

CHAPTER 2 SOLUTIONS

Exercises 2.1

- 2.1 (a) Hair color, model of car, and brand of popcorn are qualitative variables.
- (b) Number of eggs in a nest, number of cases of flu, and number of employees are discrete, quantitative variables.
- (c) Temperature, weight, and time are quantitative continuous variables.
- 2.2 (a) A qualitative variable is a nonnumerically valued variable. Its possible "values" are descriptive (e.g., color, name, gender).
- (b) A discrete, quantitative variable is one whose possible values can be listed. It is usually obtained by counting rather than by measuring.
- (c) A continuous, quantitative variable is one whose possible values form some interval of numbers. It usually results from measuring.
- 2.3 (a) Qualitative data result from observing and recording values of a qualitative variable, such as, color or shape.
- (b) Discrete, quantitative data are values of a discrete quantitative variable. Values usually result from counting something.
- (c) Continuous, quantitative data are values of a continuous variable. Values are usually the result of measuring something such as temperature that can take on any value in a given interval.
- 2.4 The classification of data is important because it will help you choose the correct statistical method for analyzing the data.
- 2.5 Of qualitative and quantitative (discrete and continuous) types of data, only qualitative yields nonnumerical data.
- 2.6 (a) The first column consists of *quantitative, discrete* data. This column provides ranks of the highest recorded temperature for each continent.
- (b) The second column consists of *qualitative* data since continent names are nonnumerical.
- (c) The fourth column consists of *quantitative, continuous* data. This column provides the highest recorded temperatures for the continents in degrees Fahrenheit.
- (d) The information that Death Valley is in the United States is *qualitative* data since country in which a place is located is nonnumerical.
- 2.7 (a) The first column consists of *quantitative, continuous* data. This column provides the time that the earthquake occurred.
- (b) The second column consists of *quantitative, continuous* data. This column provides the magnitude of each earthquake.
- (c) The third column consists of *quantitative, continuous* data. This column provides the depth of each earthquake in kilometers.
- (d) The fourth column consists of *quantitative, discrete* data. This column provides the number of stations that reported activity on the earthquake.
- (e) The fifth column consists of *qualitative* data since the region of the location of each earthquake is nonnumerical.
- 2.8 (a) The first column consists of *quantitative, discrete* data. This column provides ranks of the top ten IPOs in the United States.

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- (b) The second column consists of *qualitative* data since company names are nonnumerical.
 - (c) The third column consists of *quantitative, discrete* data. Since money involves discrete units, such as dollars and cents, the data is discrete, although, for all practical purposes, this data might be considered quantitative continuous data.
 - (d) The information that Facebook is a social networking business is *qualitative* data since type of business is nonnumerical.
- 2.9**
- (a) The first column consists of *quantitative, discrete* data. This column provides the ranks of the deceased celebrities with the top 10 earnings.
 - (b) The second column consists of *qualitative* data since names are nonnumerical.
 - (c) The third column consists of *quantitative, discrete* data, the earnings of the celebrities. Since money involves discrete units, such as dollars and cents, the data is discrete, although, for all practical purposes, this data might be considered quantitative continuous data.
- 2.10**
- (a) The first column consists of *quantitative, discrete* data. This column provides the ranks of the top 10 universities for 2012-2013.
 - (b) The second column consists of *qualitative* data since names of the institutions are nonnumerical.
 - (c) The third column consists of *quantitative, continuous* data. This column provides the overall score of the top 10 universities for 2012-2013.
- 2.11**
- (a) The first column contains types of products. They are *qualitative* data since they are nonnumerical.
 - (b) The second column contains number of units shipped in the millions. These are whole numbers and are *quantitative, discrete*.
 - (c) The third column contains money values. Technically, these are *quantitative, discrete* data since there are gaps between possible values at the cent level. For all practical purposes, however, these are *quantitative, continuous* data.
- 2.12** Player name, team, and position are nonnumerical and are therefore *qualitative* data. The number of runs batted in, or RBI, are whole numbers and are therefore *quantitative, discrete*. Weight is *quantitative, continuous*.
- 2.13** The first column contains *quantitative, discrete* data in the form of ranks. These are whole numbers. The second and third columns contain *qualitative* data in the form of names. The last column contains the rating of the program which is *quantitative, continuous*.
- 2.14** The first column is *qualitative* since it is nonnumerical. The second and third columns are *quantitative, discrete* since they report the number of grants and applications received. The last column is *quantitative, continuous* since it reports the success rate of the grants.
- 2.15** The first column is *quantitative, discrete* since it is reporting a rank. The second and third columns are *qualitative* since make/model and type are nonnumerical. The last column is *quantitative, continuous* since it is reporting mileage.
- 2.16** Of the eight items presented, only high school class rank involves ordinal data. The rank is ordinal data.

Exercises 2.2

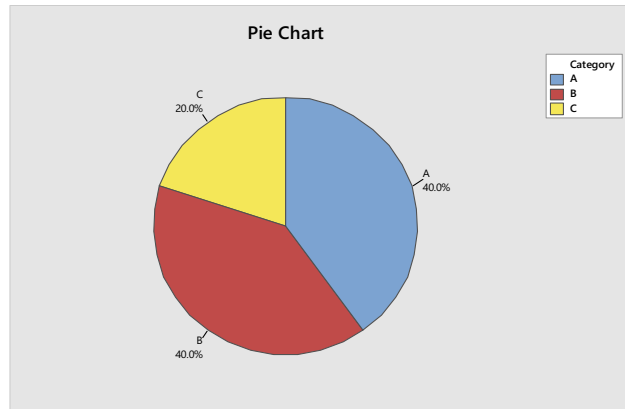
- 2.17** A frequency distribution of qualitative data is a table that lists the distinct values of data and their frequencies. It is useful to organize the data and make it easier to understand.
- 2.18** (a) The frequency of a class is the number of observations in the class, whereas, the relative frequency of a class is the ratio of the class frequency to the total number of observations.
- (b) The percentage of a class is 100 times the relative frequency of the class. Equivalently, the relative frequency of a class is the percentage of the class expressed as a decimal.
- 2.19** (a) True. Having identical frequency distributions implies that the total number of observations and the numbers of observations in each class are identical. Thus, the relative frequencies will also be identical.
- (b) False. Having identical relative frequency distributions means that the ratio of the count in each class to the total is the same for both frequency distributions. However, one distribution may have twice (or some other multiple) the total number of observations as the other. For example, two distributions with counts of 5, 4, 1 and 10, 8, 2 would be different, but would have the same relative frequency distribution.
- (c) If the two data sets have the same number of observations, either a frequency distribution or a relative-frequency distribution is suitable. If, however, the two data sets have different numbers of observations, using relative-frequency distributions is more appropriate because the total of each set of relative frequencies is 1, putting both distributions on the same basis for comparison.
- 2.20** (a) - (b)

The classes are presented in column 1. The frequency distribution of the classes is presented in column 2. Dividing each frequency by the total number of observations, which is 5, results in each class's relative frequency. The relative frequency distribution is presented in column 3.

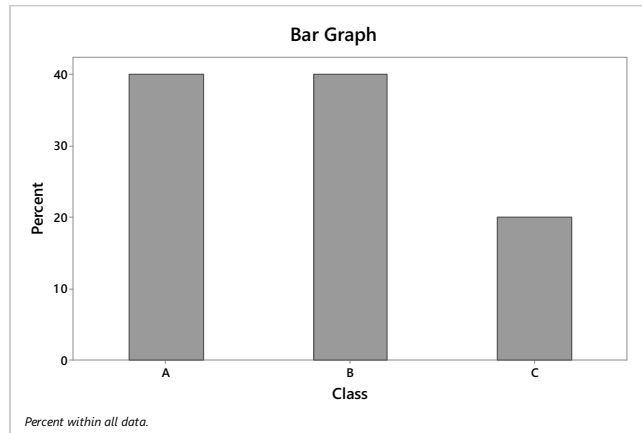
Class	Frequency	Relative Frequency
A	2	0.40
B	2	0.40
C	1	0.20
	5	1.00

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- (c) We multiply each of the relative frequencies by 360 degrees to obtain the portion of the pie represented by each class. The result using Minitab is



- (d) We use the bar chart to show the relative frequency with which each class occurs. The result is

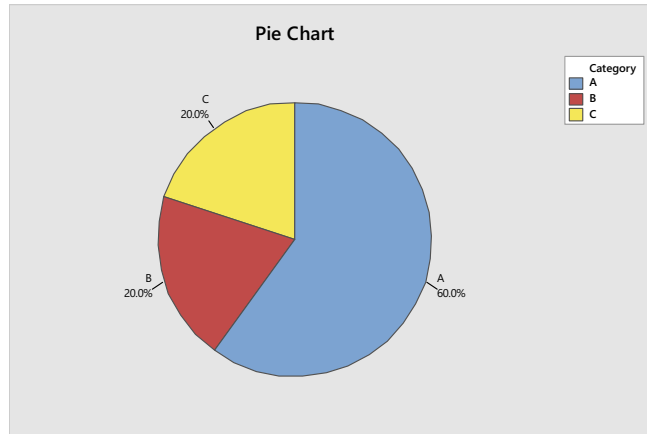


2.21 (a) - (b)

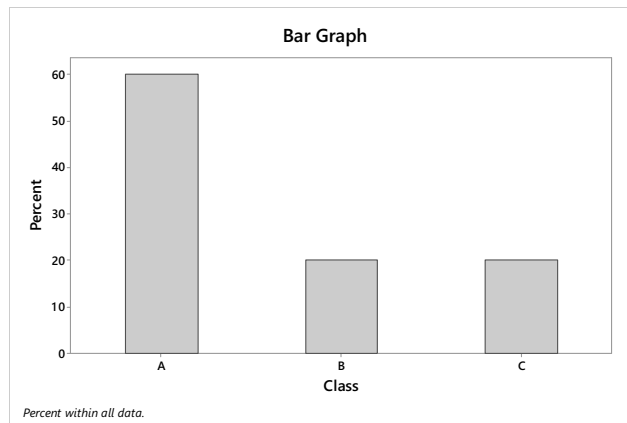
The classes are presented in column 1. The frequency distribution of the classes is presented in column 2. Dividing each frequency by the total number of observations, which is 5, results in each class's relative frequency. The relative frequency distribution is presented in column 3.

Class	Frequency	Relative Frequency
A	3	0.60
B	1	0.20
C	1	0.20
	5	1.00

- (c) We multiply each of the relative frequencies by 360 degrees to obtain the portion of the pie represented by each class. The result using Minitab is



- (d) We use the bar chart to show the relative frequency with which each class occurs. The result is



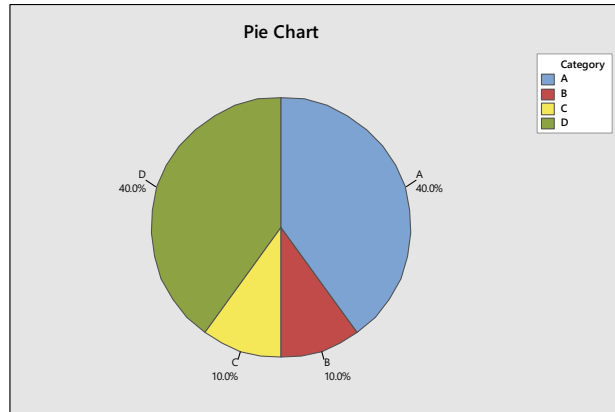
2.22 (a) - (b)

The classes are presented in column 1. The frequency distribution of the classes is presented in column 2. Dividing each frequency by the total number of observations, which is 10, results in each class's relative frequency. The relative frequency distribution is presented in column 3.

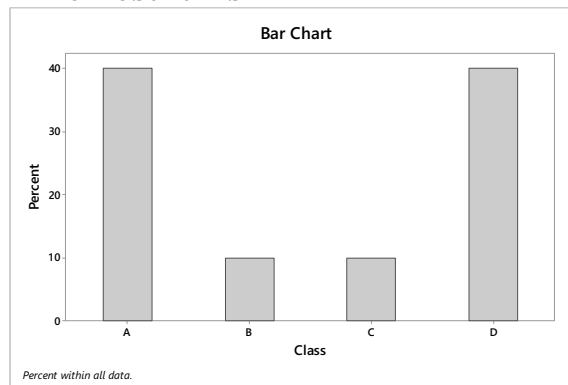
Class	Frequency	Relative Frequency
A	4	0.40
B	1	0.10
C	1	0.10
D	4	0.40
	10	1.00

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- (c) We multiply each of the relative frequencies by 360 degrees to obtain the portion of the pie represented by each class. The result using Minitab is



- (d) We use the bar chart to show the relative frequency with which each class occurs. The result is

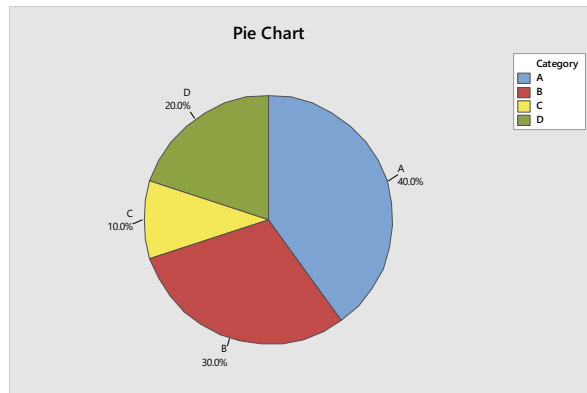


2.23 (a) - (b)

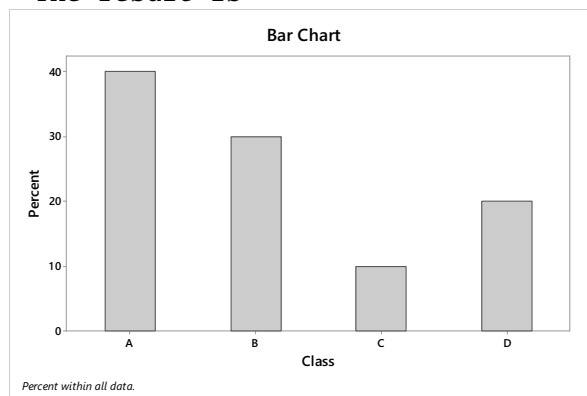
The classes are presented in column 1. The frequency distribution of the classes is presented in column 2. Dividing each frequency by the total number of observations, which is 10, results in each class's relative frequency. The relative frequency distribution is presented in column 3.

Class	Frequency	Relative Frequency
A	4	0.40
B	3	0.30
C	1	0.10
D	2	0.20
	10	1.00

- (c) We multiply each of the relative frequencies by 360 degrees to obtain the portion of the pie represented by each class. The result using Minitab is



- (d) We use the bar chart to show the relative frequency with which each class occurs. The result is



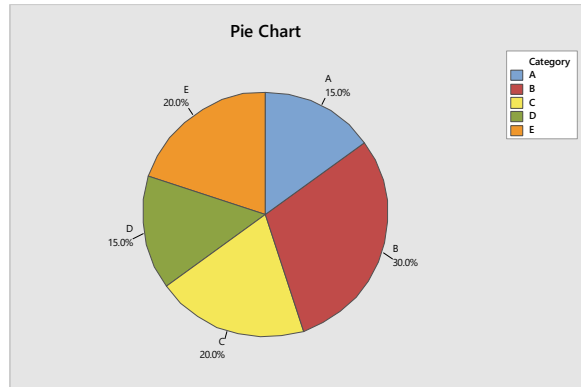
2.24 (a) - (b)

The classes are presented in column 1. The frequency distribution of the classes is presented in column 2. Dividing each frequency by the total number of observations, which is 20, results in each class's relative frequency. The relative frequency distribution is presented in column 3.

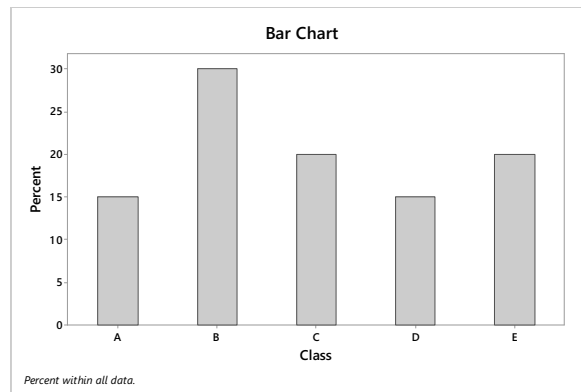
Class	Frequency	Relative Frequency
A	3	0.15
B	6	0.30
C	4	0.20
D	3	0.15
E	4	0.20
	20	1.00

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- (c) We multiply each of the relative frequencies by 360 degrees to obtain the portion of the pie represented by each class. The result using Minitab is



- (d) We use the bar chart to show the relative frequency with which each class occurs. The result is

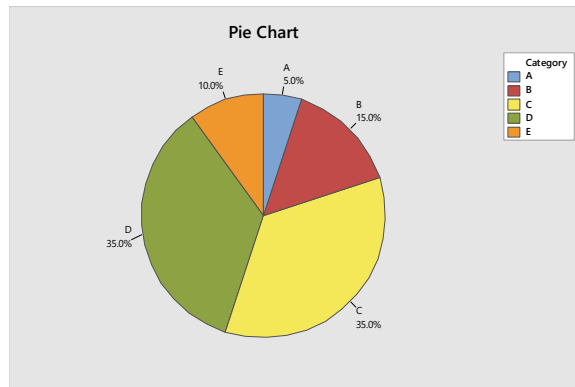


2.25 (a) - (b)

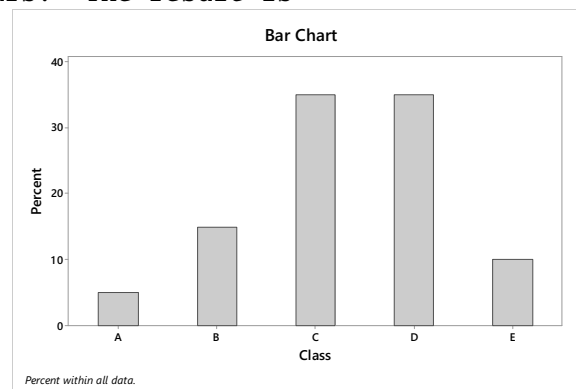
The classes are presented in column 1. The frequency distribution of the classes is presented in column 2. Dividing each frequency by the total number of observations, which is 20, results in each class's relative frequency. The relative frequency distribution is presented in column 3.

Class	Frequency	Relative Frequency
A	1	0.05
B	3	0.15
C	7	0.35
D	7	0.35
E	2	0.10
	20	1.00

- (c) We multiply each of the relative frequencies by 360 degrees to obtain the portion of the pie represented by each class. The result using Minitab is



- (d) We use the bar chart to show the relative frequency with which each class occurs. The result is

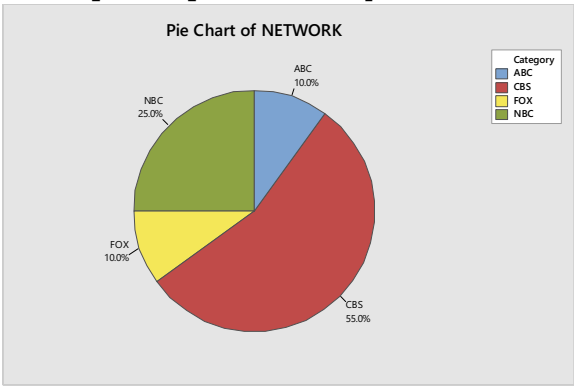


2.26 (a) - (b)

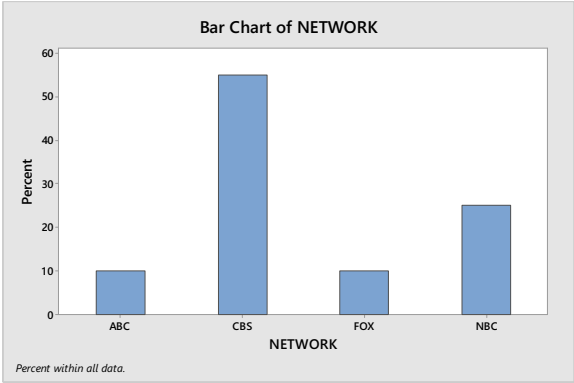
The classes are the networks and are presented in column 1. The frequency distribution of the networks is presented in column 2. Dividing each frequency by the total number of shows, which is 20, results in each class's relative frequency. The relative frequency distribution is presented in column 3.

Network	Frequency	Relative Frequency
ABC	2	0.10
CBS	11	0.55
Fox	2	0.10
NBC	5	0.25
	20	1.00

(c) We multiply each of the relative frequencies by 360 degrees to obtain the portion of the pie represented by each network. The result is



(d) We use the bar chart to show the relative frequency with which each network occurs. The result is

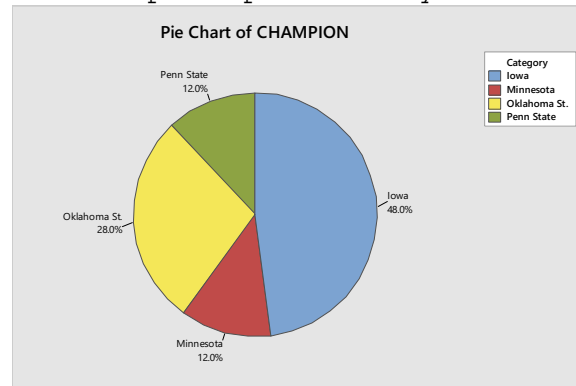


2.27 (a) - (b)

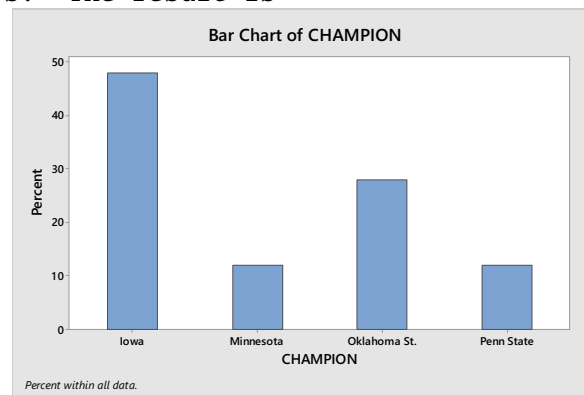
The classes are the NCAA wrestling champions and are presented in column 1. The frequency distribution of the champions is presented in column 2. Dividing each frequency by the total number of champions, which is 25, results in each class's relative frequency. The relative frequency distribution is presented in column 3.

Champion	Frequency	Relative Frequency
Iowa	12	0.48
Penn State	3	0.12
Minnesota	3	0.12
Oklahoma St.	7	0.28
	25	1.00

- (b) We multiply each of the relative frequencies by 360 degrees to obtain the portion of the pie represented by each team. The result is



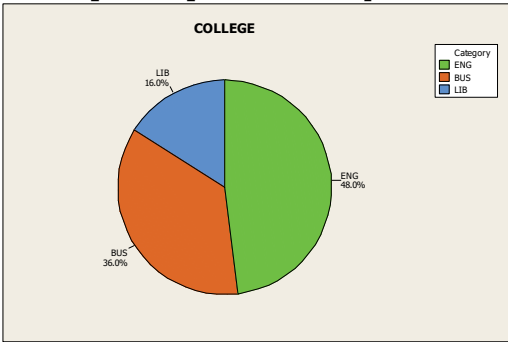
- (c) We use the bar chart to show the relative frequency with which each TEAM occurs. The result is



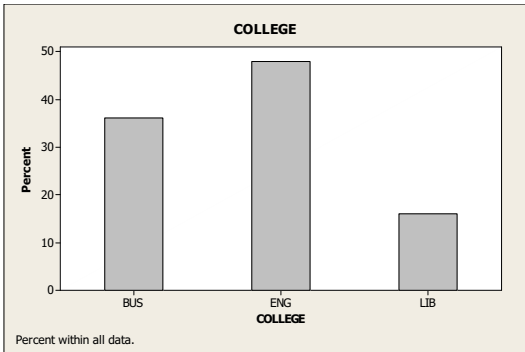
- 2.28** (a) - (b) The classes are the colleges and are presented in column 1. The frequency distribution of the colleges is presented in column 2. Dividing each frequency by the total number of students in the section of Introduction to Computer Science, which is 25, results in each class's relative frequency. The relative frequency distribution is presented in column 3.

College	Frequency	Relative Frequency
BUS	9	0.36
ENG	12	0.48
LIB	4	0.16
	25	1.00

(c) We multiply each of the relative frequencies by 360 degrees to obtain the portion of the pie represented by each college. The result is



(b) We use the bar chart to show the relative frequency with which each COLLEGE occurs. The result is

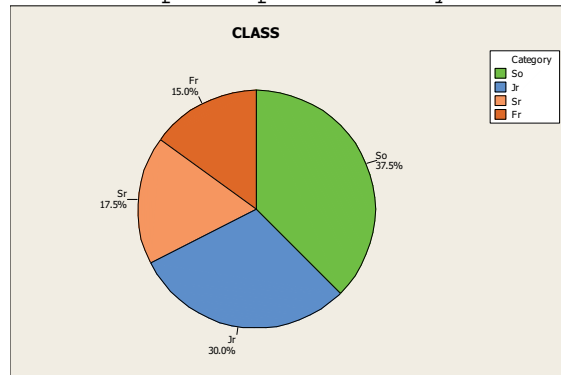


2.29 (a) - (b)

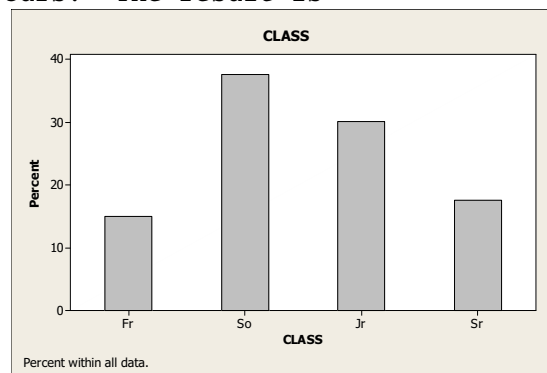
The classes are the class levels and are presented in column 1. The frequency distribution of the class levels is presented in column 2. Dividing each frequency by the total number of students in the introductory statistics class, which is 40, results in each class's relative frequency. The relative frequency distribution is presented in column 3.

Class Level	Frequency	Relative Frequency
Fr	6	0.150
So	15	0.375
Jr	12	0.300
Sr	7	0.175
	40	1.000

- (c) We multiply each of the relative frequencies by 360 degrees to obtain the portion of the pie represented by each class level. The result is



- (d) We use the bar chart to show the relative frequency with which each CLASS level occurs. The result is

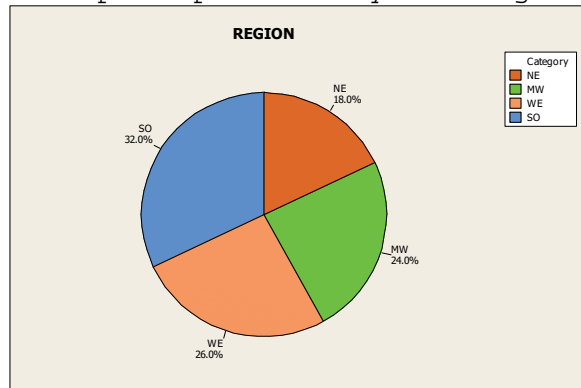


2.30 (a) - (b)

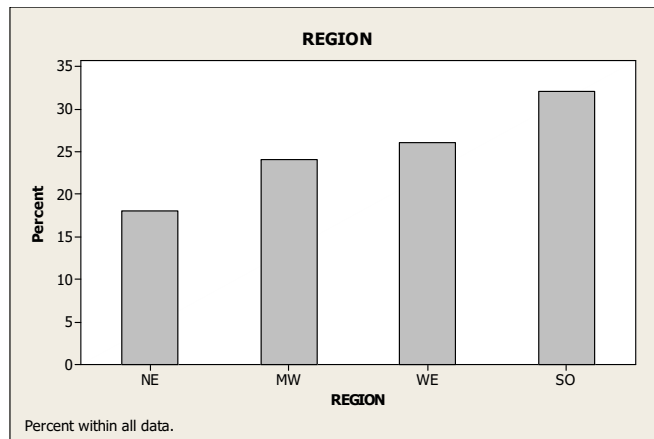
The classes are the regions and are presented in column 1. The frequency distribution of the regions is presented in column 2. Dividing each frequency by the total number of states, which is 50, results in each class's relative frequency. The relative frequency distribution is presented in column 3.

Class Level	Frequency	Relative Frequency
NE	9	0.18
MW	12	0.24
SO	16	0.32
WE	13	0.26
	50	1.00

- (c) We multiply each of the relative frequencies by 360 degrees to obtain the portion of the pie represented by each region. The result is



- (d) We use the bar chart to show the relative frequency with which each REGION occurs. The result is

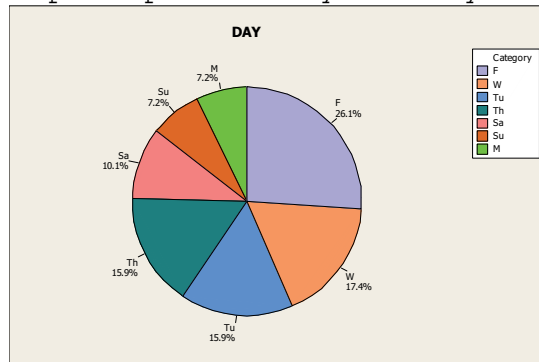


2.31 (a) - (b)

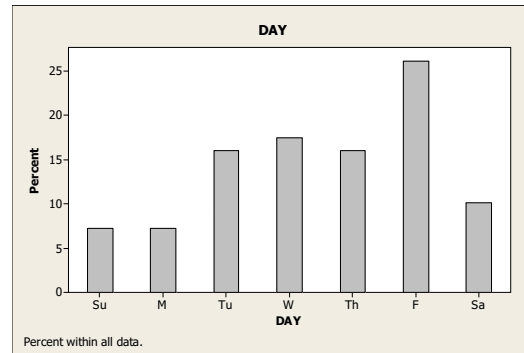
The classes are the days and are presented in column 1. The frequency distribution of the days is presented in column 2. Dividing each frequency by the total number road rage incidents, which is 69, results in each class's relative frequency. The relative frequency distribution is presented in column 3.

Class Level	Frequency	Relative Frequency
Su	5	0.0725
M	5	0.0725
Tu	11	0.1594
W	12	0.1739
Th	11	0.1594
F	18	0.2609
Sa	7	0.1014
	69	1.0000

- (c) We multiply each of the relative frequencies by 360 degrees to obtain the portion of the pie represented by each day. The result is



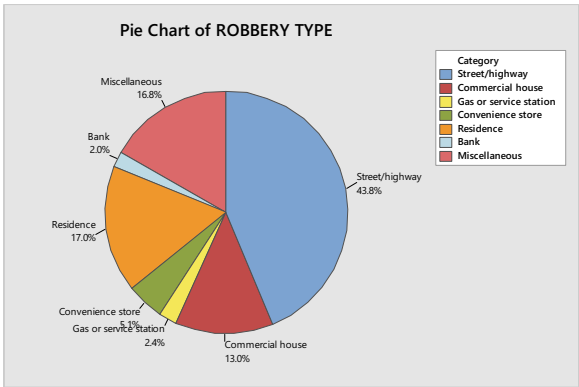
- (d) We use the bar chart to show the relative frequency with which each DAY occurs. The result is



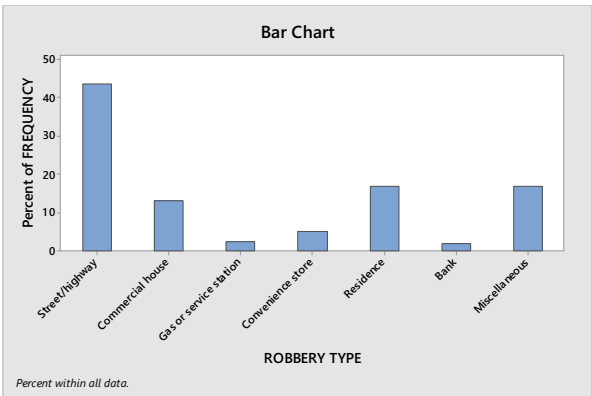
- 2.32** (a) We find each of the relative frequencies by dividing each of the frequencies by the total frequency of 291,176. Due to rounding, the sum of the relative frequency column is 0.9999.

Robbery Type	Frequency	Relative Frequency
Street/highway	127,403	0.4375
Commercial house	37,885	0.1301
Gas or service station	7,009	0.0241
Convenience store	14,863	0.0510
Residence	49,361	0.1695
Bank	5,777	0.0198
Miscellaneous	48,878	0.1679
	291,176	0.9999

(b) We multiply each of the relative frequencies by 360 degrees to obtain the portion of the pie represented by each robbery type. The result is



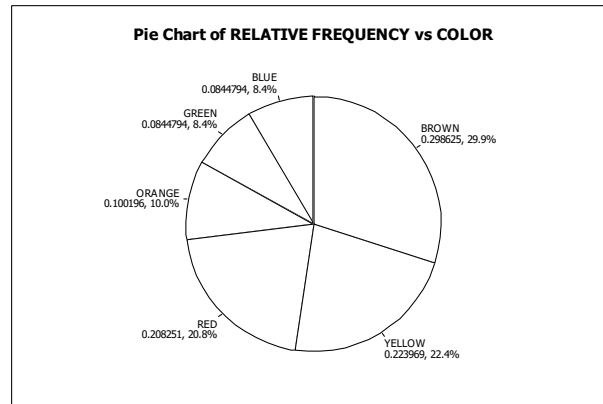
(c) We use the bar chart to show the relative frequency with which each robbery type occurs. The result is



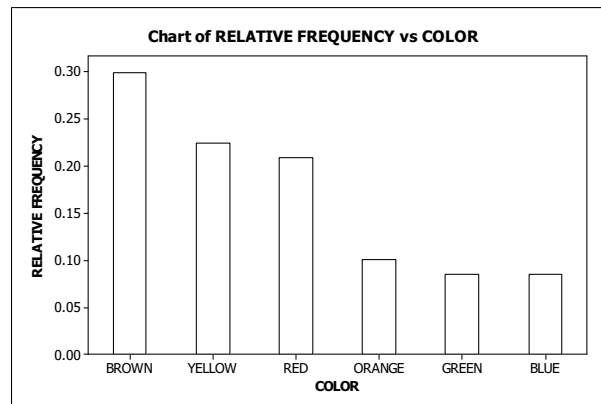
2.33 (a) We find the relative frequencies by dividing each of the frequencies by the total sample size of 509.

Color	Frequency	Relative Frequency
Brown	152	0.2986
Yellow	114	0.2240
Red	106	0.2083
Orange	51	0.1002
Green	43	0.0845
Blue	43	0.0845
	509	1.0000

- (b) We multiply each of the relative frequencies by 360 degrees to obtain the portion of the pie represented by each color of M&M. The result is



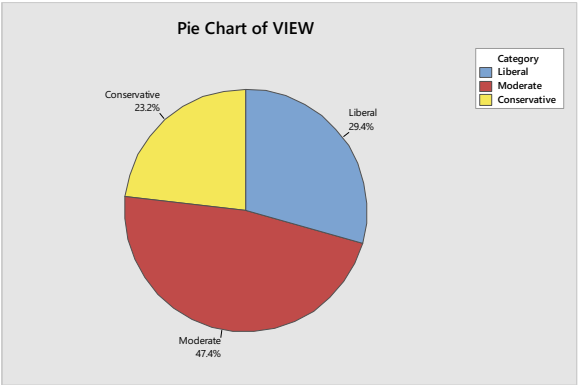
- (c) We use the bar chart to show the relative frequency with which each color occurs. The result is



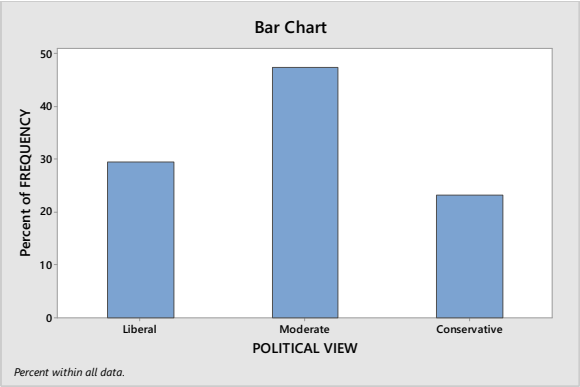
- 2.34** (a) We find the relative frequencies by dividing each of the frequencies by the total sample size of 500.

Political View	Frequency	Relative Frequency
Liberal	147	0.294
Moderate	237	0.474
Conservative	116	0.232
	500	1.000

- (b) We multiply each of the relative frequencies by 360 degrees to obtain the portion of the pie represented by each political view. The result is



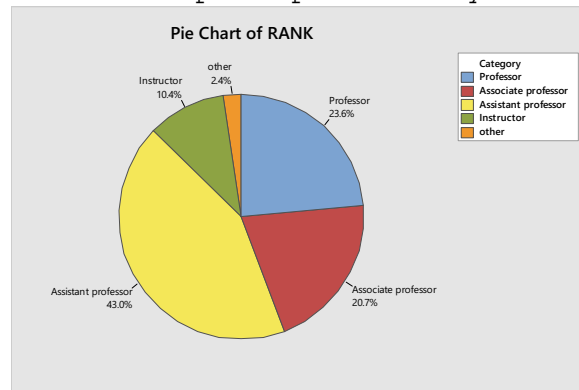
- (c) We use the bar chart to show the relative frequency with which each political view occurs. The result is



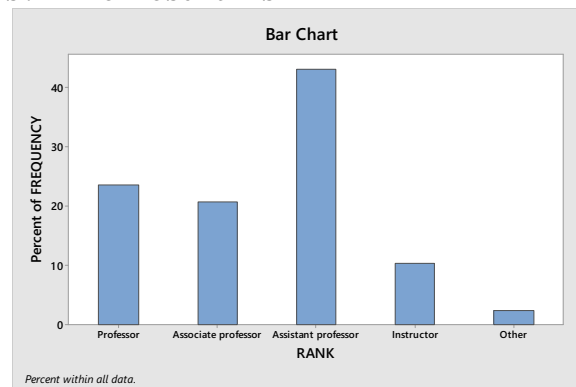
- 2.35** (a) We find the relative frequencies by dividing each of the frequencies by the total sample size of 137,925.

Rank	Frequency	Relative Frequency
Professor	32,511	0.2357
Associate professor	28,572	0.2072
Assistant professor	59,277	0.4298
Instructor	14,289	0.1036
Other	3,276	0.0238
	137,925	1.0000

- (b) We multiply each of the relative frequencies by 360 degrees to obtain the portion of the pie represented by each rank. The result is



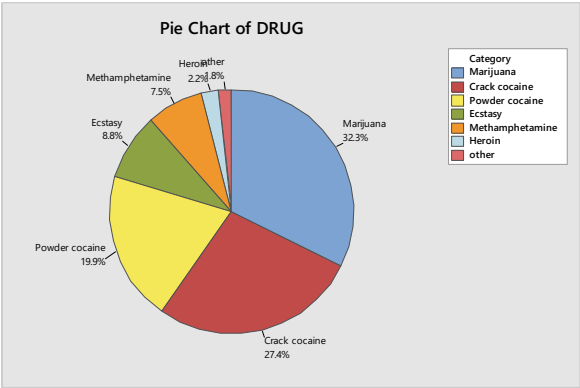
- (c) We use the bar chart to show the relative frequency with which each rank occurs. The result is



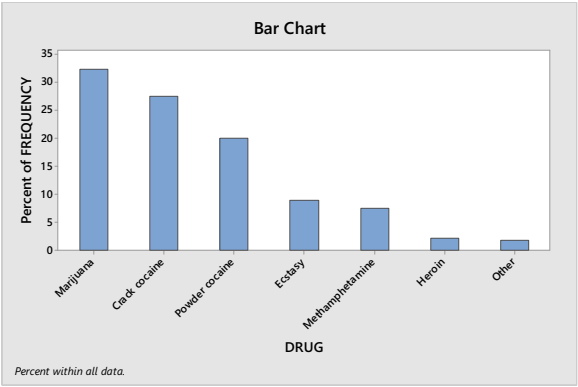
- 2.36** (a) We find the relative frequencies by dividing each of the frequencies by the total sample size of 226. The sum of the relative frequency columns is 0.9999 due to rounding.

Drug Sold	Frequency	Relative Frequency
Marijuana	73	0.3230
Crack cocaine	62	0.2743
Powder cocaine	45	0.1991
Ecstasy	20	0.0885
Methamphetamine	17	0.0752
Heroin	5	0.0221
Other	4	0.0177
	226	0.9999

(b) We multiply each of the relative frequencies by 360 degrees to obtain the portion of the pie represented by each drug type. The result is



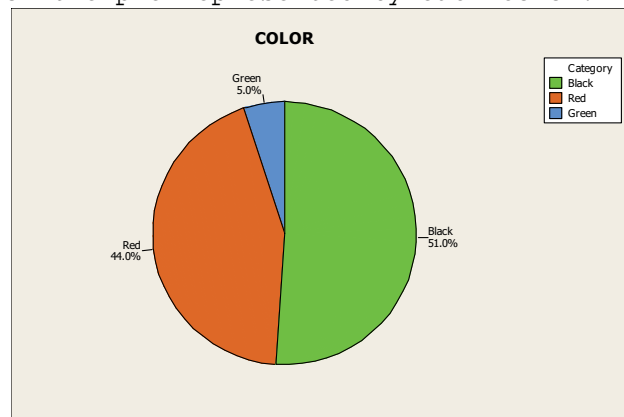
(c) We use the bar chart to show the relative frequency with which each rank occurs. The result is



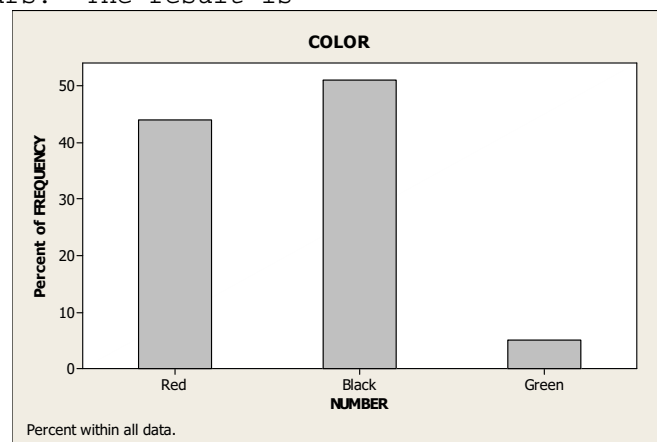
2.37 (a) We first find the relative frequencies by dividing each of the frequencies by the total sample size of 200.

Color	Frequency	Relative Frequency
Red	88	0.44
Black	102	0.51
Green	10	0.05
	200	1.00

- (b) We multiply each of the relative frequencies by 360 degrees to obtain the portion of the pie represented by each color. The result is



- (c) We use the bar chart to show the relative frequency with which each color occurs. The result is



- 2.38** (a) The classes are the different levels of health status and are presented in column 1. The frequency distribution of health status is presented in column 2. Dividing each frequency by the total number of people, which is 188.3 million for persons aged 19-64 and 41.5 million for persons aged 65 and over, results in each class's relative frequency. The relative frequency distribution is presented in column 3.

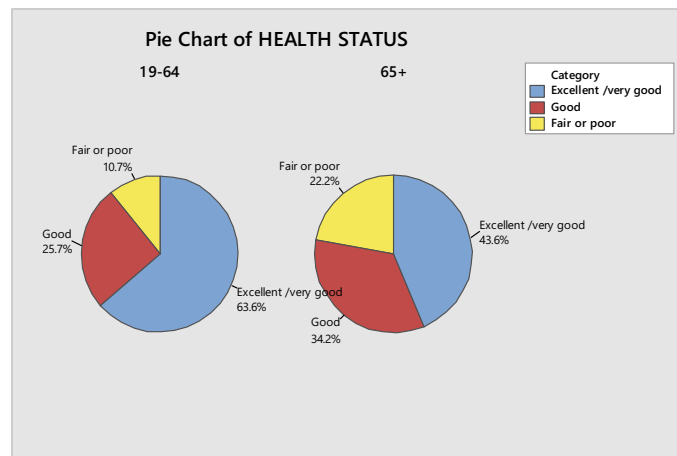
For People aged 19-64

Health Status	Frequency	Relative Frequency
Excellent or very good	119.7	0.636
Good	48.4	0.257
Fair or poor	20.2	0.107
	188.3	1.000

For People aged 65 and over

Health Status	Frequency	Relative Frequency
Excellent or very good	18.1	0.436
Good	14.2	0.342
Fair or poor	9.2	0.222
	41.5	1.000

- (b) We multiply each of the relative frequencies by 360 degrees to obtain the portion of each pie represented by each health status. The results are



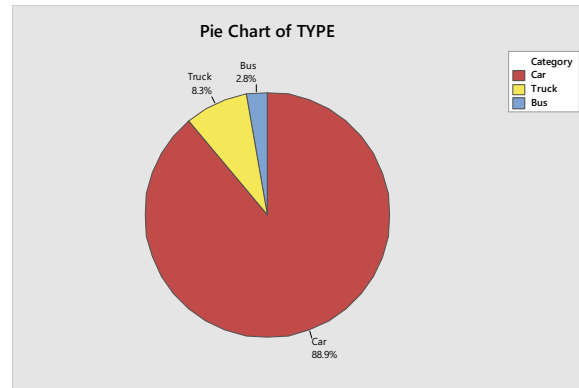
- (c) A bigger proportion of persons aged 19-64 have a health status of excellent or very good than persons aged 65 and over. A smaller proportion of persons aged 19-64 have a health status of fair or poor than persons aged 65 and over.

2.39 (a) Using Minitab, retrieve the data from the WeissStats Resource Site. Column 1 contains the type of the vehicle. From the tool bar, select

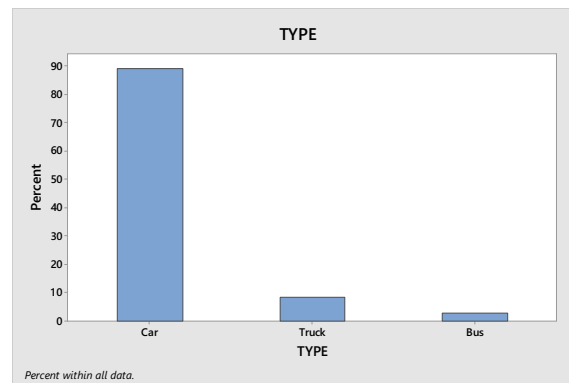
Stat < Tables < Tally Individual Variables, double-click on TYPE in the first box so that TYPE appears in the **Variables** box, put a check mark next to Counts and Percents under Display, and click **OK**. The result is

TYPE	Count	Percent
Bus	21	2.80
Car	667	88.93
Truck	62	8.27
N=	750	

- (b) The relative frequencies were calculated in part(a) by putting a check mark next to Percents. 2.8% of the vehicles were busses, 88.93% of the vehicles were cars, and 8.27% of the vehicles were trucks.
- (c) Using Minitab, select **Graph < Pie Chart**, check Chart counts of unique values, double-click on TYPE in the first box so that TYPE appears in the Categorical Variables box. Click Pie Options, check decreasing volume, click OK. Click Labels, enter TYPE in for the title, click Slice Labels, check Category Name, Percent, and Draw a line from label to slice, Click OK twice. The result is



- (d) Using Minitab, select **Graph** < **Bar Chart**, select Counts of unique values, select Simple option, click OK. Double-click on TYPE in the first box so that TYPE appears in the Categorical Variables box. Select Chart Options, check decreasing Y, check show Y as a percent, click OK. Select Labels, enter in TYPE as the title. Click OK twice. The result is

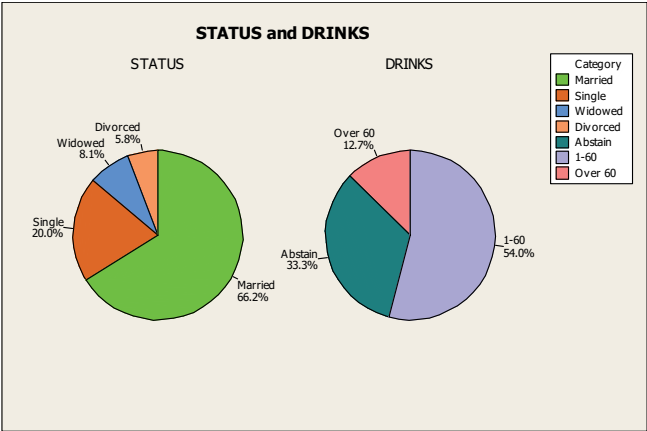


- 2.40** (a) Using Minitab, retrieve the data from the WeissStats Resource Site. Column 2 contains the marital status and column 3 contains the number of drinks per month. From the tool bar, select **Stat** < **Tables** < **Tally Individual Variables**, double-click on STATUS and DRINKS in the first box so that both STATUS and DRINKS appear in the **Variables** box, put a check mark next to Counts and Percents under Display, and click **OK**. The results are

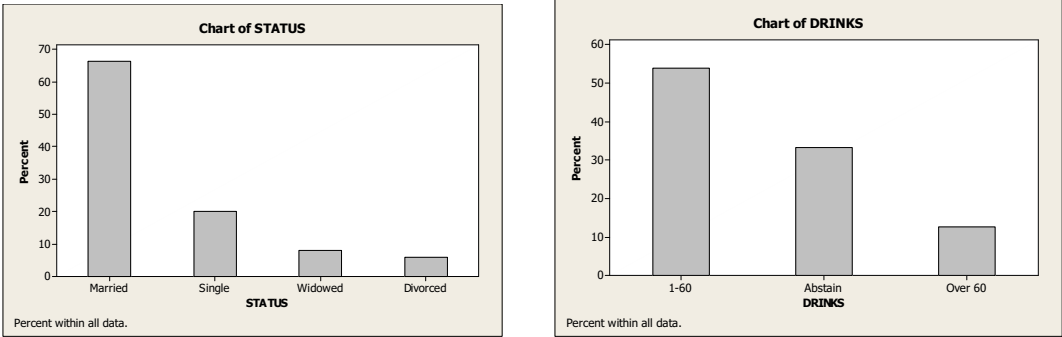
STATUS	Count	Percent	DRINKS	Count	Percent
Single	354	19.98	Abstain	590	33.30
Married	1173	66.20	1-60	957	54.01
Widowed	143	8.07	Over 60	225	12.70
Divorced	102	5.76	N=	1772	
N=	1772				

- (b) The relative frequencies were calculated in part(a) by putting a check mark next to Percents. For the STATUS variable; 19.98% of the US Adults are single, 66.20% are married, 8.07% are widowed, and 5.76% are divorced. For the DRINKS variable, 33.30% of US Adults abstain from drinking, 54.01% have 1-60 drinks per month, and 12.70% have over 60 drinks per month.

- (c) Using Minitab, select **Graph < Pie Chart**, check Chart counts of unique values, double-click on STATUS and DRINKS in the first box so that STATUS and DRINKS appear in the Categorical Variables box. Click Pie Options, check decreasing volume, click OK. Click Multiple Graphs, check On the Same Graphs, Click OK. Click Labels, click Slice Labels, check Category Name, Percent, and Draw a line from label to slice, Click OK twice. The results are



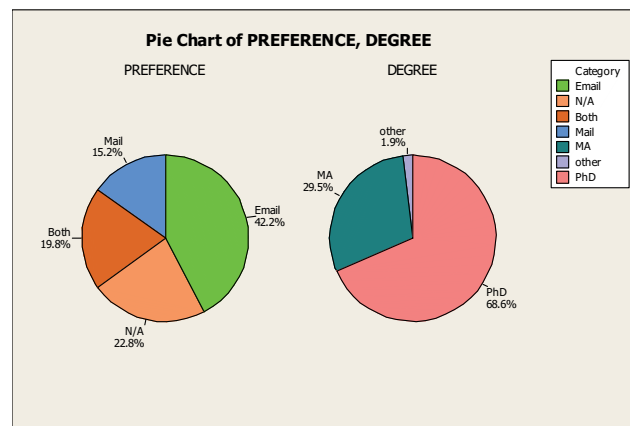
- (d) Using Minitab, select **Graph < Bar Chart**, select Counts of unique values, select Simple option, click OK. Double-click on STATUS and DRINKS in the first box so that STATUS and DRINKS appear in the Categorical Variables box. Select Chart Options, check decreasing Y, check show Y as a percent, click OK. Click OK twice. The results are



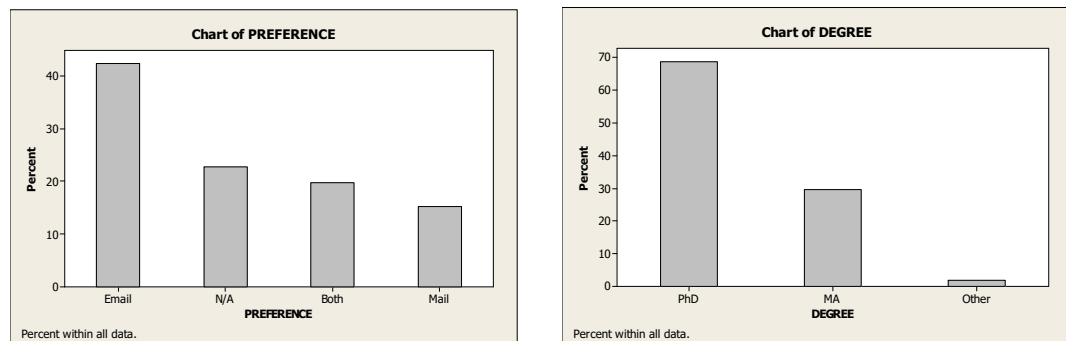
- 2.41** (a) Using Minitab, retrieve the data from the WeissStats Resource Site. Column 2 contains the preference for how the members want to receive the ballots and column 3 contains the highest degree obtained by the members. From the tool bar, select **Stat < Tables < Tally Individual Variables**, double-click on PREFERENCE and DEGREE in the first box so that both PREFERENCE and DEGREE appear in the **Variables** box, put a check mark next to Counts and Percents under Display, and click **OK**. The results are

PREFERENCE	Count	Percent	DEGREE	Count	Percent
Both	112	19.79	MA	167	29.51
Email	239	42.23	Other	11	1.94
Mail	86	15.19	PhD	388	68.55
N/A	129	22.79	N=	566	
N=	566				

- (b) The relative frequencies were calculated in part(a) by putting a check mark next to Percents. For the PREFERENCE variable; 19.79% of the members prefer to receive the ballot by both e-mail and mail, 42.23% prefer e-mail, 15.19% prefer mail, and 22.79% didn't list a preference. For the Degree variable; 29.51% obtained a Master's degree, 68.55% obtained a PhD, and 1.94% received a different degree.
- (c) Using Minitab, select **Graph < Pie Chart**, check Chart counts of unique values, double-click on PREFERENCE and DEGREE in the first box so that PREFERENCE and DEGREE appear in the Categorical Variables box. Click Pie Options, check decreasing volume, click OK. Click Multiple Graphs, check On the Same Graphs, Click OK. Click Labels, click Slice Labels, check Category Name, Percent, and Draw a line from label to slice, Click OK twice. The results are



- (d) Using Minitab, select **Graph < Bar Chart**, select Counts of unique values, select Simple option, click OK. Double-click on PREFERENCE and DEGREE in the first box so that PREFERENCE and DEGREE appear in the Categorical Variables box. Select Chart Options, check decreasing Y, check show Y as a percent, click OK. Click OK twice. The results are



Exercises 2.3

- 2.42** One important reason for grouping data is that grouping often makes a large and complicated set of data more compact and easier to understand.
- 2.43** For class limits, marks, cutpoints and midpoints to make sense, data must be numerical. They do not make sense for qualitative data classes because such data are nonnumerical.
- 2.44** The most important guidelines in choosing the classes for grouping a data set are: (1) the number of classes should be small enough to provide an effective summary, but large enough to display the relevant characteristics of the data; (2) each observation must belong to one, and only one, class; and (3) whenever feasible, all classes should have the same width.
- 2.45** In the first method for depicting classes called cutpoint grouping, we used the notation **a - under b** to mean values that are greater than or equal to **a** and up to, but not including **b**, such as 30 - under 40 to mean a range of values greater than or equal to 30, but strictly less than 40. In the alternate method called limit grouping, we used the notation **a-b** to indicate a class that extends from **a** to **b**, including both. For example, 30-39 is a class that includes both 30 and 39. The alternate method is especially appropriate when all of the data values are integers. If the data include values like 39.7 or 39.93, the first method is more advantageous since the cutpoints remain integers; whereas, in the alternate method, the upper limits for each class would have to be expressed in decimal form such as 39.9 or 39.99.
- 2.46** (a) For continuous data displayed to one or more decimal places, using the cutpoint grouping is best since the description of the classes is simpler, regardless of the number of decimal places displayed.
- (b) For discrete data with relatively few distinct observations, the single value grouping is best since either of the other two methods would result in combining some of those distinct values into single classes, resulting in too few classes, possibly less than 5.
- 2.47** For limit grouping, we find the class mark, which is the average of the lower and upper class limit. For cutpoint grouping, we find the class midpoint, which is the average of the two cutpoints.
- 2.48** A frequency histogram shows the actual frequencies on the vertical axis; whereas, the relative frequency histogram always shows proportions (between 0 and 1) or percentages (between 0 and 100) on the vertical axis.
- 2.49** An advantage of the frequency histogram over a frequency distribution is that it is possible to get an overall view of the data more easily. A disadvantage of the frequency histogram is that it may not be possible to determine exact frequencies for the classes when the number of observations is large.
- 2.50** By showing the lower class limits (or cutpoints) on the horizontal axis, the range of possible data values in each class is immediately known and the class mark (or midpoint) can be quickly determined. This is particularly helpful if it is not convenient to make all classes the same width. The use of the class mark (or midpoint) is appropriate when each class consists of a single value (which is, of course, also the midpoint). Use of the class marks (or midpoints) is not appropriate in other situations since it may be difficult to determine the location of the class limits (or cutpoints) from the values of the class marks (or midpoints), particularly if the class marks (or midpoints) are not evenly spaced. Class Marks (or midpoints) cannot be used if there is an open class.

- 2.51** If the classes consist of single values, stem-and-leaf diagrams and frequency histograms are equally useful. If only one diagram is needed and the classes consist of more than one value, the stem-and-leaf diagram allows one to retrieve all of the original data values whereas the frequency histogram does not. If two or more sets of data of different sizes are to be compared, the relative frequency histogram is advantageous because all of the diagrams to be compared will have the same total relative frequency of 1.00. Finally, stem-and-leaf diagrams are not very useful with very large data sets and may present problems with data having many digits in each number.
- 2.52** The histogram (especially one using relative frequencies) is generally preferable. Data sets with a large number of observations may result in a stem of the stem-and-leaf diagram having more leaves than will fit on the line. In that case, the histogram would be preferable.
- 2.53** You can reconstruct the stem-and-leaf diagram using two lines per stem. For example, instead of listing all of the values from 10 to 19 on a '1' stem, you can make two '1' stems. On the first, you record the values from 10 to 14 and on the second, the values from 15 to 19. If there are still too few stems, you can reconstruct the diagram using five lines per stem, recording 10 and 11 on the first line, 12 and 13 on the second, and so on.
- 2.54** For the number of bedrooms per single-family dwelling, single-value grouping is probably the best because the data is discrete with relatively few distinct observations.
- 2.55** For the ages of householders, given as a whole number, limit grouping is probably the best because the data are given as whole numbers and there are probably too many distinct observations to list them as single-value grouping.
- 2.56** For additional sleep obtained by a sample of 100 patients by using a particular brand of sleeping pill, cutpoint grouping is probably the best because the data is continuous and the data was recorded to the nearest tenth of an hour.
- 2.57** For the number of automobiles per family, single-value grouping is probably the best because the data is discrete with relatively few distinct observations.
- 2.58** For gas mileages, rounded to the nearest number of miles per gallon, limit grouping is probably the best because the data are given as whole numbers and there are probably too many distinct observations to list them as single-value grouping.
- 2.59** For carapace length for a sample of giant tarantulas, cutpoint grouping is probably the best because the data is continuous and the data was recorded to the nearest hundredth of a millimeter.
- 2.60** (a) Since the data values range from 1 to 4, we construct a table with classes based on a single value. The resulting table follows.

Single Value Class	Frequency
1	2
2	0
3	5
4	3
	10

- (b) To get the relative frequencies, divide each frequency by the sample size of 10.

Single Value Class	Relative Frequency
1	0.20
2	0.00
3	0.50
4	0.30
	1.00

- (c) The frequency histogram in Figure (a) is constructed using the frequency distribution presented in part (a) of this exercise. Column 1 demonstrates that the data are grouped using classes based on a single value. These single values in column 1 are used to label the horizontal axis of the frequency histogram. When classes are based on a single value, the middle of each histogram bar is placed directly over the single numerical value represented by the class. Also, the height of each bar in the frequency histogram matches the respective frequency in column 2.

Figure (a)

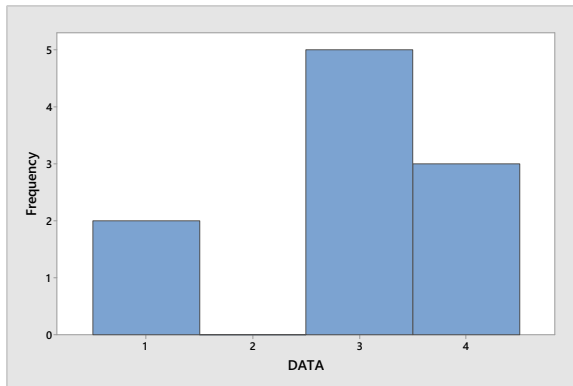
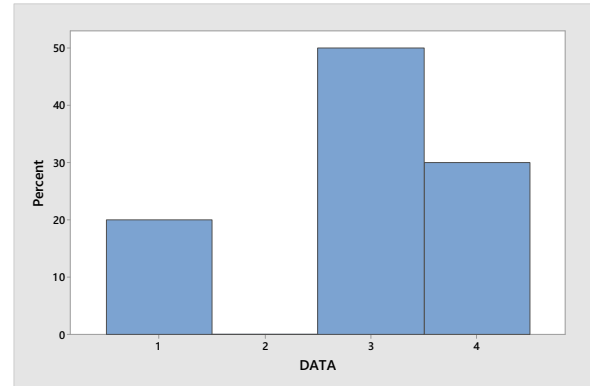


Figure (b)



- (d) The relative-frequency histogram in Figure (b) is constructed using the relative-frequency distribution presented in part (b) of this exercise. It has the same horizontal axis as the frequency histogram. The middle of each histogram bar is placed directly over the single numerical value represented by the class. Also, the height of each bar in the relative-frequency histogram matches the respective relative frequency in column 2.

- 2.61** (a) Since the data values range from 1 to 4, we construct a table with classes based on a single value. The resulting table follows.

Single Value Class	Frequency
1	2
2	2
3	5
4	1
	10

- (b) To get the relative frequencies, divide each frequency by the sample size of 10.

Single Value Class	Relative Frequency
1	0.20
2	0.20
3	0.50
4	0.10
	1.00

- (c) The frequency histogram in Figure (a) is constructed using the frequency distribution presented in part (a) of this exercise. Column 1 demonstrates that the data are grouped using classes based on a single value. These single values in column 1 are used to label the horizontal axis of the frequency histogram. When classes are based on a single value, the middle of each histogram bar is placed directly over the single numerical value represented by the class. Also, the height of each bar in the frequency histogram matches the respective frequency in column 2.

Figure (a)

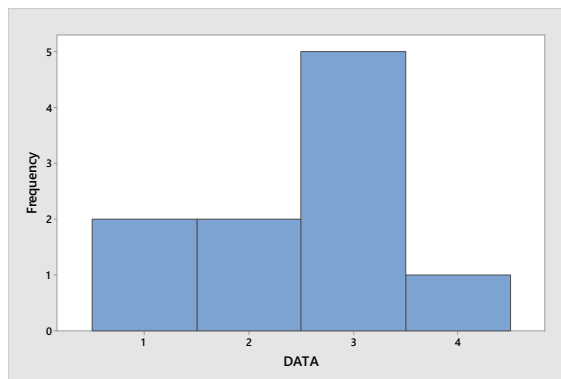
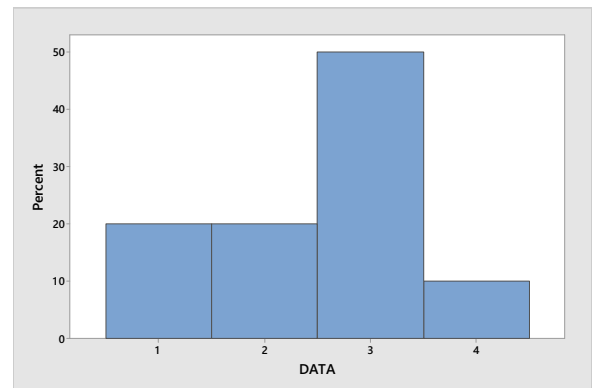


Figure (b)



- (d) The relative-frequency histogram in Figure (b) is constructed using the relative-frequency distribution presented in part (b) of this exercise. It has the same horizontal axis as the frequency histogram. The middle of each histogram bar is placed directly over the single numerical value represented by the class. Also, the height of each bar in the relative-frequency histogram matches the respective relative frequency in column 2.

- 2.62** (a) Since the data values range from 0 to 4, we construct a table with classes based on a single value. The resulting table follows.

Single Value Class	Frequency
0	2
1	8
2	7
3	2
4	1
	20

- (b) To get the relative frequencies, divide each frequency by the sample size of 20.

Single Value Class	Relative Frequency
0	0.10
1	0.40
2	0.35
3	0.10
4	0.05
	1.00

- (c) The frequency histogram in Figure (a) is constructed using the frequency distribution presented in part (a) of this exercise. Column 1 demonstrates that the data are grouped using classes based on a single value. These single values in column 1 are used to label the horizontal axis of the frequency histogram. When classes are based on a single value, the middle of each histogram bar is placed directly over the single numerical value represented by the class. Also, the height of each bar in the frequency histogram matches the respective frequency in column 2.

Figure (a)

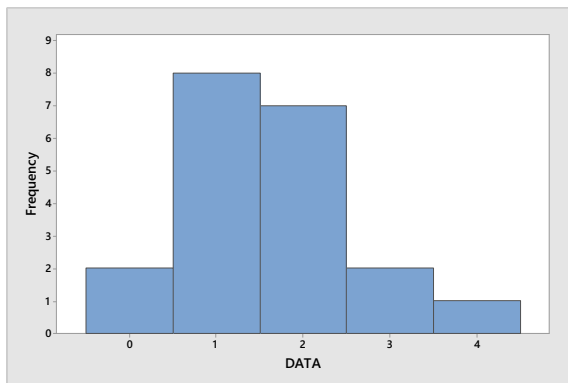
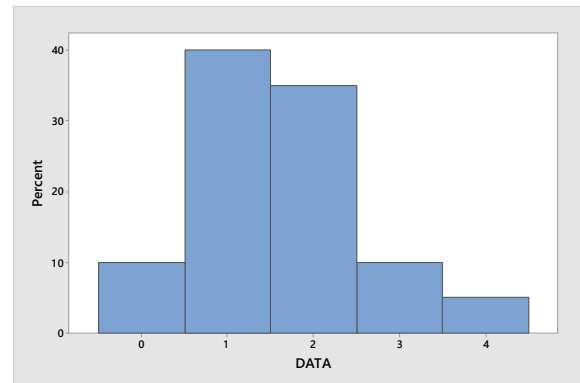


Figure (b)



- (d) The relative-frequency histogram in Figure (b) is constructed using the relative-frequency distribution presented in part (b) of this exercise. It has the same horizontal axis as the frequency histogram. The middle of each histogram bar is placed directly over the single numerical value represented by the class. Also, the height of each bar in the relative-frequency histogram matches the respective relative frequency in column 2.

- 2.63** (a) Since the data values range from 0 to 4, we construct a table with classes based on a single value. The resulting table follows.

Single Value Class	Frequency
0	1
1	1
2	4
3	8
4	6
	20

- (b) To get the relative frequencies, divide each frequency by the sample size of 20.

Single Value Class	Relative Frequency
0	0.05
1	0.05
2	0.20
3	0.40
4	0.30
	1.00

- (c) The frequency histogram in Figure (a) is constructed using the frequency distribution presented in part (a) of this exercise. Column 1 demonstrates that the data are grouped using classes based on a single value. These single values in column 1 are used to label the horizontal axis of the frequency histogram. When classes are based on a single value, the middle of each histogram bar is placed directly over the single numerical value represented by the class. Also, the height of each bar in the frequency histogram matches the respective frequency in column 2.

Figure (a)

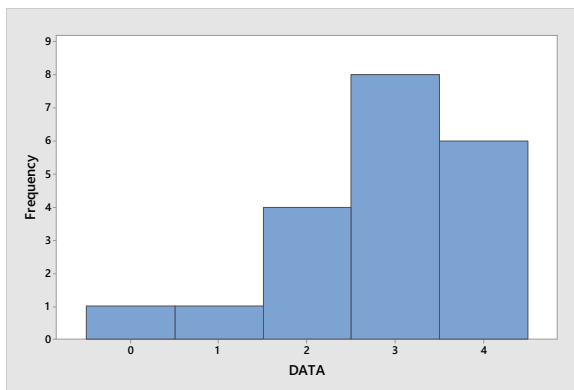
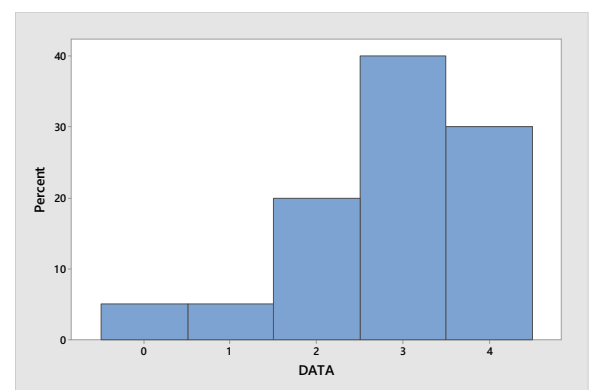


Figure (b)



- (d) The relative-frequency histogram in Figure (b) is constructed using the relative-frequency distribution presented in part (b) of this exercise. It has the same horizontal axis as the frequency histogram. The middle of each histogram bar is placed directly over the single numerical value represented by the class. Also, the height of each bar in the relative-frequency histogram matches the respective relative frequency in column 2.
- 2.64** (a) The first class to construct is 0-9. The width of all the classes is 10, so the next class would be 10-19. The classes are presented in column 1. The last class to construct is 40-49, since the largest single data value is 41. The tallied results are presented in column 2, which lists the frequencies.

Limit Grouping Classes	Frequency
0-9	3
10-19	3
20-29	5
30-39	8
40-49	1
	20

- (b) Dividing each frequency by the total number of observations, which is 20, results in each class's relative frequency. The relative frequencies for all classes are presented in column 2. The resulting table follows.

Limit Grouping Classes	Relative Frequency
0-9	0.15
10-19	0.15
20-29	0.25
30-39	0.40
40-49	0.05
	1.00

- (c) The frequency histogram in Figure (a) is constructed using the frequency distribution presented in part (a) of this exercise. The lower class limits of column 1 are used to label the horizontal axis of the frequency histogram. The height of each bar in the frequency histogram matches the respective frequency in column 2.
- (d) The relative-frequency histogram in Figure (b) is constructed using the relative-frequency distribution presented in part (b) of this exercise. It has the same horizontal axis as the frequency histogram. The height of each bar in the relative-frequency histogram matches the respective relative frequency in column 2.

Figure (a)

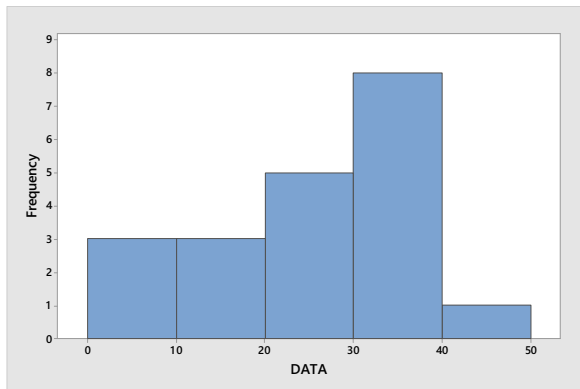
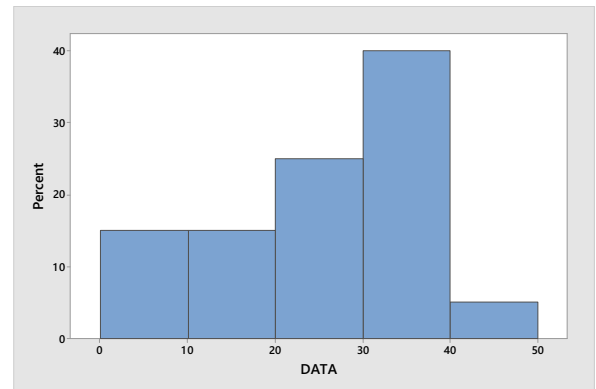


Figure (b)



- 2.65** (a) The first class to construct is 0-4. The width of all the classes is 5, so the next class would be 5-9. The classes are presented in column 1. The last class to construct is 25-29, since the largest single data value is 26. The tallied results are presented in column 2, which lists the frequencies.

Limit Grouping Classes	Frequency
0-4	5
5-9	5
10-14	1
15-19	4
20-24	2
25-29	3
	20

- (b) Dividing each frequency by the total number of observations, which is 20, results in each class's relative frequency. The relative frequencies for all classes are presented in column 2. The resulting table follows.

Limit Grouping Classes	Relative Frequency
0-4	0.25
5-9	0.25
10-14	0.05
15-19	0.20
20-24	0.10
25-29	0.15
	1.00

- (c) The frequency histogram in Figure (a) is constructed using the frequency distribution presented in part (a) of this exercise. The lower class limits of column 1 are used to label the horizontal axis of the frequency histogram. The height of each bar in the frequency histogram matches the respective frequency in column 2.
- (d) The relative-frequency histogram in Figure (b) is constructed using the relative-frequency distribution presented in part (b) of this exercise. It has the same horizontal axis as the frequency histogram. The height of each bar in the relative-frequency histogram matches the respective relative frequency in column 2.

Figure (a)

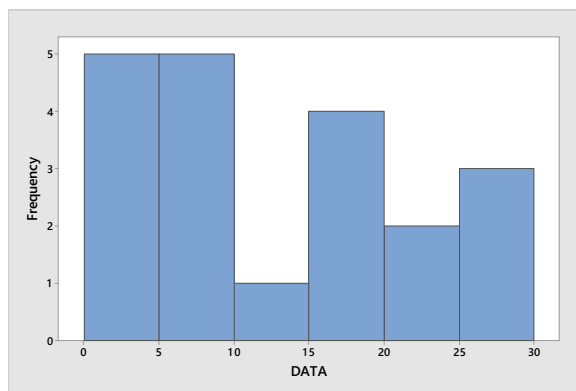
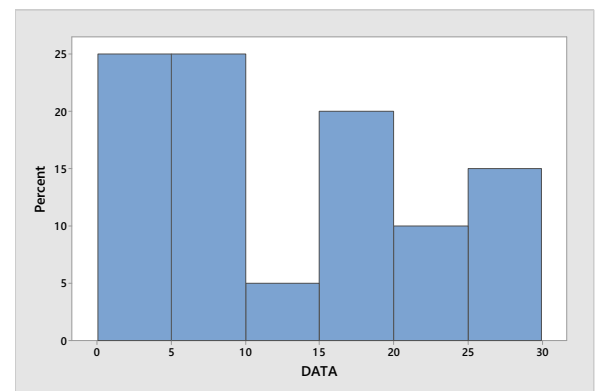


Figure (b)



- 2.66** (a) The first class to construct is 30-36. The width of all the classes is 7, so the next class would be 37-43. The classes are presented in column 1. The last class to construct is 72-78, since the largest single data value is 78. The tallied results are presented in column 2, which lists the frequencies.

Limit Grouping Classes	Frequency
30-36	7
37-43	2
44-50	5
51-57	4
58-64	3
65-71	2
72-78	2
	25

- (b) Dividing each frequency by the total number of observations, which is 25, results in each class's relative frequency. The relative frequencies for all classes are presented in column 2. The resulting table follows.

Limit Grouping Classes	Relative Frequency
30-36	0.28
37-43	0.08
44-50	0.20
51-57	0.16
58-64	0.12
65-71	0.08
72-78	0.08
	1.00

- (c) The frequency histogram in Figure (a) is constructed using the frequency distribution presented in part (a) of this exercise. The lower class limits of column 1 are used to label the horizontal axis of the frequency histogram. The height of each bar in the frequency histogram matches the respective frequency in column 2.
- (d) The relative-frequency histogram in Figure (b) is constructed using the relative-frequency distribution presented in part (b) of this exercise. It has the same horizontal axis as the frequency histogram. The height of each bar in the relative-frequency histogram matches the respective relative frequency in column 2.

Figure (a)

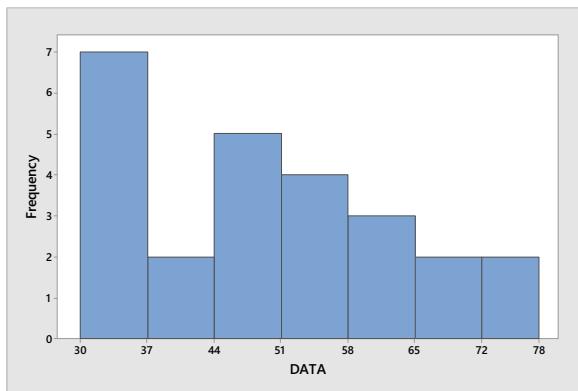
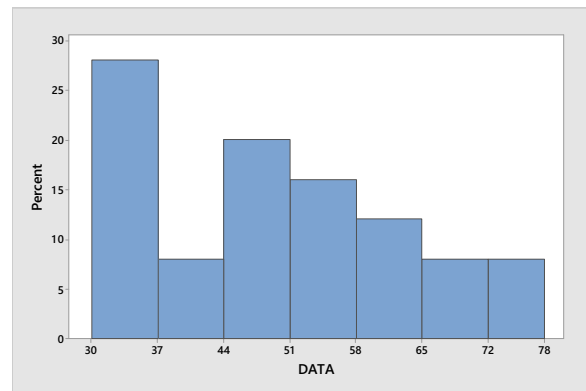


Figure (b)



- 2.67** (a) The first class to construct is 50-59. The width of all the classes is 10, so the next class would be 60-69. The classes are presented in column 1. The last class to construct is 90-99, since the largest single data value is 98. The tallied results are presented in column 2, which lists the frequencies.

Limit Grouping Classes	Frequency
50-59	6
60-69	3
70-79	6
80-89	7
90-99	3
	25

- (b) Dividing each frequency by the total number of observations, which is 25, results in each class's relative frequency. The relative frequencies for all classes are presented in column 2. The resulting table follows.

Limit Grouping Classes	Relative Frequency
50-59	0.24
60-69	0.12
70-79	0.24
80-89	0.28
90-99	0.12
	1.00

- (c) The frequency histogram in Figure (a) is constructed using the frequency distribution presented in part (a) of this exercise. The lower class limits of column 1 are used to label the horizontal axis of the frequency histogram. The height of each bar in the frequency histogram matches the respective frequency in column 2.
- (d) The relative-frequency histogram in Figure (b) is constructed using the relative-frequency distribution presented in part (b) of this exercise. It has the same horizontal axis as the frequency histogram. The height of each bar in the relative-frequency histogram matches the respective relative frequency in column 2.

Figure (a)

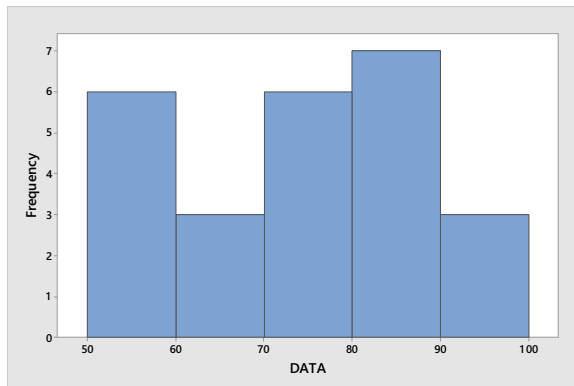
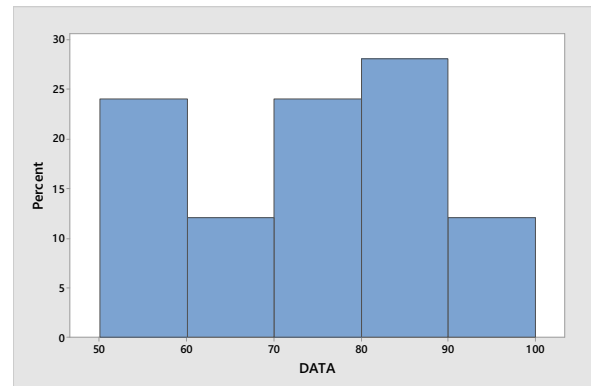


Figure (b)



- 2.68** (a) The first class to construct is 10 - under 15. Since all classes are to be of equal width 5, the second class is 15 - under 20. All of the classes are presented in column 1. The last class to construct is 35 - under 40, since the largest single data value is 38.8. The results of the tallying are presented in column 2, which lists the frequencies.

Cutpoint Grouping Classes	Frequency
10 - under 15	4
15 - under 20	5
20 - under 25	7
25 - under 30	3
30 - under 35	0
35 - under 40	1
	20

- (b) Dividing each frequency by the total number of observations, which is 20, results in each class's relative frequency. The relative frequencies for all classes are presented in column 2.

Cutpoint Grouping Classes	Relative Frequency
10 - under 15	0.20
15 - under 20	0.25
20 - under 25	0.35
25 - under 30	0.15
30 - under 35	0.00
35 - under 40	0.05
	1.00

- (c) The frequency histogram in Figure (a) is constructed using the frequency distribution obtained in part (a) of this exercise. The cutpoints are used to label the horizontal axis. Also, the height of each bar in the frequency histogram matches the respective frequency in column 2.
- (d) The relative-frequency histogram in Figure (b) is constructed using the relative-frequency distribution obtained in part (b) of this exercise. It has the same horizontal axis as the frequency histogram. The height of each bar in the relative-frequency histogram matches the respective relative frequency in column 2.

Figure (a)

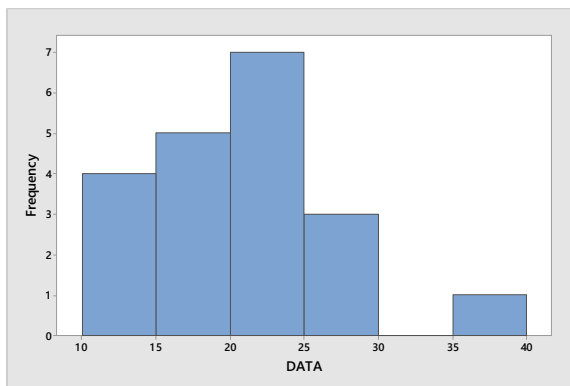
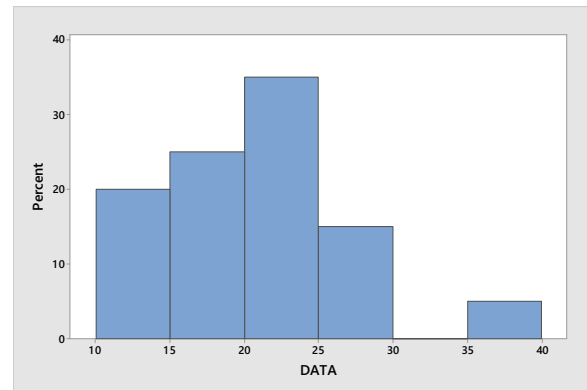


Figure (b)



- 2.69** (a) The first class to construct is 40 - under 46. Since all classes are to be of equal width 6, the second class is 46 - under 52. All of the classes are presented in column 1. The last class to construct is 64 - under 70, since the largest single data value is 65.4. The results of the tallying are presented in column 2, which lists the frequencies.

Cutpoint Grouping Classes	Frequency
40 - under 46	3
46 - under 52	6
52 - under 58	10
58 - under 64	0
64 - under 70	1
	20

- (b) Dividing each frequency by the total number of observations, which is 20, results in each class's relative frequency. The relative frequencies for all classes are presented in column 2.

Cutpoint Grouping	Relative Frequency
40 - under 46	0.15
46 - under 52	0.30
52 - under 58	0.50
58 - under 64	0.00
64 - under 70	0.05
	1.00

- (c) The frequency histogram in Figure (a) is constructed using the frequency distribution obtained in part (a) of this exercise. The cutpoints are used to label the horizontal axis. Also, the height of each bar in the frequency histogram matches the respective frequency in column 2.
- (d) The relative-frequency histogram in Figure (b) is constructed using the relative-frequency distribution obtained in part (b) of this exercise. It has the same horizontal axis as the frequency histogram. The height of each bar in the relative-frequency histogram matches the respective relative frequency in column 2.

Figure (a)

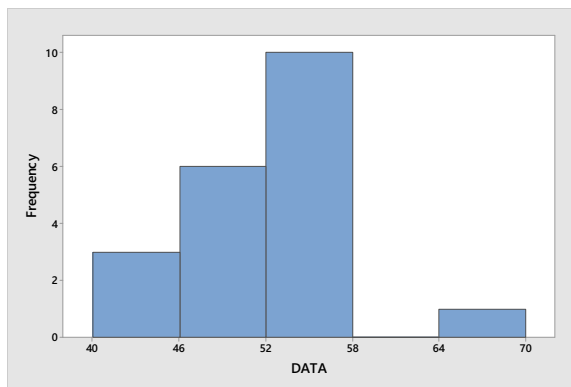
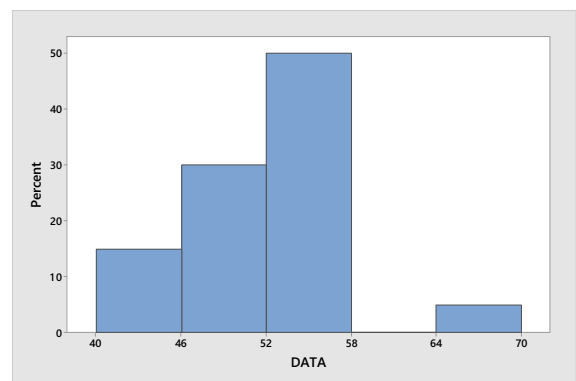


Figure (b)



- 2.70** (a) The first class' midpoint is 0.5 with a width of 1. Therefore, the first class to construct is 0 - under 1. Since all classes are to be of equal width 1, the second class is 1 - under 2. All of the classes are presented in column 1. The last class to construct is 7 - under 8, since the largest single data value is 7.69. The results of the tallying are presented in column 2, which lists the frequencies.

Cutpoint Grouping Classes	Frequency
0 - under 1	3
1 - under 2	11
2 - under 3	4
3 - under 4	1
4 - under 5	2
5 - under 6	1
6 - under 7	2
7 - under 8	1
	25

- (b) Dividing each frequency by the total number of observations, which is 25, results in each class's relative frequency. The relative frequencies for all classes are presented in column 2.

Cutpoint Grouping Classes	Relative Frequency
0 - under 1	0.12
1 - under 2	0.44
2 - under 3	0.16
3 - under 4	0.04
4 - under 5	0.08
5 - under 6	0.04
6 - under 7	0.08
7 - under 8	0.04
	1.00

- (c) The frequency histogram in Figure (a) is constructed using the frequency distribution obtained in part (a) of this exercise. The cutpoints are used to label the horizontal axis. Also, the height of each bar in the frequency histogram matches the respective frequency in column 2.
- (d) The relative-frequency histogram in Figure (b) is constructed using the relative-frequency distribution obtained in part (b) of this exercise. It has the same horizontal axis as the frequency histogram. The height of each bar in the relative-frequency histogram matches the respective relative frequency in column 2.

Figure (a)

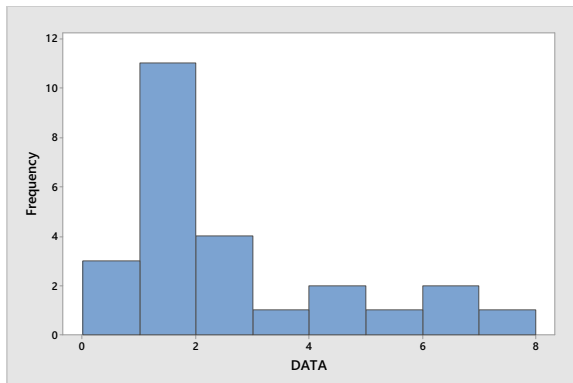
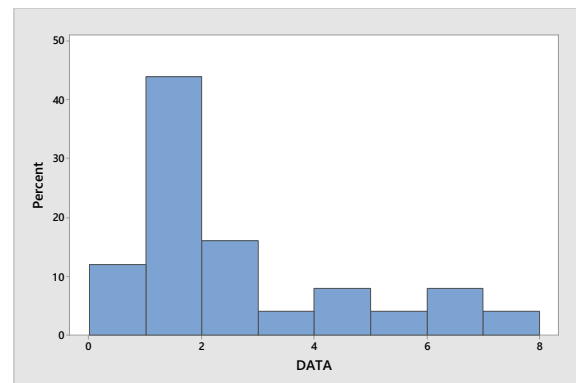


Figure (b)



- 2.71** (a) The first class' cutpoint is 25 with a width of 3. Therefore, the first class to construct is 25 - under 28. Since all classes are to be of equal width 3, the second class is 28 - under 31. All of the classes are presented in column 1. The last class to construct is 43 - under 46, since the largest single data value is 43.01. The results of the tallying are presented in column 2, which lists the frequencies.

Cutpoint Grouping Classes	Frequency
25 - under 28	1
28 - under 31	2
31 - under 34	5
34 - under 37	7
37 - under 40	5
40 - under 43	4
43 - under 46	1
	25

- (b) Dividing each frequency by the total number of observations, which is 25, results in each class's relative frequency. The relative frequencies for all classes are presented in column 2.

Cutpoint Grouping Classes	Relative Frequency
25 - under 28	0.04
28 - under 31	0.08
31 - under 34	0.20
34 - under 37	0.28
37 - under 40	0.20
40 - under 43	0.16
43 - under 46	0.04
	1.00

- (c) The frequency histogram in Figure (a) is constructed using the frequency distribution obtained in part (a) of this exercise. The cutpoints are used to label the horizontal axis. Also, the height of each bar in the frequency histogram matches the respective frequency in column 2.
- (d) The relative-frequency histogram in Figure (b) is constructed using the relative-frequency distribution obtained in part (b) of this exercise. It has the same horizontal axis as the frequency histogram. The height of each bar in the relative-frequency histogram matches the respective relative frequency in column 2.

Figure (a)

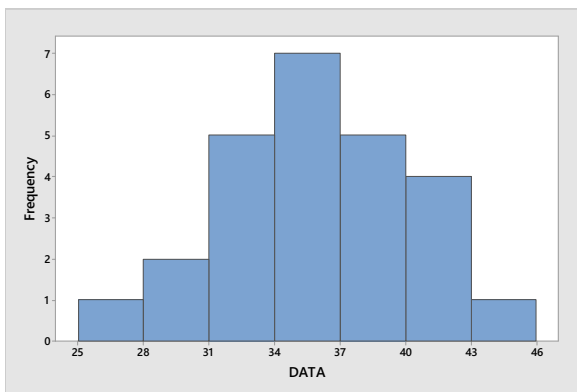
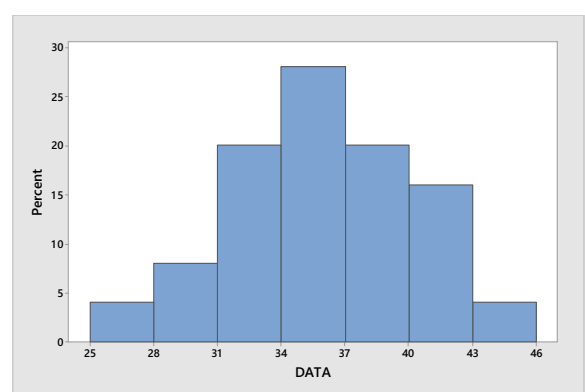
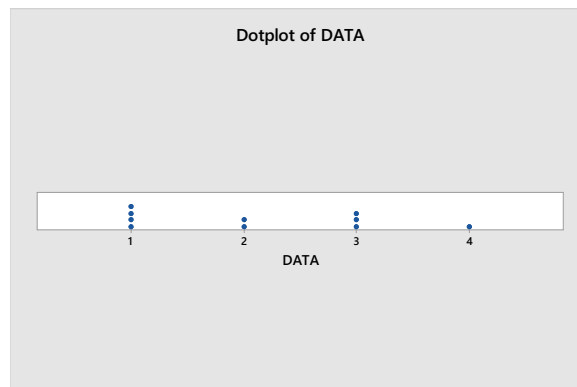


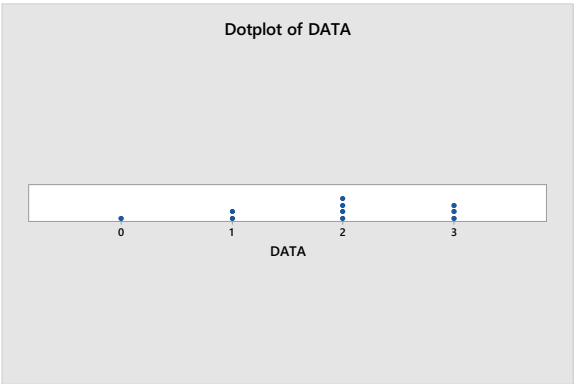
Figure (b)



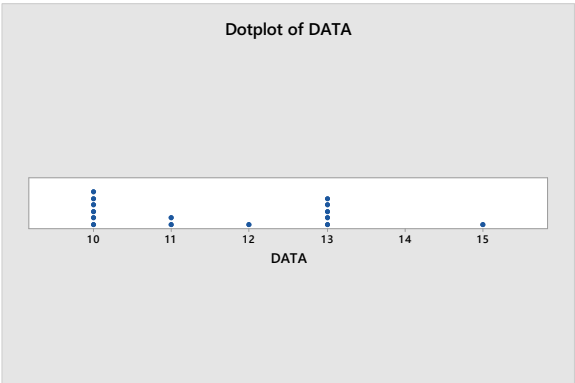
- 2.72** The horizontal axis of this dotplot displays a range of possible values. To complete the dotplot, we go through the data set and record data value by placing a dot over the appropriate value on the horizontal axis.



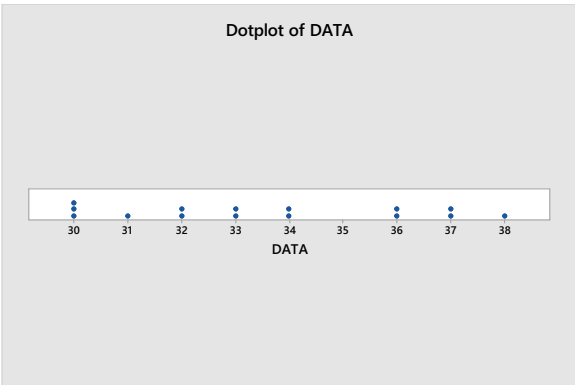
2.73 The horizontal axis of this dotplot displays a range of possible values. To complete the dotplot, we go through the data set and record data value by placing a dot over the appropriate value on the horizontal axis.



2.74 The horizontal axis of this dotplot displays a range of possible values. To complete the dotplot, we go through the data set and record data value by placing a dot over the appropriate value on the horizontal axis.



2.75 The horizontal axis of this dotplot displays a range of possible values. To complete the dotplot, we go through the data set and record data value by placing a dot over the appropriate value on the horizontal axis.



- 2.76** Each data value consists of 2 or 3 digit numbers ranging from 60 to 125. The last digit becomes the leaf and the remaining digits are the stems, so we have stems of 6 to 12. The resulting stem-and-leaf diagram is

```

6 | 0
7 |
8 |
9 | 79
10 | 068
11 | 278
12 | 5

```

- 2.77** Each data value consists of 2 digit numbers ranging from 20 to 62. The last digit becomes the leaf and the remaining digits are the stems, so we have stems of 2 to 6. The resulting stem-and-leaf diagram is

```

2 | 01
3 | 2278
4 | 13
5 | 5
6 | 2

```

- 2.78** Each data value consists of 1 or 2 digit numbers ranging from 5 to 23. The last digit becomes the leaf and the remaining digits are the stems, so we have stems of 0 to 2. Splitting the stems into five lines per stem, the resulting stem-and-leaf diagram is

```

0 | 5
0 |
0 | 89
1 | 001
1 | 2
1 | 44455
1 | 667
1 |
2 | 0
2 | 2233

```

- 2.79** Each data value consists of 2 digit numbers ranging from 22 to 46. The last digit becomes the leaf and the remaining digits are the stems, so we have stems of 2 to 4. Splitting the stems into two lines per stem, the resulting stem-and-leaf diagram is

```

2 | 224
2 | 5577789
3 | 12234
3 | 67
4 | 0
4 | 56

```

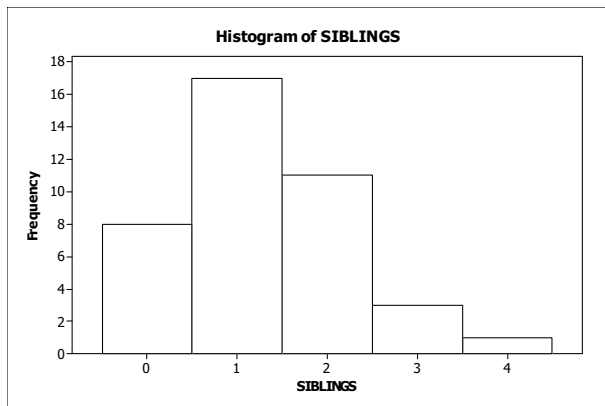
- 2.80** (a) Since the data values range from 0 to 4, we construct a table with classes based on a single value. The resulting table follows.

Number of Siblings	Frequency
0	8
1	17
2	11
3	3
4	1
	40

- (b) To get the relative frequencies, divide each frequency by the sample size of 40.

Number of Siblings	Relative Frequency
0	0.200
1	0.425
2	0.275
3	0.075
4	0.025
	1.000

- (c) The frequency histogram in Figure (a) is constructed using the frequency distribution presented in part (a) of this exercise. Column 1 demonstrates that the data are grouped using classes based on a single value. These single values in column 1 are used to label the horizontal axis of the frequency histogram. Suitable candidates for vertical axis units in the frequency histogram are the integers within the range 0 through 17, since these are representative of the magnitude and spread of the frequencies presented in column 2. When classes are based on a single value, the middle of each histogram bar is placed directly over the single numerical value represented by the class. Also, the height of each bar in the frequency histogram matches the respective frequency in column 2.



Figure

(b)

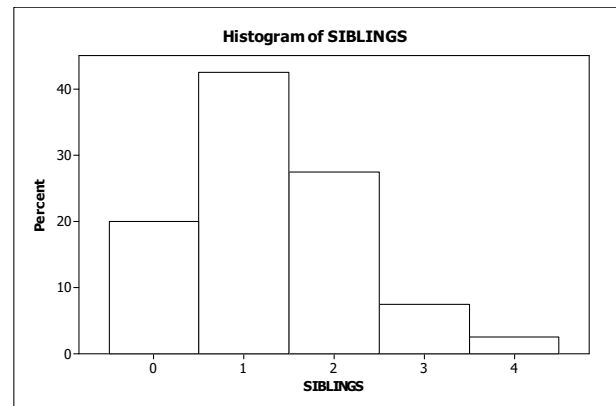


Figure (a)

- (d) The relative-frequency histogram in Figure (b) is constructed using the relative-frequency distribution presented in part (b) of this exercise. It has the same horizontal axis as the frequency histogram. We notice that the relative frequencies presented in column 2 range in size from 0.025 to 0.425. Thus, suitable candidates for vertical-axis units in the relative-frequency histogram are increments of 0.05 (or 5%), from zero to 0.45 (or 45%). The middle of each histogram bar is placed directly over the single numerical value represented by the class. Also, the height of each bar in the relative-frequency histogram matches the respective relative frequency in column 2.

- 2.81** (a) Since the data values range from 1 to 7, we construct a table with classes based on a single value. The resulting table follows.

Number of Persons	Frequency
1	7
2	13
3	9
4	5
5	4
6	1
7	1
	40

- (b) To get the relative frequencies, divide each frequency by the sample size of 40.

Number of Persons	Relative Frequency
1	0.175
2	0.325
3	0.225
4	0.125
5	0.100
6	0.025
7	0.025
	1.000

- (c) The frequency histogram in Figure (a) is constructed using the frequency distribution presented in part (a) of this exercise. Column 1 demonstrates that the data are grouped using classes based on a single value. These single values in column 1 are used to label the horizontal axis of the frequency histogram. Suitable candidates for vertical axis units in the frequency histogram are the integers within the range 0 through 13, since these are representative of the magnitude and spread of the frequencies presented in column 2. When classes are based on a single value, the middle of each histogram bar is placed directly over the single numerical value represented by the class. Also, the height of each bar in the frequency histogram matches the respective frequency in column 2.

Figure (a)

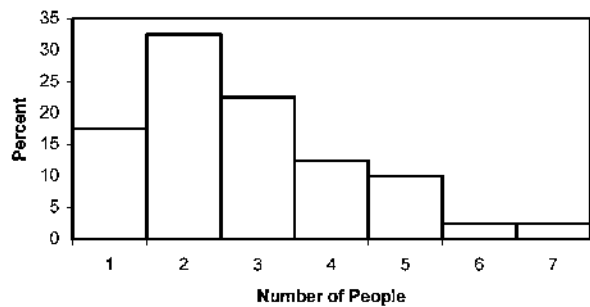


Figure (b)



(d) The relative-frequency histogram in Figure (b) is constructed using the relative-frequency distribution presented in part (b) of this exercise. It has the same horizontal axis as the frequency histogram. We notice that the relative frequencies presented in column 2 range in size from 0.025 to 0.325. Thus, suitable candidates for vertical-axis units in the relative-frequency histogram are increments of 0.05 (or 5%), from zero to 0.35 (or 35%). The middle of each histogram bar is placed directly over the single numerical value represented by the class. Also, the height of each bar in the relative-frequency histogram matches the respective relative frequency in column 2.

2.82 (a) Since the data values range from 1 to 8, we construct a table with classes based on a single value. The resulting table follows.

Litter Size	Frequency
1	1
2	0
3	1
4	3
5	7
6	6
7	4
8	2
	24

- (b) To get the relative frequencies, divide each frequency by the sample size of 24.

Litter Size	Relative Frequency
1	0.042
2	0.000
3	0.042
4	0.125
5	0.292
6	0.250
7	0.167
8	0.083
	1.000

- (c) The frequency histogram in Figure (a) is constructed using the frequency distribution presented in part (a) of this exercise. Column 1 demonstrates that the data are grouped using classes based on a single value. These single values in column 1 are used to label the horizontal axis of the frequency histogram. When classes are based on a single value, the middle of each histogram bar is placed directly over the single numerical value represented by the class. Also, the height of each bar in the frequency histogram matches the respective frequency in column 2.

Figure (a)

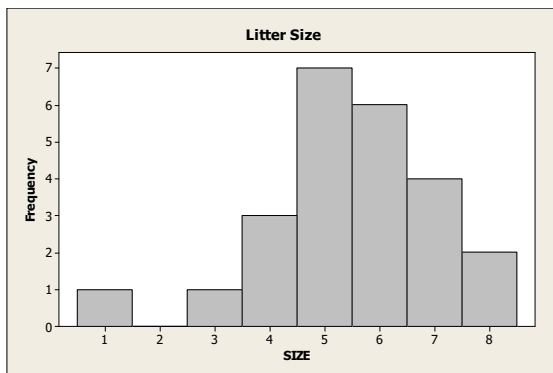
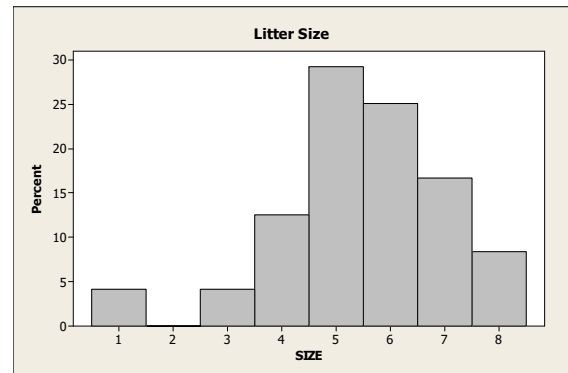


Figure (b)



- (d) The relative-frequency histogram in Figure (b) is constructed using the relative-frequency distribution presented in part (b) of this exercise. It has the same horizontal axis as the frequency histogram. We notice that the relative frequencies presented in column 2 range in size from 0.000 to 0.292. Thus, suitable candidates for vertical-axis units in the relative-frequency histogram are increments of 0.05 (or 5%), from zero to 0.30 (or 30%). The middle of each histogram bar is placed directly over the single numerical value represented by the class. Also, the height of each bar in the relative-frequency histogram matches the respective relative frequency in column 2.

- 2.83** (a) Since the data values range from 0 to 5, we construct a table with classes based on a single value. The resulting table follows.

Number of Computers	Frequency
0	5
1	22
2	11
3	2
4	4
5	1
	45

- (b) To get the relative frequencies, divide each frequency by the sample size of 45. The sum of the relative frequency column is 0.999 due to rounding

Number of Computers	Relative Frequency
0	0.111
1	0.489
2	0.244
3	0.044
4	0.089
5	0.022
	0.999

- (c) The frequency histogram in Figure (a) is constructed using the frequency distribution presented in part (a) of this exercise. Column 1 demonstrates that the data are grouped using classes based on a single value. These single values in column 1 are used to label the horizontal axis of the frequency histogram. When classes are based on a single value, the middle of each histogram bar is placed directly over the single numerical value represented by the class. Also, the height of each bar in the frequency histogram matches the respective frequency in column 2.

Figure (a)

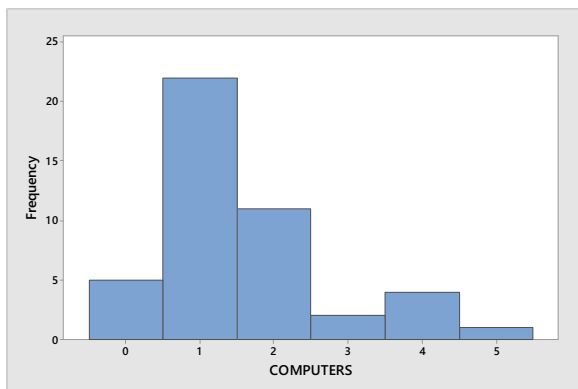
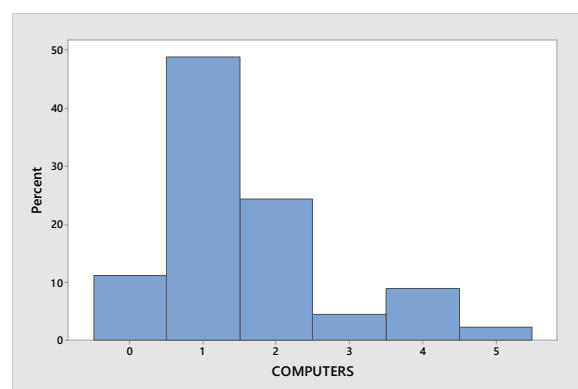


Figure (b)



- (d) The relative-frequency histogram in Figure (b) is constructed using the relative-frequency distribution presented in part (b) of this exercise. It has the same horizontal axis as the frequency histogram. The middle of each histogram bar is placed directly over the single numerical value represented by the class. Also, the height of each bar in the relative-frequency histogram matches the respective relative frequencies in column 2.

- 2.84** (a) The first class to construct is 40-49. Since all classes are to be of equal width, and the second class begins with 50, we know that the width of all classes is $50 - 40 = 10$. All of the classes are presented

in column 1. The last class to construct is 150-159, since the largest single data value is 155. Having established the classes, we tally the energy consumption figures into their respective classes. These results are presented in column 2, which lists the frequencies.

Consumption (mil. BTU)	Frequency
40-49	1
50-59	7
60-69	7
70-79	3
80-89	6
90-99	10
100-109	5
110-119	4
120-129	2
130-139	3
140-149	0
150-159	2
	50

- (b) Dividing each frequency by the total number of observations, which is 50, results in each class's relative frequency. The relative frequencies for all classes are presented in column 2. The resulting table follows.

Consumption (mil. BTU)	Relative Frequency
40-49	0.02
50-59	0.14
60-69	0.14
70-79	0.06
80-89	0.12
90-99	0.20
100-109	0.10
110-119	0.08
120-129	0.04
130-139	0.06
140-149	0.00
150-159	0.04
	1.00

- (c) The frequency histogram in Figure (a) is constructed using the frequency distribution presented in part (a) of this exercise. The lower class limits of column 1 are used to label the horizontal axis of the frequency histogram. Suitable candidates for vertical-axis units in the frequency histogram are the even integers 0 through 10, since these are representative of the magnitude and spread of the frequency presented in column 2. The height of each bar in the frequency histogram matches the respective frequency in column 2.
- (d) The relative-frequency histogram in Figure (b) is constructed using the relative-frequency distribution presented in part (b) of this exercise. It has the same horizontal axis as the frequency histogram. We notice that the relative frequencies presented in column 2 vary in size from 0.00 to 0.20. Thus, suitable candidates for vertical axis

units in the relative-frequency histogram are increments of 0.05 (or 5%), from zero to 0.20 (or 20%). The height of each bar in the relative-frequency histogram matches the respective relative frequency in column 2.

Figure (a)

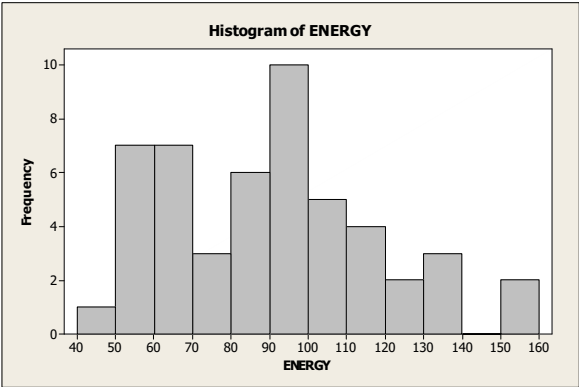
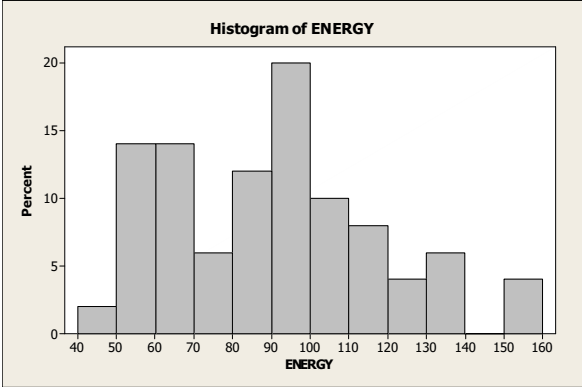


Figure (b)



- 2.85 (a) The first class to construct is 40-44. Since all classes are to be of equal width, and the second class begins with 45, we know that the width of all classes is $45 - 40 = 5$. All of the classes are presented in column 1. The last class to construct is 60-64, since the largest single data value is 61. Having established the classes, we tally the age figures into their respective classes. These results are presented in column 2, which lists the frequencies.

Age	Frequency
40-44	4
45-49	3
50-54	4
55-59	8
60-64	2
	21

- (b) Dividing each frequency by the total number of observations, which is 21, results in each class's relative frequency. The relative frequencies for all classes are presented in column 2. The resulting table follows.

Age	Relative Frequency
40-44	0.190
45-49	0.143
50-54	0.190
55-59	0.381
60-64	0.095
	1.000

- (c) The frequency histogram in Figure (a) is constructed using the frequency distribution presented in part (a) of this exercise. The lower class limits of column 1 are used to label the horizontal axis of the frequency histogram. Suitable candidates for vertical-axis units in the frequency histogram are the even integers 2 through 8, since these are representative of the magnitude and spread of the frequency presented in column 2. The height of each bar in the frequency histogram matches the respective frequency in column 2.

- (d) The relative-frequency histogram in Figure (b) is constructed using the relative-frequency distribution presented in part (b) of this exercise. It has the same horizontal axis as the frequency histogram. We notice that the relative frequencies presented in column 2 vary in size from 0.095 to 0.381. Thus, suitable candidates for vertical axis units in the relative-frequency histogram are increments of 0.10 (or 10%), from zero to 0.40 (or 40%). The height of each bar in the relative-frequency histogram matches the respective relative frequency in column 2.

Figure (a)

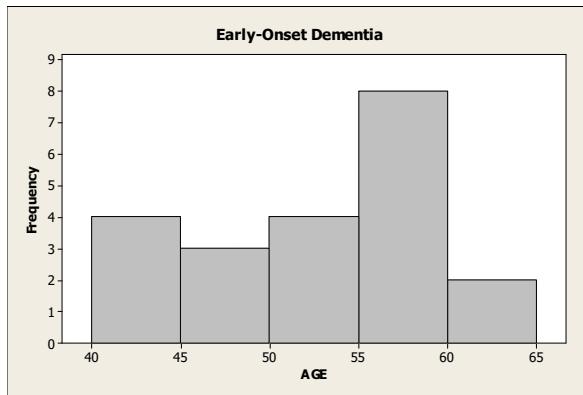
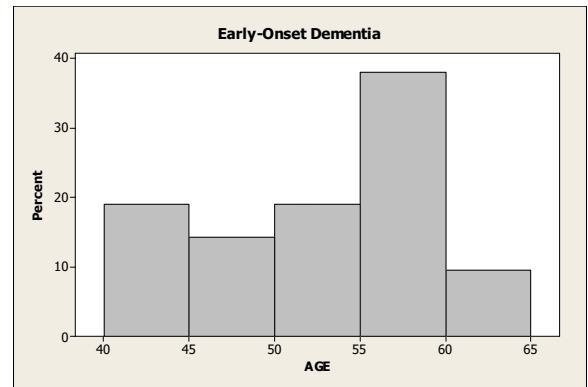


Figure (b)



- 2.86** (a) The first class to construct is 20-22. Since all classes are to be of equal width, and the second class begins with 23, we know that the width of all classes is $23 - 20 = 3$. All of the classes are presented in column 1. The last class to construct is 44-46, since the largest single data value is 46. Having established the classes, we tally the cheese consumption figures into their respective classes. These results are presented in column 2, which lists the frequencies.

Cheese Consumption	Frequency
20-22	1
23-25	3
26-28	5
29-31	3
32-34	5
35-37	9
38-40	2
41-43	4
44-46	3
	35

- (b) Dividing each frequency by the total number of observations, which is 35, results in each class's relative frequency. The relative frequencies for all classes are presented in column 2. The resulting table follows. The sum of the relative frequency column is 1.001 due to rounding.

Cheese Consumption	Relative Frequency
20-22	0.029
23-25	0.086
26-28	0.143
29-31	0.086
32-34	0.143
35-37	0.257
38-40	0.057
41-43	0.114
44-46	0.086
	1.001

- (c) The frequency histogram in Figure (a) is constructed using the frequency distribution presented in part (a) of this exercise. The lower class limits of column 1 are used to label the horizontal axis of the frequency histogram. Suitable candidates for vertical-axis units in the frequency histogram are the even integers 2 through 7, since these are representative of the magnitude and spread of the frequency presented in column 2. The height of each bar in the frequency histogram matches the respective frequency in column 2.
- (d) The relative-frequency histogram in Figure (b) is constructed using the relative-frequency distribution presented in part (b) of this exercise. It has the same horizontal axis as the frequency histogram. We notice that the relative frequencies presented in column 2 vary in size from 0.057 to 0.200. Thus, suitable candidates for vertical axis units in the relative-frequency histogram are increments of 0.05 (or 5%), from zero to 0.20 (or 20%). The height of each bar in the relative-frequency histogram matches the respective relative frequency in column 2.

Figure (a)

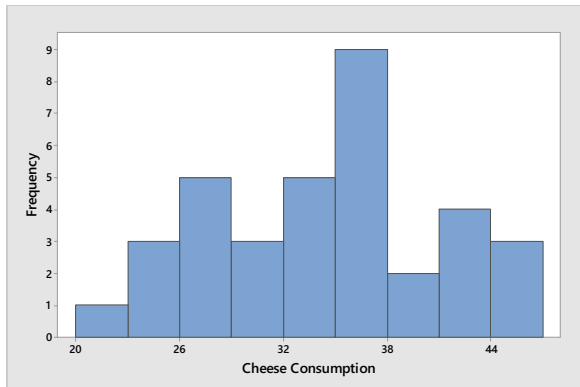
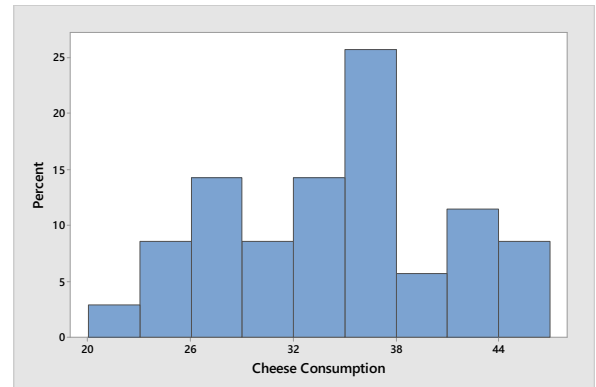


Figure (b)



- 2.87** (a) The first class to construct is 12-17. Since all classes are to be of equal width, and the second class begins with 18, we know that the width of all classes is $18 - 12 = 6$. All of the classes are presented in column 1. The last class to construct is 60-65, since the largest single data value is 61. Having established the classes, we tally the anxiety questionnaire score figures into their respective classes. These results are presented in column 2, which lists the frequencies.

Anxiety	Frequency
12-17	2
18-23	3
24-29	6
30-35	5
36-41	10
42-47	4
48-53	0
54-59	0
60-65	1
	31

- (b) Dividing each frequency by the total number of observations, which is 31, results in each class's relative frequency. The relative frequencies for all classes are presented in column 2. The resulting table follows.

Anxiety	Relative Frequency
12-17	0.065
18-23	0.097
24-29	0.194
30-35	0.161
36-41	0.323
42-47	0.129
48-53	0.000
54-59	0.000
60-65	0.032
	1.000

- (c) The frequency histogram in Figure (a) is constructed using the frequency distribution presented in part (a) of this exercise. The lower class limits of column 1 are used to label the horizontal axis of the frequency histogram. Suitable candidates for vertical-axis units in the frequency histogram are the even integers 0 through 10, since these are representative of the magnitude and spread of the frequency presented in column 2. The height of each bar in the frequency histogram matches the respective frequency in column 2.
- (d) The relative-frequency histogram in Figure (b) is constructed using the relative-frequency distribution presented in part (b) of this exercise. It has the same horizontal axis as the frequency histogram. We notice that the relative frequencies presented in column 2 vary in size from 0.000 to 0.323. Thus, suitable candidates for vertical axis units in the relative-frequency histogram are increments of 0.05 (or 5%), from zero to 0.35 (or 35%). The height of each bar in the relative-frequency histogram matches the respective relative frequency in column 2.

Figure (a)

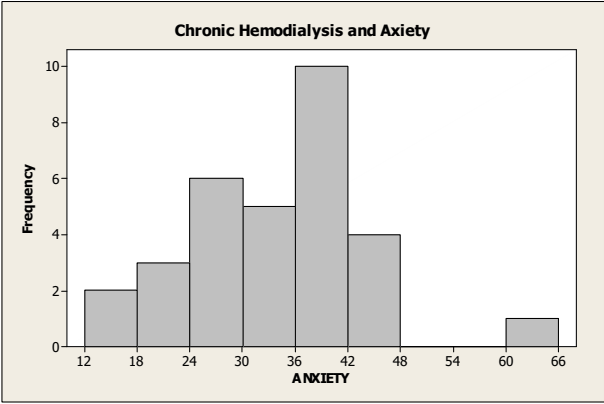
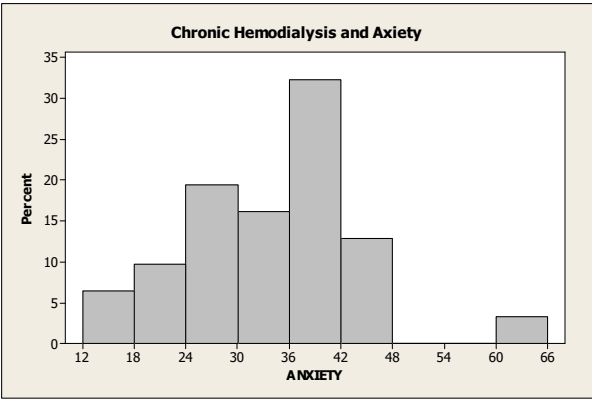


Figure (b)



2.88 (a) The first class to construct is 4 - under 5. Since all classes are to be of equal width 1, the second class is 5 - under 6. All of the classes are presented in column 1. The last class to construct is 10 - under 11, since the largest single data value is 10.360. Having established the classes, we tally the audience sizes into their respective classes. These results are presented in column 2, which lists the frequencies.

Audience (Millions)	Frequency
4 - under 5	1
5 - under 6	6
6 - under 7	7
7 - under 8	1
8 - under 9	3
9 - under 10	1
10 - under 11	1
	20

(b) Dividing each frequency by the total number of observations, which is 20, results in each class's relative frequency. The relative frequencies for all classes are presented in column 2.

Audience (Millions)	Relative
4 - under 5	0.05
5 - under 6	0.30
6 - under 7	0.35
7 - under 8	0.05
8 - under 9	0.15
9 - under 10	0.05
10 - under 11	0.05
	1.00

(c) The frequency histogram in Figure (a) is constructed using the frequency distribution obtained in part (a) of this exercise. Column 1 demonstrates that the data are grouped using classes with class widths of 1. Also, the height of each bar in the frequency histogram matches the respective frequency in column 2.

- (d) The relative-frequency histogram in Figure (b) is constructed using the relative-frequency distribution obtained in part (b) of this exercise. It has the same horizontal axis as the frequency histogram. The height of each bar in the relative-frequency histogram matches the respective relative frequency in column 2.

Figure (a)

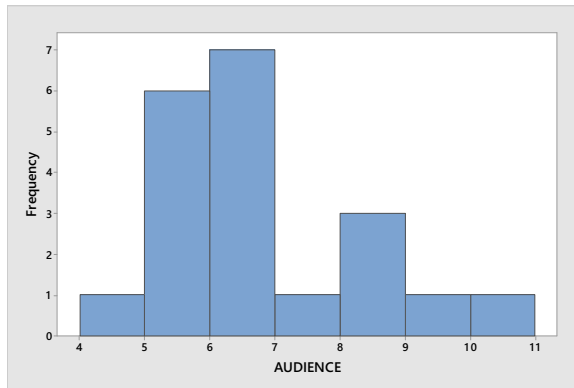
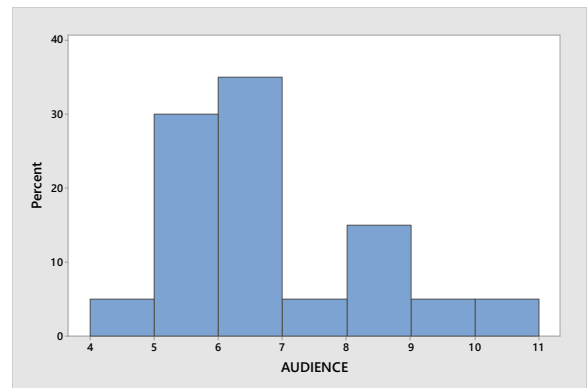


Figure (b)



- 2.89** (a) The first class to construct is 52 - under 54. Since all classes are to be of equal width 2, the second class is 54 - under 56. All of the classes are presented in column 1. The last class to construct is 74 - under 76, since the largest single data value is 75.3. Having established the classes, we tally the cheetah speeds into their respective classes. These results are presented in column 2, which lists the frequencies.

Speed	Frequency
52 - under 54	2
54 - under 56	5
56 - under 58	6
58 - under 60	8
60 - under 62	7
62 - under 64	3
64 - under 66	2
66 - under 68	1
68 - under 70	0
70 - under 72	0
72 - under 74	0
74 - under 76	1
	35

- (b) Dividing each frequency by the total number of observations, which is 35, results in each class's relative frequency. The relative frequencies for all classes are presented in column 2

Speed	Relative Frequency
52 - under 54	0.057
54 - under 56	0.143
56 - under 58	0.171
58 - under 60	0.229
60 - under 62	0.200
62 - under 64	0.086
64 - under 66	0.057
66 - under 68	0.029
68 - under 70	0.000
70 - under 72	0.000
72 - under 74	0.000
74 - under 76	0.029
	1.000

- (c) The frequency histogram in Figure (a) is constructed using the frequency distribution obtained in part (a) of this exercise. Column 1 demonstrates that the data are grouped using classes with class widths of 2. Suitable candidates for vertical axis units in the frequency histogram are the integers within the range 0 through 8, since these are representative of the magnitude and spread of the frequencies presented in column 2. Also, the height of each bar in the frequency histogram matches the respective frequency in column 2.
- (d) The relative-frequency histogram in Figure (b) is constructed using the relative-frequency distribution obtained in part (b) of this exercise. It has the same horizontal axis as the frequency histogram. We notice that the relative frequencies presented in column 3 range in size from 0.000 to 0.229. Thus, suitable candidates for vertical axis units in the relative-frequency histogram are increments of 0.05 (5%), from zero to 0.25 (25%). The height of each bar in the relative-frequency histogram matches the respective relative frequency in column 2.

Figure (a)

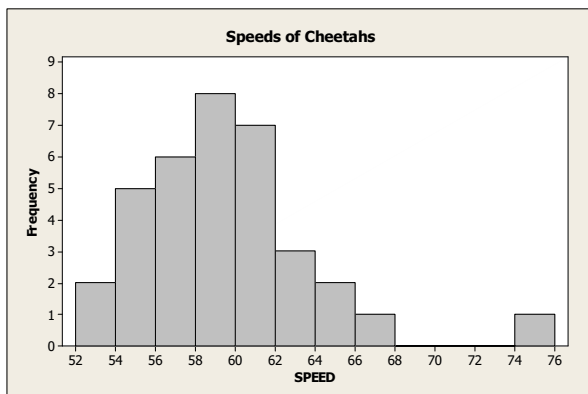
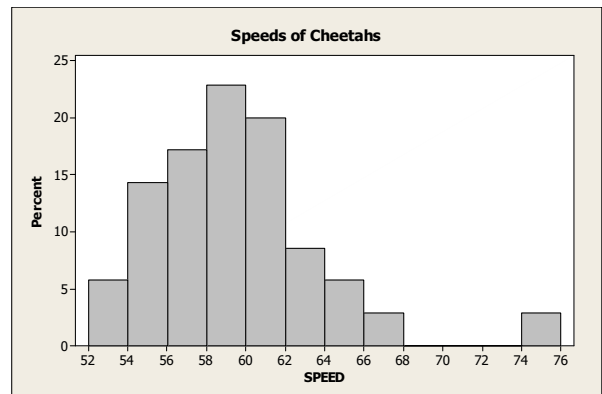


Figure (b)



- 2.90** (a) The first class to construct is 12 - under 14. Since all classes are to be of equal width 2, the second class is 14 - under 16. All of the classes are presented in column 1. The last class to construct is 26 - under 28, since the largest single data value is 26.4. Having established the classes, we tally the fuel tank capacities into their respective classes. These results are presented in column 2, which lists the frequencies.

Fuel Tank Capacity	Frequency
12 - under 14	2
14 - under 16	6
16 - under 18	7
18 - under 20	6
20 - under 22	6
22 - under 24	3
24 - under 26	3
26 - under 28	2
	35

- (b) Dividing each frequency by the total number of observations, which is 35, results in each class's relative frequency. The relative frequencies for all classes are presented in column 2

Fuel Tank Capacity	Relative Frequency
12 - under 14	0.057
14 - under 16	0.171
16 - under 18	0.200
18 - under 20	0.171
20 - under 22	0.171
22 - under 24	0.086
24 - under 26	0.086
26 - under 28	0.057
	1.000

- (c) The frequency histogram in Figure (a) is constructed using the frequency distribution obtained in part (a) of this exercise. Column 1 demonstrates that the data are grouped using classes with class widths of 2. Suitable candidates for vertical axis units in the frequency histogram are the integers within the range 2 through 7, since these are representative of the magnitude and spread of the frequencies presented in column 2. Also, the height of each bar in the frequency histogram matches the respective frequency in column 2.
- (d) The relative-frequency histogram in Figure (b) is constructed using the relative-frequency distribution obtained in part (b) of this exercise. It has the same horizontal axis as the frequency histogram. We notice that the relative frequencies presented in column 3 range in size from 0.057 to 0.200. Thus, suitable candidates for vertical axis units in the relative-frequency histogram are increments of 0.05 (5%), from zero to 0.20 (20%). The height of each bar in the relative-frequency histogram matches the respective relative frequency in column 2.

Figure (a)

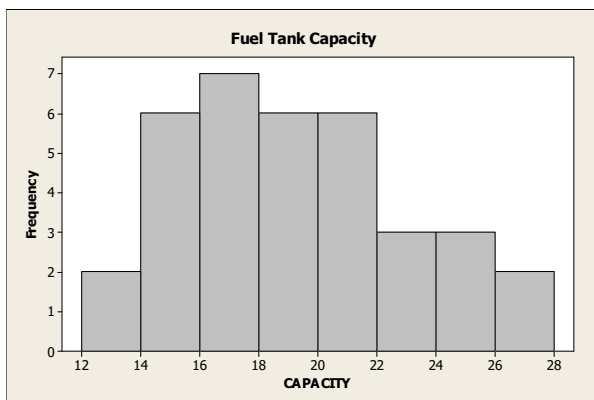
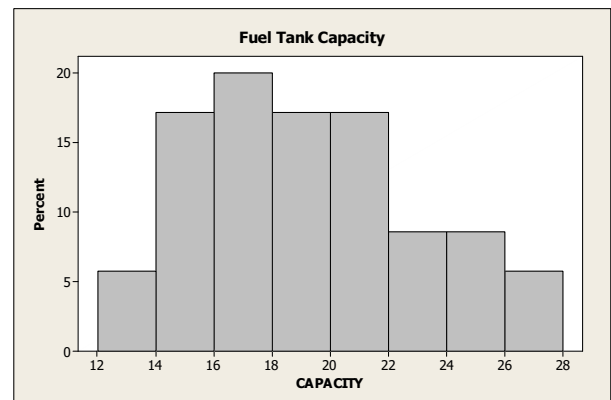


Figure (b)



- 2.91** (a) The first class to construct is 0 - under 1. Since all classes are to be of equal width 1, the second class is 1 - under 2. All of the classes are presented in column 1. The last class to construct is 7 - under 8, since the largest single data value is 7.6. Having established the classes, we tally the fuel tank capacities into their respective classes. These results are presented in column 2, which lists the frequencies.

Oxygen Distribution	Frequency
0 - under 1	1
1 - under 2	10
2 - under 3	5
3 - under 4	4
4 - under 5	0
5 - under 6	0
6 - under 7	1
7 - under 8	1
	22

- (b) Dividing each frequency by the total number of observations, which is 22, results in each class's relative frequency. The relative frequencies for all classes are presented in column 2

Oxygen Distribution	Relative Frequency
0 - under 1	0.045
1 - under 2	0.455
2 - under 3	0.227
3 - under 4	0.182
4 - under 5	0.000
5 - under 6	0.000
6 - under 7	0.045
7 - under 8	0.045
	1.000

- (c) The frequency histogram in Figure (a) is constructed using the frequency distribution obtained in part (a) of this exercise. Column 1 demonstrates that the data are grouped using classes with class widths of 2. Suitable candidates for vertical axis units in the frequency histogram are the integers within the range 0 through 10, since these are representative of the magnitude and spread of the frequencies presented in column 2. Also, the height of each bar in the frequency histogram matches the respective frequency in column 2.
- (d) The relative-frequency histogram in Figure (b) is constructed using the relative-frequency distribution obtained in part (b) of this exercise. It has the same horizontal axis as the frequency histogram. We notice that the relative frequencies presented in column 3 range in size from 0.000 to 0.455. Thus, suitable candidates for vertical axis units in the relative-frequency histogram are increments of 0.05 (5%), from zero to 0.50 (50%). The height of each bar in the relative-frequency histogram matches the respective relative frequency in column 2.

Figure (a)

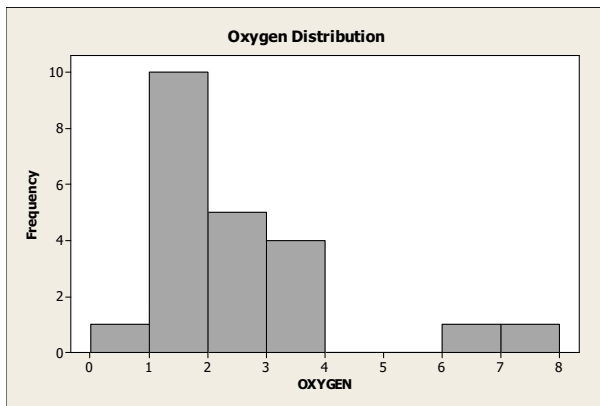
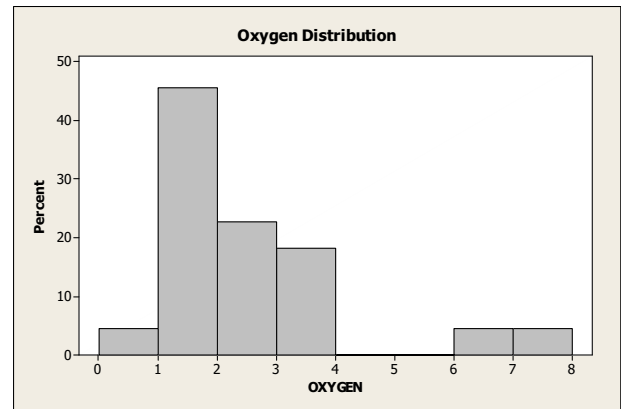
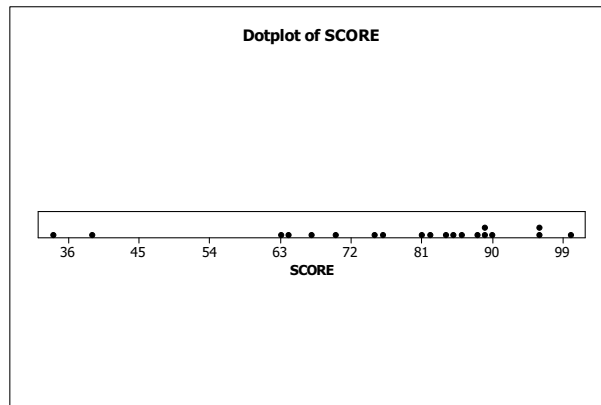


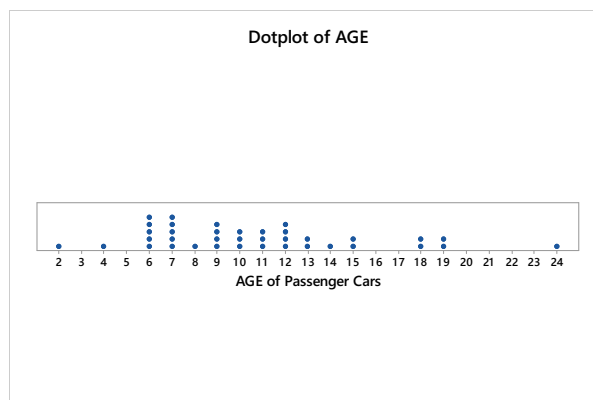
Figure (b)



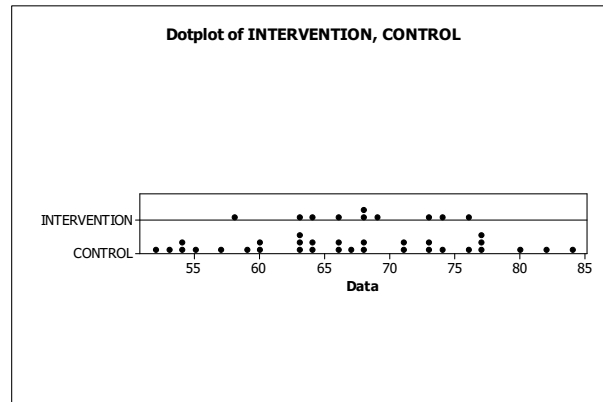
- 2.92** The horizontal axis of this dotplot displays a range of possible exam scores. To complete the dotplot, we go through the data set and record each exam score by placing a dot over the appropriate value on the horizontal axis.



- 2.93** The horizontal axis of this dotplot displays a range of possible ages of the passenger cars. To complete the dotplot, we go through the data set and record each age by placing a dot over the appropriate value on the horizontal axis.

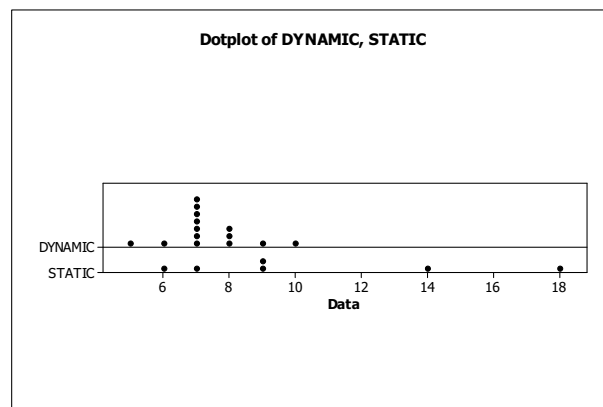


- 2.94** (a) The data values range from 52 to 84, so the scale must accommodate those values. We stack dots above each value on two different lines using the same scale for each line. The result is



- (b) The two sets of pulse rates are both centered near 68, but the Intervention data are more concentrated around the center than are the Control data.

- 2.95** (a) The data values range from 7 to 18, so the scale must accommodate those values. We stack dots above each value on two different lines using the same scale for each line. The result is



- (b) The Dynamic system does seem to reduce acute postoperative days in the hospital on the average. The Dynamic data are centered at about 7 days, whereas the Static data are centered at about 11 days and are much more spread out than the Dynamic data.

- 2.96** The data values consist of 2 digit numbers followed by a one digit decimal place ranging from 45.5 to 57.0. The last digit following the decimal will be the leaves and the stems will be the remaining digits. Therefore, the stem-and-leaf diagram will have stems of 45 through 57.

```

45 | 5
46 | 4
47 | 2
48 | 0
49 | 1
50 | 3578
51 | 35589
52 | 011
53 | 355689
54 | 13
55 | 033
56 | 0
57 | 0

```

- 2.97** Since each data value consists of 2 digits, each beginning with 1, 2, 3, or 4, we will construct the stem-and-leaf diagram with these four values as the stems. The result is

```

1 | 238
2 | 1678899
3 | 34459
4 | 04

```

- 2.98** (a) Since each data value consists of a 2 digit number with a one digit decimal, we will make the leaf the decimal digit and the stems the remaining two digit numbers of 28, 29, 30, and 31. The result is

```

28 | 8
29 | 368
30 | 1247
31 | 02

```

- (b) Splitting into two lines per stem, leafs of 0-4 belong in the first stem and leafs of 5-9 belong in the second stem. The result is

```

28 | 8
29 | 3
29 | 68
30 | 124
30 | 7
31 | 02

```

- (c) The stem-and-leaf diagram in part (b) is more useful because by splitting the stems into two lines per stem, you have created more lines. Part (a) had too few lines.

- 2.99** (a) Since each data value lies between 2 and 93, we will construct the stem-and-leaf diagram with one line per stem. The result is

```

0 | 2234799
1 | 11145566689
2 | 023479
3 | 004555
4 | 19
5 | 5
6 | 9
7 | 9
8 |
9 | 3

```

- (b) Using two lines per stem, the same data result in the following diagram:

```

0 | 2234
0 | 799
1 | 1114
1 | 5566689
2 | 0234
2 | 79
3 | 004
3 | 555
4 | 1
4 | 9
5 |
5 | 5
6 |
6 | 9
7 |
7 | 9
8 |
8 |
9 | 3

```

- (c) The stem with one line per stem is more useful. One gets the same impression regarding the shape of the distribution, but the two lines per stem version has numerous lines with no data, making it take up more space than necessary to interpret the data and giving it too many lines.

- 2.100** (a) Since we have two digit numbers, the last digit becomes the leaf and the first digit becomes the stem. For this data, we have a stem of 7. Splitting the data into five lines per stem, we put the leaves 0-1 in the first stem, 2-3 in the second stem, 4-5 in the third stem, 6-7 in the fourth stem, and 8-9 in the fifth stem. The result is

```

7 | 0011111111
7 | 2222223333333
7 | 444444445555
7 | 66666666677

```

- (b) Using one or two lines per stem would have given us too few lines.

- 2.101** (a) Since we have two digit numbers, the last digit becomes the leaf and the first digit becomes the stem. For this data, we have stems of 6, 7, and 8. Splitting the data into five lines per stem, we put the leaves 0-1 in the first stem, 2-3 in the second stem, 4-5 in the third stem, 6-7 in the fourth stem, and 8-9 in the fifth stem. The result is

```

6 | 8
7 | 11111111
7 | 222222222233333
7 | 4444555555
7 | 66666777777
7 | 8
8 | 0

```

(b) Using one or two lines per stem would have given us too few lines.

2.102 The heights of the bars of the relative-frequency histogram indicate that:

- (a) About 27.5% of the returns had an adjusted gross income between \$10,000 and \$19,999, inclusive.
- (b) About 37.5% were between \$0 and \$9,999; 27.5% were between \$10,000 and \$19,999; and 19% were between \$20,000 and \$29,999. Thus, about 84% (i.e., $37.5\% + 27.5\% + 19\%$) of the returns had an adjusted gross income less than \$30,000.
- (c) About 11% were between \$30,000 and \$39,999; and 5% were between \$40,000 and \$49,999. Thus, about 16% (i.e., $11\% + 5\%$) of the returns had an adjusted gross income between \$30,000 and \$49,999. With 89,928,000 returns having an adjusted gross income less than \$50,000, the number of returns having an adjusted gross income between \$30,000 and \$49,999 was 14,388,480 (i.e., $0.16 \times 89,928,000$).

2.103 The graph indicates that:

- (a) 20% of the patients have cholesterol levels between 205 and 209, inclusive.
- (b) 20% are between 215 and 219; and 5% are between 220 and 224. Thus, 25% (i.e., $20\% + 5\%$) have cholesterol levels of 215 or higher.
- (c) 35% of the patients have cholesterol levels between 210 and 214, inclusive. With 20 patients in total, the number having cholesterol levels between 210 and 214 is 7 (i.e., 0.35×20).

2.104 The graph indicates that:

- (a) 15 states had at least three but less than four hospital beds per 1000 people available.
- (b) 3 states had at least four and a half hospital beds per 1000 people available.

2.105 The graph indicates that:

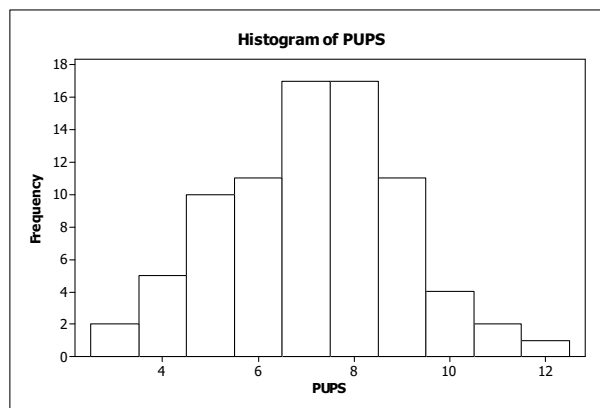
- (a) 1 of these 14 patients was under 45 years old at the onset of symptoms.
- (b) 3 of these 14 patients were at least 65 years old at the onset of symptoms.
- (c) 8 of these 14 patients were between 50 and 64 years old, inclusive, at the onset of symptoms.

2.106 (a) Using Minitab, retrieve the data from the WeissStats Resource Site. Column 1 contains the numbers of pups borne in a lifetime for each of 80 female Great White Sharks. From the tool bar, select **Stat** < **Tables** < **Tally Individual Variables**, double-click on PUPS in the first box so that PUPS appears in the **Variables** box, put a check mark next to Counts and Percents under Display, and click **OK**. The result is

PUPS	Count	Percent
3	2	2.50
4	5	6.25
5	10	12.50
6	11	13.75
7	17	21.25
8	17	21.25
9	11	13.75
10	4	5.00
11	2	2.50
12	1	1.25

(b) After retrieving the data from the WeissStats Resource Site, select

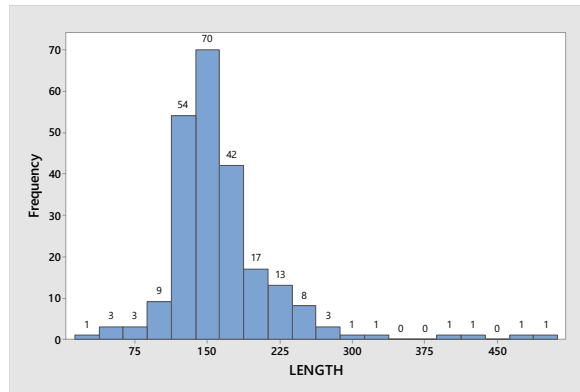
Graph < Histogram, choose **Simple** and click **OK**. Double click on PUPS in the first box to enter PUPS in the **Graphs variables** box, and click **OK**. The frequency histogram is



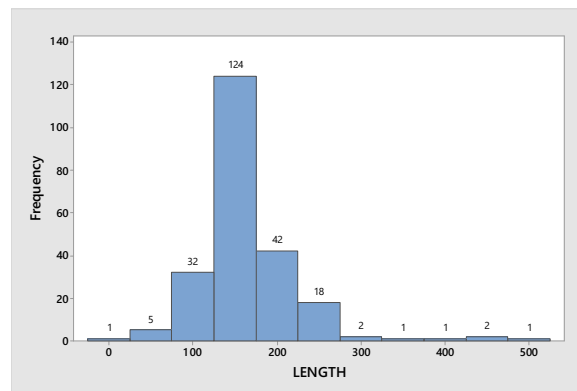
To change to a relative-frequency histogram, before clicking OK the second time, click on the **Scale** button and the **Y-Scale type** tab, and choose **Percent** and click **OK**. The graph will look like the frequency histogram, but will have relative frequencies on the vertical scale instead of counts.

The numbers of pups range from 1 to 12 per female with 7 and 8 pups occurring more frequently than any other values.

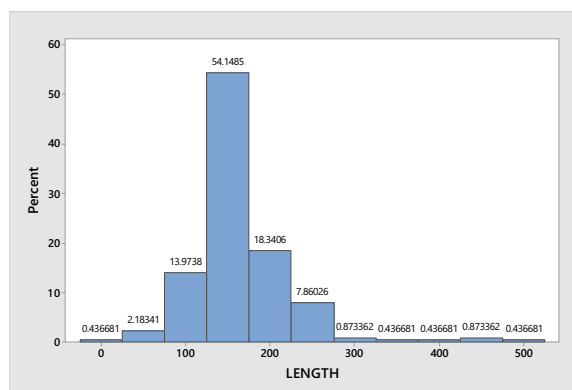
- 2.107** (a) Using Minitab, there is not a direct way to get a grouped frequency distribution. However, you can use an option in creating your histogram that will report the frequencies in each of the classes, essentially creating a grouped frequency distribution. Retrieve the data from the WeissStats Resource Site. Column 2 contains the length of the Beatles songs, in seconds. From the tool bar, select **Graph < Histogram**, choose **Simple** and click **OK**. Double click on LENGTH to enter LENGTH in the **Graph variables** box. Click **Labels**, click the **Data Labels** tab, then check **Use y-value labels**. Click **OK** twice. The result is



Above each bar is a label for each of the frequencies. Also, the labeling on the horizontal axis is the midpoint for class, where each class has a width of 25. To change the width of the bars, right Click on the bars and choose **Edit Bars**, click **Binning**, click **Midpoint/Cutpoint positions:**, type 0 50 100 150 200 250 300 350 400 450 500. The result is



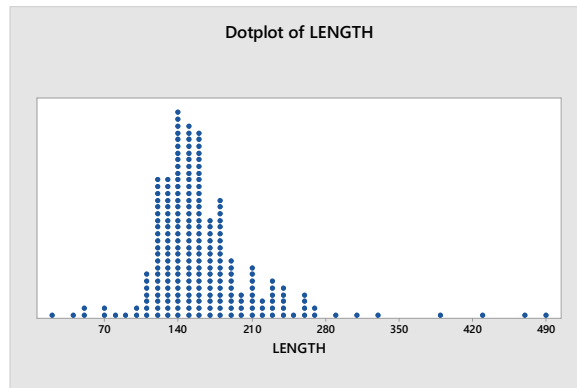
To get the relative-frequency distribution, follow the same steps as above, but also Click the **Scale** button, click the **Y-scale Type**, check **Percent**, then click **OK** twice. The result is



Above each bar is the percentage for that class, essentially creating a relative-frequency distribution. You could also transfer these results into a table.

- (b) A frequency histogram and a relative frequency distribution were created in part (a).

- (c) To obtain the dotplot, select **Graph < Dotplot**, select **Simple** in the **One Y** row, and click **OK**. Double click on **LENGTH** to enter **LEGNTH** in the **Graph variables** box and click **OK**. The result is



- (d) The graphs are similar, but not identical. This is because the dotplot preserves the raw data by plotting individual dots and the histogram loses the raw data because it groups observations into grouped classes. The overall impression, however, remains the same. They both are generally the same shape with outliers to the right.

- 2.108** (a) After entering the data from the WeissStats Resource Site, in Minitab, select **Graph < Stem-and-Leaf**, double click on **PERCENT** to enter **PERCENT** in the **Graph variables** box and enter a 10 in the **Increment** box, and click **OK**. The result is

```
Stem-and-leaf of PERCENT  N  = 51
Leaf Unit = 1.0

(35)  8   001222233344444555667777778888899999
      16  9   00000000001111122
```

- (b) Repeat part (a), but this time enter a 5 in the **Increment** box. The result is

```
Stem-and-leaf of PERCENT  N  = 51
Leaf Unit = 1.0

      15  8   001222233344444
(20)  8   555667777778888899999
      16  9   00000000001111122
```

- (c) Repeat part (a) again, but this time enter a 2 in the **Increment** box. The result is

```
Stem-and-leaf of PERCENT  N  = 51
Leaf Unit = 1.0

      3  8   001
     10  8   2222333
     18  8   44444555
(8)  8   66777777
     25  8   888889999
     16  9   000000000111111
      2  9   22
```


- (d) The last graph is the most useful since it gives a better idea of the shape of the distribution. Typically, we like to have five to fifteen classes and this is the only one of the three graphs that satisfies that condition.

- 2.109** (a) After entering the data from the WeissStats Resource Site, in Minitab, select **Graph < Stem-and-Leaf**, double click on PERCENT to enter PERCENT in the **Graph variables** box and enter a 10 in the **Increment** box, and click **OK**. The result is

```
Stem-and-leaf of PERCENT  N  = 51
Leaf Unit = 1.0

 2      1      79
(32)  2      011223334444555555566666777778999
17      3      0001112223456668
 1      4      9
```

- (b) Repeat part (a), but this time enter a 5 in the **Increment** box. The result is

```
Stem-and-leaf of PERCENT  N  = 51
Leaf Unit = 1.0

 2      1      79
14      2      011223334444
(20)  2      5555556666677778999
17      3      00011122234
 6      3      56668
 1      4
 1      4      9
```

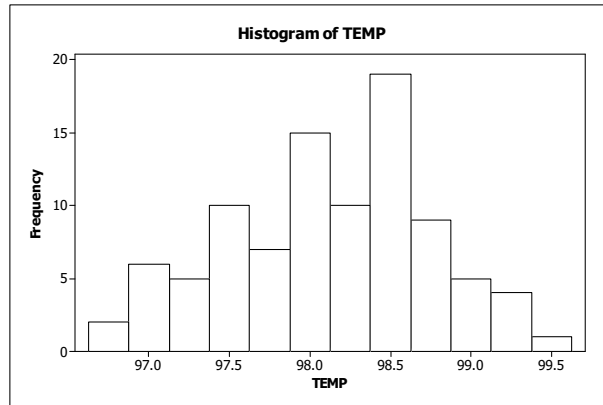
- (c) Repeat part (a) again, but this time enter a 2 in the **Increment** box. The result is

```
Stem-and-leaf of PERCENT  N  = 51
Leaf Unit = 1.0

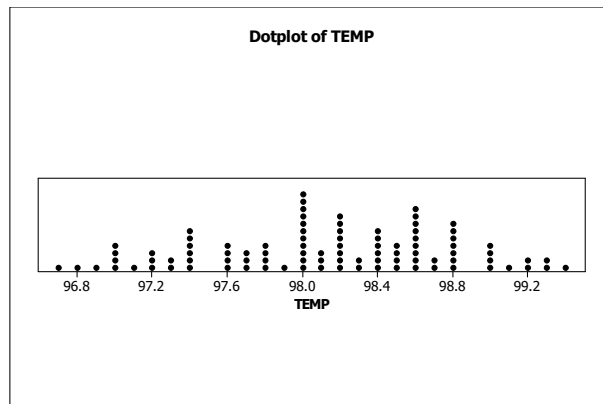
 1      1      7
 2      1      9
 5      2      011
10      2      22333
20      2      4444555555
(10)  2      6666677777
21      2      8999
17      3      000111
11      3      2223
 7      3      45
 5      3      666
 2      3      8
 1      4
 1      4
 1      4
 1      4
 1      4      9
```

- (d) The second graph is the most useful. The third one has more classes than necessary to comprehend the shape of the distribution and has a number of empty stems. Typically, we like to have five to fifteen classes and the first and second diagrams satisfy that condition, but the second one provides a better idea of the shape of the distribution.

- 2.110 (a) After entering the data from the WeissStats Resource Site, in Minitab, select **Graph < Histogram**, select **Simple** and click **OK**. double click on TEMP to enter TEMP in the **Graph variables** box and click **OK**. The result is



- (b) Now select **Graph < Dotplot**, select **Simple** in the **One Y** row, and click **OK**. Double click on TEMP to enter TEMP in the **Graph variables** box and click **OK**. The result is



- (c) Now select **Graph < Stem-and-Leaf**, double click on TEMP to enter TEMP in the **Graph variables** box and click **OK**. Leave the **Increment** box blank to allow Minitab to choose the number of lines per stem. The result is

```
Stem-and-leaf of TEMP  N  = 93
Leaf Unit = 0.10
 1    96  7
 3    96  89
 8    97  00001
13    97  22233
19    97  444444
26    97  6666777
31    97  88889
45    98  00000000000111
(10)   98  2222222233
38    98  4444445555
28    98  66666666677
17    98  8888888
10    99  00001
 5    99  2233
 1    99  4
```

- (d) The dotplot shows all of the individual values. The stem-and-leaf diagram used five lines per stem and therefore each line contains leaves with possibly two values. The histogram chose classes of width 0.25. This resulted in, for example, the class with midpoint 97.0 including all of the values 96.9, 97.0, and 97.1, while the class with midpoint 97.25 includes only the two values 97.2 and 97.3. Thus the 'smoothing' effect is not as good in the histogram as it is in the stem-and-leaf diagram. Overall, the dotplot gives the truest picture of the data and allows recovery of all of the data values.

- 2.111** (a) The classes are presented in column 1. With the classes established, we then tally the exam scores into their respective classes. These results are presented in column 2, which lists the frequencies. Dividing each frequency by the total number of exam scores, which is 20, results in each class's relative frequency. The relative frequencies for all classes are presented in column 3. The class mark of each class is the average of the lower and upper limits. The class marks for all classes are presented in column 4.

Score	Frequency	Relative Frequency	Class Mark
30-39	2	0.10	34.5
40-49	0	0.00	44.5
50-59	0	0.00	54.5
60-69	3	0.15	64.5
70-79	3	0.15	74.5
80-89	8	0.40	84.5
90-100	4	0.20	95.0
	20	1.00	

- (b) The first six classes have width 10; the seventh class had width 11.
- (c) Answers will vary, but one choice is to keep the first six classes the same and make the next two classes 90-99 and 100-109. Another possibility is 31-40, 41-50, ..., 91-100.
- 2.112** Answers will vary, but by following the steps we first decide on the approximate number of classes. Since there are 40 observations, we should have 7-14 classes. This exercise states we should have approximately seven classes. Step 2 says that we calculate an approximate class width as $(99 - 36)/7 = 9$. A convenient class width close to 9 would be a class width of 10. Step 3 says that we choose a number for the lower class limit which is less than or equal to our minimum observation of 36. Let's choose 35. Beginning with a lower class limit of 35 and width of 10, we have a first class of 35-44, a second class of 45-54, a third class of 55-64, a fourth class of 65-74, a fifth class of 75-84, a sixth class of 85-94, and a seventh class of 95-104. This would be our last class since the largest observation is 99.
- 2.113** Answers will vary, but by following the steps we first decide on the approximate number of classes. Since there are 37 observations, we should have 7-14 classes. This exercise states we should have approximately eight classes. Step 2 says that we calculate an approximate class width as $(278.8 - 129.2)/8 = 18.7$. A convenient class width close to 18.7 would be a class width of 20. Step 3 says that we choose a number for the lower cutpoint which is less than or equal to our minimum observation of 129.2. Let's choose 120. Beginning with a lower cutpoint of 120 and width of 20, we have a first class of 120 - under 140, a second class of 140 - under 160, a third class of 160 - under 180, a fourth class of 180 - under 200, a fifth

class of 200 - under 220, a sixth class of 220 - under 240, a seventh class of 240 - under 260, and an eighth class of 260 - under 280. This would be our last class since the largest observation is 278.8.

- 2.114** (a) Tally marks for all 50 students, where each student is categorized by age and gender, are presented in the contingency table given in part (b).
- (b) Tally marks in each box appearing in the following chart are counted. These counts, or frequencies, replace the tally marks in the contingency table. For each row and each column, the frequencies are added, and their sums are recorded in the proper "Total" box.

Age (yrs)

Gender	Under 21	21 - 25	Over 25	Total
Male		 		
Female	 	 		
Total				

Age (yrs)

Gender	Under 21	21-25	Over 25	Total
Male	8	12	2	22
Female	12	13	3	28
Total	20	25	5	50

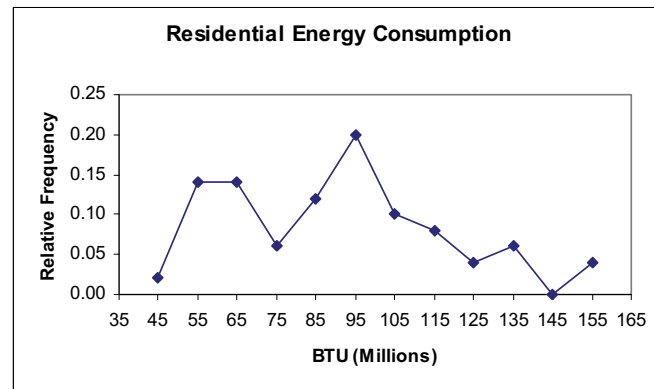
- (c) The row and column totals represent the total number of students in each of the corresponding categories. For example, the row total of 22 indicates that 22 of the students in the class are male.
- (d) The sum of the row totals is 50, and the sum of the column totals is 50. The sums are equal because they both represent the total number of students in the class.
- (e) Dividing each frequency reported in part (b) by the grand total of 50 students results in a contingency table that gives relative frequencies.

Age (yrs)

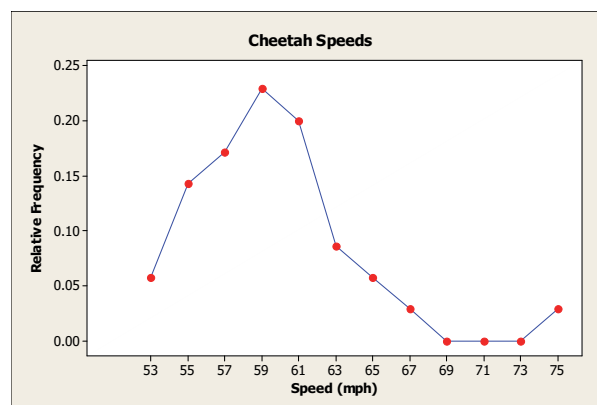
Gender	Under 21	21-25	Over 25	Total
Male	0.16	0.24	0.04	0.44
Female	0.24	0.26	0.06	0.56
Total	0.40	0.50	0.10	1.00

- (f) The 0.16 in the upper left-hand cell indicates that 16% of the students in the class are males and under 21. The 0.40 in the lower left-hand cell indicates that 40% of the students in the class are under age 21. A similar interpretation holds for the remaining entries.

- 2.115** Consider columns 1 and 2 of the energy-consumption data given in Exercise 2.56 part (b). Compute the class mark for each class presented in column 1. Pair each class mark with its corresponding relative frequency found in column 2. Construct a horizontal axis, where the units are in terms of class marks and a vertical axis where the units are in terms of relative frequencies. For each class mark on the horizontal axis, plot a point whose height is equal to the relative frequency of the class. Then join the points with connecting lines. The result is a relative-frequency polygon.



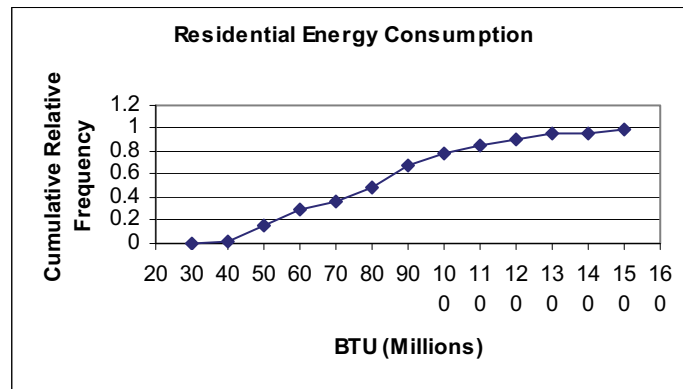
- 2.116** Consider columns 1 and 2 of the Cheetah speed data given in Exercise 2.61 part (b). Compute the midpoint for each class presented in column 1. Pair each midpoint with its corresponding relative frequency found in column 2. Construct a horizontal axis, where the units are in terms of midpoints and a vertical axis where the units are in terms of relative frequencies. For each midpoint on the horizontal axis, plot a point whose height is equal to the relative frequency of the class. Then join the points with connecting lines. The result is a relative-frequency polygon.



- 2.117** In single value grouping the horizontal axis would be labeled with the value of each class.
- 2.118** (a) Consider parts (a) and (b) of the energy-consumption data given in Exercise 2.56. The classes are now reworked to present just the lower class limit of each class. The frequencies are reworked to sum the frequencies of all classes representing values less than the specified lower class limit. These successive sums are the cumulative frequencies. The relative frequencies are reworked to sum the relative frequencies of all classes representing values less than the specified class limits. These successive sums are the cumulative relative frequencies. (Note: The cumulative relative frequencies can also be found by dividing the each cumulative frequency by the total number of data values.)

Less than	Cumulative Frequency	Cumulative Relative Frequency
40	0	0.00
50	1	0.02
60	8	0.16
70	15	0.30
80	18	0.36
90	24	0.48
100	34	0.68
110	39	0.78
120	43	0.86
130	45	0.90
140	48	0.96
150	48	0.96
160	50	1.00

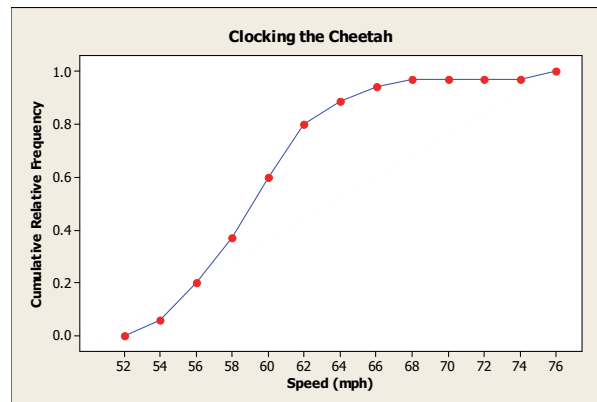
- (b) Pair each class limit with its corresponding cumulative relative frequency found in column 3. Construct a horizontal axis, where the units are in terms of the class limits and a vertical axis where the units are in terms of cumulative relative frequencies. For each class limit on the horizontal axis, plot a point whose height is equal to the cumulative relative frequency. Then join the points with connecting lines. The result, presented in the following figure, is an *ogive* using cumulative relative frequencies. (Note: A similar procedure could be followed using cumulative frequencies.)



- 2.119** (a) Consider parts (a) and (b) of the Cheetah speed data given in Exercise 2.61. The classes are now reworked to present just the lower cutpoint of each class. The frequencies are reworked to sum the frequencies of all classes representing values less than the specified lower cutpoint. These successive sums are the cumulative frequencies. The relative frequencies are reworked to sum the relative frequencies of all classes representing values less than the specified cutpoints. These successive sums are the cumulative relative frequencies. (Note: The cumulative relative frequencies can also be found by dividing the each cumulative frequency by the total number of data values.)

Less than	Cumulative Frequency	Cumulative Relative Frequency
52	0	0.000
54	2	0.057
56	7	0.200
58	13	0.371
60	21	0.600
62	28	0.800
64	31	0.886
66	33	0.943
68	34	0.971
70	34	0.971
72	34	0.971
74	34	0.971
76	35	1.000

- (b) Pair each cutpoint with its corresponding cumulative relative frequency found in column 3. Construct a horizontal axis, where the units are in terms of the cutpoints and a vertical axis where the units are in terms of cumulative relative frequencies. For each cutpoint on the horizontal axis, plot a point whose height is equal to the cumulative relative frequency. Then join the points with connecting lines. The result, presented in the following figure, is an *ogive* using cumulative relative frequencies. (Note: A similar procedure could be followed using cumulative frequencies.)



- 2.120** (a) After rounding each observation to the nearest year, the stem-and-leaf diagram for the rounded ages is

```

5 | 334469
6 | 6
7 | 256689
8 | 234678
9 | 8

```

- (b) After truncating each weight by dropping the decimal part, the stem-and-leaf diagram for the rounded weights is

```

5 | 223468
6 | 5
7 | 245688
8 | 123678
9 | 7

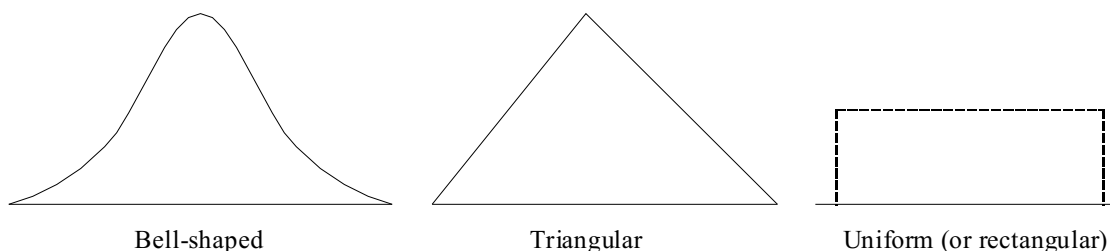
```

- (c) Although there are minor differences between the two diagrams, the overall impression of the distribution of weights is the same for both diagrams.

2.121 Minitab used truncation. Note that there was a data point of 5.8 in the sample. It would have been plotted with a stem of 0 and a leaf of 6 if it had been rounded. Instead Minitab plotted the observation with a stem of 0 and a leaf of 5.

Section 2.4

- 2.122** The distribution of a data set is a table, graph, or formula that provides the values of the observations and how often they occur.
- 2.123** Sample data are the values of a variable for a sample of the population.
- 2.124** Population data are the values of a variable for the entire population.
- 2.125** A sample distribution is the distribution of sample data.
- 2.126** A population distribution is the distribution of population data.
- 2.127** A distribution of a variable is the same as a population distribution.
- 2.128** A smooth curve makes it a little easier to see the shape of a distribution and to concentrate on the overall pattern without being distracted by minor differences in shape.
- 2.129** A large simple random sample from a bell-shaped distribution would be expected to have roughly a bell-shaped distribution since more sample values should be obtained, on average, from the middle of the distribution.
- 2.130** (a) Yes. We would expect both simple random samples to have roughly a reverse J-shaped distribution.
- (b) Yes. We would expect some variation in shape between the two sample distributions since it is unlikely that the two samples would produce exactly the same frequency table. It should be noted, however, that as the sample size is increased, the difference in shape for the two samples should become less noticeable.
- 2.131** Three distribution shapes that are symmetric are bell-shaped, triangular, and Uniform (or rectangular), shown in that order below. It should be noted that there are others as well.

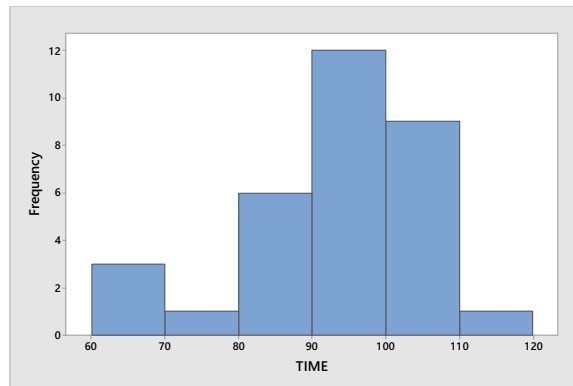


- 2.132** (a) The shape of the distribution is unimodal.
(b) The shape of the distribution is symmetric.
- 2.133** (a) The shape of the distribution is unimodal.
(b) The shape of the distribution is symmetric.
- 2.134** (a) The shape of the distribution is unimodal.
(b) The shape of the distribution is not symmetric.
(c) The shape of the distribution is right-skewed.

- 2.135** (a) The shape of the distribution is unimodal.
 (b) The shape of the distribution is not symmetric.
 (c) The shape of the distribution is left-skewed.
- 2.136** (a) The shape of the distribution is unimodal.
 (b) The shape of the distribution is not symmetric.
 (c) The shape of the distribution is right-skewed.
- 2.137** (a) The shape of the distribution is unimodal.
 (b) The shape of the distribution is not symmetric.
 (c) The shape of the distribution is left-skewed.
- 2.138** (a) The shape of the distribution is bimodal.
 (b) The shape of the distribution is symmetric.
- 2.139** (a) The shape of the distribution is multimodal.
 (b) The shape of the distribution is not symmetric.
- 2.140** The overall shape of the distribution of the number of children of U.S. presidents is right skewed.
- 2.141** Except for the one data value between 74 and 76, this distribution is close to bell-shaped. That one value makes the distribution slightly right skewed.
- 2.142** The distribution of weights of the male Ethiopian born school children is roughly symmetric.
- 2.143** The distribution of depths of the burrows is left skewed.
- 2.144** The distribution of heights of the Baltimore Ravens is roughly symmetric.
- 2.145** The distribution of PCB concentration is symmetric.
- 2.146** The distribution of adjusted gross incomes is right skewed.
- 2.147** The distribution of cholesterol levels appears to be slightly left skewed.
- 2.148** The distribution of hemoglobin levels for patients with sickle cell disease is roughly symmetric.
- 2.149** The distribution of length of stay is right skewed.
- 2.150** (a) The frequency distribution for this data is shown in the following table.

Time Between Eruptions (minutes)	Frequency
60 - under 70	3
70 - under 80	1
80 - under 90	6
90 - under 100	12
100 - under 110	9
110 - under 120	1

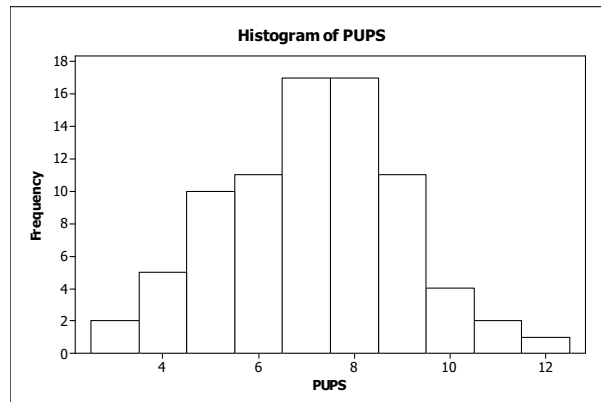
The histogram for the distribution is shown below.



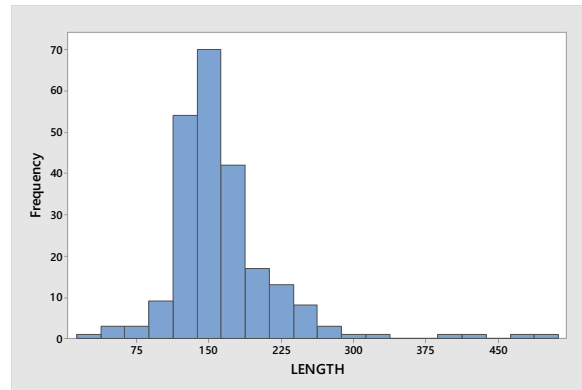
- (b) This distribution is unimodal.
- (c) This distribution is not symmetric.
- (d) This distribution is left skewed.

- 2.151** (a) The distributions for Year 1 and Year 2 are both unimodal.
 (b) Both distributions are not symmetric.
 (c) Both distributions are right skewed.
 (d) The distribution for Year 1 has a longer right tail indicating more variation than the distribution for Year 2. They are also not centered in the same place.

- 2.152** (a) After entering the data from the WeissStats Resource Site, in Minitab, select **Graph** < **Histogram**, select **Simple** and click **OK**. Double click on PUPS to enter PUPS in the **Graph variables** box and click **OK**. Our result is as follows. Results may vary depending on the type of technology used and graph obtained. The overall shape of the distribution is unimodal and symmetric.



- 2.153** (a) After entering the data from the WeissStats Resource Site, in Minitab, select **Graph** < **Histogram**, select **Simple** and click **OK**. Double click on LENGTH to enter LENGTH in the **Graph variables** box and click **OK**. Our result is as follows. Results may vary depending on the type of technology used and graph obtained.



The distribution of LENGTH is unimodal and not symmetric.

(b) The distribution is right skewed.

2.154

(a) In Exercise 2.108, we used Minitab to obtain a stem-and-leaf diagram using 5 lines per stem. That diagram is shown below

```
Stem-and-leaf of PERCENT  N  = 51
Leaf Unit = 1.0
 3   8   001
10   8   2222333
18   8   44444555
(8)  8   66777777
25   8   888889999
16   9   00000000011111
 2   9   22
```

The overall shape of this distribution is unimodal and not symmetric.

(b) The distribution is left skewed.

2.155

(a) In Exercise 2.109, we used Minitab to obtain a stem-and-leaf diagram using 2 lines per stem. That diagram is shown below.

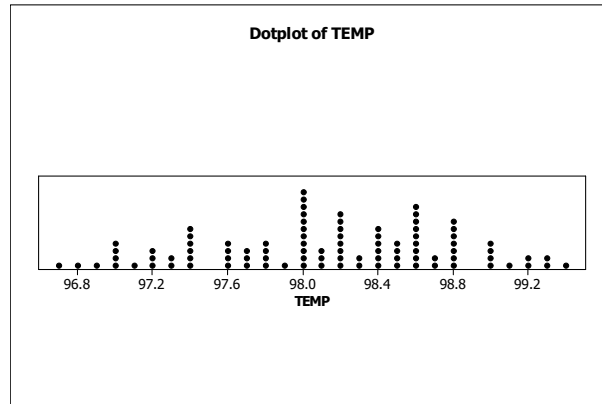
```
Stem-and-leaf of PERCENT  N  = 51
Leaf Unit = 1.0

 2   1   79
14   2   011223334444
(20) 2   55555566666777778999
17   3   00011122234
 6   3   56668
 1   4
 1   4   9
```

The overall shape of this distribution is unimodal and roughly symmetric.

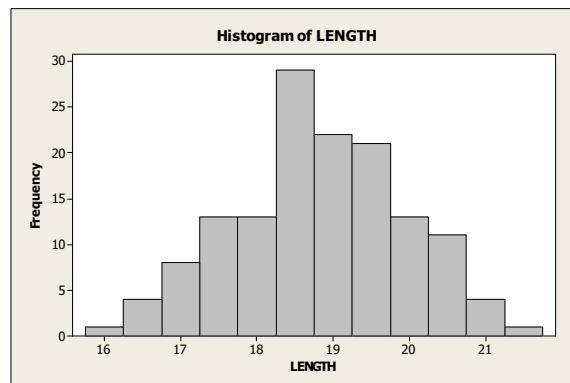
2.156

(a) After entering the data in Minitab, select **Graph** < **Dotplot**, select **Simple** in the **One Y** row, and click **OK**. Double click on TEMP to enter TEMP in the **Graph variables** box and click **OK**. Our result is as follows. Results may vary depending on the type of technology used and graph obtained.



The overall distribution of temperatures is roughly unimodal and roughly symmetric.

- 2.157** (a) After entering the data from the WeissStats Resource Site, in Minitab, select **Graph < Histogram**, select **Simple** and click **OK**. Double click on LENGTH to enter LENGTH in the **Graph variables** box and click **OK**. Our result is as follows. Results may vary depending on the type of technology used and graph obtained.

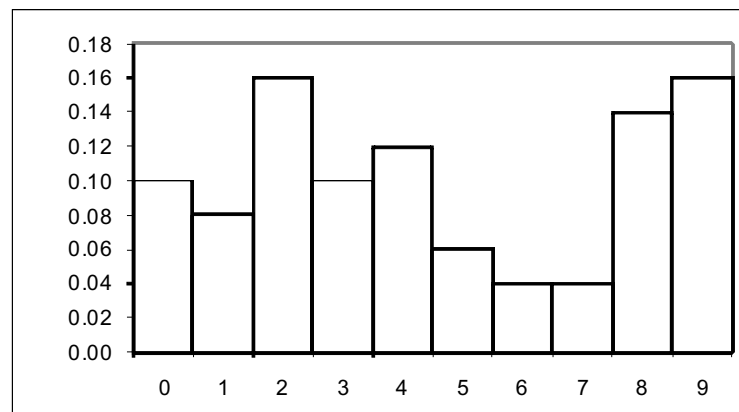


The distribution of LENGTH is approximately unimodal and symmetric.

- 2.158** Class Project. The precise answers to this exercise will vary from class to class.
- 2.159** The precise answers to this exercise will vary from class to class or individual to individual. Thus your results will likely differ from our results shown below.
- (a) We obtained 50 random digits from a table of random numbers. The digits were
- 4 5 4 6 8 9 9 7 7 2 2 2 9 3 0 3 4 0 0 8 8 4 4 5 3
- 9 2 4 8 9 6 3 0 1 1 0 9 2 8 1 3 9 2 5 8 1 8 9 2 2
- (b) Since each digit is equally likely in the random number table, we expect that the distribution would look roughly uniform.

- (c) Using single value classes, the frequency distribution is given by the following table. The relative frequency histogram is shown below.

Value	Frequency	Relative-Frequency
0	5	.10
1	4	.08
2	8	.16
3	5	.10
4	6	.12
5	3	.06
6	2	.04
7	2	.04
8	7	.14
9	8	.16



We did not expect to see this much variation.

- (d) We would have expected a histogram that was a little more 'even', more like a uniform distribution, but the relatively small sample size can result in considerable variation from what is expected.
- (e) We should be able to get a more uniformly distributed set of data if we choose a larger set of data.
- (f) Class project.

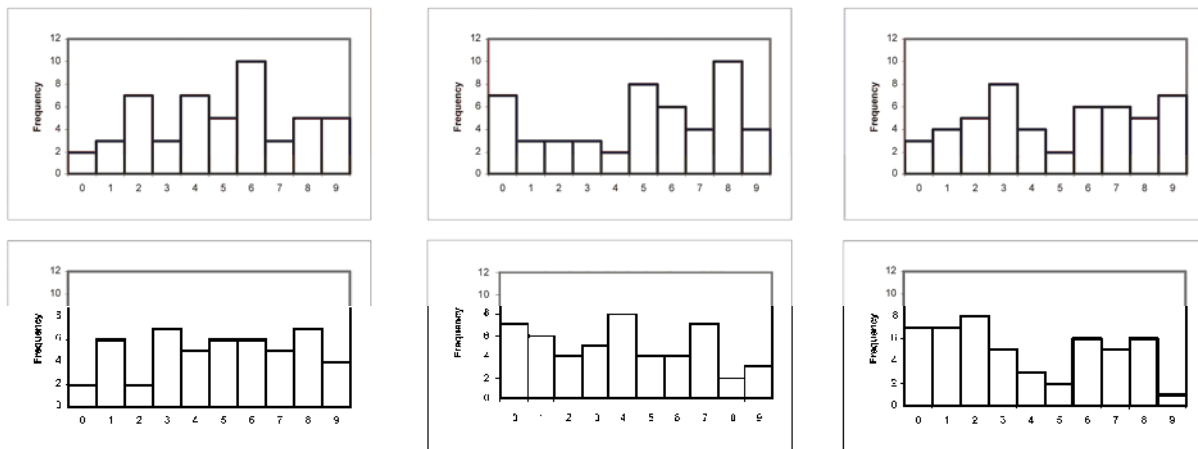
2.160 (a-c) Your results will differ from the ones below which were obtained using Excel. Enter a name for the data in cell A1, say RANDNO. Click on cell A2 and enter **=RANDBETWEEN(0,9)**. Then copy this cell into cells A3 to A51. There are two ways to produce a histogram of the resulting data in Excel. The easier way is to highlight A1-A51 with the mouse, click on the toolbar, select **Graphs and Plots**, then choose Histogram in the **Function type** box. Now click on RANDNO in the **Names and Columns** box and drag the name into the **Quantitative Variables** box. Then click OK. A graph and a summary table will be produced. To get five more samples, simply go back to the spreadsheet and press the F9 key. This will generate an entire new sample in Column A and you can repeat the procedure. The only disadvantage of this method is that the graphs produced use white lines on a black background.

The second method is a bit more cumbersome and does not provide a summary chart, but yields graphs that are better for reproduction and

that can be edited. Generate the data in the same way as was done above. In cells B1 to B10 enter the integers 0 to 9. These cells are called the **BIN**. Now click on **Tools, Data Analysis, Histogram**.

(If Data Analysis is not in the Tools menu, you will have to add it from the original CD.) Click on the **Input** box and highlight cells A2-A51 with the mouse, then click on the **Bin** box and highlight cells B1-B10. Finally click on the **Output** box and enter **C1**. This will give you a frequency table in columns C and D. Now enter the integers 0 to 9 as text in cells E2 to E11 by entering each digit preceded by a single quote mark, i.e., '0', '1', etc. In cell F2, enter **=D2**, and copy this cell into F3 through F11. Now highlight the data in columns E and F with the mouse and click the chart icon, pick the **Column** graph type, pick the first sub-type, click on the **Next** button twice, enter any titles desired, remove the legend, and then click on the **Next** button and then the **Finish** button. The graph will appear on the spreadsheet as a bar chart with spaces between the bars. Use the mouse to point to any one of the bars and click with the right mouse button. Choose **Format Data Series**. Click on the **Options** tab and change the **Gap Width** to zero, and click **OK**. Repeat this sequence to produce additional histograms, but use different cells.

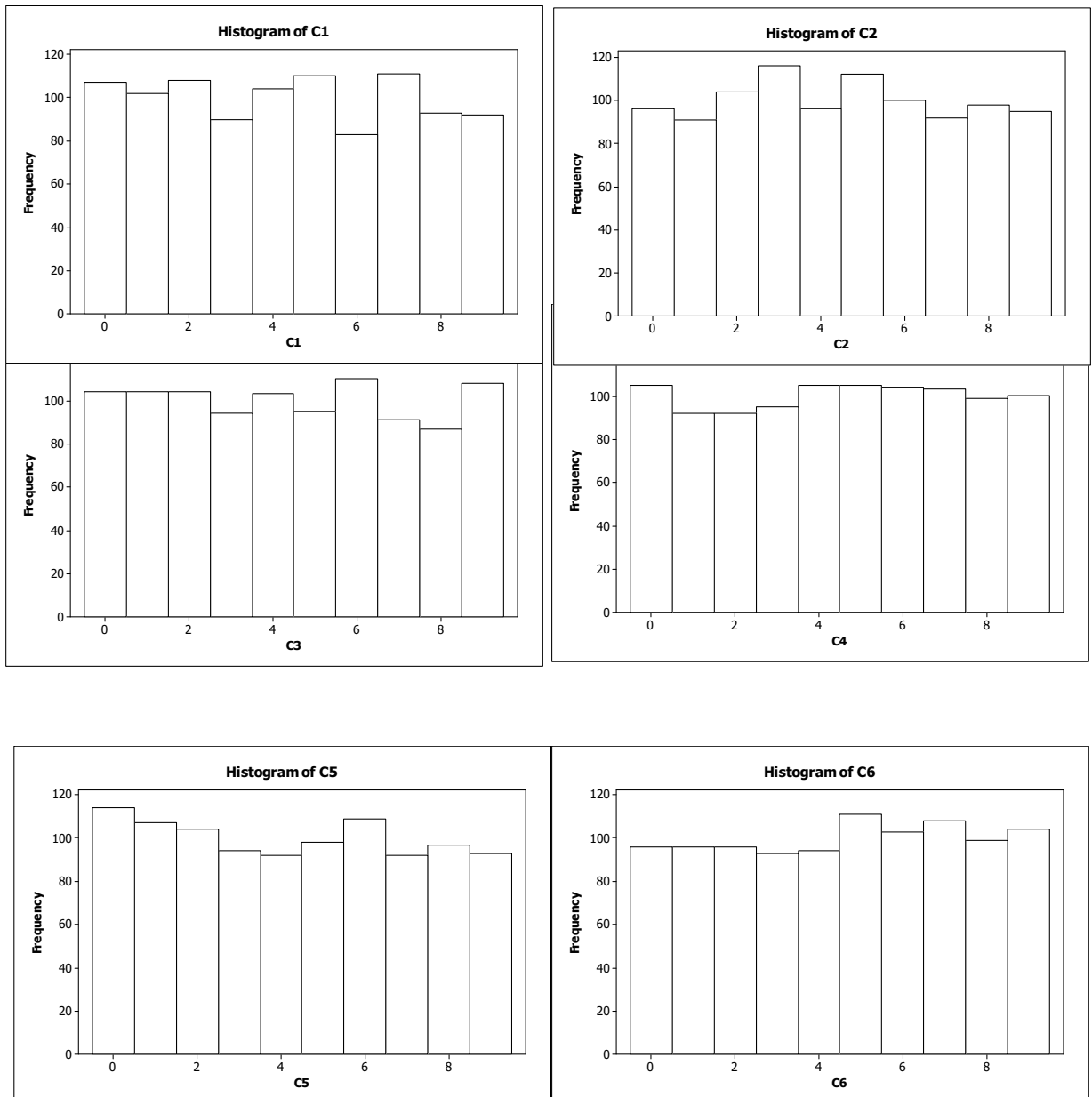
[If you would like to avoid repeating most of the above steps, click near the border of the graph and copy the graph to the Clipboard, then go to Microsoft Word or other word processor, and click on **Edit** on the Toolbar and **Paste Special**. Highlight **Microsoft Excel Chart Object**, and click **OK**. The graphs can be resized in the word processor if necessary. Now go back to Excel and hit the **F9** key. This will produce a completely new set of random numbers. Click on **Tools, Data Analysis, Histogram**, leave all the boxes as they are and click **OK**. Then click **OK** to overwrite existing data. A new table will be created and the existing histogram will be updated automatically. We used this process for the following histograms.]



(d) These shapes are about what we expected.

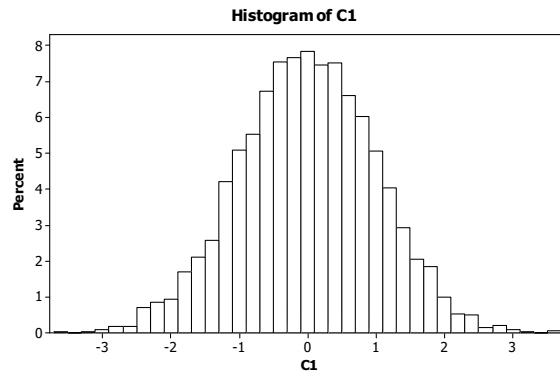
(e) The relative frequency histograms for six samples of digits of size 1000 were obtained using Minitab. Choose **Calc < Random Data < Integer...**, type 1000 in the **Generate rows of data** test box, click in the **Store in column(s)** text box and type C1 C2 C3 C4 C5 C6, click in the **Minimum value** text box and type 0, type in the **Maximum value** text

box and type 9 and click **OK**. Then choose **Graph < Histogram**, select the **Simple** version and click **OK**, enter C1 C2 C3 C4 C5 C6 in the **Graph variables** text box, C2 in the **Graph 2** text box un **x**, and so on for C3 through C6. Click on the **Multiple Graphs** button. Click on the **On separate graphs** button, and check the boxes for **Same Y** and **Same X**, including same bins. Click **OK** and click **OK**. The following graphs resulted.



The histograms for samples of size 1000 are much closer to the rectangular distribution we expected than are the ones for samples of size 50.

- 2.161** (a) Your result will differ from, but be similar to, the one below which was obtained using Minitab. Choose **Calc < Random Data < Normal...**, type 3000 in the **Generate rows of data** text box, click in the **Store in column(s)** text box and type C1, and click **OK**.
- (b) Then choose **Graph < Histogram**, choose the **Simple** version, click **OK**, enter C1 in the **Graph variables** text box, click on the **Scale** button and then on the **Y-Scale Type** tab. Check the **Percent** box and click **OK** twice.



- (c) The histogram in part (b) has the bell, unimodal and symmetric distribution. The sample of 3000 is representative of the population from which the sample was taken.

Section 2.5

- 2.162** Graphs are sometimes constructed in ways that cause them to be misleading.
- 2.163** (a) A truncated graph is one for which the vertical axis starts at a value other than its natural starting point, usually zero.
- (b) A legitimate motivation for truncating the axis of a graph is to place the emphasis on the ups and downs of the distribution rather than on the actual height of the graph.
- (c) To truncate a graph and avoid the possibility of misinterpretation, one should start the axis at zero and put slashes in the axis to indicate that part of the axis is missing.
- 2.164** Answers will vary.
- 2.165** (a) A large lower portion of the graph is eliminated. When this is done, differences between district and national averages appear greater than in the original figure.
- (b) Even more of the graph is eliminated. Differences between district and national averages appear even greater than in part (a).
- (c) The truncated graphs give the misleading impression that, in 2013, the district average is much greater relative to the national average than it actually is.
- 2.166** (a) A break is shown in the first bar on the left to warn the reader that part of the first bar itself has been removed.
- (b) It was necessary to construct the graph with a broken bar to let the reader know that the first bar is actually much taller than it appears. If the true height of the first bar were presented, but without the break, the height would span most of an entire page. This

would have used up, perhaps, more room than that desired by the person reporting the graph.

- (c) This bar chart is potentially misleading if the reader does not pay attention to the *true* magnitude of the first bar relative to the other three bars. This is precisely the reason for the break in the first bar, however. It is meant to alert the reader that special treatment is to be applied to the first bar. It is actually much taller than it appears. Supplying the numbers for each bar of the graph makes it clear that there was no intention to mislead the reader. This was necessary also because there is no scale on the vertical axis.

- 2.167** (a) The problem with the bar chart is that it is truncated. That is, the vertical axis, which should start at \$0 (in trillions), starts with \$7.6 (in trillions) instead. The part of the graph from \$0 (in trillions) to \$7.6 (in trillions) has been cut off. This truncation causes the bars to be out of correct proportion and hence creates the misleading impression that the money supply is changing more than it actually is.
- (b) A version of the bar chart with an untruncated and unmodified vertical axis is presented in Figure (a). Notice that the vertical axis starts at \$0.00 (in trillions). Increments are in trillion dollars. In contrast to the original bar chart, this one illustrates that the changes in money supply from week to week are not that different. However, the "ups" and "downs" are not as easy to spot as in the original, truncated bar chart.
- (c) A version of the bar chart in which the vertical axis is modified in an acceptable manner is presented in Figure (b). Notice that the special symbol "//" is used near the base of the vertical axis to signify that the vertical axis has been modified. Thus, with this version of the bar chart, not only are the "ups" and "downs" easy to spot but the reader is also aptly warned by the slashes that part of the vertical axis between \$0.00 (in trillions) and \$7.6 (in trillions) has been removed.

Figure (a)

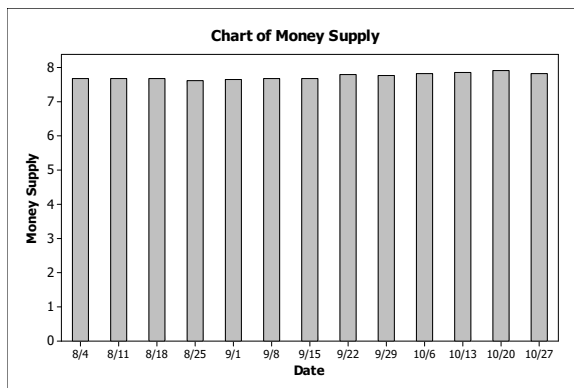
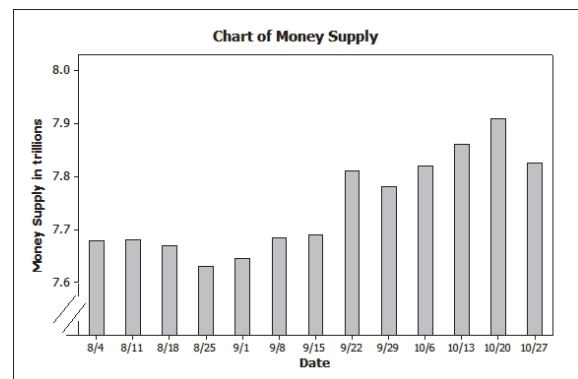


Figure (b)

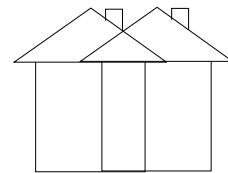
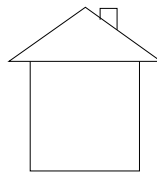


- 2.168** (a) The problem with the bar chart is that it is truncated. That is, the vertical axis, which should start at 0 for both the Total Fatalities and for the Licensed Drivers starts with 10,000 and 145 respectively. This truncation causes the time-plot to be out of proportion and hence creates the misleading impression that the number of fatalities is changing more than it actually is.

- (b) The truncation was most likely used to clearly display the yearly changes in total drunk driving fatalities. Without the truncation, if the scale continued to zero, it might be hard to notice the changes from year to year.
- (c) An acceptable manner to modify the graph would be to use the special symbol "//" near the base of the vertical axis to signify that the vertical axis has been modified. Thus, with this modified version of the bar chart, not only are the changes in total drunk driving fatalities easy to spot but the reader is also aptly warned by the slashes that part of the vertical axis between 0 and 10,000 Total Fatalities has been removed.

- 2.169** (b) Without the vertical scale, it would appear that the happiness score dropped about 25% between the ages of 15 and 20.
- (c) The actual drop was from a happiness score of about 5.5 to a happiness score of 5.25 between the ages of 15 and 20. This is a drop of $0.25/5.5 = 0.045$ or about 4.5%.
- (d) Without the vertical scale, it would look like the happiness scale has dropped about 50% from 5.5 to 5.0 where actually it really is closer to a 20% drop. The peak at 74 looks like a bigger significant increase without the vertical scale as well. Because the scale on the horizontal axis is not evenly spaced, the time between events is misleading.
- (e) The graph could be made less potentially misleading by either making the vertical scale range from zero to 6.0 and by making the scale on the vertical axis the same width.

- 2.170** A correct way in which the developer can illustrate the fact that twice as many homes will be built in the area this year as last year is as follows:

**Last Year****This Year**

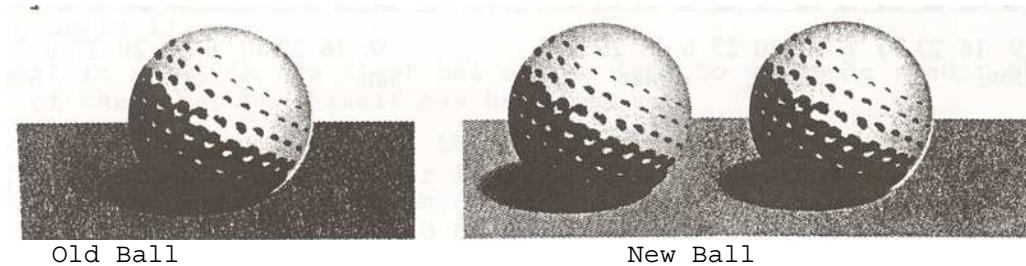
- 2.171** (a) The brochure shows a "new" ball with twice the radius of the "old" ball. The intent is to give the impression that the "new" ball lasts roughly twice as long as the "old" ball. However, if the "new" ball has twice the radius of the "old" ball, the "new" ball will have eight times the volume of the "old" ball (since the volume of a sphere is proportional to the cube of its radius, or the radius $2^3 = 8$). Thus, the scaling is improper because it gives the impression that the "new" ball lasts eight times as long as the "old" ball rather than merely two times as long.

Old Ball

New Ball



- (b) One possible way for the manufacturer to illustrate the fact that the "new" ball lasts twice as long as the "old" ball is to present pictures of two balls, side by side, each of the same magnitude as the picture of the "old" ball and to label this set of two balls "new ball". This will illustrate the point that a purchaser will be getting twice as much for the money.

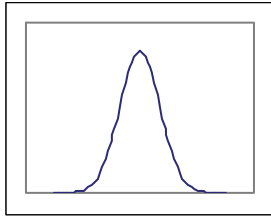


Review Problems For Chapter 2

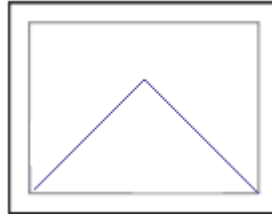
1. (a) A variable is a characteristic that varies from one person or thing to another.
 (b) Variables are quantitative or qualitative.
 (c) Quantitative variables can be discrete or continuous.
2. (d) Data are values of a variable.
 (e) The data type is determined by the type of variable being observed.
3. A frequency distribution of qualitative data is a table that lists the distinct values of data and their frequencies. It is useful to organize the data and make it easier to understand. A relative-frequency distribution of qualitative data is a table that lists the distinct values of data and a ratio of the class frequency to the total number of observations, which is called the relative frequency.
4. For both quantitative and qualitative data, the frequency and relative-frequency distributions list the values of the distinct classes and their frequencies and relative frequencies. For single value grouping of quantitative data, it is the same as the distinct classes for qualitative data. For class limit and cutpoint grouping in quantitative data, we create groups that form distinct classes similar to qualitative data.
5. The two main types of graphical displays for qualitative data are the bar chart and the pie chart.
6. The bars do not abut in a bar chart because there is not any continuity between the categories. Also, this differentiates them from histograms.
7. Answers will vary. One advantage of pie charts is that it shows the proportion of each class to the total. One advantage of bar charts is that it emphasizes each individual class in relation to each other. One disadvantage of pie charts is that if there are too many classes, the chart becomes confusing. Also, if a class is really small relative to the total, it is hard to see the class in a pie chart.
8. Single value grouping is appropriate when the data are discrete with relatively few distinct observations.

9. (a) The second class would have lower and upper limits of 9 and 14. The class mark of this class would be the average of these limits and equal 11.5.
- (b) The third class would have lower and upper limits of 15 and 20.
- (c) The fourth class would have lower and upper limits of 21 and 26. This class would contain an observation of 23.
10. (a) If the width of the class is 5, then the class limits will be four whole numbers apart. Also, the average of the two class limits is the class mark of 8. Therefore, the upper and lower class limits must be two whole numbers above and below the number 8. The lower and upper class limits of the first class are 6 and 10.
- (b) The second class will have lower and upper class limits of 11 and 15. Therefore, the class mark will be the average of these two limits and equal 13.
- (c) The third class will have lower and upper class limits of 16 and 20.
- (d) The fourth class has limits of 21 and 25, the fifth class has limits of 26 and 30. Therefore, the fifth class would contain an observation of 28.
11. (a) The common class width is the distance between consecutive cutpoints, which is $15 - 5 = 10$.
- (b) The midpoint of the second class is halfway between the cutpoints 15 and 25, and is therefore 20.
- (c) The sequence of the lower cutpoints is 5, 15, 25, 35, 45, ... Therefore, the lower and upper cutpoints of the third class are 25 and 35.
- (d) Since the third class has lower and upper cutpoints of 25 and 35, an observation of 32.4 would belong to this class.
12. (a) The midpoint is halfway between the cutpoints. Since the class width is 8, 10 is halfway between 6 and 14.
- (b) The class width is also the distance between consecutive midpoints. Therefore, the second midpoint is at $10 + 8 = 18$.
- (c) The sequence of cutpoints is 6, 14, 22, 30, 38, ... Therefore the lower and upper cutpoints of the third class are 22 and 30.
- (d) An observation of 22 would go into the third class since that class contains data greater than or equal to 22 and strictly less than 30.
13. (a) If lower class limits are used to label the horizontal axis, the bars are placed between the lower class limit of one class and the lower class limit of the next class.
- (b) If lower cutpoints are used to label the horizontal axis, the bars are placed between the lower cutpoint of one class and the lower cutpoint of the next class.
- (c) If class marks are used to label the horizontal axis, the bars are placed directly above and centered over the class mark for that class.
- (d) If midpoints are used to label the horizontal axis, the bars are placed directly above and centered over the midpoint for that class.

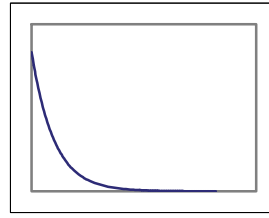
14. (a) Bell-shaped



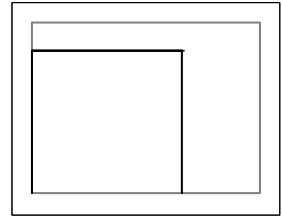
(b) Triangular



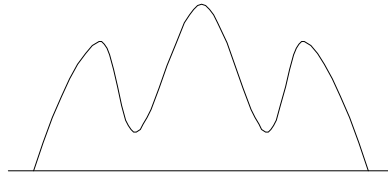
(c) Reverse J shape



(d) Uniform



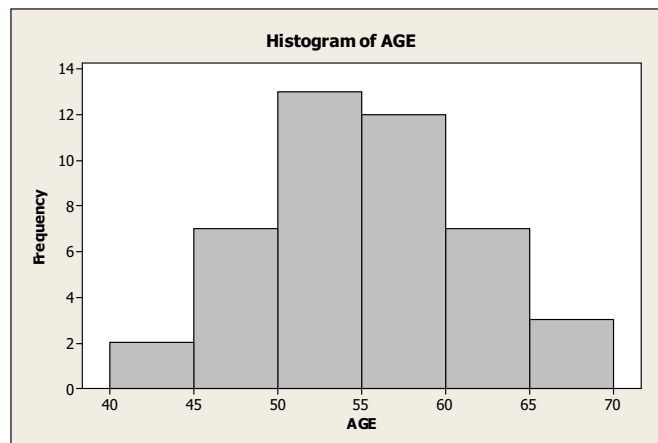
15. Answers will vary but here is one possibility.



16. (a) The distribution of the large simple random sample will reflect the distribution of the population, so it would be left-skewed as well.
- (b) No. The randomness in the samples will almost certainly produce different sets of observations resulting in shapes that are not identical.
- (c) Yes. We would expect both of the simple random samples to reflect the shape of the population and be left-skewed.
17. (a) The first column ranks the hydroelectric plants. Thus, it consists of *quantitative, discrete* data.
- (b) The fourth column provides measurements of capacity. Thus, it consists of *quantitative, continuous* data.
- (c) The third column provides nonnumerical information. Thus, it consists of *qualitative* data.
18. (a) A single value frequency histogram for the prices of DVD players would be identical to the dotplot in example 2.16 because the classes would be 197 through 224 and the height for each bar in the frequency histogram would reflect the number of dots above each observation in the dotplot.
- (b) No. The frequency histogram with cutpoint or class limit grouping would combine some of the single values together which would change the frequencies and the heights of the bars corresponding to those classes.
19. (a) The first class to construct is 40-44. Since all classes are to be of equal width, and the second class begins with 45, we know that the width of all classes is $45 - 40 = 5$. All of the classes are presented in column 1 of the grouped-data table in the figure below. The last class to construct does not go beyond 65-69, since the largest single data value is 69. The sum of the relative frequency column is 0.999 due to rounding.

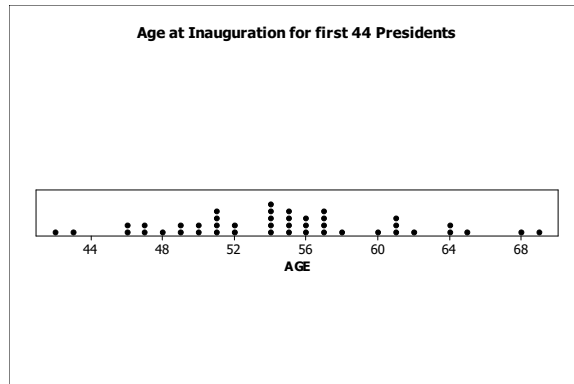
Age at Inauguration	Frequency	Relative Frequency	Class Mark
40-44	2	0.045	42
45-49	7	0.159	47
50-54	13	0.295	52
55-59	12	0.273	57
60-64	7	0.159	62
65-69	3	0.068	67
	44	0.999	

- (b) By averaging the lower and upper limits for each class, we arrive at the class mark for each class. The class marks for all classes are presented in column 4.
- (c) Having established the classes, we tally the ages into their respective classes. These results are presented in column 2, which lists the frequencies. Dividing each frequency by the total number of observations, which is 44, results in each class's relative frequency. The relative frequencies for all classes are presented in column 3.
- (d) The frequency histogram presented below is constructed using the frequency distribution presented above; i.e., columns 1 and 2. Notice that the lower cutpoints of column 1 are used to label the horizontal axis of the frequency histogram. Suitable candidates for vertical-axis units in the frequency histogram are the even integers within the range 2 through 14, since these are representative of the magnitude and spread of the frequencies presented in column 2. The height of each bar in the frequency histogram matches the respective frequency in column 2.



- (e) The shape of the inauguration ages is unimodal and symmetric.

20. The horizontal axis of this dotplot displays a range of possible ages for the 44 Presidents of the United States. To complete the dotplot, we go through the data set and record each age by placing a dot over the appropriate value on the horizontal axis.



21. (a) Using *one* line per stem in constructing the ordered stem-and-leaf diagram means vertically listing the numbers comprising the stems *once*. The leaves are then placed with their respective stems in order. The ordered stem-and-leaf diagram using one line per stem is presented in the following figure.
- ```

4 | 236677899
5 | 0011112244444555566677778
6 | 0111244589

```
- (b) Using *two* lines per stem in constructing the ordered stem-and-leaf diagram means vertically listing the numbers comprising the stems *twice*. In turn, if the leaf is one of the digits 0 through 4, it is ordered and placed with the first of the two stem lines. If the leaf is one of the digits 5 through 9, it is ordered and placed with the second of the two stem lines. The ordered stem-and-leaf diagram using two lines per stem is presented in the following figure.
- ```

4 | 23
4 | 6677899
5 | 0011112244444
5 | 555566677778
6 | 0111244
6 | 589

```
- (c) The stem-and-leaf diagram in part (b) corresponds to the frequency distribution of Problem 19.
22. (a) Using *one* line per stem in constructing the ordered stem-and-leaf diagram means vertically listing the numbers comprising the stems *once*. The leaves are then placed with their respective stems in order. The ordered stem-and-leaf diagram using one line per stem is presented in the following figure.
- ```

3 | 4778
4 | 0467
5 | 446677778
6 | 0

```
- (b) Using *two* lines per stem in constructing the ordered stem-and-leaf diagram means vertically listing the numbers comprising the stems *twice*. In turn, if the leaf is one of the digits 0 through 4, it is ordered and placed with the first of the two stem lines. If the leaf is one of the digits 5 through 9, it is ordered and placed with the second of the two stem lines. The ordered stem-and-leaf diagram using two lines per stem is presented in the following figure.

```

3 | 4
3 | 778
4 | 04
4 | 67
5 | 44
5 | 6677778
6 | 0

```

- (c) The second graph is the most useful. Typically, we like to have five to fifteen classes and the second one provides a better idea of the shape of the distribution.

- 23.** (a) The frequency and relative-frequency distribution presented below is constructed using classes based on a single value. Since each data value is one of the integers 0 through 6, inclusive, the classes will be 0 through 6, inclusive. These are presented in column 1. Having established the classes, we tally the number of busy tellers into their respective classes. These results are presented in column 2, which lists the frequencies. Dividing each frequency by the total number of observations, which is 25, results in each class's relative frequency. The relative frequencies for all classes are presented in column 3.

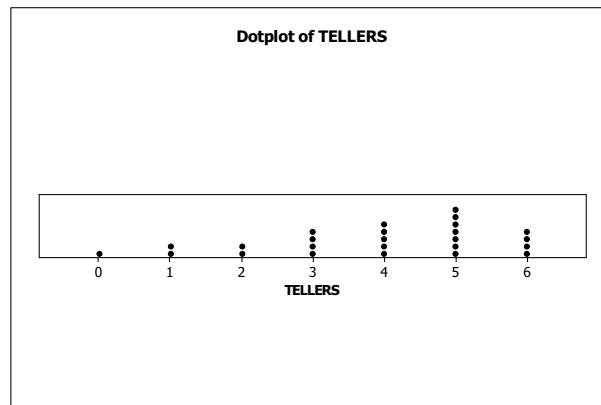
| Number<br>Busy | Frequency | Relative<br>Frequency |
|----------------|-----------|-----------------------|
| 0              | 1         | 0.04                  |
| 1              | 2         | 0.08                  |
| 2              | 2         | 0.08                  |
| 3              | 4         | 0.16                  |
| 4              | 5         | 0.20                  |
| 5              | 7         | 0.28                  |
| 6              | 4         | 0.16                  |
|                | 25        | 1.00                  |

- (b) The following relative-frequency histogram is constructed using the relative-frequency distribution presented in part (a); i.e., columns 1 and 3. Column 1 demonstrates that the data are grouped using classes based on a single value. These single values in column 1 are used to label the horizontal axis of the relative-frequency histogram. We notice that the relative frequencies presented in column 3 range in size from 0.04 to 0.28 (4% to 28%). Thus, suitable candidates for vertical axis units in the relative-frequency histogram are increments of 0.05, starting with zero and ending at 0.30. The middle of each histogram bar is placed directly over the single numerical value represented by the class. Also, the height of each bar in the relative-frequency histogram matches the respective relative frequency in column 3.





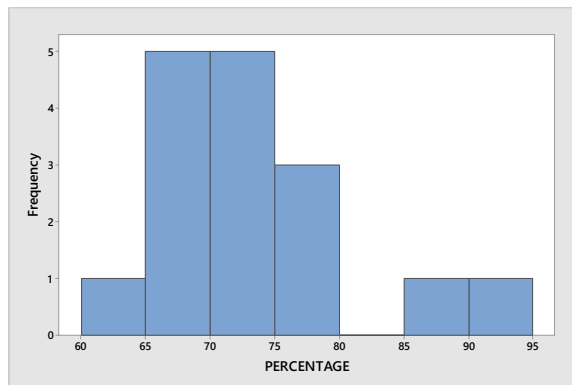
- (c) The distribution is unimodal.  
 (d) The distribution is left skewed.  
 (e)



- (f) Since both the histogram and the dotplot are based on single value grouping, they both convey exactly the same information.
- 24.**
- (a) The classes will begin with the class 60 - under 65. The second class will be 65 - under 70. The classes will continue like this until the last class, which will be 90 - under 95, since the largest observation is 93.1. The classes can be found in column 1 of the frequency distribution in part (c).
- (b) The midpoints of the classes are the averages of the lower and upper cutpoint for each class. For example, the first midpoint will be 62.5, the second midpoint will be 67.5. The midpoints will continue like this until the last midpoint, which will be 92.5. The midpoints can be found in column 4 of the frequency distribution in part (c).
- (c) The first and second columns of the following table provide the frequency distribution. The first and third columns of the following table provide the relative-frequency distribution for percentages of on-time arrivals for the airlines.

| Percent On-Time | Frequency | Relative Frequency | Midpoint |
|-----------------|-----------|--------------------|----------|
| 60 - under 65   | 1         | 0.0625             | 62.5     |
| 65 - under 70   | 5         | 0.3125             | 67.5     |
| 70 - under 75   | 5         | 0.3125             | 72.5     |
| 75 - under 80   | 3         | 0.1875             | 77.5     |
| 80 - under 85   | 0         | 0.0000             | 82.5     |
| 85 - under 90   | 1         | 0.0625             | 87.5     |
| 90 - under 95   | 1         | 0.0625             | 92.5     |
|                 | 16        | 1.0000             |          |

- (d) The frequency histogram is constructed using columns 1 and 2 from the frequency distribution from part (c). The cutpoints are used to label the horizontal axis. The vertical axis is labeled with the frequencies that range from 0 to 5.



- (e) After rounding each observation to the nearest whole number, the stem-and-leaf diagram with two lines per stem for the rounded percentages is

```

6 | 2
6 | 669
7 | 0011334
7 | 678
8 |
8 | 8
9 | 3

```

- (f) After obtaining the greatest integer in each observation, the stem-and-leaf diagram with two lines per stem is

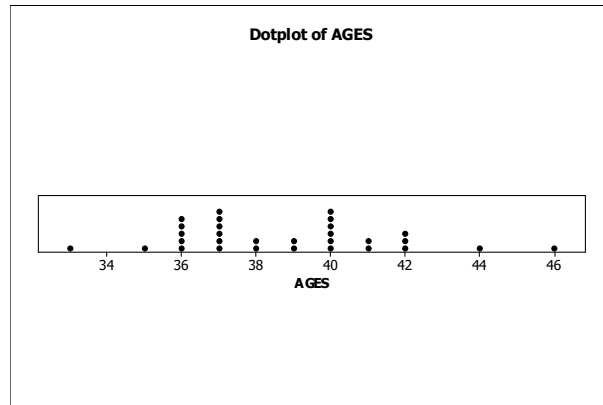
```

6 | 1
6 | 56999
7 | 01233
7 | 677
8 |
8 | 7
9 | 3

```

- (g) The stem-and-leaf diagram in part (f) corresponds to the frequency distribution in part (d) because the observations weren't rounded in constructing the frequency distribution.

25. (a) The dotplot of the ages of the oldest player on each major league baseball team is

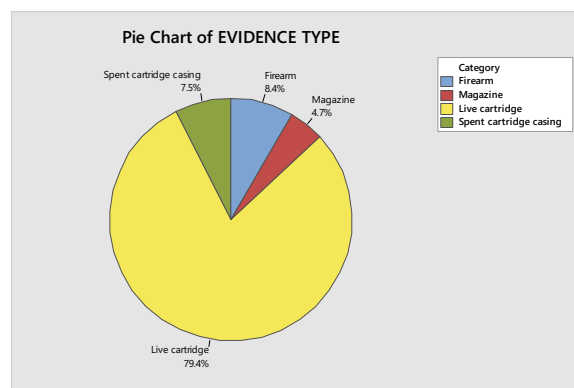


(b) The overall shape of the distribution of ages is bimodal and roughly symmetric.

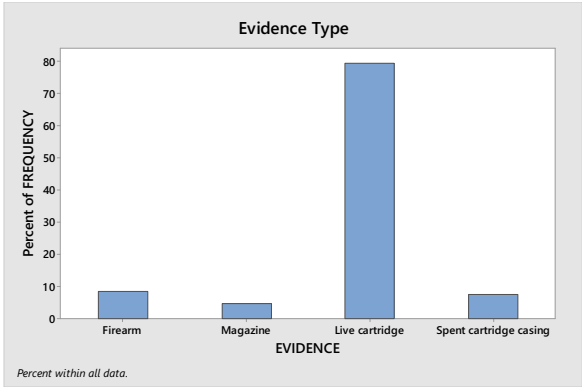
26. (a) The classes are the types of evidence and are presented in column 1. The frequency distribution of the champions is presented in column 2. Dividing each frequency by the total number of submissions, which is 3436, results in each class's relative frequency. The relative frequency distribution is presented in column 3.

| Type | Evidence        | Frequency | Relative Frequency |
|------|-----------------|-----------|--------------------|
|      | Firearm         | 289       | 0.084              |
|      | Magazine        | 161       | 0.047              |
|      | Live Cartridge  | 2727      | 0.794              |
|      | Spent Cartridge | 259       | 0.075              |
|      |                 | 3436      | 1.000              |

(b) We multiply each of the relative frequencies by 360 degrees to obtain the portion of the pie represented by each evidence type. The result is



(c) We use the bar chart to show the relative frequency with which each EVIDENCE TYPE occurs. The result is

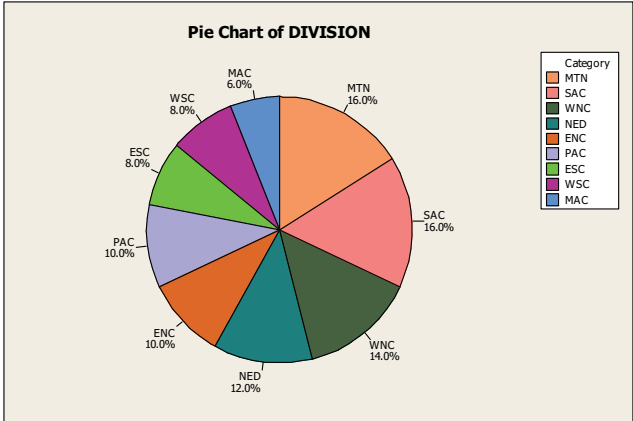


(d) The most common type of evidence type submitted to crime labs is a live cartridge which was the type submitted 79.4% of the time.

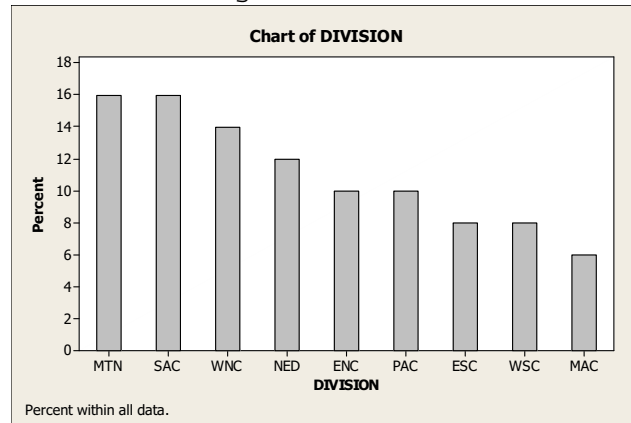
27. (a) The population consists of the states in the United States. The variable is the division.
- (b) The frequency and relative frequency distribution for Region is shown below.

| Region             | Frequency | Relative Frequency |
|--------------------|-----------|--------------------|
| East North Central | 5         | 0.10               |
| East South Central | 4         | 0.08               |
| Middle Atlantic    | 3         | 0.06               |
| Mountain           | 8         | 0.16               |
| New England        | 6         | 0.12               |
| Pacific            | 5         | 0.10               |
| South Atlantic     | 8         | 0.16               |
| West North Central | 7         | 0.14               |
| West South Central | 4         | 0.08               |
|                    | 50        | 1.000              |

(c) The pie chart for Region is shown below.



- (d) The bar chart for Region is shown below.

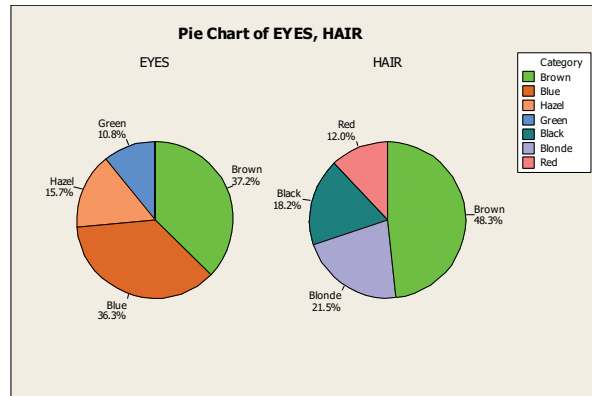


- (e) The distribution of Region seems to be almost uniformly distributed between the categories. The smallest region is the Middle Atlantic at a frequency of 3, the largest region is the Mountain and South Atlantic at a frequency of 8.
28. (a) The break in the third bar is to emphasize that the bar as shown is not as tall as it should be.
- (b) The bar for the space available in coal mines is at a height of about 30 billion tonnes. To accurately represent the space available in saline aquifers (10,000 billion tonnes), the third bar would have to be over 300 times as high as the first bar and more than 10 times as high as the second bar. If the first two bars were kept at the sizes shown, there wouldn't be enough room on the page for the third bar to be shown at its correct height. If a reasonable height were chosen for the third bar, the first bar wouldn't be visible. The only apparent solution is to present the third bar as a broken bar.
29. (a) Covering up the numbers on the vertical axis totally obscures the percentages.
- (b) Having followed the directions in part (a), we might conclude that the percentage of women in the labor force for 2000 is about three and one-half times that for 1960.
- (c) Not covering up the vertical axis, we find that the percentage of women in the labor force for 2000 is about 1.8 times that for 1960.
- (d) The graph is potentially misleading because it is truncated. Notice that vertical axis units begin at 30 rather than at zero.
- (e) To make the graph less potentially misleading, we can start it at zero instead of 30.
30. (a) Using Minitab, retrieve the data from the WeissStats Resource Site. Column 2 contains the eye color and column 3 contains the hair color

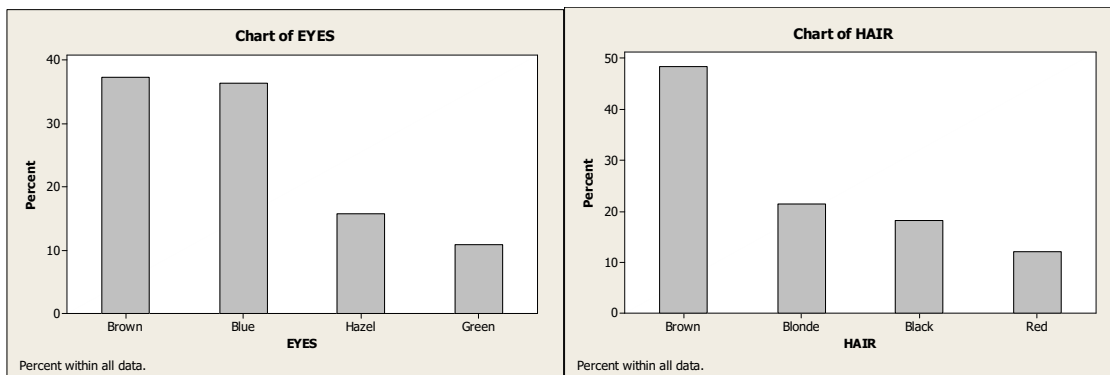
for the students. From the tool bar, select **Stat < Tables < Tally Individual Variables**, double-click on EYES and HAIR in the first box so that both EYES and HAIR appear in the **Variables** box, put a check mark next to Counts and Percents under Display, and click **OK**. The results are

| EYES  | Count | Percent | HAIR   | Count | Percent |
|-------|-------|---------|--------|-------|---------|
| Blue  | 215   | 36.32   | Black  | 108   | 18.24   |
| Brown | 220   | 37.16   | Blonde | 127   | 21.45   |
| Green | 64    | 10.81   | Brown  | 286   | 48.31   |
| Hazel | 93    | 15.71   | Red    | 71    | 11.99   |
| N=    | 592   |         | N=     | 592   |         |

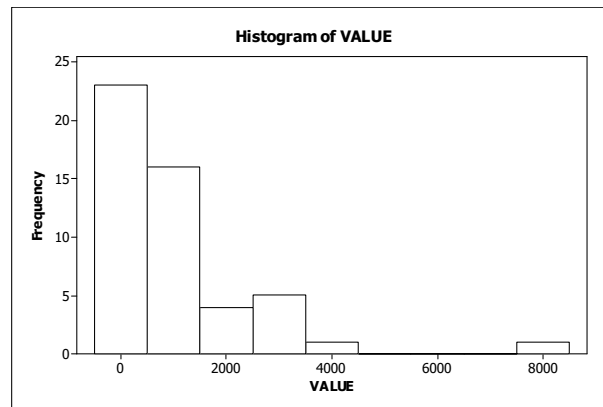
- (b) Using Minitab, select **Graph < Pie Chart**, check Chart counts of unique values, double-click on EYES and HAIR in the first box so that EYES and HAIR appear in the Categorical Variables box. Click Pie Options, check decreasing volume, click OK. Click Multiple Graphs, check On the Same Graphs, Click OK. Click Labels, click Slice Labels, check Category Name, Percent, and Draw a line from label to slice, Click OK twice. The results are



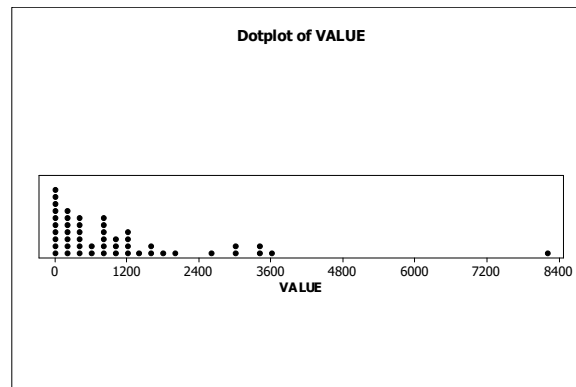
- (c) Using Minitab, select **Graph < Bar Chart**, select Counts of unique values, select Simple option, click OK. Double-click on EYES and HAIR in the first box so that EYES and HAIR appear in the Categorical Variables box. Select Chart Options, check decreasing Y, check show Y as a percent, click OK. Click OK twice. The results are



31. (a) The population consists of the states of the U.S. and the variable under consideration is the value of the exports of each state.
- (b) Using Minitab, we enter the data from the WeissStats Resource Site, choose **Graph < Histogram**, click on **Simple** and click **OK**. Then double click on VALUE to enter it in the **Graph variables** box and click **OK**. The result is



- (c) For the dotplot, we choose **Graph < Dotplot**, click on **Simple** from the **One Y** row and click **OK**. Then double click on VALUE to enter it in the **Graph variables** box and click **OK**. The result is



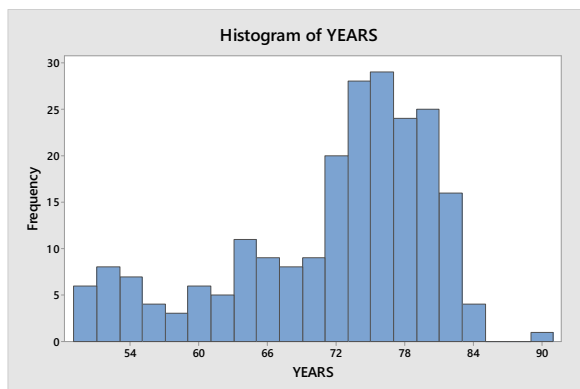
- (d) For the stem-and-leaf plot, we choose **Graph < Stem-and-Leaf**, double click on VALUE to enter it in the **Graph variables** box and click **OK**. The result is

```
Stem-and-leaf of VALUE N = 50
Leaf Unit = 100

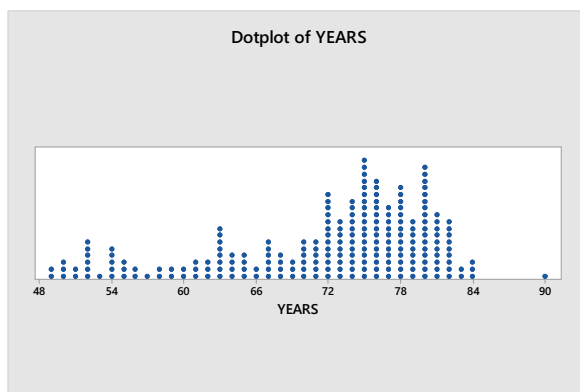
 23 0 000000000001112222344444
(10) 0 5677888899
 17 1 012224
 11 1 5679
 7 2
 7 2 69
 5 3 034
 2 3 6
 1 4
 1 4
 1 5
 1 5
 1 6
 1 6
 1 7
 1 7
 1 8 2
```

- (e) The overall shape of the distribution is unimodal and not symmetric.  
 (f) The distribution is right skewed.

32. (a) The population consists of countries of the world, and the variable under consideration is the expected life in years for people in those countries.
- (b) Using Minitab, we enter the data from the WeissStats Resource Site, choose **Graph < Histogram**, click on **Simple** and click **OK**. Then double click on YEARS to enter it in the **Graph variables** box and click **OK**. The result is



- (c) For the dotplot, we choose **Graph < Dotplot**, click on **Simple** from the **One Y** row and click **OK**. Then double click on YEARS to enter it in the **Graph variables** box and click **OK**. The result is



- (d) For the stem-and-leaf plot, we choose **Graph < Stem-and-Leaf**, double click on YEARS to enter it in the **Graph variables** box and click **OK**. The result is

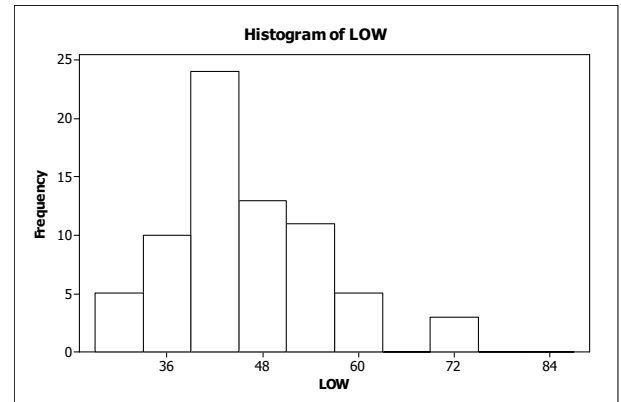
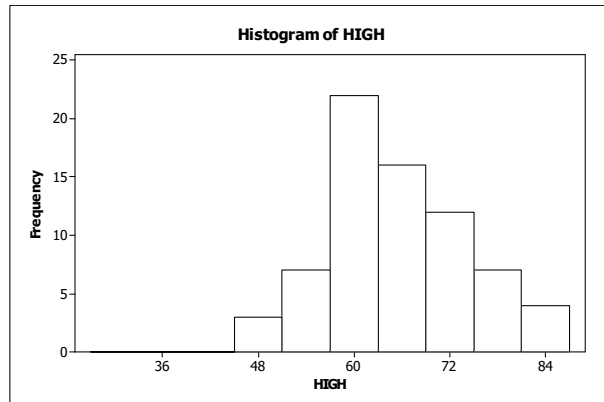
Stem-and-leaf of YEARS    N    = 223  
Leaf Unit = 1.0

[illegible]

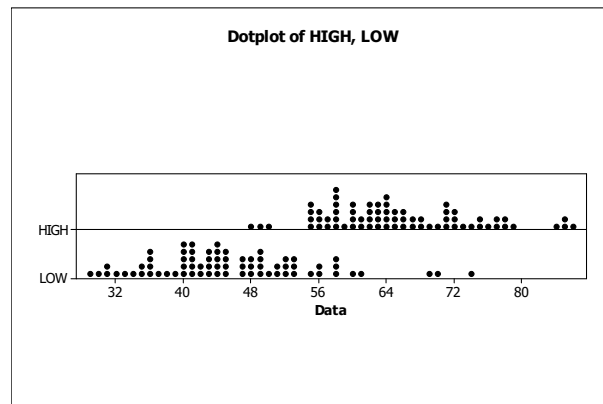
- (e) The overall shape of the distribution is unimodal and not symmetric.  
(f) This distribution is classified as left skewed.



33. (a) The population consists of cities in the U.S., and the variables under consideration are their annual average maximum and minimum temperatures.
- (b) Using Minitab, we enter the data from the WeissStats Resource Site, choose **Graph < Histogram**, click on **Simple** and click **OK**. Double click on HIGH to enter it in the **Graph variables** box, and double click on LOW to enter it in the **Graph variables** box. Now click on the **Multiple graphs** button and click to **Show Graph Variables on separate graphs** and also check both boxes under **Same Scales for Graphs**, and click **OK** twice. The result is



- (c) For the dotplot, we choose **Graph < Dotplot**, click on **Simple** from the **Multiple Y's** row and click **OK**. Then double click on HIGH and then LOW to enter them in the **Graph variables** box and click **OK**. The result is



- (d) For the stem-and-leaf diagram, we choose **Graph < Stem-and-Leaf**, double click on HIGH and then on LOW to enter then in the **Graph variables** box and click **OK**. The result is

```
Stem-and-leaf of HIGH N = 71
Leaf Unit = 1.0
 3 4 789
 6 5 444
21 5 555677777888999
(17) 6 00001122222333444
33 6 55556677779
22 7 00001122234
11 7 5577889
 4 8 444
 1 8 5
```

Stem-and-leaf of LOW N = 71  
Leaf Unit = 1.0

```

1 2 9
7 3 001234
19 3 555556779999
(20) 4 00011111223333344444
32 4 5567777888899
19 5 11122223
11 5 5667889
4 6 1
3 6 9
2 7 04

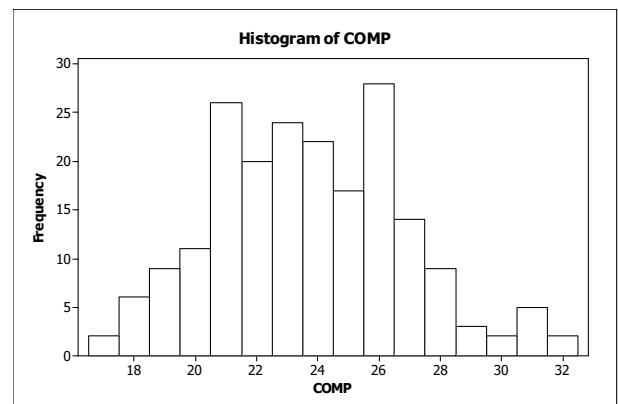
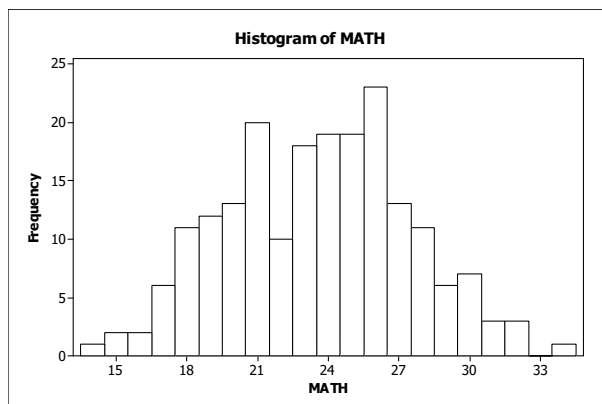
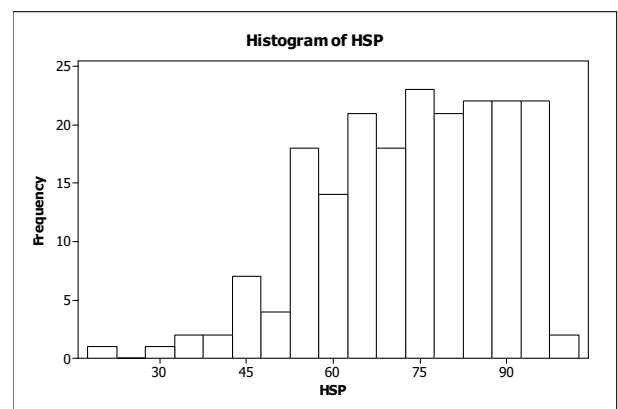
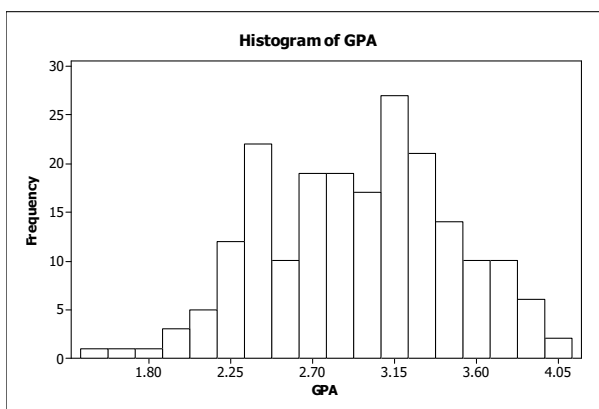
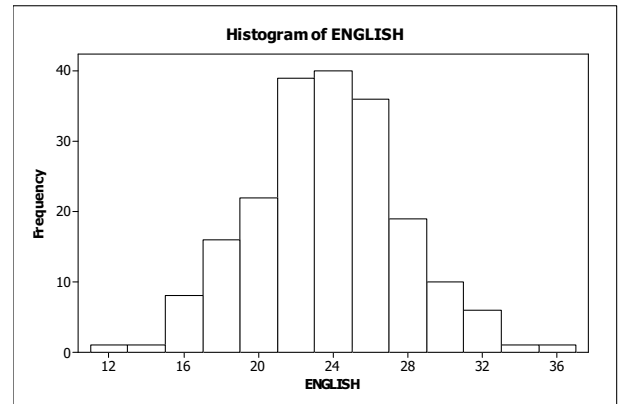
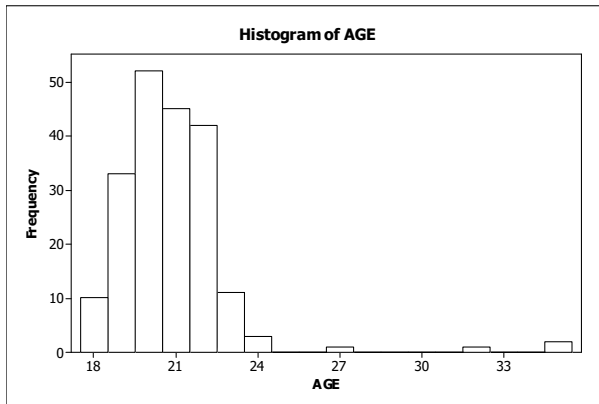
```

- (e) Both variables have distributions that are unimodal. HIGH is close to symmetric and LOW is not symmetric.  
(f) LOW is slightly right skewed.

### Using the FOCUS Database: Chapter 2

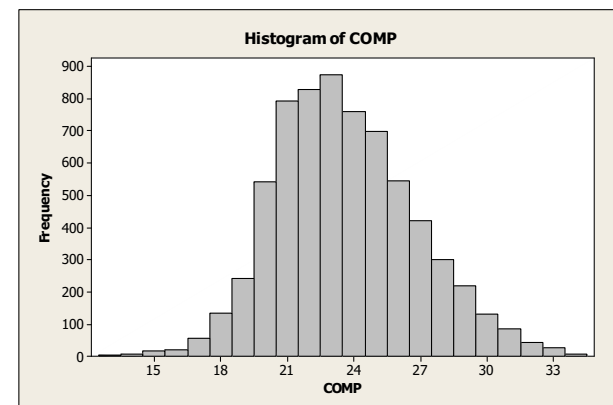
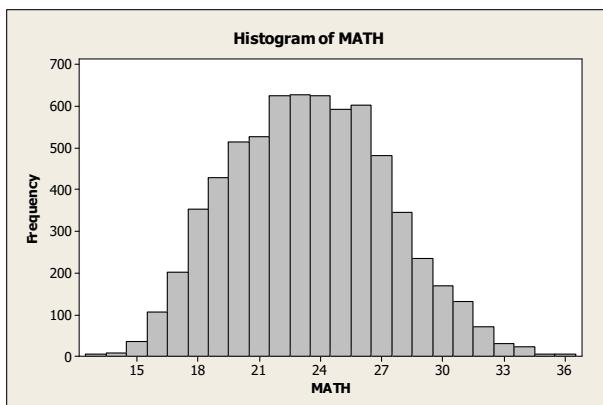
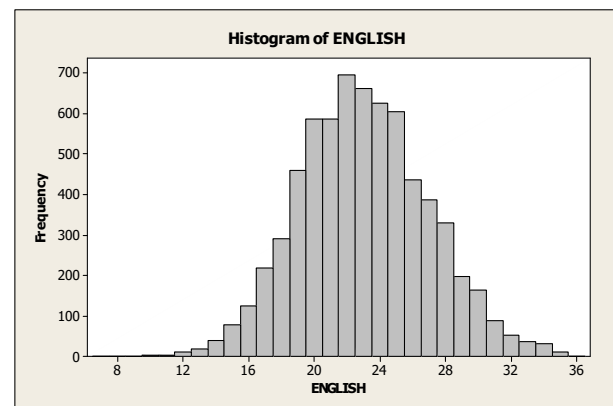
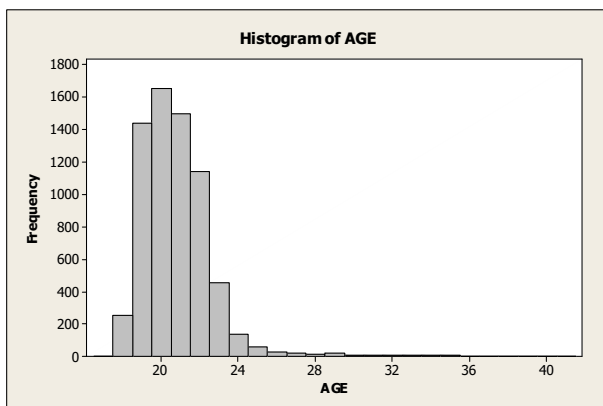
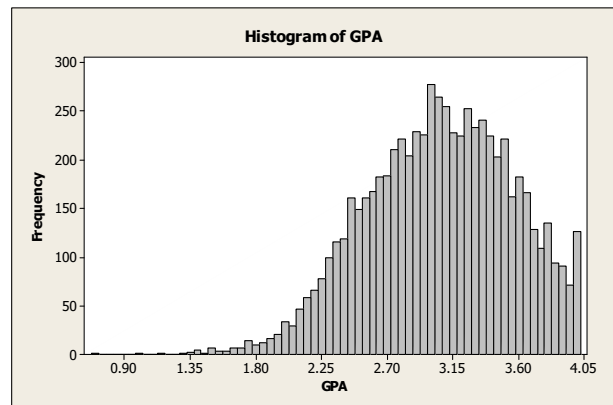
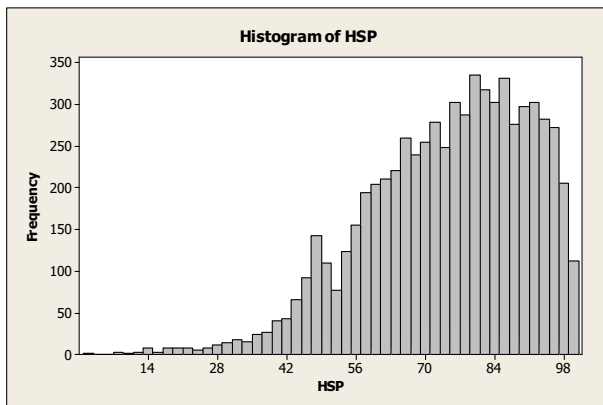
We use the *Menu commands* in Minitab to complete parts (a)-(e). The data sets in the Focus database and their names have already been stored in the file FOCUS.MTW on the WeissStats Resource Site supplied with the text.

- (a) UWEC is a school that attracts good students. HSP reflects pre-college experience and will tend to be left-skewed since fewer students with lower high school percentile scores will have been admitted, but exceptions are made for older students whose high school experience is no longer relevant. GPA will probably show left skewness tendencies since many, but not all, students with lower cumulative GPAs (below 2.0 on a 4-point scale) will likely have been suspended and will not appear in the database, but there are also upper limits on these scores, so the scores will tend to bunch up nearer to the high end than to the low end. AGE will be right skewed because there are few students below the typical 17-22 ages, but many above that range. ENGLISH, MATH, and COMP will be closer to bell-shaped. The ACT typically is taken only by high school students intending to go to college, and the scores are designed to roughly follow a bell-shaped curve. Individual colleges may, however, have a different profile that reflects their admission policies.
- (b) Using Minitab with FocusSample, choose **Graph < Histogram...**, select the **Simple** version, and Click **OK**. Then specify HSP GPA AGE ENGLISH MATH COMP in the **Graph variables** text box and click on the button for **Multiple Graphs**. Click on the button for **On separate graphs** and click **OK** twice. The results are



The graphs compare quite well with the educated guesses for all six variables.

- (d) Using Minitab with Focus, choose **Graph < Histogram...**, select the **Simple** version, and Click **OK**. Then specify HSP GPA AGE ENGLISH MATH COMP in the **Graph variables** text box and click on the button for **Multiple Graphs**. Click on the button for **On separate graphs** and click **OK** twice. The results are

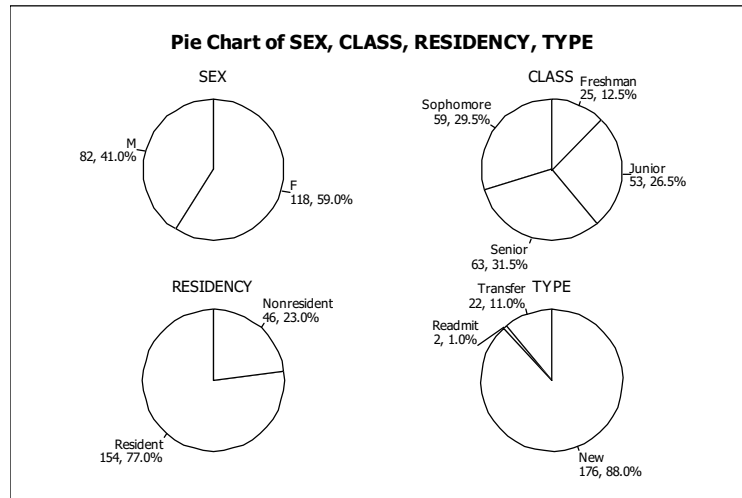


We were correct on the first five variables: HSP and GPA are left skewed, AGE is right skewed, ENGLISH and MATH are fairly symmetric. COMP is close to symmetric, but is slightly right skewed. Comparing the graphs for the sample with those for the entire population, we see similarities between each pair of graphs, but the outline of the histogram for the entire population is much smoother than that of the histogram for the sample.

- (d) Using Minitab and the FocusSample file, choose **Graph < Piechart**, click on the **Chart raw data** button, specify SEX CLASS RESIDENCY TYPE in the **Graph variables** text box and click on the **Labels** button. Now click on the tab for

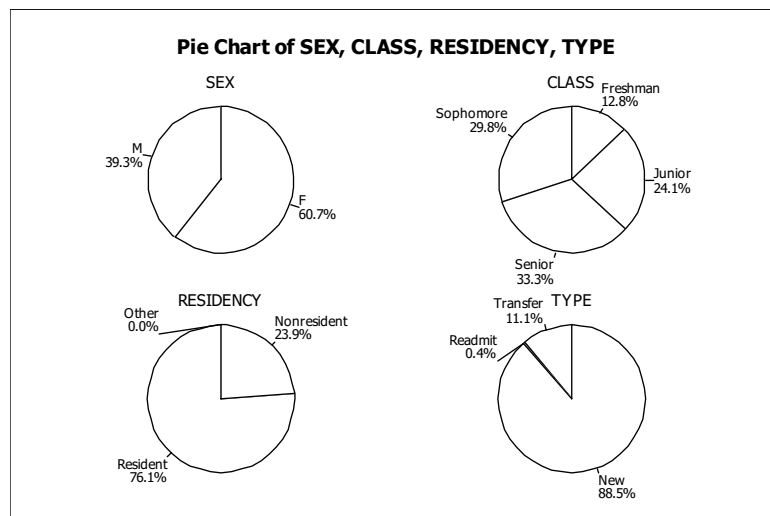
**Slice Labels**, check all four boxes and click **OK**, click on the button for **Multiple Graphs** and ensure that the button for **On the same graph** is checked, and click **OK** twice.

Once the graphs are displayed, we right clicked on the legend that was shown and selected **Delete** since we already had provided for each slice of the graphs to be labeled.



From the graph of SEX, we see that about 59% of the students are females. From the graph of CLASS, we see that the student sample is about 12.5% Freshmen, 29.5% Sophomores, 26.5% Juniors, and 31.5% Seniors. From the graph of RESIDENCY, we see that about 77% of the students are Wisconsin residents and 23% are nonresidents. From the graph of TYPE, we see that 88.0% of the students were admitted initially as new students, 11.0% were admitted initially as transfer students, and 1.0% are readmits, that is, students who were initially new or transfer students, left the university, and were later readmitted.

- (e) Now repeat part (d) using the entire Focus file. The results are



From the graph of SEX, we see that about 61% of the students are females. From the graph of CLASS, we see that the student population is about 13% Freshmen, 30% Sophomores, 24% Juniors, and 33% Seniors. From the graph of RESIDENCY, we see that about 76% of the students are Wisconsin residents and 24% are nonresidents. From the graph of TYPE, we see that 85.5% of the

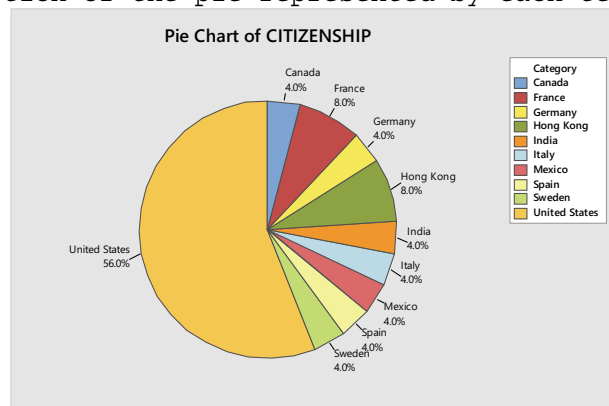
students were admitted initially as new students, 11.1% were admitted initially as transfer students, and 0.4% are readmits, that is, students who were initially new or transfer students, left the university, and were later readmitted. We would expect that the two sets of graphs would be approximately the same, but not identical since the sample contains only 200 students out of a population of 6738. This is, in fact, the case. The percentages in each sample graph are very close to the percentages in the corresponding population graph.

### **Case Study: World's Richest People**

- (a) The first column variable is Rank and is quantitative discrete. The second column variable is Name and is qualitative. The third column variable is age and it is quantitative continuous. The fourth column variable is Citizenship and is qualitative. The fifth column variable is Wealth and is quantitative discrete since money involves discrete units, such as dollars and cents. Although, for all practical purposes, Wealth might be considered quantitative continuous data.
- (b) The classes are the countries of citizenship and are presented in column 1. The frequency distribution of the champions is presented in column 2. Dividing each frequency by the total number of observations, which is 25, results in each class's relative frequency. The relative frequency distribution is presented in column 3.

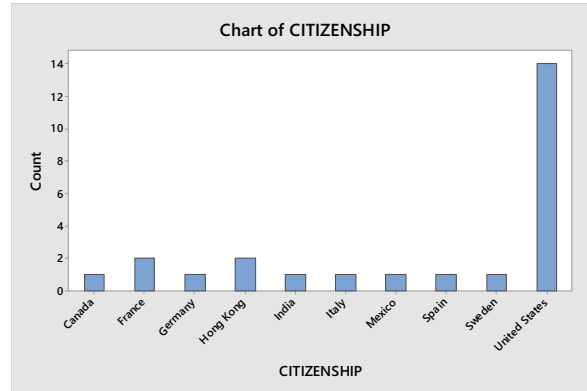
| Country       | Frequency | Relative Frequency |
|---------------|-----------|--------------------|
| Canada        | 1         | 0.04               |
| France        | 2         | 0.08               |
| Germany       | 1         | 0.04               |
| Hong Kong     | 2         | 0.08               |
| India         | 1         | 0.04               |
| Italy         | 1         | 0.04               |
| Mexico        | 1         | 0.04               |
| Spain         | 1         | 0.04               |
| Sweden        | 1         | 0.04               |
| United States | 14        | 0.56               |
|               | 25        | 1.00               |

- (c) We multiply each of the relative frequencies by 360 degrees to obtain the portion of the pie represented by each team. The result is



The United States is the most frequent country of citizenship amongst the world's richest. Otherwise, citizenship country seems to be randomly distributed.

- (d) We use the bar chart to show the relative frequency with which each COUNTRY occurs. The result is



The United States is the most frequent country of citizenship amongst the world's richest. Otherwise, citizenship country seems to be randomly distributed.

- (e) The first class to construct is "30 - 39". All of these classes are presented in column 1. The last class to construct is "90-99", since the largest data value is 93. Having established the classes, we tally the ages into their respective classes. These results are presented in column 2, which lists the frequencies. Dividing each frequency by the total number of observations, which is 25, results in the relative frequencies for each class which are presented in column 3.

| Age     | Frequency | Relative Frequency |
|---------|-----------|--------------------|
| 30 - 39 | 1         | 0.04               |
| 40 - 49 | 2         | 0.08               |
| 50 - 59 | 4         | 0.16               |
| 60 - 69 | 6         | 0.24               |
| 70 - 79 | 6         | 0.24               |
| 80 - 89 | 4         | 0.16               |
| 90 - 99 | 2         | 0.08               |
|         | 25        | 1.00               |

- (f) The frequency and relative-frequency histograms for age are constructed using the frequency and relative-frequency distribution presented in part (e); i.e. The lower class limits of column 1 are used to label the horizontal axis of the histograms. The heights of each bar in the frequency histogram in Figure (a) matches the respective frequency in column 2. The heights of each bar in the relative-frequency histogram in Figure (b) matches the respective relative-frequencies in column 3.

Figure (a)

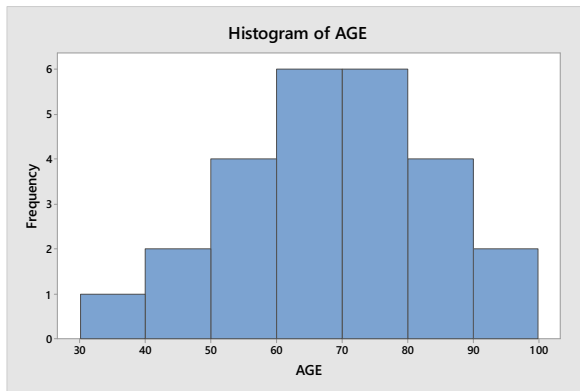
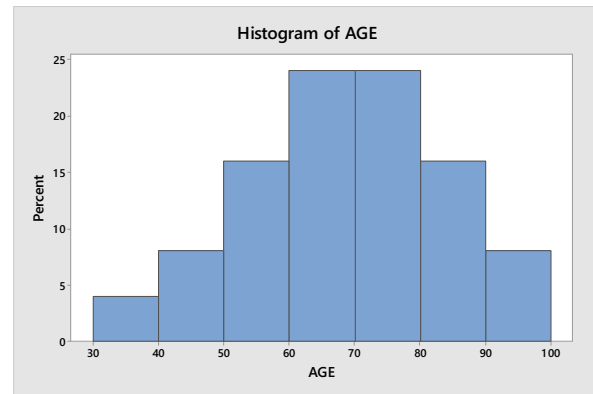


Figure (b)



(g) The shape of the distribution of age in part (e) is unimodal and is roughly symmetric.

(h) The stem-and-leaf diagram of age using one line per stem is

```

3 | 9
4 | 09
5 | 5678
6 | 345589
7 | 133779
8 | 2458
9 | 03

```

The stem-and-leaf diagram of age using two lines per stem is

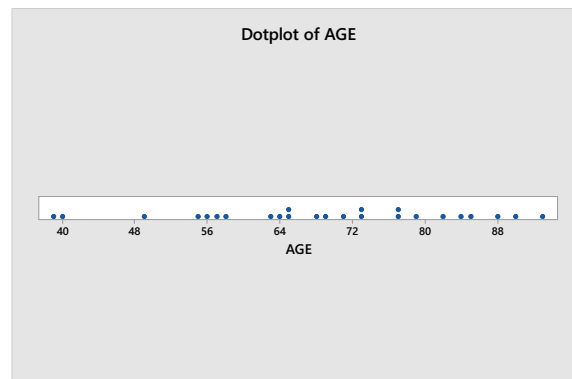
```

3 | 9
4 | 0
4 | 9
5 |
5 | 5678
6 | 34
6 | 5589
7 | 133
7 | 779
8 | 24
8 | 58
9 | 03

```

The stem-and-leaf diagram of age using one line per stem corresponds to the histogram in part (f).

(i) The dotplot for age is





- (j) The first class to construct is "20 - under 25". All of these classes are presented in column 1. The last class to construct is "70 - under 75", since the largest data value is 73. Having established the classes, we tally the into their respective classes. These results are presented in column 2, which lists the frequencies. Dividing each frequency by the total number of observations, which is 25, results in the relative frequencies for each class which are presented in column 3.

| Wealth<br>(\$ billions) | Frequency | Relative<br>Frequency |
|-------------------------|-----------|-----------------------|
| 20 - under 25           | 6         | 0.24                  |
| 25 - under 30           | 10        | 0.40                  |
| 30 - under 35           | 4         | 0.16                  |
| 35 - under 40           | 0         | 0.00                  |
| 40 - under 45           | 1         | 0.04                  |
| 45 - under 50           | 0         | 0.00                  |
| 50 - under 55           | 1         | 0.04                  |
| 55 - under 60           | 1         | 0.04                  |
| 60 - under 65           | 0         | 0.00                  |
| 65 - under 70           | 1         | 0.04                  |
| 70 - under 75           | 1         | 0.04                  |
|                         | 25        | 1.00                  |

- (k) The frequency and relative-frequency histograms for wealth are constructed using the frequency and relative-frequency distribution presented in part (j); i.e. The lower cutpoints of column 1 are used to label the horizontal axis of the histograms. The heights of each bar in the frequency histogram in Figure (a) matches the respective frequency in column 2. The heights of each bar in the relative-frequency histogram in Figure (b) matches the respective relative-frequencies in column 3.

Figure (a)

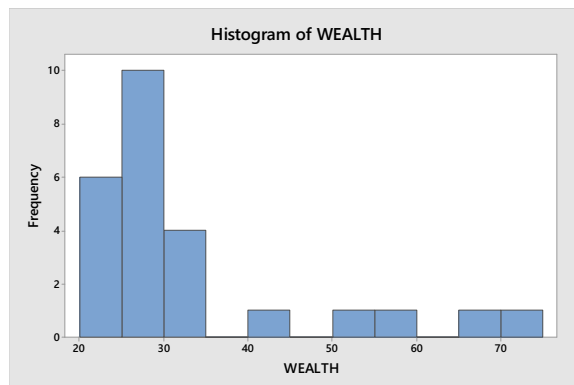
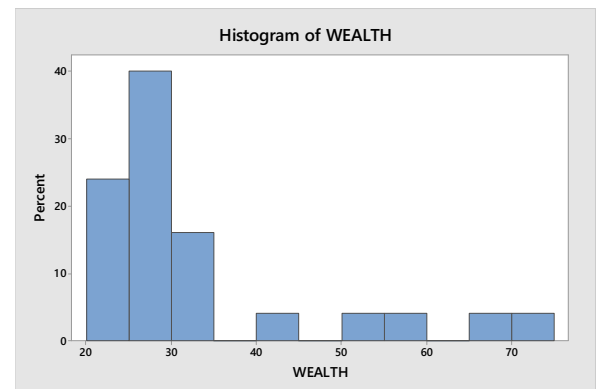


Figure (b)



- (l) The shape of the distribution of wealth in part (e) is unimodal and is not symmetric. The distribution of wealth is right skewed.

(m) Truncating wealth to a whole number, the stem-and-leaf diagram using two lines per stem is

|   |  |            |
|---|--|------------|
| 2 |  | 000123     |
| 2 |  | 5666667889 |
| 3 |  | 0144       |
| 3 |  |            |
| 4 |  | 3          |
| 4 |  |            |
| 5 |  | 3          |
| 5 |  | 7          |
| 6 |  |            |
| 6 |  | 7          |
| 7 |  | 3          |

(n) Rounding wealth to a whole number, the dotplot is

