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

## Chapter 1

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

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

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

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

**8.** **a.** 1005
**b.** Qualitative
**c.** Percentages
**d.** Approximately 291

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

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

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

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

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

**18.** **a.** 36%
**b.** 189
**c.** Qualitative

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

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

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

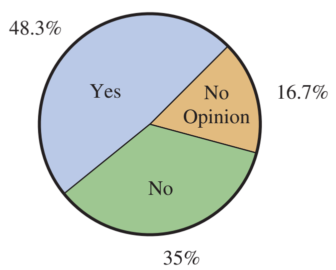
## Chapter 2

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

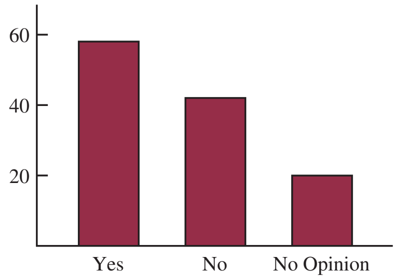
| Class | Frequency | Percent Frequency |
|---|---|---|
| A | 44 | 22 |
| B | 36 | 18 |
| C | 80 | 40 |
| D | 40 | 20 |
| Total | 200 | 100 |

**3.** **a.** $360° \times 58/120 = 174°$
**b.** $360° \times 42/120 = 126°$

**c.**




**d.**




**4. a.** Qualitative

**b.**

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

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

**6. a.**

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

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

**7.**

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

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

**8. a.**

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

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

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

**b.**

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

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

**12.**

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

**14. b/c.**

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

**15. a/b.**

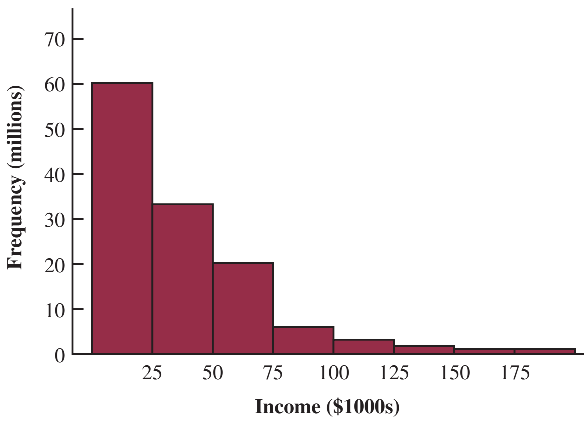
| Waiting Time | Frequency | Relative Frequency |
|---|---|---|
| 0–4 | 4 | .20 |
| 5–9 | 8 | .40 |
| 10–14 | 5 | .25 |
| 15–19 | 2 | .10 |
| 20–24 | 1 | .05 |
| Totals | 20 | 1.00 |

**c/d.**

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

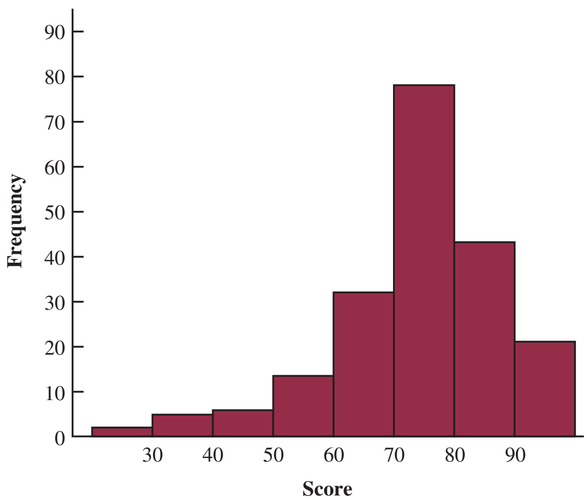
**e.** 12/20 = .60

**16. a.** Adjusted Gross Income



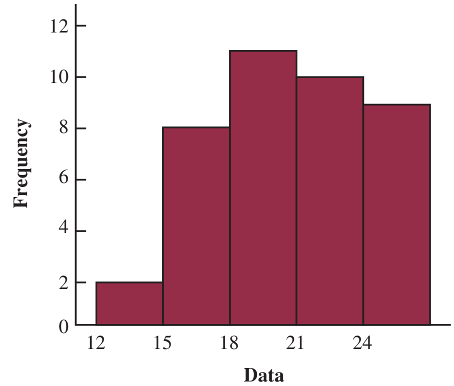

Histogram is skewed to the right

**b.** Exam Scores




Histogram is skewed to the left

**c.**




Histogram skewed slightly to the left

**18. a.** Lowest $180; highest $2050

**b.**

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

**c.** The distribution shows a positive skewness

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

**20. a.**

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

**c.** Fleetwood Mac, Harper/Johnson

**22.**

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

**23.** Leaf unit = .1

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

**24.** Leaf unit = 10

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

**25.**

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

**26. a.**

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

**b.**

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

**28. a.**

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

**b.** 40–44 with 9
**c.** 43 with 5
**d.** 10%; relatively small participation in the race

**29. a.**

| *x* \ *y* | 1 | 2 | Total |
|---|---|---|---|
| A | 5 | 0 | 5 |
| B | 11 | 2 | 13 |
| C | 2 | 10 | 12 |
| Total | 18 | 12 | 30 |

**b.**

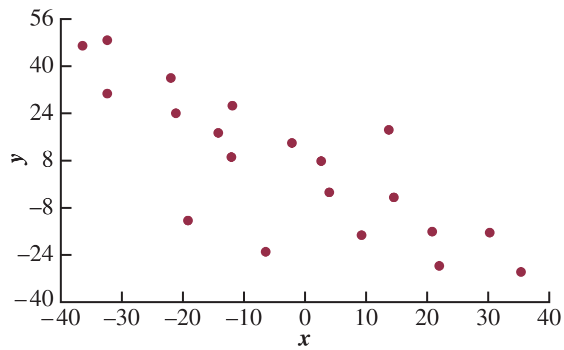
| *x* \ *y* | 1 | 2 | Total |
|---|---|---|---|
| A | 100.0 | 0.0 | 100.0 |
| B | 84.6 | 15.4 | 100.0 |
| C | 16.7 | 83.3 | 100.0 |

**c.**

| *x* \ *y* | 1 | 2 |
|---|---|---|
| A | 27.8 | 0.0 |
| B | 61.1 | 16.7 |
| C | 11.1 | 83.3 |
| Total | 100.0 | 100.0 |

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

**30. a.**




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

**32. a.**

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

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

**b.** 26.86%, 39.72%
**c.** Positive relationship between income and education level

**34. a.**

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

**b.**

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

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

**36. b.** No apparent relationship

**38. a.**

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

**b.** Ford F-Series and the Toyota Camry

**40. a.**

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

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

**42. a.**

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

**b.** Nearly symmetrical

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

**44. a.**

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

**c.** High positive skewness

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

**46. a. High Temperatures**

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

**b. Low Temperatures**

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

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

**d.**

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

**48. a.**

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

**b.**

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

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

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

**b.**

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

**c.** Crosstabulation of column percentages

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

**d.** Crosstabulation of row percentages

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

**52. a.** Crosstabulation of market value and profit

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

**b.** Crosstabulation of row percentages

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

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

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

## Chapter 3

**2.** 16, 16.5

**3.** Arrange data in order: 15, 20, 25, 25, 27, 28, 30, 34

$i = \frac{20}{100}(8) = 1.6$; round up to position 2

20th percentile $= 20$

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

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

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

65th percentile = 28

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

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

**4.** 59.73, 57, 53

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

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

**c.** Accounting salaries are approximately $9000 higher

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

Order the data from low 100 to high 360

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

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

Mode = 120 (occurs 3 times)

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

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

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

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

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

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

90% of the tax returns cost $245 or less

**10. a.** .4%, 3.5%

**b.** 2.3%, 2.5%, 2.7%

**c.** 2.0%, 2.8%

**d.** Optimistic

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

**14.** 16, 4

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

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

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

$\text{IQR} = Q_3 - Q_1 = 29 - 22.5 = 6.5$

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

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

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

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

**16. a.** Range = 190 − 168 = 22

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

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

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

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

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

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

**18. a.** 38, 97, 9.85

**b.** Eastern shows more variation

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

**22. a.** 1285, 433
Freshmen spend more

**b.** 1720, 352

**c.** 404, 131.5

**d.** 367.04, 96.96

**e.** Freshmen have more variability

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

**26.** .20, 1.50, 0, −.50, −2.20

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

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

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

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

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

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

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

**29. a.** $z = 2$ standard deviations

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

**b.** $z = 2.5$ standard deviations

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

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

**30. a.** 68%
**b.** 81.5%
**c.** 2.5%

**32. a.** −.67
**b.** 1.50
**c.** Neither an outlier
**d.** Yes; $z = 8.25$

**34. a.** 76.5, 7
**b.** 16%, 2.5%
**c.** 12.2, 7.89; no

**36.** 15, 22.5, 26, 29, 34

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

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

$Q_1 = 8$
Median (5th position) = 10

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

$Q_3 = 15$
5-number summary: 5, 8, 10, 15, 18


**40. a.** 619, 725, 1016, 1699, 4450
**b.** Limits: 0, 3160
**c.** Yes
**d.** No

**41. a.** Arrange data in order low to high

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

$Q_1 = 1872$
Median (11th position) = 4019

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

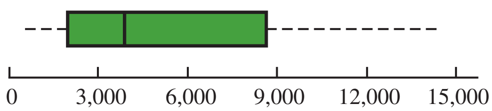
$Q_3 = 8305$
5-number summary: 608, 1872, 4019, 8305, 14,138

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

**c.** No; data are within limits

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

**e.**




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

**44. a.** 18.2, 15.35
**b.** 11.7, 23.5
**c.** 3.4, 11.7, 15.35, 23.5, 41.3
**d.** Yes; Alger Small Cap 41.3

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

**c.**

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

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

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

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

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

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

**46. b.** There appears to be a positive linear relationship between $x$ and $y$
**c.** $s_{xy} = 26.5$
**d.** $r_{xy} = .693$

**48.** −.91; negative relationship

**50. b.** .9098
**c.** Strong positive linear relationship; no

**52. a.** 3.69
**b.** 3.175

**53. a.**

| $f_i$ | $M_i$ | $f_i M_i$ |
|---|---|---|
| 4 | 5 | 20 |
| 7 | 10 | 70 |
| 9 | 15 | 135 |
| 5 | 20 | 100 |
| 25 | | 325 |

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

**b.**

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

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

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

**54. a.**

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

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

**b.** Yes

**56. a.** 3.49
**b.** .94

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

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

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

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

**66. b.** .9856, strong positive relationship

**68. a.** 817
**b.** 833

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

## Chapter 4

**2.** $\binom{6}{3} = \frac{6!}{3!3!} = \frac{6\cdot5\cdot4\cdot3\cdot2\cdot1}{(3\cdot2\cdot1)(3\cdot2\cdot1)} = 20$

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

**4. b.** (H,H,H), (H,H,T), (H,T,H), (H,T,T), (T,H,H), (T,H,T), (T,T,H), (T,T,T)
**c.** ⅛

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

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

**9.** $\binom{50}{4} = \frac{50!}{4!46!} = \frac{50\cdot49\cdot48\cdot47}{4\cdot3\cdot2\cdot1} = 230{,}300$

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

Estimate of Colorado funds = (112/2374)($32.4)
= $1.53 billion

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

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

**14. a.** 1/4
**b.** 1/2
**c.** 3/4

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

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

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

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

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

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

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

**24. a.** .05
**b.** .70

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

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

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

**32. a.**

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

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

**33. a.**

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

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

**34. a.**

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

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

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

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

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

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

**42.** $M$ = missed payment
$D_1$ = customer defaults
$D_2$ = customer does not default
$P(D_1) = .05, P(D_2) = .95, P(M \mid D_2) = .2, P(M \mid D_1) = 1$

**a.** $$P(D_1 \mid M) = \frac{P(D_1)P(M \mid D_1)}{P(D_1)P(M \mid D_1) + P(D_2)P(M \mid D_2)} = \frac{(.05)(1)}{(.05)(1) + (.95)(.2)} = \frac{.05}{.24} = .21$$

**b.** Yes, the probability of default is greater than .20

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

**46. a.** .68
**b.** 52
**c.** 10

**48. a.** 315
**b.** .29
**c.** No
**d.** Republicans

**50. a.** .76
**b.** .24

**52. b.** .2022
**c.** .4618
**d.** .4005

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

**56. a.** .25
**b.** .125
**c.** .0125
**d.** .10
**e.** No

**58. a.**

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

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

**60. a.** .40
**b.** .67

## Chapter 5

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

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

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

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

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

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

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

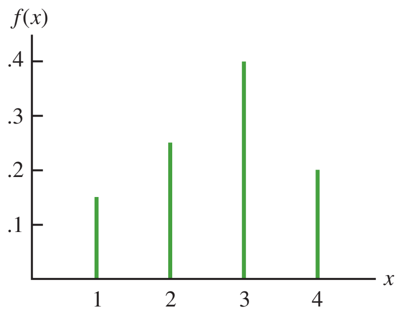
**6. a.** 0, 1, 2, . . . , 20; discrete
**b.** 0, 1, 2, . . . ; discrete
**c.** 0, 1, 2, . . . , 50; discrete
**d.** $0 \le x \le 8$; continuous
**e.** $x > 0$; continuous

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

**8. a.**

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

**b.**




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

**10. a.**

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

**b.**

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

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

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

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

**16. a.**

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

$E(y) = \mu = 5.2$

**b.**

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

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

**18. a/b.**

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

**c/d.**

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

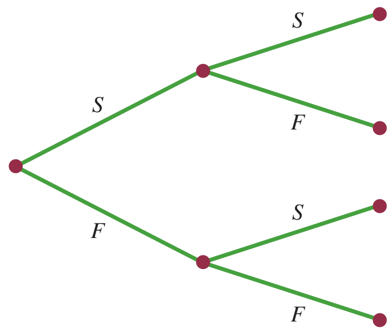
**e.** The number of bedrooms in owner-occupied houses is greater than in renter-occupied houses; the expected number of bedrooms is $2.93 - 1.84 = 1.09$ greater, and the variability in the number of bedrooms is less for the owner-occupied houses

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

**22.** **a.** 445
**b.** \$1250 loss

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

**25.** **a.**




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

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

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

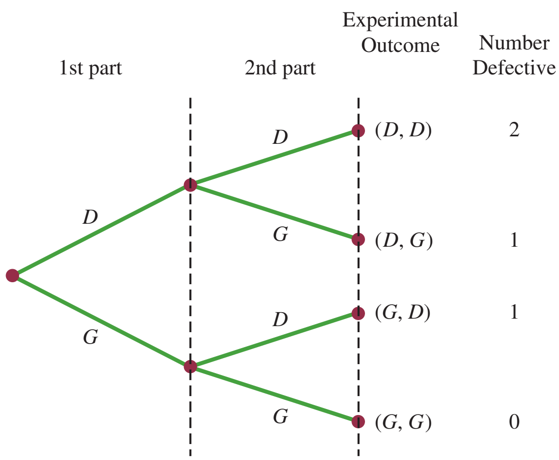
**e.** $P(x \geq 1) = f(1) + f(2) = .48 + .16 = .64$

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

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

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

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




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

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

**34.** **a.** .2262
**b.** .8355

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

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

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

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

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

**c.** $\mu = 3.5$

$$f(0) = \frac{3.5^0 e^{-3.5}}{0!} = e^{-3.5} = .0302$$

probability $= 1 - f(0) = 1 - .0302 = .9698$

**d.**

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

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

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

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

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

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

**48. a.** .5250
**b.** .1833

**50.** $N = 60, n = 10$

**a.** $r = 20, x = 0$

$$f(0) = \frac{\binom{20}{0}\binom{40}{10}}{\binom{60}{10}} = \frac{(1)\left(\frac{40!}{10!30!}\right)}{\frac{60!}{10!50!}} = \left(\frac{40!}{10!30!}\right)\left(\frac{10!50!}{60!}\right) = \frac{40\cdot39\cdot38\cdot37\cdot36\cdot35\cdot34\cdot33\cdot32\cdot31}{60\cdot59\cdot58\cdot57\cdot56\cdot55\cdot54\cdot53\cdot52\cdot51} \approx .01$$

**b.** $r = 20, x = 1$

$$f(1) = \frac{\binom{20}{1}\binom{40}{9}}{\binom{60}{10}} = 20\left(\frac{40!}{9!31!}\right)\left(\frac{10!50!}{60!}\right) \approx .07$$

**c.** $1 - f(0) - f(1) = 1 - .08 = .92$

**d.** Same as the probability one will be from Hawaii; in part (b) it was equal to approximately .07

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

**54. a.**

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

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

**56. a.** .0596
**b.** .3585
**c.** 100
**d.** 9.75

**58. a.** .9510
**b.** .0480
**c.** .0490

**60. a.** 240
**b.** 12.96
**c.** 12.96

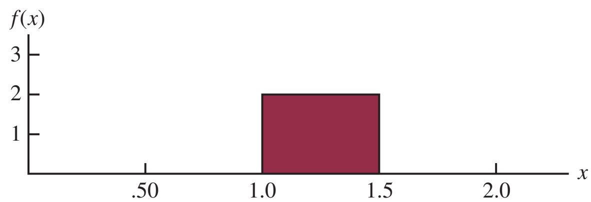
**62.** .1912

**64. a.** .2240
**b.** .5767

**66. a.** .4667
**b.** .4667
**c.** .0667

## Chapter 6

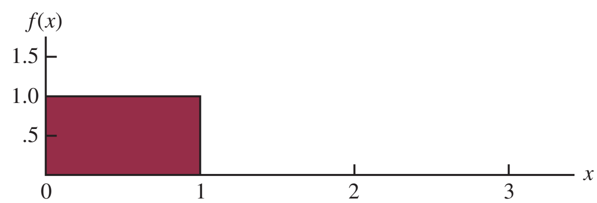
**1. a.**




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

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

**4. a.**



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

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

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

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

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

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

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

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

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

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

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

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

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

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

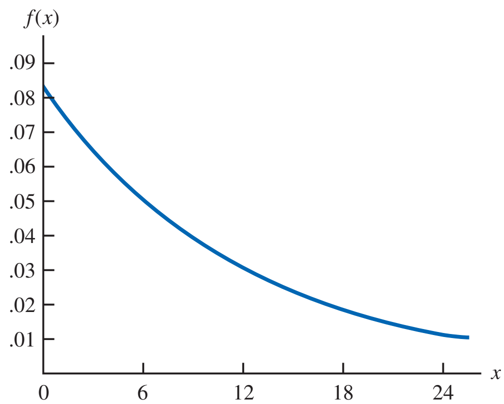
**30. a.** 220
**b.** .0392
**c.** .8962

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

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

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

**35. a.**




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

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

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

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

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

**44. a.** .0228
**b.** \$50

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

**48.** $\mu = 19.23$ ounces

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

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

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

# Chapter 7

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

**2.** 22, 147, 229, 289

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

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

**6.** 2782, 493, 825, 1807, 289

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

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

**11. a.** $\bar{x} = \dfrac{\Sigma x_i}{n} = \dfrac{54}{6} = 9$

**b.** $s = \sqrt{\dfrac{\Sigma(x_i - \bar{x})^2}{n - 1}}$

$\Sigma(x_i - \bar{x})^2 = (-4)^2 + (-1)^2 + 1^2 + (-2)^2 + 1^2 + 5^2$
$= 48$

$s = \sqrt{\dfrac{48}{6 - 1}} = 3.1$

**12. a.** .50
**b.** .3667

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

**b.**

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

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

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

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

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

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

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

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

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

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

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

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

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

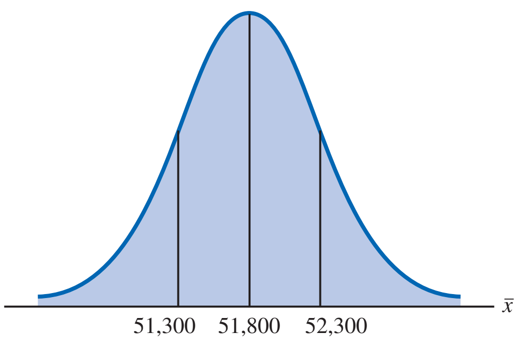
$$\text{At } \bar{x} = 190,\ z = \frac{\bar{x} - \mu}{\sigma_{\bar{x}}} = \frac{-10}{5} = -2$$

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

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

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

**23. a.**




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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

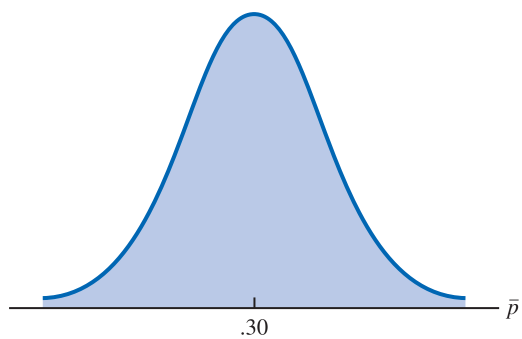
$$\begin{aligned} P(.37 \le \bar{p} \le .43) &= P(-.87 \le z \le .87) \\ &= .8078 - .1922 \\ &= .6156 \end{aligned}$$

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

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

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

**35. a.**



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

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

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

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

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

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

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

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

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

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

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

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

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

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

**48. a.** 625
**b.** .7888

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

**52. a.** .8882
**b.** .0233

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

## Chapter 8

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

**4.** 54

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

**6.** 8.1 to 8.9

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

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

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

**13. a.** $\bar{x} = \frac{\Sigma x_i}{n} = \frac{80}{8} = 10$
**b.** $s = \sqrt{\frac{\Sigma(x_i - \bar{x})^2}{n-1}} = \sqrt{\frac{84}{7}} = 3.464$
**c.** $t_{.025}\left(\frac{s}{\sqrt{n}}\right) = 2.365\left(\frac{3.46}{\sqrt{8}}\right) = 2.9$
**d.** $\bar{x} \pm t_{.025}\left(\frac{s}{\sqrt{n}}\right)$
$10 \pm 2.9$ (7.1 to 12.9)

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

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

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

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

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

$19.5 \pm 1.29$ (18.21 to 20.79)

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

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

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

**22. a.** 3.35
**b.** 2.40 to 4.30

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

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

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

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

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

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

**26. a.** 18
**b.** 35
**c.** 97

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

**30.** 81

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

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

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

.25 ± 1.96(.0217)

.25 ± .0424; .2076 to .2924

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

**34.** 1068

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

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

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

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

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

**39. a.** $n = \frac{z_{.025}^2 p^*(1-p^*)}{E^2} = \frac{(1.96)^2(.156)(1-.156)}{(.03)^2}$
$= 562$

**b.** $n = \frac{z_{.005}^2 p^*(1-p^*)}{E^2} = \frac{(2.576)^2(.156)(1-.156)}{(.03)^2}$
$= 970.77$; use 971

**40.** .0267 (.8333 to .8867)

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

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

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

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

**50.** 37

**52.** 176

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

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

**58. a.** 1267
**b.** 1509

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

## Chapter 9

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

**4. a.** $H_0: \mu \geq 220$
$H_a: \mu < 220$

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

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

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

**10. a.** $z = \frac{\bar{x} - \mu_0}{\sigma/\sqrt{n}} = \frac{26.4 - 25}{6/\sqrt{40}} = 1.48$
**b.** Using normal table with $z = 1.48$: $p$-value $= 1.0000 - .9306 = .0694$
**c.** $p$-value $> .01$, do not reject $H_0$
**d.** Reject $H_0$ if $z \geq 2.33$
$1.48 < 2.33$, do not reject $H_0$

**11.** **a.** $z = \dfrac{\bar{x} - \mu_0}{\sigma/\sqrt{n}} = \dfrac{14.15 - 15}{3/\sqrt{50}} = -2.00$
**b.** $p$-value = 2(.0228) = .0456
**c.** $p$-value $\leq$ .05, reject $H_0$
**d.** Reject $H_0$ if $z \leq -1.96$ or $z \geq 1.96$
$-2.00 \leq -1.96$, reject $H_0$

**12.** **a.** .1056; do not reject $H_0$
**b.** .0062; reject $H_0$
**c.** $\approx 0$; reject $H_0$
**d.** .7967; do not reject $H_0$

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

**15.** **a.** $H_0$: $\mu \geq 1056$
$H_a$: $\mu < 1056$
**b.** $z = \dfrac{\bar{x} - \mu_0}{\sigma/\sqrt{n}} = \dfrac{910 - 1056}{1600/\sqrt{400}} = -1.83$
$p$-value = .0336
**c.** $p$-value $\leq$ .05, reject $H_0$; the mean refund of "last-minute" filers is less than \$1056
**d.** Reject $H_0$ if $z \leq -1.645$
$-1.83 \leq -1.645$; reject $H_0$

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

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

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

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

**24.** **a.** $t = \dfrac{\bar{x} - \mu_0}{s/\sqrt{n}} = \dfrac{17 - 18}{4.5/\sqrt{48}} = -1.54$
**b.** Degrees of freedom = $n - 1 = 47$
Area in lower tail is between .05 and .10
$p$-value (two-tail) is between .10 and .20
Exact $p$-value = .1303
**c.** $p$-value > .05; do not reject $H_0$
**d.** With $df = 47$, $t_{.025} = 2.012$
Reject $H_0$ if $t \leq -2.012$ or $t \geq 2.012$
$t = -1.54$; do not reject $H_0$

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

**27.** **a.** $H_0$: $\mu \geq 238$
$H_a$: $\mu < 238$
**b.** $t = \dfrac{\bar{x} - \mu_0}{s/\sqrt{n}} = \dfrac{231 - 238}{80/\sqrt{100}} = -.88$
Degrees of freedom = $n - 1 = 99$
$p$-value is between .10 and .20
Exact $p$-value = .1905
**c.** $p$-value > .05; do not reject $H_0$
Cannot conclude mean weekly benefit in Virginia is less than the national mean
**d.** $df = 99$, $t_{.05} = -1.66$
Reject $H_0$ if $t \leq -1.66$
$-.88 > -1.66$; do not reject $H_0$

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

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

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

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

**36.** **a.** $z = \dfrac{\bar{p} - p_0}{\sqrt{\dfrac{p_0(1 - p_0)}{n}}} = \dfrac{.68 - .75}{\sqrt{\dfrac{.75(1 - .75)}{300}}} = -2.80$
$p$-value = .0026
$p$-value $\leq$ .05; reject $H_0$
**b.** $z = \dfrac{.72 - .75}{\sqrt{\dfrac{.75(1 - .75)}{300}}} = -1.20$
$p$-value = .1151
$p$-value > .05; do not reject $H_0$
**c.** $z = \dfrac{.70 - .75}{\sqrt{\dfrac{.75(1 - .75)}{300}}} = -2.00$
$p$-value = .0228
$p$-value $\leq$ .05; reject $H_0$
**d.** $z = \dfrac{.77 - .75}{\sqrt{\dfrac{.75(1 - .75)}{300}}} = .80$

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

**38. a.** $H_0$: $p$ = .64
$H_a$: $p \neq .64$
**b.** $\bar{p}$ = 52/100 = .52

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

$p$-value = 2(.0062) = .0124
**c.** $p$-value ≤ .05; reject $H_0$
Proportion differs from the reported .64
**d.** Yes, because $\bar{p}$ = .52 indicates that fewer believe the supermarket brand is as good as the name brand

**40. a.** .2702
**b.** $H_0$: $p \leq .22$
$H_a$: $p > .22$
$p$-value ≈ 0; reject $H_0$
**c.** Helps evaluate the effectiveness of commercials

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

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

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

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

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

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

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

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

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

## Chapter 10

**1. a.** $\bar{x}_1 - \bar{x}_2 = 13.6 - 11.6 = 2$
**b.** $z_{\alpha/2} = z_{.05} = 1.645$

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

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

2 ± .98 (1.02 to 2.98)
**c.** $z_{\alpha/2} = z_{.05} = 1.96$

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

2 ± 1.17 (.83 to 3.17)

**2. a.** $$z = \frac{(\bar{x}_1 - \bar{x}_2) - D_0}{\sqrt{\dfrac{\sigma_1^2}{n_1} + \dfrac{\sigma_2^2}{n_2}}} = \frac{(25.2 - 22.8) - 0}{\sqrt{\dfrac{(5.2)^2}{40} + \dfrac{(6)^2}{50}}} = 2.03$$
**b.** $p$-value = 1.0000 − .9788 = .0212
**c.** $p$-value ≤ .05; reject $H_0$

**4. a.** $\bar{x}_1 - \bar{x}_2 = 2.04 - 1.72 = .32$
**b.** $$z_{.025}\sqrt{\frac{\sigma_1^2}{n_1} + \frac{\sigma_2^2}{n_2}} = 1.96\sqrt{\frac{(.10)^2}{40} + \frac{(.08)^2}{35}} = .04$$
**c.** .32 ± .04 (.28 to .36)

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

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

**9. a.** $\bar{x}_1 - \bar{x}_2 = 22.5 - 20.1 = 2.4$
**b.** $$df = \frac{\left(\dfrac{s_1^2}{n_1} + \dfrac{s_2^2}{n_2}\right)^2}{\dfrac{1}{n_1 - 1}\left(\dfrac{s_1^2}{n_1}\right)^2 + \dfrac{1}{n_2 - 1}\left(\dfrac{s_2^2}{n_2}\right)^2}$$

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

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

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

**d.** 2.4 ± 2.1 (.3 to 4.5)

**10. a.** $$t = \frac{(\bar{x}_1 - \bar{x}_2) - 0}{\sqrt{\dfrac{s_1^2}{n_1} + \dfrac{s_2^2}{n_2}}} = \frac{(13.6 - 10.1) - 0}{\sqrt{\dfrac{5.2^2}{35} + \dfrac{8.5^2}{40}}} = 2.18$$
**b.** $$df = \frac{\left(\dfrac{s_1^2}{n_1} + \dfrac{s_2^2}{n_2}\right)^2}{\dfrac{1}{n_1 - 1}\left(\dfrac{s_1^2}{n_1}\right)^2 + \dfrac{1}{n_2 - 1}\left(\dfrac{s_2^2}{n_2}\right)^2}$$

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

Use $df = 65$

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

**d.** $p$-value $\leq .05$; reject $H_0$

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

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

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

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

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

$3.9 \pm 3.3$ (.6 to 7.2)

**14. a.** $H_0: \mu_1 - \mu_2 \geq 0$
$H_a: \mu_1 - \mu_2 < 0$

**b.** $-2.41$

**c.** Using $t$ table, $p$-value is between .005 and .01
Exact $p$-value = .009

**d.** Reject $H_0$; salaries of staff nurses are lower in Tampa

**16. a.** $H_0: \mu_1 - \mu_2 \leq 0$
$H_a: \mu_1 - \mu_2 > 0$

**b.** 38

**c.** $t = 1.80$, $df = 25$
Using $t$ table, $p$-value is between .025 and .05
Exact $p$-value = .0420

**d.** Reject $H_0$; conclude higher mean score if college grad

**18. a.** $H_0: \mu_1 - \mu_2 \geq 120$
$H_a: \mu_1 - \mu_2 < 120$

**b.** $-2.10$
Using $t$ table, $p$-value is between .01 and .025
Exact $p$-value = .0195

**c.** 32 to 118

**d.** Larger sample size

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

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

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

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

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

**20. a.** 3, $-1$, 3, 5, 3, 0, 1

**b.** 2

**c.** 2.08

**d.** 2

**e.** .07 to 3.93

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

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

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

**22.** \$.10 to \$.32

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

**26. a.** $t = -.60$
Using $t$ table, $p$-value is greater than .40
Exact $p$-value = .5633
Do not reject $H_0$

**b.** $-.103$

**c.** .39; larger sample size

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

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

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

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

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

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

**e.**

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

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

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

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

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

**28.**

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

**30.**

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

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

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

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

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

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

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

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

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

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

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

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

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

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

**36.** $p$-value $= .0000$

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

**38.** $p$-value $= .0003$

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

**40.** **a.** $H_0$: $\mu_1 - \mu_2 = 0$

$H_a$: $\mu_1 - \mu_2 \neq 0$

$z = 2.79$

$p$-value $= .0052$

Reject $H_0$

**42.** **a.** $H_0$: $\mu_1 - \mu_2 \leq 0$

$H_a$: $\mu_1 - \mu_2 > 0$

**b.** $t = .60$, $df = 57$

Using $t$ table, $p$-value is greater than .20

Exact $p$-value $= .2754$

Do not reject $H_0$

**44.** **a.** 15 (or $15,000)

**b.** 9.81 to 20.19

**c.** 11.5%

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

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

## Chapter 11

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

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

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

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

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

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

**2.** **a.** .2333

**b.** .1498

**c.** Do not reject $H_0$

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

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

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

**b.** $p$-value $\leq .05$; reject $H_0$

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

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

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

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

**11. a.** Expected frequencies: $e_1 = 200(.40) = 80$
$e_2 = 200(.40) = 80$
$e_3 = 200(.20) = 40$
Actual frequencies: $f_1 = 60, f_2 = 120, f_3 = 20$

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

Degrees of freedom: $k - 1 = 2$
$\chi^2 = 35$ shows $p$-value is less than .005
$p$-value $\le .01$; reject $H_0$
**b.** Reject $H_0$ if $\chi^2 \ge 9.210$
$\chi^2 = 35$; reject $H_0$

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

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

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

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

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

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

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

**19.** $H_0$: The column variable is independent of the row variable
$H_a$: The column variable is not independent of the row variable
Expected frequencies:

| | A | B | C |
|---|---|---|---|
| **P** | 28.5 | 39.9 | 45.6 |
| **Q** | 21.5 | 30.1 | 34.4 |

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

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

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

**21.** $H_0$: Type of ticket purchased is independent of the type of flight
$H_a$: Type of ticket purchased is not independent of the type of flight
Expected frequencies:

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

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

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

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

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

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

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

**30. a.** $p$-value $\approx 0$, reject $H_0$
**b.** .0468 to .1332

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

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

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

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

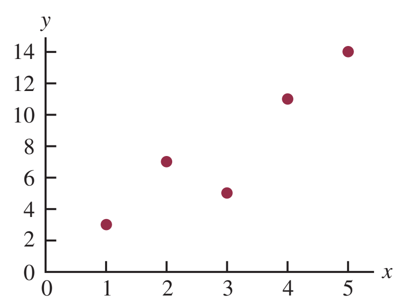
**40.** $\chi^2 = 23.37$, $df = 3$
$p$-value is less than .005
Reject $H_0$

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

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

## Chapter 12

**1. a.**




**b.** There appears to be a positive linear relationship between $x$ and $y$
**c.** Many different straight lines can be drawn to provide a linear approximation of the relationship between $x$ and $y$; in part (d) we will determine the equation of a straight line that "best" represents the relationship according to the least squares criterion
**d.** Summations needed to compute the slope and $y$-intercept:

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

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

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

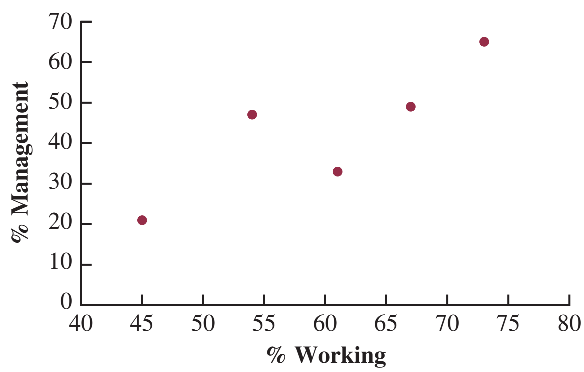
$$b_0 = \bar{y} - b_1\bar{x} = 8 - (2.6)(3) = 0.2$$

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

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

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

**4. a.**




**b.** There appears to be a positive linear relationship between the percentage of women working in the five companies ($x$) and the percentage of management jobs held by women in those companies ($y$)
**c.** Many different straight lines can be drawn to provide a linear approximation of the relationship between $x$ and $y$; in part (d) we will determine the equation of a straight line that "best" represents the relationship according to the least squares criterion
**d.** $\bar{x} = \frac{\Sigma x_i}{n} = \frac{300}{5} = 60 \quad \bar{y} = \frac{\Sigma y_i}{n} = \frac{215}{5} = 43$

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

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

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

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

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

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

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

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

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

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

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

SSR = SST − SSE = 80 − 12.4 = 67.6

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

$p$-value is between .02 and .05

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

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

**e.** $\text{MSR} = \frac{\text{SSR}}{1} = 67.6$

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

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

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

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

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

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

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

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

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

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

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

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

$p$-value is between .02 and .05

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

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

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

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

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

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

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

**c.**

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

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

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

**32. a.** $s = 2.033$

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

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

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

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

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

$10.6 \pm 3.182(1.11)$

$10.6 \pm 3.53$, or 7.07 to 14.13

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

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

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

$10.6 \pm 3.182(2.32)$

$10.6 \pm 7.38$, or 3.22 to 17.98

**34.** Confidence interval: 8.65 to 21.15
Prediction interval: −4.50 to 41.30

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

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

$= 3533.8$

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

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

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

$3533.8 \pm 2.776(68.54)$

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

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

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

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

$3533.8 \pm 2.776(161.19)$

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

**36. a.** \$201
**b.** 167.25 to 234.65
**c.** 108.75 to 293.15

**38. a.** \$5046.67
**b.** \$3815.10 to \$6278.24
**c.** Not out of line

**40. a.** 9
**b.** $\hat{y} = 20.0 + 7.21x$
**c.** 1.3626
**d.** SSE = SST − SSR = 51,984.1 − 41,587.3 = 10,396.8

MSE = 10,396.8/7 = 1485.3

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

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

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

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

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

**42. a.** $\hat{y} = 80.0 + 50.0x$
**b.** 30
**c.** Significant; $p$-value = .000
**d.** \$680,000

**44. b.** Yes
**c.** $\hat{y} = 37.1 - .779x$
**d.** Significant; $p$-value = 0.003
**e.** $r^2 = .434$; not a good fit
**f.** \$12.27 to \$22.90
**g.** \$17.47 to \$39.05

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

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

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

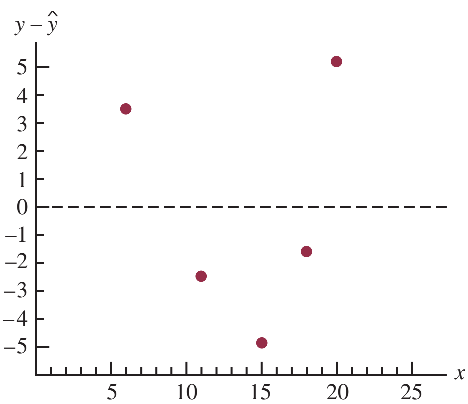
$b_0 = \bar{y} - b_1\bar{x} = 15.2 - (1.5873)(14) = -7.0222$

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

**b.**

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

**c.**



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

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

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

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

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

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

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

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

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

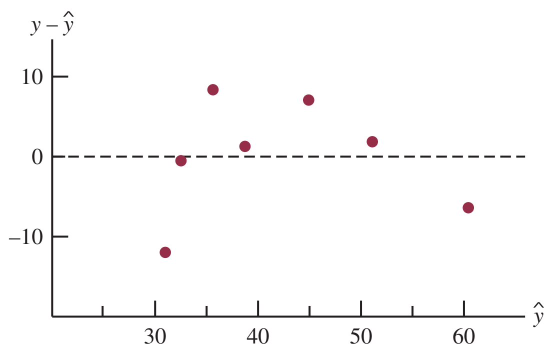
From the $F$ table (1 numerator degree of freedom and 5 denominator), $p$-value is between .01 and .025

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

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

**c.**

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




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

**48. b.** Yes

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

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

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

**d.** \$13.53

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

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

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

**e.** 1286

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

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

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

**d.** 12.294 to 17.271

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

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

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

**d.** \$559.50 to \$933.90

**58. a.** Market beta = .95

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

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

**d.** Texas Instruments has a higher risk

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

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

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

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

**f.** $r_{xy} = .86$

## Chapter 13

**2. a.** The estimated regression equation is
$\hat{y} = 45.06 + 1.94x_1$
An estimate of $y$ when $x_1 = 45$ is
$\hat{y} = 45.06 + 1.94(45) = 132.36$

**b.** The estimated regression equation is
$\hat{y} = 85.22 + 4.32x_2$
An estimate of $y$ when $x_2 = 15$ is
$\hat{y} = 85.22 + 4.32(15) = 150.02$

**c.** The estimated regression equation is
$\hat{y} = -18.37 + 2.01x_1 + 4.74x_2$
An estimate of $y$ when $x_1 = 45$ and $x_2 = 15$ is
$\hat{y} = -18.37 + 2.01(45) + 4.74(15) = 143.18$

**4. a.** \$255,000

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

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

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

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

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

**b.** Proportion Won = .865 − .0837 ERA

**FIGURE D13.5a**

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

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

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

Analysis of Variance

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

**FIGURE D13.5b**

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

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

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

Analysis of Variance

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

**19. a.** $MSR = \frac{SSR}{p} = \frac{6216.375}{2} = 3108.188$

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

**b.** $F = \frac{MSR}{MSE} = \frac{3108.188}{72.536} = 42.85$

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

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

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

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

$p$-value = .0002

Because $p$-value $\le \alpha$, $\beta_1$ is significant

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

$p$-value = .0001

Because $p$-value $\le \alpha$, $\beta_2$ is significant

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

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

**23. a.** $F = 28.38$

$p$-value = .002

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

**b.** $t = 7.53$

$p$-value = .001

Because $p$-value $\le \alpha$, $\beta_1$ is significant and $x_1$ should not be dropped from the model

**c.** $t = 4.06$

$p$-value = .010

Because $p$-value $\le \alpha$, $\beta_2$ is significant and $x_2$ should not be dropped from the model

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

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

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

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

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

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

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

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

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

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

$\beta_1$ is the change in $E(y)$ for a 1-unit change in $x_1$ holding $x_2$ constant

**34. a.** \$15,300
**b.** $\hat{y} = 10.1 - 4.2(2) + 6.8(8) + 15.3(0) = 56.1$
Sales prediction: \$56,100
**c.** $\hat{y} = 10.1 - 4.2(1) + 6.8(3) + 15.3(1) = 41.6$
Sales prediction: \$41,600

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

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

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

**42. a.** Score = 50.6 + 1.56 RecRes
**b.** $r^2 = .431$; not a good fit
**c.** Score = 33.5 + 1.90 RecRes + 2.61 Afford
Significant
$R_a^2 = .784$; much better fit

**44. a.** CityMPG = 24.1 − 2.10 Displace
Significant; $p$-value = .000
**b.** CityMPG = 26.4 − 2.44 Displace − 1.20 Drive4
**c.** Significant; $p$-value = .016
**d.** CityMPG = 33.3 − 4.15 Displace − 1.24 Drive4 + 2.16 EightCyl
**e.** Significant overall and individually