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 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 a. The variable of interest is earthquakes.

b. Type of ground motion is qualitative since the three motions are not on a numerical scale. Earthquake magnitude and peak ground acceleration are quantitative. Each of these variables are measured on a numerical scale.

1.4 a. The experimental unit is the object that is measured in the study. In this study, we are measuring surgical patients.

b. The variable that was measured was whether the surgical patient used herbal or alternative medicines against their doctor's advice before surgery.

c. Since the responses to the variable were either Yes or No, this variable is qualitative.

1.5 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.

1.6 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 500 surgical patients represent a sample. There are many more than 500 surgical patients.

b. Yes, the sample is representative. It says that the surgical patients were randomly selected.

1.9 a. The experimental units are the amateur boxers.

b. Massage or rest group are both qualitative; heart rate and blood lactate level are both quantitative.

c. There is no difference in the mean heart rates between the two groups of boxers (those receiving massage and those not receiving massage). Thus, massage did not affect the recovery rate of the boxers.

d. No. Only amateur boxers were used in the experiment. Thus, all inferences relate only to boxers.

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 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 can not be measured on a numerical scale.

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

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.

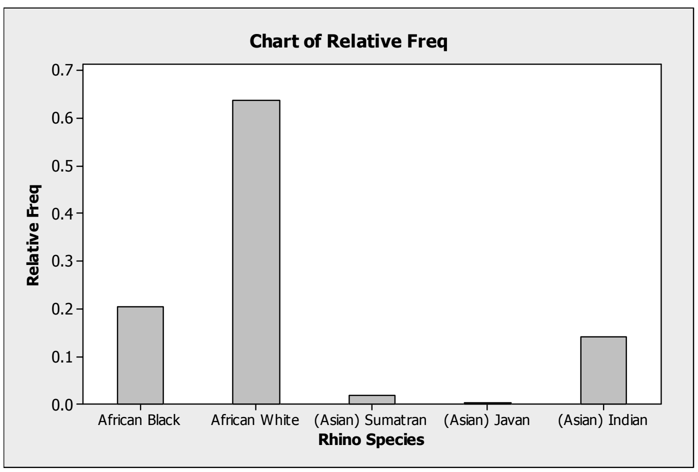
c. The Machiavellian behavior is not necessary to achieve success in the accounting profession.

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.

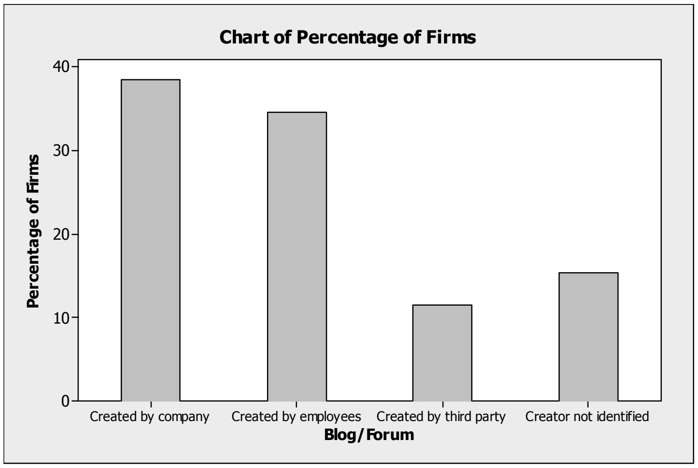
Rhino Species	**Population**	**Relative Freq**
African Black	3610	0.203
African White	11330	0.637
(Asian) Sumatran	300	0.017
(Asian) Javan	60	0.003
(Asian) Indian	2500	0.140

b.



c. African rhinos make up approximately 84% of all rhinos whereas Asian rhinos make up the remaining 16% of all rhinos.

1.14 The following bar chart shows a breakdown on the entity responsible for creating a blog/forum for a company who communicates through blogs and forums. It appears that most companies created their own blog/forum.

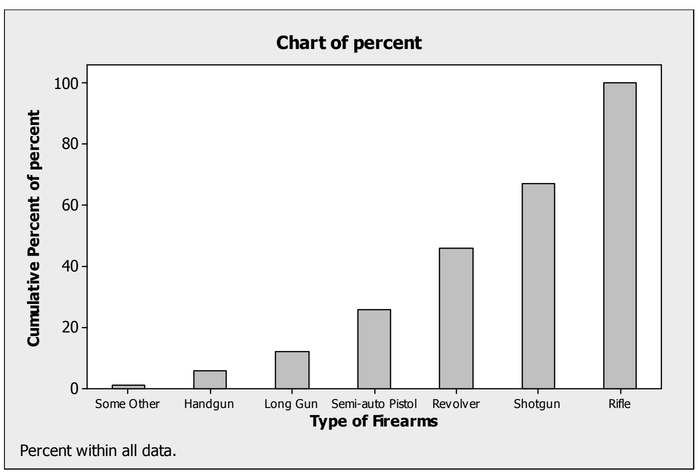


1.15 a. Pie chart

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.

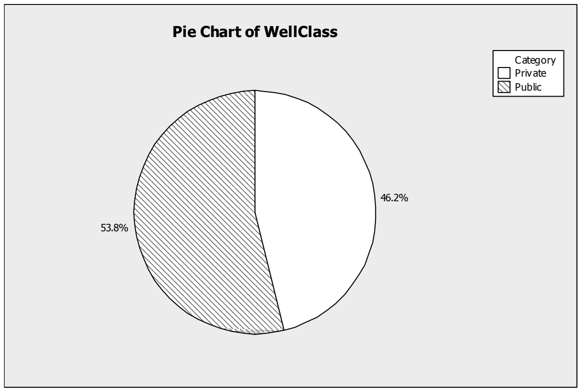


1.16 a. $\frac{196}{504} = 0.3889$ is the proportion of ice melt ponds that had landfast ice.

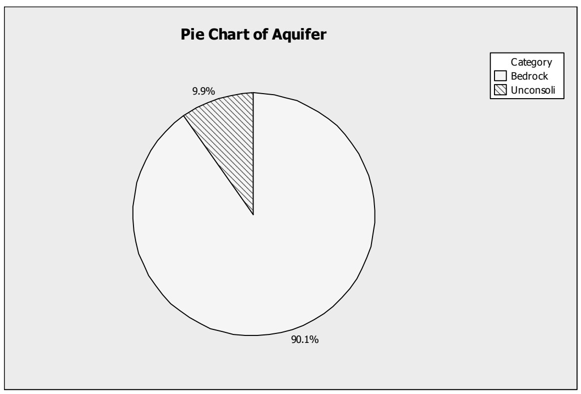
b. Yes, since $\frac{88}{504} = 0.1746$ is approximately 17%.

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.

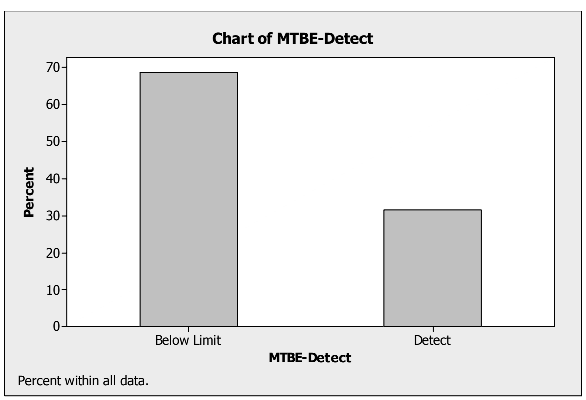
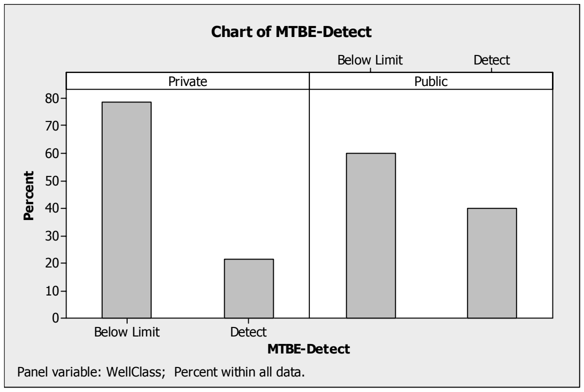


Chart of MTBE-Detect
Percent
0
10
20
30
40
50
60
70
Below Limit
Detect
MTBE-Detect
Percent within all data.

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. Data is skewed right.

1.19 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    1 001
10    1 3333
12    1 45
(2)   1 66
11    1 8999
 7    2 0011
 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.

1.20 The data is slightly skewed to the right. The bulk of the PMI scores are below 8 with a few outliers.

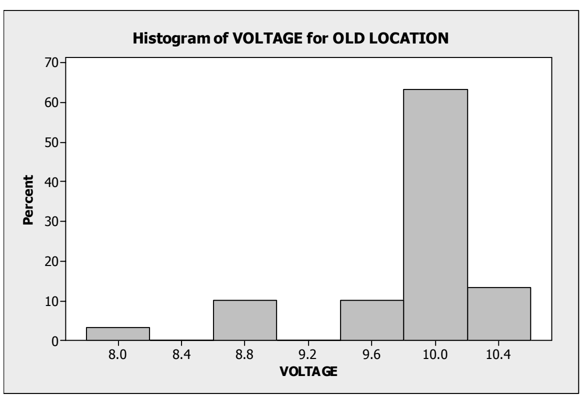
```
Stem-and-leaf of PMI  N  = 22
Leaf Unit = 0.10

1   3   3
5   4   1369
9   5   3558
(4) 6   0125
9   7   002
6   8
6   9
6   10  445
3   11  0
2   12
2   13
2   14  55
```

1.21 Yes.

1.22 a. To construct a relative frequency histogram, first calculate the range by subtracting the smallest data point (8.05) from the largest data point (10.55). Next, determine the

class width $= \frac{range}{\# of classes} = \frac{10.55 - 8.05}{7} = \frac{2.5}{7} = .4$. The classes are shown below:

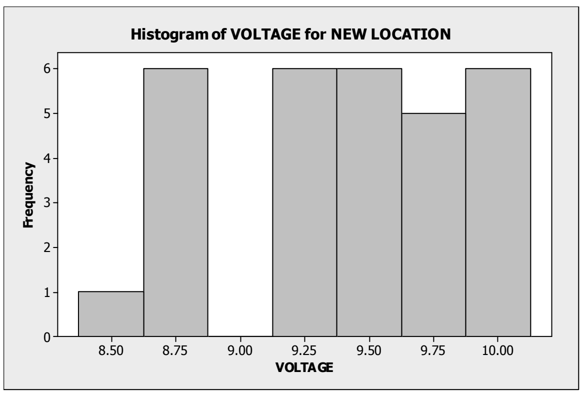
Class	Class Interval	Frequency	Relative Frequency
1	7.8 - < 8.2	1	1 / 30 = .03
2	8.2 - < 8.6	0	0 / 30 = .00
3	8.6 - < 9.0	3	3 / 30 = .10
4	9.0 - < 9.4	0	0 / 30 = .00
5	9.4 - < 9.8	3	3 / 30 = .10
6	9.8 - < 10.2	19	19 / 30 = .63
7	10.2 - < 10.6	4	4 / 30 = .13



b. The stem-and-leaf that is presented below 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.

```
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
```

c.



d. The new process appears to be better than the old process since most of the voltage is greater than 9.2 volts.

1.23 a.

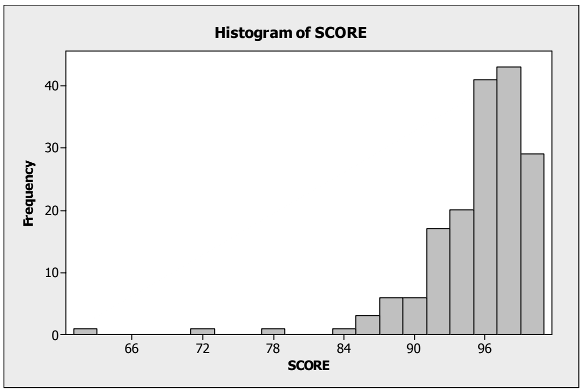
```
Stem-and-leaf of SCORE  N  = 169
Leaf Unit = 1.0

 1     6   2
 1     6
 2     7   2
 3     7   8
 4     8   4
 15    8   66677888899
 56    9   00001111111222222222233333333344444444444
(100)  9   5555555555555555555555666666666666666666677777777777777777788888 8+
 13    10  0000000000000
```

b. .98 or 98 out of every 100 ships have a sanitation score that is at least 86.

c.

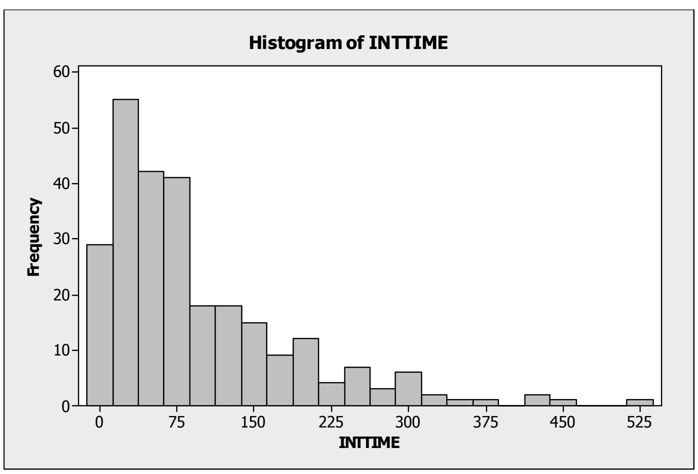
```
Stem-and-leaf of SCORE  N  = 169
Leaf Unit = 1.0

  1     6   2
  1     6
  2     7   2
  3     7   8
  4     8   4
 15     8   66677888899
 56     9   00001111111222222222233333333344444444444
(100)   9   5555555555555555555555666666666666666666777777777777777777778888+
 13    10   0000000000000
```

d.



e. Approximately 95% of the ships have an acceptable sanitation standard.

1.24 According to the histogram presented below, the data is skewed right. Answers may vary on whether the phishing attack against the organization was an "inside job."



1.25 a. 2.12; average magnitude for the aftershocks is 2.12.

b. 6.7; difference between the largest and smallest magnitude is 6.7.

c. .66; about 95% of the magnitudes fall in the interval mean $\pm$ 2(std. dev.) $= (.8, 3.4)$

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

1.26 a. Tchebysheff's theorem best describes the nicotine content data set.

b. $\bar{y} \pm 2s \Rightarrow 0.8425 \pm 2(0.345525) \Rightarrow 0.8425 \pm 0.691050 \Rightarrow (0.15145,\ 1.53355)$

c. Tchebysheff's theorem states that at least 75% of the cigarettes will have nicotine contents within the interval.

d.. Using the histogram, it appears that approximately 7-8% of the nicotine contents fall outside the computed interval. This indicates that 92-93% of the nicotine contents fall inside the computed interval. Since this interval is just an approximation, the observed findings will be said to agree with the expected 95%.

1.27 a. $\bar{y} = 94.91$, s = 4.83

b. $\bar{y} \pm 2s = 94.91 \pm 2 * 4.83 \Rightarrow (85.25, 104.57)$.

c. .976; yes

1.28 a. $\bar{y} = 50.020$, $s = 6.444$.

b. 95% of the ages should be within $\bar{y} \pm 2 * s \Rightarrow 50.02 \pm 2 * 6.444 \Rightarrow (37.132, 62.908)$

1.29 a. The average daily ammonia concentration $\bar{y}$ =

$$\frac{\sum y_i}{n} = \frac{1.53+1.50+1.37+1.51+1.55+1.42+1.41+1.48}{8}$$

$$= \frac{11.77}{8} = 1.47 \text{ ppm}$$

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

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

$$s^2 = \frac{17.3453 - \frac{(11.77)^2}{8}}{8-1} = \frac{.0287}{7} = .0041$$

$$s = \sqrt{s^2} = \sqrt{.0041} = .0640$$

We would expect about most of the daily ammonia levels to fall with $\hat{y} \pm 2s \Rightarrow 1.47 \pm 2(.0640) \Rightarrow (1.34, 1.60)$ ppm.

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

1.30 Group T: $10.5 \pm 2*7.6 \Rightarrow (-4.7, 25.7)$

Group V: $3.9 \pm 2*7.5 \Rightarrow (-11.1, 18.9)$

Group C: $1.4 \pm 2*7.5 \Rightarrow (-13.6, 16.4)$

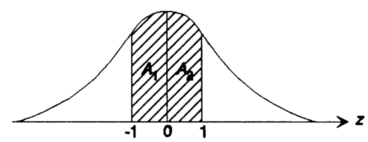
The patient is more likely to have come from Group T.

1.31 a. $(-111, 149)$

b. $(-91, 105)$

c. A student is more likely to get a 140-point increase on the SAT-Math test.

1.32 a. The probability that a normal random variable will lie between 1 standard deviation below the mean and 1 standard deviation above the mean is indicated by the shaded area in the figure:



The desired probability is:

$P(-1 \le z \le 1) = P(-1 \le z \le 0) + P(0 \le z \le 1) = A_1 + A_2.$

Now, $A_1 = P(-1 \le z \le 0)$
$= P(0 \le z \le 1)$ (by symmetry of the normal distribution)
$= .3413$ (from Table 1)

and $A_2 = P(0 \le z \le 1)$
$= .3413$ (from Table 1)

Thus, $P(-1 \le z \le 1) = .3413 + .3413 = .6826$

b. $P(-1.96 \le z \le 1.96) = P(-1.96 \le z \le 0) + P(0 \le z \le 1.96)$
$= P(0 \le z \le 1.96) + P(0 \le z \le 1.96) = .4750 + .4750 = .9500$

c. $P(-1.645 \le z \le 1.645) = P(-1.645 \le z \le 0) + P(0 \le z \le 1.645)$
$= P(0 \le z \le 1.645) + P(0 \le z \le 1.645)$

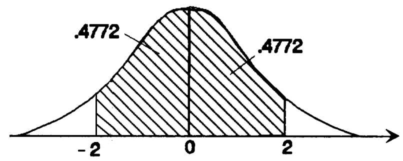
$$\text{Now, } P(0 \le z \le 1.645) = \frac{P(0 \le z \le 1.64) + P(0 \le z \le 1.65)}{2} = \frac{.4495 + .4505}{2} = .4500$$

Thus, $P(-1.645 \le z \le 1.645) = .4500 + .4500 = .9000$

d. $P(-3 \le z \le 3) = P(-3 \le z \le 0) + P(0 \le z \le 3)$
$= P(0 \le z \le 3) + P(0 \le z \le 3) = .4987 + .4987 = .9974$

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

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

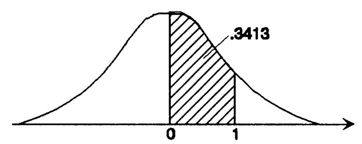


$P(\mu - 2\sigma \le y \le \mu + 2\sigma) = P(-2 \le z \le 2)$
$= P(-2 \le z \le 0) + P(0 \le z \le 2)$

Using Table 1 in Appendix D, $P(-2 \le z \le 0) = .4772$ and $P(0 \le z \le 2) = .4772$.
So $P(\mu - 2\sigma \le y \le \mu + 2\sigma) = .4772 + .4772 = .9544$

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

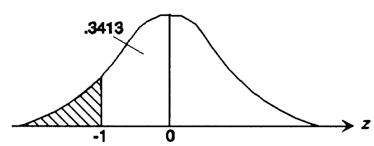
$P(y \ge 108) = P(z \ge 1)$



Using Table 1 of Appendix D, we find $P(0 \le z \le 1) = .3413$, so
$P(z \ge 1) = .5 - .3413 = .1587$

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

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

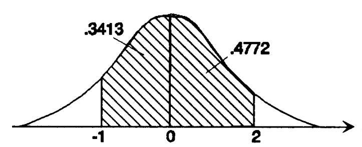


Using Table 1 of Appendix D, we find $P(-1 \le z \le 0) = .3413$, so
$P(z \le -1) = .5 - .3413 = .1587$

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

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

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

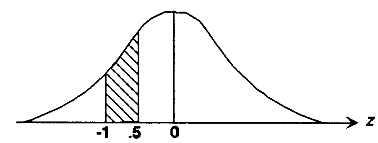


Using Table 1 of Appendix D, $P(-1 \le z \le 0) = .3413$ and
$P(0 \le z \le 2) = .4772$. So $P(92 \le y \le 116) = P(-1 \le z \le 2)$
$= .3413 + .4772 = .8185$.

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 $z = \dfrac{y-\mu}{\sigma} = \dfrac{96-100}{8} = -.5$

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

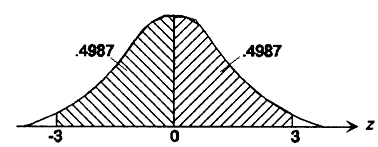


Using Table 1 of Appendix D, $P(-1 \le z \le 0) = .3413$ and $P(-.5 \le z \le 0) = .1915$. So $P(92 \le y \le 96)$ $= P(-1 \le z \le -.5) = .3413 - .1915 = .1498$.

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, $P(-3 \le z \le 0) = .4987$ and $P(0 \le z \le 3) = .4987$. So $P(76 \le y \le 124) =$ $P(-3 \le z \le 3) = .4987 + .4987 = .9974$.

1.34 a. Let y = transmission delay of an RSVP liked to a wireless device. Using Table 1, Appendix D,

$$P(y < 57) = P\left(Z < \frac{57-48.5}{8.5}\right) = P(Z < 1.00) = 0.5 + 0.3413 = 0.8413$$

b. Using Table 1, Appendix D,

$$P(40 < y < 60) = P\left(\frac{40-48.5}{8.5} < Z < \frac{60-48.5}{8.5}\right) = P(-1.00 < Z < 1.35)$$
$$= 0.3413 + 0.4115 = 0.7528$$

1.35 a. Let x = alkalinity level of water specimens collected from the Han River.

Using Table 1, Appendix D,

$$P(y > 45) = P\left(z > \frac{45-50}{3.2}\right) = P(z > -1.56) = .5 + .4406 = .9406.$$

b. Using Table 1, Appendix D,

$$P(y < 55) = P\left(z < \frac{55-50}{3.2}\right) = P(z < 1.56) = .5 + .4406 = .9406.$$

c. Using Table 1, Appendix D,

$$P(51 < y < 52) = P\left(\frac{51-50}{3.2} < z < \frac{52-50}{3.2}\right) = P(.31 < z < .63) = .2357 - .1217 = .1140.$$

1.36 Half of 90% is 45%, so the Z score should be found to be 1.645 as in problem #33, when calculating a confidence interval instead of a Z score value of 2 for a 95% confidence interval. Therefore the range should be in either $64 \pm 1.645 * 2.6 \Rightarrow (59.72, 68.28)$.

1.37 a. Using Table 1, Appendix D,

$$P(40 < y < 50) = P\left(\frac{40-37.9}{12.4} < z < \frac{50-37.9}{12.4}\right) = P(.17 < z < .98)$$
$$= .3365 - .0675 = .2690.$$

b. Using Table 1, Appendix D,

$$P(y < 30) = P\left(z < \frac{30-37.9}{12.4}\right) = P(z < -.64) = .5 - .2389 = .2611.$$

c. We know that if $P(z_L < z < z_U) = .95,$ then $P(z_L < z < 0) + P(0 < z < z_U) = .95$ and

$$P(z_L < z < 0) = P(0 < z < z_U) = .95/2 = .4750.$$

Using Table 1, Appendix D, $z_U = 1.96$ and $z_L = -1.96.$

$$P(y_L < y < y_U) = .95 \Rightarrow P\left(\frac{y_L - 37.9}{12.4} < z < \frac{y_U - 37.9}{12.4}\right) = .95$$

$$\Rightarrow \frac{y_L - 37.9}{12.4} = -1.96 \quad \text{and} \quad \frac{y_U - 37.9}{12.4} = 1.96$$

$$\Rightarrow y_L - 37.9 = -24.3 \quad \text{and} \quad y_U - 37.9 = 24.3 \Rightarrow y_L = 13.6 \text{ and } y_U = 62.2$$

1.38 a. Let *y* = gestation length. Using Table 1, Appendix D,

$$P(275.5 < y < 276.5) = P\left(\frac{275.5-280}{20} < z < \frac{276.5-280}{20}\right) = P(-.23 < z < -.18)$$
$$= .0910 - .0714 = .0196.$$

b. Using Table 1, Appendix D,

$$P(258.5 < y < 259.5) = P\left(\frac{258.5-280}{20} < z < \frac{259.5-280}{20}\right)$$
$$= P(-1.08 < z < -1.03) = .3599 - .3485 = .0114.$$

c. Using Table 1, Appendix D,

$$P(254.5 < y < 255.5) = P\left(\frac{254.5-280}{20} < z < \frac{255.5-280}{20}\right) = P(-1.28 < z < -1.23)$$
$$= .3997 - .3907 = .0090.$$

e. If births are independent, then

P(baby 1 is 4 days early ∩ baby 2 is 21 days early ∩ baby 3 is 25 days early)

= *P*(baby 1 is 4 days early) P(baby 2 is 21 days early) P(baby 3 is 25 days early)

$= .0196 * .0114 * .0090 \approx$ 2 / (1 million).

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

1.40 a. The relative frequency distribution is:

Value	Frequency	Relative Frequency
0	26	26/300 = .087
1	30	30/300 = .100
2	24	.080
3	29	.097
4	31	.103
5	25	.083
6	42	.140
7	36	.120
8	27	.090
9	30	.100
	300	1.000

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

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

d. The 50 sample means are:

4.833	4.500	4.500	5.667
4.667	5.000	4.167	5.000
5.167	4.667	5.333	4.167
4.500	5.333	3.833	2.500
5.667	3.833	4.333	2.667
5.000	4.167	4.833	5.500
7.333	4.000	3.500	2.167
5.833	3.333	3.500	7.000
4.000	4.333	6.833	5.833
6.167	4.000	6.833	2.667
3.167	3.833	5.833	5.667
4.833	5.167	3.833	5.500
5.500	3.500		

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

Sample Mean	Frequency	Relative Frequency
2.000 - 2.999	4	4/50 = .08
3.000 - 3.999	9	9/50 = .18
4.000 - 4.999	16	.32
5.000 - 5.999	16	.32
6.000 - 6.999	3	.06
7.000 - 7.999	2	.04
	50	1.00

The mean of the sample means is:

$$\bar{\bar{y}} = \frac{\sum y_i}{n} = \frac{234}{50} = 4.68$$

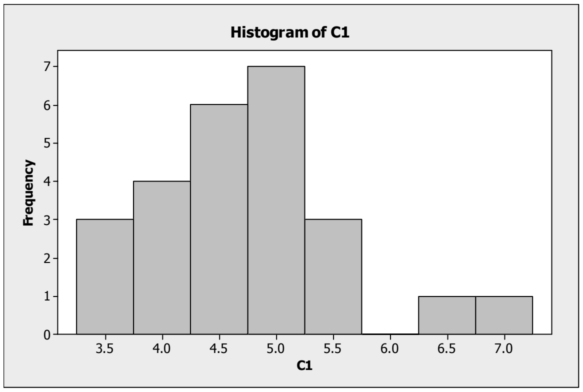
$$s_{\bar{y}}^2 = \frac{\sum \bar{y}^2 - \frac{\left(\sum \bar{y}\right)^2}{n}}{n-1} = \frac{1162.483337 - \frac{234^2}{50}}{50-1} = 1.375$$

1.41 a. The twenty-five means are:

4.75	4.58	4.00
4.83	4.58	4.92
5.33	3.50	3.92
6.58	5.33	4.33
4.75	3.33	6.83
5.00	4.08	4.83
4.00	4.58	4.25
3.67	5.08	5.58
4.33		

Class	Frequency	Relative Frequency
3.20 - 3.70	3	3/25 = .12
3.70 - 4.20	4	4/25 = .16
4.20 - 4.70	6	6/25 = .24
4.70 - 5.20	7	7/25 = .28
5.20 - 5.70	3	3/25 = .12
5.70 - 6.20	0	0/25 = .00
6.20 - 6.70	1	1/25 = .04
6.70 - 7.20	1	1/25 = .04

We can see that the histogram is less spread out than in the previous problem.



The mean of the sampling distribution is 4.680 and the standard deviation is .838. As expected, the standard deviation is smaller.

b. $\bar{\bar{y}} = \frac{\sum_{i=1}^{n} \bar{y}_i}{n} = \frac{117}{25} = 4.68$ $\qquad S_{\bar{y}} = \frac{\sum\left(\bar{y}_i - \bar{\bar{y}}\right)^2}{n-1} = \frac{20.112}{25-1} = .838$

This standard deviation is smaller than the one in the previous problem. Since the sample size is larger in this problem, we expect the standard deviation of $\bar{y}_i$'s to be smaller.

1.42 a. For df = $n - 1 = 10 - 1 = 9$, $t_0 = 2.262$ yields $P(t \geq t_0) = .025$

b. For df = $n - 1 = 5 - 1 = 4$, $t_0 = 3.747$ yields $P(t \geq t_0) = .01$

c. For df = $n - 1 = 20 - 1 = 19$, $t_0 = -2.861$ yields $P(t \leq t_0) = .005$

d. For df = $n - 1 = 12 - 1 = 11$, $t_0 = -1.796$ yields $P(t \leq t_0) = .05$

1.43 a. $E\left(\bar{y}\right) = \mu_{\bar{y}} = \mu = 0.10 \qquad Var\left(\bar{y}\right) = \frac{\sigma^2}{n} = \frac{(0.10)^2}{50} \cong 0.0002 \qquad \sigma_{\bar{y}} = \frac{s}{\sqrt{n}} = \frac{0.10}{\sqrt{50}} \cong 0.0141$

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

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

1.44 a. The difference between the aggressive behavior level of an individual who scored high on a personality test and an individual who scored low on the test is the parameter of interest for "y-Effect Size".

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 zero is not included in the interval.

1.45 a. For confidence coefficient .99, $\alpha = .01$ and $\alpha / 2 = .01/2 = .005$. From Table 1, Appendix D, $z_{.005} = 2.58$. The confidence interval is:

$$\bar{y} \pm z_{\alpha/2}\frac{s}{\sqrt{n}} \Rightarrow 1.13 \pm 2.58\left(\frac{2.21}{\sqrt{72}}\right) \Rightarrow 1.13 \pm .67 \Rightarrow (.46,\ 1.80)$$

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

1.46 Some preliminary calculations:

$$\bar{y} = \frac{\sum y}{n} = \frac{6.44}{6} = 1.073$$

$$s^2 = \frac{\sum y^2 - \frac{\left(\sum y\right)^2}{n}}{n-1} = \frac{7.1804 - \frac{6.44^2}{6}}{6-1} = .0536$$

$$s = \sqrt{.0536} = .2316$$

a. For confidence coefficient .95, $\alpha = .05$ and $\alpha / 2 = .05/2 = .025$. From Table 2, Appendix D, with $\text{df} = n - 1 = 6 - 1 = 5$, $t_{.025} = 2.571$. The confidence interval is:

$$\bar{y} \pm t_{\alpha/2}\frac{s}{\sqrt{n}} \Rightarrow 1.073 \pm 2.571\left(\frac{.2316}{\sqrt{6}}\right) \Rightarrow 1.073 \pm .243 \Rightarrow (.830,\ 1.316)$$

We are 95% confident that the true average decay rate of fine particles produced from oven cooking or toasting is between .830 and 1.316

b. The phrase "95% confident" means that in repeated sampling, 95% of all confidence intervals constructed will contain the true mean.

c. In order for the inference above to be valid, the distribution of decay rates must be normally distributed.

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

b. From Table 1 of Appendix D, $Z = 1.96$

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

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.

1.48 a. The 95% confidence interval for the mean failure time 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. 95 out of 100 repeated samples will generate the true mean failure time.

1.49 Using Table 2, Appendix D,

$$\bar{y} \pm t_{\alpha/2}\left(\frac{s}{\sqrt{n}}\right) = \bar{y} \pm t_{0.005}\left(\frac{s}{\sqrt{n}}\right) = 19 \pm 3.055\left(\frac{2.2}{\sqrt{13}}\right) = 19 \pm 1.9 \Rightarrow (17.1, 20.9)$$

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

1.50 a. $20.9 \pm 1.701\left(\frac{3.34}{\sqrt{29}}\right) = 20.9 \pm 1.1 \Rightarrow (19.8, 22.0)$ I'm 90% confident that the true mean number of eggs that a male and female pair of infected spider mites produced is between 19.8 and 22.0.

$20.3 \pm 1.717\left(\frac{3.50}{\sqrt{23}}\right) = 20.3 \pm 1.3 \Rightarrow (19, 21.6)$ I'm 90% confident that the true mean number of eggs that a treated male infected spider mite produced is between 19 and 21.6.

$22.9 \pm 1.740\left(\frac{4.37}{\sqrt{18}}\right) = 22.9 \pm 1.8 \Rightarrow (21.1, 24.7)$ I'm 90% confident that the true mean number of eggs that a treated female infected spider mite produced is between 21.1 and 24.7.

$18.6 \pm 1.725\left(\frac{2.11}{\sqrt{21}}\right) = 18.6 \pm 0.8 \Rightarrow (17.8, 19.4)$ I'm 90% confident that the true mean number of eggs that a male and female treated pair of infected spider mites produced is between 17.8 and 19.4.

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

1.51 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 do not reject the null hypothesis when the null hypothesis is in fact not true.

e. Probability of Type I error is α

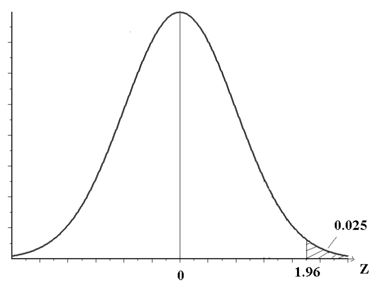
f. Probability of Type II error is β

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.

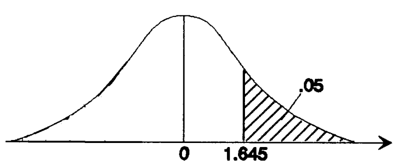
1.52 a. The rejection region is determined by the sampling distribution of the test statistic, the direction of the test (>, <, or ≠), and the tester's choice of α.

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.

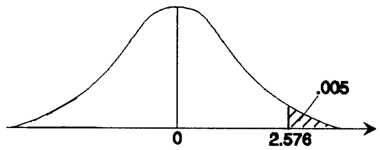
1.53 a. $\alpha = P$ (reject H_0 when H_0 is in fact true)
$= P(z > 1.96) = .025$



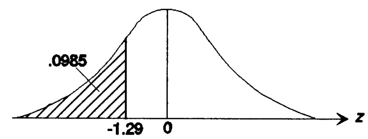
b. $\alpha = P(z > 1.645) = .05$.



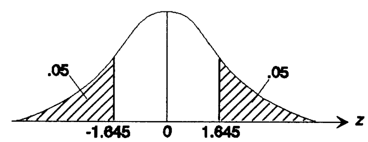
c. $\alpha = P(z > 2.576) = .005.$



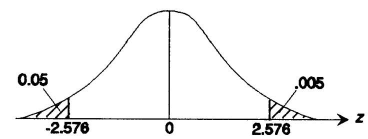
d. $\alpha = P(z < -1.29) = .0985.$



e. $\alpha = P(z < -1.645 \text{ or } z > 1.645)$
$= .05 + .05 = .10$



f. $\alpha = P(z < -2.576 \text{ or } z > 2.576)$
$= .005 + .005 = .01$



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

$H_0 : \mu = 2400$
$H_a : \mu > 2400$

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 there was not enough evidence to reject the null hypothesis that the true mean was equal to \$2400.

c. $\alpha = 0.05 =$ P(reject H_0 when H_0 is in fact true) $= \text{P}(z > 1.645)$.
The rejection region is $z > 1.645$.

1.55 a. To determine if the average level of mercury uptake in wading birds in the Everglades in 2000 is less than 15 parts per million, we test:

$H_0 : \mu = 15$
$H_a : \mu < 15$

b. A Type I error is rejecting H_0 when H_0 is true. In terms of this problem, we would be concluding that the average level of mercury uptake in wading birds in the Everglades in 2000 is less than 15 parts per million, when in fact, the average level of mercury uptake in wading birds in the Everglades in 2000 is equal to 15 parts per million.

c. A Type II error is accepting H_0 when H_0 is false. In terms of this problem, we would be concluding that the average level of mercury uptake in wading birds in the Everglades in 2000 is equal to 15 parts per million, when in fact, the average level of mercury uptake in wading birds in the Everglades in 2000 is less than 15 parts per million.

1.56 a. $\mu =$ true mean chromatic contrast of crab-spiders on daisies.

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

c. The test statistic is $t = \dfrac{\bar{y} - \mu_0}{\sigma_{\bar{y}}} = \dfrac{57.5 - 70}{\frac{32.6}{\sqrt{10}}} = -1.21$

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

e. $P - \text{value} = 0.1283.$

f. Since the $p-$ value $= 0.1283 > \alpha = 0.05$, then we can not reject the null hypothesis and conclude that there is not enough evidence to conclude that the true mean chromatic contrast of crab-spiders on daisies is less than 70.

1.57 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 $z = \dfrac{\bar{y} - \mu_0}{\sigma_{\bar{y}}} = \dfrac{2.95 - 3}{1.10 / \sqrt{6,681}} = -3.72$

The rejection region requires $\alpha / 2 = .01 / 2 = .005$ in each tail of the z distribution. From Table 1, Appendix D, $z_{.005} = 2.58$. 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 $\alpha = .01$.

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, $n = 6681$, 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, $(n = 6681)$, the Central Limit Theorem will apply. Thus, the distribution of $\bar{y}$ will be normal, regardless of the distribution of *y*. Thus, the analysis used above is appropriate.

1.58 Let μ = true mean heart rate during laughter. We will test : $\begin{array}{l} H_0 : \mu = 71 \\ H_a : \mu > 71 \end{array}$

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

The $\text{p} - \text{value} = 0.00004 < \alpha = 0.05$, then we can reject the null hypothesis and conclude that the true mean is greater than 71 beats/minute.

1.59 a. The test statistic is $z = \dfrac{\bar{y} - \mu_0}{\sigma_{\bar{y}}} = \dfrac{10.2 - 0}{31.3/\sqrt{50}} = 2.3$

b. To determine if the mean level of feminization differs from 0%, we test:

$$H_0 : \mu = 0$$
$$H_\text{a} : \mu \neq 0$$

Since the alternative hypothesis contains $\neq$, this is a two-tailed test. The *p*-value is $p = P(z \leq -2.3) + P(z \geq 2.3) = .5 - P(-2.3 < z < 0) + .5 - P(0 < z < 2.3) =$ $.5 - .4893 + .5 - .4893 = .0214$. Reject H_0.

c. The test statistic is $z = \dfrac{\bar{y} - \mu_0}{\sigma_{\bar{y}}} = \dfrac{15 - 0}{25.1/\sqrt{50}} = 4.23.$

Since the alternative hypothesis contains $\neq$, this is a two-tailed test. The *p*-value is $p = P(z \leq -4.23) + P(z \geq 4.23) = .5 - P(-4.23 < z < 0) + .5 - P(0 < z < 4.23) \approx$ $.5 - .5 + .5 - .5 = 0$. Reject H_0.

1.60 Let μ = true mean lacunarity measurement for all grasslands. We will test: $\begin{array}{l} H_0 : \mu = 220 \\ H_a : \mu \neq 220 \end{array}$

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

The $\text{p} - \text{value} = 0.0124 > \alpha = 0.01$, then we can not reject the null hypothesis and conclude that the area sampled is grassland.

1.61 Some preliminary calculations are:

$$\bar{y} = \frac{\sum y}{n} = \frac{110}{5} = 22$$

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

$$s = \sqrt{s^2} = \sqrt{4} = 2$$

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

$H_0: \mu = 15$
$H_a: \mu \neq 15$

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 $\alpha = .01$. The rejection region requires $\alpha/2 = .01/2 = .005$ in each tail of the t distribution with df $= n-1 = 5-1 = 4$. From Table 2, Appendix D, $t_{.005} = 4.604$. The rejection region is $t < -4.604$ or $t > 4.604$.

Since the observed value of the test statistic falls in the rejection region $(t = 7.83 > 4.604), H_0$ is rejected. There is sufficient evidence to indicate the mean data collected were fabricated at $\alpha = .01$.

1.62 a. Let $\mu =$ true mean heat rate of gas turbines augmented with high pressure inlet fogging.

We will test: $H_0: \mu = 10000$
$H_a: \mu > 10000$

The test statistic is $z = \dfrac{\bar{y} - \mu_0}{\frac{s}{\sqrt{n}}} = \dfrac{11066.4 - 10000}{\frac{1595}{\sqrt{67}}} = 5.47$

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 10000 kJ/kWh.

b. Type I error is committed when the decision is made based on the sample information is to reject the null hypothesis of the true mean being equal to 10000 when, in fact, the null hypothesis is true. Type II error is committed when the decision is made based on the sample information to accept the null hypothesis, when in fact, the null hypothesis is false.

1.63 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.

1.64 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.

1.65 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:
$H_0: \mu_1 - \mu_2 = 0$ (i.e. no difference in mean ratings)
$H_a: \mu_1 - \mu_2 \neq 0$ (i.e. $\mu_1 \neq \mu_2$)

Calculate the pooled estimate of variance:

$$s_p^2 = \frac{(n_1-1)s_1^2 + (n_2-1)s_2^2}{n_1+n_2-2} = \frac{(26-1)(12.5)^2 + (26-1)(12.2)^2}{26+26-2} = 152.545$$ where s_p^2 is based on $(n_1+n_2-2) = (26+26-2) = 50$ degrees of freedom.

Now we compute the test statistic:

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

The rejection region for this two-tailed test at $\alpha = 0.05$, based on 50 degrees of freedom is $|t| > t_{0.025} = 2.009$. Since the computed t value does not fall in the rejection region, we fail to reject the null hypothesis. There is insufficient evidence of a difference between the true mean rating scores for the two groups.

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

1.66 Let μ_1 = mean FNE scores for bulimic students and μ_2 = mean FNE score for normal students.

Some preliminary calculations are:

$$\bar{y}_1 = \frac{\sum y_1}{n_1} = \frac{196}{11} = 17.82$$

$$s_1^2 = \frac{\sum y_1^2 - \frac{(\sum y_1)^2}{n_1}}{n_1 - 1} = \frac{3,734 - \frac{196^2}{11}}{11-1} = 24.1636$$

$$s_1 = \sqrt{s_1^2} = \sqrt{24.1636} = 4.916$$

$$\bar{y}_2 = \frac{\sum y_2}{n_2} = \frac{198}{14} = 14.14$$

$$s_2^2 = \frac{\sum y_2^2 - \frac{\left(\sum y_2\right)^2}{n_2}}{n_2 - 1} = \frac{3{,}164 - \frac{198^2}{14}}{14-1} = 27.9780$$

$$s_2 = \sqrt{s_2^2} = \sqrt{27.9780} = 5.289$$

$$s_p^2 = \frac{(n_1 - 1)s_1^2 + (n_2 - 1)s_2^2}{n_1 + n_2 - 2} = \frac{(11-1)24.1636 + (14-1)27.9780}{11+14-2} = 26.3196$$

a. For confidence coefficient $.95, \alpha = .05$ and $\alpha / 2 = .05 / 2 = .025$. From Table 2, Appendix D, with $\text{df} = n_1 + n_2 - 2 = 11 + 14 - 2 = 23$, $t_{.025} = 2.069$. The confidence interval is:

$$\left(\bar{y}_1 - \bar{y}_2\right) \pm t_{.025}\sqrt{s_p^2\left(\frac{1}{n_1} + \frac{1}{n_2}\right)} \Rightarrow$$

$$(17.82 - 14.14) \pm 2.069\sqrt{26.3196\left(\frac{1}{11} + \frac{1}{14}\right)}$$

$$\Rightarrow 3.68 \pm 4.277 \Rightarrow (-.597,\ \ 7.957)$$

We are 95% confident that the difference in mean FNE scores for bulimic and normal students is between $-.597$ and 7.957.

b. 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.

1.67 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. Then we want to test:

$H_0 : \mu_1 - \mu_2 = 0$ (i.e. no difference in mean ratings)
$H_a : \mu_1 - \mu_2 > 0$ (i.e. $\mu_1 > \mu_2$)

Calculate the pooled estimate of variance:

$s_p^2 = \frac{(n_1 - 1)s_1^2 + (n_2 - 1)s_2^2}{n_1 + n_2 - 2} = \frac{(53-1)(7.38)^2 + (45-1)(3.992)^2}{53+45-2} = 36.806$ where s_p^2 is based on $(n_1 + n_2 - 2) = (53 + 45 - 2) = 96$ degrees of freedom.

Now we compute the test statistic:

$$t = \frac{(\bar{y}_1 - \bar{y}_2) - D_0}{\sqrt{s_p^2\left(\frac{1}{n_1} + \frac{1}{n_2}\right)}} = \frac{(11.81 - 8.51) - 0}{\sqrt{36.806\left(\frac{1}{53} + \frac{1}{45}\right)}} = 2.68$$

Since the $p-\text{value} = .0043 < \alpha = 0.01$, we reject the null hypothesis and conclude that there is significant evidence 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.

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

1.68 From the printout, the 95% confidence interval for the difference in mean seabird densities of oiled and unoiled transects is $(-2.93, 2.49)$. We are 95% confident that the true difference in mean seabird densities of oiled and unoiled transects is between -2.93 and 2.49. Since 0 is contained in the interval, there is no evidence to indicate that the mean seabird densities are different for the oiled and unoiled transects.

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

```
Two sample T for GSHWS

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

95% CI for mu (ATIPS) - mu (TIPS ): ( -1.43,  -0.82)
T-Test mu (ATIPS) = mu (TIPS ) (vs not =): T = -7.24 P = 0.0000 DF = 222
```

Let $\mu_1 =$ mean level of involvement in science homework assignments for TIPS students and $\mu_2 =$ mean level of involvement in science homework assignments for ATIPS students.
To compare the mean level of family involvement in science homework assignments of TIPS and ATIPS students, 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 $p = .0000$. Since the *p*-value is less than $\alpha\left(p = .0000 < .05\right), H_0$ is rejected. There is sufficient evidence to indicate a difference in the mean level of family involvement in science homework assignments between TIPS and ATIPS students at $\alpha = .05$.

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

```
Two sample T for MTHHWS

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

95% CI for mu (ATIPS) - mu (TIPS ): ( -0.41,  0.25)
T-Test mu (ATIPS) = mu (TIPS ) (vs not =): T = -0.50  P = 0.62  DF = 212
```

Let $\mu_1 =$ mean level of involvement in mathematics homework assignments for TIPS students and $\mu_2 =$ mean level of involvement in mathematics homework assignments for ATIPS students.

To compare the mean level of family involvement in mathematics homework assignments of TIPS and ATIPS students, 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 $p = .62$. Since the p-value is not less than $\alpha\left(p = .62 > .05\right), H_0$ 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:

```
Two sample T for LAHWS

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

95% CI for mu (ATIPS) - mu (TIPS ): ( -0.48,  0.106)
T-Test mu (ATIPS) = mu (TIPS ) (vs not =): T = -1.25  P = 0.21  DF = 211
```

Let $\mu_1 =$ mean level of involvement in language arts homework assignments for TIPS students and $\mu_2 =$ mean level of involvement in language arts homework assignments for ATIPS students. To compare the mean level of family involvement in language arts homework assignments of TIPS and ATIPS students, 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 $p = .21$. Since the p-value is not less than $\alpha\left(p = .21 > .05\right), H_0$ 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.

1.70 a. The general form of a large sample 90% confidence interval for $(\mu_1 - \mu_2)$ is:

$$(\bar{y}_1 - \bar{y}_2) \pm z_{.05}\sqrt{\frac{\sigma_1^2}{n_1} + \frac{\sigma_2^2}{n_2}}$$

Using s_1^2 and s_2^2 to estimate σ_1^2 and σ_2^2, and substituting the values of the sample statistics yields:

$$(9.80 - 9.42) \pm 1.645\sqrt{\frac{.5409^2}{30} + \frac{.4789^2}{30}} \Rightarrow .38 \pm .217 \Rightarrow (.163,\ .597)$$

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.

1.71 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 $p-$value $< .01$. 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.

1.72 For this paired data set let $\mu_d = \mu_1 - \mu_2 =$ before – after. Then we want to test the hypothesis:

$H_0: \mu_d = 0$

$H_a: \mu_d \neq 0$

Note: We must assume that the population of differences in the number of crashes is approximately normally distributed.

```
        Paired T for Before - After

              N   Mean  StDev  SE Mean
Before       13  2.513  1.976    0.548
After        13  1.506  1.448    0.402
Difference   13  1.007  1.209    0.335

95% CI for mean difference: (0.276, 1.738)
T-Test of mean difference = 0 (vs not = 0): T-Value = 3.00  P-Value = 0.011
```

From the MINITAB printout we can reject the null hypothesis, since the *p*-value is less than the significance level of 0.05. Therefore, there is a significant difference in the number of crashes since the implementation of the red light cameras.

We could have also tested the following hypothesis: $H_0 : \mu_d = 0$
$H_a : \mu_d > 0$

```
    Paired T for Before - After

    N   Mean  StdDev  SE Mean
 Before      13  2.513  1.976    0.548
 After       13  1.506  1.448    0.402
 Difference  13  1.007  1.209    0.335


95% lower bound for mean difference: 0.409
T-Test of mean difference = 0 (vs > 0): T-Value = 3.00  P-Value = 0.006
```

1.73 a. Let $\mu_1 - \mu_2 = \text{FULLDARK-TRLIGHT}$. Then we want to test the hypothesis:

$H_0 : \mu_1 - \mu_2 = 0$

$H_a : \mu_1 - \mu\ _2 \neq 0$ no difference

Assumption: The population differences between the mean standardized growth of genes in the full-dark condition and the genes in the transient light condition are approximately normally distributed.

```
Two-sample T for fulldark vs trlight

              N    Mean   StdDev  SE Mean
fulldark      10  -0.285  0.435     0.14
trlight       10   0.93   1.21      0.38

Difference = mu (fulldark) - mu (trlight)
Estimate for difference:  -1.212
99% CI for difference:  (-2.478, -0.055)
T-Test of difference = 0 (vs not =): T-Value = -2.97  P-Value = 0.016  DF = 11
```

Since the *p*-value is greater than 0.01, we can not conclude that the true means are significantly different.

b. $H_0 : \mu_1 - \mu_2 = 0$

$H_a : \mu_1 - \mu\ _2 \neq 0$ no difference

Assumption: The population differences between the mean standardized growth of genes in the full-dark condition and the genes in the transient light condition are approximately normally distributed.

```
Two-sample T for FULL-DARK vs TR-LIGHT

             N    Mean  StdDev  SE Mean
FULL-DARK  103   -0.318  0.597    0.059
TR-LIGHT   103    0.10   1.14     0.11


Difference = mu (FULL-DARK) - mu (TR-LIGHT)
Estimate for difference:  -0.420
99% CI for difference:  (0.090, 0.750)
T-Test of difference = 0 (vs not =): T-Value = -3.32  P-Value = 0.001  DF = 154
```

No, the sample of the first ten observations did not show any difference, but the entire sample of 103 has a *p*-value of .001 which indicates that there is a significant difference in the means.

c. Let $\mu_1 - \mu_2 = \text{FULLDARK-TRDARK}$. Then we want to test the hypothesis:

$H_0 : \mu_1 - \mu_2 = 0$

$H_a : \mu_1 - \mu\ _2 \neq 0$ no difference

Assumption: The population differences between the mean standardized growth of genes in the full-dark condition and the genes in the transient light condition are approximately normally distributed.

```
Two-sample T for FULL-DARK vs TR-DARK

            N    Mean  StDev  SE Mean
FULL-DARK  10  -0.285  0.435     0.14
TR-DARK    10  -0.425  0.567     0.18


Difference = mu (FULL-DARK) - mu (TR-DARK)
Estimate for difference:  0.140
99% CI for difference:  (-0.520, 0.801)
T-Test of difference = 0 (vs not =): T-Value = 0.57  P-Value = 0.58  DF = 16
```

No difference in the means with the first ten data points since the *p*-value is only .543. When all 103 data points are used, there is still not a significant difference in the full-dark and transient-dark at the .01 significance level since the *p*-value is .017 as seen below.

```
     Two-sample T for FULL-DARK vs TR-DARK

                 N    Mean  StDev  SE Mean
FULL-DARK      103  -0.318  0.597    0.059
TR-DARK        103  -0.091  0.746    0.073

Difference = mu (FULL-DARK) - mu (TR-DARK)
Estimate for difference:  -0.2274
99% CI for difference:  (-0.472, 0.0174)
T-Test of difference = 0 (vs not =): T-Value = -2.42  P-Value = 0.017 DF = 194
```

d. Let $\mu_1 - \mu_2 =$ TRLIGHT-TRDARK . Then we want to test the hypothesis:

$H_0 : \mu_1 - \mu_2 = 0$

$H_a : \mu_1 - \mu_2 \neq 0$ no difference

Assumption: The population differences between the mean standardized growth of genes in the full-dark condition and the genes in the transient light condition are approximately normally distributed.

```
        Two-sample T for TR-LIGHT vs TR-DARK

               N    Mean  StDev  SE Mean
TR-LIGHT  10    0.93   1.21     0.38
TR-DARK   10  -0.425  0.567     0.18

Difference = mu (TR-LIGHT) - mu (TR-DARK)
Estimate for difference:  1.352
99% CI for difference:  (-0.058, 2.646)
T-Test of difference = 0 (vs not =): T-Value = 3.23  P-Value = 0.01  DF = 12
```

Yes, there is a significant difference between the transient dark and transient light means of the first ten data points since the *p*-value is .008 as presented above. However, when all 103 data points are used in the analysis which is presented below we see that the *p*-value is .153 which is indicates that there is not significant difference in the means.

```
Two-sample T for TR-LIGHT vs TR-DARK

            N    Mean  StDev  SE Mean
TR-LIGHT  103    0.10   1.14     0.11
TR-DARK   103  -0.091  0.746    0.073


Difference = mu (TR-LIGHT) - mu (TR-DARK)
Estimate for difference:  0.192
99% CI for difference:  (-0.157, 0.541)
T-Test of difference = 0 (vs not =): T-Value = 1.44  P-Value = 0.153  DF = 176
```

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

a. $F_{.05} = 3.73$ b. $F_{.01} = 3.09$ c. $F_{.025} = 6.52$
d. $F_{.01} = 3.85$ e. $F_{.10} = 2.52$ f. $F_{.05} = 2.94$

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

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

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

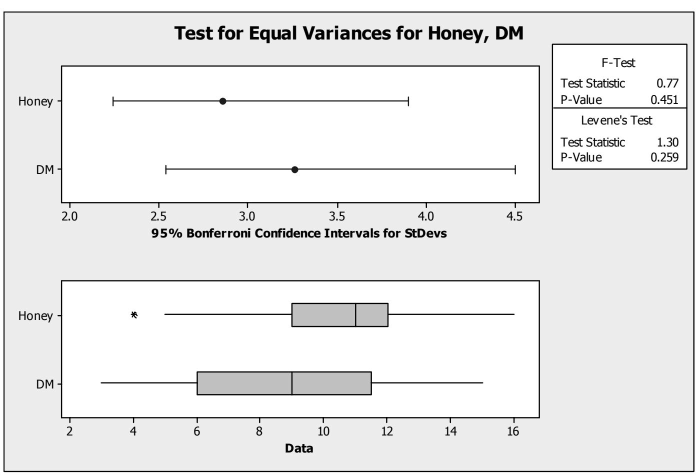
Two assumptions are required for the F test are as follows:
1. The two sample populations are normally distributed.
2. The samples are randomly and independently selected from their respective populations

We will use the test statistic: $F = \frac{s_1^2}{s_2^2} = \frac{10.604}{8.151} = 1.30$

$df = (n_1 - 1), (n_2 - 1) = (33 - 1 = 32), (35 - 1 = 34)$ respectively

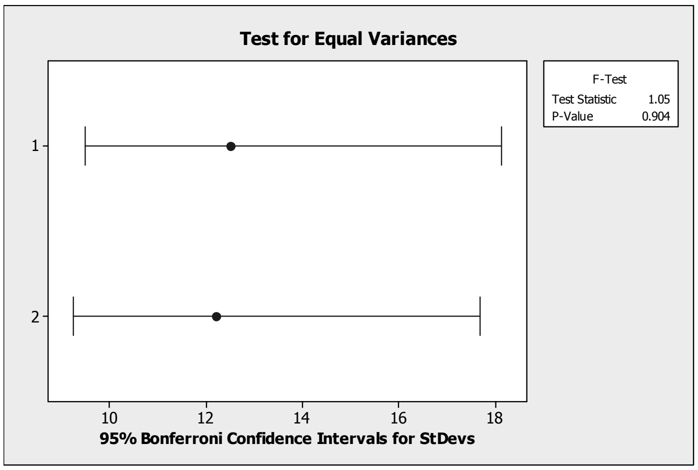
Referring to Table D.4 of Appendix D: $\alpha = 0.10$, we see that we will reject the null hypothesis if the calculated value of F exceeds the tabulated value: $F_{0.05} = 1.84$. Since the calculated F value = 1.30 does not fall in the rejection region, the data does not provide sufficient evidence to show that the variances of the two groups are unequal; $\frac{\sigma_{\text{DM}}^2}{\sigma_{\text{H}}^2} = 1$.

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



1.76 We will test the hypothesis: $H_0: \dfrac{\sigma_1^2}{\sigma_2^2} = 1$ vs. $H_a: \dfrac{\sigma_1^2}{\sigma_2^2} \neq 1$

The test statistic is $F = \dfrac{s_1^2}{s_2^2} = \dfrac{(12.5)^2}{(12.2)^2} = 1.05$ with $df = (26-1=25),(26-1=25)$ respectively for the numerator and denominator. In looking at Table D.5, $F_{0.025}$, we see that the rejection region will be $F_{calc} > 2.27$. Since the calculated F value does not fall in the rejection region, we can conclude that the two groups have equal variances.



1.77 Let σ_B^2 = variance of the FNE scores for bulimic students and σ_N^2 = variance of the FNE scores for normal students.

From Exercise 1.59, $s_B^2 = 24.1636$ and $s_N^2 = 27.9780$

To determine if the variances are equal, we test:

$H_0: \sigma_B^2 = \sigma_N^2$
$H_a: \sigma_B^2 \neq \sigma_N^2$

The test statistic is $F = \dfrac{\text{Larger sample variance}}{\text{Smaller sample variance}} = \dfrac{s_N^2}{s_B^2} = \dfrac{27.9780}{24.1636} = 1.16$

The rejection region requires $\alpha/2 = .05/2 = .025$ in the upper tail of the F distribution with numerator df $\nu_2 = n_2 - 1 = 14 - 1 = 13$ and denominator df $\nu_1 = n_1 - 1 = 11 - 1 = 10$. From Table 5, Appendix D, $F_{.025} \approx 3.62$. The rejection region is $F > 3.62$.

Since the observed value of the test statistic does not fall in the rejection region $(F = 1.16 < 3.62), H_0$ is not rejected; $\dfrac{\sigma_B^2}{\sigma_N^2} = 1$. It appears that the assumption of equal variances is valid.

1.78 a. Let σ_1^2 = variance in inspection errors for novice inspectors and σ_2^2 = variance in inspection errors for experienced inspectors. Since we wish to determine if the data support the belief that the variance is lower for experienced inspectors than for novice inspectors, we test:

$$H_0 : \sigma_1^2 = \sigma_2^2$$
$$H_a : \sigma_1^2 > \sigma_2^2$$

From the printout, the test statistic is $F = 2.26$. The *p*-value is $p = .0955$. Since the *p*-value is greater than $\alpha\left(p = .0955 > .05\right), H_0$ is not rejected. There is insufficient evidence to support her belief at $\alpha = .05$.

b. From the printout, the *p*-value is $p = .0955$.

1.79 $H_0 : \sigma_1^2 / \sigma_2^2 = 1 \quad \left(\sigma_1^2 = \sigma_2^2\right)$

$H_a : \sigma_1^2 / \sigma_2^2 \neq 1 \quad \left(\sigma_1^2 \neq \sigma_2^2\right)$

where σ_1^2 = variance of the one wet sampler readings and σ_2^2 = variance of the three wet sampler readings.

Test statistic: $F = \dfrac{\text{larger sample variance}}{\text{smaller sample variance}} = \dfrac{s_1^2}{s_2^2} = \dfrac{6.3^2}{2.6^2} = 5.87$

Rejection region: Using $\alpha = .05, n_1\text{-}1 = 364$ numerator df$, n_2\text{-}1 = 364$ denominator df, $F_{.025} \approx 1.00.$

Reject H_0 if $F > 1.00$

Conclusion: Reject $H_0; \sigma_1^2 / \sigma_2^2 \neq 1$ There is sufficient evidence (at $\alpha = .05$) to indicate the variations in hydrogen readings for the two sampling schemes differ.

Assumptions: The distributions of the hydrogen readings for the one wet sampler and the three wet samplers are both approximately normal. The samplers of the hydrogen readings are randomly and independently selected from their populations.

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

$\dfrac{3}{4}$ of the measurements will lie within 2 standard deviations of the mean.

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

$\dfrac{8}{9}$ of the measurements will lie within 3 standard deviations of the mean.

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

$\frac{5}{9}$ of the measurements will lie within 1.5 standard deviations of the mean.

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

$$s^2=\frac{\sum_{i=1}^{n}(y_i-\overline{y})^2}{n-1}=\frac{\sum_{i=1}^{n} y_i^2-\frac{\left(\sum_{i=1}^{n} y_i\right)^2}{n}}{n-1}=\frac{(11^2+2^2+2^2+1^2+9^2)-\frac{(25)^2}{5}}{5-1}$$

$$=\frac{211-125}{4}=\frac{86}{4}=21.5$$

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

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

$$s^2=\frac{\sum_{i=1}^{n}(y_i-\overline{y})^2}{n-1}=\frac{\sum_{i=1}^{n} y_i^2-\frac{\left(\sum_{i=1}^{n} y_i\right)^2}{n}}{n-1}=\frac{(22^2+9^2+21^2+15^2)-\frac{(67)^2}{4}}{4-1}$$

$=\frac{1231-1122.25}{3}=\frac{108.75}{3}=36.25$ $s=\sqrt{s^2}=\sqrt{36.25}\approx 6.021$

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

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

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

1.82 Using Table 1 of Appendix D:

a. $P(z \ge 2) = .5 - P(0 \le z \le 2) = .5 - .4772 = .0228$

b. $P(z \le -2) = P(z \ge 2) = .0228$

c. $P(z \ge -1.96) = .5 + P(-1.96 \le z \le 0) = .5 + .4750 = .9750$

d. $P(z \ge 0) = .5$

e. $P(z \le -.5) = .5 - P(-.5 \le z \le 0) = .5 - .1915 = .3085$

f. $P(z \le -1.96) = .5 - P(-1.96 \le z \le 0) = .5 - .4750 = .0250$

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

The y-value is .5 standard deviation above the mean.

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

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

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

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

1.84 a. Chip discharge rate (number of chips discarded per minute) is quantitative. The number of chips is a numerical value.

b. Drilling depth (millimeters) is quantitative. The depth is a numerical value.

c. Oil velocity (millimeters per second) is quantitative. The velocity is a numerical value.

d. Type of drilling (single-edge, BTA, or ejector) is qualitative. The type of drilling is not a numerical value.

e. Quality of hole surface is qualitative. The quality can be judged as poor, good, excellent, etc., which are categories and are not numerical values.

1.85 a. The population of interest is all men and women.

b. The sample of interest is 300 people from Gainesville, Florida

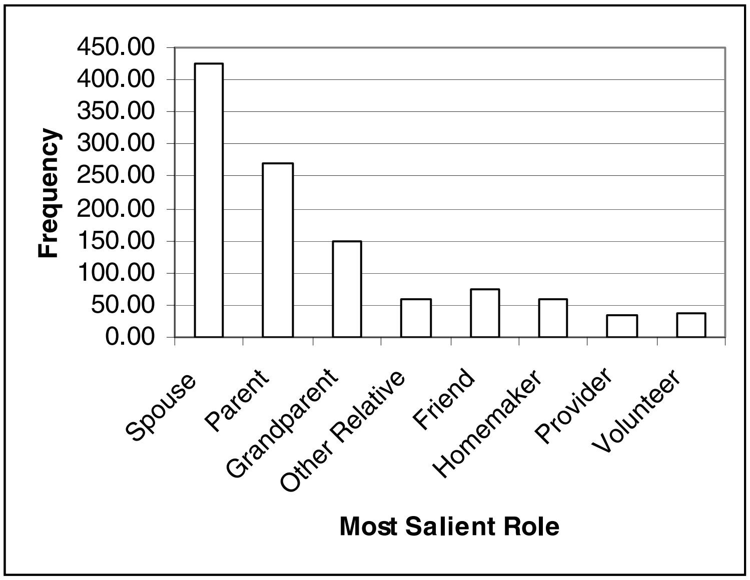
c. The study involves inferential statistics.

d. One variable is measured for each of the 20 objects placed. For each variable, the 2 possible outcomes were "yes" (place of objects was recalled) and "no" (place of object was not recalled). Since the outcomes "yes" and "no" are not measured on a numerical scale, the variables are qualitative.

1.86 a. The qualitative variable summarized in the table is the role elderly people feel is the most important later in life. There are 8 categories associated with this variable. They are: Spouse, Parent, Grandparent, Other relative, Friend, Homemaker, Provider, and Volunteer/Club/Church member.

b. The numbers in the table are frequencies because they are whole numbers. Relative frequencies are numbers between 0 and 1.

c. A bar graph of the data is:

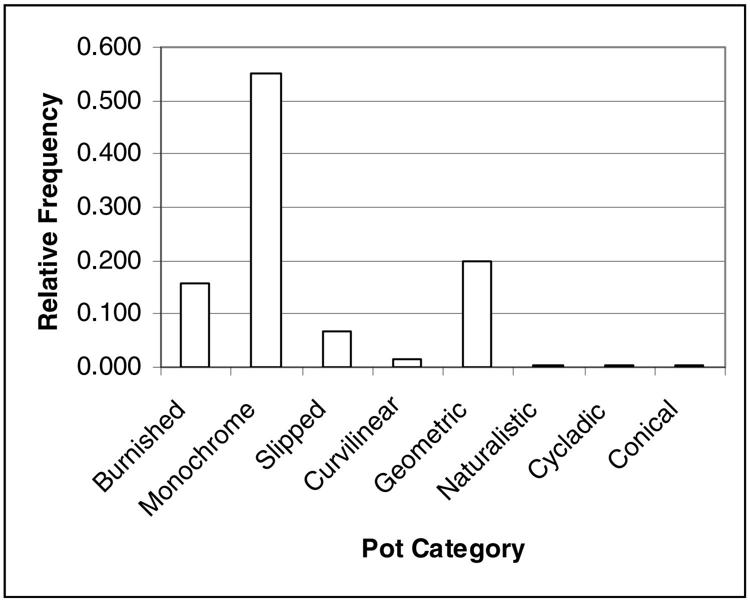


d. The role with the highest percentage of elderly adults is Spouse. The relative frequency is 424 / 1,102 = .385. Multiplying this by 100% gives a percentage of 38.5%. Of all the elderly adults surveyed, 38.5% view their most salient roles as that of spouse.

1.87 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	.159
Monochrome	460	460 / 837	.550
Slipped	55	55 / 837	.066
Curvilinear Decoration	14	14 / 837	.017
Geometric Decoration	165	165 / 837	.197
Naturalistic Decoration	4	4 / 837	.005
Cycladic White clay	4	4 / 837	.005
Cononical cup clay	2	2 / 837	.002
Total	837		1.001

A relative frequency bar chart is:

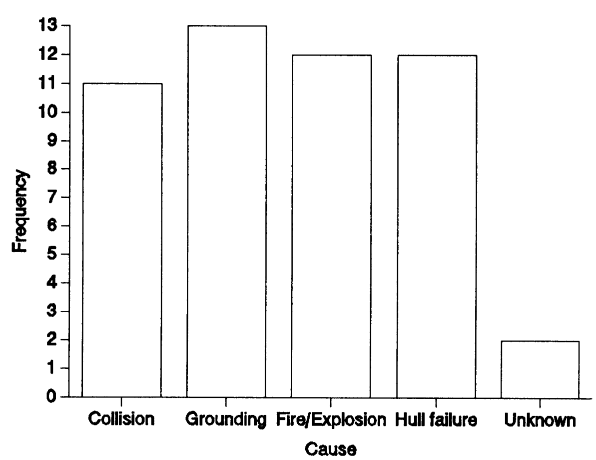


The most frequently found type of pot was the Monochrome. Of all the pots found, 55% were Monochrome. The next most frequently found type of pot was the Painted in Geometric Decoration. Of all the pots found, 19.7% were of this type. Very few pots of the types Painted in Naturalistic Decoration, Cycladic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

1.88 a. We will use a frequency bar graph to describe the data. First, we must add up the number of spills under each category. These values are summarized in the following table:

Cause of Spillage	Frequency
Collision	11
Grounding	13
Fire/Explosion	12
Hull Failure	12
Unknown	2
Total	50

The frequency bar graph is:



b. Because each of the bars are about the same height, it does not appear that one cause is more likely to occur than any other.

c. More than half of the spillage amounts are less than or equal to 50 metric tons and almost all (44 out of 50) are below 104 metric tons. There appear to be three outliers, values which are much different than the others. These three values are larger than 216 metric tons.

d. From the graph in part **a**, the data are not mound shaped. Thus, we must use Chebyshev's rule. This says that at least 8/9 of the measurements will fall within 3 standard deviations of the mean. Since most of the observations will be within 3 standard deviations of the mean, we could use this interval to predict the spillage amount of the next major oil spill. From the printout, the mean is 59.8 and the standard deviation is 53.36. The interval would be:

$\bar{y} \pm 3s \Rightarrow 59.8 \pm 3(53.36) \Rightarrow 59.8 \pm 160.08 \Rightarrow (-100.28,\ 219.88)$

Since an oil spillage amount cannot be negative, we would predict that the spillage amount of the next major oil spill will be between 0 and 219.88 metric tons.

1.89 a. Using Minitab, the stem-and-leaf display for the data is:

```
Stem-and-Leaf of LOSS       N = 19
Leaf Unit = 1.0

  8      0 11234559
 (3)     1 123
  8      2 00
  6      3 9
  5      4 (6)
  4      5 (6)
  3      6 (1)(5)
  1      7
  1      8
  1      9
  1     10 (0)
```

b. The numbers circled on the display in part a are associated with the eclipses of Saturnian satellites.

c. Since the five largest numbers are associated with eclipses of Saturnian satellites, it is much more likely that the greater light loss is associated with eclipses rather than occults.

1.90 New Location: $\bar{y} = 9.422$ and $s = .479$

$\bar{y} \pm s \Rightarrow 9.422 \pm 0.479 \Rightarrow (8.943, 9.901)$. The Empirical Rule says that approximately 60-80% of the observations should fall in this interval.

$\bar{y} \pm 2s \Rightarrow 9.422 \pm 2(0.479) \Rightarrow 9.422 \pm 0.958 \Rightarrow (8.464,\ 10.380)$. The Empirical Rule says that approximately 95% of the observations should fall in this interval.

$\bar{y} \pm 3s \Rightarrow 9.422 \pm 3(0.479) \Rightarrow 9.422 \pm 1.437 \Rightarrow (7.985,\ 10.859)$. The Empirical Rule says that approximately all of the observations should fall in this interval.

Old Location: $\bar{y} = 9.804$ and $s = .541$

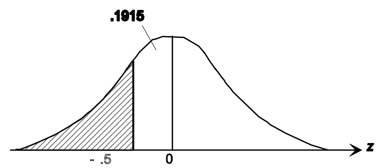
$\overline{y} \pm s \Rightarrow 9.804 \pm 0.541 \Rightarrow (9.263,\ 10.345)$. The Empirical Rule says that approximately 68% of the observations should fall in this interval.

$\overline{y} \pm 2s \Rightarrow 9.804 \pm 2(0.541) \Rightarrow 9.804 \pm 1.082 \Leftarrow (8.722,\ 10.886)$. The Empirical Rule says that approximately 95% of the observations should fall in this interval.

$\overline{y} \pm 3s \Rightarrow 9.804 \pm 3(0.541) \Rightarrow 9.804 \pm 1.623 \Rightarrow (8.181,\ 11.427)$. The Empirical Rule says that approximately all of the observations should fall in this interval.

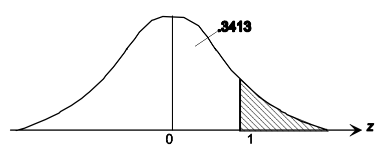
1.91 For each of these questions, we will use Table 1 in Appendix D.

a. The z-score for $y = 75$ is $z = \dfrac{y-\mu}{\sigma} = \dfrac{75-80}{10} = -.50$



$$\begin{aligned} P(y \le 75) &= P(z \le -.5) \\ &= .5 - P(-.5 \le z \le 0) \\ &= .5 - .1915 \\ &= .3085 \end{aligned}$$

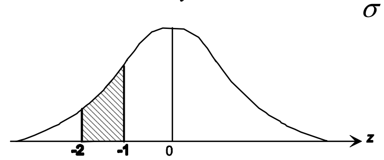
b. The z-score for $y = 90$ is $z = \dfrac{y-\mu}{\sigma} = \dfrac{90-80}{10} = 1.00$



$$\begin{aligned} P(y \ge 90) &= P(z \ge 1.00) \\ &= .5 - P(0 \le z \le 1.00) \\ &= .5 - .3413 \\ &= .1587 \end{aligned}$$

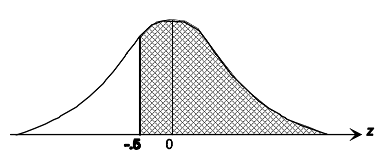
c. The z-score for $y = 60$ is $z = \dfrac{y-\mu}{\sigma} = \dfrac{60-80}{10} = -2$

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



$$\begin{aligned} P(60 \le y \le 70) &= P(-2 \le z \le -1) \\ &= P(-2 \le z \le 0) \\ &\quad - P(-1 \le z \le 0) \\ &= .4772 - .3413 \\ &= .1359 \end{aligned}$$

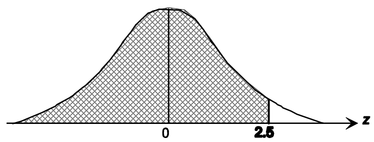
d.



$$\begin{aligned} P(y \ge 75) &= P(z \ge -.5) \\ &= .5 + P(-.5 \le z \le 0) \\ &= .5 + .1915 \\ &= .6915 \end{aligned}$$

e. $P(y = 75) = P(z = -.5) = 0$

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



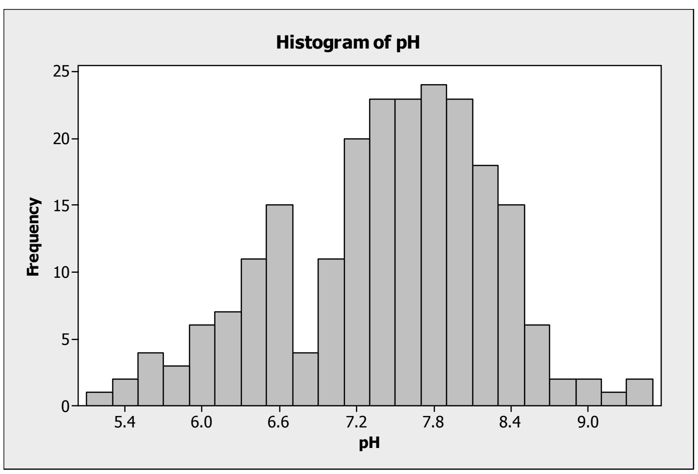
$$P(y \le 105) = P(z \le 2.5)$$
$$= .5 + P(0 \le z \le 2.5)$$
$$= .5 + .4938$$
$$= .9938$$

1.92 a. Using Minitab, the stem-and-leaf display for the data is:

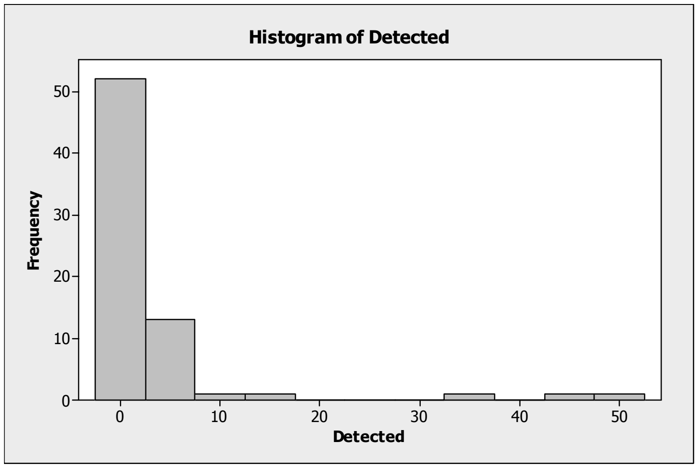
```
Stem-and-leaf of FLUID LOSS     N=9
Leaf Unit = 0.0010

 2    0  (1)(3)
 3    0  (9)
 3    1
(2)   1  78
 4    2  0044
```

b. Since the three spiders observed drinking nectar had the smallest weight losses, it appears that feeding on flower nectar reduces evaporative fluid loss for male crab spiders.

1.93 a. It appears that about 58 out of the 223 or .26 of New Hampshire wells have a pH level less than 7.0.



b. It appears that about 6 out of 70 or .086 have a value greater than 5 micrograms per liter.



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

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

1.94 a. Let y = score on Dental Anxiety Scale. Then $z = \frac{y - \mu}{\sigma} = \frac{16 - 11}{3.5} = 1.43$

b. Using Table 1, Appendix D,

$$P(10 < y < 15) = P\left(\frac{10 - 11}{3.5} < z < \frac{15 - 11}{3.5}\right) = P(-.29 < z < 1.14)$$
$$= P(-.29 < z < 0) + P(0 < z < 1.14) = .1141 + .3729 = .4870$$

c. Using Table 1, Appendix D,

$$P(y > 17) = P\left(z > \frac{17 - 11}{3.5}\right) = P(z > 1.71) \; = .5 - P(0 < z < 1.71) = .5 - .4564 = .0436$$

1.95 a. Let $y =$ change in SAT-MATH score. Using Table 1, Appendix D,

$$P(y \geq 50) = P\left(z \geq \frac{50 - 19}{65}\right) = P(z \geq .48) = .5 - .1844 = .3156.$$

b. Let $y =$ change in SAT-VERBAL score. Using Table 1, Appendix D,

$$P(y \geq 50) = P\left(z \geq \frac{50 - 7}{49}\right) = P(z \geq .88) = .5 - .3106 = .1894.$$

1.96 a. Using Table 1, Appendix D, with $\mu = 24.1$ and $\sigma = 6.30$,

$$P(y \geq 20) = P\left(z \geq \frac{20 - 24.1}{6.30}\right) = P(z \geq -.65) = P(-.65 \leq z \leq 0) + .5$$
$$= .2422 + .5 = .7422$$

b. $$P(y \leq 10.5) = P\left(z \leq \frac{10.5 - 24.1}{6.30}\right) = P(z \leq -2.16) = .5 - P(-2.16 \leq z \leq 0)$$
$$= .5 - .4846 = .0154$$

c. No. The probability of having a cardiac patient who participates regularly in sports or exercise with a maximum oxygen uptake of 10.5 or smaller is very small $(p = .0154)$. It is very unlikely that this patient participates regularly in sports or exercise.

1.97 For this problem, $\mu_{\bar{y}} = \mu = 4.59$ and $\sigma_{\bar{y}} = \frac{\sigma}{\sqrt{n}} = \frac{2.95}{\sqrt{50}} = .4172$

a. $$P(\bar{y} \geq 6) = P\left(z \geq \frac{6 - 4.59}{.4172}\right) = P(z \geq 3.38) \approx .5 - .5 = 0$$

(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.

1.98 a. Some preliminary calculations are:

$$\bar{y} = \frac{\sum y}{n} = \frac{160.6}{22} = 7.300$$

$$s^2 = \frac{\sum y^2 - \frac{\left(\sum y\right)^2}{n}}{n-1} = \frac{1385.4 - \frac{160.6^2}{22}}{22-1} = 10.1438$$

$$s = \sqrt{10.1438} = 3.185$$

For confidence coefficient $.95, \alpha = .05$ and $\alpha / 2 = .05 / 2 = .025$. From Table 1, Appendix D with df $= n - 1 = 22 - 1 = 21, t_{.025} = 2.080$. The 95% confidence interval is:

$$\bar{y} \pm t_{\alpha/2} \frac{s}{\sqrt{n}} \Rightarrow 7.300 \pm 2.080 \frac{3.185}{\sqrt{22}} \Rightarrow 7.300 \pm 1.412 \Rightarrow (5.888, 8.172)$$

b. We are 95% confident that the mean PMI for all human brain specimens obtained at autopsy is between 5.888 and 8.712.

c. We must assume that the population of all PMI's is normally distributed. From the dot plot in Exercise 1.18, the distribution does not appear to be normal.

d. "95% confidence" means that if repeated samples of size n were selected from the population and 95% confidence intervals formed for μ, 95% of the intervals formed will contain the true mean and 5% will not.

1.99 We must assume that the weights of dry seed in the crop of the pigeons are normally distributed. From the printout, the 99% confidence interval is: $(0.61,\ 2.13)$

We are 99% confident that the mean weight of dry seeds in the crop of all spinifex pigeons is between 0.61 and 2.13 grams.

1.100 a. $\mu_{\bar{y}} = \mu = 5.1;\quad \sigma_{\bar{y}} = \dfrac{\sigma}{\sqrt{n}} = \dfrac{6.1}{\sqrt{150}} = .4981$

b. Because the sample size is large, $n = 150$, the Central Limit Theorem says that the sampling distribution of $\bar{y}$ is approximately normal.

c. $P(\bar{y} > 5.5) = P\left(z > \dfrac{5.5-5.1}{.4981}\right) = P(z > .80) = .5 - .2881 = .2119$

(using Table 1, Appendix D)

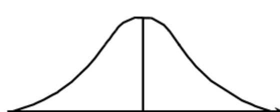
d. $P(4 < \bar{y} < 5) = P\left(\dfrac{4-5.1}{.4981} < z < \dfrac{5-5.1}{.4981}\right) = P(-2.21 < z < -.20)$

$= .4864 - .0793 = .4071$

(using Table 1, Appendix D

1.101 a. $\mu_{\bar{y}} = \mu = 293$ $\qquad \sigma_{\bar{y}} = \dfrac{\sigma}{\sqrt{n}} = \dfrac{847}{\sqrt{50}} = 119.78$

b.



c. $P(\bar{y} > 550) = P\left(z > \dfrac{\bar{y}-\mu_{\bar{y}}}{\sigma_{\bar{y}}}\right) = P\left(z > \dfrac{550-293}{119.78}\right)$

$= P(z > 2.15) = .5 - P(0 < z < 2.15)$

$= .5 - .4842 = .0158$

1.102 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 $z = \dfrac{\bar{y}-\mu_0}{\sigma_{\bar{y}}} = \dfrac{67.8-50}{14.4/\sqrt{100}} = 12.36$

The rejection region requires $\alpha = .01$ in the upper tail of the z distribution. From Table 1, Appendix D, $z_{.01} = 2.33$. 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 indicate that the mean alkalinity level of water in the tributary exceeds 50 mpl at $\alpha = .01$.

1.103 Statistix was used to conduct the test desired. The output is shown below:

```
ONE-SAMPLE T TEST FOR TEMPERATURE

NULL HYPOTHESIS: MU =  2550
ALTERNATIVE HYP: MU <> 2550

MEAN          2558.7
STD ERROR     7.1927
MEAN - H0     8.7000
LO 95% CI    -7.5709
UP 95% CI     24.971
T               1.21
DF                 9
P             0.2573

CASES INCLUDED 10    MISSING CASES 0
```

To determine if the mean pouring temperature differs from the target setting, we test:

$H_o : \mu = 2550$
$H_a : \mu \neq 2550$

The test statistic is: $t = 1.21$

The p-value is: $p = .2573$

Since $\alpha = .01 < p = .2573, H_0$ cannot be rejected. There is insufficient evidence to indicate that the mean pouring temperature differs from the target setting.

1.104 Let $\sigma =$ variance of the effective population size of the outcrossing snails and $\sigma =$ variance of the effective population size of the selfing snails. To determine if the variances for the two groups differ, we test:

$H_0 : \sigma_1^2 = \sigma_2^2$
$H_a : \sigma_1^2 \neq \sigma_2^2$

The test statistic is $F = \frac{\text{Larger sample variance}}{\text{Smaller sample variance}} = \frac{s_1^2}{s_2^2} = \frac{1932^2}{1890^2} = 1.045$

Since α is not given, we will use $\alpha = .05$. The rejection region requires $\alpha / 2 = .05 / 2 = .025$ in the upper tail of the F distribution with $\nu_1 = n_1 - 1 = 17 - 1 = 16$ and $\nu_2 = n_2 - 1 = 5 - 1 = 4$. From Table 5, Appendix D, $F_{.025} \approx 8.66$. The rejection region is $F > 8.66$.

Since the observed value of the test statistic does not fall in the rejection region $(F = 1.045 < 8.66), H_0$ is not rejected. There is insufficient evidence to indicate the variances for the two groups differ at $\alpha = .05$.

1.105 Let μ_{Repeated} = mean height of Australian boys who repeated a grade and μ_{Never} = 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:

$H_0 : \mu_{\text{Repeated}} = \mu_{\text{Never}}$
$H_a : \mu_{\text{Repeated}} < \mu_{\text{Never}}$

The test statistic is $z = \dfrac{\bar{y}_1 - \bar{y}_2}{\sqrt{\dfrac{s_1^2}{n_1} + \dfrac{s_2^2}{n_2}}} = \dfrac{-.04 - .30}{\sqrt{\dfrac{1.17^2}{86} + \dfrac{.97^2}{1349}}} = -2.64$

The rejection region requires $\alpha = .05$ in the lower tail of the z distribution. From Table 1, Appendix D, $z_{.05} = 1.645$. The rejection region is $z < -1.645$.

Since the observed value of the test statistic falls in the rejection region $(z = -2.64 < -1.645), H_0$ 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 $\alpha = .05$.

b. Let μ_1 = mean height of Australian girls who repeated a grade and μ_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 $z = \dfrac{\bar{y}_1 - \bar{y}_2}{\sqrt{\dfrac{s_1^2}{n_1} + \dfrac{s_2^2}{n_2}}} = \dfrac{.26 - .22}{\sqrt{\dfrac{.94^2}{43} + \dfrac{1.04^2}{1366}}} = .27$

The rejection region requires $\alpha = .05$ in the lower tail of the z distribution. From Table 1, Appendix C, $z_{.05} = 1.645$. The rejection region is $z < -1.645$.
Since $(z = .27 \not< -1.645)$, fail to reject $H_0 : \mu_{Never} - \mu_{Repeat} = 0$. 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 $\alpha = .05$.

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.

1.106 a. Let μ_1 = mean attitude towards fathers and μ_2 = mean attitude towards mothers. Then $\mu_D = \mu_1 - \mu_2$.

To determine if the male students' attitudes toward their fathers differ from their attitudes toward their mothers, we test:

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

b. Some preliminary calculations are:

$$\bar{y}_D = \frac{\sum y_D}{n} = \frac{-4}{13} = -.308$$

$$s_D^2 = \frac{\sum y_D^2 - \frac{\left(\sum y_D\right)^2}{n_D}}{n_D - 1} = \frac{14 - \frac{(-4)^2}{13}}{13-1} = 1.0641$$

$$s_D = \sqrt{s_D^2} = \sqrt{1.0641} = 1.0316$$

The test statistic is $t = \frac{\bar{y}_D - 0}{s_D / \sqrt{n_D}} = \frac{-.308 - 0}{1.0316 / \sqrt{13}} = -1.08$

The rejection region requires $\alpha / 2 = .05 / 2 = .025$ in each tail of the t distribution. From Table 2, Appendix D, with $\text{df} = n - 1 = 13 - 1 = 12, t_{.025} = 2.179$. The rejection region is $t < -2.179$ or $t > 2.179$.

Since the observed value of the test statistic does not fall in the rejection region $(t = -1.08 \nless -2.179), H_0$ is not rejected. There is insufficient evidence to indicate the male students' attitudes toward their fathers differ from their attitudes toward their mothers at $\alpha = .05$.

1.107 a. Let μ_1 = mean mathematics test score for males and μ_2 = mean mathematics test score for females.

To determine if there is a difference between the true mean mathematics test scores of male and female 8th-graders, we test:

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

The test statistic is $z = \frac{(\bar{y}_1 - \bar{y}_2) - 0}{\sqrt{\left(\frac{\sigma_1^2}{n_1} + \frac{\sigma_2^2}{n_2}\right)}} = \frac{(48.9 - 48.4) - 0}{\sqrt{\left(\frac{12.96^2}{1764} + \frac{11.85^2}{1739}\right)}} = 1.19$

Since no α was given, we will use $\alpha = .05$. The rejection region requires $\alpha/2 = .05/2 = .025$ in each tail of the z distribution. From Table 1, Appendix D, $z_{.025} = 1.96$. The rejection region is $z < -1.96$ or $z > 1.96$.

Since the observed value of the test statistic does not fall in the rejection region $(z = 1.19 < 1.96), H_0$ is not rejected. There is insufficient evidence to indicate there is a difference between the true mean mathematics test scores of male and female 8th-graders at $\alpha = .05$.

b. For confidence coefficient $.90, \alpha = .10$ and $\alpha/2 = .10/2 = .05$. From Table 1, Appendix D, $z_{.05} = 1.645$. The 90% confidence interval is:

$$(\bar{y}_1 - \bar{y}_2) \pm z_{.05}\sqrt{\left(\frac{\sigma_1^2}{n_1} + \frac{\sigma_2^2}{n_2}\right)}$$

$$\Rightarrow (48.9 - 48.4) \pm 1.645\sqrt{\left(\frac{12.96^2}{1764} + \frac{11.85^2}{1739}\right)}$$

$$\Rightarrow .5 \pm .690 \Rightarrow (-.190,\ 1.190)$$

We are 90% confident that the true differences in mean mathematics test scores between males and females is between –.190 and 1.190.

This agrees with the results in part a, even though different $\alpha-$levels were used. We are 90% confident that the interval contains the true difference in mean scores. Since the interval contains 0, 0 is a likely candidate for the true value of the difference. Thus, we would not be able to reject H_0.

c. Since both sample sizes are large, the only assumption necessary is that the samples are independent.

d. The observed significance level of the test in part a is the same as the *p*-value. The *p*-value is the probability of observing your test statistic or anything more unusual, given H_0 is true. Thus, the $p-\text{value} = P(z \le -1.19) + P(z \ge 1.19) = .5 - .3830 + .5 - .3830 = .2340$.

e. To determine if the males' test scores are more variable than the female test scores we test:
$H_0: \sigma_1 = \sigma_2$
$H_a: \sigma_1 > \sigma_2$

The test statistic is $F = \frac{s_1^2}{s_2^2} = \frac{(12.96)^2}{(11.85)^2} = 1.196$

The rejection region requires $\alpha = .05$ in the upper tail of the F distribution with $v_1 = n_1 - 1 = 1764 - 1 = 1763$ and $v_2 = n_2 - 1 = 1739 - 1 = 1738$. From Table 5, Appendix D, $F_{0.05} > 1.00$ since both degrees of freedom are too large, thus we can reject the null hypothesis and conclude that the males' variability is significantly larger than that of the females: $\frac{\sigma^2_{\text{Males}}}{\sigma^2_{\text{Females}}} = 1$.

1.108 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 $\mu_1 =$ mean reaction time under the random condition and $\mu_2 =$ 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 .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.

1.109 a. When testing the difference in the two sample means of milk prices, we see from the MINITAB printout that the $t = -6.02$; $p-$ value ≈ 0; which is smaller than a significance level of 1%. Therefore, we can conclude that the two mean milk prices are significantly different at the 1% level.

b. When testing the difference in the two sample means of milk prices that occurred in a sealed bid market, we see from the MINITAB printout that the *p*-value of Levene's Test is 0.264 which is significantly greater than a significance level of 1% or 5%. Therefore, we can conclude that the variances of the two mean milk prices are not significantly different.

Also, the *p*-value for the F test is .048, which means that (unlike with Levene's Test) we would reject the null hypothesis at the 5% level but not at the 1% level. $F = 1.41$, fail to reject $H_0: \frac{\sigma_{TRI}^2}{\sigma_S^2} = 1$ at the 1% significance level.

1.110 Let $\mu_1 =$ mean homophone confusion errors for time 1 and $\mu_2 =$ mean homophone confusion errors for time 2. Then $\mu_D = \mu_1 - \mu_2$.

To determine if Alzheimer's patients show a significant increase in mean homophone confusion errors over time, we test:

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

The test statistic is $t = -2.306$.

The *p*-value is $p = .0163$. Since the *p*-value is small, there is sufficient evidence to indicate an increase in mean homophone confusion errors from time 1 to time 2

We must assume that the population of differences is normally distributed and that the sample was randomly selected. A stem-and-leaf display of the data indicate that the data are mound-shaped. It appears that these assumptions are valid.