Chapter 9 - Testing the Difference Between Two Means, Two Proportions, and Two Variances

Note: Graphs are not to scale and are intended to convey a general idea.
Answers may vary due to rounding, TI-83's, or computer programs.

EXERCISE SET 9-1

1.
Testing a single mean involves comparing a population mean to a specific value such as $\mu = 100$; whereas testing the difference between two means involves comparing the means of two populations such as $\mu_1 = \mu_2$.

2.
When both samples are greater than or equal to 30 the distribution will be approximately normal. The mean of the differences will be equal to zero. The standard deviation of the differences will be $\sqrt{\frac{\sigma_1^2}{n_1} + \frac{\sigma_2^2}{n_2}}$.

3.
Both samples are random samples. The populations must be independent of each other and they must be normally distributed or approximately normally distributed.

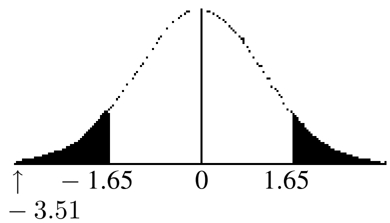
4.
H_0: $\mu_1 = \mu_2$ or H_0: $\mu_1 - \mu_2 = 0$

5.
H_0: $\mu_1 = \mu_2$
H_1: $\mu_1 \neq \mu_2$ (claim)
C. V. $= \pm 1.65$
$\overline{X}_1 = 8.6$ $\qquad$ $\overline{X}_2 = 10.6$

$$z = \frac{(\overline{X}_1 - \overline{X}_2) - (\mu_1 - \mu_2)}{\sqrt{\frac{\sigma_1^2}{n_1} + \frac{\sigma_2^2}{n_2}}} = \frac{(8.6 - 10.6) - 0}{\sqrt{\frac{2.1^2}{36} + \frac{2.7^2}{36}}}$$

$z = -3.51$
(TI83 answer is $z = -3.508$)

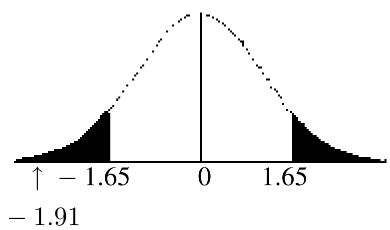
5. continued



Reject the null hypothesis. There is enough evidence to support the claim that the mean number of hours that families with and without children participate in recreational activities are different.

6.
H_0: $\mu_1 = \mu_2$
H_1: $\mu_1 \neq \mu_2$ (claim)
C. V. $= \pm 1.65$

$$z = \frac{(73{,}195 - 76{,}409) - 0}{\sqrt{\frac{8200^2}{45} + \frac{7800^2}{45}}} = -1.91$$



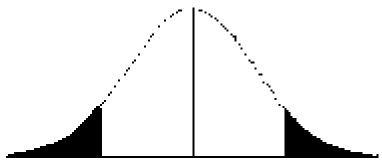
Reject the null hypothesis. There is enough evidence to support the claim that the mean annual salaries for teachers in New York and Massachusetts are different.

7.
H_0: $\mu_1 = \mu_2$
H_1: $\mu_1 \neq \mu_2$ (claim)
C. V. $= \pm 1.96$

$$z = \frac{(\overline{X}_1 - \overline{X}_2) - (\mu_1 - \mu_2)}{\sqrt{\frac{\sigma_1^2}{n_1} + \frac{\sigma_2^2}{n_2}}} = \frac{(28.5 - 35.2) - 0}{\sqrt{\frac{7.2^2}{40} + \frac{9.1^2}{40}}}$$

$z = -3.65$

7. continued

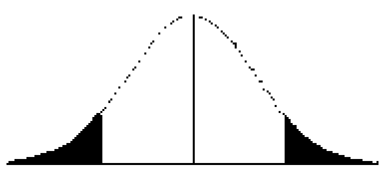


↑ -1.96 0 1.96
-3.65

Reject the null hypothesis. There is sufficient evidence at α=0.05 to conclude that commuting times are different in the winter.

8.
H_0: $\mu_1 = \mu_2$
H_1: $\mu_1 \neq \mu_2$ (claim)
C. V. = ± 1.96

$$z = \frac{(123.5-126.2)-0}{\sqrt{\frac{98}{60}+\frac{120}{50}}} = -1.34$$

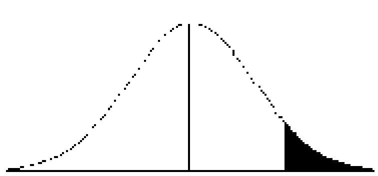


-1.96 ↑ 0 1.96
-1.34

Do not reject the null hypothesis. There is not enough evidence to support the claim that there is a difference in heights.

9.
H_0: $\mu_1 = \mu_2$
H_1: $\mu_1 > \mu_2$ (claim)
C. V. = 2.33

$$z = \frac{(\overline{X}_1-\overline{X}_2)-(\mu_1-\mu_2)}{\sqrt{\frac{\sigma_1^2}{n_1}+\frac{\sigma_2^2}{n_2}}} = \frac{(5.5-4.2)-0}{\sqrt{\frac{1.2^2}{32}+\frac{1.5^2}{30}}} = 3.75$$



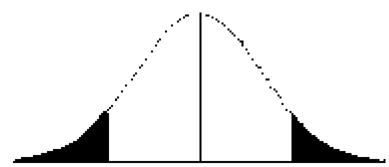
0 2.33 ↑
3.75

9. continued

Reject the null hypothesis. There is enough evidence at $\alpha = 0.01$ to support the claim that the average stay is longer for men than for women.

10.
H_0: $\mu_1 = \mu_2$ (claim)
H_1: $\mu_1 \neq \mu_2$
C. V. = ± 2.58

$$z = \frac{(93{,}430-98{,}043)-0}{\sqrt{\frac{5602^2}{35}+\frac{4731^2}{40}}} = -3.82$$

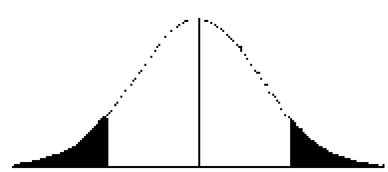


↑ -2.58 0 2.58
-3.82

Reject the null hypothesis. There is enough evidence to reject the claim that the average costs are the same.

11.
H_0: $\mu_1 = \mu_2$
H_1: $\mu_1 \neq \mu_2$ (claim)
C. V. = ± 2.58

$$z = \frac{(\overline{X}_1-\overline{X}_2)-(\mu_1-\mu_2)}{\sqrt{\frac{\sigma_1^2}{n_1}+\frac{\sigma_2^2}{n_2}}} = \frac{(87-92)-0}{\sqrt{\frac{7.2^2}{30}+\frac{7.2^2}{30}}} = -2.69$$



↑ -2.58 0 2.58
-2.69

Reject the null hypothesis. There is enough evidence to support the claim that the mean per capita income in Wisconsin and South Dakota are different.

12.

H_0: $\mu_1 = \mu_2$

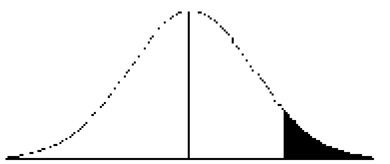
H_1: $\mu_1 > \mu_2$ (claim)

C. V. = 1.65

$\overline{X}_1 = 21.4$ $\quad$ $\overline{X}_2 = 20.8$

$s_1 = 3$ $\quad$ $s_2 = 3$

$$z = \frac{(21.4 - 20.8) - 0}{\sqrt{\frac{3^2}{1000} + \frac{3^2}{500}}} = 3.65$$



Reject the null hypothesis. There is enough evidence to support the claim that ACT scores for Ohio students are below the national average.

13.

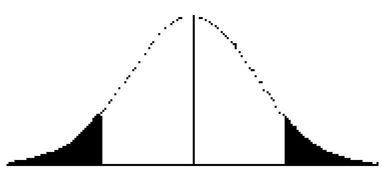
H_0: $\mu_1 = \mu_2$

H_1: $\mu_1 \neq \mu_2$ (claim)

C. V. = ± 1.96

$$z = \frac{(\overline{X}_1 - \overline{X}_2) - (\mu_1 - \mu_2)}{\sqrt{\frac{\sigma_1^2}{n_1} + \frac{\sigma_2^2}{n_2}}}$$

$$z = \frac{(40{,}275 - 38{,}750) - 0}{\sqrt{\frac{10{,}500^2}{50} + \frac{12{,}500^2}{50}}} = 0.66$$



Do not reject the null hypothesis. There is not enough evidence to support the claim that the average incomes are different.

14.

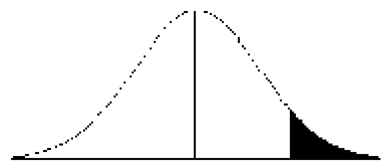
H_0: $\mu_1 - \mu_2 = 30$

H_1: $\mu_1 - \mu_2 > 30$ (claim)

14. continued

C. V. = 1.65

$$z = \frac{(960.50 - 902.89) - 30}{\sqrt{\frac{98^2}{60} + \frac{101^2}{60}}} = 1.52$$



Do not reject the null hypothesis. There is not enough evidence to support the claim that the difference in average benefits is greater than 30.

15.

H_0: $\mu_1 = \mu_2$

H_1: $\mu_1 \neq \mu_2$ (claim)

$$z = \frac{(\overline{X}_1 - \overline{X}_2) - (\mu_1 - \mu_2)}{\sqrt{\frac{\sigma_1^2}{n_1} + \frac{\sigma_2^2}{n_2}}} = \frac{(3.05 - 2.96) - 0}{\sqrt{\frac{0.75^2}{103} + \frac{0.75^2}{225}}}$$

$z = 1.01$

Area = 0.8438

P-value = $2(1 - 0.8438) = 0.3124$

Since P-value > 0.05, do not reject the null hypothesis. There is not enough evidence to support the claim that there is a difference in scores. (TI: P-value = 0.3131)

16.

Residents	Commuters
$\overline{X}_1 = 22.12$	$\overline{X}_2 = 22.76$
$s_1 = 3.68$	$s_2 = 4.70$
$n_1 = 50$	$n_2 = 50$

H_0: $\mu_1 = \mu_2$ (claim)

H_1: $\mu_1 \neq \mu_2$

$$z = \frac{(22.12 - 22.76) - 0}{\sqrt{\frac{3.68^2}{50} + \frac{4.70^2}{50}}} = -0.76$$

16. continued

Area $= 0.2236$

P-value $= 2(0.2236) = 0.4472$

Since P-value > 0.05, do not reject the null hypothesis. There is not enough evidence to reject the claim that there is no difference in the ages.

17.

$D = 21 - 14 = 7$

$$(\overline{X}_1 - \overline{X}_2) - z_{\frac{\alpha}{2}}\sqrt{\frac{\sigma_1^2}{n_1} + \frac{\sigma_2^2}{n_2}} < \mu_1 - \mu_2 < (\overline{X}_1 - \overline{X}_2) + z_{\frac{\alpha}{2}}\sqrt{\frac{\sigma_1^2}{n_1} + \frac{\sigma_2^2}{n_2}}$$

$$7 - (1.65)\sqrt{\frac{4.2^2}{32} + \frac{4.2^2}{32}} < \mu_1 - \mu_2 < 7 + (1.65)\sqrt{\frac{4.2^2}{32} + \frac{4.2^2}{32}}$$

$5.3 < \mu_1 - \mu_2 < 8.7$

(TI: $5.2729 < \mu_1 - \mu_2 < 8.7271$)

18.

$D = 4.7 - 6.2 = -1.5$

$$(\overline{X}_1 - \overline{X}_2) - z_{\frac{\alpha}{2}}\sqrt{\frac{\sigma_1^2}{n_1} + \frac{\sigma_2^2}{n_2}} < \mu_1 - \mu_2 < (\overline{X}_1 - \overline{X}_2) + z_{\frac{\alpha}{2}}\sqrt{\frac{\sigma_1^2}{n_1} + \frac{\sigma_2^2}{n_2}}$$

$$-1.5 - (1.96)\sqrt{\frac{1.5^2}{40} + \frac{1.7^2}{40}} < \mu_1 - \mu_2 < -1.5 + (1.96)\sqrt{\frac{1.5^2}{40} + \frac{1.7^2}{40}}$$

$-2.20 < \mu_1 - \mu_2 < -0.80$

19.

$D = 315 - 280 = 35$

$$(\overline{X}_1 - \overline{X}_2) - z_{\frac{\alpha}{2}}\sqrt{\frac{\sigma_1^2}{n_1} + \frac{\sigma_2^2}{n_2}} < \mu_1 - \mu_2 < (\overline{X}_1 - \overline{X}_2) + z_{\frac{\alpha}{2}}\sqrt{\frac{\sigma_1^2}{n_1} + \frac{\sigma_2^2}{n_2}}$$

$$35 - (1.96)\sqrt{\frac{56.2^2}{40} + \frac{52.1^2}{35}} < \mu_1 - \mu_2 < 35 + (1.96)\sqrt{\frac{56.2^2}{40} + \frac{52.1^2}{35}}$$

$10.5 < \mu_1 - \mu_2 < 59.5$

The interval gives evidence to reject the claim that there is no difference in the means because 0 is not contained in the interval.

20.

$D = 30.2 - 31.7 = -1.5$

$$-1.5 - (2.58)\sqrt{\frac{5.6^2}{40} + \frac{4.3^2}{30}} < \mu_1 - \mu_2 < -1.5 + (2.58)\sqrt{\frac{5.6^2}{40} + \frac{4.3^2}{30}}$$

$-4.67 < \mu_1 - \mu_2 < 1.67$

or $-4.7 < \mu_1 - \mu_2 < 1.7$

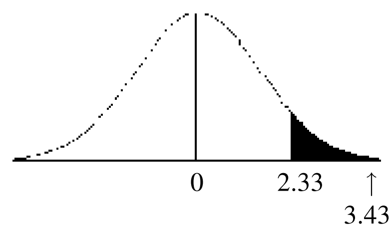
21.

H_0: $\mu_1 = \mu_2$

H_1: $\mu_1 > \mu_2$ (claim)

C. V. $= 2.33$

$$z = \frac{(\overline{X}_1 - \overline{X}_2) - (\mu_1 - \mu_2)}{\sqrt{\frac{\sigma_1^2}{n_1} + \frac{\sigma_2^2}{n_2}}} = \frac{(48.2 - 44.3) - 0}{\sqrt{\frac{5.6^2}{40} + \frac{4.5^2}{40}}} = 3.43$$



Reject the null hypothesis. There is enough evidence to support the claim that women watch more television than men.

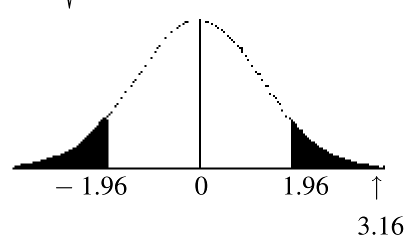
22.

H_0: $\mu_1 = \mu_2$

H_1: $\mu_1 \neq \mu_2$ (claim)

C. V. $= \pm 1.96$

$$z = \frac{(40.5 - 34.8) - 0}{\sqrt{\frac{67.24}{35} + \frac{39.69}{30}}} = 3.16$$



Reject the null hypothesis. There is enough evidence to support the claim that there is a difference in commuting times.

23.

H_0: $\mu_1 = \mu_2$

H_1: $\mu_1 \neq \mu_2$ (claim)

$$z = \frac{(\overline{X}_1 - \overline{X}_2) - (\mu_1 - \mu_2)}{\sqrt{\frac{\sigma_1^2}{n_1} + \frac{\sigma_2^2}{n_2}}}$$

$$z = \frac{(\$995 - \$1120) - 0}{\sqrt{\frac{120^2}{30} + \frac{250^2}{30}}} = -2.47$$

Area = 0.0068

P-value = 2(0.0068) = 0.0136

Since P-value > 0.01, do not reject the null hypothesis. There is not enough evidence to support the claim that there is a difference in sales.

24.

H_0: $\mu_1 = \mu_2$

H_1: $\mu_1 > \mu_2$ (claim)

$$z = \frac{(\$216{,}000 - \$203{,}000) - 0}{\sqrt{\frac{\$30{,}000^2}{45} + \frac{\$32{,}500^2}{40}}}$$

z = 1.91

Area = 1 − 0.9719 = 0.0281

P-value = 0.0281

Since P-value < 0.05, reject the null hypothesis. There is enough evidence to support the claim that the average price of a home in Dallas is greater than the average price of a home in Orlando.

25.

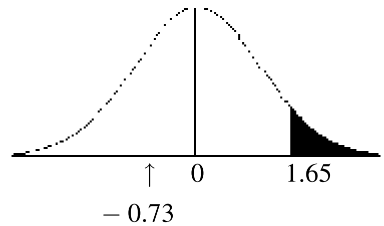
H_0: $\mu_1 - \mu_2 = 8$ (claim)

H_1: $\mu_1 - \mu_2 > 8$

C. V. = 1.65

$$z = \frac{(\overline{X}_1 - \overline{X}_2) - (\mu_1 - \mu_2)}{\sqrt{\frac{\sigma_1^2}{n_1} + \frac{\sigma_2^2}{n_2}}} = \frac{(110 - 104) - 8}{\sqrt{\frac{15^2}{60} + \frac{15^2}{60}}} = -0.73$$

25. continued



Do not reject the null hypothesis. There is not enough evidence to reject the claim that private school students have exam scores that are at most 8 points higher than public school students.

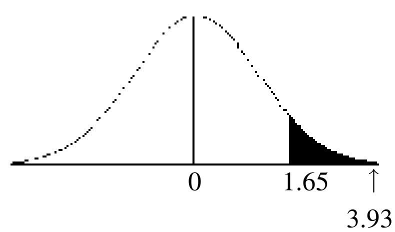
26.

H_0: $\mu_1 - \mu_2 = \$3400$

H_1: $\mu_1 - \mu_2 > \$3400$ (claim)

C. V. = 1.65

$$z = \frac{(261{,}500 - 248{,}200) - 3400}{\sqrt{\frac{10{,}500^2}{40} + \frac{12{,}000^2}{40}}} = 3.93$$



Reject the null hypothesis. There is enough evidence to support the claim that the difference in the average sale prices is greater than $3400.

27.

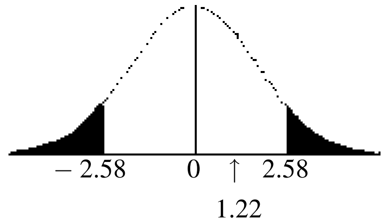
H_0: $\mu_1 - \mu_2 = \$30{,}000$

H_1: $\mu_1 - \mu_2 \neq \$30{,}000$ (claim)

C. V. = ± 2.58

$$z = \frac{(90{,}200 - 57{,}800) - 30{,}000}{\sqrt{\frac{15{,}000^2}{100} + \frac{12{,}800^2}{100}}} = 1.22$$

27. continued



Do not reject the null hypothesis. There is not enough evidence to support the claim that the difference in income is not \$30,000.

EXERCISE SET 9-2

1.

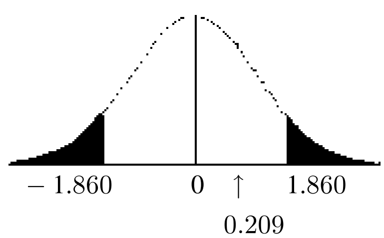
H$_0$: $\mu_1 = \mu_2$

H$_1$: $\mu_1 \neq \mu_2$ (claim)

C. V. $= \pm 1.860$ d. f. $= 8$

$$t = \frac{(\overline{X}_1 - \overline{X}_2) - (\mu_1 - \mu_2)}{\sqrt{\frac{s_1^2}{n_1} + \frac{s_2^2}{n_2}}}$$

$$t = \frac{(883.22 - 840.33) - 0}{\sqrt{\frac{387.15^2}{9} + \frac{477.65^2}{9}}} = 0.209$$



Do not reject the null hypothesis. There is not enough evidence to support the claim that there is a significant difference in the average heights in feet of waterfalls in Europe and the ones in Asia.

2.

H$_0$: $\mu_1 = \mu_2$

H$_1$: $\mu_1 \neq \mu_2$ (claim)

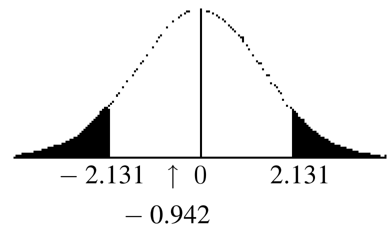
C. V. $= \pm 2.131$ d. f. $= 15$

$\overline{X}_1 = 24.75$ $s_1 = 25.965$

$\overline{X}_2 = 42.94$ $s_2 = 72.745$

2. continued

$$t = \frac{(24.75 - 42.94) - 0}{\sqrt{\frac{25.965^2}{16} + \frac{72.745^2}{16}}} = -0.942$$



Do not reject the null hypothesis. There is not enough evidence to support the claim that there is a difference in average values.

(Note: Each data set contains a suspected outlier which may make the results suspect.)

3.

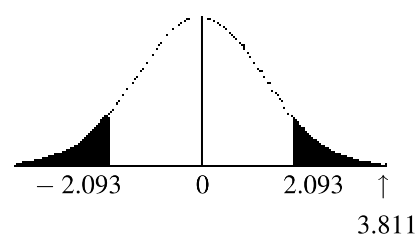
H$_0$: $\mu_1 = \mu_2$

H$_1$: $\mu_1 \neq \mu_2$ (claim)

C. V. $= \pm 2.093$ d. f. $= 19$

$$t = \frac{(\overline{X}_1 - \overline{X}_2) - (\mu_1 - \mu_2)}{\sqrt{\frac{s_1^2}{n_1} + \frac{s_2^2}{n_2}}}$$

$$t = \frac{(63.1 - 56.3) - 0}{\sqrt{\frac{4.1^2}{20} + \frac{7.5^2}{24}}} = 3.811$$



Reject the null hypothesis. There is enough evidence to support the claim that there is a difference in noise levels.

4.

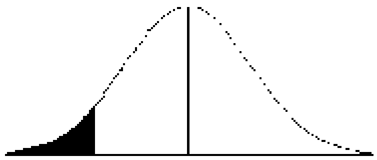
H$_0$: $\mu_1 = \mu_2$

H$_1$: $\mu_1 < \mu_2$ (claim)

C. V. $= -1.711$ d. f. $= 24$

$$t = \frac{(48.7 - 55.3) - 0}{\sqrt{\frac{6.8^2}{25} + \frac{3.2^2}{35}}} = -4.509$$

4. continued



↑ − 1.711   0

− 4.509

Reject the null hypothesis. There is enough evidence to support the claim that the average age of slot machine players is less than the average age of roulette players.

5.

H_0: $\mu_1 = \mu_2$

H_1: $\mu_1 \neq \mu_2$ (claim)

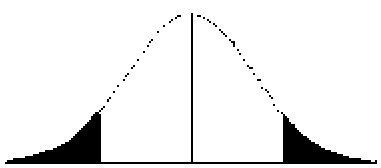
C. V. $= \pm 1.812$ d. f. $= 10$

$\overline{X}_1 = 29.69$ $s_1 = 6.499$

$\overline{X}_2 = 34.36$ $s_2 = 11.201$

$$t = \frac{(\overline{X}_1 - \overline{X}_2) - (\mu_1 - \mu_2)}{\sqrt{\frac{s_1^2}{n_1} + \frac{s_2^2}{n_2}}}$$

$$t = \frac{(29.69 - 34.36) - 0}{\sqrt{\frac{6.499^2}{13} + \frac{11.201^2}{11}}} = -1.220$$



− 1.812 ↑   0   1.812

− 1.220

Do not reject the null hypothesis. There is not enough evidence to support the claim that there is a significant difference in the average number of grams of carbohydrates.

6.

H_0: $\mu_1 = \mu_2$

H_1: $\mu_1 \neq \mu_2$ (claim)

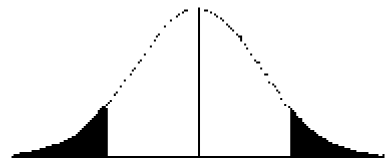
6. continued

C. V. $= \pm 2.571$ d. f. $= 5$

$\overline{X}_1 = 17.412$ $s_1 = 2.451$

$\overline{X}_2 = 14.667$ $s_2 = 4.761$

$$t = \frac{(17.412 - 14.667) - 0}{\sqrt{\frac{2.451^2}{17} + \frac{4.761^2}{6}}} = 1.351$$



− 2.571   0   ↑ 1.812

1.351

Do not reject the null hypothesis. There is not enough evidence to support the claim that the means are different.

7.

H_0: $\mu_1 = \mu_2$

H_1: $\mu_1 \neq \mu_2$ (claim)

$\overline{X}_1 = 12.48$ $s_1 = 1.477$

$\overline{X}_2 = 9.94$ $s_2 = 0.666$

d.f. $= 9$

$$t = \frac{(\overline{X}_1 - \overline{X}_2) - (\mu_1 - \mu_2)}{\sqrt{\frac{s_1^2}{n_1} + \frac{s_2^2}{n_2}}}$$

$$t = \frac{(12.48 - 9.94) - 0}{\sqrt{\frac{1.477^2}{10} + \frac{0.666^2}{15}}} = 5.103$$

For $t = 5.103$, the area is greater than 0.9999. The P-value is $1 - 0.9999 < 0.0001$.

Since the P-value is less than $\alpha = 0.05$, reject the null hypothesis. There is enough evidence to support the claim that there is a difference in the weights of running shoes.

8.

H_0: $\mu_1 = \mu_2$

H_1: $\mu_1 > \mu_2$ (claim)

8. continued

$$t = \frac{(\$48{,}256 - \$45{,}633) - 0}{\sqrt{\frac{\$3912.40^2}{26} + \frac{\$5533^2}{24}}} = 1.921$$

The P-value is $0.025 <$ P-value < 0.05 (0.031). The decision is to reject the null hypothesis since P-value is < 0.05. There is enough evidence to support the claim that the average salary for elementary school teachers is greater than the average salary for secondary school teachers.

9.
For the 90% Confidence Interval:

$42.89 - 1.860(204.9484) < \mu_1 - \mu_2 <$

$42.89 + 1.860(204.9484)$

$-338.31 < \mu_1 - \mu_2 < 424.09$

(TI: $-315.90 < \mu_1 - \mu_2 < 401.65$)

10.
For the 95% Confidence Interval:

$2.745 - 2.571(2.0325) < \mu_1 - \mu_2 <$

$2.745 + 2.571(2.0325)$

$-2.48 < \mu_1 - \mu_2 < 7.97$

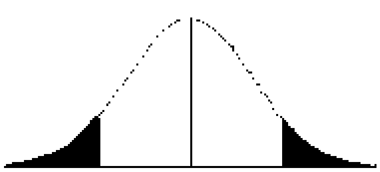
(TI: $-2.24 < \mu_1 - \mu_2 < 7.73$)

11.
H_0: $\mu_1 = \mu_2$

H_1: $\mu_1 \neq \mu_2$ (claim)

C. V. $= \pm 2.977$ d. f. $= 14$

$$t = \frac{(22.45 - 18.5) - 0}{\sqrt{\frac{16.4}{15} + \frac{18.2}{15}}} = 2.601$$



-2.977 0 $\uparrow$ 2.977
2.601

Do not reject the null hypothesis. There is not enough evidence to support the claim that there is a difference in TV viewing times between children and teens.

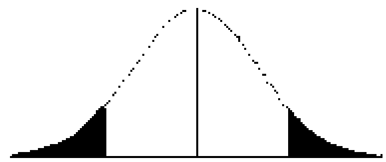
12.
H_0: $\mu_1 = \mu_2$

H_1: $\mu_1 \neq \mu_2$ (claim)

C. V. $= \pm 2.262$

d. f. $= 9$

$$t = \frac{(4973.10 - 1286.50) - 0}{\sqrt{\frac{3914.87^2}{10} + \frac{1477.87^2}{10}}} = 2.786$$



-2.262 0 2.262 $\uparrow$
2.786

Reject the null hypothesis. There is enough evidence to support the claim that there is difference between Professional Golfers' Earnings in the PGA and LPGA.

13.
H_0: $\mu_1 = \mu_2$

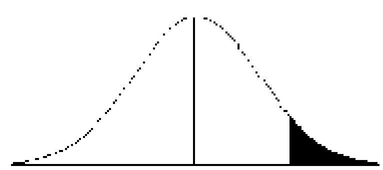
H_1: $\mu_1 > \mu_2$ (claim)

$\overline{X}_1 = 39.6667$ $s_1 = 18.3703$

$\overline{X}_2 = 28.8333$ $s_2 = 17.1279$

C. V. $= 3.365$ d. f. $= 5$

$$t = \frac{(39.6667 - 28.8333) - 0}{\sqrt{\frac{18.3703^2}{6} + \frac{17.1279^2}{6}}} = 1.057$$



0 $\uparrow$ 3.365
1.057

Do not reject the null hypothesis. There is not enough evidence to support the claim that the average number of students attending cyber schools in Allegheny County is greater than those who attend cyber schools outside Allegheny County. One reason why caution should be used is that cyber charter schools are a relatively new concept.

14.

H_0: $\mu_1 = \mu_2$

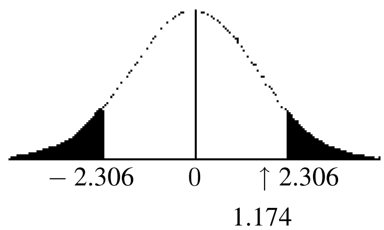
H_1: $\mu_1 \neq \mu_2$ (claim)

C. V. $= \pm\, 2.306$ d. f. $= 8$

$\overline{X}_1 = 65.727$ $\quad s_1 = 9.122$

$\overline{X}_2 = 60.222$ $\quad s_2 = 11.389$

$$t = \frac{(65.727 - 60.222) - 0}{\sqrt{\frac{9.122^2}{11} + \frac{11.389^2}{9}}} = 1.174$$



Do not reject the null hypothesis. There is not enough evidence to support the claim that the average scores are different.

15.

H_0: $\mu_1 = \mu_2$ (claim)

H_1: $\mu_1 \neq \mu_2$

P-value: $0.02 <$ P-value < 0.05 (0.026)

d. f. $= 15$

$$t = \frac{(2.3 - 1.9) - 0}{\sqrt{\frac{0.6^2}{16} + \frac{0.3^2}{16}}} = 2.385$$

Since P-value > 0.01, do not reject the null hypothesis. There is not enough evidence to reject the claim that the mean hospital stay is the same.

(TI: P-value $= 0.026$)

99% Confidence Interval:

$0.4 - 2.947(0.1677) < \mu_1 - \mu_2 <$

$\quad 0.4 + 2.947(0.1677)$

$-\,0.1 < \mu_1 - \mu_2 < 0.9$

(TI: $-\,0.07 < \mu_1 - \mu_2 < 0.87$)

16.

H_0: $\mu_1 = \mu_2$

H_1: $\mu_1 > \mu_2$ (claim)

C. V. $= 1.729$ $\quad$ d. f. $= 19$

$$t = \frac{(62.1 - 55.6) - 0}{\sqrt{\frac{5.4^2}{20} + \frac{3.9^2}{20}}} = 4.364$$

P-value < 0.005 (0.00005) which is $< \alpha$.

(TI: P-value $= 0.000055$)

Reject the null hypothesis. There is enough evidence to support the claim that houses in Whiting are older.

17.

Research: $\overline{X}_1 = 596.2353$ $\; s_1 = 163.2362$

Primary Care: $\overline{X}_2 = 481.5$

$s_2 = 179.3957$

90% Confidence Interval:

$$114.7353 - 1.753\sqrt{\frac{163.2363^2}{17} + \frac{179.3957^2}{16}}$$

$< \mu_1 - \mu_2 <$

$$114.7353 + 1.753\sqrt{\frac{163.2363^2}{17} + \frac{179.3957^2}{16}}$$

$114.7353 - 104.87 < \mu_1 - \mu_2$

$\quad < 114.7353 + 104.87$

$9.8653 < \mu_1 - \mu_2 < 219.6053$

(TI: $13.23 < \mu_1 - \mu_2 < 216.24$)

18.

Private: $\overline{X} = \$16{,}147.5$ $\quad s = 4023.7$

Public: $\overline{X} = \$9039.9$ $\quad s = 3325.5$

95% Confidence Interval:

$$7107.6 - 2.571\sqrt{\frac{4023.7^2}{6} + \frac{3325.5^2}{7}}$$

$< \mu_1 - \mu_2 <$

$$7107.6 + 2.571\sqrt{\frac{4023.7^2}{6} + \frac{3325.5^2}{7}}$$

$\$1789.70 < \mu_1 - \mu_2 < \$12{,}425.41$

(TI: $\$2484.6 < \mu_1 - \mu_2 < \$11{,}731$)

19.

H_0: $\mu_1 = \mu_2$

H_1: $\mu_1 < \mu_2$ (claim)

$\overline{X}_1 = 2.563$ $\quad s_1 = 0.360$

$\overline{X}_2 = 2.690$ $\quad s_2 = 0.223$

$$t = \frac{(\overline{X}_1 - \overline{X}_2) - (\mu_1 - \mu_2)}{\sqrt{\frac{s_1^2}{n_1} + \frac{s_2^2}{n_2}}}$$

$$t = \frac{(2.563 - 2.690) - 0}{\sqrt{\frac{0.360^2}{6} + \frac{0.223^2}{7}}} = -0.75$$

$0.20 < \text{P-value} < 0.25$ (0.2435). Since the P-value is greater than $\alpha = 0.01$, do not reject the null hypothesis. There is not enough evidence to support the claim that the average gasoline price in 2011 was less than the average price in 2015.

20.

H_0: $\mu_1 = \mu_2$

H_1: $\mu_1 \neq \mu_2$ (claim)

$\overline{X}_1 = 55$ $\quad s_1 = 7.01$

$\overline{X}_2 = 49.57$ $\quad s_2 = 6.73$

$$t = \frac{(55 - 49.57) - 0}{\sqrt{\frac{7.01^2}{8} + \frac{6.73^2}{7}}} = 1.529$$

$0.10 < \text{P-value} < 0.20$ (0.1506). Since the P-value is greater than $\alpha = 0.05$, do not reject the null hypothesis. There is not enough evidence to support the claim that there is a difference in the scores.

21.

H_0: $\mu_1 = \mu_2$

H_1: $\mu_1 \neq \mu_2$ (claim)

C. V. $= \pm 1.796$ d. f. $= 11$

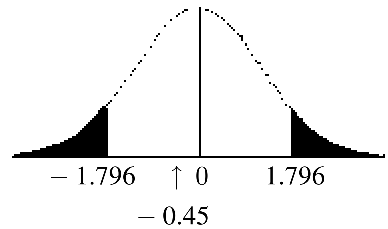
$\overline{X}_1 = 10.17$ $\quad s_1 = 8.943$

$\overline{X}_2 = 11.67$ $\quad s_2 = 7.315$

$$t = \frac{(\overline{X}_1 - \overline{X}_2) - (\mu_1 - \mu_2)}{\sqrt{\frac{s_1^2}{n_1} + \frac{s_2^2}{n_2}}}$$

21. continued

$$t = \frac{(10.17 - 11.67) - 0}{\sqrt{\frac{8.943^2}{12} + \frac{7.315^2}{12}}} = -0.45$$



Do not reject the null hypothesis. There is not enough evidence to support the claim that the mean number of home runs for the two leagues are different.

22.

H_0: $\mu_1 = \mu_2$

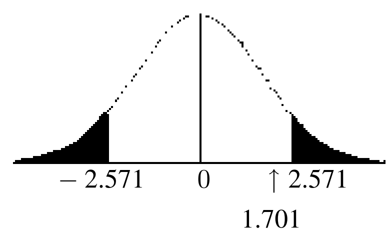
H_1: $\mu_1 \neq \mu_2$ (claim)

C. V. $= \pm 2.571$ $\quad$ d. f. $= 5$

$\overline{X}_1 = 0.438$ $\quad s_1 = 0.168$

$\overline{X}_2 = 0.321$ $\quad s_2 = 0.013$

$$t = \frac{(0.438 - 0.321) - 0}{\sqrt{\frac{0.168^2}{6} + \frac{0.013^2}{6}}} = 1.701$$



Do not reject the null hypothesis. There is not enough evidence to support the claim that the means of the batting averages are different.

EXERCISE SET 9-3

1.

a. Dependent

b. Dependent

1. continued

c. Independent

d. Dependent

e. Independent

2.

Book	DVD	D	D^2
90	85	5	25
80	72	8	64
90	80	10	100
75	80	-5	25
80	70	10	100
90	75	15	225
84	80	4	16
		$\sum D = 47$	$\sum D^2 = 555$

H_0: $\mu_D = 0$

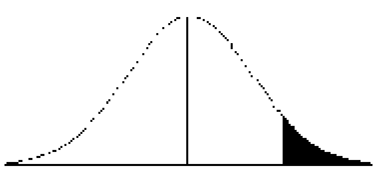
H_1: $\mu_D > 0$ (claim)

C. V. = 1.943 d. f. = 6

$$\overline{D} = \frac{\sum D}{n} = \frac{47}{7} = 6.714$$

$$s_D = \sqrt{\frac{n\sum D^2 - (\sum D)^2}{n(n-1)}} = \sqrt{\frac{7(555) - 47^2}{7(6)}} = 6.317$$

$$t = \frac{\overline{D} - \mu_D}{\frac{s_D}{\sqrt{n}}} = \frac{6.714 - 0}{\frac{6.317}{\sqrt{7}}} = 2.812$$



Reject the null hypothesis. There is enough evidence to support the claim that book scores are higher than DVD scores.

3.

Before	After	D	D^2
9	9	0	0
12	17	-5	25
6	9	-3	9
15	20	-5	25
3	2	1	1
18	21	-3	9
10	15	-5	25
13	22	-9	81
7	6	1	1
		$\sum D = -28$	$\sum D^2 = 176$

H_0: $\mu_D = 0$

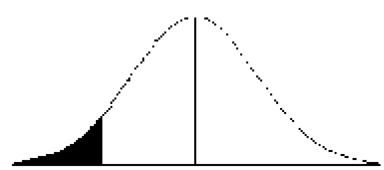
H_1: $\mu_D < 0$ (claim)

C. V. = − 1.397 d. f. = 8

$$\overline{D} = \frac{\sum D}{n} = -3.11$$

$$s_D = \sqrt{\frac{n\sum D^2 - (\sum D)^2}{n(n-1)}} = \sqrt{\frac{9(176) - (-28)^2}{9(8)}} = 3.333$$

$$t = \frac{-3.11 - 0}{\frac{3.33}{\sqrt{9}}} = -2.818$$



Reject the null hypothesis. There is enough evidence to support the claim that the seminar increased the number of hours students studied.

4.

Before	After	D	D^2
67	68	-1	1
72	70	2	4
80	76	4	16
70	65	5	25
78	75	3	9
82	78	4	16
69	65	4	16
75	68	7	49
		$\sum D = 28$	$\sum D^2 = 136$

H_0: $\mu_D = 0$

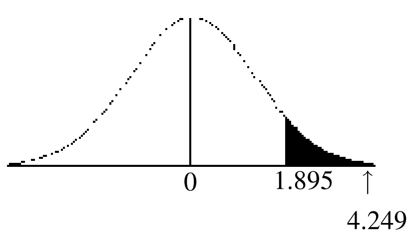
H_1: $\mu_D > 0$ (claim)

C. V. $= 1.895$ d. f. $= 7$

$\overline{D} = \frac{28}{8} = 3.5$

$s_D = \sqrt{\frac{8(136) - (28)^2}{8(7)}} = 2.33$

$t = \frac{3.5 - 0}{\frac{2.33}{\sqrt{8}}} = 4.249$



Reject the null hypothesis. There is enough evidence to support the claim that students did better the second time. Possible reasons include familiarity with the course, warmed up, etc.

5.

Before	After	D	D^2
243	215	28	784
216	202	14	196
214	198	16	256
222	195	27	729
206	204	2	4
219	213	6	36
		$\sum D = 93$	$\sum D^2 = 2005$

H_0: $\mu_D = 0$

H_1: $\mu_D > 0$ (claim)

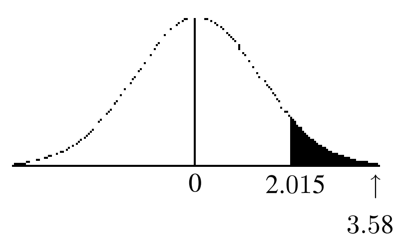
C. V. $= 2.015$ d. f. $= 5$

$\overline{D} = \frac{\sum D}{n} = \frac{93}{6} = 15.5$

$s_D = \sqrt{\frac{n\sum D^2 - (\sum D)^2}{n(n-1)}}$

$s_D = \sqrt{\frac{6(2005) - (93)^2}{6(5)}} = 10.616$

$t = \frac{15.5 - 0}{\frac{10.616}{\sqrt{6}}} = 3.58$



Reject the null hypothesis. There is enough evidence to support the claim that the film motivated the people to eat better.

6.

Thursday	Friday	D	D^2
67	68	-1	1
65	70	-5	25
68	69	-1	1
68	71	-3	9
68	72	-4	16
70	69	1	1
69	70	-1	1
70	70	0	0
		$\sum D = -14$	$\sum D^2 = 54$

H_0: $\mu_D = 0$

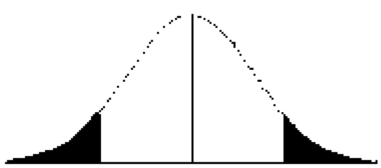
H_1: $\mu_D \neq 0$ (claim)

C. V. $= \pm 2.365$ d. f. $= 7$

$\overline{D} = \frac{-14}{8} = -1.75$

$s_D = \sqrt{\frac{8(54) - (-14)^2}{8(7)}} = 2.053$

$t = \frac{-1.75 - 0}{\frac{2.053}{\sqrt{8}}} = -2.411$



↑ -2.365 0 2.365

-2.411

Reject the null hypothesis. There is enough evidence to support the claim that there is a difference in the scores.

7.

Before	After	D	D^2
12	9	3	9
9	6	3	9
0	1	-1	1
5	3	2	4
4	2	2	4
3	3	0	0
		$\sum D = 9$	$\sum D^2 = 27$

H_0: $\mu_D = 0$

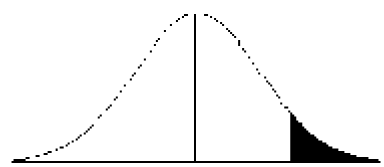
H_1: $\mu_D > 0$ (claim)

C. V. $= 2.571$ d. f. $= 5$

$\overline{D} = \frac{\sum D}{n} = \frac{9}{6} = 1.5$

$s_D = \sqrt{\frac{n\sum D^2 - (\sum D)^2}{n(n-1)}} = \sqrt{\frac{6(27) - 9^2}{6(5)}} = 1.643$

$t = \frac{1.5 - 0}{\frac{1.643}{\sqrt{6}}} = 2.236$



0 ↑ 2.571

2.236

Do not reject the null hypothesis. There is not enough evidence to support the claim that the errors have been reduced.

8.

Before	After	D	D^2
42	39	3	9
53	45	8	64
48	40	8	64
65	58	7	49
40	42	-2	4
52	47	5	25
		$\sum D = 29$	$\sum D^2 = 215$

8. continued

H_0: $\mu_D = 0$

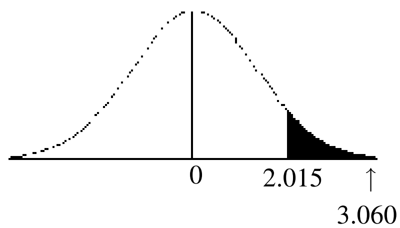
H_1: $\mu_D > 0$ (claim)

C. V. = 2.015 d. f. = 5

$\overline{D} = \frac{29}{6} = 4.833$

$s_D = \sqrt{\frac{6(215) - (29)^2}{6(5)}} = 3.869$

$t = \frac{4.833 - 0}{\frac{3.869}{\sqrt{6}}} = 3.060$



Reject the null hypothesis. There is enough evidence to support the claim that the dogs lost weight.

9.

A	B	D	D^2
87	83	4	16
92	95	-3	9
78	79	-1	1
83	83	0	0
88	86	2	4
90	93	-3	9
84	80	4	16
93	86	7	49
		$\sum D = 10$	$\sum D^2 = 104$

H_0: $\mu_D = 0$

H_1: $\mu_D \neq 0$ (claim)

d. f. = 7

$\overline{D} = \frac{\sum D}{n} = \frac{10}{8} = 1.25$

$s_D = \sqrt{\frac{n\sum D^2 - (\sum D)^2}{n(n-1)}} = \sqrt{\frac{8(104) - 10^2}{8(7)}} = 3.62$

9. continued

$t = \frac{1.25 - 0}{\frac{3.62}{\sqrt{8}}} = 0.978$

P-value > 0.20 (0.361). Do not reject the null hypothesis since P-value > 0.01. There is not enough evidence to support the claim that there is a difference in the pulse rates.

Confidence Interval:

$1.25 - 3.499\left(\frac{3.62}{\sqrt{8}}\right) < \mu_D < 1.25 + 3.499\left(\frac{3.62}{\sqrt{8}}\right)$

$-3.2 < \mu_D < 5.7$

10.

Child	1	2	D	D^2
1	100	90	10	100
2	150	130	20	400
3	150	150	0	0
4	110	90	20	400
5	130	105	25	625
6	120	110	10	100
7	118	120	-2	4
			$\sum D = 83$	$\sum D^2 = 1629$

H_0: $\mu_D = 0$

H_1: $\mu_D > 0$ (claim)

d. f. = 6

$\overline{D} = \frac{\sum D}{n} = \frac{83}{7} = 11.857$

$s_D = \sqrt{\frac{n\sum D^2 - (\sum D)^2}{n(n-1)}} = \sqrt{\frac{7(1629) - 83^2}{7(6)}}$

$s_D = 10.367$

$t = \frac{11.857 - 0}{\frac{10.367}{\sqrt{7}}} = 3.026$

0.01 < P-value < 0.025 (0.012). Do not reject the null hypothesis since P-value > 0.01. There is not enough evidence to support the claim that learning has occurred.

10. continued

Confidence Interval:

$$11.857 - 3.707\left(\frac{10.367}{\sqrt{7}}\right) < \mu_D < 11.857 + 3.707\left(\frac{10.367}{\sqrt{7}}\right)$$

$$-2.7 < \mu_D < 26.4$$

11.

Before	After	D	D^2
8	6	2	4
3	4	-1	1
10	8	2	4
5	1	4	16
9	4	5	25
11	7	4	16
12	11	1	1
		$\sum D = 17$	$\sum D^2 = 67$

H_0: $\mu_D = 0$

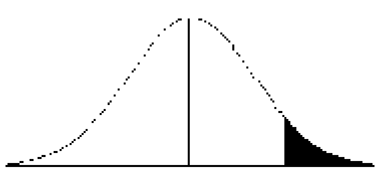
H_1: $\mu_D > 0$ (claim)

C. V. $= 1.943$ d. f. $= 6$

$\overline{D} = \frac{17}{7} = 2.429$

$$s_D = \sqrt{\frac{7(67) - (17)^2}{7(6)}} = 2.07$$

$$t = \frac{2.429 - 0}{\frac{2.07}{\sqrt{7}}} = 3.104$$



Reject the null hypothesis. There is enough evidence to support the claim that the average number of spelling errors have reduced.

12.

Student	Before	After	D	D^2
A	10	4	6	36
B	6	2	4	16
C	8	2	6	36
D	8	7	1	1
E	13	8	5	25
F	8	9	-1	1
			$\sum D = 21$	$\sum D^2 = 115$

H_0: $\mu_D = 0$

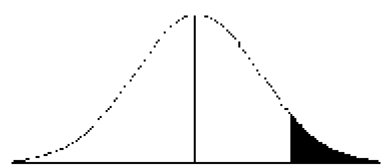
H_1: $\mu_D > 0$ (claim)

C. V. $= 2.015$ d. f. $= 5$

$\overline{D} = 3.5$

$s_D = 2.881$

$$t = \frac{3.5 - 0}{\frac{2.881}{\sqrt{6}}} = 2.976$$



Reject the null hypothesis. There is enough evidence to support the claim that the average number of mistakes has decreased.

13.

$$\overline{X_1 - X_2} = \sum \frac{X_1 - X_2}{n}$$

$$\sum \frac{X_1 - X_2}{n} = \sum\left(\frac{X_1}{n} - \frac{X_2}{n}\right)$$

$$\sum\left(\frac{X_1}{n} - \frac{X_2}{n}\right) = \sum \frac{X_1}{n} - \sum \frac{X_2}{n}$$

$$\sum \frac{X_1}{n} - \sum \frac{X_2}{n} = \overline{X}_1 - \overline{X}_2$$

EXERCISE SET 9-4

1

Use $\hat{p} = \frac{X}{n}$ and $\hat{q} = 1 - \hat{p}$

a. $\hat{p} = \frac{32}{52}$ $\quad \hat{q} = \frac{20}{52}$

b. $\hat{p} = \frac{66}{80}$ $\quad \hat{q} = \frac{14}{80}$

c. $\hat{p} = \frac{12}{36}$ $\quad \hat{q} = \frac{24}{36}$

d. $\hat{p} = \frac{7}{42}$ $\quad \hat{q} = \frac{35}{42}$

e. $\hat{p} = \frac{50}{160}$ $\quad \hat{q} = \frac{110}{160}$

2.

Use $\hat{p} = \frac{X}{n}$ and $\hat{q} = 1 - \hat{p}$

a. $\hat{p} = \frac{20}{36}$ $\quad \hat{q} = \frac{16}{36}$

b. $\hat{p} = \frac{35}{50}$ $\quad \hat{q} = \frac{15}{50}$

c. $\hat{p} = \frac{16}{64}$ $\quad \hat{q} = \frac{48}{64}$

d. $\hat{p} = \frac{175}{200}$ $\quad \hat{q} = \frac{25}{200}$

e. $\hat{p} = \frac{16}{148}$ $\quad \hat{q} = \frac{132}{148}$

3.

a. $x = 0.60(240) = 144$

b. $x = 0.20(320) = 64$

c. $x = 0.60(520) = 312$

d. $x = 0.80(50) = 40$

e. $x = 0.35(200) = 70$

4.

a. $x = 0.24(300) = 72$

b. $x = 0.09(200) = 18$

c. $x = 0.88(500) = 440$

d. $x = 0.4(480) = 192$

e. $x = 0.32(700) = 224$

5.

For each part, use the formulas $\bar{p} = \frac{X_1 + X_2}{n_1 + n_2}$ and $\bar{q} = 1 - \bar{p}$

a. $\bar{p} = \frac{25 + 40}{75 + 90} = 0.3939$
$\bar{q} = 1 - 0.3939 = 0.6061$

b. $\bar{p} = \frac{9 + 7}{15 + 20} = 0.4571$
$\bar{q} = 1 - 0.4571 = 0.5429$

c. $\bar{p} = \frac{3 + 5}{20 + 40} = 0.1333$
$\bar{q} = 1 - 0.1333 = 0.8667$

d. $\bar{p} = \frac{21 + 32}{50 + 50} = 0.53$
$\bar{q} = 1 - 0.53 = 0.47$

e. $\bar{p} = \frac{20 + 30}{150 + 50} = 0.25$
$\bar{q} = 1 - 0.25 = 0.75$

6.

For each part, use the formulas $\bar{p} = \frac{X_1 + X_2}{n_1 + n_2}$ and $\bar{q} = 1 - \bar{p}$

a. $\bar{p} = \frac{6 + 9}{15 + 15} = 0.5$
$\bar{q} = 1 - 0.5 = 0.5$

b. $\bar{p} = \frac{21 + 43}{100 + 150} = 0.256$
$\bar{q} = 1 - 0.256 = 0.744$

6. continued

c. $\bar{p} = \frac{20+65}{80+120} = 0.425$

$\bar{q} = 1 - 0.425 = 0.575$

d. $\bar{p} = \frac{15+3}{50+12} = 0.290$

$\bar{q} = 1 - 0.290 = 0.710$

e. $\bar{p} = \frac{24+18}{40+36} = 0.553$

$\bar{q} = 1 - 0.553 = 0.447$

7.

$\hat{p}_1 = 0.83 \qquad \hat{p}_2 = 0.75$

$X_1 = 0.83(100) = 83$

$X_2 = 0.75(100) = 75$

$\bar{p} = \frac{83+75}{100+100} = 0.79 \quad \bar{q} = 1 - 0.79 = 0.21$

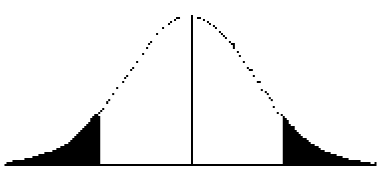
H_0: $p_1 = p_2$ (claim)

H_1: $p_1 \neq p_2$

C. V. $= \pm 1.96 \quad \alpha = 0.05$

$$z = \frac{(\hat{p}_1 - \hat{p}_2) - (p_1 - p_2)}{\sqrt{(\bar{p})(\bar{q})(\frac{1}{n_1} + \frac{1}{n_2})}} = \frac{(0.83 - 0.75) - 0}{\sqrt{(0.79)(0.21)(\frac{1}{100} + \frac{1}{100})}}$$

$z = 1.39$



$-1.96 \qquad 0 \qquad \uparrow\ 1.96$

1.39

Do not reject the null hypothesis. There is not enough evidence to reject the claim that the proportions are equal.

$$(\hat{p}_1 - \hat{p}_2) - z_{\frac{\alpha}{2}}\sqrt{\frac{\hat{p}_1\hat{q}_1}{n_1} + \frac{\hat{p}_1\hat{q}_1}{n_2}} < p_1 - p_2 < (\hat{p}_1 - \hat{p}_2) + z_{\frac{\alpha}{2}}\sqrt{\frac{\hat{p}_1\hat{q}_1}{n_1} + \frac{\hat{p}_1\hat{q}_1}{n_2}}$$

$$0.08 - 1.96\sqrt{\frac{0.83(0.17)}{100} + \frac{0.75(0.25)}{100}} < p_1 - p_2$$

$$< 0.08 + 1.96\sqrt{\frac{0.83(0.17)}{100} + \frac{0.75(0.25)}{100}}$$

$-0.032 < p_1 - p_2 < 0.192$

8.

$\hat{p}_1 = \frac{132}{150} = 0.88 \qquad \hat{p}_2 = \frac{240}{250} = 0.96$

$\bar{p} = \frac{X_1 + X_2}{n_1 + n_2} = \frac{132 + 240}{150 + 250} = 0.93$

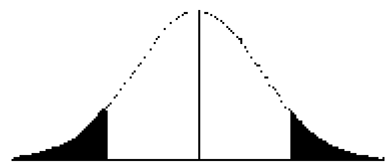
$\bar{q} = 1 - 0.93 = 0.07$

H_0: $p_1 = p_2$

H_1: $p_1 \neq p_2$ (claim)

C. V. $= \pm 1.65$

$$z = \frac{(0.88 - 0.96) - 0}{\sqrt{(0.93)(0.07)(\frac{1}{150} + \frac{1}{250})}} = -3.04$$



$\uparrow \quad -1.65 \qquad 0 \qquad 1.65$

-3.04

(Using the TI83, the 90% confidence interval is

$-0.1282 < p_1 - p_2 < -0.032$).

Reject the null hypothesis. There is enough evidence to support the claim that the proportions are different. A researcher might want to find out why people feel that they have less leisure time now as opposed to 10 years ago. Are they working more? Raising a family? etc.

9.

$\hat{p}_1 = \frac{44}{80} = 0.55 \qquad \hat{p}_2 = \frac{41}{90} = 0.4556$

$\bar{p} = \frac{X_1 + X_2}{n_1 + n_2} = \frac{44 + 41}{80 + 90} = 0.5$

$\bar{q} = 1 - \bar{p} = 1 - 0.5 = 0.5$

H_0: $p_1 = p_2$

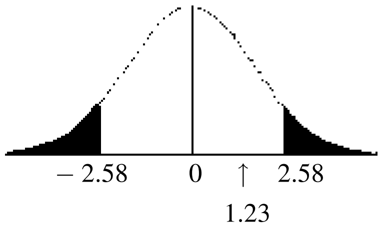
H_1: $p_1 \neq p_2$ (claim)

C. V. $= \pm 2.58 \quad \alpha = 0.01$

$$z = \frac{(\hat{p}_1 - \hat{p}_2) - (p_1 - p_2)}{\sqrt{(\bar{p})(\bar{q})(\frac{1}{n_1} + \frac{1}{n_2})}} = \frac{(0.55 - 0.4556) - 0}{\sqrt{(0.5)(0.5)(\frac{1}{80} + \frac{1}{90})}}$$

$z = 1.23$

9. continued



Do not reject the null hypothesis. There is not enough evidence to support the claim that the proportions are different.

$$(\hat{p}_1 - \hat{p}_2) - z_{\frac{\alpha}{2}}\sqrt{\frac{\hat{p}_1\hat{q}_1}{n_1} + \frac{\hat{p}_1\hat{q}_1}{n_2}} < p_1 - p_2 < (\hat{p}_1 - \hat{p}_2) + z_{\frac{\alpha}{2}}\sqrt{\frac{\hat{p}_1\hat{q}_1}{n_1} + \frac{\hat{p}_1\hat{q}_1}{n_2}}$$

$$0.0944 - 2.58\sqrt{\frac{0.55(0.4556)}{80} + \frac{0.4556(0.55)}{90}} < p_1 - p_2 < 0.0944 + 2.58\sqrt{\frac{0.55(0.4556)}{80} + \frac{0.4556(0.55)}{90}}$$

$-0.104 < p_1 - p_2 < 0.293$

(TI: $-0.104 < p_1 - p_2 < 0.293$)

10.

$\hat{p}_1 = \frac{10}{73} = 0.14 \quad \hat{p}_2 = \frac{16}{80} = 0.20$

$\bar{p} = \frac{10 + 16}{73 + 80} = 0.17$

$\bar{q} = 1 - 0.17 = 0.83$

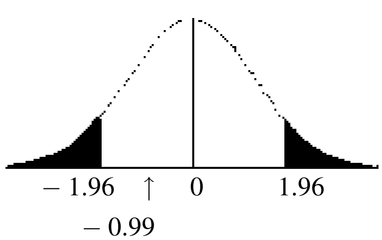
H_0: $p_1 = p_2$

H_1: $p_1 \neq p_2$ (claim)

C. V. $= \pm 1.96$

$$z = \frac{(0.14 - 0.20) - 0}{\sqrt{(0.17)(0.83)(\frac{1}{73} + \frac{1}{80})}} = -0.99$$

(TI: $z = -1.04$)



10. continued

Do not reject the null hypothesis. There is not enough evidence to support the claim that there is a difference in the proportions.

$$(\hat{p}_1 - \hat{p}_2) - z_{\frac{\alpha}{2}}\sqrt{\frac{\hat{p}_1\hat{q}_1}{n_1} + \frac{\hat{p}_1\hat{q}_1}{n_2}} < p_1 - p_2 < (\hat{p}_1 - \hat{p}_2) + z_{\frac{\alpha}{2}}\sqrt{\frac{\hat{p}_1\hat{q}_1}{n_1} + \frac{\hat{p}_1\hat{q}_1}{n_2}}$$

$$(0.14 - 0.2) - 1.96\sqrt{\frac{0.14(0.86)}{73} + \frac{0.2(0.8)}{80}} < p_1 - p_2 < (0.14 - 0.2) + 1.96\sqrt{\frac{0.14(0.86)}{73} + \frac{0.2(0.8)}{80}}$$

$-0.06 - 0.12 < p_1 - p_2 < -0.06 + 0.12$

$-0.181 < p_1 - p_2 < 0.055$

11.

$\hat{p}_1 = \frac{14}{50} = 0.28 \qquad \hat{p}_2 = \frac{21}{60} = 0.35$

$\bar{p} = \frac{X_1 + X_2}{n_1 + n_2} = \frac{14 + 21}{50 + 60} = 0.3182$

$\bar{q} = 1 - \bar{p} = 1 - 0.3852 = 0.6818$

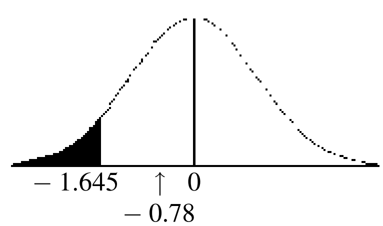
H_0: $p_1 = p_2$

H_1: $p_1 < p_2$ (claim)

C. V. $= -1.65 \quad \alpha = 0.05$

$$z = \frac{(\hat{p}_1 - \hat{p}_2) - (p_1 - p_2)}{\sqrt{(\bar{p})(\bar{q})(\frac{1}{n_1} + \frac{1}{n_2})}} = \frac{(0.28 - 0.35) - 0}{\sqrt{(0.3182)(0.6818)(\frac{1}{50} + \frac{1}{60})}}$$

$z = -0.78$



Do not reject the null hypothesis. There is not enough evidence to support the claim that less household owners have cats than household owners who have dogs as pets.

12.

$$\hat{p}_1 = \frac{X_1}{n_1} = \frac{130}{200} = 0.65$$

$$\hat{p}_2 = \frac{X_2}{n_2} = \frac{63}{300} = 0.21$$

$$\bar{p} = \frac{X_1 + X_2}{n_1 + n_2} = \frac{130 + 63}{200 + 300} = 0.386$$

$$\bar{q} = 1 - \bar{p} = 1 - 0.386 = 0.614$$

H_0: $p_1 = p_2$

H_1: $p_1 > p_2$ (claim)

$$z = \frac{(0.65-0.21)-0}{\sqrt{(0.386)(0.614)(\frac{1}{200}+\frac{1}{300})}} = 9.90$$

P-value < 0.0001

Since P-value < 0.01, reject the null hypothesis. There is enough evidence to support the claim that men are more safety-conscious than women.

13.

$$\hat{p}_1 = \frac{X_1}{n_1} = \frac{24}{80} = 0.30$$

$$\hat{p}_2 = \frac{X_2}{n_2} = \frac{6}{50} = 0.12$$

$$\bar{p} = \frac{X_1 + X_2}{n_1 + n_2} = \frac{24 + 6}{80 + 50} = 0.2308$$

$$\bar{q} = 1 - \bar{p} = 1 - 0.2308 = 0.7692$$

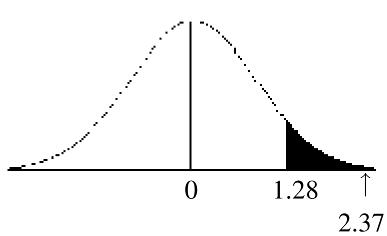
H_0: $p_1 = p_2$

H_1: $p_1 > p_2$ (claim)

C. V. $= 1.28$ $\alpha = 0.10$

$$z = \frac{(\hat{p}_1-\hat{p}_2) - (p_1 - p_2)}{\sqrt{(\bar{p})(\bar{q})(\frac{1}{n_1} + \frac{1}{n_2})}} = \frac{(0.30-0.12)-0}{\sqrt{(0.2308)(0.7692)(\frac{1}{80}+\frac{1}{50})}}$$

$z = 2.37$



13. continued

Reject the null hypothesis. There is enough evidence to support the claim that the percentage of women who were attacked by relatives is greater than the percentage of men who were attacked by relatives.

14.

$$\hat{p}_1 = \frac{43}{150} = 0.287 \quad \hat{p}_2 = \frac{52}{150} = 0.347$$

$$\bar{p} = \frac{43 + 52}{150 + 150} = 0.317$$

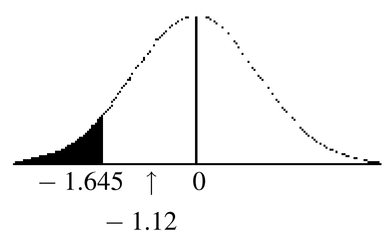
$$\bar{q} = 1 - \bar{p} = 0.683$$

H_0: $p_1 = p_2$

H_1: $p_1 < p_2$ (claim)

C. V. $= -1.65$

$$z = \frac{(0.287 - 0.347) - 0}{\sqrt{(0.317)(0.683)(\frac{1}{150} + \frac{1}{150})}} = -1.12$$



Do not reject the null hypothesis. There is not enough evidence to support the claim that a higher percentage of women have high blood pressure.

15.

$\alpha = 0.05$

$\hat{p}_1 = 0.8$ $\hat{q}_1 = 0.20$

$\hat{p}_1 = 0.517$ $\hat{q}_1 = 0.483$

$$\hat{p}_1 - \hat{p}_2 = 0.8 - 0.517 = 0.283$$

$$(\hat{p}_1 - \hat{p}_2) - z_{\frac{\alpha}{2}}\sqrt{\frac{\hat{p}_1\hat{q}_1}{n_1} + \frac{\hat{p}_1\hat{q}_1}{n_2}} < p_1 - p_2 < (\hat{p}_1 - \hat{p}_2) + z_{\frac{\alpha}{2}}\sqrt{\frac{\hat{p}_1\hat{q}_1}{n_1} + \frac{\hat{p}_1\hat{q}_1}{n_2}}$$

15. continued

$$0.283 - 1.96\sqrt{\frac{(0.8)(0.2)}{100} + \frac{(0.517)(0.483)}{120}} < p_1$$
$$- p_2 < 0.283 + 1.96\sqrt{\frac{(0.8)(0.2)}{100} + \frac{(0.517)(0.483)}{120}}$$

$0.164 < p_1 - p_2 < 0.402$

16.

$\hat{p}_1 = \frac{50}{180} = 0.278 \qquad \hat{q}_1 = 0.722$

$\hat{p}_2 = \frac{39}{150} = 0.26 \qquad \hat{q}_2 = 0.74$

$\hat{p}_1 - \hat{p}_2 = 0.278 - 0.26 = 0.018$

$$0.018 - 2.326\sqrt{\frac{(0.278)(0.722)}{180} + \frac{(0.26)(0.74)}{150}}$$
$$< p_1 - p_2 <$$
$$0.018 + 2.326\sqrt{\frac{(0.278)(0.722)}{180} + \frac{(0.26)(0.74)}{150}}$$

$- 0.096 < p_1 - p_2 < 0.132$

The interval does not support the claim that there is a difference. The interval contains 0 which allows for the possibility that no difference exists.

17.

$\hat{p}_1 = \frac{80}{200} = 0.4 \qquad \hat{p}_2 = \frac{59}{200} = 0.295$

$\bar{p} = \frac{X_1 + X_2}{n_1 + n_2} = \frac{80 + 59}{200 + 200} = 0.3475$

$\bar{q} = 1 - \bar{p} = 1 - 0.3475 = 0.6525$

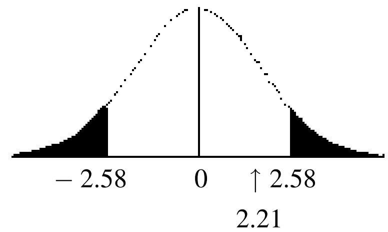
H_0: $p_1 = p_2$
H_1: $p_1 \neq p_2$ (claim)

C. V. $= \pm 2.58$

$$z = \frac{(\hat{p}_1 - \hat{p}_2) - (p_1 - p_2)}{\sqrt{(\bar{p})(\bar{q})(\frac{1}{n_1} + \frac{1}{n_2})}} = \frac{(0.4 - 0.295) - 0}{\sqrt{(0.3475)(0.6525)(\frac{1}{200} + \frac{1}{200})}}$$

$z = 2.21$

17. continued



Do not reject the null hypothesis. There is not enough evidence to support the claim that the proportions are different.

18.

$\hat{p}_1 = \frac{X_1}{n_1} = \frac{213}{300} = 0.71 \qquad \hat{p}_2 = \frac{185}{250} = 0.74$

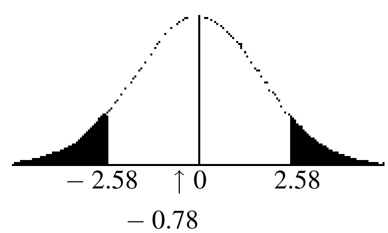
$\bar{p} = \frac{X_1 + X_2}{n_1 + n_2} = \frac{213 + 185}{300 + 250} = 0.724$

$\bar{q} = 1 - \bar{p} = 1 - 0.7236 = 0.276$

H_0: $p_1 = p_2$
H_1: $p_1 \neq p_2$ (claim)

C. V. $= \pm 2.58$

$$z = \frac{(0.71 - 0.74) - 0}{\sqrt{(0.724)(0.276)(\frac{1}{300} + \frac{1}{250})}} = -0.78$$



Do not reject the null hypothesis. There is not enough evidence to support the claim that there is a difference in the proportions.

19.

$\hat{p}_1 = \frac{100}{350} = 0.2857 \qquad \hat{q}_1 = 0.7143$

$\hat{p}_2 = \frac{115}{400} = 0.2875 \qquad \hat{q}_2 = 0.7125$

$\hat{p}_1 - \hat{p}_2 = -0.0018$

19. continued

$$(\hat{p}_1 - \hat{p}_2) - z_{\frac{\alpha}{2}}\sqrt{\frac{\hat{p}_1\hat{q}_1}{n_1} + \frac{\hat{p}_1\hat{q}_1}{n_2}} < p_1 - p_2 <$$

$$(\hat{p}_1 - \hat{p}_2) + z_{\frac{\alpha}{2}}\sqrt{\frac{\hat{p}_1\hat{q}_1}{n_1} + \frac{\hat{p}_1\hat{q}_1}{n_2}}$$

$$-0.0018 - 1.96\sqrt{\frac{(0.2857)(0.7143)}{350} + \frac{(0.2875)(0.7125)}{400}}$$

$$< p_1 - p_2 <$$

$$-0.0018 + 1.96\sqrt{\frac{(0.2857)(0.7143)}{350} + \frac{(0.2875)(0.7125)}{400}}$$

$$-0.0667 < p_1 - p_2 < 0.0631$$

The interval does agree with the *Almanac* statistics stating a difference of -0.042 since -0.042 is contained in the interval.

20.

$$\hat{p}_1 = \frac{178}{300} = 0.593 \quad \hat{p}_2 = \frac{139}{300} = 0.463$$

$$\bar{p} = \frac{X_1 + X_2}{n_1 + n_2} = \frac{178 + 139}{300 + 300} = \frac{317}{600} = 0.528$$

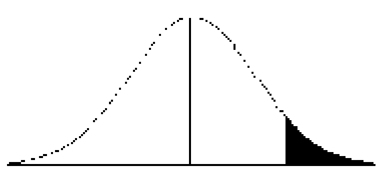
$$\bar{q} = 1 - \bar{p} = 1 - 0.5283 = 0.472$$

H_0: $p_1 = p_2$

H_1: $p_1 > p_2$ (claim)

C. V. $= 1.65$

$$z = \frac{(0.593 - 0.463) - 0}{\sqrt{(0.528)(0.472)(\frac{1}{300} + \frac{1}{300})}} = 3.19$$



0 1.65 ↑
3.19

Reject the null hypothesis. There is enough evidence to support the claim that the proportion of married men is greater than the proportion of married women.

21.

$$\hat{p}_1 = \frac{X_1}{n_1} = \frac{200}{250} = 0.8 \quad \hat{p}_2 = \frac{180}{300} = 0.6$$

21. continued

$$\bar{p} = \frac{X_1 + X_2}{n_1 + n_2} = \frac{200 + 180}{250 + 300} = 0.691$$

$$\bar{q} = 1 - \bar{p} = 1 - 0.691 = 0.31$$

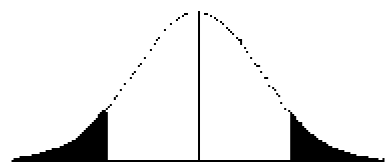
H_0: $p_1 = p_2$

H_1: $p_1 \neq p_2$ (claim)

C. V. $= \pm 2.58$

$$z = \frac{(\hat{p}_1 - \hat{p}_2) - (p_1 - p_2)}{\sqrt{(\bar{p})(\bar{q})(\frac{1}{n_1} + \frac{1}{n_2})}} = \frac{(0.8 - 0.6) - 0}{\sqrt{(0.691)(0.31)(\frac{1}{250} + \frac{1}{300})}}$$

$z = 5.05$



-2.58 0 2.58 ↑
5.05

Reject the null hypothesis. There is enough evidence to support the claim that the proportion of students receiving aid has changed.

22.

$$\hat{p}_1 = \frac{X_1}{n_1} = \frac{980}{1200} = 0.8167$$

$$\hat{p}_2 = \frac{940}{1200} = 0.7833$$

$$\bar{p} = \frac{X_1 + X_2}{n_1 + n_2} = \frac{980 + 940}{1200 + 1200} = 0.8$$

$$\bar{q} = 1 - \bar{p} = 1 - 0.8 = 0.2$$

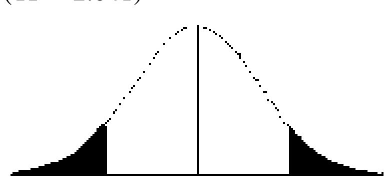
H_0: $p_1 = p_2$

H_1: $p_1 \neq p_2$ (claim)

C. V. $= \pm 1.96$

$$z = \frac{(0.8167 - 0.7833) - 0}{\sqrt{(0.8)(0.2)(\frac{1}{1200} + \frac{1}{1200})}} = 2.045$$

(TI $= 2.041$)



-1.96 0 1.96 ↑
2.045

22. continued

Reject the null hypothesis. There is enough evidence to support the claim that the proportions are different.

23.

$$\hat{p}_1 = \frac{X_1}{n_1} = \frac{72}{120} = 0.6$$

$$\hat{p}_2 = \frac{80}{150} = 0.533$$

$$\bar{p} = \frac{X_1 + X_2}{n_1 + n_2} = \frac{72 + 80}{120 + 150} = 0.563$$

$$\bar{q} = 1 - \bar{p} = 1 - 0.563 = 0.437$$

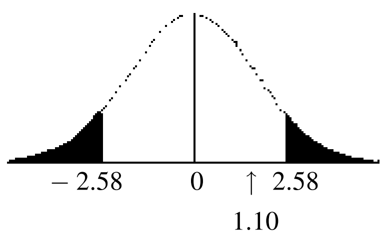
H_0: $p_1 = p_2$

H_1: $p_1 \neq p_2$ (claim)

C. V. $= \pm 2.58$

$$z = \frac{(\hat{p}_1 - \hat{p}_2) - (p_1 - p_2)}{\sqrt{(\bar{p})(\bar{q})(\frac{1}{n_1} + \frac{1}{n_2})}} = \frac{(0.6 - 0.533) - 0}{\sqrt{(0.563)(0.437)(\frac{1}{120} + \frac{1}{150})}}$$

$z = 1.10$



Do not reject the null hypothesis. There is not enough evidence to support the claim that the proportions are different between male interviewees and female interviewees.

24.

$$\hat{p}_1 = \frac{X_1}{n_1} = \frac{114}{200} = 0.57$$

$$\hat{p}_2 = \frac{80}{200} = 0.4$$

$$\bar{p} = \frac{X_1 + X_2}{n_1 + n_2} = \frac{114 + 80}{200 + 200} = 0.485$$

$$\bar{q} = 1 - \bar{p} = 1 - 0.485 = 0.515$$

H_0: $p_1 = p_2$

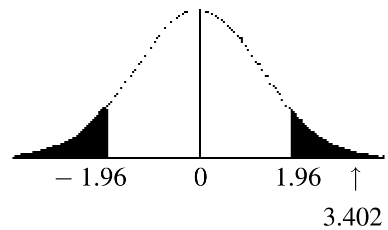
H_1: $p_1 \neq p_2$ (claim)

C. V. $= \pm 1.96$

24. continued

$$z = \frac{(\hat{p}_1 - \hat{p}_2) - (p_1 - p_2)}{\sqrt{(\bar{p})(\bar{q})(\frac{1}{n_1} + \frac{1}{n_2})}} = \frac{(0.57 - 0.4) - 0}{\sqrt{(0.485)(0.515)(\frac{1}{200} + \frac{1}{200})}}$$

$z = 3.402$



Reject the null hypothesis. There is enough evidence to support the claim that the proportions are different.

25.

$$\hat{p}_1 = \frac{132}{180} = 0.733 \quad \hat{p}_2 = \frac{56}{100} = 0.56$$

$$\bar{p} = \frac{X_1 + X_2}{n_1 + n_2} = \frac{132 + 56}{180 + 100} = \frac{188}{280} = 0.671$$

$$\bar{q} = 1 - \bar{p} = 1 - 0.671 = 0.329$$

H_0: $p_1 = p_2$

H_1: $p_1 > p_2$ (claim)

$$z = \frac{(\hat{p}_1 - \hat{p}_2) - (p_1 - p_2)}{\sqrt{(\bar{p})(\bar{q})(\frac{1}{n_1} + \frac{1}{n_2})}} = \frac{(0.733 - 0.56) - 0}{\sqrt{(0.671)(0.329)(\frac{1}{180} + \frac{1}{100})}}$$

$z = 2.96$

(TI: $z = 2.9589$; P-value $= 0.00154$)

P-value < 0.002 (0.0015).

Since P-value $< \alpha$, reject the null hypothesis. There is enough evidence to support the claim that the proportion of women who use coupons is greater than the proportion of men who use coupons.

26.

$$\hat{p}_1 = \frac{78}{250} = 0.312 \quad \hat{p}_2 = \frac{58}{200} = 0.29$$

$$\bar{p} = \frac{X_1 + X_2}{n_1 + n_2} = \frac{78 + 58}{250 + 200} = 0.302$$

$$\bar{q} = 1 - \bar{p} = 1 - 0.302 = 0.698$$

26. continued

H_0: $p_1 = p_2$

H_1: $p_1 > p_2$ (claim)

$$z = \frac{(\hat{p}_1 - \hat{p}_2) - (p_1 - p_2)}{\sqrt{(\bar{p})(\bar{q})\left(\frac{1}{n_1} + \frac{1}{n_2}\right)}} = \frac{(0.312 - 0.29) - 0}{\sqrt{(0.302)(0.698)\left(\frac{1}{250} + \frac{1}{200}\right)}}$$

$z = 0.505$ or 0.51

P-value $= 0.3050$.

Since P-value $> \alpha$, do not reject the null hypothesis. There is not enough evidence to support the claim that the proportion of men who have never married is greater than the proportion of women who have never married.

27.

$\hat{p}_1 = \frac{13}{200} = 0.065$ $\hat{p}_2 = \frac{16}{200} = 0.08$

$\bar{p} = \frac{13 + 16}{200 + 200} = 0.0725$

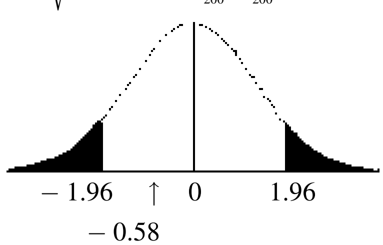
$\bar{q} = 1 - \bar{p} = 1 - 0.0725 = 0.9275$

H_0: $p_1 = p_2$

H_1: $p_1 \neq p_2$ (claim)

C. V. $= \pm 1.96$

$$z = \frac{(0.065 - 0.08) - 0}{\sqrt{(0.0725)(0.9275)\left(\frac{1}{200} + \frac{1}{200}\right)}} = -0.58$$



Do not reject the null hypothesis. There is not enough evidence to support the claim that there is a difference in the proportions.

28.

No, because p_1 could equal p_3.

EXERCISE SET 9-5

1.

The variance in the numerator should be the larger of the two variances.

2.

Since the larger variance is placed in the numerator of the formula, $F \geq 1$.

3.

One degree of freedom is used for the variance associated with the numerator, and one is used for the variance associated with the denominator.

4.

The characteristics of the F-distribution are:

a. The values of F cannot be negative.

b. The distribution is positively skewed.

c. The mean value of F is approximately equal to 1.

d. The F distribution is a family of curves based upon the degrees of freedom.

5.

a. d. f. N = 24, d. f. D = 13; C. V. = 2.89

b. d. f. N = 15, d. f. D = 11; C. V. = 2.17

c. d. f. N = 20, d. f. D = 17; C. V. = 3.16

6.

a. d. f. N = 8, d. f. D = 4, C. V. = 14.80

b. d. f. N = 20, d. f. D = 16; C. V. = 2.28

c. d. f. N = 10, d. f. D = 10; C. V. = 2.98

7.

Note: Specific P-values are in parentheses.

a. $0.025 < \text{P-value} < 0.05$ (0.033)

b. $0.05 < \text{P-value} < 0.10$ (0.072)

c. $\text{P-value} = 0.05$

d. $0.005 < \text{P-value} < 0.01$ (0.006)

8.

a. $\text{P-value} = 0.05$

b. $P > 0.10$ (0.112)

c. $0.05 < \text{P-value} < 0.10$ (0.068)

d. $0.01 < \text{P-value} < 0.02$ (0.015)

9.

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

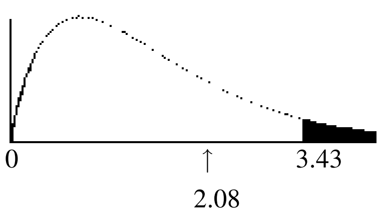
H_1: $\sigma_1^2 \neq \sigma_2^2$ (claim)

$s_1 = 2.290$ $s_2 = 1.586$

C. V. $= 3.43$ $\alpha = \frac{0.05}{2}$

d. f. N $= 12$ d. f. D $= 11$

$F = \frac{s_1^2}{s_2^2} = \frac{2.290^2}{1.586^2} = 2.08$



Do not reject the null hypothesis. There is not enough evidence to support the claim that the variances are different.

10.

H_0: $\sigma_1 = \sigma_2$

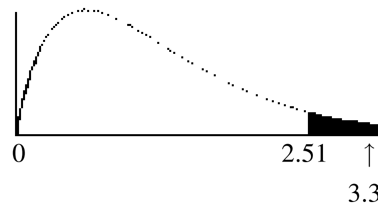
H_1: $\sigma_1 \neq \sigma_2$ (claim)

C. V. $= 2.51$ $\alpha = \frac{0.05}{2}$

d. f. N $= 23$ d. f. D $= 19$

10. continued

$F = \frac{(7.5)^2}{(4.1)^2} = 3.35$



Reject the null hypothesis. There is enough evidence to support the claim that the standard deviations are different.

11.

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

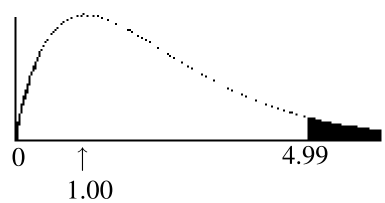
H_1: $\sigma_1^2 \neq \sigma_2^2$ (claim)

$s_1 = 33.99$ $s_2 = 33.99$

C. V. $= 4.99$ $\alpha = \frac{0.05}{2}$

d. f. N $= 7$ d. f. D $= 7$

$F = \frac{s_1^2}{s_2^2} = \frac{(33.99)^2}{(33.99)^2} = 1$



Do not reject the null hypothesis. There is not enough evidence to support the claim that the variances are different.

12.

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

H_1: $\sigma_1^2 \neq \sigma_2$ (claim)

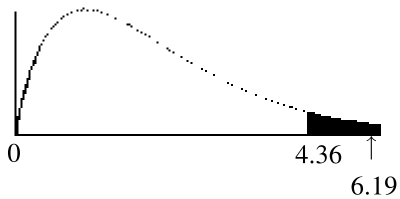
$s_1 = 8.039$ $s_2 = 3.232$

C. V. $= 4.36$ $\alpha = \frac{0.05}{2}$

d. f. N $= 9$ d. f. D $= 8$

$F = \frac{8.039^2}{3.232^2} = 6.19$

12. continued



Reject the null hypothesis. There is enough evidence to support the claim that there is a difference in the variances.

13.

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

H_1: $\sigma_1^2 > \sigma_2^2$ (claim)

$s_1 = 111.211$ $s_2 = 35.523$

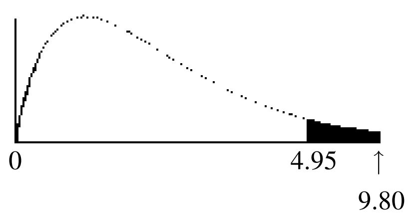
$n_1 = 7$ $n_2 = 6$

d. f. N = 6 d. f. D = 5

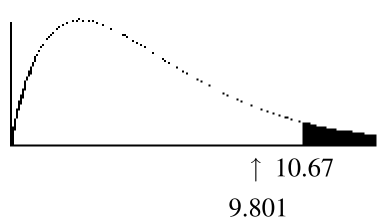
C. V. = 4.950 at $\alpha = 0.05$

C. V. = 10.67 at $\alpha = 0.01$

$$F = \frac{s_1^2}{s_2^2} = \frac{(111.211)^2}{(35.523)^2} = 9.80$$



Reject the null hypothesis at $\alpha = 0.05$. There is enough evidence to support the claim that the variance in area is greater for Eastern cities.



13. continued

Do not reject the null hypothesis at $\alpha = 0.01$. There is not enough evidence to support the claim that the variance in area is greater for Eastern cities.

14.

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

H_1: $\sigma_1^2 \neq \sigma_2^2$ (claim)

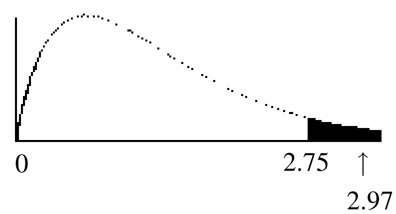
Chocolate: s = 6.4985

Non-chocolate: s = 11.2006

C. V. = 2.75 $\alpha = \frac{0.10}{2}$

d. f. N = 10 d. f. D = 12

$$F = \frac{11.2006^2}{6.4985^2} = 2.97$$



Reject the null hypothesis. There is enough evidence to support the claim that the variances in carbohydrate grams of chocolate candy and non-chocolate candy are not the same.

15.

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

H_1: $\sigma_1^2 \neq \sigma_2^2$ (claim)

Research: $s_1 = 5501.118$

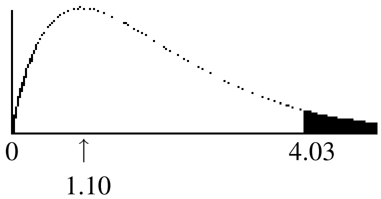
Primary Care: $s_2 = 5238.809$

C. V. = 4.03 $\alpha = \frac{0.05}{2}$

d. f. N = 9 d. f. D = 9

$$F = \frac{s_1^2}{s_2^2} = \frac{(5501.118)^2}{(5238.809)^2} = 1.10$$

15. continued



Do not reject the null hypothesis. There is not enough evidence to support the claim that there is a difference between the variances in tuition costs.

16.

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

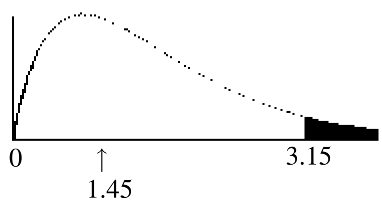
H_1: $\sigma_1^2 < \sigma_2^2$ (claim)

$s_1 = 98.2$ $s_2 = 118.4$

C. V. $= 3.15$ $\alpha = 0.01$

d. f. N $= 19$ d. f. D $= 19$

$F = \frac{(118.4)^2}{(98.2)^2} = 1.45$



Do not reject the null hypothesis. There is not enough evidence to support the claim that the variance of the areas in Indiana is less than the variance of the areas in Iowa.

17.

H_0: $\sigma_1^2 = \sigma_2^2$ (claim)

H_1: $\sigma_1^2 \neq \sigma_2^2$

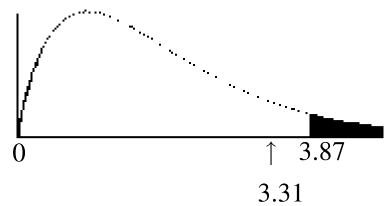
$s_1 = 130.496$ $s_2 = 71.753$

C. V. $= 3.87$ $\alpha = \frac{0.10}{2}$

d. f. N $= 6$ d. f. D $= 7$

17. continued

$F = \frac{s_1^2}{s_2^2} = \frac{(130.496)^2}{(71.753)^2} = 3.31$



Do not reject the null hypothesis. There is not enough evidence to reject the claim that the variances of the heights are equal.

18.

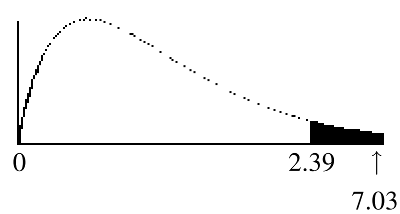
H_0: $\sigma_1^2 = \sigma_2^2$

H_1: $\sigma_1^2 \neq \sigma_2^2$ (claim)

C. V. $= 2.39$ $\alpha = \frac{0.05}{2}$

d. f. N $= 20$ d. f. D $= 22$

$F = \frac{6.1^2}{2.3^2} = 7.03$



Reject the null hypothesis. There is enough evidence to support the claim that the variances of the two teams are different.

19.

Men	Women
$s_1^2 = 2.363$	$s_2^2 = 0.444$
$n_1 = 15$	$n_2 = 15$

H_0: $\sigma_1^2 = \sigma_2^2$ (claim)

H_1: $\sigma_1^2 \neq \sigma_2$

$\alpha = 0.05$ P-value $= 0.004$

d. f. N $= 14$ d. f. D $= 14$

19. continued

$F = \frac{s_1^2}{s_2^2} = \frac{2.363}{0.444} = 5.32$

Since P-value $< \alpha$, reject the null hypothesis. There is enough evidence to reject the claim that the variances in weights are equal.

20.

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

H_1: $\sigma_1^2 > \sigma_2^2$ (claim)

$\alpha = 0.05$ P-value $= 0.003$

d. f. N $= 29$ d. f. D $= 29$

$F = \frac{8324}{2862} = 2.91$

Since P-value $< \alpha$, reject the null hypothesis. There is enough evidence to support the claim that the variation in the salaries of the elementary school teachers is greater than the variation in salaries of the secondary teachers.

21.

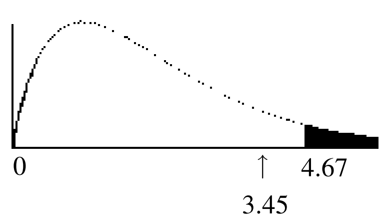
H_0: $\sigma_1^2 = \sigma_2^2$

H_1: $\sigma_1^2 \neq \sigma_2$ (claim)

C. V. $= 4.67$ $\alpha = \frac{0.05}{2}$

d. f. N $= 12$ d. f. D $= 7$

$F = \frac{1.3^2}{0.7^2} = 3.45$



Do not reject the null hypothesis. There is not enough evidence to support the claim that the variances of ages of dog owners in Miami and Boston are different.

22.

$s_1 = 16.359$ $s_2 = 15.072$

$n_1 = 10$ $n_2 = 10$

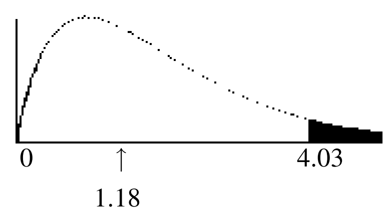
H_0: $\sigma_1^2 = \sigma_2^2$

H_1: $\sigma_1^2 \neq \sigma_2$ (claim)

C. V. $= 4.03$ $\alpha = \frac{0.05}{2}$

d. f. N $= 9$ d. f. D $= 9$

$F = \frac{16.359^2}{15.072^2} = 1.18$



Do not reject the null hypothesis. There is not enough evidence to support the claim that there is a difference in the variances.

23.

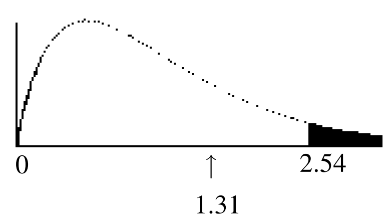
H_0: $\sigma_1^2 = \sigma_2^2$

H_1: $\sigma_1^2 > \sigma_2^2$ (claim)

C. V. $= 2.54$ $\alpha = 0.05$

d. f. N $= 10$ d. f. D $= 15$

$F = \frac{s_1^2}{s_2^2} = \frac{3.2^2}{2.8^2} = 1.31$



Do not reject the null hypothesis. There is not enough evidence to support the claim that the variance of the final exam scores for the students who took the online course is greater than the variance of the final exam scores of the students who took the classroom final exam.

24.

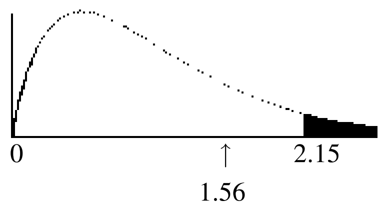
H_0: $\sigma_1^2 = \sigma_2^2$

H_1: $\sigma_1^2 \neq \sigma_2^2$ (claim)

C. V. $= 2.15$ $\quad \alpha = \frac{0.05}{2}$

D.F.N $= 29$ $\quad$ d.f.D $= 29$

$F = \frac{65^2}{52^2} = 1.56$



Do not reject the null hypothesis. There is not enough evidence to support the claim that there is a difference in the variances.

REVIEW EXERCISES - CHAPTER 9

1.

H_0: $\mu_1 = \mu_2$

H_1: $\mu_1 > \mu_2$ (claim)

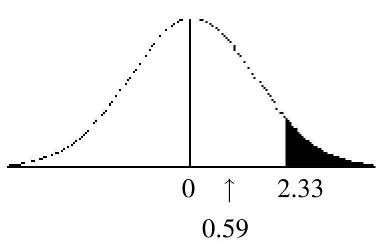
CV $= 2.33$ $\quad \alpha = 0.01$

$\overline{X}_1 = 120.1$ $\quad \overline{X}_2 = 117.8$

$s_1 = 16.722$ $\quad s_2 = 16.053$

$$z = \frac{(\overline{X}_1 - \overline{X}_2) - (\mu_1 - \mu_2)}{\sqrt{\frac{\sigma_1^2}{n_1} + \frac{\sigma_2^2}{n_2}}} = \frac{(120.1 - 117.8) - 0}{\sqrt{\frac{16.722^2}{36} + \frac{16.053^2}{35}}}$$

$z = 0.59$



Do not reject the null hypothesis. There is not enough evidence to support the claim that single people do more pleasure driving than married people.

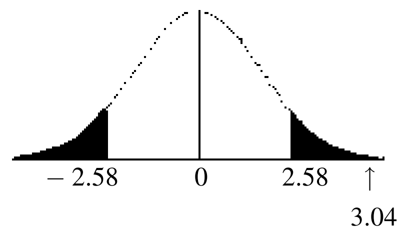
2.

H_0: $\mu_1 = \mu_2$

H_1: $\mu_1 \neq \mu_2$ (claim)

C. V. $= \pm 2.58$ $\quad \alpha = 0.05$

$$z = \frac{(59{,}235 - 52{,}487) - 0}{\sqrt{\frac{8945^2}{40} + \frac{10{,}125^2}{35}}} = 3.04$$



Reject the null hypothesis. There is enough evidence to support the claim that there is a difference in the mean earnings.

3.

H_0: $\mu_1 = \mu_2$

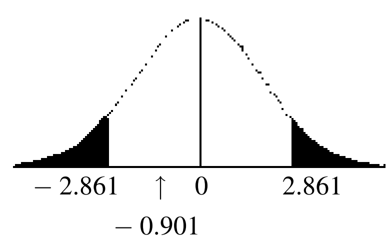
H_1: $\mu_1 \neq \mu_2$ (claim)

C. V. $= \pm 2.861$ $\quad$ d. f. $= 19$

$\overline{X}_1 = 9.6$ $\quad \overline{X}_2 = 10.3$

$$t = \frac{(\overline{X}_1 - \overline{X}_2) - (\mu_1 - \mu_2)}{\sqrt{\frac{s_1^2}{n_1} + \frac{s_2^2}{n_2}}} = \frac{(9.6 - 10.3) - 0}{\sqrt{\frac{2.8^2}{20} + \frac{2.3^2}{25}}}$$

$t = -0.901$



Do not reject the null hypothesis. There is not enough evidence to support the claim that the means are different.

4.

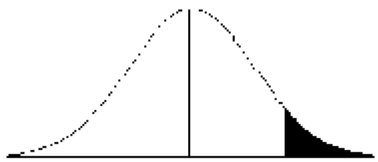
H_0: $\mu_1 = \mu_2$

H_1: $\mu_1 > \mu_2$ (claim)

C. V. $= 1.318$ $\quad$ d. f. $= 24$ $\quad \alpha = 0.10$

4. continued

$$t = \frac{(72.92 - 70.8) - 0}{\sqrt{\frac{5.499^2}{25} + \frac{5.817^2}{25}}} = 1.324$$

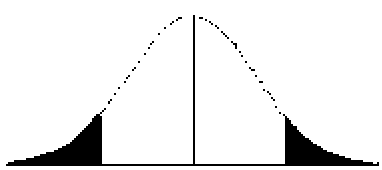


Reject the null hypothesis. There is enough evidence to support the claim that it is warmer in Birmingham.

5.
H_0: $\mu_1 = \mu_2$
H_1: $\mu_1 \neq \mu_2$ (claim)
C. V. $= \pm 2.624$ d. f. $= 14$

$$t = \frac{(\overline{X}_1 - \overline{X}_2) - (\mu_1 - \mu_2)}{\sqrt{\frac{s_1^2}{n_1} + \frac{s_2^2}{n_2}}} = \frac{(35{,}270 - 29{,}512) - 0}{\sqrt{\frac{3256^2}{15} + \frac{1432^2}{15}}}$$

$t = 6.540$



Reject the null hypothesis. There is enough evidence to support the claim that there is a difference in the teachers' salaries.

98% Confidence Interval:
$\$3{,}494.80 < \mu_1 - \mu_2 < \$8{,}021.20$

6.
H_0: $\mu_1 = \mu_2$
H_1: $\mu_1 \neq \mu_2$ (claim)
$\alpha = 0.10$ P-value $= 0.4647$

$$t = \frac{(150.8333 - 254) - 0}{\sqrt{\frac{(173.1432)^2}{6} + \frac{(183.4748)^2}{3}}} = -0.810$$

6. continued

Do not reject the null hypothesis since P-value > 0.10. There is not enough evidence to support the claim that the means are different. A cafeteria manager would want to know the results in order to make a decision on which beverage to serve.

7.

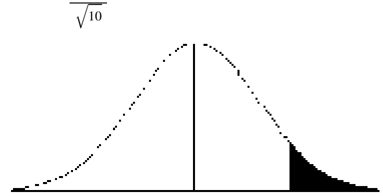
Maximum	Minimum	D	D^2
44	27	17	289
46	34	12	144
46	24	22	484
36	19	17	289
34	19	15	225
36	26	10	100
57	33	24	576
62	57	5	25
73	46	27	729
53	26	27	729
		$\sum D = 176$	$\sum D^2 = 3590$

H_0: $\mu_D = 10$
H_1: $\mu_D > 10$
C. V. $= 2.821$

$$\overline{D} = \frac{176}{10} = 17.6$$

$$s_D = \sqrt{\frac{10(3590) - 176^2}{10(9)}} = 7.3967$$

$$t = \frac{17.6 - 10}{\frac{7.3967}{\sqrt{10}}} = 3.249$$



Reject the null hypothesis. There is enough evidence to support the claim that the mean difference is more than 10 degrees.

8.

Pretest	Posttest	D	D^2
52	62	-10	100
50	65	-15	225
40	50	-10	100
58	65	-7	49
60	68	-8	64
52	63	-11	121
		$\sum D = -61$	$\sum D^2 = 659$

H_0: $\mu_D = 0$

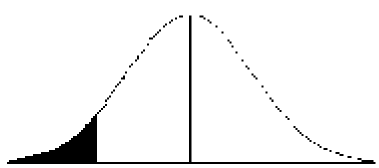
H_1: $\mu_D < 0$ (claim)

C. V. $= -2.015$ d. f. $= 5$ $\alpha = 0.05$

$$\overline{D} = \frac{\sum D}{n} = \frac{-61}{6} = -10.17$$

$$s_D = \sqrt{\frac{6(659) - (-61)^2}{6(5)}} = 2.787$$

$$t = \frac{-10.17 - 0}{\frac{2.787}{\sqrt{6}}} = -8.94$$



↑ -2.015 0

-8.94

Reject the null hypothesis. There is enough evidence to support the claim that the review improved the students' scores.

9.

$\hat{p}_1 = \frac{49}{200} = 0.245$ $\hat{p}_2 = \frac{62}{200} = 0.31$

$$\overline{p} = \frac{49 + 62}{200 + 200} = 0.2775$$

$$\overline{q} = 1 - 0.2775 = 0.7225$$

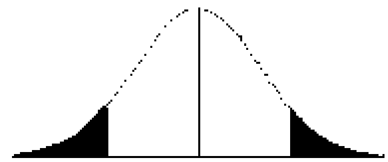
H_0: $p_1 = p_2$

H_1: $p_1 \neq p_2$ (claim)

C. V. $= \pm 1.96$

$$z = \frac{(0.245 - 0.31) - 0}{\sqrt{(0.2775)(0.7225)(\frac{1}{200} + \frac{1}{200})}} = -1.45$$

9. continued



-1.96 ↑ 0 1.96

-1.45

Do not reject the null hypothesis. There is not enough evidence to support the claim that the proportions of men and women who gamble are different.

10.

$\hat{p}_1 = \frac{36}{60} = 0.60$ $\hat{p}_2 = \frac{28}{50} = 0.56$

$$\overline{p} = \frac{36 + 28}{60 + 50} = 0.5818$$

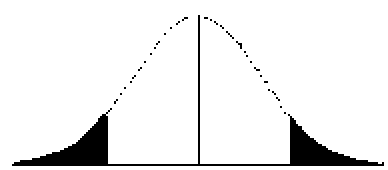
$$\overline{q} = 1 - 0.5818 = 0.4182$$

H_0: $p_1 = p_2$

H_1: $p_1 \neq p_2$ (claim)

C. V. $= \pm 2.58$

$$z = \frac{(0.60 - 0.56) - 0}{\sqrt{(0.5818)(0.4182)(\frac{1}{60} + \frac{1}{50})}} = 0.42$$



-2.58 0 ↑ 2.58

0.42

Do not reject the null hypothesis. There is not enough evidence to support the claim that there is a difference in the proportions.

11.

H_0: $\sigma_1 = \sigma_2$

H_1: $\sigma_1 \neq \sigma_2$ (claim)

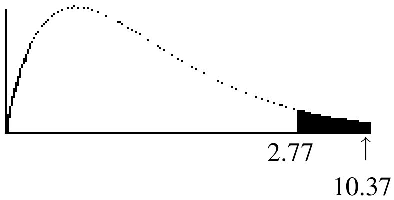
$\alpha = 0.10$

d.f.N. $= 23$ d.f.D. $= 10$

C. V. $= 2.77$

$$F = \frac{13.2^2}{4.1^2} = 10.37$$

11. continued



Reject the null hypothesis. There is enough evidence to support the claim that there is a difference in the standard deviations.

12.

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

H_1: $\sigma_1^2 \neq \sigma_2^2$ (claim

$s_1 = 36.0533$

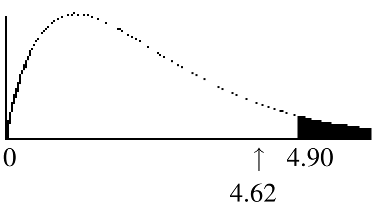
$s_2 = 77.5206$

$\alpha = 0.05$

d.f.N. = 8 d.f.D. = 7

C. V. = 4.90

$F = \frac{77.5206^2}{36.0533^2} = 4.62$



Do not reject the null hypothesis. There is not enough evidence to support the claim that there is a difference in the variances.

13.

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

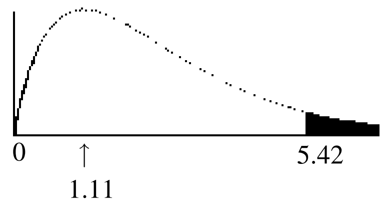
H_1: $\sigma_1^2 \neq \sigma_2^2$ (claim)

C. V. = 5.42 $\alpha = \frac{0.01}{2}$

d.f.N. = 11 d.f.D. = 11

13. continued

$F = \frac{4.868^2}{4.619^2} = 1.11$



Do not reject the null hypothesis. There is not enough evidence to support the claim that there is a difference in the variances.

CHAPTER 9 QUIZ

1. False, there are different formulas for independent and dependent samples.

2. False, the samples are independent.

3. True

4. False, they can be right, left, or two tailed.

5. d

6. a

7. c

8. a

9. $\mu_1 = \mu_2$

10. t

11. Normal

12. Negative

13. $F = \frac{s_1^2}{s_2^2}$

14. H_0: $\mu_1 = \mu_2$
H_1: $\mu_1 \neq \mu_2$ (claim)
C. V. $= \pm 2.58$ $z = -3.69$
Reject the null hypothesis. There is enough evidence to support the claim that there is a difference in the cholesterol levels of the two groups.

99% Confidence Interval:
$-10.2 < \mu_1 - \mu_2 < -1.8$
or $-10 < \mu_1 - \mu_2 < -2$

15. H_0: $\mu_1 = \mu_2$
H_1: $\mu_1 > \mu_2$ (claim)
C. V. $= 1.28$ $z = 1.61$
Reject the null hypothesis. There is enough evidence to support the claim that average rental fees for the Eastern apartments is greater than the average rental fees for the Western apartments.

16. H_0: $\mu_1 = \mu_2$
H_1: $\mu_1 \neq \mu_2$ (claim)
$t = 11.094$ C. V. $= \pm 3.106$ Reject the null hypothesis. There is enough evidence to support the claim that the average prices are different.

99% Confidence Interval:
$0.298 < \mu_1 - \mu_2 < 0.502$
(TI: $0.2995 < \mu_1 - \mu_2 < 0.5005$)

17. H_0: $\mu_1 = \mu_2$
H_1: $\mu_1 < \mu_2$ (claim)
C. V. $= -2.132$ d.f. $= 4$ $t = -4.05$
Reject the null hypothesis. There is enough evidence to support the claim that accidents have increased.

18. H_0: $\mu_1 = \mu_2$
H_1 $\mu_1 \neq \mu_2$ (claim)
C. V. $= \pm 2.718$ $t = 9.807$

18. continued

Reject the null hypothesis. There is enough evidence to support the claim that the salaries are different.

98% Confidence Interval:
$\$6653 < \mu_1 - \mu_2 < \$11{,}757$
(TI: $\$6619 < \mu_1 - \mu_2 < \$11{,}491$)

19. H_0: $\mu_1 = \mu_2$
H_1 $\mu_1 > \mu_2$ (claim)
d. f. $= 10$ $t = 0.874$
$0.10 <$ P-value < 0.25 (0.198)
Do not reject the null hypothesis since P-value > 0.05. There is not enough evidence to support the claim that the incomes of city residents are greater than the incomes of rural residents.

20. H_0: $\mu_D = 0$
H_1 $\mu_D < 0$ (claim)
C. V. $= -2.821$ $t = -4.172$
Reject the null hypothesis. There is enough evidence to support the claim that the sessions improved math skills.

21. H_0: $\mu_D = 0$
H_1 $\mu_D < 0$ (claim)
C. V. $= -1.833$ $t = -1.714$
Do not reject the null hypothesis. There is not enough evidence to support the claim that egg production was increased.

22. H_0: $p_1 = p_2$
H_1: $p_1 \neq p_2$ (claim)
C. V. $= \pm 1.65$ $z = -0.69$
Do not reject the null hypothesis. There is not enough evidence to support the claim that the proportions are different.

90% Confidence Interval:
$-0.105 < p_1 - p_2 < 0.045$

23. H_0: $p_1 = p_2$ (claim)
H_1: $p_1 \neq p_2$
C. V. = $\pm$ 1.96 z = 0.54
Do not reject the null hypothesis. There is not enough evidence to support the claim that the proportions have changed.

95% Confidence Interval:
$-0.026 < p_1 - p_2 < 0.0460$

Yes, the confidence interval contains 0; hence, the null hypothesis is not rejected.

24. H_0: $\sigma_1^2 = \sigma_2^2$
H_1 $\sigma_1^2 \neq \sigma_2^2$ (claim)
d. f. N. = 17 d. f. D. = 14
F = 1.64
P-value $>$ 0.20 (0.357)
Do not reject since P-value $>$ 0.05. There is not enough evidence to support the claim that the variances are different.

25. H_0: $\sigma_1^2 = \sigma_2^2$
H_1 $\sigma_1^2 \neq \sigma_2^2$
C. V. = 1.90 F = 1.30
Do not reject. There is not enough evidence to support the claim that the variances are different.