1-2 Basic Skills and Concepts

2. A voluntary response sample may have a bias resulting from participation by those with a special interest in the subject being studied.

4. The context of the data affects the statistical methods that will be used.

6. Yes, the subjects constitute a voluntary response sample because they themselves decided to be included in the study.

8. Possible, but very unlikely

10. Impossible.

12. Possible and likely

14. Possible, but very unlikely.

16. The Federal Trade Commission is a government agency that does not profit from the results, so it is likely to be an unbiased source.

18. Given that consumption of nicotine is unsafe, it appears that the first type of cigarette is safer than the second type, but we cannot conclude that the first type of cigarette is safe.

20. Is there a relationship or an association between the weight of a car and its fuel consumption amount?

22. No. A conclusion of a correlation (or relationship or association) does not imply that one variable is the cause of the other.

24. The difference between Mendel's 25% rate and the result of 26% is not statistically significant. According to Mendel's theory, 145 of the 580 peas would have yellow pods, but the results consisted of 152 peas with yellow pods. The difference of 7 peas with yellow pods among the 580 offspring does not appear to be significant.

26. a. Yes. Surgery appears to have a substantially better success rate.
   b. Yes. Because the given success rates are so unlikely to occur with equal success rates, it appears that the success rates are not in fact equal. The success rate for surgery appears to be higher.
   c. Yes. The 92% success rate for surgery appears to be substantially better than the 72% success rate for splints.
   d. Yes. Surgery appears to have a substantially higher success rate, so it should be recommended treatment.

28. Without knowing anything about the number of ATVs in use, or the number of ATV drivers, or the amount of ATV usage, the number of 740 fatal accidents has no context. Some information should be given so that the reader could understand the rate of ATV fatalities.
1-3 Basic Skills and Concepts

2. Quantitative data consists of numbers representing counts or measurements, whereas categorical data can be separated into different categories that are distinguished by some non-numeric characteristic.

4. Statistic. The population consists of all executives. Practical implication: Be sure to carefully proofread all of your job applications.

6. Parameter

8. Parameter

10. Parameter

12. Statistic

14. Discrete

16. Continuous

18. Continuous

20. Discrete

22. Nominal

24. Interval

26. Ratio

28. Ordinal

30. Sample: The 1012 people surveyed. Population: All adults. The sample is likely to be representative of the population (because subjects were randomly selected and the Gallup organizations is known to conduct polls using sound and effective procedures).

32. Sample: The 33,160 responses. Population: The population presumably consisted of the entire population. Because the subscribers could choose to respond or not respond, the sample is a voluntary response sample, so it is not likely to be representative of the greater population.

34. Such calculations with nominal data are generally meaningless.

1-4 Basic Skills and concepts
2. No, it is possible that a voluntary response sample might be representative of the general population. No, there are other types of sampling that are bad, such as selecting only friends and relatives for a survey.

4. No, she used a voluntary response sample, so those with strong feelings about the topics are more likely to respond. Even though the sample is large, it is a bad sample.

6. Because correlation does not imply causality, it would be more correct to say that there is an association between the numbers of times songs are played on radio stations and the numbers of times the songs are purchased. It is possible that there are other factors, such as the general popularity of the artist, that cause radio stations to play the songs while people are buying the songs.

8. Failure on the exam appears to be associated with (but not necessarily caused by) membership in the minority group. It is possible that the test is unbiased and the failures are attributable to other factors, such as differences in experience and training.

10. No, the sample is a voluntary response sample and might not reflect the opinions of the greater population.

12. The headline suggests that the population was precisely counted, but a population count from a census is always an estimate. The headline should have used a number, such as 28,422,000, that does not suggest that it is precise.

14. The question appears to be designed to influence voter's opinion in favor of Sweeney's opponent.

16. Because the response are given to the Financial Consultant, the respondent might not be willing to give unfavorable responses that might jeopardize a working relationship. Better results are likely to be obtained with a commitment to confidentially.

18. It requires a calculation, which will result in some errors. Also, by asking for heights instead of measuring them, we tend to get desired values instead of actual values.

20. Instead of implying that the supine position is a cause of the decrease in deaths, the correct statement should observe that there is an association.

22. a. 251, b. 0.83, c. 4.5%, d. 29.4%

24. a. 7%, b. 312

26. Because a reduction of 100% would eliminate all plaque, it is not possible to reduce it by more than 100%

28. If the Club eliminated all car thefts, it would reduce odds of car theft by 100% so the 400% figure is misleading.
1-5 Basic Skills and Concepts

2. In an observational study, we observe and measure specific characteristics, but we don’t attempt to modify the subjects being studied. In an experiment, we apply some treatment and proceed to observe its effects on the subjects.

4. Because there is nothing about left-handedness or right-handedness that would affect being in the author’s classes, the results are likely to be typical of the population. The results are likely to be good, but convenience samples in general are not likely to be so good.

6. Observational study.

8. Experiment

10. Random

12. Systematic

14. Cluster

16. Convenience

18. Stratified

20. Random

22. No, no. The second M&M has no chance of being selected. Samples including the second M&M have no chance of being included.

24. Yes, no. All adults have the same chance of being chosen, but some samples (such as a sample with 600 men and 400 women) have no chance of being chosen.

26. Yes, Yes. Each student has the same chance, and every sample of size 6 has the same chance of being chosen.

28. Prospective

30. Retrospective

32. Answers vary.

2-2 Basic Skills and Concepts

2. If percentages are used, the sum should be 100%. If proportions are used, the sum should be 1.

4. The gap in the frequencies suggests that the table includes heights of two different populations: students and faculty/staff.

8. Class width: 1.00. Class midpoints: 0.495, 1.495, 2.495, 3.495, 4.495, 5.495. Class boundaries: -0.005, 0.995, 1.995, 2.995, 3.995, 4.995, 5.995.

10. No, no. The frequencies do not increase, reach a maximum, then decrease.

12. The weights are different, but they do not appear to be substantially different.

<table>
<thead>
<tr>
<th>Weight (lb)</th>
<th>Relative Frequency (Metal)</th>
<th>Relative Frequency (Plastic)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.00-0.99</td>
<td>8.1%</td>
<td>22.6%</td>
</tr>
<tr>
<td>1.00-1.99</td>
<td>41.9%</td>
<td>32.3%</td>
</tr>
<tr>
<td>2.00-2.99</td>
<td>24.2%</td>
<td>33.9%</td>
</tr>
<tr>
<td>3.00-3.99</td>
<td>19.4%</td>
<td>6.5%</td>
</tr>
<tr>
<td>4.00-4.99</td>
<td>5.5%</td>
<td>3.2%</td>
</tr>
<tr>
<td>5.00-5.99</td>
<td>5%</td>
<td>1.6%</td>
</tr>
</tbody>
</table>

14. Tar (mg) in Filtered Cigarettes | Cumulative Frequency

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Less than 6</td>
<td>2</td>
</tr>
<tr>
<td>Less than 10</td>
<td>4</td>
</tr>
<tr>
<td>Less than 14</td>
<td>10</td>
</tr>
<tr>
<td>Less than 18</td>
<td>25</td>
</tr>
</tbody>
</table>

16. Category | Relative Frequency

<table>
<thead>
<tr>
<th>Category</th>
<th>Relative Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Smoking after Nicotine Gum treatment</td>
<td>33.5%</td>
</tr>
<tr>
<td>Not smoking after Nicotine Gum Treatment</td>
<td>10.4%</td>
</tr>
<tr>
<td>Smoking after Nicotine Patch Treatment</td>
<td>46.1%</td>
</tr>
<tr>
<td>Non Smoking after Nicotine Patch Treatment</td>
<td>10.0%</td>
</tr>
</tbody>
</table>

18. The data are important because they can be helpful in determining effects of radiation from sources such as nuclear power plants.

<table>
<thead>
<tr>
<th>Strontium-90</th>
<th>Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>110-119</td>
<td>2</td>
</tr>
<tr>
<td>120-129</td>
<td>2</td>
</tr>
<tr>
<td>130-139</td>
<td>5</td>
</tr>
<tr>
<td>140-149</td>
<td>9</td>
</tr>
<tr>
<td>150-159</td>
<td>13</td>
</tr>
<tr>
<td>160-169</td>
<td>6</td>
</tr>
<tr>
<td>170-179</td>
<td>2</td>
</tr>
<tr>
<td>180-189</td>
<td>1</td>
</tr>
</tbody>
</table>
20. The amounts of nicotine appear to be substantially lower in the filtered cigarettes.

<table>
<thead>
<tr>
<th>Nicotine (mg)</th>
<th>Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.2-0.3</td>
<td>1</td>
</tr>
<tr>
<td>0.4-0.5</td>
<td>1</td>
</tr>
<tr>
<td>0.6-0.7</td>
<td>1</td>
</tr>
<tr>
<td>0.8-0.9</td>
<td>8</td>
</tr>
<tr>
<td>1.0-1.1</td>
<td>12</td>
</tr>
<tr>
<td>1.2-1.3</td>
<td>2</td>
</tr>
</tbody>
</table>

22. The frequency distribution does appear to have a normal distribution. In comparison to the result from Exercise 21, the generator frequencies appear to be substantially higher.

<table>
<thead>
<tr>
<th>Voltage (volts)</th>
<th>Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>123.9-124.0</td>
<td>2</td>
</tr>
<tr>
<td>124.1-124.2</td>
<td>1</td>
</tr>
<tr>
<td>124.3-124.4</td>
<td>6</td>
</tr>
<tr>
<td>124.5-124.6</td>
<td>9</td>
</tr>
<tr>
<td>124.7-124.8</td>
<td>13</td>
</tr>
<tr>
<td>124.9-125.0</td>
<td>5</td>
</tr>
<tr>
<td>125.1-124.2</td>
<td>4</td>
</tr>
</tbody>
</table>

24. The frequency distribution does appear to have a normal distribution. The weights of discarded paper are substantially greater than the weights of discarded metal.

<table>
<thead>
<tr>
<th>Weight (lb)</th>
<th>Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.00-4.99</td>
<td>8</td>
</tr>
<tr>
<td>5.00-8.99</td>
<td>21</td>
</tr>
<tr>
<td>9.00-12.99</td>
<td>22</td>
</tr>
<tr>
<td>13.00-16.99</td>
<td>8</td>
</tr>
<tr>
<td>17.00-20.99</td>
<td>3</td>
</tr>
</tbody>
</table>

26. The weights of regular cake appear to be significantly higher, probably due to the sugar content.

<table>
<thead>
<tr>
<th>Weight (lb)</th>
<th>Regular</th>
<th>Diet</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.7750-0.7799</td>
<td></td>
<td>11.1%</td>
</tr>
<tr>
<td>0.7800-0.7849</td>
<td></td>
<td>36.1%</td>
</tr>
<tr>
<td>0.7850-0.7899</td>
<td></td>
<td>41.7%</td>
</tr>
<tr>
<td>0.7900-0.7949</td>
<td>2.8%</td>
<td></td>
</tr>
<tr>
<td>0.7950-0.7999</td>
<td>0.0%</td>
<td></td>
</tr>
<tr>
<td>0.8000-0.8049</td>
<td>2.8%</td>
<td></td>
</tr>
<tr>
<td>0.8050-0.8099</td>
<td>8.3%</td>
<td></td>
</tr>
<tr>
<td>0.8100-0.8149</td>
<td>11.1%</td>
<td></td>
</tr>
<tr>
<td>0.8150-0.8199</td>
<td>47.2%</td>
<td></td>
</tr>
<tr>
<td>0.8200-0.8249</td>
<td>16.7%</td>
<td></td>
</tr>
<tr>
<td>0.8250-0.8299</td>
<td>11.1%</td>
<td></td>
</tr>
</tbody>
</table>

28. The post-1964 quarters weight considerably less than the pre-1964 quarters.

<table>
<thead>
<tr>
<th>Weight (g)</th>
<th>Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>Range</td>
<td>Frequency</td>
</tr>
<tr>
<td>---------------</td>
<td>-----------</td>
</tr>
<tr>
<td>5.5000-5.5499</td>
<td>3</td>
</tr>
<tr>
<td>5.5500-5.5999</td>
<td>9</td>
</tr>
<tr>
<td>5.6000-5.6499</td>
<td>11</td>
</tr>
<tr>
<td>5.6500-5.6999</td>
<td>9</td>
</tr>
<tr>
<td>5.7000-5.7499</td>
<td>7</td>
</tr>
<tr>
<td>5.7500-5.7999</td>
<td>1</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Cause</th>
<th>Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bad track</td>
<td>3</td>
</tr>
<tr>
<td>Faulty equipment</td>
<td>9</td>
</tr>
<tr>
<td>Human error</td>
<td>12</td>
</tr>
<tr>
<td>Other</td>
<td>6</td>
</tr>
</tbody>
</table>


2.3 Basic Skills and Concepts

2. Not necessarily. It is very possible that the voluntary response sample has characteristics that are fundamentally different from those of the population. Because those with special interests are more likely to respond, the voluntary response sample is likely to consist of a group with smaller range of characteristics that the general population.

4. When referring to a normal distribution, the term "normal" has a meaning that is different from the meaning in ordinary language. A normal distribution is characterized by a histogram that is approximately bell-shaped. Determination of whether a histogram is approximately bell-shaped does require subjective judgment.

6. 5000 miles; 2500 miles and 7500 miles.

8. The histogram includes mileage amounts from samples drawn from two different populations, such as the population of privately owned passenger cars and the population of taxi cabs, which are driven much longer distances.

10., 12., 14., 16., 18., 20., 22., Answers (Cut and Paste)
2. The scatterplot reveals pairs of quantitative data values. The scatterplot helps reveal a relationship between the two variables.

4. The Pareto chart does a better job of drawing attention to the important features. Pin charts are not recommended because they waste ink on uninteresting components, and they lack an appropriate scale.

6. The amounts have a distribution that is approximately normal, and they are centered around 150 millibecquerels.

<table>
<thead>
<tr>
<th>Age</th>
<th>Count</th>
</tr>
</thead>
<tbody>
<tr>
<td>11</td>
<td>46</td>
</tr>
<tr>
<td>12</td>
<td>49</td>
</tr>
<tr>
<td>13</td>
<td>93</td>
</tr>
<tr>
<td>14</td>
<td>1026</td>
</tr>
<tr>
<td>15</td>
<td>1024</td>
</tr>
<tr>
<td>16</td>
<td>1032</td>
</tr>
<tr>
<td>17</td>
<td>20</td>
</tr>
<tr>
<td>18</td>
<td>8</td>
</tr>
</tbody>
</table>

8. Eighteen of the amounts are below 150 millibecquerels.

10. The dotplot suggests that the weights of discarded glass have a distribution that is skewed to the right, but it is not too far from being a normal distribution.

12. The Pareto chart is more effective. It has a scale, and the categories with the highest frequencies are located furthest to the left.

14. The Pareto chart is more effective. It has a scale, and the categories with the highest frequencies are located furthest to the left.

16. By using a scaled scale and by arranging the bars in descending order, the Pareto chart is more effective at showing the relative importance of the categories.

18. By using a scaled scale and by arranging the bars in descending order, the Pareto chart is more effective at showing the relative importance of the categories.

20. By using a scaled scale and by arranging the bars in descending order, the Pareto chart is more effective at showing the relative importance of the categories.

22. There appears to be a weak pattern of higher energy consumption (in kWh) for lower temperatures (when heating is required) and lower temperatures (when air conditioning is required).
2. No. The poll involves a voluntary response sample, so it is very possible that the results do not accurately reflect the greater population, and no graph can overcome that fundamental sampling flaw.

4. The graph is not misleading. Areas are used to depict amounts that are actually areas, so the resulting graph correctly depicts the relative sizes of the countries.

Average Weight

<table>
<thead>
<tr>
<th>Country</th>
<th>Average Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>Women</td>
<td>137 lb or 62 kg</td>
</tr>
<tr>
<td>Men</td>
<td>172 lb or 78 kg</td>
</tr>
</tbody>
</table>

6. The graph creates the impression that men have salaries that are more than twice the amount of women. The graph is not fair, because the vertical scale does not start at 0.

8. The graph distorts the data. By using objects of volume, the difference is exaggerated. Comparing the actual numbers, the U.S. consumption is roughly four times that of Japan, but the graph makes that difference appear to be much greater.

10. The graph has a vertical scale that does not begin with zero, so the difference between the two frequencies is exaggerated. The graph makes it appear that adoptions more than doubled in 2005, but that is not the case.
2. The term average is not used in statistics. The mean should be used for the value obtained when data values are added, then the sum is divided by the number of data values.

4. V. The numbers do not meaningfully count anything, so the mean would be a meaningless statistic.

6. $x = 703.7$ hic; median = 630.5 hic; mode = none; midrange = 820.5 hic. All of the measures of center are less than 1000 hic, but that does not indicate that all of the individual booster seats satisfy the requirement. One of the booster seats has a measurement of 1210 hic, which does not satisfy the specified requirement of being less than 1000 hic.

8. $x = 760.9$; median = 764.0; mode = none; midrange = 750.0. The sample mean of 760.9 appears to be substantially higher than the reported mean of 678, so the sample FOC scores do not appear to be consistent with that reported mean.

10. $x = 1.9$; median = 2.0; mode = 1; midrange = 2.5. The mode of 1 correctly indicates that the smooth-yellow peas occur more than any other phenotype, but the other measures of center don't make sense with these data at the nominal level of measurement.

12. $x = 1.9$ kg; median = 1.5 kg; mode = 2 kg; midrange = 3.0 kg. No, because the mean weight gain is only 1.9 kg, which is far below the 6.8 kg weight gain given in the legend.

14. $x = 5457.874$; median = $3255.072$; mode = none; midrange = 6907.715. If the highest salary is omitted, the mean drops from $5457.874$ to $3247.7674$, but the median drops from $3255.072$ to $3200.040$. The mean changes by a large amount, but the median changes by a much smaller amount.

16. $x = 10.8$; median = 7.5; mode = 1; midrange = 79.5. Yes, 158 is an exceptional number of satellites, and they are from the United States.

18. $x = 7.60$ tons; median = 7.30 tons; mode = 7.2 tons; midrange = 7.90 tons. A simple random sample of cars from Data Set 16 is not a simple random sample of cars in use. Many cars in use are not included in Data Set 16. Also, the different models of cars in use do not

20. $x = 149.2$ µg; median = 150.0 µg; mode = 151.0 µg; midrange = 151.0 µg. The measures of center are all close together, which suggests that the data are roughly symmetric with a single value that occurs with the maximum frequency.

22. From the 1920s and 1930s: $x = 20.1$; median = 19.85, from recent winners: $x = 18.74$; median = 18.95. The more recent winners do appear to have lower measures of body mass index.

24. Jefferson Valley: $x = 7.15$ min; median = 7.20 min. Providence: same results as Jefferson Valley. Although the measures of center are the same, the Providence times are much more varied than the Jefferson Valley times.

26. $x = 0.7606$ lb; median = 0.7440 lb. The swans do have a length of 3/4 in, except for a very small and insignificant area.

28. B-class: $x = 572.4$ million; median = 551.0 million; mode = 549.3 million; midrange = 571.0 million. The results contradict the stated claim.

30. $x = 7.63$. The mean from the frequency table is close to the mean of 7.63 for the original list of data values.

32. $x = 1.998$ lb. The mean from the frequency table is close to the mean of 1.991 lb for the original list of data values.

33. 2.35; no

34. 14, 8, 8
2. The statement is incorrect because it defines the standard deviation as a value that depends on the minimum and maximum values, but it uses every data value.

4. Yes, because it differs from the mean by more than two standard deviations.

6. Range = 779.0 lb;
   \(s^2 = 74,383.5 \text{ lb}^2\); \(s = 272.7 \text{ lb}\).
   Yes, there appears to be much variation. The largest value is more than twice the smallest value.

8. Range = 172.0; \(s^2 = 3997.0\);
   \(s = 58.3\). A FICO score of 500 is unusual because it is more than two standard deviations below the mean.

10. Range = 3.0; \(s^2 = 0.9\); \(s = 0.9\).
    Because the data are at the nominal level of measurement, these results make no sense.

12. Range = 16 kg; \(s^2 = 16.5 \text{ kg}^2\);
    \(s = 4.1 \text{ kg}\). The weight gain of 6.8 kg is not unusual because it is within two standard deviations of the mean. Although a gain of 6.8 kg is not unusual, the mean weight gain of 1.9 kg is not close to the legendary 6.8 kg, so an individual weight gain of 6.8 kg does not support the legend.

14. Range = 51,081,421.0;
    \(s^2 = 138,043,695,500 \text{ dollars}^2\);
    \(s = 377,574.5\). If the highest salary is omitted, the standard deviation drops from 377,574.5 to 327,031.8, so the change is substantial.

16. Range = 157.0 satellites;
    \(s^2 = 1009.7 \text{ satellites}^2\); \(s = 31.8\) satellites. No, because 8 satellites is within two standard deviations of the mean.

18. Range = 2.80 tons;
    \(s^2 = 0.74 \text{ ton}^2\); \(s = 0.86 \text{ ton}\). No, because 9.3 tons is within two standard deviations of the mean.

20. Range = 74.0 m/s;
    \(s^2 = 224.5 \text{ m/s}^2\); \(s = 15.0 \text{ m/s}\).
    The values of 116 m/s, 114 m/s, and 108 m/s are unusual, because they are more than two standard deviations away from the mean.

22. From the 1920s and 1930s 7.3%.
    From recent winners: 6.3%.
    The amounts of variation from the two time periods are about the same.

24. Jefferson Valley: 6.7%. Prevalence:
    25.5%. The single line results in much less variation than the individual lines.

26. Range = 0.0460 in.;
    \(s^2 = 0.0002 \text{ in.}^2\); \(s = 0.013 \text{ in.}\).

28. Rated: Range = 5294.0 million;
    \(s^2 = 3343.2 \text{ (million dollars)}^2\);
    \(s = 57.8 \text{ million. P/E or P/G-12:}
    Range = 5248.0 million;
    \(s^2 = 11,668.2 \text{ (million dollars)}^2\);
    \(s = 108.0 \text{ million. The coefficients of variation are 79.8% and 72.3% so the amounts of variation are not substantially different.}

30. \(s = 12.3\). The standard deviation is close to the value of 12.5 for the original list of data values.

32. Answer varies, but \(s = 12\) years,
    based on a minimum of 23 years and a maximum of 70 years.

34. \(\text{a. } 95\%\)
    \(\text{b. } 99.7\%\).

36. At least 39% of the voltage amounts are within 3 standard deviations of the mean. The mean is 120.1 volts and the maximum is 129.9 volts.
30. __________

32. The weights of regular Coke appears to be somewhat less than those of regular Pepsi
   __________

34. The home voltage amounts appear to be somewhat less than the voltage amounts from the generator.
   __________

   __________

38. a. $7 million, $80 million, $118 million

4-2 Basic Skills and Concepts:

2. The reasoning is wrong because it assumes that the two outcomes are equally likely, but they are not. The probability will depend on such factors as the candidates, the issues, and so on.

4. The answers varies, but an answer in the neighborhood of 0.99 is reasonable.

6. 0.80

8. ½ or 0.5

10. 18/28 or 9/19 or 0.474

12. 1

14. a. 1; b. 0; c. 1/10 or 0.1; d. ½ or 0.5; e. 1/5 or 0.2

16. ½ or 0.25; no. it is not unusual.

18. a. 51; b. 51/98; c. 0.520

20. 0.0918. The probability of this error is high (roughly one chance in ten), so the test is not very accurate.

22. 0.738; yes

24. 0.920; yes

26. 0.159; no; yes

28. 0.000195. Yes, it is unusual. Because the probability is so low, it does not appear to be a serious problem for Delta passengers.
30. 0.480; not unusual

32. 0.0477; yes, it is unusual

34. a. bbbb, bbbg, bbgb, bbgg, bgbb, bggb, gbbb, gbbg, gbgb, gbgg, gbbg, ggbg, gggb, gggg, gggg
   b. 6/16 or 3/8 or 0.375
   c. 1/16 or 0.0625

36. a. 0; b. 0; c. 0.5; d. 0

4-3 Basic Skills and Concepts

2. Yes. There is no overlap between an event not occurring and the event occurring. They are completely separate and disjoint.

4. The events G (girl) and H (heads) are not events from a single trial, as required. They are events from two different trials, so the addition rule described in this section does not apply.

6. Disjoint

8. Disjoint

10. Disjoint

12. Not disjoint

14. 0.9975

16. P(1) denotes the probability of screening a drive and finding that he or she is not intoxicated, and P(1) = 0.99112 = 0.991 (rounded).

18. 47/98 or 0.480

20. 83/98 or 0.847

22. 350/839 or 0.417

24. 551/839 or 0.657

26. 638/839 or 0.760

28. 202/1205 = 0.168

30. 358/1205 = 0.297
32. \( \frac{431}{1205} = 0.358 \)

34. 0.487

36. \( \frac{122}{300} = 0.407 \). No, the general population probably has a marijuana use rate less than 0.407 or 40.7%.

38. \( \frac{273}{300} = 0.910 \). Exercise 37 results in the probability of a wrong result and this exercise results in the probability of a correct result, so these exercises deal with events that are complements.

### 4.4 Basic Skills and Concepts

2. The probability of event B occurring, given that event A has already occurred.

4. Yes. The 5% guideline applies because the sample of 1068 is no more than 5% of the population of 477,938, and the calculations with dependent events would be extremely cumbersome.

6. Dependent (some power supply)

8. Independent

10. Independent

12. Dependent

14. 0.00299. Yes, it is unusual because the probability is very low, such as less than 0.05

16. 0.00294. The event is very unlikely because its probability is so small.

18. a. 0.000008; b. 0.150

20. a. 0.000064; b. 0.0000247

22. 0.941

24. \( \frac{1}{5} \times \frac{1}{8} = 0.0000256 \). (The first victim could choose any of the men, then the other eight must match that first choice.) No.

26. \( \frac{1}{1024} = 0.000977 \). The likelihood of getting 10 girls in 10 births by chance is very small, so the results do suggest that the method is effective.

28. 0.000004. With one radio, there is a 0.002 probability of a serious problem, but with two independent radios, the probability of a serious problem drops to 0.000004, which is dramatically lower. The flight therefore becomes much safer with two independent radios.
30. a. No; b. 0.926; c/ 0.927; c. Although the answers are close, the answer from part (b) is better because it is based on an exact calculation.

4-5 Basic Skills and Concepts

2. $P(B)$ denotes the probability of an event $B$ occurring, assuming that the event $A$ has already occurred.

4. Incorrectly believing that $P(B|A)$ is the same as $P(A|B)$, or to incorrectly use one of those values for the other.

6. At least one of the defibrillators is defective.

8. None of the five women accepts a date with Brutus.

10. 0.996. Either a very rare event has occurred or there is some factor that makes boys more likely for this couple.

12. 0.998. The probability of being forced to complete the exam without a calculator drops from 0.04 to 0.002, (or from 40 chances in a thousand to 2 chances in a thousand), so she does gain a substantial increase in reliability.

14. 0.0394

16. 0.932. The system cannot continue indefinitely because there would be no girls to give birth.

18. a. 0.943; b. 0.00000916; c. The defective is much better than average.

20. $9/51 = 0.176$. The probability of this error is high, suggesting that the polygraph test is not very accurate.

22. a. $32/47 = 0.681$; b. $32/41 = 0.780$; c. They are not equal.

24. a. $2/3$ or $0.667$; b. 1

26. $\frac{3}{4}$ or 0.25

28. a. 0.0592 (not 0.0591); b. 0.952

30. 0.114

4-6 Basic Skills and Concepts

2. One number between 1 and 6 is generated, then a second number between 1 and 6 is generated, then the two results are added.
4. The simulation does not necessarily provide the exact probability, so the student should state that the probability is estimated to be 0.977.

6. Randomly generate 15 numbers between 1 and 10, and consider all 1s to be left-handed people, while the numbers 2 through 10 are people who are not left-handed.

8. Randomly generate 20 integers between 1 and 4 inclusive, and consider an outcome of 1 or 2 or 3 to be a peas with a green pod, while an outcome of 1 or 2 or 3 to be a pea with a green pod, while an outcome of 4 is a pea with a yellow pod.

10. a. Answer varies. b. It would not be unusual to randomly select 15 people and find that none of them are left-handed.

12. a. Answer varies. b. It would be unusual to find that none of the peas have yellow pods.

14. The exact answer is 0.21875, so an answer from a simulation should be around 0.2. Such runs are not unusual.

16. For the simulation, generate 2103 numbers randomly selected between 1 and 1671, and consider results of 1 or 2 to be infections. Sort the results so that it is easy to count the number of infections (1s or 2s). Repeat the simulation often enough to see that an outcome of 6 is unusual. The results suggest that the infection rate with Nasonex is higher, although 6 infections among 2103 treated subjects is not substantially greater than 2 infections among 1671 subjects.

4-7 Basic Skills and Concepts

2. No. Because the numbers must be entered in the correct order, the locks are actually based on permutations, not combinations. They are actually permutation locks.

4. Because the order of the first two finishers does not make a difference, the quinella involves combinations.

6. 362,880

8. 2,598,960

10. 1,176,000

12. 720

14. 1/22,957,480

16. a. 1/16,991; b. 1/20,389,320
18. a. \(1/10,000,000,000,000,000\); b. \(1/1,000,000,000,000,000\); c. \(1/100,000,000\). The number of possibilities is still quite large, so there is no reason to worry.

20. 64

22. 10

24. 15,504; 1/15,504

26. 60 ways; BAGGY; 1/60

28. 1/100,000,000. No, there are too many different possibilities.

30. a. \(\frac{1}{4}\) or 25; b. \(\frac{3}{16}\) or 0.188; c. Trick question. There is no finite number of attempts, because you could continue to get the wrong position every time.

32. a. 1,048,576 b. 184,756 c. 0.176 d. with a probability of 0.176, the result is common, but it should not happen consistently.

34. 1/175,711,536

36. a. 63; b. 0.363 = 1.08 x 10^19; c. 5,738,31575 or about 5.7 billion

5-2 Basic Skills and Concepts

2. No. There is no requirement that the expected value must be an integer, so the correct expected value is 1.5, not 2. The expected value is not the most likely value in one trial; it is a mean value obtained from infinitely many trials.

4. No. Because the sum of the probabilities is 2.1, it is impossible to have the outcomes occur with the given probabilities. The list of outcomes with the corresponding probabilities does not describe a probability distribution.

6. A. Continuous; B. Discrete C. Discrete d. Continuous e. Discrete

8. Not a probability distribution because \(P(x) = 0.984 = 1\).

10. Probability distribution with \(u = 0.6\) and \(o = 0.7\)

12. Probability distribution with \(u = 0.6\) and \(o = 7\)

14. 3.6 to 8.4; yes, it is unusual to get 1 pea with a green pod, because the value of 1 is outside of the range of usual values.

16. a. 0.023 b. 0.027 c. Part (b) d. Yes, because the probability of 3 or fewer peas with green pods is 0.027, which is very low (less than 0.05).
18. a. Yes  b. \( = 2.9 \) interviews and \( o = 1.2 \) interviews.  c. 0.5 to 5.3  d. No because the value of 1 is within the range of usual values.

20. a. Yes  b. \( u = 4.0 \) females and \( o = 1.4 \) females.  c. 1.2 females to 6.8 females  d. Yes, because 0 females is outside of the range of the usual numbers of females.

22. \( u = 2.0; \ o = 1.0. \) It is not unusual to get 4 girls, because the probabilities of 4 girls (1/6) is greater than 0.05, indicating that 4 girls could easily occur by chance.

24. a. 1,2,3,4,5,6,7,8,9  b. \( u = 5.0 \) and \( o = 2.6 \)  c. -0.2 to 10.2  d. No, because no leading digit is outside of the range of usual values given in part (c).

26. a. 10,000  b. 1/10,000 or 0.0001  c. $2787.50  d. -22.12 cents or -22 cents  e. The 50 cents bet in New Jersey’s pick 4 games is better, because it has a large expected value (-22 cents is greater than - 25 cents)

28. a. $131,477.54  b. $253,584.47  c. $375,691.40 to $638,646.48  d. Yes, because the values are outside of the range of usual values given in part (c).

30. a. -$226 and $49,774  b. -$66  c. Yes. The expected value for the insurance company is $66, which indicates that the company can expect to make an average of $66 for each such policy.

5-3 Basic Skills and Concepts

2. If \( p \) represents the probability of getting a person with blue eyes, then \( x \) should count the number of people with blue eyes. The format of Formula 5-5 requires that \( p \) and \( x \) refer to the same event.

4. \( 0+ \) indicates that the probability is a very small positive value. Table A-1 shows that \( 0+ \) is a positive probability less than 0.00005. The event is possible, but it is very unlikely.

6. Not binomial: there are more than two possible outcomes.

8. Binomial

10. Not binomial. Because the Governors are selected without replacement, the event are not independent, and they cannot be treated as being independent.

12. Binomial. Although the events are not independent, they can be treated as being independent by applying the 5% guideline.

14. a. 0.00220  b. Each of the 15 arrangements has probability 0.00220.  c. 0.0330

16. 0+

18. 0.014
20. 0.014

22. 0.216

24. 0.0000293

26. 0.407; it is not very likely that at least three Group O donors will be obtained.

28. 0.593

30. 0.135; 0.865

32. 0.113 or 0.114. The probability is high enough to justify making plans for at least one delinquent account.

34. 0.999999. If the answer is rounded to three significant digits, the result becomes 1.00, which incorrectly suggests that it is certain that at least one of the offspring peas will have a green pod.

36. a. 0.00000250  b. 0.00000250  c. No, it is extremely unlikely to occur by chance.

38. 0.0336. It is not likely that such combines samples test positive, so the company will rarely need to test the individual blood samples.

40. a. 0.309  b. Unlike part (a) the 9 selected subjects are more than 5% of the 150 subjects available, so independence cannot be assumed by the 5% guideline. The independence requirement for the binomial probability formula is not satisfied.

42. 0.295. The probability is no low, and it is high enough to be a real concern for passengers and Air America.

44. a. 0.0935  b. 0.0244  c. 0.118 (the probability that 1 is an unusually low number of defects, which is P(0) + P(1))  d. Because there is a good chance of getting 1 or fewer defects, there is not strong evidence supporting the claim that the modified procedure is better.

5-4 Basic Skills and Concepts

2. The standard deviation cannot be a negative number, so the given standard deviation cannot be correct.

4. Sampling is done without replacement, so the binomial requirement of independence is not satisfied. Also, the 5% guideline suggests that we should not treat the events as independent because the sample size of  n = 12 is more than 5% of the total number of students (40). The situation cannot be described by a binomial distribution, so Formulas 5-6 and 5-8 do not apply.
6. \( u = 76.0; \sigma = 6.2 \); minimum = 63.6; maximum = 88.4

8. \( u = 37.5; \sigma = 12.2 \); minimum = 148.6; maximum = 97.4

10. \( u = 20.0 \) and \( \sigma = 4.0 \)  b. It would be unusual to pass by getting at least 60 correct answers, because the range of usual numbers of correct answers is from 12.0 to 28.0, and 60 is outside of that range of usual values.

12. \( u = 24.0 \) and \( \sigma = 4.3 \). b. The result of 27 blue M&Ms is not unusual because it is within the range of usual values, which is from 15.4 to 32.6. The claimed rate of 24% does not appear to be wrong.

14. a. \( u = 76.0 \) and \( \sigma = 6.2 \)  b. The result of 127 boys is unusual because it is outside of the range of usual values, which is from 63.6 to 88.4. The results suggest that the YSORT method is effective.

16. a. \( u = 266.0 \) and \( \sigma = 14.1 \)  b. The actual result of 277 plants with short stems is not unusual because it is within the range of usual numbers, which is from 237.8 to 294.2. The actual results suggest that Mendel’s theory appears to be correct.

18. a. \( u = 142.8, \sigma = 11.9 \)  b. No, 135 is not unusual because it is within the range of usual values (119.0 to 166.6). c. Based on the given results, cell phones do not pose a health hazard that increases the likelihood of cancer of the brain or nervous system.

20. a. \( u = 140.0, \sigma = 8.4 \)  b. The result of 123 correct identifications is just outside of the range of usual values (123.2 to 156.8), but this indicates that 123 is unusually low. If the touch therapists really had an ability to select the correct hand, they would have made more than 156.8 correct identifications. Therefore, they do not appear to have that ability.

5-5 Basic Skills and Concepts

2. \( u = 0.345, \sigma = 0.588, \sigma^2 = 0.345 \)

4. 0.335 is correct. The Poisson distribution should not be used because we are not dealing with occurrences of 2s over some interval, so the requirements are not all satisfied.

6. 0.222

8. 0.846

10. a. 0.575  b. 0.114  c. It is not unusual, because the probability of 0.114 is not very small.

12. a. 0.497  b. 0.348  c. 0.122  d. 0.0284  e. 0.00497 The expected frequencies of 139, 97, 34.8, and 1.4 compare reasonably well to the actual frequencies, so the Poisson distribution does provide good results.
14. a. 0.136719 (or 0.137)  b. 0.991464  c. 0.009536  d. No, the probability of more than 1 case is extremely small so the probability of getting as many as 4 cases is even smaller.

16. a. 1.82  b. 0.725  c. 0.725 is the same result when rounded to three decimal places.

6-2 Basic Skills and Concepts

2. The bell shape starts low, rises to a maximum, then decreases. Also, it is symmetric. It has the same shape as Figure 6-1.

4. The notation $Z_a$ represents the $Z$ score that has an area of 0 to its right.

6. 0.25

8. 0.2

10. 0.7734

12. 0.7611

14. -0.66

16. -1.57

18. 0.0030

20. 0.9904

22. 0.0099

24. 0.9750

26. 0.1574 (Tech: 0.1573)

28. 0.1498 (Tech: 0.1499)

30. 0.9078

32. 0.8412 (Tech: 8413)

34. 0.0001

36. 0.5000

38. 95.44% (Tech: 95.45%)
40. 99.98% (Tech: 99.95%)
42. 2.33
44. 2.05
46. 0.9500
48. 0.0500
50. 2.33
52. -2.575, 2.575 (Tech: -2.576, 2.576)

6-3 Basic Skills and Concepts

2. a. 1  b. 100  c. 1000

4. No, because the generated digits do not have a normal distribution. The probability of a digit less than 5 is 0.5.

6. 0.9082 (Tech: 0.9088)

8. 0.7011 (Tech: 0.6997)

10. 87.4

12. 135.0 (Tech: 134.9)

14. 0.0179

16. 0.1596

18. 90.0 (Tech: 89.9)

20. 105.0

22. a. 0.01% (Tech: 0.00%); practically no men can fit without bending.  B. 0.01% (Tech: 0.00%); practically no women can fit without bending.  C. The door design is very inadequate, but the jet is relatively small and seats only six people. A much higher door would require such major changes in the design and cost of the jet, that the greater height is not practical.  D. 69.7 in.

24. a. 73.9 in.  b. 68.0 in.
26. a. 96.32% (Tech: 96.29%). There aren't many men not satisfying the height requirements, but with roughly 4% of men not satisfying those requirements, the number of men who are ineligible is not very small. B. Minimum: 63.7 in.; maximum: 73.9 in.

28.a. 0.5279 (Tech: 0.5275)   b. 25 men   c. 20   d. The mean weight is increasing over time, so the safety limits must be updated to avoid an unsafe condition.

30. 17.7 in.

32. 21.1 in., 25.3 in.

34. a. The graph is approximately bell shaped and \( x = 220.1 \) hours and \( s = 86.0 \) hours. B. \( Q_1 = 162.5 \) hours, \( Q_2 = 220.1 \) hours, and \( Q_3 = 277.7 \) hours.

6-4 Basic Skills and Concepts

2. No. The data set is only one sample, but the sampling distribution of the mean is the distribution of the means from all samples, not the one sample mean obtained from this single sample.

4. When selecting a relatively small sample significant difference whether we sample with replacement or without replacement. Sampling with replacements results in independent events that are unaffected by previous outcomes, and independent events are easier to analyze and they result in simpler calculations and formulas.

6. Mean, proportion, variance

8. Normal (approximately)

10. a.

<table>
<thead>
<tr>
<th>s</th>
<th>Probability</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>3/9</td>
</tr>
<tr>
<td>0.707</td>
<td>2/9</td>
</tr>
<tr>
<td>4.950</td>
<td>2/9</td>
</tr>
<tr>
<td>5.657</td>
<td>2/9</td>
</tr>
</tbody>
</table>

b. The population standard deviation is 3.559, but the mean of the sample standard deviations is 2.519. The values are not equal. C. The sample standard deviations do not target the population standard deviation of 3.559, so sample standard deviations do not make good estimators of population standard deviations. (However, for large samples the bias is relatively small, so sample standard deviations are used as estimators of populations standard deviations.)

12. a.

<table>
<thead>
<tr>
<th>Sample Mean</th>
<th>Probability</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1/9</td>
</tr>
<tr>
<td>2.5</td>
<td>2/9</td>
</tr>
</tbody>
</table>
3  1/9
6  2/9
6.5 2/9
10 1/9

b. The population mean is 5, and the mean of the sample means is also 5. The values are equal.
c. The sample means target the population mean of 5, so the sample means do make good estimators of the population mean.

14. a. Same as Exercise 13 part (a).  b. Same as Exercise 13 (b)  c. The median of the population is 5.25, but the mean of the sample medians is 52.25, so those values are not equal.  D. The sample medians do not target the population median of 52.5, so sample medians do not make good estimators of population medians.

16. a. Same as Exercise 13 part (a).
   b. | $s^2$ | Probability |
   -----|--------|-------------|
   0   | 4/16   |
   1   | 2/16   |
   4.5 | 2/16   |
   24.5| 2/16   |
   40.5| 2/16   |
   50  | 2/16   |
   72  | 2/16   |

   c. The population variance is 24,1875, and the mean of the sample variances is also 24,1875. Those values are equal.  D. The sample variances do target the population variance, so sample variances do make good estimators of the population variance.

18. Portion of Girls | Probability |
-------------------|-------------|
0                  | 1/8         |
1/3                | 3/8         |
2/3                | 3/8         |
1                  | 1/8         |

Yes. The proportion of girls in 3 births is 0.5, and the mean of the sample proportions is 0.5.

20. a. The proportions of 0.05, 1 have the corresponding probabilities of 9/25, 12/25, 4/25.  B. 0.4  
c. Yes; yes

6-5 Basic Skills and Concepts

2. The population must have a normal distribution.

4. No. The distribution of income is skewed to the right, with many people having no income or low incomes, and with very few people having extremely large incomes of millions of dollars. The distribution of sample values will be skewed no matter how large the samples is. If we were to collect
many samples of size \( n > 30 \), the sample means will have a distribution that is approximately normal, but the distribution of the values in a sample will be skewed.

6. a. 0.4013 (Tech: 0.4004)  b. 0.0217 (Tech: 0.0218)

8. a. 0.0470 (Tech: 0.483)  b. 0.1507 (Tech: 0.1515)  c. If the original population is normally distributed, then the distribution of sample means is normally distributed for any sample size.

10. a. 0.0139  b. 0.0001 (Tech: 0.0000)  c. No, the means can be 133 while some individual scores are below 131.5

12. a. 0.2981 (Tech: 0.2969)  b. 0.0038  c. Yes, because it is unlikely (with a probability of only 0.0038) that the mean will be that low because of chance.

14. a. 0.5793  b. 0.9772  c. Although the mean head breadth of 100 men is very likely to be less than 6.2 in., there could be many individual men that could not use the helmets because they have head breadths greater than 6.2 in. Based on the result from par (a), these helmets would not fit about 42% of men.

16. a. 0.5239 (Tech: 0.5231)  b. 0.8944 (Tech: 0.8941)  c. Instead of filling each bag with exactly 465 M&Ms, the company probably fills the bags so that the weight is as stated. In any event, the company appears to be doing a good job of filling the bags.

18. a. 15  b. 0.9998 (Tech: 1)  c. Part (a), because the individual rejected quarters could result in lost sales and lower profits.

20. 0.0001 (Tech: The probability is very small, such as 0.000000000002.) The probability suggests that the mean is not 98.60F.

6.6 Basic Skills and Concepts

2. The continuity correction is used to compensate for the fact that continuous distribution is being used to approximate a discrete distribution. In this case, the discrete IQ score of 107 is represented by the interval from 106.5 to 107.5.

4. \( u = 20 \) and \( o = 4 \). \( u \) is the mean, and the value of 20 indicates that for many people who make random guesses, the mean number of correct responses is 20. \( o \) is the standard deviation and it is a measure of how much the numbers of correct responses will vary.

6. The area to the right of 1.5

8. The area between 3.5 and 4.5

10. The area between 11.5 and 16.5

12. The area between 23.5 and 24.5
14. 0.236; normal approximations is not suitable.

18. 0.0075 (Tech using binomial: 0.0078). Yes, 20202 is an unusually low number of internet users because the probability of 2060 or fewer Internet users is so small. It is not likely that such a small number would occur by chance.

20. 0.0001 (Tech: 0.0000). The method appears to be effective, because the probability of getting at least 127 boys by chance is so small.

22. 0.0001 (Tech: 0.0000). The results suggest that the surveyed people did not respond accurately.

24. 0.0454 (Tech using normal approximation: 0.0457; tech using binomial: 0.0481)

26. 0.261 (Tech using normal approximation: 0.2622; tech using binomial: 0.2746). The Teletronics Company has quality control problems, because only 26.11% of its batches are being accepted. Unless corrective action is taken, the company will soon go out of business.

28. The probability of getting at least 479 checks with a leading digit of 5 is extremely close to 0. This indicated that the checks cannot be explained by random chance fluctuations. There appears to be very strong evidence that the checks are not the result of honest transactions.

30. Assuming that the polygraph makes random guesses, the probability of 15 or fewer false positives among 57 positive results is 0.0003 (Tech using binomial: 0.0002). Because that probability is so small, conclude that 15 is unusually low, so that the polygraph does not appear to be making random guesses.

32. 0.0197 (Tech using normal approximation: 0.0199; tech using binomial: 0.0198). Because the probability of at least 122 men is so low, the load will not have to be adjusted very often.

5.7 Basic Skills and Concepts

2. The points do not lie reasonable close to a straight line. The points show some systematic pattern that is not a straight-line pattern.

4. Identify outliers. If there is more than one outlier, conclude that the data do not have a normal distribution.

6. Normal. The points are reasonably close to a straight-line pattern and there is no other pattern that is not a straight-line pattern.

8. Not normal. The points show a systematic pattern that is not a straight-line pattern.

10. Not normal

12. Normal
14. Not normal

16. Normal

18. Elbow breadths appear to be normal, but systolic blood pressure levels do not appear to be normal. Systolic blood pressure levels are affected by diet, and diets might vary in dramatically different ways that do not yield normally distributed results.

20. Not normal; -1.38, -0.67, -0.21, 0.21, 0.67, 1.38

7-2 Basic Skills and Concepts

2. When using 43% as the value used to estimate the percentage of the population who would answer "yes", the maximum likely difference between 43% and the true population percentage is 1 percentage point, so the true population percentage is likely to be between 42% and 44%.

4. No. The sample would be a voluntary response sample, not a simple random sample, so it is very possible that the sample would not be representative of the population.

6. 2.81 (Tech: 2.8076338)

8. 2.33 (Tech: 2.3263479)

10. 0.750 # 0.030

12. 0.178 <p < 0.266

14. 0.774; 0.002

16. 0.169; 0.067

18. 0.0572

20. 0.0186

22. 0.182 <p < 0.218

24. 0.913 <p < 0.936

26. 66,307 (Tech: 66,349)

28. 483
30. a. 0.836  b. 0.758 <p < 0.913  c. Yes. The true proportion of boys with the YSORT method is substantially above the proportion of (about) 0.5 that is expected with no method of gender selection.

32. a. 0.697  b. 0.663 <p < 0.731  c. Yes. The population proportion does appear to be a value that is greater than 0.5

34. a. 0.662 <p < 0.737  b. No, because 0.61 is not included in the confidence interval.

36. a. 55.0%  b. 0.519 <p < 0.581  c. Yes, because the confidence interval shows that the proportion is very likely to be a value that is greater than 0.5

38. Using x = 71:0.368 <p < 0.578. Using p' = 0.47: 0.365 <p < 0.575. Because the confidence interval limits certain the value of 0.5, it is possible that the population proportion is exactly one-half.

40. a. 0.5  b. 0.439  c. 0.363 <p < 0.516  d. If the touch therapists really had an ability to select the correct hand by sensing an energy field, their success rate would be significantly greater than 0.5, but the sample success rate of 0.439 and the confidence interval suggest that they do not have the ability to select the correct hand by sensing an energy field.

42. a. 423  b. 125

44. 865

46. a. 67.2% (from 45/67)  b. 55.9% <p < 78.4%  c. 67% of college students in the United States gain weight in their freshman year. That percentage is based on a study of 67 college students at Rutgers University. In theory, in 95% of such studies, the percentage should differ by no more the 11 percentage points in either direction from the percentage that would be found by studying all college students in the United States.

48. 0.186 <p < 0.500. Yes. The confidence interval limits show that the proportion of movies with R rating is likely to be less than 0.5, so it follows that most movies have ratings different from R. (The upper limit is 0.50011 when given with more precision, and this changes the answer to "no")

7-3 Basic Skills and Concepts

2. The simple random sample is obtained from a convenience sample, not the population, so the confidence interval will not necessarily be a good estimate. She needs to obtain a simple random samples from the entire population, not a simple random sample obtained from some subgroup that might not be representative of the population.

4. Values of the statistic tend to target the value of the population parameter instead of systematically tending to underestimate it or overestimate it.

6. 2.33 (Tech: 2.3263479)
8. 2.05 (Tech: 2.0537489)

10. E = 2.4 ft; 134.6 ft < u < 139.4 ft

12. The margin of error and confidence interval cannot be calculated by the methods of this section.

14. 82

16. 333

18. 19.853 mg < u < 22.387 mg

20. There is 95% confidence that the interval between 19.853 mg and 22.387 mg contains the mean amount of tar in cigarettes that are king size, nonfiltered, nonmenthol, and non-light.

22. a. $415,943    b. $272,355 < u < $559,551 (Tech: $272,358 < u < $559,548)    c. Yes

24. a. 4.63    b. 4.43 < u < 4.83    c. The confidence interval is mostly within the normal range for males and is entirely within the normal range for females. The mean is roughly within the normal limits.

26. a. 3321 g < u < 3545 g    b. 3429 g < u < 3437 g    c. The confidence interval in part (a) is wider. The smaller sample size results in an estimate that is not as accurate.

28. a. 2.1 < u < 5.7    b. No. the digits are randomly generated in a way that results in a uniform distribution and the sample size is less than 31. The requirement that the population is normally distributed or n > 30" is not satisfied. In general, if the requirements are not satisfied, the confidence interval does not necessarily provide a good estimate of the mean. However, in this particular case we know that the population mean is 4.5, and the confidence interval does contain 4.5, so this confidence interval does provide a good estimate.

30. 6794.4 < u < 726.9

32. 1037

34. 210

36. The range is 40, so o is estimated to be 40/4 = 10 by the range rule of thumb, and the sample size is 97. The sample standard deviation is s = 11.3, which results in a sample size of 123. The sample size of 123 is likely to be better because s is a better estimate of o than range /4.

7.4 Basic Skills and Concepts

2. Robust against departures from normality means that the methods for constructing confidence intervals are not strongly affected by departures from normality, provided that those departures are not too extreme. The methods of this section are not robust against poor sampling methods, and very poor results can occur with samples that are not simple random samples.
4. The number of degrees of freedom is 4. If 5 drivers have a particular mean reaction time, we can freely assign values to 4 of those reaction times, but the 5th value is then determined. Because 4 of the values can be freely selected to be any values, we say that there are 4 degrees of freedom available.

6. \( t \alpha/2 = 2.575 \) (Tech: 2.5758293)

8. \( t \alpha/2 = 2.023 \)

10. Neither normal nor \( t \) distribution applies.

12. \( t \alpha/2 = 2.026 \)

14. \( E = 0.06; 0.06 < u < 0.18 \)

16. 1.55 lb < \( u < 2.271 \) lb. there is 99% confidence that the limits of 1.551 lb and 2.271 lb contain the mean weight of the plastic discarded by the population of all household.

18. a. 3103 g   b. 3002 g < \( u < 3204 \) g   c. The mean weight of babies born to mothers who used cocaine appear to be substantially less than the mean weight of babies born to mothers who did not use cocaine. Cocaine use appears to be associated with lower birth weights.

20. a. 21 lb   b. 0.0 lb < \( u < 4.2 \) lb   c. There does appear to be a loss of weight, but the actual amount of lost weight is so small that the weight loss program does not appear to be practical.

22. a. 1.6 < \( u < 2.0 \)   b. 1.3 < \( u < 1.9 \)   c. The two confidence interval are very similar. The acupuncture treatment group does not appear to fare any better than the sham treatment group, so the acupuncture treatment does not appear to be effective.

24. a. 32.4 years < \( u < 39.2 \) years   b. 41.2 years < \( u < 46.4 \) years   c. The entire confidence interval for actresses is less than the confidence interval for actor, so there appears to be a substantial difference in the mean ages. It appears that Oscar-winning best actresses are considerable young than Oscar-winning best actors.

26. 0.075 < \( u < 0.168 \); no, it is possible that the requirement is being met, but it is also very possible that the mean is not less than 0.165 grams/mile.

28. a. 103.5 min < \( u < 140.0 \) min   b. 170 minutes (Using the range rule of thumb results in a reasonable result of 162.5 min + 30 min + 192.5 min).

30. 52.3 years < \( u < 57.4 \) years. The population is the collection of all ages of presidents at the time of inauguration, presumable including future presidents. The confidence interval estimate of the mean does not necessarily provide a good estimate of the population mean, because increased longevity and other factors could cause a trend that is changing over time.

32. a. 65.8 < \( u < 73.0 \)   b. 72.3 < \( u < 80.3 \)   c. Because the two Cls overlap, we cannot conclude that the two population means are different.
7-5 Basic Skills and Concepts

2. Yes; no. The format of $E$ cannot be used due to the lack of symmetry of the chi-square distribution. The confidence interval does not have $E$ at its center.

4. An unbiased estimator is a statistic that targets the corresponding population parameter, instead of systematically underestimating it or overestimating it. The sample variance is an unbiased estimator, but the sample standard deviation is a biased estimator.

6. 8.907, 32.852

8. 34.764, 67.505

10. 1.8 mi/h $< \alpha < 3.2$ mi/h

12. 0.07 sec $< \alpha < 0.32$ sec

14. 21; yes, the sample size is small enough to be practical.

16. 211

18. a. 0.07975 g  b. 0.0453 g $< \alpha < 0.0598$ g (Tech: 0.0455 g $< \alpha < 0.0602$ g)  c. No. The results suggest that the estimated $\alpha$ from the range rule of thumb isn’t very accurate.

20. a. 8.6 $< \alpha < 15.5$ (Tech: 8.7 $< \alpha < 15.8$)  b. 9.6 $< \alpha < 17.2$ (Tech: 9.6 $< \alpha < 17.5$)  c. The two confidence intervals are not substantially different. There does not appear to be a difference between the standard deviations of pulse rates of men and women.

22. 24.8 mm $< \alpha < 59.4$ mm; yes

24. a. 0.33 min $< \alpha < 0.87$ min  b. 1.25 min $< \alpha < 3.33$ min  c. The variation appears to be significantly lower with a single line. The single line appears to be better.

26. 532.2 kWh $< \alpha < 896.8$ kWh (Tech: 545.3 kWh $< \alpha < 934.6$ kWh)

8-2 Basic Skills and Concepts

2. The P-value of 0.001 is preferred because it corresponds to the sample evidence that most strongly supports the alternative hypothesis that the XSORT method is effective.

4. No; no. No sample proportion less than 0.5 can even be used to support a claim that the population proportion is greater than 0.5.
6. There is sufficient evidence to support the claim that the proportion of households with telephones is now greater than 0.35.

8. There is not sufficient evidence to support the claim that movie patrons have a standard deviation less than 15.

10. \( H_0: p = 0.20 \), \( H_1: p \neq 0.20 \).

12. \( H_0: p = 0.5 \), \( H_1: p > 0.5 \).

14. \( H_0: \sigma = 0.66 \text{ cm} \), \( H_1: \sigma \neq 0.66 \text{ cm} \).

16. \( H_0: u = 1 \text{ kg} \), \( H_1: u < 1 \text{ kg} \).

18. \( z = 1.645 \)

20. \( z = -1.28 \)

22. \( z = 2.33 \)

24. \( z = 2.81 \)

26. \( z = 2.56 \)

28. \( z = 8.06 \)

30. \( 0.0062; \) reject the null hypothesis.

32. \( 0.5824 \) (Tech: 0.5823); fail to reject the null hypothesis.

34. \( 0.7264 \) (Tech: 0.7263); fails to reject the null hypothesis.

36. \( 0.0016; \) reject the null hypothesis.

38. There is sufficient evidence to support the claim that the parentage of on-time U.S. airline flights is less than 75%.

40. There is sufficient evidence to warrant rejection of the claim that the percentage of American who believe in heaven is equal to 90%.

42. Type I error: Reject the claim that the percentage of Americans who believe that life exists only on earth is equal to 20% when that percentage is actually 20%. Type II error: Fail to reject the claim that the percentage of Americans who believe that life exists only on earth is equal to 20% when that percentage is actually different from 20%.

44. Type I error: Reject the claim that the percentage of households with at least two cell phones is equal to 60% when that percentage is actually 60%. Type II error: Fail to reject the claim that the percentage of households with at least two cell phones is equal to 60% when it is actually less than 60%.
2. Ho: Because the sample is a voluntary response sample instead of a simple random sample, it is not suitable for making inferences about the population.

4. a. The symbol \( p \) represents the population proportion, and the \( p \)-value is the probability of getting sample results that are at least as extreme as those obtained.

b. If the \( p \)-value is small (such as less than or equal to 0.05), the null hypothesis should be rejected. But if the \( p \)-value is high (such as greater than 0.05), we should fail to reject the null hypothesis.

c. 0.000 (Tech: 0.0001)

d. There is sufficient evidence to reject the claim that more than 80% of adults believe that texting while driving should be illegal.

6. Ho: \( p = 0.05 \); \( H_1: p < 0.05 \). Test statistic: \( z = -0.42 \). \( p \)-value = 0.338. Fail to reject \( H_0 \). There is not sufficient evidence to support the claim that fewer than 5% of people aged 15 or older were arrested within the last year.

8. Ho: \( p = 0.45 \); \( H_1: p = 0.45 \). Test statistic: \( z = 3.70 \). \( p \)-value = 0.000. Fail to reject \( H_0 \). There is not sufficient evidence to warrant rejection of the claim that the percentage who believe that they voted for the winning candidate is equal to 45%. There appears to be a substantial discrepancy between how people said that they voted and how they actually did vote.

10. Ho: \( p = 0.1 \); \( H_1: p < 0.1 \). Test statistic: \( z = -1.645 \). \( p \)-value = 0.0001 (Tech: 0.2810). Fail to reject \( H_0 \). There is not sufficient evidence to support the claim that less than 10% of the test results are wrong. The sample results suggest that the test is wrong too often to be considered very reliable.

12. Ho: \( p = 0.1 \); \( H_1: p < 0.1 \). Test statistic: \( z = 1.13 \). \( p \)-value = 0.087 (Tech: 0.912). Fail to reject \( H_0 \). There is not sufficient evidence to support the claim that less than 0.5 of the deaths occur the week before Thanksgiving. Based on these results, there is no indication that people can temporarily postpone their deaths to avoid Thanksgiving.

16. Ho: \( p = 0.5 \); \( H_1: p > 0.5 \). Test statistic: \( z = 2.33 \). \( p \)-value = 0.000. Reject \( H_0 \). There is sufficient evidence to support the claim that women with more than 12 years of education have a proportion of correct predictions that is greater than 0.5. These women appear to have some ability to correctly predict the sex of their babies.

18. Ho: \( p = 0.5 \); \( H_1: p < 0.5 \). Test statistic: \( z = 9.16 \). Critical value: \( z = 2.33 \). \( p \)-value = 0.0001 (Tech: 0.00009). Reject \( H_0 \). There is sufficient evidence to support the claim that the proportion of boys is greater than the 0.5% threshold.

20. Ho: \( p = 0.5 \); \( H_1: p = 0.5 \). Test statistic: \( z = 2.66 \). Critical value: \( z = \pm 2.575 \). \( p \)-value = 0.000. Reject \( H_0 \). There is sufficient evidence to reject the claim that the proportion of those in favor of a boy is equal to 0.5. The result suggests that the population is wrong in claiming that the responses are random guesses equivalent to a coin flip.

22. Ho: \( p = 0.25 \); \( H_1: p > 0.25 \). Test statistic: \( z = 2.33 \). Critical value: \( z = \pm 1.645 \). \( p \)-value = 0.0001 (Tech: 0.0000009). Reject \( H_0 \). There is not sufficient evidence to support the claim that the arrest rate is greater than 25%.

24. Ho: \( p = 0.27 \); \( H_1: p < 0.27 \). Test statistic: \( z = -2.33 \). Critical value: \( z = -1.645 \). \( p \)-value = 0.0001 (Tech: 0.0000009). Reject \( H_0 \). There is sufficient evidence to support the claim that the proportion of those who have not graduated is less than 27% for the general population.

26. Ho: \( p = 0.25 \); \( H_1: p < 0.25 \). Test statistic: \( z = -4.47 \). Critical value: \( z = -1.645 \). \( p \)-value = 0.000. Reject \( H_0 \). There is sufficient evidence to reject the claim that the proportion of those in favor is less than 25%.

32. Ho: \( p = 0.1 \); \( H_1: p > 0.1 \). Test statistic: \( z = 1.645 \). Critical value: \( z = \pm 1.645 \). \( p \)-value = 0.0001 (Tech: 0.0000009). Fail to reject \( H_0 \). There is not sufficient evidence to warrant rejection of the claim that the proportion of pets with yellow paws is equal to 0.1.

34. Ho: \( p = 0.5 \); \( H_1: p < 0.5 \). Test statistic: \( z = -0.33 \). Critical value: \( z = -1.645 \). \( p \)-value = 0.0001 (Tech: 0.0000009). Fail to reject \( H_0 \). There is not sufficient evidence to warrant rejection of the claim that the proportion of males in the population is equal to 0.5.

36. Ho: \( p = 0.55 \); \( H_1: p > 0.55 \). Test statistic: \( z = -0.33 \). Critical value: \( z = -1.645 \). \( p \)-value = 0.0001 (Tech: 0.0000009). Fail to reject \( H_0 \). There is not sufficient evidence to warrant rejection of the claim that the proportions of movies in Data Set 9 are from a population in which 55% of the movies have R ratings.
2. We can consider the normally requirement to be satisfied if there are no outliers and a histogram of the sample data is not dramatically different from being bell-shaped. We could also use a normal quantile plot or a formal hypothesis test, such as the Ryan-Joiner test described in Section 6.7.

3. 90% or 99%

4. The mean weight loss of 2.1 pounds has statistical significance, because the hypothesis test led to the conclusion of rejecting the claim that the mean weight change is less than 0, but it does not have practical significance because a mean weight loss of only 2.1 pounds after one year is too small to justify all of the effort.

6. $H_0: \mu = 2.5 \text{ g}, \ H_1: \mu < 2.5 \text{ g}$
   Test statistic: $z = -0.33$. Critical value: $z = -1.645$ (assuming a 0.05 significance level). $p$-value: 0.370. Fail to reject $H_0$. There is not sufficient evidence to support the claim that pennies have a mean weight less than 2.5 g.

8. $H_0: \mu = 5.4, \ H_1: \mu < 5.4$, Test statistic: $z = -2.23$. Critical value: $z = -1.645$. $p$-value: 0.0131 [Tech: 0.0130]. Fail to reject $H_0$. There is not sufficient evidence to support the claim that the sample is from a population with a mean less than 5.4. Because there is not sufficient evidence to conclude that the mean is less than the upper limit of the range of normal values, the sample group appears to have red blood cell counts that are too high, so they should be given further tests.

10. $H_0: \mu = 98.6^\circ F, \ H_1: \mu \neq 98.6^\circ F$, Test statistic: $z = -6.64$. Critical values: $z = \pm 1.645$. $p$-value: 0.0000 [Tech: 0.0000]. Reject $H_0$. There is sufficient evidence to warrant rejection of the claim that the mean body temperature is 98.6°C. There is sufficient evidence to conclude that the common belief is wrong.

14. $H_0: \mu = 150 \text{ lb}, \ H_1: \mu \geq 150 \text{ lb}$
   Test statistic: $z = 1.98$. Critical values: $z = 1.645$. $p$-value: 0.0239 [Tech: 0.0238]. Reject $H_0$. There is sufficient evidence to support the claim that the population mean weight is more than 150 lb.

16. $H_0: \mu = 12 \text{ oz}, \ H_1: \mu \neq 12 \text{ oz}$
   Test statistic: $z = 10.36$. Critical values: $z = \pm 2.575$. $p$-value: 0.0002 [Tech: 0.0000]. Reject $H_0$. There is sufficient evidence to warrant rejection of the claim that cans of regular Cola have a mean volume of 12 oz. Based on the sample mean of 12.19 oz, the amounts of Cola do not differ from 12 oz by very much. The difference has statistical significance, but not much practical significance.

$p$-value: 0.5754 [Tech: 0.5740]. Fail to reject $H_0$. There is not sufficient evidence to warrant rejection of the claim that the new baseballs have a mean bounce height of 235.8 cm. The new baseballs do not appear to be different.

18. $H_0: \mu = 30 \text{ lb}, \ H_1: \mu < 30 \text{ lb}$
   Test statistic: $z = -1.62$. Critical value: $z = -1.645$. $p$-value: 0.0526 [Tech: 0.0526]. Fail to reject $H_0$. There is not sufficient evidence to support the claim that the mean is less than 30 lb. Based on these results, it is possible that the population mean is 30 lb or more, so the system could be in danger of being overloaded.
2. $df$ denotes the number of degrees of freedom. For the sample of 20 speeds, $df = 19$.

4. This section is more realistic, because it is rare to know the value of $\sigma$ without already knowing the value of $\mu$.

6. Neither normal nor Student $t$.
7. Neither normal nor Student $t$.
8. Normal
9. Table A-3: $P$-value > 0.10; technology: $P$-value = 0.3355.
10. Table A-3: $P$-value < 0.05; technology: $P$-value = 0.1771.
12. Table A-3: $P$-value < 0.005; technology: $P$-value = 0.0028.
14. $H_0: \mu = 5.4, H_a: \mu < 5.4$. Test statistic: $t = -2.238, P$-value: 0.0152. Fail to reject $H_0$. There is not sufficient evidence to support the claim that the sample is from a population with a mean less than 5.4.

There is not enough evidence to conclude that the sample is from a population with a mean that is less than the upper limit of the range of normal values, so it is possible that the population has red blood cell counts that are too high.

16. $H_0: \mu = 0$, $H_a: \mu > 0$. Test statistic: $t = 2.426, P$-value < 0.005 [Tech: 0.0002]. Reject $H_0$. There is sufficient evidence to support the claim that the mean weight loss is greater than 0.

Although the diet appears to have statistical significance, it does not appear to have practical significance, because the mean weight loss of only 3.0 lbs does not seem to be worth the effort and cost.

18. $H_0: \mu = 49.5$, $H_a: \mu > 49.5$. Test statistic: $t = -0.561, P$-value = 0.5719. Fail to reject $H_0$. There is not sufficient evidence to warrant rejection of the claim that the mean is 49.5

cents. The results suggest that the cents portions of check amounts are such that the values from 0 cents to 99 cents could be equally likely.

20. $H_0: \mu = 120$, $H_a: \mu > 120$. Test statistic: $t = 73.242, P$-value < 0.01 [Tech: 0.0000]. Reject $H_0$. There is sufficient evidence to warrant rejection of the claim that the mean voltage amount is 120 volts.

22. $H_0: \mu = 65$, $H_a: \mu > 65$. Test statistic: $t = 3.773, P$-value < 0.005 [Tech: 0.0003]. Reject $H_0$. There is sufficient evidence to support the claim that the mean speed is greater than 65 mph.

24. $H_0: \mu = 63.6$, $H_a: \mu > 63.6$. Test statistic: $t = 12.600, P$-value < 0.005 [Tech: 0.0000]. Reject $H_0$. There is sufficient evidence to support the claim that supermodels have a greater mean height than women from the general population.

26. $H_0: \mu = 48.0$, $H_a: \mu > 48.0$. Test statistic: $t = 1.979, P$-value < 0.005 [Tech: 0.0023]. Reject $H_0$. There is sufficient evidence to support the claim that the mean number of defined words on a page is greater than 48.0. There is not enough evidence to support the claim that there are more than 72,000 defined words in the dictionary.

28. $H_0: \mu = 20.16$, $H_a: \mu < 20.16$. Test statistic: $t = -3.739, P$-value < 0.005 [Tech: 0.0001]. Reject $H_0$. There is sufficient evidence to support the claim that the population of recent winners has a mean BMI less than 20.16. Recent winners appear to be significantly different from those in the 1920s and 1930s.

30. $H_0: \mu = 120$, $H_a: \mu < 120$. Test statistic: $t = 9.353, P$-value < 0.01 [Tech: 0.0000]. Reject $H_0$. There is sufficient evidence to warrant rejection of the claim that the mean voltage amount is 120 volts.

32. $H_0: \mu = 678$, $H_a: \mu < 678$. Test statistic: $t = 2.723, P$-value < 0.01 [Tech: 0.0007]. Reject $H_0$. There is sufficient evidence to warrant rejection of the claim that these sample FICO scores are from a population with a mean FICO score equal to 678.
2. We have 95% confidence that the limits of \(-0.0518\) and 0.0194 contain the true value of the difference between the two population proportions. This means that if we were to repeat the clinical trials many times with the same sample sizes, the confidence interval limits would contain the true difference between the population proportions in 95% of the cases.

4a. No. The P-value method and the traditional method will always agree, but the conclusion based on the confidence interval may or may not agree with them. The P-value and traditional methods use a standard deviation based on the assumption that the two proportions are equal, but the confidence interval uses a different standard deviation.

6. 16

20. \(H_0: \alpha = 60\) sec, \(H_1: \alpha < 60\) sec. Test statistic: \(z = 2.2938, \text{Critical value: } z = 1.645\). There is not sufficient evidence to support the claim that the standard deviation of the songs is less than one minute.

21. 65.673 and 137.957

22. 66.495, 138.996

26. \(H_0: p_1 = p_2, H_1: p_1 < p_2\). Test statistic: \(z = 1.49\). Critical value: \(z = \pm 1.96\). There is not sufficient evidence to support the claim that men and women tennis players have different success rates when challenging aces.

28. 0.147 < \(p_1 - p_2 < 0.228\) (Tech: 0.1350). Fail to reject \(H_0\). There is not sufficient evidence to support the claim that men and women tennis players have different success rates when challenging aces.

30. Using \(x_1 = 504\) and \(x_2 = 539\): \(H_0: p_1 = p_2, H_1: p_1 < p_2\). Test statistic: \(z = 0.44\). Critical value: \(z = \pm 1.96\). There is not sufficient evidence to support the claim that the percentage of males who answer “yes” is less than the percentage of females who answer “yes.”

32. 0.128 < \(p_1 - p_2 < 0.278\) (Tech: 0.129). Because the confidence interval limits do not contain 0, there is a significant difference between the two proportions. Because the confidence interval includes only positive values, it appears that the proportion of S3 designations in 1976 was greater than it is now.

34. Using \(x_1 = 117\) and \(x_2 = 29\): \(0.0836 < \frac{x_1 - p_1}{\sqrt{p_1(1-p_1)}} < 0.155\) (Tech: 0.0837 < \(p_1 < p_2 < 0.155\)). Using \(p_1 = 0.16\) and \(p_2 = 0.04; 0.0842 < \frac{x_2 - p_2}{\sqrt{p_2(1-p_2)}} < 0.156\). Because the confidence interval limits do not contain 0, there is a significant difference between the two proportions. Because the confidence interval includes only positive values, it appears that the proportion of headaches for those treated with Viagra is greater than the proportion of headaches for those given a placebo.
2. Because the confidence interval does not include the value of 0, the two population means do not appear to be equal. The mean pulse rate of men appears to be less than the mean pulse rate of women.

3. 98%

4. The critical value of 2.426 is more conservative than 2.376 in the sense that rejection of the null hypothesis requires a greater difference between the sample means. The sample evidence must be stronger with 2.426.

5. Independent

6. Dependent

1. Although the data seem paired because they are collected on the same days, they are not naturally related. The gasoline-powered generator is completely independent of the voltage supplied by the power company to the home, so the two samples are independent.

10. $-0.50 < \mu_1 - \mu_2 < 0.38$

2. $H_0: \mu_1 = \mu_2$, $H_a: \mu_1 > \mu_2$, Test statistic: $t = 3.284$, Critical value: $t = 1.776$ (T-DIST: $t = 1.776$).

18. $H_0: \mu_1 = \mu_2$, $H_a: \mu_1 > \mu_2$. Test statistic: $t = 2.372$, Critical value: $t = 1.796$ (T-DIST: $t = 1.796$).

22. $-198.2 < \mu_1 - \mu_2 < -182.6$

24. $-0.07 < \mu_1 - \mu_2 < -0.06$

26. $0.3 < \mu_1 - \mu_2 < 3.7$, Because the confidence interval limits do not include 0, the two means do not appear to be equal.

28. $-0.61 < \mu_1 - \mu_2 < 0.71$

30. $H_0: \mu_1 = \mu_2$, $H_a: \mu_1 < \mu_2$, Test statistic: $t = 3.264$, Critical value: $t = 1.776$ (T-DIST: $t = 1.776$).

32. $H_0: \mu_1 = \mu_2$, $H_a: \mu_1 \neq \mu_2$, Test statistic: $t = 2.948$, Critical value: $t = 2.948$ (T-DIST: $t = 2.948$).

34. $H_0: \mu_1 = \mu_2$, $H_a: \mu_1 \neq \mu_2$, Test statistic: $t = 1.776$, Critical value: $t = 1.776$ (T-DIST: $t = 1.776$).

36. $n_1 = 36$, $\bar{x}_1 = 0.815622$, $s_1 = 0.005674$, $n_2 = 36$, $\bar{x}_2 = 0.784744$, $s_2 = 0.004393$.

38. $-0.59 < \mu_1 - \mu_2 < 0.37$. In this case, the critical value is the same as the one obtained by using technology with Exercise 10. This confidence interval is very close to the one obtained in Exercise 10 if Table A-3 is used instead of technology.
2. No. The sample data are not really paired in a way that makes any sense. The 40 males and 40 females are two independent samples.

4. The first confidence interval shows that there is 95% confidence that the mean of the population of differences is contained within the limits of 0.2 kg and 2.1 kg, but the second confidence interval shows that there is 95% confidence that the difference between the two population means is contained within the limits of -2.7 kg and 5.0 kg.

6. a. \( H_0: \mu_d = 0, H_1: \mu_d \not= 0 \). Test statistic: \( t = -2.201 \). Critical values: \( \pm 2.201 \). P-value: > 0.20 ( Tech: 0.2461). Fail to reject \( H_0 \). There is not sufficient evidence to support the claim that there is a difference between self-reported heights and measured heights.

b. -3.2 in. < \( \mu_d < 1.2 \) in. because the confidence interval limits contain 0, there is not sufficient evidence to support the claim that there is a difference between self-reported heights and measured heights.

7. -9.0 < \( \mu_d < -7.5 \).

8. -3.9 < \( \mu_d < 7.5 \).

10. -0.947 < \( \mu_d < 0.967 \). The confidence interval includes 0, which suggests that the mean of the differences could be 0 and there is no change in BMI during freshman year.

12. \( H_0: \mu_d = 0, H_1: \mu_d \not= 0 \). Test statistic: \( t = 4.712 \). Critical value: \( t = 3.143 \). P-value < 0.05 ( Tcd: 0.0016). Reject \( H_0 \). There is sufficient evidence to support the claim that flights scheduled one day in advance cost more than flights scheduled 30 days in advance.

14. \( H_0: \mu_d = 0, H_1: \mu_d \not= 0 \). Test statistic: \( t = -17.339 \). Critical values: \( t = \pm 2.776 \). P-value < 0.01 ( Tcd: 0.0001). Reject \( H_0 \). There is sufficient evidence to support the claim of a difference in measurements between the two arms. The right and left arms should yield the same measurements, but the given data show that this is not happening.

16. \( H_0: \mu_d = 0, H_1: \mu_d \not= 0 \). Test statistic: \( t = 1.626 \). Critical value: \( t = 1.833 \). P-value > 0.05 ( Tcd: 0.0762). Fail to reject \( H_0 \). There is not sufficient evidence to support the claim that the mean of the differences is greater than 0. See. There is not sufficient evidence to support the claim that more time is devoted to showing tobacco than alcohol. No time should be spent showing the use of tobacco and alcohol.
2. A correlation between two variables indicates that values of the two variables are somehow associated, but the mathematical association does not necessarily imply that one of the variables is a direct cause of the other variable. There might be some other variable(s) that affects the two given variables, or the correlation might be the result of a coincidence.

4. Table 4.6 shows that the critical values of $r$ are $\pm 0.312$ (assuming a 0.05 significance level), so there is sufficient evidence to support a claim of a linear correlation between the before and after weights. The value of $r$ does not indicate that the diet is effective in reducing weight. While the diet might be effective in reducing weight, there could be a linear correlation if the diet has no effect so that the before and after weights are about the same, or there could be a linear correlation if the diet causes people to gain weight.

6. No. The value of $0.693$ is less than the critical value 0.707.

7. No. The value of $0.202$ is less than the critical value 0.312.

8. No. The value of $0.360$ is less than the critical value 0.666.

10. a. $r = 0.816$. Critical values: $r = \pm 0.692$, $P\text{-value} = 0.002$. There is sufficient evidence to support the claim of a linear correlation between the two variables.

b. The scatterplot reveals a perfect straight-line pattern, except for the presence of one outlier.

c. $r = 0.901$. Critical values: $r = \pm 0.707$, $P\text{-value} = 0.002$. There is sufficient evidence to support the claim of a linear correlation between the numbers of commuters and the numbers of parking spots.

12. a. There does not appear to be a linear correlation.

b. There does not appear to be a linear correlation.

c. $r = 0$. Critical values: $r = \pm 0.550$ (for a 0.05 significance level). There does not appear to be a linear correlation. The same results are obtained with the four points in the upper right corner.

d. $r = 0.835$. Critical values: $r = \pm 0.787$ (for a 0.05 significance level). There is a linear correlation.

e. There are two different populations that should be considered separately. It is misleading to use the combined data from women and men and conclude that there is a relationship between $x$ and $y$.

14. $r = 0.976$. Critical values: $r = \pm 0.811$, $P\text{-value} = 0.001$. There is sufficient evidence to support the claim of a linear correlation between CPI and cost of subway fare.

16. $r = -0.221$. Critical values: $r = \pm 0.707$, $P\text{-value} = 0.599$. There is not sufficient evidence to support the claim of a linear correlation between heights of winning presidential candidates and the heights of the runners-up.

18. $r = 0.445$. Critical values: $r = \pm 0.754$, $P\text{-value} = 0.318$. There is not sufficient evidence to support the claim of a linear correlation between casino size and revenue.

20. $r = 0.998$. Critical values: $r = \pm 0.962$, $P\text{-value} = 0.000$. There is sufficient evidence to support the claim of a linear correlation between the old and new fuel economy ratings.

22. $r = 0.998$. Critical values: $r = \pm 0.962$, $P\text{-value} = 0.000$. There is sufficient evidence to support the claim of a linear correlation between the old and new fuel economy ratings.

24. $r = 0.543$. Critical values: $r = \pm 0.707$, $P\text{-value} = 0.164$. There is not sufficient evidence to support the claim of a linear correlation between the quality rating score and price of rear-projection televisions. It does not appear that as the price increases, the quality score increases. It does not appear that as you pay more, you get better quality.
2. The regression line has the property that the sum of squares of the residuals is the lowest possible sum (where a residual is the difference between the observed and predicted values of \( y \)).

4. The regression equation \( \hat{y} = \hat{b}_0 + \hat{b}_1 x \) represents the regression line that best fits sample data, whereas the regression equation \( y = \beta_0 + \beta_1 x \) represents the regression line that best fits all of the paired data in a population.

26. \( y = 27.6 + 0.0523x; 70^\circ F \). The predicted temperature is unrealistic because 3000 chips in one minute is far beyond the scope of the available data.

28. \( y = 50.3 - 0.211x; 42.5 \) years

30. \( y = 141 - 0.00124x; 137 \) ft

6. 63.3 in.

8. 117 lb

10. \( y = 3.00 + 0.500x \). There is an outlier.

12. a. \( y = 0.0846 + 0.985x \)
   b. \( y = 1.5 + 0.8x \) (or \( y = 1.5 \))
   c. \( y = 9.5 + 0.9x \) (or \( y = 9.5 \))
   d. The results are very different, indicating that combinations of clusters can produce results that differ dramatically from results within each cluster alone.

14. \( y = -0.124 + 0.00955x; \$1.62 \) (which might be rounded up to the more convenient value of \( \$1.75 \)).

16. \( y = 55.4 - 0.321x; 72.1 \) in. In this case, the predicted height of 72.1 in. is close to Goldwater's height of 72 in., but the predicted height is always the same 72.1 in., so the predicted value will not always be so close.

18. \( y = 65.9 + 0.443x; \$135 \) million. The predicted revenue of \$135 million is far from the actual revenue of \$657 million. Note that the given size of 87,000 square feet is well beyond the scope of the values given in the sample data, and the predicted revenue is the mean of the sample revenues.

20. \( y = 89.5 + 0.409x; \$230 \) million. Yes, the predicted value of 123.6 is quite close to the actual value of 127.4.

22. \( y = 0.808 + 0.863x; 0.2 \) mi/gal.

24. \( y = 48.2 + 0.0029x; 46.7 \). The predicted quality score of 46.7 is not close to the actual score of 56.

2. Given the height of 70 in., a prediction interval is an interval estimate of a predicted weight. The interval consists of a range of weights.

4. \( s^2 = 0.272 \). We know that 27.2% of the variation in weight is explained by the linear correlation between height and weight, and 72.8% of the variation in weight is explained by other factors.

14. a. 2.389669
   b. 0.107414
   c. 2.487083
   d. 0.956982
   e. 0.1633794

16. a. 0.3986065
   b. 0.1023935
   c. 0.5010000
   d. 0.7956219
   e. 0.1151335

18. a. \$1.66
   b. \$1.14 < \$ < \$2.19

20. a. 14.5°C
   b. 13.1°C < \$ < 15.0°C

21. \$1.32 < \$ < \$2.72
22. \$1.69 < \$ < \$2.35
23. \$0.12 < \$ < \$0.90
24. \$0.12 < \$ < \$1.37

2. a. The unadjusted \( R^2 \) increases (or remains the same) as more variables are included, but the adjusted \( R^2 \) is adjusted for the number of variables and sample size. The unadjusted \( R^2 \) incorrectly suggests that the best multiple regression equation is obtained by including all of the available variables, but by taking into account the sample size and number of predictor variables, the adjusted \( R^2 \) is much more helpful in weighing and selecting variables that should not be included.

12. \$391,699. The predicted selling price is likely to be a good estimate because it is based on a regression equation that is a good model, as indicated by the low \( R^2 \) of 0.000 and the high adjusted \( R^2 \) value.

14. \( y = -69.6 + 1.25 x_1 + 15.7 x_2 \) where \( x_1 \) represents the budget and \( x_2 \) represents the viewer rating. That regression equation has adjusted \( R^2 \) of 0.624 (which is slightly less than 0.633 for all 3 predictor variables) and the lowest \( R^2 \) of 0.000. The regression equation is good for predicting the amount that a movie will gross. Using budget and viewer rating makes sense, because a larger budget tends to result in better overall quality, and the viewer rating is a measure of audience appeal.

10. Choose either LP (list price) and LA (low average price) or LP (list price) and LS (list size). Because both combinations have the lowest \( R^2 \) of 0.000 and the highest adjusted \( R^2 \) of 0.989. An argument might be made for choosing the combination of LP and LA, because it is much easier to measure the living area of a home than the area of the lot.
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2. The quadratic model is best because it has the highest value of $R^2$, but this best model is not a good model because the $R^2$ value of 0.082 is too low. Using the available models, it appears that we cannot make accurate predictions of the number of points scored in future Super Bowl games.

4. The year 2999 is too far beyond the scope of the available data. Conditions could easily change so that the model should not be used for the year 2999.

6. Exponential: $y = 95.2375 (1.05)^x$.
   (If the values were given with more precision, the exponential function would be $y = 100(1.05)^x$)

8. Power: $y = 1.10^x$

10. Exponential: $y = 47763.9 (0.981768)^x$, where 1975 is coded as 1, 1980 is coded as 2, and so on. The projected number for the year 2010 using the exponential model is 41,226, and the projected number using the quadratic model is 41,745, and the difference between the two projections is not substantial.

12. Quadratic: $y = 0.10235x^2 - 0.505365x + 14.26$, where 1980 is coded as 1. Because the $R^2$ value of 0.429 is not very high, the model is not a very good model. The projected number of 75 isn’t substantially far from the actual number of 81.

14. Exponential: $y = 861.663 (1.11836)^x$, where 1980 is coded as 1. The projected value for the year 2005 is 17,681, which is very far from the actual value of 12,464.

16. Exponential: $y = 0.353896x^2 + 1.23152x + 308.659$, where 1950 is coded as 1, 1955 is coded as 2, and so on. The predicted concentration for 2010 is 391 parts per million.

2. A large value of the test statistic suggests that the fit of the sample data with the claimed distribution is not good; there are substantial discrepancies between the expected frequencies and the observed frequencies. A small value of the test statistic suggests that the fit is extremely good; the expected frequencies and observed frequencies are nearly identical.

4. Assuming that weddings really do occur in the 12 months with equal frequency, there is a 0.477 probability that the given results or more extreme results would occur by chance. Because the probability is high, we conclude that the assumption cannot be rejected. There is not sufficient evidence to warrant rejection of the claim that weddings occur in the 12 months with equal frequency.

   $P$-value < 0.05 (Tech: 0.027).
   There is sufficient evidence to support the claim that the "A" students are not evenly distributed throughout the classroom. The results do not imply that you can increase the likelihood of getting an A by sitting in the front of the room.

8. Test statistic: $x^2 = 4.608$. Critical value: $x^2 = 7.815$. $P$-value = 0.2035.
   There is not sufficient evidence to warrant rejection of the claim that the fires are equally likely. Students do not have the ability to select the same fire.

10. Test statistic: $x^2 = 0.523$. Critical value: $x^2 = 9.488$. $P$-value > 0.95 (Tech: 0.971).
    There is not sufficient evidence to warrant rejection of the claim that injuries and illnesses occur with equal frequency on the different days of the week.

12. Test statistic: $x^2 = 16.595$. Critical value: $x^2 = 16.812$. $P$-value < 0.01 (Tech: 0.0097).
    There is sufficient evidence to warrant rejection of the claim that births occur on the days of the week with equal frequency. Because many births are induced or involve Cesarean section, they are scheduled for days other than Saturday or Sunday, so those two days have smaller numbers of births.

    There is not sufficient evidence to warrant rejection of the claim that the test digits occur with the same frequency. It appears that the digits are not random, and a test such as the chi-square test may be appropriate.

   $P$-value < 0.005 (Tech: 0.999).
   There is sufficient evidence to warrant rejection of the claim that the rate of violent crime is the same for each month. The two months with the highest numbers of violent crimes are July and August, and these are summer months when more people are away on vacation or outside of their homes.

18. Test statistic: $x^2 = 0.976$. Critical value: $x^2 = 9.488$. $P$-value > 0.10 (Tech: 0.971).
    There is not sufficient evidence to warrant rejection of the claim that the actual frequencies fit a Poisson distribution.

20. Test statistic: $x^2 = 524.713$. Critical value: $x^2 = 13.277$. $P$-value < 0.005 (Tech: 0.000).
    There is sufficient evidence to warrant rejection of the claim that the distribution of clinical trial participants fits well with the population distribution. Hispanics have an observed frequency of 60 and an expected frequency of 391.027, so they are very underrepresented.

22. Test statistic: $x^2 = 14.432$. Critical value: $x^2 = 15.507$. $P$-value > 0.05 (Tech: 0.971).
    There is not sufficient evidence to warrant rejection of the claim that the leading digits are from a population with a distribution that conforms to Benford's law. The author's check amounts appear to be legitimate.

24. Test statistic: $x^2 = 63.605$. Critical value: $x^2 = 9.488$. $P$-value < 0.005 (Tech: 0.999).
    There is sufficient evidence to warrant rejection of the claim that the leading digits are from a population with a distribution that conforms to Benford's law. The leading digits do not appear to conform to Benford's law.
16. Test statistic: \( \chi^2 = 71.679 \). Critical value: \( \chi^2 = 3.841 \). \( P \)-value < 0.005 \( (\text{Tech: 0.000}) \). There is sufficient evidence to warrant rejection of the claim that getting norovirus is independent of the ship. It appears that an outbreak of norovirus has a different effect on different ships.

18. Test statistic: \( \chi^2 = 19.529 \). Critical value: \( \chi^2 = 9.210 \). \( P \)-value < 0.005 \( (\text{Tech: 0.000}) \). There is sufficient evidence to warrant rejection of the claim that the age bracket of the respondent is independent of the choice for the cause of global warming. The choices of those under 30 years of age appear to be substantially different from the choices of those of age 65 and older.

20. Test statistic: \( \chi^2 = 1.358 \). Critical value: \( \chi^2 = 7.815 \) (assuming a 0.05 significance level). \( P \)-value > 0.10 \( (\text{Tech: 0.715}) \). There is not sufficient evidence to warrant rejection of the claim that the amount of smoking is independent of seat belt use. The theory is not supported by the given data.

22. Test statistic: \( \chi^2 = 9.971 \). Critical value: \( \chi^2 = 9.488 \) (assuming a 0.05 significance level). \( P \)-value < 0.005 \( (\text{Tech: 0.041}) \). There is sufficient evidence to warrant rejection of the claim that injuries are independent of helmet color. It appears that motorcycle drivers should use yellow or orange helmets.

14. Test statistic: \( \chi^2 = 36.125 \). Critical value: \( \chi^2 = 3.841 \). \( P \)-value < 0.005 \( (\text{Tech: 0.000}) \). There is sufficient evidence to warrant rejection of the claim that the following two proportions are the same: (1) the proportion of women who are immune to rubella who are not immune to measles; (2) the proportion of women who are immune to rubella who are immune to measles. The results show that immunity to rubella does not necessarily correspond to immunity to measles. If a woman is likely to be pregnant and she is found to have rubella immunity, she also should be tested for immunity to measles if she has been exposed to measles.

16. Test statistic: \( \chi^2 = 36.013 \). Critical value: \( \chi^2 = 3.841 \). \( P \)-value < 0.005 \( (\text{Tech: 0.000}) \). There is sufficient evidence to warrant rejection of the claim that the following two proportions are the same: (1) the proportion of subjects with no cure on the fungicide-treated foot and a cure on the foot treated with a placebo; (2) the proportion of subjects with a cure on the fungicide-treated foot and a cure on the foot treated with a placebo. The fungicide treatment does appear to be effective.

18. Test statistic: \( \chi^2 = 9.600 \). Critical value: \( \chi^2 = 3.841 \) (assuming a 0.05 significance level). \( P \)-value = 0.002. Reject the null hypothesis that the following two proportions are the same: (1) the proportion of smokers who stopped after the treatment; (2) the proportion of non-smokers who began to smoke after the treatment. The treatment does appear to be effective. The conclusion makes sense, because 44% of the smokers stopped smoking after the treatment, but only 2% of the non-smokers were smoking after the treatment, so the treatment does have an affect.
2. As we increase the number of individual tests of significance, we increase the risk of finding a difference by chance alone (instead of a real difference in the means). The risk of a type I error—finding a difference in one of the pairs when no such difference actually exists—is too high. The method of analysis of variance helps us avoid that particular pitfall (rejecting a true null hypothesis) by using one test for equality of several means, instead of several tests that each compare two means at a time.

4. No. The results from analysis of variance indicate that either the means appear to be equal or the means are not all equal. The results from analysis of variance do not indicate which mean is different from the others. Such determinations are made using other methods, such as multiple comparison tests discussed in Part 2 of this section.

6. Test statistic: $F = 3.91$. Critical value of $F$ is approximately $3.3156$ (Tech: $2.2849$, $P$-value: $0.030$). Reject $H_0: \mu_1 = \mu_2 = \mu_3$. There is sufficient evidence to warrant rejection of the claim that the three books have the same mean number of words per sentence.

8. Test statistic: $F = 0.4430$. Critical value: $F = 2.3113$. $P$-value: $0.0173$. Fail to reject $H_0: \mu_1 = \mu_2 = \mu_3 = \mu_4 = \mu_5 = \mu_6$. There is not sufficient evidence to warrant rejection of the claim that weights of males in the six different color categories have the same mean. It appears that weights of males are not affected by their colors.

10. Test statistic: $F = 183.0126$. Critical value of $F$ is approximately $2.9957$ (Tech: $3.0738$, $P$-value: $0.0001$). Reject $H_0: \mu_1 = \mu_2 = \mu_3$. There is sufficient evidence to warrant rejection of the claim that the three power supplies have the same mean voltage. Electrical appliances cannot be expected to behave the same way when run from the three different power sources.

12. Test statistic: $F = 1.4063$. Critical value: $F = 3.3541$. $P$-value: $0.2624$. Fail to reject $H_0: \mu_1 = \mu_2 = \mu_3$. There is not sufficient evidence to warrant rejection of the claim that the different car categories have the same mean. These do not suggest that larger cars are safer.

14. Test statistic: $F = 32.3210$. Critical value: $F = 3.3277$. $P$-value: $0.0000$. Reject $H_0: \mu_1 = \mu_2 = \mu_3$. There is sufficient evidence to warrant rejection of the claim that the different car categories have the same mean. Given that the sample means are 6.52 (1 cylinder), 8.03 (6 cylinder), and 9.11 (9 cylinder), it appears that cars with more cylinders produce larger amounts of greenhouse gases.

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2. We can determine whether weight appears to be affected by an interaction between sex and age bracket, we can determine whether weight appears to be affected by sex, and we can determine whether weight appears to be affected by age bracket.

4. Because the corresponding line segments are dramatically far from being parallel, there does appear to be an effect from an interaction between the site and the treatment.

6. Test statistic: $F = 53.211$. $P$-value: $0.0000$. Reject the null hypothesis of no effect from sex. There is sufficient evidence to support the claim that sex has an effect on height.

8. Test statistic: $F = 1.41$. $P$-value: $0.281$. Fail to reject the null hypothesis of no interaction effect. There is not sufficient evidence to warrant rejection of the claim that head injury measurements are not affected by an interaction between the type of car (foreign, domestic) and size of the car (small, medium, large). There does not appear to be an effect from an interaction between the type of car (foreign or domestic) and whether the car is small, medium, or large.

10. Test statistic: $F = 0.44$. $P$-value: $0.655$. Fail to reject the null hypothesis of no effect from the size of the car. There is not sufficient evidence to support the claim that whether the car is small, medium, or large has an effect on head injury measurements.

12. Test statistic: $F = 4.9777$. $P$-value: $0.0291$. Reject the null hypothesis of no effect from the category of the target. There is sufficient evidence to support the claim that whether the target has low or high self-esteem has an effect on the measurements of self-esteem.

14. For interaction, the test statistic is $F = 2.38$ and the $P$-value is 0.076, so there is no significant interaction effect. For sex, the test statistic is $F = 2.01$ and the $P$-value is 0.169, so there is no significant effect from sex. For age bracket, the test statistic is $F = 0.75$ and the $P$-value is 0.482, so there is no significant effect from age bracket.

16. Row factor: Test statistic is $F = 0.22$ and $P$-value = 0.688, so fail to reject the null hypothesis of no effect from the row factor of sex; there is not sufficient evidence to support the claim that cholesterol levels are affected by sex. Column factor: Test statistic is $F = 0.43$ and $P$-value = 0.690, so fail to reject the null hypothesis of no effect from the column factor of age bracket; there is not sufficient evidence to support the claim that cholesterol levels are affected by age bracket.
2. a. Both variables have ranks of 1, 2, 3, 4, 5, 6.
   b. Each of the differences is 0.
   c. 0
   d. 1

4. The efficiency rating of 0.71 indicates that with all other factors being the same, rank correlation requires 100 pairs of sample observations to achieve the same results as 91 pairs of observations with the parametric ttest using linear correlation, assuming that the stricter requirements for using linear correlation are met.

6. \( r_s = -1 \). Critical values are -0.648 and 0.648. Reject the null hypothesis of \( \rho_s = 0 \). There is sufficient evidence to support a claim of a correlation between altitude and time.

8. a. ±0.833
   b. ±0.563
   c. ±0.327
   d. ±0.286

10. \( r_s = 0.607 \). Critical values: -0.786, 0.786. Fail to reject the null hypothesis of \( \rho_s = 0 \). There is not sufficient evidence to support the claim of a correlation between the two judges. The two judges appear to rank the bands very differently.

12. \( r_s = 0.564 \). Critical values: -0.648, 0.648. Fail to reject the null hypothesis of \( \rho_s = 0 \). There is not sufficient evidence to support the claim of a correlation between quality score and cost. Based on these results, you cannot expect to get higher quality by purchasing a more expensive plasma TV.

14. \( r_s = 0.300 \). Critical values: -0.560, 0.560. Fail to reject the null hypothesis of \( \rho_s = 0 \). There is not sufficient evidence to support the claim of a correlation between quality score and cost. Based on these results, you cannot get better quality by paying more.