A Review of Basic Concepts (Optional)

Chapter 1

1.1 a. High school GPA is a number usually between 0.0 and 4.0. Therefore, it is quantitative.

b. Country of citizenship: USA, Japan, etc. is qualitative.

c. The scores on the SAT's are numbers between 200 and 800. Therefore, it is quantitative.

d. Gender is either male or female. Therefore, it is qualitative.

e. Parent's income is a number: $25,000, $45,000, etc. Therefore, it is quantitative.

f. Age is a number: 17, 18, etc. Therefore, it is quantitative.

1.2 a. The experimental units are the new automobiles. The model name, manufacturer, type of transmission, engine size, number of cylinders, estimated city miles/gallon, and estimated highway miles/gallon are measured on each automobile.

b. Model name, manufacturer, and type of transmission are qualitative. None of these is measured on a numerical scale. Engine size, number of cylinders, estimated city miles/gallon, and estimated highway miles/gallon are all quantitative. Each of these variables is measured on a numerical scale.

1.3 Both the variables current position and type of organization are qualitative. The variable years of experience is quantitative because it is measured on a numerical scale.

1.4 The experimental units are the operational satellites currently in orbit around Earth. The variables country of operator/owner, primary use, and class of orbit are all qualitative because none are measured on a numerical scale. The variables longitudinal position, apogee, launch mass, usable electric power, and expected lifetime are all quantitative variables. All of these variables are measured on a numerical scale.

1.5 a. Species of sea buckthorn is a qualitative variable.

b. Altitude of collection location is a quantitative variable.

c. Total flavonoid content in berries is a quantitative variable.

1.6 Gender and level of education are both qualitative since neither is measured on a numerical scale. Age, income, job satisfaction score, and Machiavellian rating score are all quantitative since they can be measured on a numerical scale.

1.7 a. The population of interest is all decision makers. The sample set is 155 volunteer students. Variables measured were the emotional state and whether to repair a very old car (yes or no).

b. Subjects in the guilty-state group are less likely to repair an old car.

1.8 a. The data would represent the population. These data are all of the data that are of interest to the researchers.

b. If the 80 jamming attacks are actually a sample, then the population would be all jamming attacks by the U.S. military over the past several years.

1.9 a. The experimental units are the participants in the study.

b. The variables of interest are the price of the engagement ring and the level of appreciation. The price of the ring is quantitative, while the level of appreciation is qualitative.

c. The population of interest is average American engaged couples.

d. The sample of 33 respondents is probably not representative of the population. Only engaged couples who used a popular website for engaged couples were used. Those who used this website were probably not representative of all average American engaged couples.

1.10 a. The sample is the set of 505 teenagers selected at random from all U.S. teenagers.

b. The population from which the sample was selected is the set of all teenagers in the U.S.

c. Since the sample was a random sample, it should be representative of the population.

d. The variable of interest is the topics that teenagers most want to discuss with their parents.

e. The inference is expressed as a percent of the population that want to discuss particular topics with their parents.

f. The “margin of error” is the measure of reliability. This margin of error measures the uncertainty of the inference.

1.11 a. The population of interest is all young women who recently participated in a STEM program.

b. The sample is the 159 young women who were recruited to complete an online survey.

c. We would infer that 27% of all young women who recently participated in a STEM program felt that participation in the STEM program increased their interest in science.

1.12 a. The population of interest is the Machiavellian traits in accountants.

b. The sample is 198 accounting alumni of a large southwestern university.

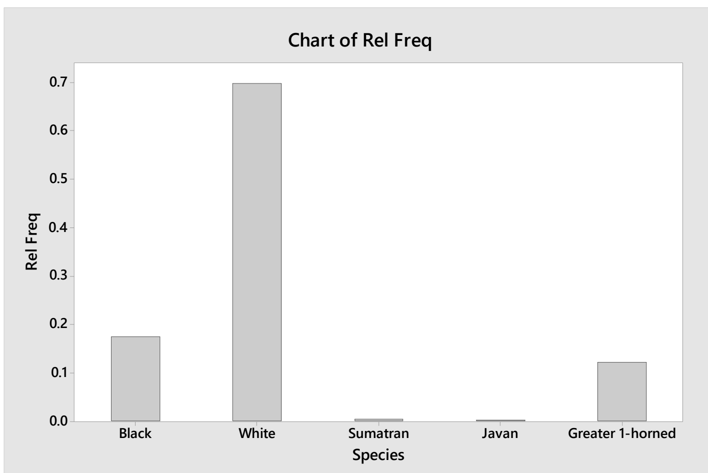
c. The Machiavellian behavior is not necessary to achieve success in the accounting profession.

d. Non-response could bias the results by not including potential other important information that could direct the researcher to a conclusion.

1.13 a. A relative frequency table is:

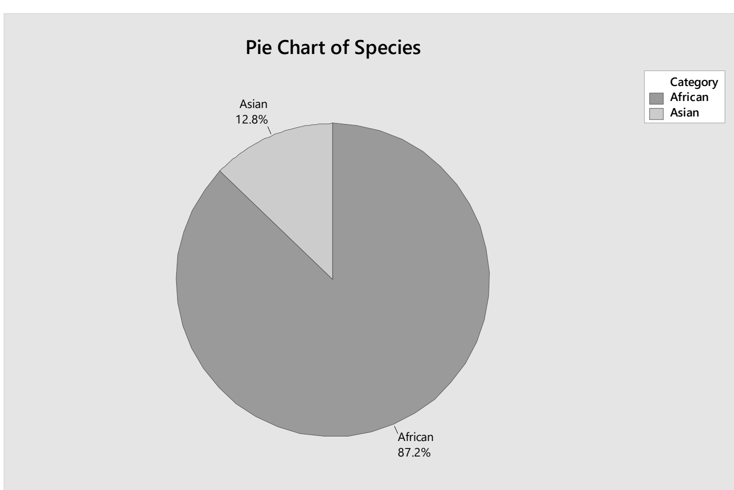
Rhino Species	**Frequency**	**Relative Frequency**
African Black	5,000	0.1745
African White	20,000	0.6978
(Asian) Sumatran	100	0.0035
(Asian) Javan	60	0.0021
(Asian) Greater One-Horned	3,500	0.1221
Total	28,660	1.000

b. Using MINITAB, the relative frequency bar graph is:



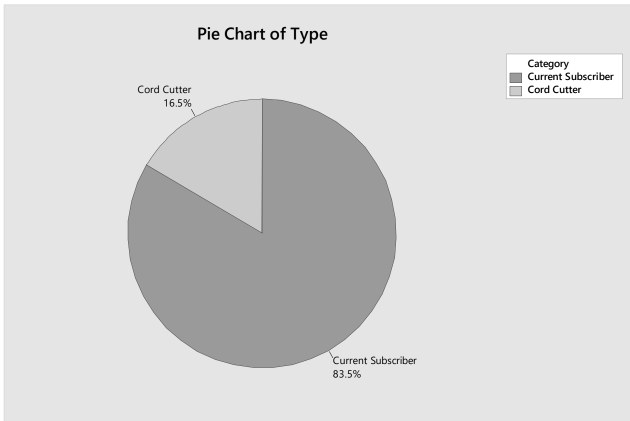
c. The proportion of African rhinos is $0.1745 + 0.6978 = 0.8723$. The proportion of Asian rhinos is $0.0035 + 0.0021 + 0.1221 = 0.1277$.

d. Using MINITAB, the pie chart for these proportions is:

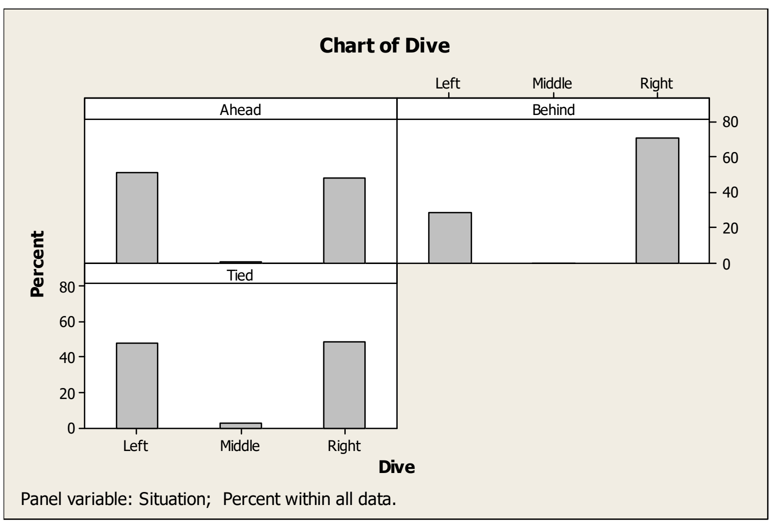


1.14 a. From the pie chart, 76.0% of the sample have a cable/satellite subscription at home. The proportion would be 0.76. This can be found by computing the relative frequency or $1,521/2,001 = 0.76$.

b. Using MINITAB, the pie chart is:



1.15 Using MINITAB, the side-by-side bar graphs are:



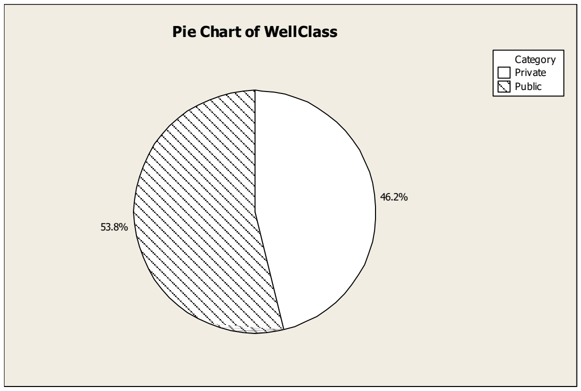
From the graphs, it appears that if the team is either tied or ahead, the goal-keepers tend to dive either right or left with equal probability, with very few diving in the middle. However, if the team is behind, then the majority of goal-keepers tend to dive right (71%).

1.16 a. $\frac{196}{504} = 0.3889$ is the proportion of ice melt ponds that had landfast ice.

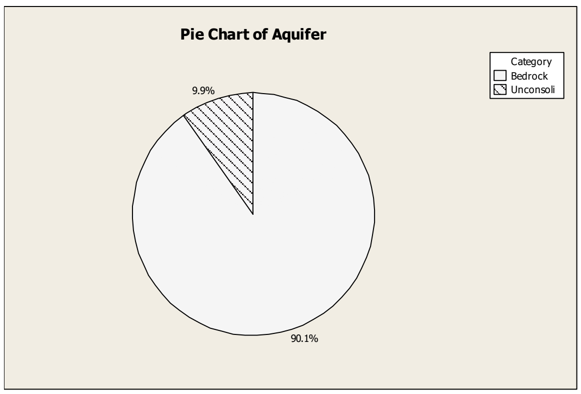
b. Yes, since $\frac{88}{504} = 0.1746$ is approximately 17%.

c. The multiyear ice type appears to be significantly different from the first-year ice melt.

1.17 a.


Pie Chart of WellClass
Category
Private
Public
46.2%
53.8%

b.


Pie Chart of Aquifer
Category
Bedrock
Unconsoli
9.9%
90.1%

c.

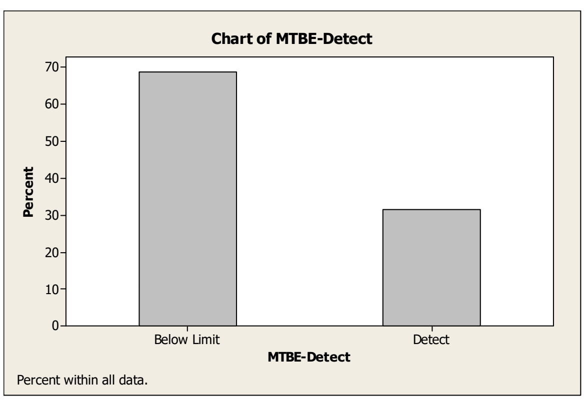
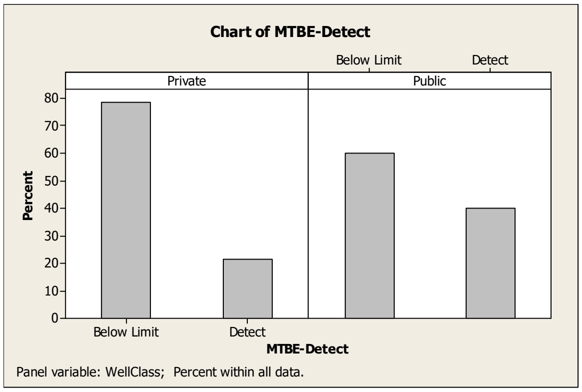


Chart of MTBE-Detect
Percent
70
60
50
40
30
20
10
0
Below Limit
Detect
MTBE-Detect
Percent within all data.

d.



Public wells (40%); Private wells (21%).

1.18 a. The estimated percentage of aftershocks measuring between 1.5 and 2.5 on the Richter scale is approximately 68%.

b. The estimated percentage of aftershocks measuring greater than 3.0 on the Richter scale is approximately 12%.

c. The data are skewed right.

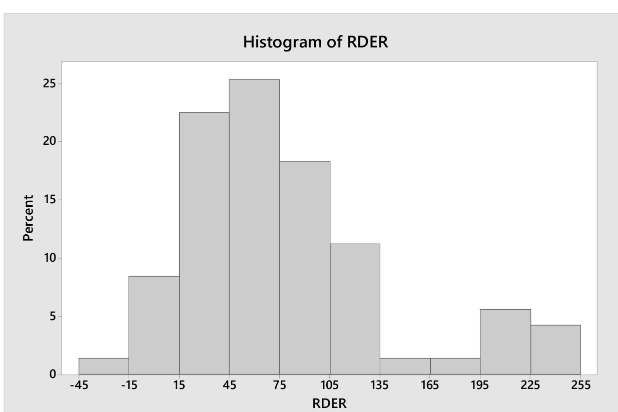
1.19 a. The graph is a frequency histogram.

b. The quantitative variable summarized in the graph is the fup/fumic ratio.

c. The proportion of ratios greater than 1 is $\frac{8+5+1}{416}=\frac{14}{416}=0.034$.

d. The proportion of ratios less than 0.4 is $\frac{181+108}{416}=\frac{289}{416}=.695$.

1.20 a. Using MINITAB, the frequency histogram is:



b. From the graph, it appears that about 0.18 of the RDER values are between 75 and 105.

c. From the graph, it appears that about 0.10 of the RDER values are below 15.

1.21 The tem-and-leaf display with the leaves for the honey dosage group bolded.

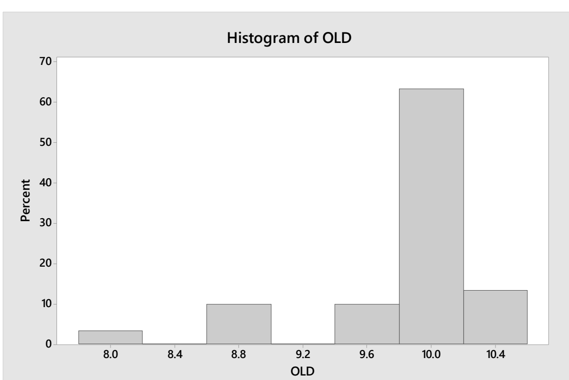
Stem-and-leaf of TotalScore N = 105

1	0	0
4	1	000
4	2	
7	3	000
16	4	000000000
20	5	0000
28	6	00000000
41	7	0000000000000
52	8	00000000000
(13)	9	0000000000000
40	10	0000000000
30	11	000000
24	12	0000000000000
11	13	0000
7	14	0
6	15	00000
1	16	0

Leaf Unit = 0.1

Yes. Most of the scores for the honey dosage tend to be higher than the other treatments.

1.22 a. Using MINITAB, the frequency histogram is:

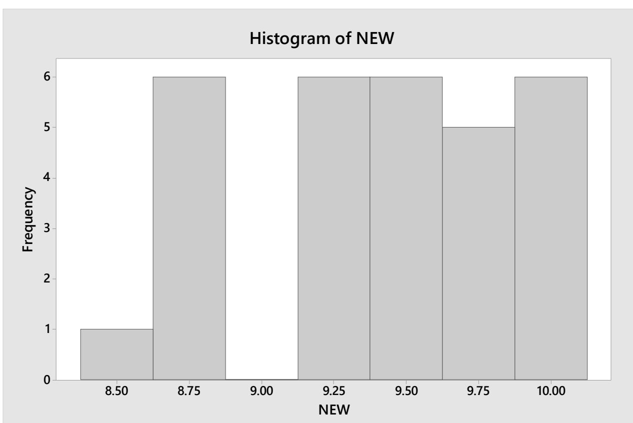


b. Using MINITAB, the stem-and-leaf display is:

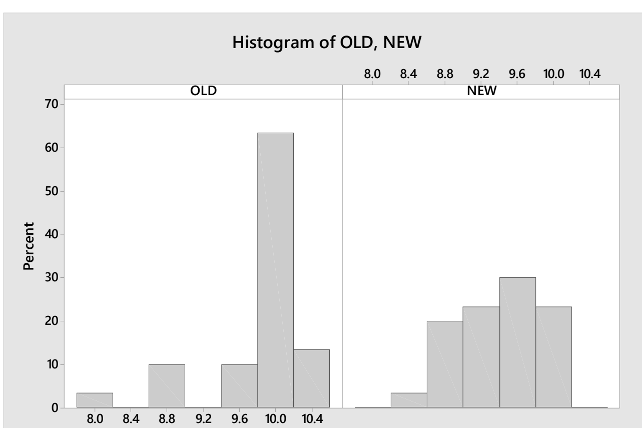
```
Stem-and-leaf of VOLTAGE LOCATION_OLD = 1 N = 30
Leaf Unit = 0.10
1     8   0
1     8
1     8
3     8   77
4     8   8
4     9
4     9
5     9   5
7     9   77
(10)  9   8888889999
13    10  000000111
4     10  222
1     10  5
```

The stem-and-leaf is more informative since the actual values of the old location can be found. The histogram is useful if shape and spread of the data is what is needed, but the actual data points are absorbed in the graph.

c. Using MINITAB, the frequency histogram is:



d. Side-by-side graphs are:



The old process appears to be better than the new process. For the old process, only about 0.13 of the observations are less than 9.2. For the new process, about 0.3 of the observations are below 9.2.

1.23 a. Using MINITAB, the stem-and-leaf display is:

Stem-and-leaf of Score N = 194

1	6	1
1	6	
1	7	
3	7	88
5	8	24
24	8	6667777788889999999
83	9	00000000001111112222222222222223333333333344444444444444444
(84)	9	55555555555555555555666666666666666667777777777777777777777788888888889999999999+
27	10	000000000000000000000000000

Leaf Unit = 1

b. Of the 194 observations, 189 have acceptable standard of sanitation scores. The proportion is $\frac{189}{194} = 0.974$.

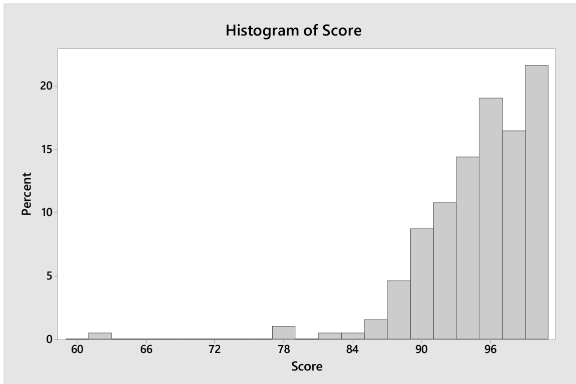
c. The score of 78 is highlighted in bold below.

Stem-and-leaf of Score N = 194

1	6	1
1	6	
1	7	
3	7	**8**8
5	8	24
24	8	6667777788889999999
83	9	00000000001111112222222222222223333333333344444444444444444
(84)	9	55555555555555555555666666666666666667777777777777777777777788888888889999999999+
27	10	000000000000000000000000000

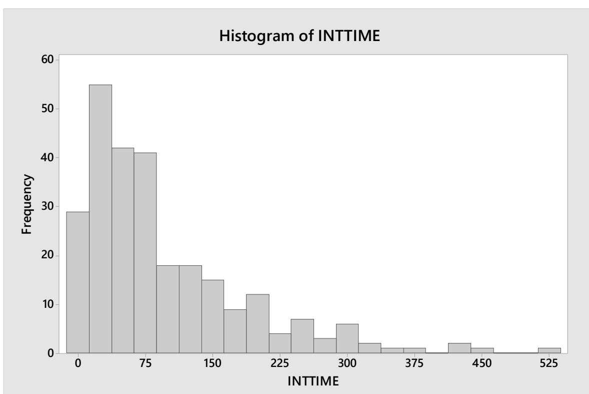
Leaf Unit = 1

d. Using MINITAB, the histogram of the data is:



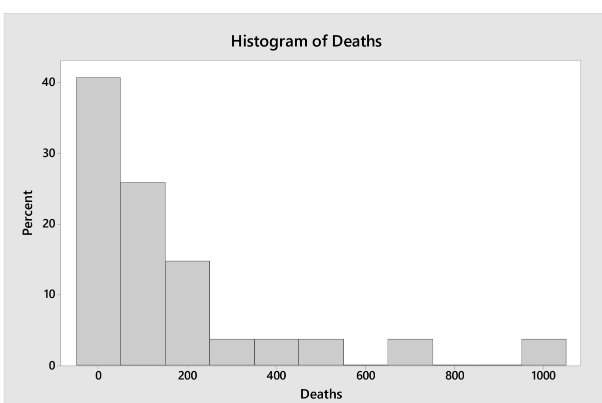
e. The proportion of ships with acceptable sanitation scores is about 0.97.

1.24 Using MINITAB, the histogram is:



The data are skewed right. Answers may vary on whether the phishing attack against the organization was an "inside job."

1.25 a. Using MINITAB, the histograms of the number of deaths is:



b. The interval containing the largest proportion of estimates is 0-50. Almost half of the estimates fall in this interval.

1.26 a. The sample mean is:

$$\bar{y} = \frac{\sum y}{n} = \frac{1+2+3+1+5+6+2+4+1+2+4+2+9}{13} = \frac{42}{13} = 3.231$$

b. The sample variance is:

$$s^2 = \frac{\sum y^2 - \frac{\left(\sum y\right)^2}{n}}{n-1} = \frac{202 - \frac{42^2}{13}}{13-1} = 5.526$$

The standard deviation is: $s = \sqrt{5.526} = 2.351$

c. Using Tchebysheff's Theorem, at least 75% of the observations will fall within 2 standard deviations of the mean. This interval is:
$\bar{y} \pm 2s \Rightarrow 3.231 \pm 2(2.351) \Rightarrow 3.231 \pm 4.702 \Rightarrow (-1.471, 7.933)$
At least 75% of all shaft graves will contain between 0 and 7 sword shafts.

1.27 a. $\bar{y} = 2.12$; The average magnitude for the aftershocks is 2.12.

b. Range = 6.7. The difference between the largest and smallest magnitude is 6.7.

c. $s = 0.66$; About 95% of the magnitudes fall in the interval
$\bar{y} \pm 2s \Rightarrow 2.1197 \pm 2(0.6636) \Rightarrow 2.1197 \pm 1.3272 \Rightarrow (0.79, 3.44)$

d. $\mu =$ mean; $\sigma =$ Standard deviation

1.28 a. The mean RDER score is 78.1885. On average, subjects make 78.19 more error under the irrelevant background speech than under silence.

b. From the histogram in Exercise 1.20, it appears that the data are approximately mound-shaped. By the rule of thumb, approximately 95% of the observations will fall within 2 standard deviations of the mean.

c. We would expect approximately 95% of the observations to fall within the following interval:
$\bar{y} \pm 2s \Rightarrow 78.19 \pm 2(63.24) \Rightarrow 78.19 \pm 126.48 \Rightarrow (-48.29, 204.67)$

1.29 a. Using MINITAB, the descriptive statistics are:

Statistics

Variable	N	Mean	StDev	Minimum	Maximum
Score	194	94.474	4.897	61.000	100.000

$\bar{y} = 94.474$, $s = 4.897$

b. $\bar{y} \pm 2s \Rightarrow 94.474 \pm 2(4.897) \Rightarrow 94.474 \pm 9.794 \Rightarrow (84.680, 104.268)$

c. The percentage of scores that fall in the interval is $\frac{189}{194}(100\%) = 97.42\%$. This number is agrees with the rule of thumb which says that approximately 95% of the observations will fall within 2 standard deviations of the mean.

1.30 a. The average score for Energy Star is 4.44. The average score is close to 5 meaning the average score is close to 'very familiar'.

b. The ecolabel that had the most variation in the numerical responses is Audubon International because it has the largest standard deviation.

c. The interval would be
$\bar{y} \pm 2s \Rightarrow 4.44 \pm 2(0.82) \Rightarrow 4.44 \pm 1.64 \Rightarrow (2.80, 6.08)$

1.31 a. $z = \frac{293 - 353}{30} = -2$ A score of 293 would be 2 standard deviations below the mean.

$z = \frac{413 - 353}{30} = 2$ A score of 413 would be 2 standard deviations above the mean.

Using Tchebysheff's Theorem, at least 3/4 of the observations will be within 2 standard deviations of the mean.

b. For a mound-shaped, symmetric distribution, approximately 95% of the observations will be within 2 standard deviations of the mean, using the rule of thumb.

c. $z = \frac{134 - 184}{25} = -2$ A score of 134 would be 2 standard deviations below the mean.

$z = \frac{234 - 184}{25} = 2$ A score of 234 would be 2 standard deviations above the mean.

Using Tchebysheff's Rule, at least 3/4 of the observations will be within 2 standard deviations of the mean.

d. For a mound-shaped, symmetric distribution, approximately 95% of the observations will be within 2 standard deviations of the mean, using the rule of thumb.

1.32 We will find intervals within 2 standard deviations for each group.
Group T: $\bar{y} \pm 2s \Rightarrow 10.5 \pm 2(7.6) \Rightarrow 10.5 \pm 15.2 \Rightarrow (-4.7, 25.7)$
Group V: $\bar{y} \pm 2s \Rightarrow 3.9 \pm 2(7.5) \Rightarrow 3.9 \pm 15.0 \Rightarrow (-11.1, 18.9)$
Group C: $\bar{y} \pm 2s \Rightarrow 1.4 \pm 2(7.5) \Rightarrow 1.4 \pm 15.0 \Rightarrow (-13.6, 16.4)$
Since the only interval that contains 22.5 is the interval for Group T, the patient is most likely to have come from Group T.

1.33 a. Using Table 1, Appendix D:
$P(-1 \le z \le 1) = P(-1 \le z \le 0) + P(0 \le z \le 1) = 0.3413 + 0.3413 = 0.6826$

b. $P(-1.96 \le z \le 1.96) = P(-1.96 \le z \le 0) + P(0 \le z \le 1.96) = 0.4750 + 0.4750 = 0.9500$

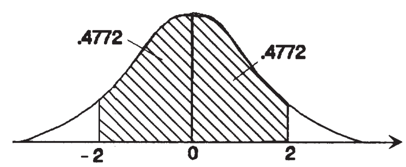
c. Since 1.645 is half way between 1.64 and 1.65 in the table, we will use halfway between the corresponding areas. Halfway between the 2 areas is $\frac{0.4495 + 0.4505}{2} = \frac{0.9}{2} = 0.4500$

$P(-1.645 \le z \le 1.645) = P(-1.645 \le z \le 0) + P(0 \le z \le 1.645) = 0.4500 + 0.4500 = 0.9000$

d. $P(-3 \le z \le 3) = P(-3 \le z \le 0) + P(0 \le z \le 3) = 0.4987 + 0.4987 = 0.9974$

1.34 a. The z-score for $\mu - 2\sigma$ is $z = \frac{(\mu - 2\sigma) - \mu}{\sigma} = -2$.

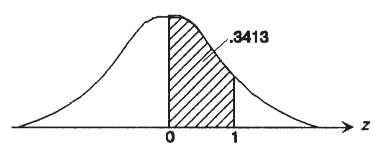
The z-score for $\mu + 2\sigma$ is $z = \frac{(\mu + 2\sigma) - \mu}{\sigma} = 2$.



$P(\mu - 2\sigma \le y \le \mu + 2\sigma) = P(-2 \le z \le 2)$
$= P(-2 \le z \le 0) + P(0 \le z \le 2)$

Using Table 1 in Appendix D, $P(-2 \le z \le 0) = 0.4772$ and $P(0 \le z \le 2) = 0\ .4772$.
So $P(\mu - 2\sigma \le y \le \mu + 2\sigma) = 0\ .4772 + 0\ .4772 = 0.9544$

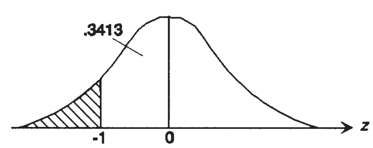
b. The z-score for $y = 108$ is $z = \frac{y - \mu}{\sigma} = \frac{108 - 100}{8} = 1$.



$P(y \ge 108) = P(z \ge 1)$

Using Table 1 of Appendix D, we find $P(0 \le z \le 1) = 0.3413$.
so $P(z \ge 1) = 0.5 - 0.3413 = 0.1587$

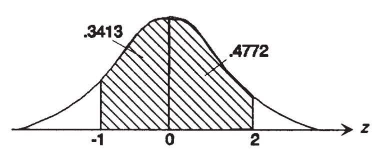
c. The z-score for $y = 92$ is $z = \frac{y - \mu}{\sigma} = \frac{92 - 100}{8} = -1$.



$P(y \le 92) = P(z \le -1)$

Using Table 1 of Appendix D, we find
$P(-1 \le z \le 0) = 0.3413$,
so $P(z \le -1) = 0.5 - 0.3413 = 0.1587$

d. The z-score for $y = 92$ is $z = \frac{y - \mu}{\sigma} = \frac{92 - 100}{8} = -1$.



The z-score for $y = 116$ is $z = \dfrac{y-\mu}{\sigma} = \dfrac{116-100}{8} = 2.$

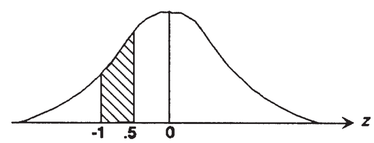
$P(92 \le y \le 116) = P(-1 \le z \le 2)$

Using Table 1 of Appendix D, $P(-1 \le z \le 0) = 0.3413$ and $P(0 \le z \le 2) = 0.4772$. So $P(92 \le y \le 116) = P(-1 \le z \le 2)$
$= 0.3413 + 0.4772 = 0.8185.$

e. The z-score for $y = 92$ is $z = \dfrac{y-\mu}{\sigma} = \dfrac{92-100}{8} = -1.$

The z-score for $y = 96$ is $z = \dfrac{y-\mu}{\sigma} = \dfrac{96-100}{8} = -0.5.$

$P(92 \le y \le 96) = P(-1 \le z \le -.5)$

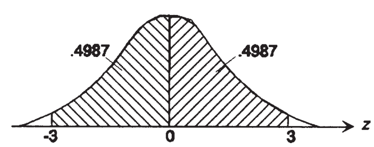


Using Table 1 of Appendix D, $P(-1 \le z \le 0) = 0.3413$ and $P(-0.5 \le z \le 0) = 0.1915$. So $P(92 \le y \le 96)$
$= P(-1 \le z \le -0.5) = 0.3413 - 0.1915 = 0.1498.$

f. The z-score for $y = 76$ is $z = \dfrac{y-\mu}{\sigma} = \dfrac{76-100}{8} = -3.$

The z-score for $y = 124$ is $z = \dfrac{y-\mu}{\sigma} = \dfrac{124-100}{8} = 3.$

$P(76 \le y \le 124) = P(-3 \le z \le 3)$



Using Table 1 of Appendix D, $P(-3 \le z \le 0) = 0.4987$ and $P(0 \le z \le 3) = 0.4987$. So $P(76 \le y \le 124) = P(-3 \le z \le 3) = 0.4987 + 0.4987 = 0.9974.$

1.35 a. Using Table 1, Appendix D:

$P(y > 4) = P\left(z > \dfrac{4-4.44}{0.82}\right) = P(z > -0.54) = P(-0.54 < z < 0) + P(z > 0)$
$= 0.2054 + 0.5 = 0.7054$

b. $P(2 < y < 4) = P\left(\dfrac{2-4.44}{0.82} < z < \dfrac{4-4.44}{0.82}\right) = P(-2.98 < z < -0.54)$
$= P(-2.98 < z < 0) - P(-0.54 < z < 0) = 0.4986 - 0.2054 = 0.2932$

c. $P(y \le 1) = P\left(z \le \dfrac{1-4.44}{0.82}\right) = P(z < -4.20) = P(z < 0) - P(-4.20 < z < 0) \approx 0.5 - 0.5 = 0$

Since the probability of observing a value of 1 or less is so small, it would be extremely unlikely that the ecolabel shown was *Energy Star*.

1.36 a. Using Table 1, Appendix D:

$$P(y<400)=P\left(z<\frac{400-353}{30}\right)=P(z<1.57)=P(0<z<1.57)+P(z<0)$$
$$=0.4418+0.5=.9418$$

b. $$P(y>100)=P\left(z>\frac{100-184}{25}\right)=P(z>-3.36)=P(-3.36<z<0)+P(z>0)$$
$$\approx 0.5+0.5=1.0$$

1.37 a. Using Table 1, Appendix D:

$$P(y\geq 60)=P\left(z\geq\frac{60-59}{5}\right)=P(z\geq 0.2)=P(z\geq 0)-P(0<z<0.2)$$
$$=0.5-0.0793=0.4207$$

b. $$P(y\geq 60)=P\left(z\geq\frac{60-43}{5}\right)=P(z\geq 3.4)=P(z\geq 0)-P(0<z<3.4)\approx 0.5-0.5=0$$

1.38 We want to find y_1 and y_2 such that $P(y_1<y<y_2)=0.90$. First, we must find z_1 and z_2 such that $P(z_1<z<z_2)=0.90$. By symmetry, we know that $P(z_1<z<0)=P(0<z<z_2)=0.90/2=0.4500$. Using Table 1, Appendix D, $z_1=-1.645$ and $z_2=1.645$.

$$z_1=\frac{y_1-\mu}{\sigma}\Rightarrow -1.645=\frac{y_1-64}{2.6}\Rightarrow y_1=64-1.645(2.6)=64-4.277=59.723$$
$$z_2=\frac{y_2-\mu}{\sigma}\Rightarrow 1.645=\frac{y_2-64}{2.6}\Rightarrow y_2=64+1.645(2.6)=64+4.277=68.277$$

Thus, the interval would be $(59.723, 68.277)$.

1.39 For *Tunnel Face*,

$$P(y\leq 1)=P\left(z\leq\frac{1-1.2}{0.16}\right)=P(z\leq -1.25)=0.5-P(-1.25\leq z<0)=0.5-0.3944=0.1056$$

For *Tunnel Walls*,

$$P(y\leq 1)=P\left(z\leq\frac{1-1.4}{0.20}\right)=P(z\leq -2.00)=0.5-P(-2.00\leq z<0)=0.5-0.4772=0.0228$$

For *Tunnel Crown*,

$$P(y\leq 1)=P\left(z\leq\frac{1-2.1}{0.70}\right)=P(z\leq -1.57)=0.5-P(-1.57\leq z<0)=0.5-0.4418=0.0582$$

The probability of failing for *Tunnel Face* is larger than the probabilities of failure for the other two areas. Thus, *Tunnel Face* is more likely to result in failure.

1.40 We have to find the probability of observing $y = 0.7$ or anything more unusual given the two different values of μ.

Without receiving executive coaching: Using Table I, Appendix D with $\mu = 0.75$ and $\sigma = 0.085$,

$$P(y \le 0.7) = P\left(z \le \frac{0.7 - 0.75}{0.085}\right) = P(z \le -0.59) = 0.5 - 0.2224 = 0.2776.$$

After receiving executive coaching: Using Table II, Appendix D with $\mu = 0.52$ and $\sigma = 0.075$,

$$P(y \ge 0.7) = P\left(z \ge \frac{0.7 - 0.52}{0.075}\right) = P(z \ge 2.40) = 0.5 - 0.4918 = 0.0082.$$

Since the probability of observing $y \le 0.7$ for those not receiving executive coaching is much larger than the probability of $y \ge 0.7$ for those receiving executive coaching, it is more likely that the leader did not receive executive coaching.

1.41 a. The relative frequency distribution is:

Value	**Frequency**	**Relative Frequency**
0	26	26/300 = 0.087
1	30	30/300 = 0.100
2	24	0.080
3	29	0.097
4	31	0.103
5	25	0.083
6	42	0.140
7	36	0.120
8	27	0.090
9	30	0.100
	300	1.000

b. $$\bar{y} = \frac{\sum y}{n} = \frac{1404}{300} = 4.68$$

c. $$s^2 = \frac{\sum y^2 - \frac{\left(\sum y\right)^2}{n}}{n-1} = \frac{8942 - \frac{1404^2}{300}}{300-1} = 7.9307$$

d. The 50 sample means are:

4.8333	4.5000	4.5000	5.6667
4.6667	5.0000	4.1667	5.0000
5.1667	4.6667	5.3333	4.1667
4.5000	5.3333	3.8333	2.5000
5.6667	3.8333	4.3333	2.6667
5.0000	4.1667	4.8333	5.5000
7.3333	4.0000	3.5000	2.1667
5.8333	3.3333	3.5000	7.0000
4.0000	4.3333	6.8333	5.8333

6.1667	4.0000	6.8333	2.6667
3.1667	3.8333	5.8333	5.6667
4.8333	5.1667	3.8333	5.5000
5.5000	3.5000		

The frequency distribution for $\bar{y}$ is:

Sample Mean	Frequency	Relative Frequency
2.000 – 2.999	4	4/50 = 0.08
3.000 – 3.999	9	9/50 = 0.18
4.000 – 4.999	16	0.32
5.000 – 5.999	16	0.32
6.000 – 6.999	3	0.06
7.000 – 7.999	2	0.04
	50	1.00

The mean of the sample means is $\bar{\bar{y}} = \frac{\sum \bar{y}}{n} = \frac{234}{50} = 4.68$.

$$s_{\bar{y}}^2 = \frac{\sum \bar{y}^2 - \frac{\left(\sum \bar{y}\right)^2}{n}}{n-1} = \frac{1{,}162.5 - \frac{234^2}{50}}{50-1} = 1.3751, \quad s_{\bar{y}} = \sqrt{1.375} = 1.1726$$

1.42 a. The twenty-five means are:

4.7500	4.0833	6.8333
4.8333	3.8333	4.8333
5.3333	3.9167	5.3333
6.5833	4.3333	3.3333
5.0833	4.3333	4.0833
4.0000	4.5833	4.5833
5.0000	4.5833	4.2500
4.8333	3.5000	5.5833
4.5833		

Using the same intervals as in Exercise 1.41, the frequency distribution for $\bar{y}$ is:

Sample Mean	Frequency	Relative Frequency
2.000 – 2.999	0	0/25 = 0.00
3.000 – 3.999	4	4/25 = 0.16
4.000 – 4.999	14	0.56
5.000 – 5.999	5	0.20
6.000 – 6.999	2	0.08
7.000 – 7.999	0	0.00
	25	1.00

This distribution is not as spread out as that in Exercise 1.41.

b. $\bar{\bar{y}} = \dfrac{\sum \bar{y}}{n} = \dfrac{117}{25} = 4.68$

$$s_{\bar{y}}^2 = \frac{\sum \bar{y}^2 - \frac{\left(\sum \bar{y}\right)^2}{n}}{n-1} = \frac{563.972222 - \frac{117^2}{25}}{25-1} = 0.68384, \quad s_{\bar{y}} = \sqrt{0.68384} = 0.8269$$

The variance for Exercise 1.41 is $s_{\bar{y}} = \sqrt{1.375} = 1.1726$. The standard deviation for this exercise is less than the standard deviation in Exercise 1.41 because the standard deviation in Exercise 1.41 is based on samples of size 6, while the standard deviation in this Exercise is based on samples of size 12. As the sample size increases, the spread of the distribution will decrease.

1.43 a. For $df = n-1 = 10-1 = 9,\ t_0 = 2.262$ yields $P(t > t_0) = 0.025$.

b. For $df = n-1 = 5-1 = 4,\ t_0 = 3.747$ yields $P(t > t_0) = 0.01$.

c. For $df = n-1 = 20-1 = 19,\ t_0 = -2.861$ yields $P(t \le t_0) = 0.005$.

d. For $df = n-1 = 12-1 = 11,\ t_0 = -1.796$ yields $P(t \le t_0) = 0.05$.

1.44 a. For confidence coefficient 0.95, $\alpha = 0.05$ and $\alpha / 2 = 0.05/2 = 0.025$. From Table 1, Appendix D, $z_{.025} = 1.96$.

b. We are 95% confident that the true mean HRV for all officers diagnosed with hypertension is between 4.1 and 124.5.

We are 95% confident that the true mean HRV for all officers who are not hypertensive is between 148.0 and 192.6.

c. 95% confidence means that in repeated sampling, 95% of all confidence intervals constructed in the same manner will contain the true mean.

d. To reduce the width of the confidence interval, we would use a smaller confidence coefficient. A smaller confidence coefficient corresponds to a smaller level of confidence. The lower the level of, confidence, the smaller the interval.

1.45 a. $E(\bar{y}) = \mu_{\bar{y}} = \mu = 0.10 \quad Var(\bar{y}) = \dfrac{\sigma^2}{n} = \dfrac{(0.10)^2}{50} \cong 0.0002$

$$\sigma_{\bar{y}} = \frac{s}{\sqrt{n}} = \frac{0.10}{\sqrt{50}} \cong 0.0141$$

b. Since the sample size is greater than 30, the sample distribution of $\bar{y}$ is approximately normal by The Central Limit Theorem.

c. $$P(\bar{y} > 0.13) = P\left(Z > \frac{0.13 - 0.10}{\frac{0.10}{\sqrt{50}}}\right) = P(Z > 2.12) = 0.50 - 0.4830 = 0.0170$$

1.46 a. The parameter of interest for this study is the mean effect size, μ, for all psychological studies of personality and aggressive behavior.

b. It appears to be approximately normal with a few high outliers. Since the sample size is large, the Central Limit Theorem ensures that the data for the average is normally distributed.

c. We can be 95% confident that the interval (0.4786, 0.8167) encloses μ , the true mean effect size.

d. Yes, the researcher can conclude that those who score high on the personality test are more aggressive since 0 is not included in the interval.

1.47 a. $$\bar{y} = \frac{\sum y}{n} = \frac{365}{8} = 45.625$$

b. $$s^2 = \frac{\sum y^2 - \frac{\left(\sum y\right)^2}{n}}{n-1} = \frac{16{,}957 - \frac{\left(\sum 365\right)^2}{8}}{8-1} = 43.410714, \quad s = \sqrt{43.410714} = 6.5887$$

c. For confidence coefficient 0.95, $\alpha = 0.05$ and $\alpha/2 = 0.05/2 = 0.025$. From Table 2, Appendix D, with $df = n-1 = 8-1 = 7$, $t_{0.025} = 2.365$. The 95% confidence interval is:

$$\bar{y} \pm t_{0.025}\frac{s}{\sqrt{n}} \Rightarrow 45.625 \pm 2.365\frac{6.5887}{\sqrt{8}} \Rightarrow 45.625 \pm 5.509 \Rightarrow (40.116, 51.134)$$

d. In order for the interval to be valid, the distribution of all PAI values for music performance anxiety studies must be approximately normal.

e. In repeated sampling, 95% of all intervals constructed will contain the true mean value of μ.

1.48 For confidence coefficient 0.95, $\alpha = 0.05$ and $\alpha/2 = 0.05/2 = 0.025$. From Table 1, Appendix D, $z_{.025} = 1.96$. The 95% confidence interval is:

$$\bar{y} \pm z_{0.025}\frac{\sigma}{\sqrt{n}} \Rightarrow 112 \pm 1.96\frac{560}{\sqrt{2{,}617}} \Rightarrow 112 \pm 21.456 \Rightarrow (90.544, 133.456)$$

We are 95% confident that the true mean tipping point of all daily deal offerings in Korea is between 90.544 and 133.456.

1.49 a. $E(y) = \mu_{\bar{y}} = \mu = 99.6$

b. For confidence coefficient 0.95, $\alpha = 0.05$ and $\alpha / 2 = 0.05 / 2 = 0.025$. From Table 1, Appendix D, $z_{0.025} = 1.96$.

$$\bar{y} \pm z_{0.025}\left(s_{\bar{y}}\right) = \bar{y} \pm z_{0.025}\left(\frac{s}{\sqrt{n}}\right) = 99.6 \pm 1.96\left(\frac{12.6}{\sqrt{122}}\right) = 99.6 \pm 2.2 \Rightarrow (97.4, 101.8)$$

c. We are 95% confident that the true mean Mach rating score is between 97.4 and 101.8.

d. Yes, since the value of 85 is not contained in the confidence interval it is unlikely that the true mean Mach rating score could be 85.

1.50 a. For confidence coefficient 0.90, $\alpha = 0.10$ and $\alpha / 2 = 0.10 / 2 = 0.05$. From Table 1, Appendix D, $z_{0.05} = 1.645$. The 90% confidence interval is:

$$\bar{y} \pm z_{0.05}\frac{\sigma}{\sqrt{n}} \Rightarrow 2.42 \pm 1.645\frac{2.84}{\sqrt{86}} \Rightarrow 2.42 \pm 0.504 \Rightarrow (1.916, 2.924)$$

b. We are 90% confident that the true mean intention to comply score is between 1.916 and 2.924.

c. The proportion of all similarly constructed confidence intervals that will contain the true mean is 0.90.

1.51 a. For confidence coefficient 0.90, $\alpha = 0.10$ and $\alpha / 2 = 0.10 / 2 = 0.05$. From Table 2, Appendix D, with $df = n - 1 = 15 - 1 = 14$, $t_{0.05} = 1.761$. The 90% confidence interval is:

$$\bar{y} \pm t_{0.05}\frac{s}{\sqrt{n}} \Rightarrow 18 \pm 1.761\frac{20}{\sqrt{15}} \Rightarrow 18 \pm 9.094 \Rightarrow (8.906, 27.094)$$

b. Yes, the new formula is better than the ASHRAE formula. We are 90% confident that the true mean absolute deviation percentage for the new formula is between 8.906% and 27.094%. This interval is below the 34% for the ASHRAE formula.

1.52 a. The target parameter is μ, the mean difference in error rates for all subjects who perform the memorization tasks.

b. The interval $\bar{y} \pm 2s$ is an interval in which most actual observations will fall. The interval for the population mean is much smaller.

c. For confidence coefficient 0.98, $\alpha = 0.02$ and $\alpha / 2 = 0.02 / 2 = 0.01$. From Table 1, Appendix D, $z_{0.01} = 2.33$. The 98% confidence interval is:

$$\bar{y} \pm z_{0.01}\frac{\sigma}{\sqrt{n}} \Rightarrow 78.1885 \pm 2.33\frac{63.243}{\sqrt{71}} \Rightarrow 78.1885 \pm 17.4880 \Rightarrow (60.7005, 95.6765)$$

We are 98% confident that the true mean difference in error rates for all subjects who perform the memorization tasks is between 60.7005 and 95.6765.

d. 98% confidence means that in repeated sampling, 98% of all intervals constructed in a similar manner will contain the true mean.

e. No. The sample size in the problem is 71, which is greater than 30.

1.53 a. Null Hypothesis $= H_0$

b. Alternative Hypothesis $= H_a$

c. Type I error is when we reject the null hypothesis when the null hypothesis is, in fact, true.

d. Type II error is when we accept the null hypothesis when the null hypothesis is, in fact, not true.

e. Probability of Type I error is α.

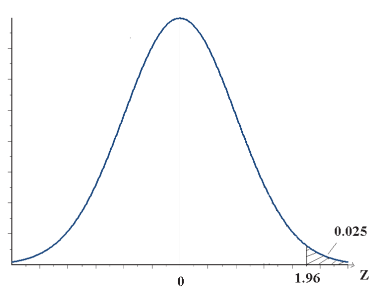
f. Probability of Type II error is β.

g. *p*-value is the observed significance level, which is the probability of observing a value of the test statistics at least as contradictory to the null hypothesis as the observed test statistic value, assuming the null hypothesis is true.

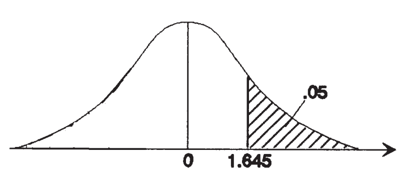
1.54 a. The rejection region is determined by the sampling distribution of the test statistic, the direction of the test $(>, <, \text{or} \neq)$, and the tester's choice of α..

b. No, nothing is proven. When the decision based on sample information is to reject H_0, we run the risk of committing a Type I error. We might have decided in favor of the research hypothesis when, in fact, the null hypothesis was the true statement. The existence of Type I and Type II errors makes it impossible to prove anything using sample information.

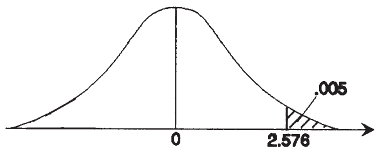
1.55 a. $\alpha = P$ (reject H_0 when H_0 is in fact true) $= P(z > 1.96) = 0.025$



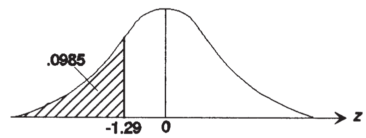
b. $\alpha = P(z > 1.645) = 0.05$



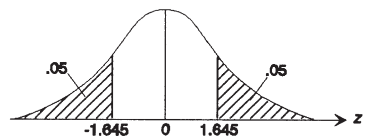
c. $\alpha = P(z > 2.576) = 0.005$



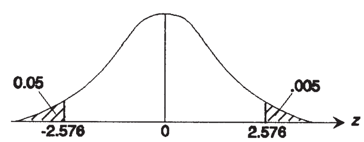
d. $\alpha = P(z < -1.29) = 0.0985$



e. $\alpha = P(z < -1.645) + P(z > 1.645)$
$= 0.05 + 0.05 = 0.10$



f. $\alpha = P(z < -2.576) + P(z > 2.576)$
$= 0.005 + 0.005 = 0.01$



1.56 a. To determine if the average gain in green fees, lessons, or equipment expenditures for participating golf facilities exceed \$2400, we test:

$H_0: \mu = 2,400$
$H_a: \mu > 2,400$

b. The probability of making a Type I error will be at most 0.05. That is, 5% of the time when repeating this experiment the final conclusion would be that the true mean gain exceeded \$2400 when in fact the true mean was equal to \$2400.

c. The rejection region requires $\alpha = 0.05$ in the upper tail of the z distribution. From Table 1, Appendix D, $z_{.05} = 1.645$. The rejection region is $z > 1.645$.

1.57 To determine if the mean Libor rate of 1.55% is too high, we test:

$H_0: \mu = 1.55$
$H_a: \mu < 1.55$

1.58 a. The parameter of interest is μ, the mean number of days in the past month that adults walked for the purpose of health or recreation.

b. To determine if the true mean number of days in the past month that adults walked for the purpose of health or recreation is lower than 5.5 days, we test:

$H_0: \mu = 5.5$
$H_a: \mu < 5.5$

c. A Type I error would be concluding the true mean number of days in the past month that adults walked for the purpose of health or recreation is lower than 5.5 days when the true mean is 5.5 days.

d. A Type II error would be concluding the true mean number of days in the past month that adults walked for the purpose of health or recreation is equal to 5.5 days when the true mean is less than 5.5 days.

1.59 a. To determine if the true mean PAI value for similar studies of music performance anxiety exceeds 40, we test:

$H_0: \mu = 40$
$H_a: \mu > 40$

b. The rejection region requires $\alpha = 0.05$ in the upper tail of the *t* distribution. From Table 2, Appendix D, with $df = n - 1 = 8 - 1 = 7$, $t_{.05} = 1.895$. The rejection region is $t > 1.895$.

c. The test statistic is $t = \dfrac{\bar{y} - \mu}{s/\sqrt{n}} = \dfrac{45.63 - 40}{6.59/\sqrt{8}} = 2.416$.

d. Since the observed value of the test statistic falls in the rejection region $(t = 2.416 > 1.895)$, H_0 is rejected. There is sufficient evidence to indicate the true mean PAI value for similar studies of music performance anxiety exceeds 40 at $\alpha = 0.05$.

e. In order for the test to be valid, the distribution of all PAI values for similar studies of music performance anxiety must be approximately normal.

f. From the printout, the *p*-value is $p = 0.023$. Since the *p*-value is less than α $(p = 0.023 < 0.05)$, H_0 is rejected.

g. If $\alpha = 0.01$, then the *p*-value is not less than α $(p = 0.023 \not< 0.01)$. Thus, H_0 is would not be rejected.

1.60 Let μ = true mean heart rate during laughter. To determine if the true mean heart rate during laughter exceeds 71 beats/minutes, we test:

$H_0: \mu = 71$
$H_a: \mu > 71$

The test statistic is $z = \dfrac{\bar{y} - \mu_0}{s/\sqrt{n}} = \dfrac{73.5 - 71}{6/\sqrt{90}} = 3.95$.

The rejection region requires $\alpha = 0.05$ in the upper tail of the z distribution. From Table 1, Appendix D, $z_{0.05} = 1.645$. The rejection region is $z > 1.645$.

Since the observed value of the test statistic falls in the rejection region $(z = 3.95 > 1.645)$, H_0 is rejected. There is sufficient evidence to conclude that the true mean heart rate during laughter exceeds 71 beats/minute at $\alpha = 0.05$.

1.61 To determine if the mean difference in error rates for all subjects who perform the memorization tasks exceeds 75%, we test:

$$H_0: \mu = 75$$
$$H_a: \mu > 75$$

The test statistic is $z = \dfrac{\bar{y} - \mu_0}{s/\sqrt{n}} = \dfrac{78.1885 - 75}{63.2429/\sqrt{71}} = 0.42.$

The rejection region requires $\alpha = 0.01$ in the upper tail of the z distribution. From Table 1, Appendix D, $z_{0.01} = 2.33$. The rejection region is $z > 2.33$.

Since the observed value of the test statistic does not fall in the rejection region $(z = 0.42 \ngtr 2.33)$, H_0 is not rejected. There is insufficient evidence to conclude that the true mean difference in error rates for all subjects who perform the memorization tasks exceeds 75% at $\alpha = 0.01$.

1.62 a. To determine if the true mean number of vouchers sold 30 minutes before the tipping point is less than 5, we test:

$$H_0: \mu = 5$$
$$H_a: \mu < 5$$

The test statistic is $z = \dfrac{\bar{y} - \mu_0}{s/\sqrt{n}} = \dfrac{4.73 - 5}{27.58/\sqrt{2,211}} = -0.46.$

The rejection region requires $\alpha = 0.10$ in the lower tail of the z distribution. From Table 1, Appendix D, $z_{0.10} = 1.28$. The rejection region is $z < -1.28$.

Since the observed value of the test statistic does not fall in the rejection region $(z = -0.46 \nless -1.28)$, H_0 is not rejected. There is insufficient evidence to conclude that the true mean number of vouchers sold 30 minutes before the tipping point is less than 5 at $\alpha = 0.10$.

b. To determine if the true mean number of vouchers sold 30 minutes after the tipping point is greater than 10, we test:

$H_0: \mu = 10$
$H_a: \mu > 10$

The test statistic is $z = \dfrac{\bar{y} - \mu_0}{s/\sqrt{n}} = \dfrac{14.26 - 10}{110.71/\sqrt{2,617}} = 1.97.$

The rejection region requires $\alpha = 0.10$ in the upper tail of the z distribution. From Table 1, Appendix D, $z_{0.10} = 1.28$. The rejection region is $z > 1.28$.

Since the observed value of the test statistic falls in the rejection region $(z = 1.97 > 1.28)$, H_0 is rejected. There is sufficient evidence to conclude that the true mean number of vouchers sold 30 minutes after the tipping point is greater than 10 at $\alpha = 0.10$.

1.63 a. To determine whether the mean full-service fee of U.S. funeral homes this year is less than \$8,755, we test:

$H_0: \mu = 8.755$
$H_a: \mu < 8.755$

b. Using MINITAB, the descriptive statistics are:

Statistics

Variable	N	Mean	StDev
NFDA	36	6.819	1.265

The test statistic is $z = \dfrac{\bar{y} - \mu_0}{s/\sqrt{n}} = \dfrac{6.819 - 8.755}{1.265/\sqrt{36}} = -9.18.$

The rejection region requires $\alpha = 0.05$ in the upper tail of the z distribution. From Table 1, Appendix D, $z_{0.05} = 1.645$. The rejection region is $z < -1.645$.

Since the observed value of the test statistic falls in the rejection region $(z = -9.18 < -1.645)$, H_0 is rejected. There is sufficient evidence to conclude that the mean full-service fee of U.S. funeral homes this year is less than \$8,755 at $\alpha = 0.05$.

c. No, we did not have to assume that the data were normally distributed. Since the sample size was larger than 30, the distribution of $\bar{y}$ will be approximately normal.

1.64 a. To determine if the mean heat rate of gas turbines augmented with high pressure inlet fogging exceeds 10,000 kJ/kWh, we test:

$H_0: \mu = 10,000$
$H_a: \mu > 10,000$

The test statistic $z = \dfrac{\bar{y} - \mu_0}{s/\sqrt{n}} = \dfrac{11{,}066.4 - 10{,}000}{1{,}595/\sqrt{67}} = 5.47.$

The p-value is essentially zero and is significantly smaller than the significance level. Thus we can conclude that the true mean heat rate of gas turbines augmented with high pressure inlet fogging is greater than 10,000 kJ/kWh.

b. A Type I error would be if you concluded the true mean is greater than 10,000 kJ/kWh when, in fact, the true mean is equal to 10,000 kJ/kWh . A Type II error would be if you concluded the true mean is equal to 10,000 kJ/kWh when, in fact, the true mean is greater than 10,000 kJ/kWh .

1.65 Using MINITAB, some preliminary calculations are:

Descriptive Statistics

N	Mean	StDev	SE Mean	95% CI for μ
8	0.4225	0.1219	0.0431	(0.3206, 0.5244)

μ: mean of Recall

Test

Null hypothesis	H_0: μ = 0.5
Alternative hypothesis	H_1: μ ≠ 0.5

T-Value	P-Value
-1.80	0.115

To determine if the mean ratio of repetition for all participants in a similar memory study differs from 0.50, we test:

$$H_0: \mu = 0.5$$
$$H_a: \mu \neq 0.5$$

From the printout, the test statistics is $t = -1.80$.

From the printout, the p-value of the test is $p = 0.115$. No α value was given, so we will use $\alpha = 0.05$. Since the p-value is not less than α $\left(p = 0.115 \nless 0.05\right)$, H_0 is not rejected. There is insufficient evidence to indicate that the mean ratio of repetition for all participants in a similar memory study differs from 0.50 at $\alpha = 0.05$.

1.66 There are three things to describe:

1) Mean: $\mu_{\bar{y}_1 - \bar{y}_2} = \mu_1 - \mu_2$

2) Std Deviation: $\sigma_{\bar{y}_1 - \bar{y}_2} = \sqrt{\dfrac{\sigma_1^2}{n_1} + \dfrac{\sigma_2^2}{n_2}}$

3) Shape: For sufficiently large samples, the shape of the sampling distribution is approximately normal.

1.67 The two populations must have:
1) relative frequency distributions that are approximately normal, and
2) variances that are equal.
The two samples must both have been randomly and independently chosen.

1.68 a. Let μ_1 = mean leadership value for captains from successful teams, and μ_2 = mean leadership value for captains from unsuccessful teams. To determine whether the mean leadership values for captains from successful and unsuccessful teams differ, we test:

$$H_0: \mu_1 - \mu_2 = 0$$
$$H_a: \mu_1 - \mu_2 \neq 0$$

The *p*-value is $p = 0.000$. Since the *p*-value is less than α $(p = 0.000 < 0.05)$, H_0 is rejected. There is sufficient evidence to indicate that the mean leadership values for captains from successful and unsuccessful teams differ at $\alpha = 0.05$.

b. Let μ_1 = mean leadership value for flight attendants from successful teams, and μ_2 = mean leadership value for flight attendants from unsuccessful teams. To determine whether the mean leadership values for flight attendants from successful and unsuccessful teams differ, we test:

$$H_0: \mu_1 - \mu_2 = 0$$
$$H_a: \mu_1 - \mu_2 \neq 0$$

The *p*-value is $p = 0.907$. Since the *p*-value is not less than α $(p = 0.907 \nless 0.05)$, H_0 is not rejected. There is insufficient evidence to indicate that the mean leadership values for flight attendants from successful and unsuccessful teams differ at $\alpha = 0.05$.

1.69 For this experiment let μ_1 and μ_2 represent the mean ratings for Group 1 (support favored position) and Group 2 (weaken opposing position), respectively. Then we want to test:

$$H_0: \mu_1 - \mu_2 = 0$$
$$H_a: \mu_1 - \mu_2 \neq 0$$

Calculate the pooled estimate of variance:

$$s_p^2 = \frac{(n_1 - 1)s_1^2 + (n_2 - 1)s_2^2}{n_1 + n_2 - 2} = \frac{(26-1)(12.5)^2 + (26-1)(12.2)^2}{26 + 26 - 2} = 152.545$$

.

The test statistic is $t = \dfrac{(\bar{y}_1 - \bar{y}_2) - D_0}{\sqrt{s_p^2\left(\dfrac{1}{n_1} + \dfrac{1}{n_2}\right)}} = \dfrac{(28.6 - 24.9) - 0}{\sqrt{152.545\left(\dfrac{1}{26} + \dfrac{1}{26}\right)}} = 1.08.$

The rejection region requires $\alpha / 2 = 0.05/2 = 0.025$ in each tail of the t-distribution. From Table 2, Appendix D, with $df = (n_1 + n_2 - 2) = (26 + 26 - 2) = 50$, $t_{0.025} = 2.009$. The rejection region is $t < -2.009$ or $t > 2.009$.
Since the observed value of the test statistic does not fall in the rejection region $(t = 1.08 \ngtr 2.009)$, H_0 is not rejected. There is insufficient evidence of a difference between the true mean rating scores for the two groups at $\alpha = 0.05$.

Assumptions: This procedure requires the assumption that the samples of rating scores are randomly and independently selected from normal populations with equal variances.

1.70 a. For none of the five varieties of apricot jelly can we conclude that the mean taste scores of the two protocols differ at $\alpha = 0.05$. None of the p-values are less than $\alpha = 0.05$.

b. We can conclude that the mean taste scores for cheese varieties A, C, and D differ for the two protocols at $\alpha = 0.05$ because those varieties of cheese have p-values less than $\alpha = 0.05$. We cannot conclude that the mean taste scores for cheese variety B differ for the two protocols at $\alpha = 0.05$ because that variety of cheese has p-values greater than $\alpha = 0.05$.

c. The sample sizes in each study were $n_1 = n_2 = 25$. Although these numbers are less than 30, they are fairly close. Therefore, the distributions of $\bar{y}_1$ and $\bar{y}_2$ will be approximately normal.

1.71 a. Let $\mu_1 =$ mean percentage of board members who are female at firms with nominating committees, and $\mu_2 =$ mean percentage of board members who are female at firms without nominating committees. To determine whether firms with a nominating committee would appoint more female directors than firms without a nominating committee, we test:

$$H_0: \mu_1 - \mu_2 = 0$$
$$H_a: \mu_1 - \mu_2 > 0$$

b. Since the p-value is less than α $(p < 0.001 < 0.05)$, H_0 is rejected. There is sufficient evidence to indicate firms with a nominating committee would appoint more female directors than firms without a nominating committee at $\alpha = 0.05$.

c. No, the population percentages for each type of firm do not need to be normally distributed for the inference to be valid because the sample sizes were both greater than 30.

d. $$z = \frac{(\bar{y}_1 - \bar{y}_2) - D_0}{s_{\bar{y}_1 - \bar{y}_2}} = \frac{(\bar{y}_1 - \bar{y}_2) - 0}{s_{\bar{y}_1 - \bar{y}_2}} = 5.51 \Rightarrow \frac{(7.5 - 4.3)}{s_{\bar{y}_1 - \bar{y}_2}} = 5.51 \Rightarrow s_{\bar{y}_1 - \bar{y}_2} = 0.5808$$

For confidence coefficient 0.95, $\alpha = 0.05$ and $\alpha / 2 = 0.05/2 = 0.025$. From Table 1, Appendix D, $z_{0.025} = 1.96$. The 95% confidence interval is:

$$(\bar{y}_1 - \bar{y}_2) \pm z_{.025}\left(s_{\bar{y}_1 - \bar{y}_2}\right) \Rightarrow (7.5 - 4.3) \pm 1.96(0.5808) \Rightarrow 3.2 \pm 1.138 \Rightarrow (2.062, 4.338)$$

We are 95% confident that the difference in mean percentage of female board directors at firms with a nominating committee and firms without a nominating committee is between

2.062% and 4.338%. Since both of these numbers are positive, there is evidence that there is a difference in the mean percentages for the two groups.

1.72 a. Let μ_1 = mean voltage reading at the old location, and μ_2 = mean voltage reading at the new location. For confidence coefficient 0.90, $\alpha = 0.10$ and $\alpha/2 = 0.10/2 = 0.05$. From Table 1, Appendix D, $z_{0.05} = 1.645$. The 90% confidence interval is:

$$(\bar{y}_1 - \bar{y}_2) \pm z_{0.05}\sqrt{\frac{\sigma_1^2}{n_1} + \frac{\sigma_2^2}{n_2}} \Rightarrow (9.80 - 9.42) \pm 1.645\sqrt{\frac{0.5409^2}{30} + \frac{0.4789^2}{30}}$$

$$\Rightarrow 0.38 \pm 0.217 \Rightarrow (0.163, 0.597)$$

b. No. Since the interval constructed in part (a) contains only positive values, we can conclude that there is evidence that the mean voltage readings are higher at the old location than at the new location.

1.73 a. Using MINITAB, some preliminary calculations are:

Statistics

Variable	N	Mean	StDev
Handshake	5	104.4	24.8
HighFive	5	55.80	13.10
FistBump	5	20.00	6.00

$$s_p^2 = \frac{(n_1 - 1)s_1^2 + (n_2 - 1)s_2^2}{n_1 + n_2 - 2} = \frac{(5-1)24.8^2 + (5-1)13.1^2}{5+5-2} = 393.325$$

Let μ_1 = mean percentage of bacteria present relative to the mean of the handshake for the handshake, and μ_2 = mean percentage of bacteria present relative to the mean of the handshake for the high five. For confidence coefficient 0.95, $\alpha = 0.05$ and $\alpha/2 = 0.05/2 = 0.025$. From Table 2, Appendix D, with $df = n_1 + n_2 - 2 = 5 + 5 - 2 = 8$, $t_{0.025} = 2.306$. The 95% confidence interval is:

$$(\bar{y}_1 - \bar{y}_2) \pm t_{0.025}\sqrt{s_p^2\left(\frac{1}{n_1} + \frac{1}{n_2}\right)} \Rightarrow (104.4 - 55.80) \pm 2.306\sqrt{393.325\left(\frac{1}{5} + \frac{1}{5}\right)}$$

$$\Rightarrow 48.6 \pm 28.92 \Rightarrow (19.68, 77.52)$$

If nearly twice as many bacteria were transferred during a handshake compared with a high five, then the confidence interval for the difference in the mean percentage of bacteria present between the handshake and the fist bump should contain 50%. The above confidence interval does contain 50%, so the confidence interval supports the statement.

b. μ_3 = mean percentage of bacteria present relative to the mean of the handshake for the fist bump.

$$s_p^2 = \frac{(n_2 - 1)s_2^2 + (n_3 - 1)s_3^2}{n_2 + n_3 - 2} = \frac{(5-1)13.1^2 + (5-1)6.0^2}{5+5-2} = 103.805$$

The 95% confidence interval is:

$$(\bar{y}_2 - \bar{y}_3) \pm t_{0.025}\sqrt{s_p^2\left(\frac{1}{n_2}+\frac{1}{n_3}\right)} \Rightarrow (55.80 - 20.00) \pm 2.306\sqrt{103.805\left(\frac{1}{5}+\frac{1}{5}\right)}$$

$$\Rightarrow 35.80 \pm 14.86 \Rightarrow (20.94, 50.66)$$

Since this interval contains only positive values, this supports the statement that the fist bump gave a lower transmission of bacteria.

c. Based on the answers to parts a and b, the fist bump is the most hygienic.

1.74 a. If the manipulation was successful, then the positive display group should have a larger mean response than the positive display group. (The smaller the number the higher the agreement.)

b. Using MINITAB, some preliminary calculations are:

Descriptive Statistics: RATING

RULE	N	Mean	StDev	SE Mean
Neutral	67	1.896	0.496	0.061
Positive	78	4.487	0.659	0.075

Let $\mu_1 =$ mean response for the neutral display, and $\mu_2 =$ mean response for the positive display. To determine if the manipulation was successful (mean response for the neutral group is less than that for the positive group), we test:

$$H_0 : \mu_1 - \mu_2 = 0$$
$$H_a : \mu_1 - \mu_2 < 0$$

The test statistic is $z = \dfrac{(\bar{y}_1 - \bar{y}_2) - (\mu_1 - \mu_2)}{\sqrt{\left(\dfrac{s_1^2}{n_1}+\dfrac{s_2^2}{n_2}\right)}} = \dfrac{(1.896 - 4.487) - 0}{\sqrt{\left(\dfrac{0.496^2}{67}+\dfrac{0.659^2}{78}\right)}} = -26.96.$

The rejection region requires $\alpha = 0.05$ in the lower tail of the z distribution. Using Table 1, Appendix D, $z_{0.05} = 1.645$. The rejection region is $z < -1.645$.

Since the test statistic is in the rejection region $(z = -26.96 < -1.645)$, H_0 is rejected. There is sufficient evidence to indicate the manipulation was successful at $\alpha = 0.05$.

c. We must assume that the samples are independent.

1.75 a. A paired-samples *t*-test was used because the samples are not independent. Each subject rated both TV and magazine ads.

b. Since the *p*-value is so small $(p < 0.001)$, H_0 is rejected at any value of $\alpha > 0.001$. There is sufficient evidence to indicate a difference in mean ratings between TV and magazine ads.

c. For confidence coefficient 0.95, $\alpha = 0.05$ and $\alpha / 2 = 0.05/2 = 0.025$. From Table 1, Appendix D, $z_{0.025} = 1.96$. The 95% confidence interval is:

$$\bar{y}_d \pm z_{0.025} \frac{s_d}{\sqrt{n_d}} \Rightarrow 0.45 \pm 1.96 \frac{0.815}{\sqrt{159}} \Rightarrow 0.45 \pm 0.127 \Rightarrow (0.323, 0.577)$$

We are 95% confident that the mean difference between TV and magazine ads is between 0.323 and 0.577. Even though there is a statistical difference between the means of the two types of ads, the difference is quite small compared to the actual responses. Thus, there is no practical difference.

1.76 Let $\mu_d = \mu_1 - \mu_2 =$ before – after. Using MINITAB, some preliminary calculations are:

Descriptive Statistics

Sample	N	Mean	StDev	SE Mean
Before	13	2.513	1.976	0.548
After	13	1.506	1.448	0.402

Test

Null hypothesis H₀: μ_difference = 0
Alternative hypothesis H₁: μ_difference > 0

T-Value	P-Value
3.00	0.006

To determine if the photo-red enforcement program was successful in reducing red light-running crash incidents, we test:

$$H_0 : \mu_d = 0$$
$$H_a : \mu_d > 0$$

From the printout, the test statistic is $t = 3.00$ and the p-value is $p = 0.006$. Since the p-value is so small, H_0 is rejected. There is sufficient evidence to indicate the photo-red enforcement program was successful in reducing red light-running crash incidents at any value of $\alpha > 0.006$.

1.77 Let $\mu_d = \mu_1 - \mu_2 =$ North-South – East-West. Using MINITAB, some preliminary calculations are:

Descriptive Statistics

Sample	N	Mean	StDev	SE Mean
NS	5	7719	1548	692
EW	5	7436	1484	663

Estimation for Paired Difference

Mean	StDev	SE Mean	95% CI for μ_difference
283.6	86.4	38.7	(176.3, 390.9)

μ_difference: mean of (NS - EW)

For confidence coefficient 0.95, $\alpha = 0.05$ and $\alpha/2 = 0.05/2 = 0.025$. From Table 2, Appendix D, with $df = n_d - 1 = 5 - 1 = 4$, $t_{0.025} = 2.776$. The 95% confidence interval is:

$$\bar{y}_d \pm z_{0.025}\frac{s_d}{\sqrt{n_d}} \Rightarrow 283.6 \pm 2.776\frac{86.4}{\sqrt{5}} \Rightarrow 283.6 \pm 107.26 \Rightarrow (176.34, 390.86)$$

We are 95% confident that the difference in mean solar energy amounts generated between north-south oriented roadways and east-west oriented roadways is between 176.34 and 390.86 kilowatt-hours. Since all of the numbers in the interval are positive, this supports the researchers' conclusion.

1.78 From Tables 3, 4, 5, 6 of Appendix D,

a. $F_{0.05} = 3.73$ b. $F_{0.01} = 3.09$ c. $F_{0.025} = 6.52$

d. $F_{0.01} = 3.85$ e. $F_{0.10} = 2.52$ f. $F_{0.05} = 2.94$

1.79 Let σ_1^2 = variance of the number of hippo trails from a water source in the National Reserve and σ_2^2 = variance of the number of hippo trails from a water source in the pastoral ranch. To determine if the variability in the number of hippo trails from a water source in the National Reserve differs from the variability in the number of hippo trails from a water source in the pastoral ranch, we test:

$$H_0: \frac{\sigma_1^2}{\sigma_2^2} = 1$$

$$H_a: \frac{\sigma_1^2}{\sigma_2^2} \neq 1$$

The test statistic is $F = \frac{s_1^2}{s_2^2} = \frac{0.40^2}{0.30^2} = 1.778$.

The rejection region requires $\alpha/2 = 0.10/2 = 0.05$ in the upper tail of the F-distribution. From Table 4, Appendix D, with $v_1 = n_1 - 1 = 406 - 1 = 405$ and $v_2 = n_2 - 1 = 230 - 1 = 229$, $F_{0.05} \approx 1.00$. The rejection region is $F > 1.00$.

Since the value of the test statistic falls in the rejection region $(F = 1.778 > 1.000)$, H_0 is rejected. There is sufficient evidence to indicate the variability in the number of hippo trails from a water source in the National Reserve differs from the variability in the number of hippo trails from a water source in the pastoral ranch at $\alpha = 0.10$.

1.80 a. We have to assume that the variances of the two groups are the same.

b. Let σ_1^2 = variance of the percentage of bacteria transferred for the handshake and σ_2^2 = variance of the percentage of bacteria transferred for the fist bump. To determine if the variance in percentage of bacteria transferred for the handshake differs from the variance of the percentage of bacteria transferred for the fist bump, we test:

$$H_0: \frac{\sigma_1^2}{\sigma_2^2} = 1$$
$$H_a: \frac{\sigma_1^2}{\sigma_2^2} \neq 1$$

Using the descriptive statistics from Exercise 1.73, the test statistic is
$$F = \frac{s_1^2}{s_2^2} = \frac{24.8^2}{6^2} = 17.084.$$

The rejection region requires $\alpha/2 = 0.05/2 = 0.025$ in the upper tail of the F-distribution. From Table 5, Appendix D, with $\nu_1 = n_1 - 1 = 4 - 1 = 4$ and $\nu_2 = n_2 - 1 = 5 - 1 = 4$, $F_{0.025} = 9.60$. The rejection region is $F > 9.60$.

Since the value of the test statistic falls in the rejection region $(F = 17.084 > 9.60)$, H_0 is rejected. There is sufficient evidence to indicate the variance in percentage of bacteria transferred for the handshake differs from the variance of the percentage of bacteria transferred for the fist bump at $\alpha = 0.05$.

c. The decisions made in Exercise 1.73 may not be valid. There is evidence that the population variances are not equal, which is a requirement for the test in Exercise 1.73.

1.81 We will test to see if the ratio of the variances differ from 1 or not:

$$H_0: \frac{\sigma_1^2}{\sigma_2^2} = 1$$
$$H_a: \frac{\sigma_1^2}{\sigma_2^2} \neq 1$$

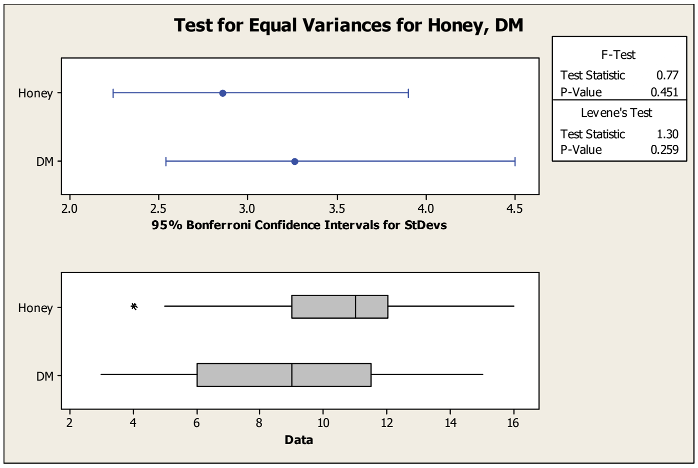
Two assumptions are required for the F test are as follows:
1. The two populations are normally distributed.
2. The samples are randomly and independently selected from their respective populations

The test statistic is $F = \frac{s_1^2}{s_2^2} = \frac{10.604}{8.151} = 1.30.$

The rejection region requires $\alpha/2 = 0.10/2 = 0.05$ in the upper tail of the F distribution. Using Table 4, Appendix D with $\nu_1 = n_1 - 1 = 33 - 1 = 32$ and $\nu_2 = n_2 - 1 = 35 - 1 = 34$, $F_{0.05} = 1.84$. The rejection region is $F > 1.84$.

Since the observed value of the test statistic does not fall in the rejection region $(F = 1.30 \ngtr 1.84)$, H_0 is not rejected. There is insufficient evidence to show that the variances of the two groups differ at $\alpha = 0.10$.

Note: we will always place the larger sample variance in the numerator of the F test.



1.82 Let σ_1^2 = variance for the "support favored position" group and σ_2^2 = variance for the "weaken opposing position" group. To determine if the variances for the two groups differ, we test:

$$H_0: \frac{\sigma_1^2}{\sigma_2^2} = 1$$

$$H_a: \frac{\sigma_1^2}{\sigma_2^2} \neq 1$$

The test statistic is $F = \frac{s_1^2}{s_2^2} = \frac{12.5^2}{12.2^2} = 1.05.$

The rejection region requires $\alpha/2 = 0.05/2 = 0.025$ in the upper tail of the F-distribution. From Table 5, Appendix D, with $v_1 = n_1 - 1 = 26 - 1 = 25$ and $v_2 = n_2 - 1 = 26 - 1 = 25$, $F_{0.025} \approx 2.24$. The rejection region is $F > 2.24$.

Since the value of the test statistic does not fall in the rejection region $\left(F = 1.05 \not> 2.24\right)$, H_0 is not rejected. There is insufficient evidence to indicate the variances for the two groups differ at $\alpha = 0.05$.

1.83 Let σ_1^2 = variance of the internal oil content for the vacuum fryer and σ_2^2 = variance of the internal oil content for the two-stage frying process. To determine if the variances for the two groups differ, we test:

$$H_0: \frac{\sigma_1^2}{\sigma_2^2} = 1$$

$$H_a: \frac{\sigma_1^2}{\sigma_2^2} \neq 1$$

The test statistic is $F = \frac{s_1^2}{s_2^2} = \frac{0.011^2}{0.002^2} = 30.25.$

No value of α was given, so we will use $\alpha = 0.10$. The rejection region requires $\alpha / 2 = 0.10 / 2 = 0.05$ in the upper tail of the F-distribution. From Table 4, Appendix D, with $\nu_1 = n_1 - 1 = 6 - 1 = 5$ and $\nu_2 = n_2 - 1 = 6 - 1 = 5$, $F_{0.05} = 5.05$. The rejection region is $F > 5.05$.

Since the value of the test statistic falls in the rejection region $(F = 30.25 > 5.05)$, H_0 is rejected. There is sufficient evidence to indicate the variances for the two groups differ at $\alpha = 0.10$. Since there is evidence that the variances of the two groups are different, we would not recommend that the researchers carry out this analysis.

1.84 a. $1-\left(\frac{1}{K^2}\right)=1-\left(\frac{1}{2^2}\right)=1-\frac{1}{4}=\frac{3}{4}$

At least ¾ of the measurements will lie within 2 standard deviations of the mean

b. $1-\left(\frac{1}{K^2}\right)=1-\left(\frac{1}{3^2}\right)=1-\frac{1}{9}=\frac{8}{9}$

At least 8/9 of the measurements will lie within 3 standard deviations of the mean

c. $1-\left(\frac{1}{K^2}\right)=1-\left(\frac{1}{1.5^2}\right)=1-\frac{1}{2.25}=\frac{1.25}{2.25}=\frac{5}{9}$

At least 5/9 of the measurements will lie within 1.5 standard deviations of the mean

1.85 a. $\bar{y}=\frac{\sum_{i=1}^{n} y_i}{n}=\frac{11+2+2+1+9}{5}=\frac{25}{5}=5$

$$s^2=\frac{\sum_{i=1}^{n}(y_i-\bar{y})^2}{n-1}=\frac{\sum_{i=1}^{n} y_i^2-\frac{\left(\sum_{i=1}^{n} y_i\right)^2}{n}}{n-1}=\frac{(11^2+2^2+2^2+1^2+9^2)-\frac{(25)^2}{5}}{5-1}$$
$$=\frac{211-125}{4}=\frac{86}{4}=21.5$$

$s=\sqrt{s^2}=\sqrt{21.5}\approx 4.637$

b. $\bar{y}=\frac{\sum_{i=1}^{n} y_i}{n}=\frac{22+9+21+15}{4}=\frac{67}{4}=16.75$

$$s^2=\frac{\sum_{i=1}^{n}(y_i-\bar{y})^2}{n-1}=\frac{\sum_{i=1}^{n} y_i^2-\frac{\left(\sum_{i=1}^{n} y_i\right)^2}{n}}{n-1}=\frac{(22^2+9^2+21^2+15^2)-\frac{(67)^2}{4}}{4-1}$$
$$=\frac{1231-1122.25}{3}=\frac{108.75}{3}=36.25$$

$s=\sqrt{s^2}=\sqrt{36.25}\approx 6.021$

c. $\overline{y} = \dfrac{\sum_{i=1}^{n} y_i}{n} = \dfrac{34}{7} = 4.857$

$$s^2 = \frac{\sum_{i=1}^{n} y_i^2 - \frac{\left(\sum_{i=1}^{n} y_i\right)^2}{n}}{n-1} = \frac{344 - \frac{(34)^2}{7}}{7-1} = \frac{178.857}{6} \approx 29.81$$

$s = \sqrt{s^2} = \sqrt{29.81} \approx 5.460$

d. $\overline{y} = \dfrac{\sum_{i=1}^{n} y_i}{n} = \dfrac{16}{4} = 4$

$$s^2 = \frac{\sum_{i=1}^{n} y_i^2 - \frac{\left(\sum_{i=1}^{n} y_i\right)^2}{n}}{n-1} = \frac{64 - \frac{(16)^2}{4}}{4-1} = \frac{0}{3} \approx 0$$

$s = \sqrt{s^2} = \sqrt{0} \approx 0$

1.86 Using Table 1, Appendix D:

a. $P(z \geq 2) = 0.5 - P(0 \leq z \leq 2) = 0.5 - 0.4772 = 0.0228$

b. $P(z \leq -2) = P(z \geq 2) = 0.0228$

c. $P(z \geq -1.96) = 0.5 + P(-1.96 \leq z \leq 0) = 0.5 + 0.4750 = 0.9750$

d. $P(z \geq 0) = 0.5$

e. $P(z \leq -0.5) = 0.5 - P(-0.5 \leq z \leq 0) = 0.5 - 0.1915 = 0.3085$

f. $P(z \leq -1.96) = 0.5 - P(-1.96 \leq z \leq 0) = 0.5 - 0.4750 = 0.0250$

1.87 a. $z = \dfrac{y-\mu}{\sigma} = \dfrac{10-30}{5} = \dfrac{-20}{5} = -4$

The sign and magnitude of the z-value indicate that the y-value is 4 standard deviations below the mean.

b. $z = \dfrac{y-\mu}{\sigma} = \dfrac{32.5-30}{5} = \dfrac{2.5}{5} = 0.5$

The *y*-value is 0.5 standard deviations above the mean.

c. $z = \dfrac{y-\mu}{\sigma} = \dfrac{30-30}{5} = \dfrac{0}{5} = 0$

The *y*-value is equal to the mean of the random variable *y*.

d. $z = \dfrac{y-\mu}{\sigma} = \dfrac{60-30}{5} = \dfrac{30}{5} = 6$

The *y*-value is 6 standard deviations above the mean.

1.88 a. Town where sample collected is qualitative since this variable is not measured on a numerical scale.

b. Type of water supply is qualitative since this variable is not measured on a numerical scale.

c. Acidic level is quantitative since this variable is measured on a numerical scale (pH level 1 to 14).

d. Turbidity level is quantitative since this variable is measured on a numerical scale

e. Temperature quantitative since this variable is measured on a numerical scale.

f. Number of fecal coliforms per 100 millimeters is quantitative since this variable is measured on a numerical scale.

g. Free chlorine-residual (milligrams per liter) is quantitative since this variable is measured on a numerical scale.

h. Presence of hydrogen sulphide (yes or no) is qualitative since this variable is not measured on a numerical scale.

1.89 a. The population is all adults in Tennessee. The sample is 575 study participants.

b. The number of years of education is quantitative since it can be measured on a numerical scale. The insomnia status (normal sleeper or chronic insomnia) is qualitative since it cannot be measured on a numerical scale.

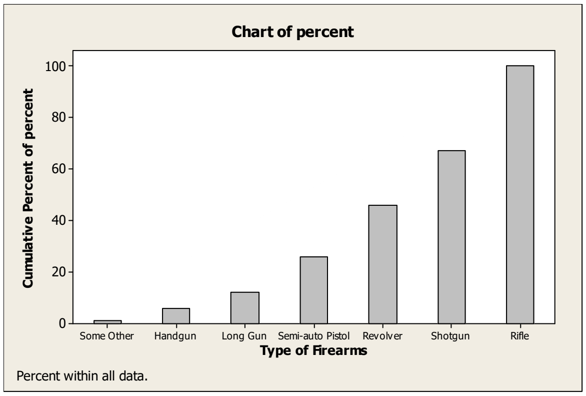
c. Less educated adults are more likely to have chronic insomnia.

1.90 a. Pie chart

b. The type of firearms owned is the qualitative variable.

c. Rifle (33%), shotgun (21%), and revolver (20%) are the most common types of firearm.

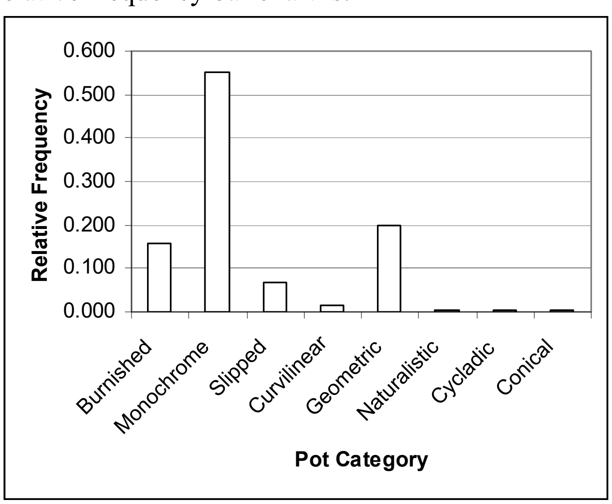
d.



1.91 Suppose we construct a relative frequency bar chart for this data. This will allow the archaeologists to compare the different categories easier. First, we must compute the relative frequencies for the categories. These are found by dividing the frequencies in each category by the total 837. For the burnished category, the relative frequency is 133 / 837 = .159. The rest of the relative frequencies are found in a similar fashion and are listed in the table.

Pot Category	Number Found	Computation	Relative Frequency
Burnished	133	133 / 837	0.159
Monochrome	460	460 / 837	0.550
Slipped	55	55 / 837	0.066
Curvilinear Decoration	14	14 / 837	0.017
Geometric Decoration	165	165 / 837	0.197
Naturalistic Decoration	4	4 / 837	0.005
Cycladic White clay	4	4 / 837	0.005
Cononical cup clay	2	2 / 837	0.002
Total	837		1.001

A relative frequency bar chart is:



The most frequently found type of pot was the Monochrome. Of all the pots found, 55% were Monochrome. The next most frequently found type of pot was the Painted in Geometric Decoration. Of all the pots found, 19.7% were of this type. Very few pots of the types Painted in Naturalistic Decoration, Cycladic White clay, and Conical cup clay were found.

1.92 a. A stem-and-leaf display of the data using MINITAB is:

Stem-and-leaf of FNE N = 25
Leaf Unit = 1.0

2	0	67
3	0	8
6	1	**0**01
10	1	**33**33
12	1	**4**5
(2)	1	**6**6
11	1	8**9**99
7	2	**0**0**11**
3	2	3
2	2	**45**

b. The numbers in bold in the stem-and-leaf display represent the bulimic students. Those numbers tend to be the larger numbers. The larger numbers indicate a greater fear of negative evaluation. Yes, the bulimic students tend to have a greater fear of negative evaluation.

c. A measure of reliability indicates how certain one is that the conclusion drawn is correct. Without a measure of reliability, anyone could just guess at a conclusion.

d. Let $\mu_1 =$ mean FNE score for bulimic students and $\mu_1 =$ mean FNE score for normal students. Using MINITAB, some preliminary calculations are:

Descriptive Statistics: FNESCORE

GROUP	N	Mean	StDev	SE Mean
Bulimic	11	17.82	4.92	1.5
Normal	14	14.14	5.29	1.4

Estimation for Difference

Difference	Pooled StDev	95% CI for Difference
3.68	5.13	(-0.60, 7.95)

For confidence coefficient 0.95, $\alpha = 0.05$ and $\alpha/2 = 0.05/2 = 0.25$. From Table 2, Appendix D, with $df = n_1 + n_2 - 2 = 11 + 14 - 2 = 23$, $t_{0.025} = 2.069$. The 95% confidence interval is:

$$\left(\bar{y}_1 - \bar{y}_2\right) \pm t_{0.025}\sqrt{s_p^2\left(\frac{1}{n_1} + \frac{1}{n_2}\right)} \Rightarrow \left(17.82 - 14.14\right) \pm 2.069\sqrt{5.13^2\left(\frac{1}{11} + \frac{1}{14}\right)}$$

$$\Rightarrow 3.68 \pm 4.276 \Rightarrow \left(-0.596, 7.956\right)$$

We are 95% confident that the difference in mean FNE scores for bulimic and normal students is between −0.596 and 7.956.

e. We must assume that the distribution of FNE scores for the bulimic students and the distribution of the FNE scores for the normal students are normally distributed. We must also assume that the variances of the two populations are equal. Both sample distributions look somewhat mound-shaped and the sample variances are fairly close in value. Thus, both assumptions appear to be reasonably satisfied.

f. Let σ_{B}^2 = variance of the FNE scores for bulimic students and σ_{N}^2 = variance of the FNE scores for normal students.

To determine if the variances are equal, we test:

$$H_0: \frac{\sigma_B^2}{\sigma_N^2} = 1$$
$$H_a: \frac{\sigma_B^2}{\sigma_N^2} \neq 1$$

The test statistic is $F = \dfrac{\text{Larger sample variance}}{\text{Smaller sample variance}} = \dfrac{s_{\text{N}}^2}{s_{\text{B}}^2} = \dfrac{5.29^2}{4.92^2} = 1.16.$

The rejection region requires $\alpha / 2 = 0.05/2 = 0.025$ in the upper tail of the F-distribution with $\nu_{\text{N}} = n_{\text{N}} - 1 = 14 - 1 = 13$ and $\nu_{\text{B}} = n_{\text{B}} - 1 = 11 - 1 = 10$. From Table 5, Appendix D, $F_{0.025} \approx 3.62$. The rejection region is $F > 3.62$.

Since the observed value of the test statistic does not fall in the rejection region $\left(F = 1.16 \not> 3.62\right)$, H_0 is not rejected. It appears that the assumption of equal variances is valid.

1.93 Some preliminary calculations are:

$$\bar{y} = \frac{\sum y}{n} = \frac{110}{5} = 22 \qquad s^2 = \frac{\sum y^2 - \frac{\left(\sum y\right)^2}{n}}{n-1} = \frac{2,436 - \frac{110^2}{5}}{5-1} = 4 \qquad s = \sqrt{s^2} = \sqrt{4} = 2$$

To determine if the data collected were fabricated, we test:

$$H_0: \mu = 15$$
$$H_{\text{a}}: \mu \neq 15$$

The test statistic is $t = \dfrac{\bar{y} - \mu_0}{s/\sqrt{n}} = \dfrac{22 - 15}{2/\sqrt{5}} = 7.83.$

If we want to choose a level of significance to benefit the students, we would choose a small value for α. Suppose we use $\alpha = 0.01$. The rejection region requires $\alpha/2 = 0.01/2 = 0.005$ in each tail of the t distribution with $df = n - 1 = 5 - 1 = 4$. From Table 2, Appendix D, $t_{0.005} = 4.604$. The rejection region is $t < -4.604$ or $t > 4.604$.

Since the observed value of the test statistic falls in the rejection region $\left(t = 7.83 > 4.604\right)$, H_0 is rejected. There is sufficient evidence to indicate the mean data collected were fabricated at $\alpha = 0.01$.

1.94 For the New Location, $\overline{y} = 9.4223$ and $s = 0.4789$.

$\overline{y} \pm s \Rightarrow 9.4223 \pm 0.4789 \Rightarrow (8.9434, 9.9012)$ The Empirical Rule says that approximately 60-80% of the observations should fall in this interval.

$\overline{y} \pm 2s \Rightarrow 9.4223 \pm 2(0.4789) \Rightarrow 9.4223 \pm 0.9578 \Rightarrow (8.4645, 10.3801)$ The Empirical Rule says that approximately 95% of the observations should fall in this interval.

$\overline{y} \pm 3s \Rightarrow 9.4223 \pm 3(0.4789) \Rightarrow 9.4223 \pm 1.4367 \Rightarrow (7.9856, 10.8590)$ The Empirical Rule says that approximately all of the observations should fall in this interval.

For the Old Location, $\overline{y} = 9.8037$ and $s = 0.5409$.

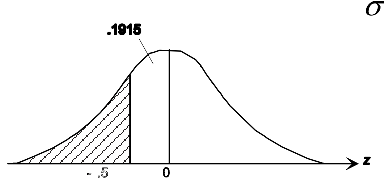
$\overline{y} \pm s \Rightarrow 9.8037 \pm 0.5409 \Rightarrow (9.2628, 10.3446)$ The Empirical Rule says that approximately 60-80% of the observations should fall in this interval.

$\overline{y} \pm 2s \Rightarrow 9.8037 \pm 2(0.5409) \Rightarrow 9.8037 \pm 1.0818 \Rightarrow (8.7219, 10.8855)$ The Empirical Rule says that approximately 95% of the observations should fall in this interval.

$\overline{y} \pm 3s \Rightarrow 9.8037 \pm 3(0.5409) \Rightarrow 9.8037 \pm 1.6227 \Rightarrow (8.1810, 11.4264)$ The Empirical Rule says that approximately all of the observations should fall in this interval.

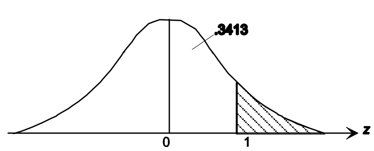
1.95 For each of these questions, we will use Table 1, Appendix D.

a. The z-score for $y = 75$ is $z = \dfrac{y-\mu}{\sigma} = \dfrac{75-80}{10} = -0.50$.



$$
\begin{aligned}
P(y \le 75) &= P(z \le -0.5) \\
&= 0.5 - P(-0.5 \le z \le 0) \\
&= 0.5 - 0.1915 = 0.3085
\end{aligned}
$$

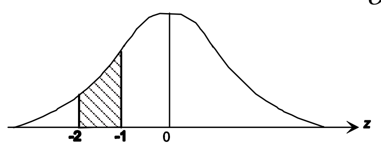
b. The z-score for $y = 90$ is $z = \dfrac{y-\mu}{\sigma} = \dfrac{90-80}{10} = 1.00$.



$$
\begin{aligned}
P(y \ge 90) &= P(z \ge 1.00) \\
&= 0.5 - P(0 \le z \le 1.00) \\
&= 0.5 - 0.3413 = 0.1587
\end{aligned}
$$

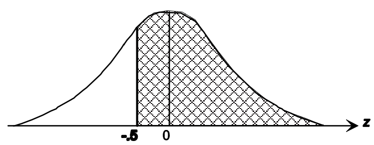
c. The z-score for $y = 60$ is $z = \dfrac{y-\mu}{\sigma} = \dfrac{60-80}{10} = -2$.

The z-score for $y = 70$ is $z = \dfrac{y-\mu}{\sigma} = \dfrac{70-80}{10} = -1$.



$$\begin{aligned} P(60 \le y \le 70) &= P(-2 \le z \le -1) \\ &= P(-2 \le z \le 0) + P(-1 \le z \le 0) \\ &= 0.4772 - 0.3413 = 0.1359 \end{aligned}$$

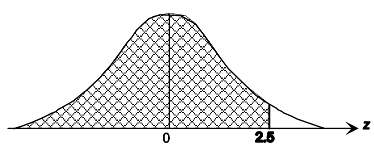
d.



$$\begin{aligned} P(y \ge 75) &= P(z \ge -0.5) \\ &= 0.5 + P(-0.5 \le z \le 0) \\ &= 0.5 + 0.1915 = 0.6915 \end{aligned}$$

e. $P(y = 75) = P(z = -0.5) = 0$

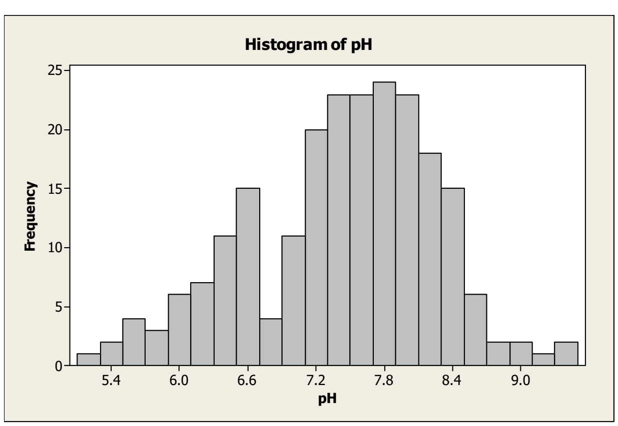
f. The z-score for $y = 105$ is $z = \dfrac{y-\mu}{\sigma} = \dfrac{105-80}{10} = 2.5$.



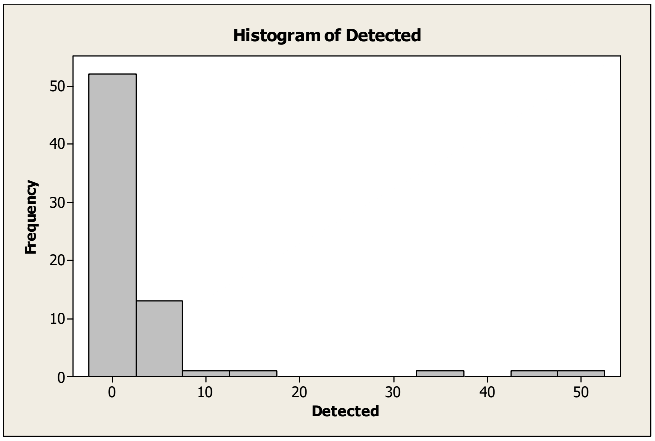
$$\begin{aligned} P(y \le 105) &= P(z \le 2.5) \\ &= 0.5 + P(0 \le z \le 2.5) \\ &= 0.5 + 0.4938 = 0.9938 \end{aligned}$$

1.96 Using Table 1, Appendix D, $P(-1.5 < z < 1.5) = 2(0.4332) = 0.8664$. Approximately 87% of the time *Six Sigma* will meet their goal.

1.97 a. It appears that about 58 out of the 223 or 0.26 of New Hampshire wells have a pH level less than 7.0.



b. It appears that about 6 out of 70 or 0.086 have a value greater than 5 micrograms per liter.



c. $\bar{y} = 7.43,\ s = 0.82,\ \bar{y} \pm 2s \Rightarrow 7.43 \pm 2(0.82) \Rightarrow (5.79, 9.06)$; 95% (Empirical Rule).

d. $\bar{y} = 1.22,\ s = 5.11,\ \bar{y} \pm 2s \Rightarrow 1.22 \pm 2(5.11) \Rightarrow (-9.00, 11.44)$; 75% (Empirical Rule).

1.98 a. $z = \frac{y-\mu}{\sigma} = \frac{16-11}{3.5} = 1.43$

b. Using Table 1, Appendix D,

$$P(10 < y < 15) = P\left(\frac{10-11}{3.5} < z < \frac{15-11}{3.5}\right) = P(-0.29 < z < 1.14)$$
$$= P(-0.29 < z < 0) + P(0 < z < 1.14) = 0.1141 + 0.3729 = 0.4870$$

c. Using Table 1, Appendix D,

$$P(y > 17) = P\left(z > \frac{17-11}{3.5}\right) = P(z > 1.17) = 0.5 - P(0 < z < 1.71) = 0.5 - 0.4564 = 0.0436$$

1.99 For confidence level 0.99, $\alpha = 0.01$ and $\alpha/2 = 0.01/2 = 0.005$. From Table 2, Appendix D, with $df = n - 1 = 13 - 1 = 12$, $t_{0.005} = 3.055$. The 99% confidence interval is:

$$\bar{y} \pm t_{0.005}\left(\frac{s}{\sqrt{n}}\right) = 19 \pm 3.055\left(\frac{2.2}{\sqrt{13}}\right) = 19 \pm 1.9 \Rightarrow (17.1, 20.9)$$

We are 99% confident that the true mean quality of the methodology of the Wong scale is between 17.1 and 20.9.

1.100 a. The average daily ammonia concentration is

$$\bar{y} = \frac{\sum y_i}{n} = \frac{1.53 + 1.50 + 1.37 + 1.51 + 1.55 + 1.42 + 1.41 + 1.48}{8} = \frac{11.77}{8} = 1.47 \text{ ppm}$$

b. $$s^2 = \frac{\sum y_i^2 - \frac{\left(\sum y_i\right)^2}{n}}{n-1}$$

$$= \frac{\left(1.53^2 + 1.50^2 + 1.37^2 + 1.51^2 + 1.55^2 + 1.42^2 + 1.41^2 + 1.48^2\right) - \frac{(11.77)^2}{8}}{8-1}$$

$$= \frac{17.3453 - \frac{(11.77)^2}{8}}{8-1} = \frac{0.0287}{7} = 0.0041$$

$$s = \sqrt{s^2} = \sqrt{0.0041} = 0.0640$$

We would expect about most of the daily ammonia levels to fall within
$\bar{y} \pm 2s \Rightarrow 1.47 \pm 2(0.0640) \Rightarrow 1.47 \pm 0.128 \Rightarrow (1.34, 1.60)$ ppm.

c. The morning drive-time has more variable ammonia levels as it has the larger standard deviation.

1.101 For this problem, $\mu_{\bar{y}} = \mu = 4.59$ and $\sigma_{\bar{y}} = \frac{\sigma}{\sqrt{n}} = \frac{2.95}{\sqrt{50}} = 0.4172.$

a. $$P(\bar{y} \geq 6) = P\left(z \geq \frac{6 - 4.59}{0.4172}\right) = P(z \geq 3.38) \approx 0.5 - 0.5 = 0$$

(using Table 1, Appendix D)

Since the probability of observing a sample mean CAHS score of 6 or higher is so small (p is essentially 0), we would not expect to see a sample mean of 6 or higher.

b. μ and/or σ differ from stated values.

1.102 a. For confidence level 0.90, $\alpha = 0.10$ and $\alpha / 2 = 0.10 / 2 = 0.05$. From Table 2, Appendix D, with $df = n - 1 = 29 - 1 = 28$, $t_{0.05} = 1.701$. The 90% confidence interval is:

$$\bar{y} \pm t_{0.05} \frac{s}{\sqrt{n}} \Rightarrow 20.9 \pm 1.701 \frac{3.34}{\sqrt{29}} \Rightarrow 20.9 \pm 1.055 \Rightarrow (19.845, 21.955)$$

We are 90% confident that the true mean number of eggs that a male and female pair of infected spider mites produced is between 19.845 and 21.955.

For confidence level 0.90, $\alpha = 0.10$ and $\alpha / 2 = 0.10 / 2 = 0.05$. From Table 2, Appendix D, with $df = n - 1 = 23 - 1 = 22$, $t_{0.05} = 1.717$. The 90% confidence interval is:

$$\bar{y} \pm t_{0.05} \frac{s}{\sqrt{n}} \Rightarrow 20.3 \pm 1.717 \frac{3.50}{\sqrt{23}} \Rightarrow 20.3 \pm 1.253 \Rightarrow (19.047, 21.553)$$

We are 90% confident that the true mean number of eggs that a treated male infected spider mite produced is between 19.047 and 21.553.

For confidence level 0.90, $\alpha = 0.10$ and $\alpha / 2 = 0.10/2 = 0.05$. From Table 2, Appendix D, with $df = n-1 = 18-1 = 17$, $t_{0.05} = 1.740$. The 90% confidence interval is:

$$\bar{y} \pm t_{0.05} \frac{s}{\sqrt{n}} \Rightarrow 22.9 \pm 1.740 \frac{4.37}{\sqrt{18}} \Rightarrow 22.9 \pm 1.792 \Rightarrow (21.108, 24.692)$$

We are 90% confident that the true mean number of eggs that a treated female infected spider mite produced is between 21.108 and 24.692.

For confidence level 0.90, $\alpha = 0.10$ and $\alpha / 2 = 0.10/2 = 0.05$. From Table 2, Appendix D, with $df = n-1 = 21-1 = 20$, $t_{0.05} = 1.725$. The 90% confidence interval is:

$$\bar{y} \pm t_{0.05} \frac{s}{\sqrt{n}} \Rightarrow 18.6 \pm 1.725 \frac{2.11}{\sqrt{21}} \Rightarrow 18.6 \pm 0.794 \Rightarrow (17.806, 19.394)$$

We are 90% confident that the true mean number of eggs that a male and female treated pair of infected spider mites produced is between 17.806 and 19.394.

b. It appears that the female treated group produces the highest mean number of eggs.

1.103 a. From the printout, the 95% confidence interval is $(1.6711, 2.1989)$.

b. We are 95% confident that the true mean failure time of used colored display panels is between 1.6711 and 2.1989 years.

c. In repeated sampling, 95% of all confidence intervals constructed will contain the true mean failure time.

1.104 a. For confidence coefficient 0.99, $\alpha = 0.01$ and $\alpha / 2 = 0.01/2 = 0.005$. From Table 1, Appendix D, $z_{0.005} = 2.58$. The 99% confidence interval is:

$$\bar{y} \pm z_{0.005} \frac{s}{\sqrt{n}} \Rightarrow 1.13 \pm 2.58\left(\frac{2.21}{\sqrt{72}}\right) \Rightarrow 1.13 \pm 0.67 \Rightarrow (0.46,\ 1.80)$$

We are 99% confident that the true mean number of pecks made by chickens pecking at blue string is between 0.458 and 1.802.

b. Yes, there is evidence that chickens are more apt to peck at white string. The mean number of pecks at white string is 7.5. Since 7.5 is not in the 99% confidence interval for the mean number of pecks at blue string, it is not a likely value for the true mean for blue string.

1.105 a. To determine if the mean social interaction score of all Connecticut mental health patients differs from 3, we test:

$$H_0: \mu = 3$$
$$H_a: \mu \neq 3$$

The test statistic is $z = \dfrac{\overline{y} - \mu_0}{\sigma_{\overline{y}}} = \dfrac{2.95 - 3}{1.10 / \sqrt{6,681}} = -3.72$.

The rejection region requires $\alpha / 2 = 0.01 / 2 = 0.005$ in each tail of the z distribution. From Table 1, Appendix D, $z_{0.005} = 2.58$. The rejection region is $z < -2.58$ or $z > 2.58$.

Since the observed value of the test statistic falls in the rejection region $(z = -3.72 < -2.58)$, H_0 is rejected. There is sufficient evidence to indicate that the mean social interaction score of all Connecticut mental health patients differs from 3 at $\alpha = 0.01$.

b. From the test in part a, we found that the mean social interaction score was statistically different from 3. However, the sample mean score was 2.95. Practically speaking, 2.95 is very similar to 3.0. The very large sample size, $n = 6,681$, makes it very easy to find statistical significance, even when no practical significance exists.

c. Because the variable of interest is measured on a 5-point scale, it is very unlikely that the population of the ratings will be normal. However, because the sample size was extremely large, $(n = 6,681)$, the Central Limit Theorem will apply. Thus, the distribution of $\overline{y}$ will be normal, regardless of the distribution of y. Thus, the analysis used above is appropriate.

1.106 To determine if the mean alkalinity level of water in the tributary exceeds 50 mpl, we test:

$$H_0 : \mu = 50$$
$$H_a : \mu > 50$$

The test statistic is $z = \dfrac{\overline{y} - \mu_0}{s/\sqrt{n}} = \dfrac{67.8 - 50}{14.4/\sqrt{100}} = 12.36$.

The rejection region requires $\alpha = 0.01$ in the upper tail of the z distribution. From Table 1, Appendix D, $z_{0.01} = 2.33$. The rejection region is $z > 2.33$.

Since the observed value of the test statistic falls in the rejection region $(z = 12.36 > 2.33)$, H_0 is rejected. There is sufficient evidence to conclude that the mean alkalinity level of water in the tributary exceeds 50 mpl at $\alpha = 0.01$.

1.107 For this experiment let μ_1 and μ_2 represent the performance level of students in the control group and the rudeness condition group, respectively.

Using MINITAB, some preliminary calculations are:

Statistics

Variable	Condition	N	Mean	StDev
UsesBrick	Control	53	11.81	7.38
	Rude	45	8.511	3.992

To determine if the true mean performance level for students in the rudeness condition is lower than the true mean performance level for students in the control group, we want to test:

$H_0: \mu_1 - \mu_2 = 0$
$H_a: \mu_1 - \mu_2 > 0$

The test statistic is $z = \dfrac{(\bar{y}_1 - \bar{y}_2) - D_0}{\sqrt{\dfrac{s_1^2}{n_1} + \dfrac{s_2^2}{n_2}}} = \dfrac{(11.81 - 8.51) - 0}{\sqrt{\dfrac{7.38^2}{53} + \dfrac{3.992^2}{45}}} = 2.81.$

The rejection region requires $\alpha = 0.01$ in the upper tail of the z distribution. From Table 1, Appendix D, $z_{0.01} = 2.33$. The rejection region is $z > 2.33$.
Since the observed value of the test statistic falls in the rejection region $(z = 2.81 > 2.33)$, H_0 is rejected. There is significant evidence to indicate that the true mean performance level for students in the rudeness condition is lower than the true mean performance level for students in the control group at $\alpha = 0.01$.

Assumptions: This procedure requires the assumption that the samples are randomly and independently selected.

1.108 a. μ = true mean chromatic contrast of crab-spiders on daisies.

b. To determine if the true mean chromatic contrast of crab-spiders on daisies is less than 70, we test:

$H_0: \mu = 70$
$H_a: \mu < 70$

c. Using MINITAB, some descriptive statistics are:

Statistics

Variable	N	Mean	StDev
CONTRAST	10	57.5	32.6

The test statistic is $t = \dfrac{\bar{y} - \mu_0}{s/\sqrt{n}} = \dfrac{57.5 - 70}{32.6/\sqrt{10}} = -1.21.$

d. The rejection region requires $\alpha = 0.10$ in the lower tail of the t distribution. From Table 2, Appendix D, with $df = n - 1 = 10 - 1 = 9$, $t_{0.10} = 1.383$. The rejection region is $t < -1.383$.

e. Using MINITAB, some calculations are:

Test

Null hypothesis H_0: μ = 70
Alternative hypothesis H_1: μ < 70

T-Value	P-Value
-1.21	0.128

The p-value is $p = 0.128$.

f. Since the test statistics does not fall in the rejection region $\left(t = -1.21 \nless -1.383\right)$, H_0 is not rejected. There is insufficient evidence to indicate the true mean chromatic contrast of crab-spiders on daisies is less than 70 at $\alpha = 0.10$.

1.109 Let $\mu_1 =$ mean height of Australian boys who repeated a grade and $\mu_2 =$ mean height of Australian boys who never repeated a grade.

a. To determine if the average height of Australian boys who repeated a grade is less than the average height of boys who never repeated, we test:

$$H_0 : \mu_1 = \mu_2$$
$$H_a : \mu_1 < \mu_2$$

The test statistic is $z = \dfrac{\bar{y}_1 - \bar{y}_2}{\sqrt{\dfrac{s_1^2}{n_1} + \dfrac{s_2^2}{n_2}}} = \dfrac{-0.04 - 0.30}{\sqrt{\dfrac{1.17^2}{86} + \dfrac{.97^2}{1349}}} = -2.64.$

The rejection region requires $\alpha = 0.05$ in the lower tail of the z distribution. From Table 1, Appendix D, $z_{0.05} = 1.645$. The rejection region is $z < -1.645$.

Since the observed value of the test statistic falls in the rejection region $\left(z = -2.64 < -1.645\right)$, H_0 is rejected. There is sufficient evidence to indicate that the average height of Australian boys who repeated a grade is less than the average height of boys who never repeated at $\alpha = 0.05$.

b. Let $\mu_1 =$ mean height of Australian girls who repeated a grade and $\mu_2 =$ mean height of Australian girls who never repeated a grade.

To determine if the average height of Australian girls who repeated a grade is less than the average height of girls who never repeated, we test:

$$H_0 : \mu_1 = \mu_2$$
$$H_a : \mu_1 < \mu_2$$

The test statistic is $z = \dfrac{\bar{y}_1 - \bar{y}_2}{\sqrt{\dfrac{s_1^2}{n_1} + \dfrac{s_2^2}{n_2}}} = \dfrac{0.26 - 0.22}{\sqrt{\dfrac{0.94^2}{43} + \dfrac{1.04^2}{1366}}} = 0.27.$

The rejection region is $z < -1.645$.

Since the observed value of the test statistic falls in the rejection region $\left(z = 0.27 \nless -1.645\right)$, H_0 is not rejected. There is insufficient evidence to indicate that the average height of Australian girls who repeated a grade is less than the average height of girls who never repeated at $\alpha = 0.05$.

c. From the data, there is evidence to indicate that the average height of Australian boys who repeated a grade is less than the average height of boys who never repeated a grade. However, there is no evidence that the average height of Australian girls who repeated a grade is less than the average height of girls who never repeated.

1.110 To determine if the true mean lacunarity measurement for all grassland pixels differs from 220, we test:

$$H_0: \mu = 220$$
$$H_a: \mu \neq 220$$

The test statistic is $z = \frac{\bar{y} - \mu_0}{s/\sqrt{n}} = \frac{225 - 220}{20/\sqrt{100}} = 2.50.$

The rejection region requires $\alpha / 2 = 0.01/2 = 0.005$ in each tail of the z distribution. From Table 1, Appendix D, $z_{0.005} = 2.575$. The rejection region is $z < -2.575$ or $z > 2.575$.

Since the observed value of the test statistic does not fall in the rejection region $\left(z = 2.50 \ngtr 2.575\right)$, H_0 is not rejected. There is insufficient evidence to conclude that the true mean lacunarity measurement for all grassland pixels differs from 220 at $\alpha = 0.01$. There is no evidence to indicate the area sampled is not grassland.

1.111 a. Each participant acted as a speaker and an audience member

b. Let $\mu_d = \mu_{\text{speaker}} - \mu_{\text{audience}}$ = true mean number of laugh episodes for speakers minus the true mean number of laugh episodes as an audience member.

c. No, you need sample statistics for differences.

d. When testing the hypothesis: $H_0: \mu_d = 0$ vs $H_a: \mu_d \neq 0$, the *t*-test revealed that the $p < 0.01$. Thus, we can reject H_0 and conclude that there is a significant difference in the true mean number of laugh episodes for speakers and audience members for any value of $\alpha \geq 0.01$.

1.112 a. The data should be analyzed using a paired-difference analysis because that is how the data were collected. Reaction times were collected twice from each subject, once under the random condition and once under the static condition. Since the two sets of data are not independent, they cannot be analyzed using independent samples analyses.

b. Let μ_1 = mean reaction time under the random condition and μ_2 = mean reaction time under the static condition. Let $\mu_d = \mu_1 - \mu_2$. To determine if there is a difference in mean reaction time between the two conditions, we test:

$H_0: \mu_d = 0$
$H_a: \mu_d \neq 0$

c. The test statistic is $t = 1.52$ with a p-value of $p = 0.15$. Since the p-value is not small, there is no evidence to reject H_0 for any reasonable value of α. There is insufficient evidence to indicate a difference in the mean reaction times between the two conditions. This supports the researchers' claim that visual search has no memory.

1.113 a. To determine if the dairies in the tri-county market participated in collusive practices, we test:

$H_0: \mu_1 - \mu_2 = 0$
$H_a: \mu_1 - \mu_2 < 0$

The test statistic is $t = -5.58$ and the p-value is $p = 0.000$. Since the p-value is smaller than $\alpha = 0.01$ $(p = 0.000 < 0.01)$, H_0 is rejected. Therefore, we can conclude that the two mean milk price in the surrounding market is less than the mean milk price in the tri-county market at $\alpha = 0.01$. This indicates that the dairies in the tri-county market participated in collusive practices.

b. To determine if the bid price variance for the surrounding market exceeds the bid price variance for the tri-county market, we test:

$H_0: \dfrac{\sigma_1^2}{\sigma_2^2} = 1$

$H_a: \dfrac{\sigma_1^2}{\sigma_2^2} > 1$

The test statistic is $F = 1.41$ and the p-value is $p = 0.048/2 = 0.024$. If we use $\alpha = 0.05$, then the p-value is less than α $(p = 0.024 < 0.05)$ and H_0 would be rejected. There is sufficient evidence to indicate bid price variance for the surrounding market exceeds the bid price variance for the tri-county market at $\alpha = 0.05$. If we use $\alpha = 0.01$, then the p-value is not less than α $(p = 0.024 \nless 0.01)$ and H_0 would be not rejected. There is insufficient evidence to indicate bid price variance for the surrounding market exceeds the bid price variance for the tri-county market at $\alpha = 0.01$.

1.114 a. Using MINITAB, the output for comparing the mean level of family involvement in science homework assignments of TIPS and ATIPS students is:

Descriptive Statistics: SCIENCE

HWCOND	N	Mean	StDev	SE Mean
ATIPS	98	1.43	1.06	0.11
TIPS	128	2.55	1.27	0.11

Test

Null hypothesis	$H_0: \mu_1 - \mu_2 = 0$
Alternative hypothesis	$H_1: \mu_1 - \mu_2 \neq 0$

T-Value	DF	P-Value
-7.24	222	0.000

Let $\mu_1 =$ mean level of involvement in science homework assignments for ATIPS students and $\mu_2 =$ mean level of involvement in science homework assignments for TIPS students. To determine if the mean level of family involvement in science homework assignments of TIPS and ATIPS students differ, we test:

$$H_0 : \mu_1 = \mu_2$$
$$H_a : \mu_1 \neq \mu_2$$

From the printout, the test statistic is $t = -7.24$ and the p-value is $p = 0.000$. Since the p-value is less than $\alpha\left(p = 0.000 < 0.05\right)$, H_0 is rejected. There is sufficient evidence to indicate there is a difference in the mean level of family involvement in science homework assignments between TIPS and ATIPS students at $\alpha = 0.05$.

b. Using MINITAB, the output for comparing the mean level of family involvement in mathematics homework assignments of TIPS and ATIPS students is:

Descriptive Statistics: MATH

HWCOND	N	Mean	StDev	SE Mean
ATIPS	98	1.48	1.22	0.12
TIPS	128	1.56	1.27	0.11

Test

Null hypothesis	$H_0: \mu_1 - \mu_2 = 0$
Alternative hypothesis	$H_1: \mu_1 - \mu_2 \neq 0$

T-Value	DF	P-Value
-0.50	212	0.620

Let $\mu_1 =$ mean level of involvement in mathematics homework assignments for ATIPS students and $\mu_2 =$ mean level of involvement in mathematics homework assignments for TIPS students. To determine if the mean level of family involvement in mathematics homework assignments of TIPS and ATIPS students differ, we test:

$$H_0 : \mu_1 = \mu_2$$
$$H_a : \mu_1 \neq \mu_2$$

From the printout, the test statistic is $t = -0.50$ and the p-value is $p = 0.620$. Since the p-value is not less than $\alpha\left(p = 0.620 \not< 0.05\right)$, H_0 is not rejected. There is insufficient evidence to indicate a difference in the mean level of family involvement in mathematics homework assignments between TIPS and ATIPS students at $\alpha = .05$.

c. Using MINITAB, the output for comparing the mean level of family involvement in language arts homework assignments of TIPS and ATIPS students is:

Descriptive Statistics: LANGUAGE

HWCOND	N	Mean	StDev	SE Mean
ATIPS	98	1.01	1.09	0.11
TIPS	128	1.20	1.12	0.099

Test

Null hypothesis H_0: $\mu_1 - \mu_2 = 0$
Alternative hypothesis H_1: $\mu_1 - \mu_2 \neq 0$

T-Value	DF	P-Value
-1.25	211	0.212

Let $\mu_1 =$ mean level of involvement in language arts homework assignments for ATIPS students and $\mu_2 =$ mean level of involvement in language arts homework assignments for TIPS students. To determine if the mean level of family involvement in language arts homework assignments of TIPS and ATIPS students differ, we test:

$$H_0 : \mu_1 = \mu_2$$
$$H_a : \mu_1 \neq \mu_2$$

From the printout, the test statistic is $t = -1.25$ and the p-value is $p = 0.212$. Since the p-value is not less than $\alpha \left(p = 0.212 \not< 0.05 \right)$, H_0 is not rejected. There is insufficient evidence to indicate a difference in the mean level of family involvement in language arts homework assignments between TIPS and ATIPS students at $\alpha = .05$.

d. Since both sample sizes are greater than 30, the only assumption necessary is:

1. The samples are random and independent.

From the information given, there is no reason to dispute this assumption.