1)}{45} = .067 \)
c. \[ f(0) = \frac{\binom{3}{0} \binom{10-3}{2}}{\binom{10}{2}} = \frac{(1)(21)}{45} = 0.4667 \]

d. \[ f(2) = \frac{\binom{3}{1} \binom{10-3}{4}}{\binom{10}{4}} = \frac{(3)(21)}{210} = 0.30 \]

50. \( N = 60, n = 10 \)

a. \( r = 20, x = 0 \)

\[ f(0) = \frac{\binom{20}{0} \binom{40}{10}}{\binom{60}{10}} = \frac{(1)(40!)}{10!50!} = \frac{40!}{10!30!} \cdot \frac{10!50!}{60!} = \frac{40!}{10!30!} \cdot \frac{10!50!}{60!} \]

\( = 0.01 \)

b. \( r = 20, x = 1 \)

\[ f(1) = \frac{\binom{20}{1} \binom{40}{9}}{\binom{60}{10}} = \frac{20(40!)}{9!31!} \cdot \frac{10!50!}{60!} \]

\( = 0.07 \)

c. \( 1 - f(0) - f(1) = 1 - 0.08 = 0.92 \)

d. Same as the probability one will be from Hawaii; in part (b) it was equal to approximately 0.07

52. a. \( 0.5333 \)
b. \( 0.6667 \)
c. \( 0.7778 \)
d. \( n = 7 \)

54. a. \( x \quad 1 \quad 2 \quad 3 \quad 4 \quad 5 \)

\[ f(x) \quad 0.24 \quad 0.21 \quad 0.10 \quad 0.21 \quad 0.24 \]

b. \( 3.00, 2.34 \)
c. Bonds: \( E(x) = 1.36, Var(x) = 0.23 \)

Stocks: \( E(x) = 4, Var(x) = 1 \)

56. a. \( 0.0596 \)
b. \( 0.3585 \)
c. \( 100 \)
d. \( 9.75 \)

58. a. \( 0.9510 \)
b. \( 0.0480 \)
c. \( 0.0490 \)

60. a. \( 240 \)
b. \( 12.96 \)
c. \( 12.96 \)

62. \( 0.1912 \)

64. a. \( 0.2240 \)
b. \( 0.5767 \)

66. a. \( 0.4667 \)
b. \( 0.4667 \)
c. \( 0.0667 \)

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. \( P(1.0 \leq x \leq 1.25) = 2(0.25) = 0.50 \)

d. \( P(1.20 < x < 1.5) = 2(0.30) = 0.60 \)

2. b. \( 0.50 \)
c. \( 0.60 \)
d. \( 15 \)
e. \( 8.33 \)

4. a. 

b. \( P(0.25 < x < 0.75) = 1(0.50) = 0.50 \)

c. \( P(x \leq 0.30) = 1(0.30) = 0.30 \)

d. \( P(x > 0.60) = 1(0.40) = 0.40 \)

6. a. \( 0.125 \)
b. \( 0.50 \)
c. \( 0.25 \)

10. a. \( 0.9332 \)
b. \( 0.8413 \)
c. \( 0.0919 \)
d. \( 0.4938 \)

12. a. \( 0.2967 \)
b. \( 0.4418 \)
c. \( 0.3300 \)
d. \( 0.5910 \)
e. \( 0.8849 \)
f. \( 0.2389 \)
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 \( z = -0.80 \)
   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 \( x = 40, z = 1.22 \)
      \( P(z \leq 1.22) = .8888 \)
      \( P(x \geq 40) = 1.000 - .8888 = .1112 \)
   b. At \( x = 20, z = -1.22 \)
      \( P(z \leq -1.22) = .1112 \)
      \( P(x \leq 20) = .1112 \)
   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
38. a. .0228  
   b. $50
40. a. 38.3%  
   b. 3.59% better, 96.41% worse  
   c. 38.21%
42. \( \mu = 19.23 \text{ ounces} \)
44. a. \( \frac{7}{4} \text{ minute} \)  
   b. \( 7e^{-\frac{7}{4}} \)  
   c. .0009  
   d. .2466
46. 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. B and D because the two smallest random numbers are .0476 and .0957
2. Elements 2, 3, 5, and 10
3. The simple random sample consists of New York, Detroit, Oakland, Boston, and Kansas City
4. Step 1. Generate a random number for each company  
   Step 2. Sort with respect to random numbers and select the first three companies
6. a. finite  
   b. process  
   c. process  
   d. finite  
   e. process
7. a. \( \bar{x} = \frac{\sum x_i}{n} = \frac{54}{6} = 9 \)  
   b. \( s = \sqrt{\frac{\sum (x_i - \bar{x})^2}{n-1}} \)  
   \( \sum (x_i - \bar{x})^2 = (-4)^2 + (-1)^2 + 1^2 + (-2)^2 + 1^2 + 5^2 = 48 \)  
   \( s = \sqrt{\frac{48}{6-1}} = 3.1 \)
8. a. .50  
   b. .3667
9. a. \( \bar{x} = \frac{\sum x_i}{n} = \frac{465}{5} = 93 \)  
   b. \begin{tabular}{|c|c|c|} 
   \hline  
   \( x_i \) & \( (x_i - \bar{x}) \) & \( (x_i - \bar{x})^2 \) 
   \hline  
   94 & +1 & 1 
   100 & +7 & 49 
   85 & -8 & 64 
   94 & +1 & 1 
   92 & -1 & 1 
   \hline  
   Totals & 465 & 0 
   \hline 
   \end{tabular}  
   \( s = \sqrt{\frac{\sum (x_i - \bar{x})^2}{n-1}} = \sqrt{\frac{116}{4}} = 5.39 \)
10. a. .45  
    b. .15  
    c. .45
12. a. .10  
    b. 20  
    c. .72
15. a. The sampling distribution is normal with:  
    \( E(\bar{x}) = \mu = 200 \)  
    \( \sigma_{\bar{x}} = \frac{\sigma}{\sqrt{n}} = \frac{50}{\sqrt{100}} = 5 \)  
    For \( +5, (\bar{x} - \mu) = 5, \)  
    \( z = \frac{\bar{x} - \mu}{\sigma_{\bar{x}}} = \frac{5}{5} = 1 \)  
    Area = .8413 - .1587 = .6826  
    b. For \( \pm 10, (\bar{x} - \mu) = 10, \)  
    \( z = \frac{\bar{x} - \mu}{\sigma_{\bar{x}}} = \frac{10}{5} = 2 \)  
    Area = .9772 - .0228 = .9544
16. 3.54, 2.50, 2.04, 1.77  
    \( \sigma_{\bar{x}} \) decreases as \( n \) increases
18. 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
19. a.
Appendix D  Self-Test Solutions and Answers to Even-Numbered Exercises

891

\[ \sigma_s = \frac{\sigma}{\sqrt{n}} = \frac{4000}{\sqrt{60}} = 516.40 \]

At \( \bar{x} = 52.300 \),
\[ z = \frac{52.300 - 51.800}{516.40} = .97 \]
\[ P(\bar{x} \leq 52.300) = P(z \leq .97) = .8430 \]

At \( \bar{x} = 51.300 \),
\[ z = \frac{51.300 - 51.800}{516.40} = -.97 \]
\[ P(\bar{x} < 51.300) = P(z < -.97) = .1660 \]
\[ P(51.300 \leq \bar{x} \leq 52.300) = .8340 - .1660 = .6680 \]

Using Excel:
\( =NORMDIST(52.300,51.800,516.40,TRUE) - NORMDIST(51.300,51.800,516.40,TRUE) = .6671 \)

b. \( \sigma_s = \frac{\sigma}{\sqrt{n}} = \frac{4000}{\sqrt{120}} = 365.15 \)

At \( \bar{x} = 52.300 \),
\[ z = \frac{52.300 - 51.800}{365.15} = 1.37 \]
\[ P(\bar{x} \leq 52.300) = P(z \leq 1.37) = .9147 \]

At \( \bar{x} = 51.300 \),
\[ z = \frac{51.300 - 51.800}{365.15} = -.137 \]
\[ P(\bar{x} < 51.300) = P(z < -.137) = .4085 \]
\[ P(51.300 \leq \bar{x} \leq 52.300) = .9147 - .4085 = .5062 \]

Using Excel:
\( =NORMDIST(52.300,51.800,365.15,TRUE) - NORMDIST(51.300,51.800,365.15,TRUE) = .5062 \)

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

22. a. Using table: .4246, .5284, .6922, .9586
b. Higher probability with a larger sample size

24. a. Normal with \( E(\bar{x}) = 95 \) and \( \sigma_s = 2.56 \)
b. Using table: .7580; using NORMDIST: .7595
c. Using table: .8502; using NORMDIST: .8494
d. Part (c) because of the larger sample size

26. a. \( n/N = .01 \); no
b. 1.29, 1.30; little difference
c. Using table: .8764

28. a. \( E(\bar{p}) = .40 \)
\[ \sigma_p = \sqrt{\frac{p(1-p)}{n}} = \sqrt{\frac{(.40)(.60)}{200}} = .0346 \]
Within \( \pm .03 \) means \( .37 \leq \bar{p} \leq .43 \)
Using table: \( z = \frac{\bar{p} - p}{\sigma_p} = \frac{.03}{.0346} = .87 \)
\[ P(.37 \leq \bar{p} \leq .43) = P(-.87 \leq z \leq .87) \]
\[ = .8078 - .1922 \]
\[ = .6156 \]

Using Excel:
\( =NORMDIST(.43,.40,.0346,TRUE) - NORMDIST(.37,.40,.0346,TRUE) = .6156 \)

b. Using table: \( z = \frac{\bar{p} - p}{\sigma_p} = \frac{.05}{.0346} = 1.44 \)
\[ P(.35 \leq \bar{p} \leq .45) = P(-1.44 \leq z \leq 1.44) \]
\[ = .9251 - .0749 \]
\[ = .8502 \]

Using Excel:
\( =NORMDIST(.45,.40,.0346,TRUE) - NORMDIST(.35,.40,.0346,TRUE) = .8516 \)

30. a. Using table: .6156; using NORMDIST: .6175
b. Using table: .7814; using NORMDIST: .7830
c. Using table: .9488; using NORMDIST: .9490
d. Using table: .9942; using NORMDIST: .9942
e. Higher probability with larger \( n \)

31. a. \[
\begin{align*}
\bar{p} & \sim N \left( \mu, \frac{\sigma^2}{n} \right) \\
\mu & = \frac{np}{n} = p \\
\sigma & = \sqrt{\frac{np(1-p)}{n}} = \sqrt{np(1-p)} \\
\sigma & = \sqrt{np(1-p)} = \sqrt{np(1-p)} \\
\end{align*}
\]

\[ \alpha_p = \sqrt{\frac{p(1-p)}{n}} = \sqrt{\frac{.30(1-.70)}{100}} = .0458 \]

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

b. \( P(\bar{p} \leq .40) = ? \)
\[ z = \frac{.40 - .30}{.0458} = 2.18 \]
\[ P(\bar{p} \leq .40) = P(z \leq 2.18) = .9854 - .0146 = .9708 \]

Using Excel:
\( =NORMDIST(.40,.30,.0458,TRUE) - NORMDIST(20,.30,.0458,TRUE) = .9710 \)

c. \( P(\bar{p} \leq .35) = ? \)
\[ z = \frac{.35 - .30}{.0458} = 1.09 \]
\[ P(\bar{p} \leq .35) = P(z \leq 1.09) = .8621 - .1379 = .7242 \]

Using Excel:
\( =NORMDIST(.35,.30,.0458,TRUE) - NORMDIST(.25,.30,.0458,TRUE) = .7250 \)

32. a. Normal with \( E(\bar{p}) = .66 \) and \( \sigma_p = .0273 \)
b. Using table: .8584; using NORMDIST: .8571
c. Using table: .9606; using NORMDIST: .9608

34. a. Normal with $E(\hat{p}) = .56$ and $\sigma_p = .0248$
   b. Using table: .5820; using NORMDIST: .5800
   c. Using table: .8926; using NORMDIST: .8932

36. a. Normal with $E(\hat{p}) = .76$ and $\sigma_p = .0214$
   b. Using table: .8384; using NORMDIST: .8390
   c. Using table: .9452; using NORMDIST: .9455

38. Thoroughbreds, The Marker, Officers Club, SeaBlue, Crickets

40. a. Normal with $E(\bar{x}) = 115.50$ and $\sigma_p = 5.53$
   b. Using table: .9298; using NORMDIST: .9292
   c. Using table: $z = -2.80$.0026; using NORMDIST: .0025

42. a. 707
   b. .50
   c. Using table: $z = \pm 1.41$, .8414; using NORMDIST: .8428
   d. .9544

44. a. 625
   b. .7888

46. a. Normal with $E(\hat{p}) = .28$ and $\sigma_p = .0290$
   b. Using table: $z = \pm 1.38$, .8324; using NORMDIST: .8322
   c. Using table: $z = \pm .69$, .5098; using NORMDIST: .5096

48. a. Using table: $z = \pm 1.59$, .8882; using NORMDIST: .8900
   b. Using table: $z = \pm 1.99$, .0233; using NORMDIST: .0232

50. a. 48
   b. Normal, $E(\hat{p}) = .25$, $\sigma_p = .0625$
   c. .2119

Chapter 8

2. Use $\bar{x} \pm z_{0.025}(\sigma/\sqrt{n})$
   a. $32 \pm 1.645(6/\sqrt{50})$
      $32 \pm 3.06$ to 33.4
   b. $32 \pm 1.96(6/\sqrt{50})$
      $32 \pm 3.66$ to 33.66
   c. $32 \pm 2.576(6/\sqrt{50})$
      $32 \pm 2.19$ to 34.19

4. 54

5. a. $1.96\sigma/\sqrt{n} = 1.96(5/\sqrt{49}) = 1.40$
   b. $24.80 \pm 1.40$; $23.40$ 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. $\bar{x} = \frac{\sum x_i}{n} = \frac{80}{8} = 10$
    b. $s = \sqrt{\frac{\sum (x_i - \bar{x})^2}{n - 1}} = \sqrt{\frac{36}{7}} = 3.46$
    c. $t_{0.025}(\frac{s}{\sqrt{n}}) = 2.365(\frac{3.46}{\sqrt{8}}) = 2.9$
    d. $\bar{x} \pm t_{0.025}(\frac{s}{\sqrt{n}})$
       $10 \pm 2.9$ (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. $\bar{x} \pm t_{0.025}(s/\sqrt{n})$
    90% confidence: $df = 64$ and $t_{0.05} = 1.669$
    $19.5 \pm 1.669(\frac{5.2}{\sqrt{65}})$
    $19.5 \pm 1.08$ (18.42 to 20.58)
    95% confidence: $df = 64$ and $t_{0.025} = 1.998$
    $19.5 \pm 1.998(\frac{5.2}{\sqrt{65}})$
    $19.5 \pm 1.29$ (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. .8429
    c. 2.96 to 4.64
    d. Larger $n$ next time

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

22. a. 3.348%
    b. 2.40% to 4.29%

24. a. Planning value of $\sigma = \frac{\text{Range}}{4} = \frac{36}{4} = 9$
    b. $n = \frac{z_{0.025}^2\sigma^2}{E^2} = \frac{(1.96)^2(9)^2}{(3)^2} = 34.57$; use $n = 35$
    c. $n = \frac{(1.96)^2(9)^2}{(2)^2} = 77.79$; use $n = 78$
Appendix D  Self-Test Solutions and Answers to Even-Numbered Exercises

25. a. Use \( n = \frac{z_{0.025}^2 \sigma^2}{E^2} \)

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

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

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. \( \hat{p} = \frac{100}{400} = .25 \)

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

c. \( \hat{p} \pm z_{0.025} \sqrt{\frac{\hat{p}(1 - \hat{p})}{n}} \)

\[ .25 \pm 1.96(.0217) \]

\[ .25 \pm .0424; .2076 \text{ to } .2924 \]

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

34. 1068

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

b. \( z_{0.05} \sqrt{\frac{\hat{p}(1 - \hat{p})}{n}} = 1.645 \sqrt{\frac{.4599(1 - .4599)}{611}} = .0332 \)

c. \( \hat{p} \pm .0332 \)

\[ .4599 \pm .0332 (.4267 \text{ to } .4931) \]

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

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

39. a. \( n = \frac{1.96^2\hat{p}^*(1 - \hat{p}^*)}{E^2} \)

\[ n = \frac{1.96^2(.156)(1 - .156)}{.03^2} = 562 \]

b. \( n = \frac{2.576^2(.156)(1 - .156)}{.03^2} = 970.77; \text{ use } n = 971 \)

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. Margin of error is larger when \( \hat{p} \) is closer to \( \frac{1}{2} \)

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. \( H_0: \mu \leq 14 \)
\( H_1: \mu > 14 \)

b. No evidence that the new plan increases sales

c. The research hypothesis \( \mu > 14 \) is supported; the new plan increases sales

4. a. \( H_0: \mu \geq 220 \)
\( H_1: \mu < 220 \)

5. a. Rejecting \( H_0: \mu \leq 56.2 \) when it is true

b. Accepting \( H_0: \mu \leq 56.2 \) when it is false

6. a. \( H_0: \mu \leq 1 \)
\( H_1: \mu > 1 \)

b. Claiming \( \mu > 1 \) when it is not true
c. Claiming \( \mu \leq 1 \) when it is not true

8. a. \( H_0: \mu \geq 220 \)
\( H_1: \mu < 220 \)

b. Claiming \( \mu < 220 \) when it is not true
c. Claiming \( \mu \geq 220 \) 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

Using Excel; \( p\)-value = 1 - NORMSDIST(1.48) = .0694
c. \( p\)-value > .01, do not reject \( H_0 \)
d. Reject \( H_0 \) if \( z \geq 2.33 \)

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 \leq .05, reject \( H_0 \)
d. Reject \( H_0 \) if \( z \leq -1.96 \) or \( z \geq 1.96 \)

\(-2.00 \leq -1.96, \text{ reject } H_0 \)
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. 0.34; do not reject $H_0$
b. .0074; reject $H_0$
c. .0836; do not reject $H_0$
15. a. $H_0: \mu \geq 1056$
   $H_a: \mu < 1056$
b. $z = \frac{\hat{x} - \mu_0}{s/\sqrt{n}} = \frac{910 - 1056}{1600/\sqrt{400}} = -1.83$
   $p\text{-value} = .0336$
c. $p\text{-value} \leq .05$, reject $H_0$; the mean refund of “last-minute” filers is less than $1056$
d. Reject $H_0$ if $z \leq -1.645$ 
16. a. $H_0: \mu \leq 895$
   $H_a: \mu > 895$
b. .1706 
c. Do not reject $H_0$
d. Withhold judgment; collect more data
18. a. $H_0: \mu = 4.1$
   $H_a: \mu \neq 4.1$
b. $-2.21, .0272$ 
c. Reject $H_0$
20. a. $H_0: \mu = 32.79$
   $H_a: \mu < 32.79$
b. $-2.73$ 
c. .0032 
d. Reject $H_0$
22. a. $H_0: \mu = 8$
   $H_a: \mu \neq 8$
b. .1706 
c. Do not reject $H_0$
d. 7.93 to 9.07; yes
24. a. $t = \frac{\hat{x} - \mu_0}{s/\sqrt{n}} = \frac{17 - 18}{4.5/\sqrt{48}} = -1.54$
   Degrees of freedom = $n - 1 = 47$
   Area in lower tail is between .05 and .10 
   $p\text{-value} = TDIST(1.54,47,2) = .1303$
c. $p\text{-value} > .05$; do not reject $H_0$
d. With df = 47, $t_{.025} = 2.012$
   Reject $H_0$ if $t < -2.012$ or $t > 2.012$
   $t = -1.54$; do not reject $H_0$
26. a. Between .02 and .05; using Excel: $p\text{-value} = TDIST(2.10,64,2) = .0397$; reject $H_0$
b. Between .01 and .02; using Excel: $p\text{-value} = TDIST(2.57,64,2) = .0125$; reject $H_0$
c. Between .10 and .20; using Excel: $p\text{-value} = TDIST(1.54,64,2) = .1285$; do not reject $H_0$
28. a. $H_0: \mu \geq 9$
   $H_a: \mu < 9$
b. Between .005 and .01 
   Using Excel: $p\text{-value} = TDIST(2.50,84,1) = .0072$
c. Reject $H_0$
30. a. $H_0: \mu = 600$
   $H_a: \mu \neq 600$
b. Between .20 and .40 
   Using Excel: $p\text{-value} = TDIST(1.17,39,2) = .2491$
c. Do not reject $H_0$
d. A larger sample size
32. a. $H_0: \mu = 10.192$
   $H_a: \mu \neq 10.192$
b. Between .02 and .05 
   Using Excel: $p\text{-value} = TDIST(2.23,49,2) = .0304$
c. Reject $H_0$
34. a. $H_0: \mu = 2$
   $H_a: \mu \neq 2$
b. 2.2 
c. .52 
d. Between .20 and .40 
   Using Excel: $p\text{-value} = TDIST(1.22,99,2) = .2535$
e. Do not reject $H_0$
36. a. $z = \frac{\bar{p} - p_0}{\sqrt{p_0(1 - p_0)/n}} = \frac{.68 - .75}{.75(1 - .75)/300} = -2.80$
   $p\text{-value} = .0026$ 
   $p\text{-value} \leq .05$; reject $H_0$
b. $z = \frac{.72 - .75}{\sqrt{.75(1 - .75)/300}} = -1.20$
   $p\text{-value} = .1151$ 
   $p\text{-value} > .05$; do not reject $H_0$
c. $z = \frac{.70 - .75}{\sqrt{.75(1 - .75)/300}} = -2.00$
   $p\text{-value} = .0228$ 
   $p\text{-value} \leq .05$; reject $H_0$
d. $z = \frac{.77 - .75}{\sqrt{.75(1 - .75)/300}} = .80$
   $p\text{-value} = .7881$ 
   $p\text{-value} > .05$; do not reject $H_0$
38. a. $H_{0:} p = .64$
   $H_{a:} p \neq .64$
   b. $\hat{p} = 52/100 = .52$
   $$z = \frac{\hat{p} - p_0}{\sqrt{p_0(1 - p_0)/n}} = \frac{.52 - .64}{\sqrt{.64(1 - .64)/100}} = -2.50$$
   Area = .4938
   p-value = 2(.0062) = .0124
   c. p-value <= .05; reject $H_0$
   Proportion differs from the reported .64
   d. Yes, because $\hat{p} = .52$ indicates that fewer believe the supermarket brand is as good as the name brand
40. a. $\chi^2_0 = .2702$
   b. $H_{0:} \hat{x} \leq .22$
   $H_{a:} \hat{x} > .22$
   $p$-value = 0; reject $H_0$
   c. Helps evaluate the effectiveness of commercials
42. a. $\bar{p} = .15$
   b. .0718 to .2218
   c. Houston proportion is different
44. a. $H_{0:} \mu = 1.6$
   $H_{a:} \mu \neq 1.6$
   b. $p$-value = 1 - NORMSDIST(2.80) = .0026
   c. reject $H_0$
46. a. $H_{0:} \mu = 16$
   $H_{a:} \mu > 16$
   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. $H_{0:} \mu = 119,155$
   $H_{a:} \mu > 119,155$
   b. .0047
   c. Reject $H_0$
50. $t = -93$
   p-value between .20 and .40
   Using Excel: p-value = TDIST(.93,31,2) = .3596
   Do not reject $H_0$
52. $t = 2.26$
   p-value between .01 and .025
   Using Excel: p-value = TDIST(2.26,31,1) = .0155
   Reject $H_0$
54. a. $H_{0:} \mu \leq 50$
   $H_{a:} \mu > 50$
   b. .64
   c. .0026; reject $H_0$
56. a. $H_{0:} \mu \leq .80$
   $H_{a:} \mu > .80$
   b. .84
   c. .0418; 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. $z_{0.05} = 1.645$
   $$\bar{x}_1 - \bar{x}_2 \pm 1.645 \sqrt{\frac{(2.2)^2}{50} + \frac{(3)^2}{35}}$$
   $2 \pm 1.645(\frac{22.8}{50} + \frac{9}{35})$
   $2 \pm .98$ (1.02 to 2.98)
   c. $z_{0.05} = 1.96$
   $$\bar{x}_1 - \bar{x}_2 \pm 1.96 \sqrt{\frac{(2.2)^2}{50} + \frac{(3)^2}{35}}$$
   $2 \pm 1.96(\frac{22.8}{50} + \frac{9}{35})$
   $2 \pm 1.17$ (.83 to 3.17)
2. a. $$z = (\bar{x}_1 - \bar{x}_2) - D_0 = (25.2 - 22.8) - 0 = 2.03$$
   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. $z_{0.05} \sqrt{\frac{(10)^2}{40} + \frac{(0.8)^2}{35}} = .04$
   c. .32 <= .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. $df = \frac{1}{s_1^2/n_1 + s_2^2/n_2} = \frac{1}{s_1^2/n_1 + s_2^2/n_2}$
   $$= \frac{1}{\frac{2.5^2}{20} + \frac{4.8^2}{30}} = 45.8$$
   c. df = 45, $t_{0.05} = 2.014$
   $$t_{0.05} \sqrt{s_1^2/n_1 + s_2^2/n_2} = 2.014 \sqrt{\frac{2.5^2}{20} + \frac{4.8^2}{30}} = 2.1$$
   d. 2.4 ± 2.1 (3 to 4.5)
10. a. $$t = \frac{(\bar{x}_1 - \bar{x}_2) - 0}{\sqrt{\frac{s_1^2}{n_1} + \frac{s_2^2}{n_2}}} = \frac{(13.6 - 10.1) - 0}{\sqrt{\frac{5.2^2}{35} + \frac{8.5^2}{40}}} = 2.18$$
Appendix D  Self-Test Solutions and Answers to Even-Numbered Exercises

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

\[ = \frac{1}{34} \left( \frac{5.2^2}{35} + \frac{8.5^2}{40} \right)^2 = 65.7 \]

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. \( \bar{x}_1 - \bar{x}_2 = 22.5 - 18.6 = 3.9 \) miles

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

\[ = \frac{1}{49} \left( \frac{8.4^2}{50} + \frac{7.4^2}{40} \right)^2 = 87.1 \]

Use \( df = 87, t_{0.025} = 1.988 \)

\[ 3.9 = 1.988 \sqrt{\frac{8.4^2}{50} + \frac{7.4^2}{40}} \]

\[ 3.9 = 3.3 ( .6 \ to \ 7.2 ) \]

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 \( H_0; \) conclude 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. \( d = 2 \bar{d}/n = 5/5 = 1 \)

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

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. \( H_0: \mu_d \leq 0 \)

\( H_a: \mu_d > 0 \)

\( d = .625 \)

\( s_d = 1.30 \)

\( t = \frac{\bar{d} - \mu_d}{s_d/\sqrt{n}} = \frac{.625 - 0}{.30} = 1.36 \)

\( df = n - 1 = 7 \)

Using \( t \) table, \( p \)-value is between .10 and .20

Exact \( p \)-value = .1080

\( p \)-value > .05; do not reject \( H_0 \)

22. \$1.10 to \$3.32

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

28. a. \( \bar{p}_1 - \bar{p}_2 = .48 - .36 = .12 \)

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

\[ = .12 \pm 1.645 \sqrt{\frac{.48(1 - .48)}{400} + \frac{.36(1 - .36)}{300}} = .12 \pm .0614 (.0586 \ to \ .1814) \]

c. \( .12 = 1.96 \sqrt{\frac{.48(1 - .48)}{400} + \frac{.36(1 - .36)}{300}} = .12 \pm .0731 (.0469 \ to .1931) \)

29. a. \( \tilde{p} = \frac{n_1\bar{p}_1 + n_2\bar{p}_2}{n_1 + n_2} = \frac{100(.28) + 140(.20)}{100 + 140} = .2333 \)

b. \( z = \frac{\bar{p}_1 - \bar{p}_2}{\sqrt{\bar{p}(1 - \bar{p})(\frac{1}{n_1} + \frac{1}{n_2})}} \)

\[ = \frac{.28 - .20}{\sqrt{.2333(1 - .2333)(\frac{1}{100} + \frac{1}{140})}} = 1.44 \]

\( p \)-value = 2(.1 - .9251) = .1498
c. p-value > .05; do not reject $H_0$. We cannot conclude that the two population proportions differ.

30. a. Professional Golfers: $\hat{p}_1 = 688/1075 = .64$
Amateur Golfers: $\hat{p}_2 = 696/1200 = .58$
Professional golfers have the better putting accuracy.
b. $\hat{p}_1 - \hat{p}_2 = .64 - .58 = .06$
Professional golfers make 6% more 6-foot putts than the very best amateur golfers.
c. $\hat{p}_1 - \hat{p}_2 \pm z_{.025} \sqrt{\frac{\hat{p}_1(1 - \hat{p}_1)}{n_1} + \frac{\hat{p}_2(1 - \hat{p}_2)}{n_2}}$
$.64 - .58 \pm 1.96 \sqrt{\frac{.64(1 - .64)}{1075} + \frac{.58(1 - .58)}{1200}}$
$.06 \pm .04 (.02 to .10)$
The confidence interval shows that professional golfers make from 2% to 10% more 6-foot putts than the best amateur golfers.

32. a. $H_0: p_w \leq p_m$
$H_1: p_w > p_m$
b. $\hat{p}_w = .5699$
c. $\hat{p}_m = .5400$
d. p-value = .1093
Do not reject $H_0$

34. a. $H_0: p_1 - p_2 = 0$
$H_1: p_1 - p_2 \neq 0$
b. .28
c. .26
d. .3078, do not reject

36. a. $H_0: p_1 - p_2 = 0$
$H_1: p_1 - p_2 \neq 0$
b. .13
c. p-value = .0404

38. a. 412
b. 267.79
c. 412 ± 267.79

40. a. $H_0: \mu_1 - \mu_2 \leq 0$
$H_1: \mu_1 - \mu_2 > 0$
b. $t = .60, df = 57$
Using t-table, p-value is greater than .20
Exact p-value = .2754
Do not reject $H_0$

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

44. a. p-value = 0, reject $H_0$
b. .0468 to .1332

d. 163.66
b. .0804 to .2196
c. Yes

Chapter 11

2. $s^2 = 25$
   a. With 19 degrees of freedom, $\chi^2_{.05} = 30.144$ and $\chi^2_{.05} = 10.117$
   $19(25) \leq \sigma^2 \leq 19(25)$
   $30.144 \leq \sigma^2 \leq 10.117$
   $15.76 \leq \sigma^2 \leq 46.95$
   b. With 19 degrees of freedom, $\chi^2_{.05} = 32.852$ and $\chi^2_{.05} = 8.907$
   $19(25) \leq \sigma^2 \leq 19(25)$
   $32.852 \leq \sigma^2 \leq 8.907$
   c. $3.8 \leq \sigma \leq 7.3$

4. a. .22 to .71
   b. .47 to .84

6. a. .2205, .4795, .692
   b. 5.27 to 10.11

8. a. .00845
   b. .092
   c. .0042 to .0244
   .065 to .156

9. $H_0: \sigma^2 \leq .0004$
$H_1: \sigma^2 > .0004$
$\chi^2 = (n - 1)\sigma^2 = (30 - 1)(.0005) = 36.25$
From table with 29 degrees of freedom, p-value is greater than .10
p-value > .05; do not reject $H_0$
The product specification does not appear to be violated

10. $H_0: \sigma^2 \leq 331.24$
$H_1: \sigma^2 > 331.24$
$\chi^2 = 52.07, df = 35$
p-value between .025 and .05
Reject $H_0$

12. a. .8106
   b. $\chi^2 = 9.49$
p-value greater than .20
Do not reject $H_0$

14. a. $F = 2.4$
p-value between .025 and .05
Reject $H_0$
b. $F_{.05} = 2.2$; reject $H_0$

15. a. Larger sample variance is $s_1^2$
$F = \frac{s_1^2}{s_2^2} = \frac{8.2}{4} = 2.05$
Degrees of freedom: 20, 25
From table, area in tail is between .025 and .05
p-value for two-tailed test is between .05 and .10
p-value > .05; do not reject $H_0$
b. For a two-tailed test:
\[ F_{0.05} = F_{0.025} = 2.30 \]
Reject \( H_0 \) if \( F \geq 2.30 \). Do not reject \( H_0 \)

16. \( F = 2.63 \)
p-value less than .01
Reject \( H_0 \)

17. a. Population 1 is 4-year-old automobiles
\[ H_0: \sigma_1^2 = \sigma_2^2 \]
\[ H_A: \sigma_1^2 > \sigma_2^2 \]
\[ b. \ F = \frac{s_1^2}{s_2^2} = \frac{170^2}{100} = 2.89 \]
Degrees of freedom: 25, 24
From tables, \( p \)-value is less than .01
\( p \)-value \( < .01 \); reject \( H_0 \)
Conclude that 4-year-old automobiles have a larger variance in annual repair costs compared to 2-year-old automobiles, which is expected because older automobiles are more likely to have more expensive repairs that lead to greater variance in the annual repair costs

18. \( F = 3.54 \)
p-value between .10 and .20
Do not reject \( H_0 \)

20. \( F = 5.29 \)
p-value = 0
Reject \( H_0 \)

22. a. \( F = 4 \)
p-value less than .01
Reject \( H_0 \)

24. 10.72 to 24.68

26. a. \( \chi^2 = 27.44 \)
p-value between .01 and .025
Reject \( H_0 \)
\( b. \ .00012 \) to .00042

28. \( \chi^2 = 31.50 \)
p-value between .05 and .10
Reject \( H_0 \)

30. a. \( n = 15 \)
b. 6.25 to 11.13

32. \( F = 1.39 \)
Do not reject \( H_0 \)

34. \( F = 2.08 \)
p-value between .05 and .10
Reject \( H_0 \)

**Chapter 12**

1. 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 \( < .01 \); reject \( H_0 \)

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

3. \( H_0: p_{ABC} = .29, p_{CBS} = .28, p_{NBC} = .25, p_{PBS} = .18 \)
\( H_A: \) The proportions are not equal
\( \chi^2 = 28.5, 39.9, 45.6 \)

4. \( \chi^2 = 29.51, df = 5 \)
p-value is less than .005
Reject \( H_0 \)

6. 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
\( c. \ 51\% \)

8. \( \chi^2 = 16.31, df = 3 \)
p-value less than .005
Reject \( H_0 \)

9. \( H_0: \) The column variable is independent of the row variable
\( H_A: \) The column variable is not independent of the row variable

**Expected frequencies:**

<table>
<thead>
<tr>
<th></th>
<th>A</th>
<th>B</th>
<th>C</th>
</tr>
</thead>
<tbody>
<tr>
<td>P</td>
<td>28.5</td>
<td>39.9</td>
<td>45.6</td>
</tr>
<tr>
<td>Q</td>
<td>21.5</td>
<td>30.1</td>
<td>34.4</td>
</tr>
</tbody>
</table>
Appendix D  Self-Test Solutions and Answers to Even-Numbered Exercises  899

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

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

10. \(\chi^2 = 19.77, df = 4\)
\[ p\text{-value less than } .005 \]
Reject \( H_0 \)

11. \(H_0: \) Type of ticket purchased is independent of the type of flight
\(H_0: \) Type of ticket purchased is not independent of the type of flight

Expected frequencies:
\[ e_{11} = 35.59 \]
\[ e_{12} = 15.41 \]
\[ e_{21} = 150.73 \]
\[ e_{22} = 65.27 \]
\[ e_{31} = 455.68 \]
\[ e_{32} = 197.32 \]

<table>
<thead>
<tr>
<th>Ticket</th>
<th>First Domestic</th>
<th>First International</th>
<th>Business Domestic</th>
<th>Business International</th>
<th>Full-fare Domestic</th>
<th>Full-fare International</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flight</td>
<td>Frequency</td>
<td>Expected Frequency</td>
<td>((f_i - e_i)^2/e_i )</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>First</td>
<td>29</td>
<td>35.59</td>
<td>1.22</td>
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<td></td>
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<tr>
<td>Domestic</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>First</td>
<td>22</td>
<td>15.41</td>
<td>2.82</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>International</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>Business</td>
<td>95</td>
<td>150.73</td>
<td>20.61</td>
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<tr>
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<td></td>
<td></td>
</tr>
<tr>
<td>Business</td>
<td>121</td>
<td>65.27</td>
<td>47.59</td>
<td></td>
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<td></td>
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<tr>
<td>International</td>
<td>518</td>
<td>455.68</td>
<td>8.52</td>
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<tr>
<td>Full-fare</td>
<td>135</td>
<td>197.32</td>
<td>19.68</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Domestic</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Full-fare</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Totals</td>
<td>920</td>
<td></td>
<td>100.43</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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

12. a. \( \chi^2 = 7.95, df = 3 \)
\[ p\text{-value is between } .025 \text{ and } .05 \]
Reject \( H_0 \)
b. 18 to 24 use most

14. a. \( \chi^2 = 10.60, df = 4 \)
\[ p\text{-value is between } .025 \text{ and } .05 \]
Reject \( H_0 \)
b. Higher negative effect on grades as hours increase

16. a. \( \chi^2 = 7.85, df = 3 \)
\[ p\text{-value is between } .025 \text{ and } .05 \]
Reject \( H_0 \)
b. Pharmaceutical, 98.6%

18. \( \chi^2 = 3.01, df = 2 \)
\[ p\text{-value is greater than } .10 \]
Do not reject \( H_0 \)

20. First estimate \( \mu \) from the sample data (sample size = 120)
\[ \mu = \frac{0(39) + 1(30) + 2(30) + 3(18) + 4(3)}{120} \]
\[ = \frac{156}{120} = 1.3 \]

Therefore, we use Poisson probabilities with \( \mu = 1.3 \) to compute expected frequencies

\[ \chi^2 = \frac{(6.30)^2}{32.70} + \frac{(-12.51)^2}{42.51} + \frac{(2.37)^2}{27.63} + \frac{(6.02)^2}{11.98} + \frac{(-2.17)^2}{5.16} = 9.04 \]

Degrees of freedom: \(5 - 1 - 1 = 3\)
\[ \chi^2 = 9.04, p\text{-value is between } .025 \text{ and } .05 \]
Reject \( H_0 \); not a Poisson distribution

21. With \( n = 30 \) we will use six classes with .1667 of the probability associated with each class
\[ x = 22.8, s = 6.27 \]
The \( z \) values that create 6 intervals, each with probability .1667 are \(-.98, -.43, 0, .43, .98\)

<table>
<thead>
<tr>
<th>Cutoff Value of ( x )</th>
</tr>
</thead>
<tbody>
<tr>
<td>-.98</td>
</tr>
<tr>
<td>-.43</td>
</tr>
<tr>
<td>0</td>
</tr>
<tr>
<td>.43</td>
</tr>
<tr>
<td>.98</td>
</tr>
</tbody>
</table>

Therefore, we use Poisson probabilities with \( \mu = 1.3 \) to compute expected frequencies

\[ \chi^2 = \frac{(6.30)^2}{32.70} + \frac{(-12.51)^2}{42.51} + \frac{(2.37)^2}{27.63} + \frac{(6.02)^2}{11.98} + \frac{(-2.17)^2}{5.16} = 9.04 \]

Degrees of freedom: \(5 - 1 - 1 = 3\)
\[ \chi^2 = 9.04, p\text{-value is between } .025 \text{ and } .05 \]
Reject \( H_0 \)

Assumption of a normal distribution is not rejected

22. \( \chi^2 = 4.30, df = 2 \)
\[ p\text{-value greater than } .10 \]
Do not reject \( H_0 \)

24. \( \chi^2 = 2.8, df = 3 \)
\[ p\text{-value greater than } .10 \]
Do not reject \( H_0 \)
26. $\chi^2 = 8.04$, $df = 3$
   p-value between .025 and .05
   Reject $H_0$
   
28. $\chi^2 = 4.64$, $df = 2$
   p-value between .05 and .10
   Do not reject $H_0$
   
30. $\chi^2 = 42.53$, $df = 4$
   p-value is less than .005
   Reject $H_0$
   
32. $\chi^2 = 23.37$, $df = 3$
   p-value is less than .005
   Reject $H_0$
   
34. a. $\chi^2 = 12.86$, $df = 2$
   p-value is less than .005
   Reject $H_0$
   
36. $\chi^2 = 6.17$, $df = 6$
   p-value is greater than .10
   Do not reject $H_0$
   
38. $\chi^2 = 7.75$, $df = 3$
   p-value is between .05 and .10
   Do not reject $H_0$

Chapter 13

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

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

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

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

   $SSE = \sum_{j=1}^{k} (n_j - 1)s_j^2$

   $\quad = 5(164.4) + 5(131.2) + 5(110.4)$

   $\quad = 2030$

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

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

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

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

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

2. 

<table>
<thead>
<tr>
<th>Source of Variation</th>
<th>Sum of Squares</th>
<th>Degrees of Freedom</th>
<th>Mean Square</th>
<th>$F$</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Treatments</td>
<td>300</td>
<td>4</td>
<td>75</td>
<td>14.07</td>
<td>.0000</td>
</tr>
<tr>
<td>Error</td>
<td>160</td>
<td>30</td>
<td>5.33</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>460</td>
<td>34</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

4. 

<table>
<thead>
<tr>
<th>Source of Variation</th>
<th>Sum of Squares</th>
<th>Degrees of Freedom</th>
<th>Mean Square</th>
<th>$F$</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Treatments</td>
<td>150</td>
<td>2</td>
<td>75</td>
<td>4.80</td>
<td>.0233</td>
</tr>
<tr>
<td>Error</td>
<td>250</td>
<td>16</td>
<td>15.63</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>400</td>
<td>18</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Using Excel, the p-value corresponding to $F = 4.80$ is .0233

Because $p$-value $\leq \alpha = .05$, we do not reject the null hypothesis that the means of the three treatments are equal.

6. Because $p$-value $\approx 0.0082$ is less than $\alpha = .05$, we reject the null hypothesis that the means of the three treatments are equal.

8. \[ \bar{x} = (79 + 74 + 66)/3 = 73 \]

\[ SSTR = \sum_{j=1}^{k} n_j (\bar{x}_j - \bar{x})^2 = 6(79 - 73)^2 + 6(74 - 73)^2 + 6(66 - 73)^2 = 744 \]

\[ MSTR = \frac{SSTR}{k-1} = \frac{516}{2} = 258 \]

\[ s_1^2 = 34, s_2^2 = 20, s_3^2 = 32 \]

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

\[ MSE = \frac{SSE}{n_r - k} = \frac{430}{18 - 3} = 28.67 \]

\[ F = \frac{MSTR}{MSE} = \frac{258}{28.67} = 9.00 \]

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

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

Because $p$-value $\leq \alpha = .05$, 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.
10. p-value = .0000
Because p-value ≤ α = .05, we reject the null hypothesis that the means for the three groups are equal

12. p-value = .0003
Because p-value ≤ α = .05, we reject the null hypothesis that the mean miles per gallon ratings are the same for the three automobiles

13. a. \( \bar{x} = (30 + 45 + 36)/3 = 37 \)
\[
SSTR = \sum_{j=1}^{k} n_j (\bar{x}_j - \bar{x})^2 = 5(30 - 37)^2 + 5(45 - 37)^2 + 5(36 - 37)^2 = 570
\]
\[
MSTR = \frac{SSTR}{k - 1} = \frac{570}{2} = 285
\]
\[
SSE = \sum_{j=1}^{k} (n_j - 1)s_j^2 = 4(6) + 4(4) + 4(6.5) = 66
\]
\[
MSE = \frac{SSE}{n_T - k} = \frac{66}{15 - 3} = 5.5
\]
\[
F = \frac{MSTR}{MSE} = \frac{285}{5.5} = 51.82
\]
Using F table (2 numerator degrees of freedom and 12 denominator), p-value is less than .01
Using Excel, the p-value corresponding to \( F = 51.82 \) is .0000
Because p-value ≤ α = .05, we reject the null hypothesis that the means of the three populations are equal

b. LSD = \( t_{0.025} \sqrt{\frac{MSE}{n_1}} \)
\[
= t_{0.025} \sqrt{\frac{5.5}{3}} = \frac{2.179 \times 2.2}{3} = 3.23
\]
\[
| \bar{x}_1 - \bar{x}_2 | = | 30 - 45 | = 15 > LSD; significant difference
\]
\[
| \bar{x}_1 - \bar{x}_3 | = | 30 - 36 | = 6 > LSD; significant difference
\]
\[
| \bar{x}_2 - \bar{x}_3 | = | 45 - 36 | = 9 > LSD; significant difference
\]
c. \( \bar{x}_1 - \bar{x}_2 ± \text{LSD} \)
\[
7 - 3.23 = 3.77
\]
\[
8 - 3.23 = 4.77
\]
\[
10.67 - 3.23 = 7.44
\]
14. a. Significant; p-value = .0106
b. LSD = 15.34
1 and 2; significant
1 and 3; not significant
2 and 3; significant

15. a.

<table>
<thead>
<tr>
<th>Manufacturer</th>
<th>Manufacturer</th>
<th>Manufacturer</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Sample Mean</td>
<td>23</td>
<td>28</td>
</tr>
<tr>
<td>Sample Variance</td>
<td>6.67</td>
<td>4.67</td>
</tr>
</tbody>
</table>

\[
\bar{x} = (23 + 28 + 21)/3 = 24
\]
\[
SSTR = \sum_{j=1}^{k} n_j (\bar{x}_j - \bar{x})^2
\]
\[
= 4(23 - 24)^2 + 4(28 - 24)^2 + 4(21 - 24)^2
\]
\[
= 104
\]
\[
MSTR = \frac{SSTR}{k - 1} = \frac{104}{2} = 52
\]
\[
SSE = \sum_{j=1}^{k} (n_j - 1)S_j^2
\]
\[
= 3(6.67) + 3(4.67) + 3(3.33) = 44.01
\]
\[
MSE = \frac{SSE}{n_T - k} = \frac{44.01}{12 - 3} = 4.89
\]
\[
F = \frac{MSTR}{MSE} = \frac{52}{4.89} = 10.63
\]
Using F table (2 numerator degrees of freedom and 9 denominator), p-value is less than .01
Using Excel, the p-value corresponding to \( F = 10.63 \) is .0043
Because p-value ≤ α = .05, we reject the null hypothesis that the mean time needed to mix a batch of material is the same for each manufacturer

b. LSD = \( t_{0.025} \sqrt{\frac{MSE}{n_1}} \)
\[
= t_{0.025} \sqrt{\frac{4.89(1/3 + 1/3)}{4}}
\]
\[
= 2.262 \sqrt{2.25} = 3.54
\]
Since \( | \bar{x}_1 - \bar{x}_2 | = | 23 - 21 | = 2 < 3.54 \), there does not appear to be any significant difference between the means for manufacturer 1 and manufacturer 3

16. \( \bar{x}_1 \pm \text{LSD} \)
23 ± 28 ± 3.54
\[
-5 ± 3.54 = -8.54 \text{ to } -1.46
\]
18. a. Significant; p-value = .0000
b. Significant; 2.3 > LSD = 1.19
20. a. Significant; p-value = .0419
b. LSD = 5.74; significant difference between small and large

21. Treatment Means
\[
\bar{x}_1 = 13.6, \quad \bar{x}_2 = 11.0, \quad \bar{x}_3 = 10.6
\]
Block Means
\[
\bar{x}_v = 9, \quad \bar{x}_v = 7.67, \quad \bar{x}_v = 15.67, \quad \bar{x}_v = 18.67, \quad \bar{x}_v = 7.67
\]
Overall Mean
\[
\bar{x} = 176/15 = 11.73
\]
Step 1
\[
\text{SST} = \sum_{j=1}^{k} \sum_{i=1}^{n_j} (x_{ij} - \bar{x})^2
\]
\[
= (10 - 11.73)^2 + (9 - 11.73)^2 + \cdots + (8 - 11.73)^2
\]
\[
= 354.93
\]
Step 2
\[ \text{SSTR} = b \sum_j \sum_i (\bar{x}_{ij} - \bar{\bar{x}})^2 \]
\[ = 5[(13.6 - 11.73)^2 + (11.0 - 11.73)^2 + (10.6 - 11.73)^2] = 26.53 \]

Step 3
\[ \text{SSBL} = k \sum_i \sum_j (\bar{x}_{ij} - \bar{\bar{x}})^2 \]
\[ = 3[(9 - 11.73)^2 + (7.67 - 11.73)^2 + (15.67 - 11.73)^2 + (18.67 - 11.73)^2 + (7.67 - 11.73)^2] = 312.32 \]

Step 4
\[ \text{SSE} = \text{SST} - \text{SSTR} - \text{SSBL} \]
\[ = 354.93 - 26.53 - 312.32 = 16.08 \]

<table>
<thead>
<tr>
<th>Source of Variation</th>
<th>Sum of Squares</th>
<th>Degrees of Freedom</th>
<th>Mean Square</th>
<th>F</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Treatments</td>
<td>26.53</td>
<td>2</td>
<td>13.27</td>
<td>6.60</td>
<td>.0203</td>
</tr>
<tr>
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<td>354.93</td>
<td>14</td>
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</table>

From the F table (2 numerator degrees of freedom and 8 denominator), p-value is between .01 and .025
Actual p-value = .0203
Because p-value ≤ α = .05, we reject the null hypothesis that the means of the three treatments are equal

Step 3
\[ \text{SSB} = ar \sum_i (\bar{x}_{ij} - \bar{\bar{x}})^2 \]
\[ = 2(2)[(130 - 111)^2 + (97 - 111)^2 + (106 - 111)^2] = 2328 \]

Step 4
\[ \text{SSAB} = r \sum_j \sum_i (\bar{x}_{ij} - \bar{x}_i - \bar{x}_j + \bar{\bar{x}})^2 \]
\[ = 2[(150 - 104 - 130 + 111)^2 + (78 - 104 - 97 + 111)^2 + \cdots + (128 - 118 - 106 + 111)^2] = 4392 \]

Step 5
\[ \text{SSE} = \text{SST} - \text{SSA} - \text{SSB} - \text{SSAB} \]
\[ = 9028 - 588 - 2328 - 4392 = 1720 \]

<table>
<thead>
<tr>
<th>Source of Variation</th>
<th>Sum of Squares</th>
<th>Degrees of Freedom</th>
<th>Mean Square</th>
<th>F</th>
<th>p-value</th>
</tr>
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<tbody>
<tr>
<td>Factor A</td>
<td>588</td>
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<td>Factor B</td>
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<td>2</td>
<td>1164</td>
<td>4.06</td>
<td>.0767</td>
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<tr>
<td>Interaction</td>
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<td>2196</td>
<td>7.66</td>
<td>.0223</td>
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<tr>
<td>Error</td>
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<td>6</td>
<td>286.67</td>
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<tr>
<td>Total</td>
<td>9028</td>
<td>11</td>
<td></td>
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<td></td>
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</tbody>
</table>

Factor A: F = 2.05
Using F table (1 numerator degree of freedom and 6 denominator), p-value is greater than .10
Using Excel, the p-value corresponding to F = 2.05 is .2022
Because p-value > α = .05, Factor A is not significant
Factor B: F = 4.06
Using F table (2 numerator degrees of freedom and 6 denominator), p-value is between .05 and .10
Using Excel, the p-value corresponding to F = 4.06 is .0767
Because p-value > α = .05, Factor B is not significant
Interaction: F = 7.66
Using F table (2 numerator degrees of freedom and 6 denominator), p-value is between .01 and .025
Using Excel, the p-value corresponding to F = 7.66 is .0223
Because p-value ≤ α = .05, interaction is significant

Step 6
\[ \text{SST} = \sum_{i,j} \sum_{k,i,j} (x_{ijk} - \bar{x})^2 \]
\[ = (135 - 111)^2 + (165 - 111)^2 + \cdots + (136 - 111)^2 = 9028 \]

<table>
<thead>
<tr>
<th>Source of Variation</th>
<th>Sum of Squares</th>
<th>Degrees of Freedom</th>
<th>Mean Square</th>
<th>F</th>
<th>p-value</th>
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</table>

Significant; p-value ≤ α = .05

p-value = .0453
Because p-value ≤ α = .05, we reject the null hypothesis that the mean tune-up times are the same for both analyzers

26. Significant; p-value = .0000

28. Step 1
\[ \text{SST} = \sum_{i,j} \sum_{k} (x_{ijk} - \bar{x})^2 \]
\[ = (135 - 111)^2 + (165 - 111)^2 + \cdots + (136 - 111)^2 = 9028 \]

Step 2
\[ \text{SSA} = br \sum_j (\bar{x}_j - \bar{\bar{x}})^2 \]
\[ = 3(2)[(104 - 111)^2 + (118 - 111)^2] = 588 \]

30. Design: p-value = .0104; significant
Size: p-value = .1340; not significant
Interaction: p-value = .2519; not significant

32. Gender: p-value = .0001; significant
Occupation: p-value = .0001; significant
Interaction: p-value = .0106; significant

34. Significant; p-value = .0134
36. Significant; p-value = .0459
38. Not significant; p-value = .2455
40. a. Significant; p-value = .0175
42. Significant; p-value = .0037
44. Type of machine (p-value = .0226) is significant; type of loading system (p-value = .7913) and interaction (p-value = .0671) are not significant

Chapter 14

1. a. $y$ vs $x$

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:

\[
\bar{x} = \frac{\sum x_i}{n} = 15, \quad \bar{y} = \frac{\sum y_i}{n} = 40, \\
\sum(x_i - \bar{x})(y_i - \bar{y}) = 26, \quad \sum(x_i - \bar{x})^2 = 10 \\
b_1 = \frac{\sum(x_i - \bar{x})(y_i - \bar{y})}{\sum(x_i - \bar{x})^2} = \frac{26}{10} = 2.6 \\
b_0 = \bar{y} - b_1\bar{x} = 8 - (2.6)(3) = 0.2 \\
\hat{y} = 0.2 + 2.6x
\]
e. $\hat{y} = 0.2 + 2.6x = 0.2 + 2.6(4) = 10.6$

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

e. $\hat{y} = 68 - 3x$

4. a. $y$ vs $x$

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 that company ($y$)

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:

\[
x_i, y_i, \hat{y}_i, y_i - \hat{y}_i, (x_i - \hat{y}_i)^2, y_i - \hat{y}_i, (y_i - \hat{y}_i)^2 \\
1, 3, 2, 5, 25, 1, 7, 1.6, 53, 16, 9, 10.5, 13.2, 6, 36 \\
SSE = 12.40 \quad SST = 80 \\
SSE = SST - SSE = 80 - 12.4 = 67.6 \\
b. $r^2 = \frac{SSR}{SST} = \frac{67.6}{80} = .845$
\]
The least squares line provided a good fit; 84.5% of the variability in $y$ has been explained by the least squares line.

c. $r_w = \sqrt{.845} = .9192$

16. a. $SSE = 230$, $SST = 1850$, $SSR = 1620$

b. $r^2 = .876$

c. $r_w = -.936$

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:

\[
SSE = \sum(y_i - \hat{y}_i)^2 = 85,135.14 \\
SST = \sum(y_i - \hat{y}_i)^2 = 335,000 \\
\]
Thus, $SSR = SST - SSE = 335,000 - 85,135.14 = 249,864.86$
26. a. $r^2 = \frac{SSR}{SST} = \frac{249,864.86}{335,000} = .746$
   The least squares line accounted for 74.6% of the total sum of squares
c. $r_{xy} = \sqrt{.746} = .8637$
20. a. $\hat{y} = 12.0169 + .0127 x$
b. $r^2 = .4503$
c. 53
22. a. $\hat{y} = -745.480627 + 117.917320 x$
b. $r^2 = .7071$
c. $r_{xy} = \sqrt{.7071} = .84$
23. a. $s^2 = \frac{SSE}{n - 2} = \frac{12.4}{3} = 4.133$
b. $s = \sqrt{MSE} = \sqrt{4.133} = 2.033$
c. $\Sigma(x_i - \bar{x})^2 = 10$
d. $s_{xy} = \frac{s}{\sqrt{\Sigma(x_i - \bar{x})^2}} = \frac{2.033}{\sqrt{10}} = .643$
   c. $b = \frac{12.4}{3} = 4.133$  d. $t = \frac{b - \beta_1}{s_{xy}} = \frac{2.6 - 0}{.643} = 4.04$
   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, the $p$-value corresponding to $t = 4.04$ is .0272
   Because $p$-value ≤ $\alpha$, we reject $H_0: \beta_1 = 0$
c. $MSR = \frac{SSR}{1} = 67.6$
   $F = \frac{MSR}{MSE} = \frac{67.6}{4.133} = 16.36$
   From the $F$ table (1 numerator degree of freedom and 3 denominator), $p$-value is between .025 and .05
   Using Excel, the $p$-value corresponding to $F = 16.36$ is .0272
   Because $p$-value ≤ $\alpha$, we reject $H_0: \beta_1 = 0$

24. a. 76.6667  
   b. 8.7560  
   c. .6526  
   d. Significant; $p$-value = .0193  
   e. Significant; $p$-value = .0193
26. a. $s^2 = \frac{SSE}{n - 2} = \frac{85,135.14}{4} = 21,283.79$
   $s = \sqrt{MSE} = \sqrt{21,283.79} = 145.89$
   $\Sigma(x_i - \bar{x})^2 = .74$
   $s_{xy} = \frac{s}{\sqrt{\Sigma(x_i - \bar{x})^2}} = \frac{145.89}{\sqrt{.74}} = 169.59$
   $t = \frac{b - \beta_1}{s_{xy}} = \frac{581.08 - 0}{169.59} = 3.43$
   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, the $p$-value corresponding to $t = 3.43$ is .0266
   Because $p$-value ≤ $\alpha$, we reject $H_0: \beta_1 = 0$
b. $MSR = \frac{SSR}{1} = 249,864.86$
   $F = \frac{MSR}{MSE} = \frac{249,864.86}{21,283.79} = 11.74$
   From the $F$ table (1 numerator degree of freedom and 4 denominator), $p$-value is between .025 and .05
   Using Excel, the $p$-value corresponding to $F = 11.74$ is .0266
   Because $p$-value ≤ $\alpha$, we reject $H_0: \beta_1 = 0$

c. | Source of Variation | Sum of Squares | Degrees of Freedom | Mean Square | $F$ | p-value |
<table>
<thead>
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<td>Total</td>
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<td>5</td>
<td></td>
<td></td>
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</tr>
</tbody>
</table>

28. They are related; $p$-value = .000
30. Significant; $p$-value = .002
32. a. $\hat{y} = 6.1092 + .8951 x$
b. Significant relationship
c. $r^2 = .82$; a good fit
34. a. $\hat{y} = 80.0 + 50.0 x$
b. $p$-value ≤ $\alpha$; reject $H_0: \beta_1 = 0$
c. $p$-value ≤ $\alpha$; reject $H_0: \beta_1 = 0$
d. $p$-value = .000
36. b. There appears to be a linear relationship between the two variables
c. $\hat{y} = 37.0747 - 0.7792 x$
d. Significant relationship
e. 0.43; not a good fit
37. a. $s = 2.033$
   $\bar{x} = 3, \Sigma(x_i - \bar{x})^2 = 10$
   $s_{xy} = \frac{1}{\sqrt{n}} \left( \frac{(x_i - \bar{x})^2}{\Sigma(x_i - \bar{x})^2} \right) = 2.033 \sqrt{\frac{1}{5} \frac{(4 - 3)^2}{10}} = 1.11$
   b. $\hat{y} = \hat{y} + 2.66 x = .2 + 2.6(4) = 10.6$
   $\hat{y} + \pm t_{a/2} s_{xy}$
   $10.6 \pm 3.182(1.11)$
   $10.6 \pm 3.53,$ or 7.07 to 14.13
Appendix D  Self-Test Solutions and Answers to Even-Numbered Exercises

44. a. 
\[ s_{\text{ind}} = s \sqrt{1 + \frac{1}{n} + \frac{(y_i - \bar{y})^2}{\sum(x_i - \bar{x})^2}} \]
\[ = 2.033 \sqrt{1 + \frac{1}{5} + \frac{(4 - 3)^2}{10}} = 2.32 \]
d. \[ \hat{y}_p = t_{a/2} s_{\text{ind}} \]
\[ 10.6 \pm 3.182(2.32) \]
\[ 10.6 \pm 7.38, \text{ or } 3.22 \text{ to } 17.98 \]

38. a. 8.7560
b. 30.07 to 57.93
c. 9.7895
d. 12.85 to 75.15

40. a. \[ s = 145.89, \bar{x} = 3.2, \sum(x_i - \bar{x})^2 = .74 \]
\[ \hat{y} = 1790.5 + 581.1x = 1790.5 + 581.1(3) \]
\[ = 3533.8 \]
\[ s_p = s \sqrt{\frac{1}{n} + \frac{(x_p - \bar{x})^2}{\sum(x_i - \bar{x})^2}} \]
\[ = 145.89 \sqrt{\frac{1}{6} + \frac{(3 - 3.2)^2}{.74}} = 68.54 \]
\[ \hat{y}_p = t_{a/2} s_p \]
\[ 3533.8 \pm 2.776(68.54) \]
\[ 3533.8 \pm 190.27, \text{ or }$3343.53 \text{ to } 3724.07 \]
b. \[ s_{\text{ind}} = s \sqrt{1 + \frac{1}{n} + \frac{(y_i - \bar{y})^2}{\sum(x_i - \bar{x})^2}} \]
\[ = 145.89 \sqrt{1 + \frac{1}{6} + \frac{(3 - 3.2)^2}{.74}} = 161.19 \]
\[ \hat{y}_p = t_{a/2} s_{\text{ind}} \]
\[ 3533.8 \pm 2.776(161.19) \]
\[ 3533.8 \pm 447.46, \text{ or }$3086.34 \text{ to } 3981.26 \]

42. a. $11,740 to $14,420
b. $9300 to $16,860
c. Yes
d. Any deductions exceeding the $16,860 upper limit

44. a. \[ \hat{y} = -6.76 + 1.755x \]
b. \[ r^2 = .713; \text{ good fit} \]
c. 31.8 to 60
d. 6.3 to 85.5; not much value

45. a. \[ \bar{x} = \frac{\sum x_i}{n} = 70 \text{ and } \bar{y} = \frac{\sum y_i}{n} = 76 \text{ and } 5 = 15.2, \]
\[ \sum(x_i - \bar{x})(y_i - \bar{y}) = 200, \sum(x_i - \bar{x})^2 = 126 \]
b. \[ h_i = \frac{\sum(x_i - \bar{x})(y_i - \bar{y})^2}{\sum(x_i - \bar{x})^2} = \frac{200}{126} = 1.5873 \]
b. \[ b_0 = \bar{y} - b_1 \bar{x} = 15.2 - (1.5873)(14) = -7.0222 \]
\[ \hat{y} = -7.02 + 1.59x \]
b. 
<table>
<thead>
<tr>
<th>( x_i )</th>
<th>( y_i )</th>
<th>( \hat{y}_i )</th>
<th>( y_i - \hat{y}_i )</th>
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<td>24.78</td>
<td>5.22</td>
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</table>

e. The plot of the standardized residuals against \( \hat{y} \) has the same shape as the original residual plot; as stated in part (c), the curvature observed indicates that the assumptions regarding the error term may not be satisfied

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. \( \text{SST} = 1002, \text{SSE} = 310.28, \text{SSR} = 691.72 \)
\[ \text{MSR} = \frac{\text{SSR}}{1} = 691.72 \]
\[ \text{MSE} = \frac{\text{SSE}}{n - 2} = \frac{310.28}{5} = 62.0554 \]
\[ F = \frac{\text{MSR}}{\text{MSE}} = \frac{691.72}{62.0554} = 11.15 \]

From the \( F \) table (1 numerator degree of freedom and 5 denominator), \( p \)-value is between .01 and .025
50. a. The scatter diagram is shown below:

\[
\begin{array}{ccc|c|c}
 x_i & y_i & \hat{y}_i & y_i - \hat{y}_i \\
 1 & 19 & 30.95 & -11.95 \\
 2 & 32 & 32.50 & -0.50 \\
 4 & 44 & 35.60 & 8.40 \\
 6 & 40 & 38.70 & 1.30 \\
 10 & 52 & 44.90 & 7.10 \\
 14 & 53 & 51.10 & 1.90 \\
 20 & 54 & 60.40 & -6.40 \\
\end{array}
\]

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.

54. a. $\hat{y} = 707.0299 + .0048x$

58. a. $\hat{y} = 9.26 + .711x$
b. Significant; $p$-value = .0013
c. $r^2 = .744$; good fit
d. $\$13.53$

60. b. $\hat{y} = -182.1083 + .1334$ DJIA
c. Significant; $p$-value = .000
d. Excellent fit; $r^2 = .9561$
e. $1285$
f. No

62. a. $\hat{y} = 22.1739 - .1478x$
b. Significant relationship; $p$-value = .0281
c. Good fit; $r^2 = .739$
d. $12.294$ to $17.271$

64. a. $\hat{y} = 220 + 131.6667x$
b. Significant; $p$-value = .000
c. $r^2 = .873$; very good fit
d. $\$559.50$ to $\$933.90$

66. a. Market beta = .95
b. Significant; $p$-value = .029
c. $r^2 = .470$; not a good fit
d. Texas Instruments has a higher risk

68. b. There appears to be a positive linear relationship between the two variables
c. $\hat{y} = 9.3742 + 1.2875$ Top Five (%)
d. Significant; $p$-value = .0002
e. $r^2 = .7413$; good fit
f. $r_{xy} = .86$

Chapter 15

2. a. The estimated regression equation is

$$\hat{y} = 45.0594 + 1.9436x_1$$

An estimate of $y$ when $x_1 = 45$ is

$$\hat{y} = 45.0594 + 1.9436(45) = 132.52$$

b. The estimated regression equation is

$$\hat{y} = 85.2171 + 4.3215x_2$$

An estimate of $y$ when $x_2 = 15$ is

$$\hat{y} = 85.2171 + 4.3215(15) = 150.04$$

c. The estimated regression equation is

$$\hat{y} = -18.3683 + 2.0102x_1 + 4.7378x_2$$

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

$$\hat{y} = -18.3683 + 2.0102(45) + 4.7378(15) = 143.16$$

4. a. $\$255,000$

5. a. The Excel output is shown in Figure D15.5a
b. The Excel output is shown in Figure D15.5b
c. It is $1.6039$ in part (a) and $2.2902$ 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 = $83.2301 + 2.2902(3.5) + 1.3010(1.8)$ = $93.59$ or $93,590$
6. a. \( \hat{y} = .3540 + .0009 \text{ HR} \)
b. \( \hat{y} = .8647 - .0837 \text{ ERA} \)
c. \( \hat{y} = .7092 + .0014 \text{ HR} - .1026 \text{ ERA} \)
d. .551

8. a. Return = 247.3579 – 32.8445 Safety + 34.5887 ExpRatio
b. 70.2

10. a. \( \hat{y} = -1.2207 + 3.9576 \text{ FG\%} \)
b. .04
c. \( \hat{y} = -1.2346 + 4.8166 \text{ FG\%} - 2.5895 \text{ Opp 3 Pt\%} + .0344 \text{ Opp \text{ TO}} \)
d. .6372

12. a. \( R^2 = \frac{\text{SSR}}{\text{SST}} = \frac{14,052.2}{15,182.9} = .926 \)
b. \( R^2_a = 1 - (1 - R^2) \frac{n - 1}{n - p - 1} = 1 - (1 - .926) \frac{10 - 1}{10 - 2 - 1} = .905 \)
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. \( R^2 = \frac{SSR}{SST} = \frac{23,435}{25.5} = .919 \)
   b. \( R^2_a = 1 - (1 - R^2) \frac{n - 1}{n - p - 1} = 1 - (1 - .919) \frac{8 - 1}{8 - 2 - 1} = .887 \)

16. a. No, \( R^2 = .1532 \)
   b. Using both independent variables provides a better fit

18. a. \( R^2 = .5638, R^2_a = .5114 \)
   b. The fit is not very good; but it does explain over 50% of the variability in y

19. a. MSR = \( \frac{SSR}{p} = \frac{6216.375}{2} = 3108.188 \)
   MSE = \( \frac{SSE}{n - p - 1} = \frac{507.75}{10 - 2 - 1} = 72.536 \)
   b. \( F = \frac{MSR}{MSE} = \frac{3108.188}{72.536} = 42.85 \)

20. a. Significant; p-value = .0001
   b. Significant; p-value = .0000
   c. Significant; p-value = .0016

22. a. SSE = 4000, MSE = 571.43, MSR = 6000
   b. Significant; p-value = .0078

23. a. \( F = 28.38 \)
   b. \( t = 7.53 \)

Because \( p\)-value \( \leq \alpha = .05 \), \( \beta_1 \) is significant and \( x_1 \) should not be dropped from the model

c. \( t = 4.06 \)
   \( t_{0.025} = 2.571 \)
   With \( t > t_{0.025} = 2.571 \), \( \beta_2 \) is significant and \( x_2 \) should not be dropped from the model

24. a. \( \hat{y} = -0.6820 + 0.0498 \text{Revenue} + 0.0147 \%\text{Wins} \)
   b. Significant; p-value = .001
   c. Revenue is significant; p-value = .0007
   d. \%\text{Wins} is significant; p-value = .0253

25. \( R^2 = .6820 \)

26. a. Significant; p-value = .0000
   b. All of the independent variables are significant

28. 143.15

29. a. See Excel output in Figure D15.5b.
   \( \hat{y} = 83.2 + 2.29(3.5) + 1.30(1.8) = 93.555 \)
   or \$93,555
   b. Using StatTools, 91.774 to 95.401, or \$91,774 to \$95,401

30. a. 49
   b. 44.815 to 52.589

32. a. \( E(y) = \beta_0 + \beta_1 x_1 + \beta_2 x_2 \)
   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. \( \beta_2 = E(y \mid \text{level 2}) - E(y \mid \text{level 1}) \)
   \( \beta_1 \) is the change in \( E(y) \) for a one-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. \( \hat{y} = 1.8602 + 0.2914 \text{Months} + 1.1024 \text{Type} - 0.6091 \text{Person} \)
   b. Significant; p-value = .0021 < \( \alpha = .05 \)
   c. Person is not significant

38. a. \( \hat{y} = -91.7595 + 1.0767 \text{Age} + .2518 \text{Pressure} + 8.7399 \text{Smoker} \)
   b. Significant; p-value = .0102 < \( \alpha = .05 \)
   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. \( \hat{y} = -53.28 + 3.11x \)
   b. \(-1.27, -.15, 1.39, .49, -.45; \) no outliers

42. b. Unusual trend
   c. No outliers
44. b. 3.19
46. a. \( \hat{y} = 8.103 + 7.602x_1 + 3.111x_2 \)
   b. Significant; \( p \)-value = .000
   c. \( \beta_1 \) is significant; \( p \)-value = .0036
   \( \beta_2 \) is significant; \( p \)-value = .0003
48. a. \( \hat{y} = 14.4 - 8.69x_1 + 13.517x_2 \)
   b. Significant; \( p \)-value = .0008
   c. \( \hat{y} = 67.6762 \) Price
   b. Significant; \( p \)-value = .0004
   c. \( \hat{y} = 65.6597 + .0023 \) Price + 10.2097 Quality-E + 5.9246 Quality-VG
   d. Significant; \( p \)-value = .0002
   e. All significant
50. a. \( \hat{y} = 56.9432 + 9.8714x \)
   b. Significant; \( p \)-value = .0008
   c. \( \hat{y} = 22.5168 + 2.4127x - .0480x^2 \)
   d. Overall significance; \( p \)-value = .000
   Individual: Suggested retail price is not significant
   Type of vehicle is the strongest predictor of resale value

Chapter 16

1. a. The Excel output is shown in Figure D16.1a
   b. The \( p \)-value corresponding to \( F = 6.8530 \) is .0589 > \( \alpha = .05 \); therefore, the relationship is not significant

FIGURE D16.1a

Regression Statistics

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ANOVA

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Coefficients

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<th>P-value</th>
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<td>x</td>
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</table>
c. The fitted value is 1302.01 with a standard deviation of 9.93. The 95% confidence interval is 1270.41 to 1333.61; the 95% prediction interval is 1242.55 to 1361.47.

6. b. No, the relationship appears to be curvilinear.

c. Several possible models; e.g.,
\[ \hat{y} = 2.90 - 1.85x + .0035x^2 \]

8. a. It appears that a simple linear regression model is not appropriate.

b. Price = $33829 - 4571 \text{Rating} + 154 \text{RatingSq}$

c. logPrice = $-10.2 + 10.4 \log \text{Rating}$

d. Part (c); higher percentage of variability is explained.

10. a. Significant; p-value = .0000

b. Significant; p-value = .0000

11. a. SSE = 1805 - 1760 = 45

\[ F = \frac{\text{MSR}}{\text{MSE}} = \frac{1760/4}{45/25} = 244.44 \]

p-value (4 degrees of freedom numerator and 25 denominator) = .0000

Because p-value < \( \alpha \), we reject \( H_0 \); the relationship is significant.

b. SSE($x_1, x_2, x_3, x_4$) = 45

c. SSE($x_2, x_3$) = 1805 - 1705 = 100
Appendix D  Self-Test Solutions and Answers to Even-Numbered Exercises

911

d. \[ F = \frac{(100 - 45)/2}{1.8} = 15.28 \] \[ F_{0.05} = 3.39 \]

With \( F = 15.28 > 3.39 \), \( x_1 \) and \( x_2 \) are significant

12. a. \( \hat{y} = 46.2774 + 14.1028 \) Putting Avg.
   b. \( \hat{y} = 59.0219 - 10.2812 \) Greens in Reg. + 11.4132 Putting Avg. – 1.8130 Sand Saves

14. a. \( \hat{y} = -110.9423 + 1.3150 \) Age + .2964 Pressure
   b. \( \hat{y} = -123.1650 + 1.5130 \) Age + .4483 Pressure + 8.8656 Smoker – .0028 AgePress

16. a. \( \hat{y} = -8.6800 + 1.5092 \) Age
   b. \( \hat{y} = -.0689 + 1.7252 \) Age – 15.0857 Head – 17.4213 Sales

18. a. \( \hat{y} = -4.0491 + 27.5548 \) OBP
   b. Hard to make an argument that there is one best model; the following five independent variable model seems like a reasonable choice

\[ \hat{y} = -9.0888 + 32.1835 \) OBP + .1088 HR – 21.5107 AVG + .2439 3B – .0223 BB

19.

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<th>( x_3 )</th>
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<td>0</td>
<td>B</td>
</tr>
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<td>0</td>
<td>C</td>
</tr>
<tr>
<td>0</td>
<td>0</td>
<td>1</td>
<td>D</td>
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\[ E(y) = \hat{\beta}_0 + \hat{\beta}_1 x_1 + \hat{\beta}_2 x_2 + \hat{\beta}_3 x_3 \]

20.

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<tr>
<td>0</td>
<td>1</td>
<td>3</td>
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</tbody>
</table>

\( x_3 = 0 \) if block 1; \( x_3 = 1 \) if block 2

\[ E(y) = \hat{\beta}_0 + \hat{\beta}_1 x_1 + \hat{\beta}_2 x_2 + \hat{\beta}_3 x_3 \]

22. a. 

<table>
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<th>( D_1 )</th>
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<td>0</td>
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<td>3</td>
</tr>
</tbody>
</table>

\[ E(y) = \hat{\beta}_0 + \hat{\beta}_1 D_1 + \hat{\beta}_2 D_2 \]

b. See Figure D16.22b

c. \( H_0: \hat{\beta}_1 = \hat{\beta}_2 = 0 \)

d. The \( p \)-value is .0043 < \( \alpha = .05 \); therefore, we conclude that the mean time to mix a batch of material is not the same for each manufacturer

24. Significant difference between the two analyzers

26. a. \( \hat{y} = 81.9894 + .4024 \) Period
   b. Significant positive autocorrelation; Durbin-Watson statistic is .798118

27. \( d = 1.60 \); test is inconclusive

28. a. Curvature in the scatter diagram; a simple linear regression model may not be appropriate

b. \( \hat{y} = 49.9123 + 14.8770 \) Speed – 1.8257 SpeedSq.

---

**FIGURE D16.22b**

**Regression Statistics**

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**ANOVA**

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**Coefficients**

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<td>D2</td>
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<td>-1.2792</td>
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</table>
Appendix D  Self-Test Solutions and Answers to Even-Numbered Exercises

30. a. \( \hat{y} = 80.4286 + 11.9442 \text{ Industry} - 4.8163 \text{ Public} - 2.6236 \text{ Quality} - 4.0725 \text{ Finished} \)
   
   b. Not a good fit
   
   c. Scatter diagram suggests a curvilinear relationship
   
   d. \( \hat{y} = 112.7902 + 11.6310 \text{ Industry} - 2.4870 \text{ Quality} - 36.5508 \text{ Finished} + 6.6301 \text{ FinishedSq} \)

32. a. \( \hat{y} = 70.6336 + 12.7372 \text{ Industry} - 2.9187 \text{ Quality} \)
   
   b. No significant positive autocorrelation; Durbin-Watson statistic is 1.43.

34. Significant difference; \( p \)-value = .0037

Chapter 17

1. Binomial probabilities for \( n = 10, p = .50 \)

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<th>( x )</th>
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<tr>
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<td>.2461</td>
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Number of plus signs = 7

\[ P(x \geq 7) = P(7) + P(8) + P(9) + P(10) = \frac{1172}{1024} + \frac{439}{1024} + \frac{1172}{1024} + \frac{2051}{1024} = .1719 \]

\( p \)-value = 2(.1719) = .3438

\( p \)-value > .05; do not reject \( H_0 \)

No indication difference exists

2. \( n = 27 \) cases in which a value different from 150 is obtained

Use normal approximation with \( \mu = np = .5(27) = 13.5 \) and \( \sigma = \sqrt{np(1-p)} = \sqrt{27} = 2.6 \)

Use \( x = 22 \) as the number of plus signs and obtain the following test statistic:

\[ z = \frac{x - \mu}{\sigma} = \frac{22 - 13.5}{2.6} = 3.27 \]

Largest table value \( z = 3.09 \)

Area in tail = 1.0000 - .9900 = .001

For \( z = 3.27 \), \( p \)-value less than .001

\( p \)-value ≤ .01; reject \( H_0 \) and conclude median > 150

4. We need to determine the number of “better” responses and the number of “worse” responses; the sum of the two is the sample size used for the study

\[ n = .34(1253) + .29(1253) = 789.4 \]

Use the large-sample test and the normal distribution; the value of \( n = 789.4 \) need not be integer.

Use \( \mu = .5n = .5(789.4) = 394.7 \)

\[ \sigma = \sqrt{np} = \sqrt{394.7} = 14.05 \]

Let \( p \) = proportion of adults who feel children will have a better future

\[ H_0: p \leq .50 \]

\[ H_1: p > .50 \]

\[ x = .34(1253) = 426.0 \]

\[ z = \frac{x - \mu}{\sigma} = \frac{426.0 - 394.7}{14.05} = 2.23 \]

\( p \)-value = 1.0000 - .9781 = .0219

Reject \( H_0 \) and conclude that more adults feel their children will have a better future

6. \( z = 2.32 \)

\( p \)-value = .0204

Reject \( H_0 \)

8. \( z = 3.76 \)

\( p \)-value = .0000

Reject \( H_0 \)

10. \( z = 1.27 \)

\( p \)-value = .1040

Do not reject \( H_0 \)

12. \( H_0: \) The populations are identical

\( H_1: \) The populations are not identical

<table>
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<th>Additive</th>
<th>Difference</th>
<th>Absolute</th>
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<th>Rank</th>
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\( T = 62 \)

\( \mu_T = 0 \)

\( \sigma_T = \sqrt{\frac{n(n+1)(2n+1)}{6}} = \sqrt{\frac{12(13)(25)}{6}} = 25.5 \)

\[ z = \frac{T - \mu_T}{\sigma_T} = \frac{62 - 0}{25.5} = 2.43 \]

\( p \)-value = 2(1.0000 - .9925) = .0150

Reject \( H_0 \) and conclude that there is a significant difference between the additives
Appendix D  Self-Test Solutions and Answers to Even-Numbered Exercises

13.  
\[ p\text{-value} / H_1 / 0.0000 / H_1 / 0.9664 / H_1 / 0.0336 \]

Reject \( H_0 \) and conclude there is a significant difference in favor of the relaxant.

14.  
\[ z / H_1 / 2.29 / p\text{-value} / H_1 / 0.0220 \]

Reject \( H_0 \).

16.  
\[ z / H_1 / -1.48 / p\text{-value} / H_1 / 0.1388 \]

Do not reject \( H_0 \).

18.  
Rank the combined samples and find rank sum for each sample; this is a small-sample test because \( n_1 = 7 \) and \( n_2 = 9 \)

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<td>+6.5</td>
</tr>
<tr>
<td>9</td>
<td>6</td>
<td>3</td>
<td>6.5</td>
<td>+6.5</td>
</tr>
</tbody>
</table>

\[ T = 36 \]

\[ z = \frac{T - \mu_T}{\sigma_T} = \frac{36}{19.62} = 1.83 \]

\[ p\text{-value} = 1.0000 - .9664 = .0336 \]

Reject \( H_0 \) and conclude there is a significant difference in favor of the relaxant.

19.  
\[ a. \quad \mu_T = \frac{1}{2} n_1(n_1 + 1) = \frac{1}{2} (10)(10 + 1) = 105 \]

\[ \sigma_T = \sqrt{\frac{1}{12} n_1 n_2(n_1 + n_2 + 1)} = \sqrt{\frac{1}{12} (10)(10)(10 + 1)} = 13.23 \]

\[ T = 136.5 \]

\[ z = \frac{136.5 - 105}{13.23} = 2.38 \]

\[ p\text{-value} = 2(1.0000 - .9913) = .0174 \]

Reject \( H_0 \) and conclude that salaries differ significantly for the two professions.

\[ b. \quad \text{Public Accountant} \quad \$50,200 \]

\[ \text{Financial Planner} \quad \$46,700 \]

20.  
\[ a. \quad \text{Men 49.9, Women 35.4} \]

\[ b. \quad T = 36, T_L = 37 \]

Reject \( H_0 \).

22.  
\[ z = 2.77 \]

\[ p\text{-value} = .0056 \]

Reject \( H_0 \).

24.  
\[ z = -0.25 \]

\[ p\text{-value} = 0.8026 \]

Do not reject \( H_0 \).

26.  
Rankings:

<table>
<thead>
<tr>
<th>Product A</th>
<th>Product B</th>
<th>Product C</th>
</tr>
</thead>
<tbody>
<tr>
<td>4</td>
<td>11</td>
<td>7</td>
</tr>
<tr>
<td>8</td>
<td>14</td>
<td>2</td>
</tr>
<tr>
<td>10</td>
<td>15</td>
<td>1</td>
</tr>
<tr>
<td>3</td>
<td>12</td>
<td>6</td>
</tr>
<tr>
<td>9</td>
<td>13</td>
<td>5</td>
</tr>
<tr>
<td>34</td>
<td>65</td>
<td>21</td>
</tr>
</tbody>
</table>

\[ W = \frac{12}{(15)(16)} \left[ \frac{(34)^2}{5} + \frac{(65)^2}{5} + \frac{(21)^2}{5} \right] - 3(15 + 1) \]

\[ = 58.22 - 48 = 10.22 \quad (df = 2) \]

\[ p\text{-value} \text{ is between .005 and .01} \]

Reject \( H_0 \) and conclude the ratings for the products differ.
28. Rankings:

<table>
<thead>
<tr>
<th></th>
<th>Swimming</th>
<th>Tennis</th>
<th>Cycling</th>
</tr>
</thead>
<tbody>
<tr>
<td>8</td>
<td>8</td>
<td>9</td>
<td>5</td>
</tr>
<tr>
<td>4</td>
<td>14</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>13</td>
<td></td>
<td>3</td>
</tr>
<tr>
<td>6</td>
<td>10</td>
<td></td>
<td>7</td>
</tr>
<tr>
<td>12</td>
<td>15</td>
<td></td>
<td>2</td>
</tr>
<tr>
<td>41</td>
<td>61</td>
<td></td>
<td>18</td>
</tr>
</tbody>
</table>

\[ W = \frac{12}{15(15 + 1)} \left[ \left( \frac{4!}{2 + 1} \right)^2 + \left( \frac{6!}{2 + 1} \right)^2 + \left( \frac{18!}{2 + 1} \right)^2 \right] - 3(15 + 1) \]

\[ = 9.26 \quad (df = 2) \]

\[ p\text{-value is between .005 and .01} \]

Reject \( H_0 \) and conclude that activities differ.

30. \( W = 8.03; df = 3 \)

\[ p\text{-value is between .025 and .05} \]

Reject \( H_0 \)

32. \( \sum d_i^2 = 52 \)

\[ r_s = 1 - \frac{6\sum d_i^2}{n(n^2 - 1)} = 1 - \frac{6(52)}{10(99)} = .68 \]

b. \( \sigma_{r_s} = \frac{1}{\sqrt{n-1}} = \frac{1}{\sqrt{9}} = .33 \)

\[ z = \frac{r_s - 0}{\sigma_{r_s}} = \frac{.68}{.33} = 2.05 \]

\[ p\text{-value} = 2(1.0000 - .9798) = .0404 \]

Reject \( H_0 \) and conclude that significant rank correlation exists.

34. \( \sum d_i^2 = 250 \)

\[ r_s = 1 - \frac{6\sum d_i^2}{n(n^2 - 1)} = 1 - \frac{6(250)}{11(120)} = -.136 \]

\[ \sigma_{r_s} = \frac{1}{\sqrt{n-1}} = \frac{1}{\sqrt{10}} = .32 \]

\[ z = \frac{r_s - 0}{\sigma_{r_s}} = \frac{-.136}{.32} = -.43 \]

\[ p\text{-value} = 2(3.336) = .6672 \]

Do not reject \( H_0 \); we cannot conclude that there is a significant relationship between the rankings.

36. \( r_s = -.71, z = -2.13 \)

\( p\text{-value} = .0332 \)

Reject \( H_0 \)

38. \( z = -3.17 \)

\( p\text{-value is less than .002} \)

Reject \( H_0 \)

40. \( z = -2.59 \)

\( p\text{-value} = .0096 \)

Reject \( H_0 \)

42. \( z = -2.97 \)

\( p\text{-value} = .003 \)

Reject \( H_0 \)

44. \( W = 12.61; df = 2 \)

\( p\text{-value is between .01 and .025} \)

Reject \( H_0 \)

46. \( r_s = .76, z = 2.83 \)

\( p\text{-value} = .0046 \)

Reject \( H_0 \)

Chapter 18

2. a. 5.42

b. UCL = 6.09, LCL = 4.75

4. \( R \) chart:

\[ UCL = \bar{R}D_4 = 1.6(1.864) = 2.98 \]

\[ LCL = \bar{R}D_1 = 1.6(.136) = .22 \]

\( \bar{x} \) chart:

\[ UCL = \bar{x} + A_2\bar{R} = 28.5 + .373(1.6) = 29.10 \]

\[ LCL = \bar{x} - A_2\bar{R} = 28.5 - .373(1.6) = 27.90 \]

6. 20.01, .082

8. a. .0470

b. UCL = .0989, LCL = -0.0049 (use LCL = 0)

c. \( \bar{p} = .08; \) in control

d. UCL = 14.826, LCL = -0.726 (use LCL = 0)

Process is out of control if more than 14 defective

e. In control with 12 defective

f. \( np \) chart

10. \( f(x) = \frac{n!}{x!(n - x)!} p^x (1 - p)^{n-x} \)

When \( p = .02, \) the probability of accepting the lot is

\[ f(0) = \frac{25!}{0!(25 - 0)!} (.02)^0 (.98)^{25} = .6035 \]

When \( p = .06, \) the probability of accepting the lot is

\[ f(0) = \frac{25!}{0!(25 - 0)!} (.06)^0 (.94)^{25} = .2129 \]

12. \( p_0 = .02; \) producer’s risk = .0599

\( p_0 = .06; \) producer’s risk = .3396

Producer’s risk decreases as the acceptance number \( c \) is increased

14. \( n = 20, c = 3 \)

16. a. 95.4

b. UCL = 96.07, LCL = 94.73

c. No

18. \( R \) Chart | \( \bar{x} \) Chart

<table>
<thead>
<tr>
<th></th>
<th>UCL</th>
<th>LCL</th>
</tr>
</thead>
<tbody>
<tr>
<td>4.23</td>
<td>6.57</td>
<td>4.27</td>
</tr>
</tbody>
</table>

Estimate of standard deviation = .86
Appendix D  Self-Test Solutions and Answers to Even-Numbered Exercises  915

20. | R Chart | \( \bar{x} \) Chart |
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>UCL</td>
<td>.1121</td>
</tr>
<tr>
<td>LCL</td>
<td>0</td>
</tr>
</tbody>
</table>

22. a. \( \text{UCL} = .0817, \text{LCL} = -.0017 \) (use \( \text{LCL} = 0 \))

24. a. \( .03 \)
b. \( \beta = .0802 \)

Chapter 19

1. a.

\[ \begin{align*}
\text{EV}(d_1) &= .65(250) + .15(100) + .20(25) = 182.5 \\
\text{EV}(d_2) &= .65(100) + .15(100) + .20(75) = 95 \\
\end{align*} \]

The optimal decision is \( d_1 \)

b. \( \text{EV}(d_1) = 11.3 \)

b. \( \text{EV}(d_2) = 9.5 \)

3. a. \( \text{EV(own staff)} = .2(650) + .5(650) + .3(600) = 635 \)

\( \text{EV(outside vendor)} = .2(900) + .5(600) + .3(300) = 570 \)

\( \text{EV(combination)} = .2(800) + .5(650) + .3(500) = 635 \)

Optimal decision: hire an outside vendor with an expected cost of $570,000

b. \( \text{EV w/PI} = .2(650) + .5(600) + .3(300) = 520 \)

\( \text{EVPI} = |520 - 570| = 50, or $50,000 \)

4. b. Discount; \( \text{EV} = 565 \)
c. Full Price; \( \text{EV} = 670 \)

d. Only Chardonnay; \( \text{EV} = 42.5 \)

e. Both grapes; \( \text{EV} = 46.4 \)

e. Both grapes; \( \text{EV} = 39.6 \)

8. a.

\[ \begin{align*}
\text{EV (node 6)} &= .57(100) + .43(300) = 186 \\
\text{EV (node 7)} &= .57(400) + .43(200) = 314 \\
\text{EV (node 8)} &= .18(100) + .82(300) = 264 \\
\text{EV (node 9)} &= .18(400) + .82(200) = 236 \\
\text{EV (node 10)} &= .40(100) + .60(300) = 220 \\
\text{EV (node 11)} &= .40(400) + .60(200) = 280 \\
\text{EV (node 2)} &= \max(186, 314) = 314 \quad d_2 \\
\text{EV (node 4)} &= \max(1870, 2000) = 264 \quad d_1 \\
\text{EV (node 5)} &= \max(220, 280) = 280 \quad d_2 \\
\text{EV (node 3)} &= \max(186, 314, 314) = 314 \quad d_2 \\
\text{EV (node 1)} &= \max(292, 280) = 292 \\
\end{align*} \]

b. If Favorable, decision \( d_2 \)

If Unfavorable, decision \( d_1 \)

10. a. \( 5000 - 200 = 2000 - 150 = 2650 \)

3000 - 200 - 2000 - 150 = 650

b. Expected values at nodes

\( 8: 2350 \)

\( 5: 2350 \)

\( 9: 1100 \)

\( 6: 1150 \)

\( 10: 2000 \)

\( 7: 2000 \)

\( 4: 1870 \)

\( 3: 2000 \)

\( 2: 1560 \)

\( 1: 1560 \)

b. Expected values at nodes

\( 8: 2350 \)

\( 5: 2350 \)

\( 9: 1100 \)

\( 6: 1150 \)

\( 10: 2000 \)

\( 7: 2000 \)

\( 4: 1870 \)

\( 3: 2000 \)

\( 2: 1560 \)

\( 1: 1560 \)

c. Cost would have to decrease by at least $130,000
12.  
   b. $d_1$, 1250  
   c. 1700  
   d. If $N$, $d_1$  
       If $U$, $d_2$; 1666

14.

| State of Nature | $P(s_j)$ | $P(I|s_j)$ | $P(I \cap s_j)$ | $P(s_j|I)$ |
|-----------------|---------|-----------|-----------------|-----------|
| $s_1$           | .2      | .10       | .020            | .1905     |
| $s_2$           | .5      | .05       | .025            | .2381     |
| $s_3$           | .3      | .20       | .060            | .5714     |
| **1.0**         |         | **P(I) = .105** |               | **1.0000** |

16.  
   a. .695, .215, .090  
       .98, .02  
       .79, .21  
       .00, 1.00  
   c. If C, Expressway  
       If O, Expressway  
       If R, Queen City  
       26.6 minutes