Note: Graphs are not to scale and are intended to convey a general idea. Answers may vary due to rounding.

EXERCISE SET 8-1

1.
The null hypothesis is a statistical hypothesis that states there is no difference between a parameter and a specific value or there is no difference between two parameters. The alternative hypothesis specifies a specific difference between a parameter and a specific value, or that there is a difference between two parameters. Examples will vary.

2.
A type I error occurs by rejecting the null hypothesis when it is true. A type II error occurs when the null hypothesis is not rejected and it is false. They are related in that decreasing the probability of one type of error increases the probability of the other type of error.

3.
A statistical test uses the data obtained from a sample to make a decision as to whether or not the null hypothesis should be rejected.

4.
A one-tailed test indicates the null hypothesis should be rejected when the test statistic value is in the critical region on one side of the mean. A two-tailed test indicates the null hypothesis should be rejected when the test statistic value is in either critical region on both sides of the mean.

5.
The critical region is the region of values of the test-statistic that indicates a significant difference and the null hypothesis should be rejected. The non-critical region is the region of values of the test-statistic that indicates the difference was probably due to chance, and the null hypothesis should not be rejected.

6.
"H_0" represents the null hypothesis. "H_1" represents the alternative hypothesis.

7.
Type I is represented by α, type II is represented by β.

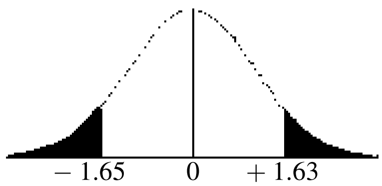
8.
When the difference between the sample mean and the hypothesized mean is large, then the difference is said to be significant and probably not due to chance.

9.
A one-tailed test should be used when a specific direction, such as greater than or less than, is being hypothesized, whereas when no direction is specified, a two-tailed test should be used.

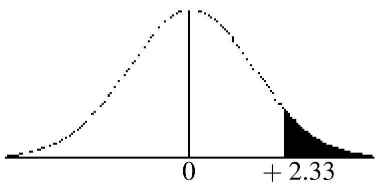
10.
Hypotheses can only be proved true when the entire population is used to compute the test statistic. In most cases, this is impossible.

11.

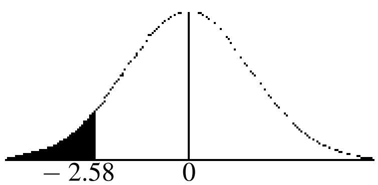
a. ± 1.65



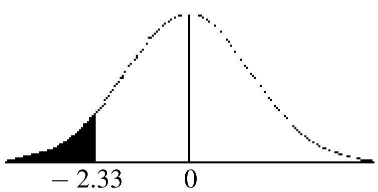
b. + 2.33



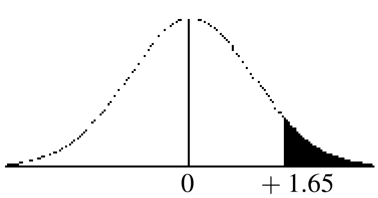
c. − 2.58



d. − 2.33

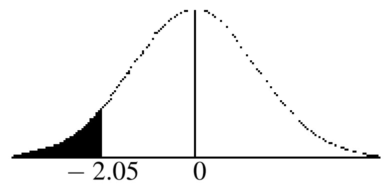


e. + 1.65

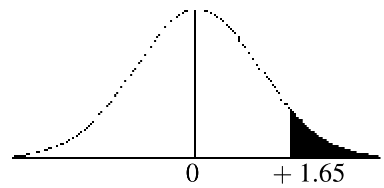


12.

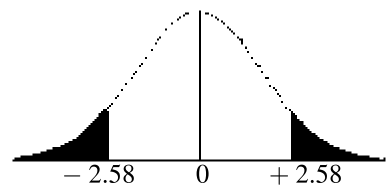
a. − 2.05



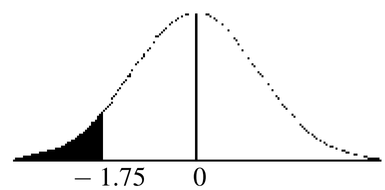
b. + 1.65



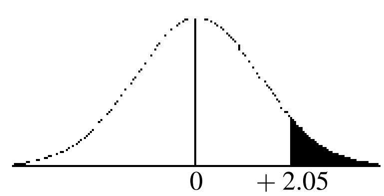
c. ± 2.58



d. − 1.75



e. + 2.05



13.

a. H_0: $\mu = 15.6$
   H_1: $\mu \neq 15.6$

b. H_0: $\mu = 10.8$
   H_1: $\mu > 10.8$

c. H_0: $\mu = 390$
   H_1: $\mu > 390$

d. H_0: $\mu = 12{,}603$
   H_1: $\mu \neq 12{,}603$

e. H_0: $\mu = 24$
   H_1: $\mu < 24$

14.

a. H_0: $\mu = 27$
   H_1: $\mu > 27$

b. H_0: $\mu = 4.71$
   H_1: $\mu \neq 4.71$

c. H_0: $\mu = 36$
   H_1: $\mu > 36$

d. H_0: $\mu = \$79.95$
   H_1: $\mu \neq \$79.95$

e. H_0: $\mu = 8.2$
   H_1: $\mu \neq 8.2$

EXERCISE SET 8-2

1.

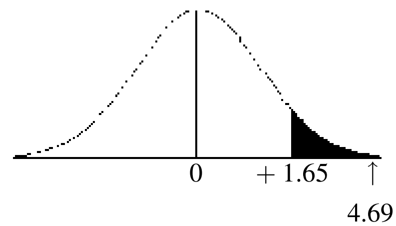
H_0: $\mu = 305$

H_1: $\mu > 305$ (claim)

C. V. $= 1.65$ $\sigma = \sqrt{3.6} = 1.897$

$$z = \frac{\overline{X} - \mu}{\frac{\sigma}{\sqrt{n}}} = \frac{306.2 - 305}{\frac{1.897}{\sqrt{55}}} = 4.69$$

1. continued



Reject the null hypothesis. There is enough evidence to support the claim that the mean depth is greater than 305 feet. Many factors could contribute to the increase, including warmer temperatures and higher than usual rainfall.

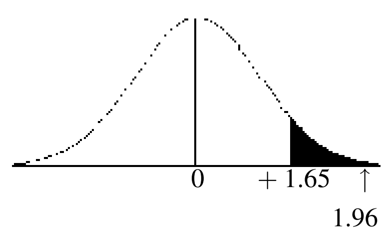
2.

H_0: $\mu = 338$

H_1: $\mu > 338$ (claim)

C. V. $= 1.65$

$$z = \frac{\overline{X} - \mu}{\frac{\sigma}{\sqrt{n}}} = \frac{350 - 338}{\frac{43.2}{\sqrt{50}}} = 1.96$$



Reject the null hypothesis. There is enough evidence to support the claim that the mean number of facebook friends is greater than 338.

3.

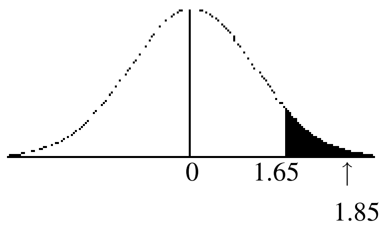
H_0: $\mu = \$24$ billion

H_1: $\mu > \$24$ billion (claim)

C. V. $= +1.65$ $\overline{X} = \$31.5$ $\sigma = \$28.7$

$$z = \frac{\overline{X} - \mu}{\frac{\sigma}{\sqrt{n}}} = \frac{31.5 - 24}{\frac{28.7}{\sqrt{50}}} = 1.85$$

3. continued

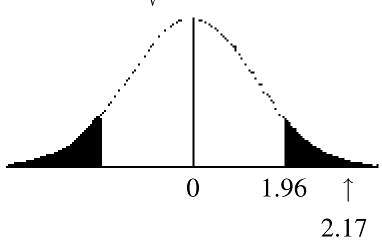


Reject the null hypothesis. There is enough evidence to support the claim that the average revenue exceeds $24 billion.

4.
H$_0$: $\mu = 8.5$
H$_1$: $\mu \neq 8.5$ (claim)

C. V. $= \pm 1.96$

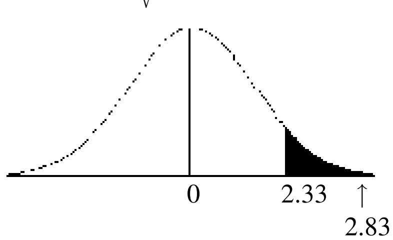
$$z = \frac{\overline{X} - \mu}{\frac{\sigma}{\sqrt{n}}} = \frac{9.6 - 8.5}{\frac{3.2}{\sqrt{40}}} = 2.17$$



Reject the null hypothesis. There is enough evidence to support the claim that there is a difference in the average number of movies.

5.
H$_0$: $\mu = 5$
H$_1$: $\mu > 5$ (claim)
C. V. $= 2.33$

$$z = \frac{\overline{X} - \mu}{\frac{\sigma}{\sqrt{n}}} = \frac{5.6 - 5}{\frac{1.2}{\sqrt{32}}} = 2.83$$

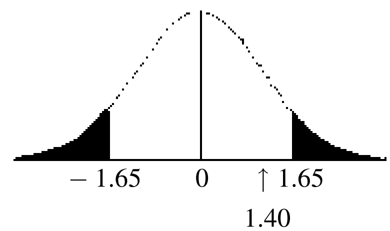


5. continued

Reject the null hypothesis. There is enough evidence to support the claim that the mean number of sick days a person takes is greater than 5.

6.
H$_0$: $\mu = \$117.91$
H$_1$: $\mu \neq \$117.91$ (claim)
C. V. $= \pm 1.65$

$$z = \frac{\overline{X} - \mu}{\frac{\sigma}{\sqrt{n}}} = \frac{\$122.57 - \$117.91}{\frac{\$20}{\sqrt{36}}} = 1.40$$

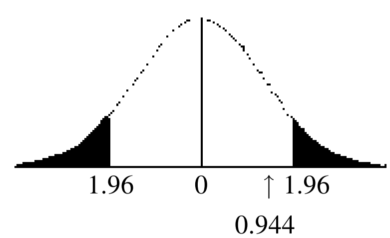


Do not reject the null hypothesis. There is not enough evidence to support the claim that the cost per square foot differs from$117.91.

7.
H$_0$: $\mu = 29$
H$_1$: $\mu \neq 29$ (claim)

C. V. $= \pm 1.96$ $\overline{X} = 29.45$ $\sigma = 2.61$

$$z = \frac{\overline{X} - \mu}{\frac{\sigma}{\sqrt{n}}} = \frac{29.45 - 29}{\frac{2.61}{\sqrt{30}}} = 0.944$$



Do not reject the null hypothesis. There is not enough evidence to say that the average height differs from 29 inches.

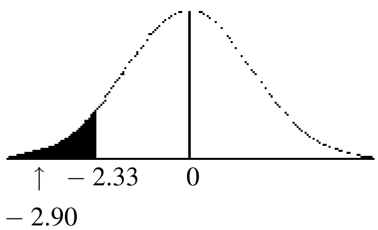
8.

H_0: $\mu = \$59{,}593$

H_1: $\mu < \$59{,}593$ (claim)

C. V. $= -2.33$

$$z = \frac{\overline{X} - \mu}{\frac{\sigma}{\sqrt{n}}} = \frac{\$58{,}800 - \$59{,}593}{\frac{\$1500}{\sqrt{30}}} = -2.90$$



Reject the null hypothesis. There is enough evidence to support the claim that the average income is less than $59,593 and state employees earn less than federal employees.

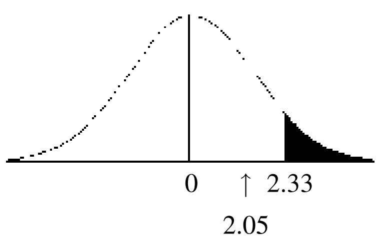
9.

H_0: $\mu = 2.8$

H_1: $\mu > 2.8$ (claim)

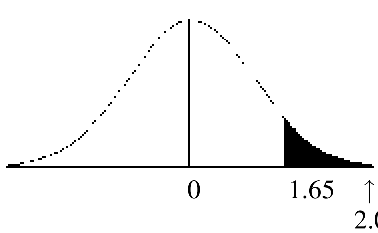
C. V. $= 2.33$

$$z = \frac{\overline{X} - \mu}{\frac{\sigma}{\sqrt{n}}} = \frac{3.1 - 2.8}{\frac{0.8}{\sqrt{30}}} = 2.05$$



Do not reject the null hypothesis. There is not enough evidence to support the claim that the mean number of telephone calls a person makes is greater than 2.8.

C. V. $= 1.65$



9. continued

Reject the null hypothesis. There is enough evidence to support the claim that the mean number of telephone calls a person makes is greater than 2.8.

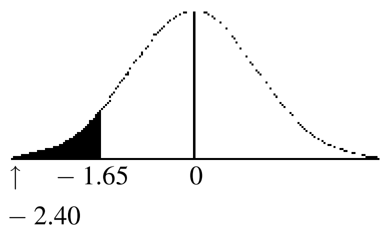
10.

H_0: $\mu = 24$

H_1: $\mu < 24$ (claim)

C. V. $= -1.65$

$$z = \frac{\overline{X} - \mu}{\frac{\sigma}{\sqrt{n}}} = \frac{22.8 - 24}{\frac{3.5}{\sqrt{49}}} = -2.40$$



Reject the null hypothesis. There is enough evidence to support the claim that people over 60 drive less than 24 miles per day.

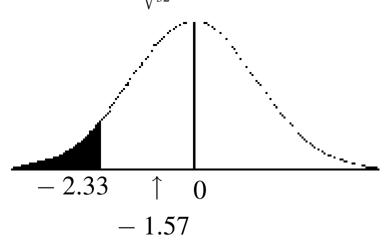
11.

H_0: $\mu = 7$

H_1: $\mu < 7$ (claim)

C. V. $= -2.33$

$$z = \frac{\overline{X} - \mu}{\frac{\sigma}{\sqrt{n}}} = \frac{6.5 - 7}{\frac{1.8}{\sqrt{32}}} = -1.57$$



Do not reject the null hypothesis. There is not enough evidence to support the claim that the average weight loss of a newborn baby is less than 7 ounces in the first 2 days of life.

12.

H_0: $\mu = \$10{,}337$

H_1: $\mu \neq \$10{,}337$ (claim)

C. V. $= \pm 1.65$ at 0.10, ± 1.96 at 0.05, and ± 2.58 at 0.01

$$z = \frac{\overline{X}-\mu}{\frac{\sigma}{\sqrt{n}}} = \frac{\$10{,}798-\$10{,}337}{\frac{1560}{\sqrt{150}}} = 3.62$$

Since 3.62 is outside the critical values of $\alpha = 0.10$, 0.05, and 0.01, reject the null hypothesis. There is a significant difference in student expenditures.

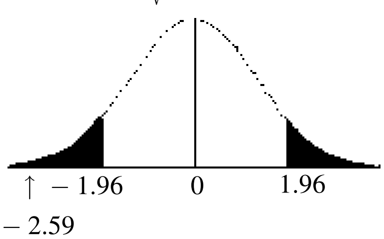
13.

H_0: $\mu = 15$

H_1: $\mu \neq 15$ (claim)

C. V. $= \pm 1.96$

$$z = \frac{\overline{X}-\mu}{\frac{\sigma}{\sqrt{n}}} = \frac{13.8-15}{\frac{3}{\sqrt{42}}} = -2.59$$



Reject the null hypothesis. There is enough evidence to support the claim that the average differs from 15 shirts.

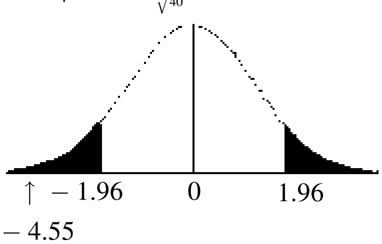
14.

H_0: $\mu = 34.9$

H_1: $\mu \neq 34.9$ (claim)

C. V. $= \pm 2.05$

$$z = \frac{\overline{X}-\mu}{\frac{\sigma}{\sqrt{n}}} = \frac{28.5-34.9}{\frac{8.9}{\sqrt{40}}} = -4.55$$



14. continued

Reject the null hypothesis. There is enough evidence to support the claim that the average stay differs from 34.9 months.

15.

a. Do not reject.
b. Reject.
c. Do not reject.
d. Reject.
e. Reject.

16.

H_0: $\mu = 52$ (claim)

H_1: $\mu \neq 52$

$$z = \frac{\overline{X}-\mu}{\frac{\sigma}{\sqrt{n}}} = \frac{56.3-52}{\frac{3.5}{\sqrt{50}}} = 8.69$$

The area corresponding to $z = 8.69$ is $+0.9999$. Then P-value < 0.01. Hence, the null hypothesis should be rejected. There is enough evidence to reject the claim that the mean is 52. The researcher's claim is not valid.

17.

H_0: $\mu = 264$

H_1: $\mu < 264$ (claim)

$$z = \frac{\overline{X}-\mu}{\frac{\sigma}{\sqrt{n}}} = \frac{262.3-264}{\frac{3}{\sqrt{20}}} = -2.53$$

The area corresponding to $z = 2.53$ is 0.9943. The P-value is $1 - 0.9943 = 0.0057$. The decision is to reject the null hypothesis since $0.0057 < 0.01$. There is enough evidence to support the claim that the average stopping distance is less than 264 feet. (TI: P-value œ 0.0056)

18.

H_0: $\mu = 40$

H_1: $\mu < 40$ (claim)

$\overline{X} = 29.26$ $\sigma = 30.9$

$z = \frac{\overline{X}-\mu}{\frac{\sigma}{\sqrt{n}}} = \frac{29.3-40}{\frac{30.9}{\sqrt{50}}} = -2.458$

The area corresponding to $z = -2.458$ is 0.0069. The decision is reject the null hypothesis since $0.0069 < 0.01$. There is enough evidence to support the claim that the average number of copies is less than 40. (TI: P-value = 0.00699)

19.

H_0: $\mu = 7.8$

H_1: $\mu > 7.8$ (claim)

$z = \frac{\overline{X}-\mu}{\frac{\sigma}{\sqrt{n}}} = \frac{8.7-7.8}{\frac{2.6}{\sqrt{35}}} = 2.05$

The area corresponding to $z = 2.05$ is 0.97985.

Thus, P-value $= 1 - 0.9798 = 0.0202$.

The decision is do not reject the null hypothesis since $0.0202 < 0.01$. There is not enough evidence to support the claim that the average number of applications a potential medical school student is higher than 7.8. (TI: P-value = 0.0202)

20.

H_0: $\mu = 800$ (claim)

H_1: $\mu \neq 800$

$z = \frac{\overline{X}-\mu}{\frac{\sigma}{\sqrt{n}}} = \frac{793-800}{\frac{12}{\sqrt{200}}} = -2.61$

The area corresponding to $z = -2.61$ is 0.0045. The P-value is found by multiplying by 2 since this is a two-tailed test. Hence, $2(0.0045) = 0.0090$. The decision is to reject the null hypothesis since $0.009 < 0.01$. There is enough evidence to reject the null hypothesis that the breaking strength is 800 pounds.

21.

H_0: $\mu = 444$

H_1: $\mu \neq 444$

$z = \frac{\overline{X}-\mu}{\frac{\sigma}{\sqrt{n}}} = \frac{430-444}{\frac{52}{\sqrt{40}}} = -1.70$

The area corresponding to $z = -1.70$ is 0.0446. The P-value is $2(0.0446) = 0.0892$. The decision is do not reject the null hypothesis since P-value < 0.05. There is not enough evidence to support the claim that the mean differs from 444.

(TI: P-value = 0.0886)

22.

H_0: $\mu = 65$ (claim)

H_1: $\mu \neq 65$

$z = \frac{\overline{X}-\mu}{\frac{\sigma}{\sqrt{n}}} = \frac{63.2-65}{\frac{7}{\sqrt{22}}} = -1.21$

The area corresponding to $z = -1.21$ is 0.1131. The P-value is $2(0.1131) = 0.2262$. The decision is do not reject the null hypothesis since $0.2262 > 0.10$. Hence, there is not enough evidence to reject the claim that the average is 65 acres.

23.

H_0: $\mu = 30{,}000$ (claim)

H_1: $\mu \neq 30{,}000$

$z = \frac{\overline{X}-\mu}{\frac{\sigma}{\sqrt{n}}} = \frac{30{,}456-30{,}000}{\frac{1684}{\sqrt{40}}} = 1.71$

The area corresponding to $z = 1.71$ is 0.9564. The P-value is $2(1 - 0.9564) = 2(0.0436) = 0.0872$. The decision is to reject the null hypothesis at $\alpha = 0.10$ since $0.0872 < 0.10$. The conclusion is that there is enough evidence to reject the claim that customers are adhering to the recommendation. Yes, the 0.10 significance level is appropriate.

(TI: P-value = 0.0868)

24.

H_0: $\mu = 60$ (claim)

H_1: $\mu \neq 60$

$\overline{X} = 59.93$ $s = 13.42$

$z = \frac{\overline{X} - \mu}{\frac{\sigma}{\sqrt{n}}} = \frac{59.93 - 60}{\frac{13.42}{\sqrt{30}}} = -0.03$

The P-value is $2(0.4880) = 0.9760$.
(TI: P-value $= 0.9783$). Since $0.9760 > 0.05$, the decision is do not reject the null hypothesis. There is not enough evidence to reject the claim that the average number of speeding tickets is 60.

25.

H_0: $\mu = 10$

H_1: $\mu < 10$ (claim)

$\overline{X} = 5.025$ $s = 3.63$

$z = \frac{\overline{X} - \mu}{\frac{\sigma}{\sqrt{n}}} = \frac{5.025 - 10}{\frac{3.63}{\sqrt{40}}} = -8.67$

The area corresponding to -8.67 is less than 0.0001. Since $0.0001 < 0.05$, the decision is to reject the null hypothesis. There is enough evidence to support the claim that the average number of days missed per year is less than 10.

26.

Reject the claim at $\alpha = 0.05$ but not at $\alpha = 0.01$. There is no contradiction since the value of α should be chosen before the test is conducted.

27.

The mean and standard deviation are found as follows:

	f	X_m	$f \cdot X_m$	$f \cdot X_m^2$
8.35 - 8.43	2	8.39	16.78	140.7842
8.44 - 8.52	6	8.48	50.88	431.4624
8.53 - 8.61	12	8.57	102.84	881.3388
8.62 - 8.70	18	8.66	155.88	1349.9208
8.71 - 8.79	10	8.75	87.5	765.625
8.80 - 8.88	2	8.84	17.68	156.2912
	50		431.56	3725.4224

$\overline{X} = \frac{\sum f \cdot X_m}{n} = \frac{431.56}{50} = 8.63$

$s = \sqrt{\frac{\sum f \cdot X_m^2 - \frac{\sum (f \cdot X_m)^2}{n}}{n-1}} = \sqrt{\frac{3725.4224 - \frac{(431.56)^2}{50}}{49}}$

$s = 0.105$

H_0: $\mu = 8.65$ (claim)

H_1: $\mu \neq 8.65$

C. V. $= \pm 1.96$

$z = \frac{\overline{X} - \mu}{\frac{s}{\sqrt{n}}} = \frac{8.63 - 8.65}{\frac{0.105}{\sqrt{50}}} = -1.35$

Do not reject the null hypothesis. There is not enough evidence to reject the claim that the average hourly wage of the employees is$8.65.

EXERCISE SET 8-3

1.

It is bell-shaped, symmetric about the mean, and it never touches the x axis. The mean, median, and mode are all equal to 0 and they are located at the center of the distribution.

1. continued

The t distribution differs from the standard normal distribution in that it is a family of curves, the variance is greater than 1, and as the degrees of freedom increase the t distribution approaches the standard normal distribution.

2.
The degrees of freedom are the number of values that are free to vary after a sample statistic has been computed. They tell the researcher which specific curve to use when a distribution consists of a family of curves.

3.
a. d. f. = 11 C. V. = -2.718
b. d. f. = 15 C. V. = $+1.753$
c. d. f. = 6 C. V. = ± 1.943
d. d. f. = 10 C. V. = $+2.228$
e. d. f. = 9 C. V. = ± 2.262

4.
a. d. f. = 14 C. V. = ± 1.761
b. d. f. = 22 C. V. = -2.819
c. d. f. = 27 C. V. = ± 2.771
d. d. f. = 16 C. V. = ± 2.583

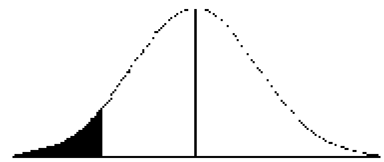
5.
a. $0.01 < \text{P-value} < 0.025$ (0.018)
b. $0.05 < \text{P-value} < 0.10$ (0.062)
c. $0.10 < \text{P-value} < 0.25$ (0.123)
d. $0.10 < \text{P-value} < 0.20$ (0.138)

6.
a. $\text{P-value} < 0.005$ (0.003)
b. $0.10 < \text{P-value} < 0.25$ (0.158)
c. $\text{P-value} = 0.05$ (0.05)
d. $\text{P-value} > 0.25$ (0.261)

7.
H_0: $\mu = 31$
H_1: $\mu < 31$ (claim)

C. V. = -1.833 d. f. = 9

$$t = \frac{\overline{X}-\mu}{\frac{s}{\sqrt{n}}} = \frac{28-31}{\frac{2.7}{\sqrt{10}}} = -3.514$$



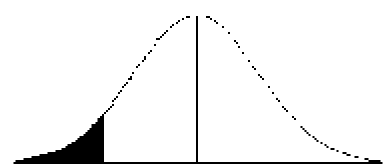
$\uparrow$ -1.833 0
-3.514

Reject the null hypothesis. There is enough evidence to support the claim that the mean number of cigarettes that smokers smoke is less than 31 per day.

8.
H_0: $\mu = \$5400$
H_1: $\mu < \$5400$ (claim)

C. V. = -2.052 d. f. = 27

$$t = \frac{\overline{X}-\mu}{\frac{s}{\sqrt{n}}} = \frac{\$5250-\$5400}{\frac{\$629}{\sqrt{28}}} = -1.262$$



-2.052 $\uparrow$ 0
-1.262

Do not reject the null hypothesis. There is not enough evidence to support the claim that the average cost is less than \$5400.

9.

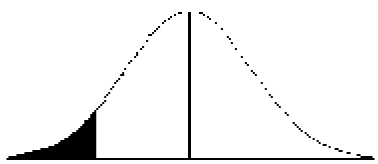
H_0: $\mu = 700$ (claim)

H_1: $\mu < 700$

$\overline{X} = 606.5 \quad s = 109.1$

C. V. $= -2.262$ d. f. $= 9$

$$t = \frac{\overline{X} - \mu}{\frac{s}{\sqrt{n}}} = \frac{606.5 - 700}{\frac{109.1}{\sqrt{10}}} = -2.710$$



↑ − 2.262 0

− 2.710

Reject the null hypothesis. There is enough evidence to reject the claim that the average height of the buildings is at least 700 feet.

10.

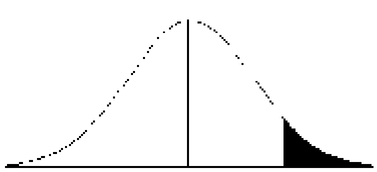
H_0: $\mu = 50{,}000$

H_1: $\mu > 50{,}000$ (claim)

C. V. $= 1.440$ d. f. $= 6$

$\overline{X} = 50{,}363.57 \quad s = 1113.16$

$$t = \frac{\overline{X} - \mu}{\frac{s}{\sqrt{n}}} = \frac{50{,}363.57 - 50{,}000}{\frac{1113.16}{\sqrt{7}}} = 0.864$$



0 ↑ 1.440

0.864

Do not reject the null hypothesis. There is not enough evidence to support the claim that the average number of words is greater than 50,000.

11.

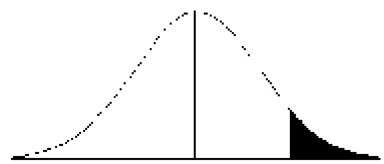
H_0: $\mu = 58$

H_1: $\mu > 58$ (claim)

C. V. $= 2.821$ d. f. $= 9$

$\overline{X} = 123.5 \quad s = 39.303$

$$t = \frac{\overline{X} - \mu}{\frac{s}{\sqrt{n}}} = \frac{123.5 - 58}{\frac{39.303}{\sqrt{10}}} = 5.27$$



0 2.821 ↑

5.27

Reject the null hypothesis. There is enough evidence to support the claim that the average is greater than the national average.

12.

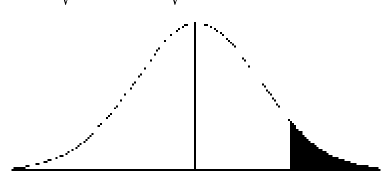
H_0: $\mu = 110$

H_1: $\mu > 110$ (claim)

C. V. $= 2.624$ d. f. $= 14$

$\overline{X} = 137.333 \quad s = 24.118$

$$t = \frac{\overline{X} - \mu}{\frac{s}{\sqrt{n}}} = \frac{137.333 - 110}{\frac{24.118}{\sqrt{15}}} = 4.389$$



0 2.624 ↑

4.389

Reject the null hypothesis. There is enough evidence to support the claim that the average number of calories is greater than 110.

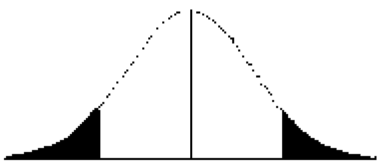
13.

H_0: $\mu = 7.2$

H_1: $\mu \neq 7.2$ (claim)

C. V. $= \pm 2.145$ d. f. $= 14$

$$t = \frac{\overline{X} - \mu}{\frac{s}{\sqrt{n}}} = \frac{8.3 - 7.2}{\frac{1.2}{\sqrt{15}}} = 3.550$$



Reject the null hypothesis. There is enough evidence to support the claim that the mean number of hours that college students sleep on Friday night to Saturday morning is not 7.2 hours.

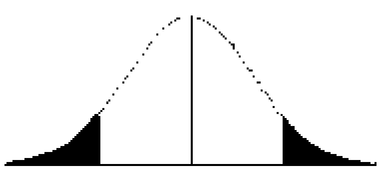
14.

H_0: $\mu = 36$

H_1: $\mu \neq 36$ (claim)

C. V. $= \pm 2.807$ d. f. $= 23$

$$t = \frac{\overline{X} - \mu}{\frac{s}{\sqrt{n}}} = \frac{42.1 - 36}{\frac{5.3}{\sqrt{24}}} = 5.638$$



Reject the null hypothesis. There is enough evidence to support the claim that the mean is not 36 visits.

15.

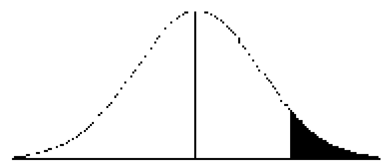
H_0: $\mu = \$50.07$

H_1: $\mu > \$50.07$ (claim)

C. V. $= 1.833$ d. f. $= 9$

$\overline{X} = \$56.11$ $s = \$6.97$

$$t = \frac{\overline{X} - \mu}{\frac{s}{\sqrt{n}}} = \frac{\$56.11 - \$50.07}{\frac{6.97}{\sqrt{10}}} = 2.741$$



Reject the null hypothesis. There is enough evidence to support the claim that the average bill has increased.

16.

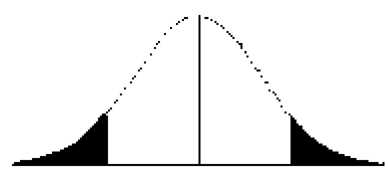
H_0: $\mu = \$15{,}000$

H_1: $\mu \neq \$15{,}000$ (claim)

C. V. $= \pm 2.201$ d. f. $= 11$

$\overline{X} = \$14{,}347.17$ $s = \$2048.54$

$$t = \frac{\overline{X} - \mu}{\frac{s}{\sqrt{n}}} = \frac{\$14{,}347.17 - \$15{,}000}{\frac{\$2048.54}{\sqrt{12}}} = -1.104$$



Do not reject the null hypothesis. There is not enough evidence to support the claim that the average stipend differs from \$15,000.

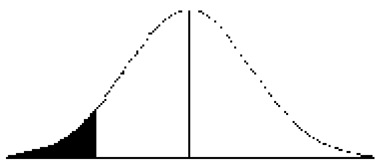
17.

H_0: $\mu = 211$

H_1: $\mu < 211$ (claim)

C. V. $= -1.345$ d. f. $= 14$

$$t = \frac{\overline{X} - \mu}{\frac{s}{\sqrt{n}}} = \frac{208.8 - 211}{\frac{3.8}{\sqrt{15}}} = -2.242$$

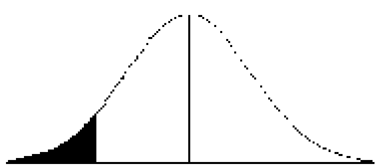


↑ -1.345 0

-2.24

Reject the null hypothesis. There is enough evidence to support director's feelings that his surgeons perform fewer operations per year than the national average of 211.

C. V. $= -2.624$ d. f. $= 14$



-2.624 ↑ 0

-2.24

Do not reject the null hypothesis. There is not enough evidence to support director's feelings that his surgeons perform fewer operations per year than the national average of 211.

18.

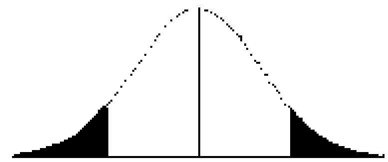
H_0: $\mu = 2.27$

H_1: $\mu \neq 2.27$ (claim)

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

$$t = \frac{\overline{X} - \mu}{\frac{s}{\sqrt{n}}} = \frac{2.98 - 2.27}{\frac{0.98}{\sqrt{20}}} = 3.240$$

18. continued



-2.093 0 2.093 ↑

3.240

Reject the null hypothesis. There is enough evidence to support the claim that the average call differs from 2.27 minutes.

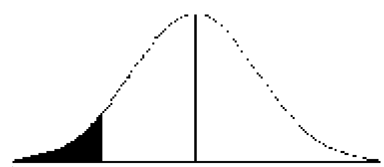
19.

H_0: $\mu = 25.4$

H_1: $\mu < 25.4$ (claim)

C. V. $= -1.318$ d. f. $= 24$

$$t = \frac{\overline{X} - \mu}{\frac{s}{\sqrt{n}}} = \frac{22.1 - 25.4}{\frac{5.3}{\sqrt{25}}} = -3.11$$



↑ -1.318 0

-3.11

Reject the null hypothesis. There is enough evidence to support the claim that the commute time is less than 25.4 minutes.

20.

H_0: $\mu = 3.18$

H_1: $\mu \neq 3.18$ (claim)

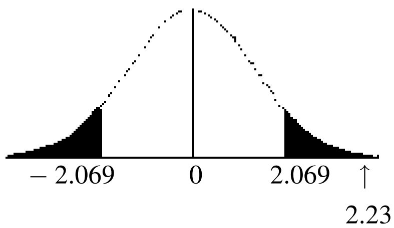
$\overline{X} = 3.833$ s $= 1.4346$

d. f. $= 23$ C. V. $= \pm 2.069$

$$t = \frac{\overline{X} - \mu}{\frac{s}{\sqrt{n}}} = \frac{3.833 - 3.18}{\frac{1.4346}{\sqrt{24}}} = 2.2299 \text{ or } 2.23$$

(TI answer $= 2.231$)

20. continued



Reject the null hypothesis. There is enough evidence to support the claim that the average family size differs from 3.18.

21.
H_0: $\mu = 5.8$
H_1: $\mu \neq 5.8$ (claim)
$\overline{X} = 3.85$ $s = 2.519$
d. f. $= 19$ $\alpha = 0.05$
P-value < 0.01 (0.0026)
$t = \frac{\overline{X}-\mu}{\frac{s}{\sqrt{n}}} = \frac{3.85-5.8}{\frac{2.519}{\sqrt{20}}} = -3.462$

Since P-value < 0.01, reject the null hypothesis. There is enough evidence to support the claim that the mean is not 5.8.

22.
H_0: $\mu = 9.2$ (claim)
H_1: $\mu \neq 9.2$
$\overline{X} = 8.25$ $s = 5.06$
d. f. $= 7$
P-value > 0.50 (0.6121)
$t = \frac{\overline{X}-\mu}{\frac{s}{\sqrt{n}}} = \frac{8.25-9.2}{\frac{5.06}{\sqrt{8}}} = -0.531$

Since P-value > 0.50, do not reject the null hypothesis. There is enough evidence to support the claim that the mean number of jobs is 9.2. One reason why a person may not give the exact number of jobs is that he or she may have forgotten about a particular job.

23.
H_0: $\mu = 123$
H_1: $\mu \neq 123$ (claim)
d. f. $= 15$
P-value < 0.01 (0.0086)
$t = \frac{\overline{X}-\mu}{\frac{s}{\sqrt{n}}} = \frac{119-123}{\frac{5.3}{\sqrt{16}}} = -3.019$

Since P-value < 0.05, reject the null hypothesis. There is enough evidence to support the claim that the mean is not 123 gallons.

EXERCISE SET 8-4

1.
Answers will vary.

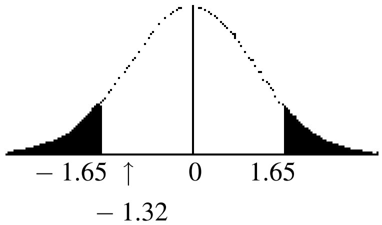
2.
The proportion of A items can be considered a success whereas the proportion of items that are not included in A can be considered a failure. Hence, there are two outcomes.

3.
$np \geq 5$ and $nq \geq 5$

4.
$\mu = p$ $\sigma = \sqrt{pq/n}$

5.
H_0: $p = 0.46$
H_1: $p \neq 0.46$ (claim)
$\hat{p} = \frac{48}{120} = 0.4$ $p = 0.46$ $q = 0.54$
C. V. $= \pm 1.65$
$z = \frac{\hat{p}-p}{\sqrt{\frac{pq}{n}}} = \frac{0.4-0.46}{\sqrt{\frac{(0.46)(0.54)}{120}}} = -1.32$
(TI: $z = -1.32$)

5. continued



Do not reject the null hypothesis. There is not enough evidence to support the claim that the percentage has changed.

6.

H_0: $p = 0.503$

H_1: $p \neq 0.503$ (claim)

$\widehat{p} = \frac{171}{300} = 0.57 \quad p = 0.503 \quad q = 0.497$

$z = \frac{\widehat{p} - p}{\sqrt{\frac{pq}{n}}} = \frac{0.57 - 0.503}{\sqrt{\frac{(0.503)(0.497)}{300}}} = 2.32$

Therefore, reject H_0 at any $\alpha > 0.025$ since the critical value will be greater than 2.33 (or any P-value ≤ 0.025).

7.

H_0: $p = 0.11$

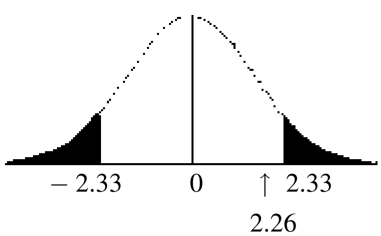
H_1: $p \neq 0.11$ (claim)

$\widehat{p} = \frac{32}{200} = 0.16 \quad p = 0.11 \quad q = 0.89$

C. V. $= \pm 2.33$

$z = \frac{\widehat{p} - p}{\sqrt{\frac{pq}{n}}} = \frac{0.16 - 0.11}{\sqrt{\frac{(0.11)(0.89)}{200}}} = 2.26$

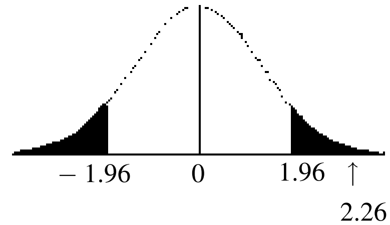
(TI: $z = 2.26$)



Do not reject the null hypothesis. There is not enough evidence to reject the claim that 11% of individuals eat takeout food every day.

7. continued

C. V. $= \pm 1.96$



Reject the null hypothesis. There is enough evidence to reject the claim that 11% of individuals eat takeout food every day.

8.

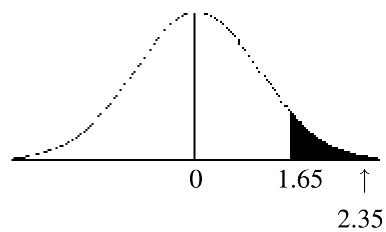
H_0: $p = 0.279$

H_1: $p > 0.279$ (claim)

$\widehat{p} = \frac{45}{120} = 0.375 \quad p = 0.279 \quad q = 0.721$

C. V. $= 1.65$

$z = \frac{\widehat{p} - p}{\sqrt{\frac{pq}{n}}} = \frac{0.375 - 0.279}{\sqrt{\frac{(0.279)(0.721)}{120}}} = 2.35$



Reject the null hypothesis. There is enough evidence to conclude that the proportion of female physicians is higher than 27.9%.

9.

H_0: $p = 0.58$

H_1: $p > 0.58$ (claim)

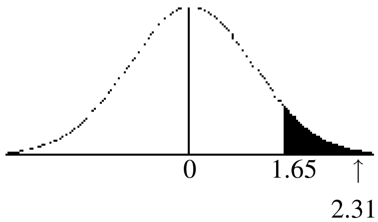
$\widehat{p} = \frac{63}{90} = 0.70 \quad p = 0.58 \quad q = 0.42$

C. V. $= 1.65$

$z = \frac{\widehat{p} - p}{\sqrt{\frac{pq}{n}}} = \frac{0.70 - 0.58}{\sqrt{\frac{(0.58)(0.42)}{90}}} = 2.31$

(TI: $z = 2.31$)

9. continued



Reject the null hypothesis. There is enough evidence to conclude that the proportion of female runaways is higher than 58%.

10.

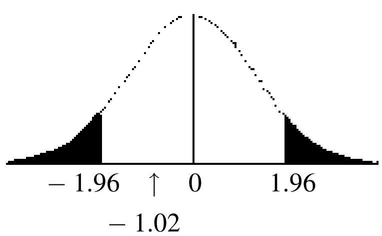
H_0: $p = 0.856$

H_1: $p \neq 0.856$ (claim)

$\hat{p} = \frac{420}{500} = 0.84 \quad p = 0.856 \quad q = 0.144$

C. V. $= \pm 1.96$

$z = \frac{\hat{p} - p}{\sqrt{\frac{pq}{n}}} = \frac{0.84 - 0.856}{\sqrt{\frac{(0.856)(0.144)}{500}}} = -1.02$



Do not reject the null hypothesis. There is not enough evidence to support the claim that the percentage differs from the national rate.

11.

H_0: $p = 0.76$

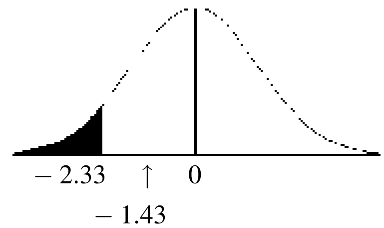
H_1: $p < 0.76$ (claim)

$\hat{p} = \frac{38}{56} = 0.6786 \quad p = 0.76 \quad q = 0.24$

C. V. $= -2.33$

$z = \frac{\hat{p} - p}{\sqrt{\frac{pq}{n}}} = \frac{0.6786 - 0.76}{\sqrt{\frac{(0.76)(0.24)}{56}}} = -1.43$

11. continued



Do not reject the null hypothesis. There is not enough evidence to support the claim that the percentage is less than 76%.

12.

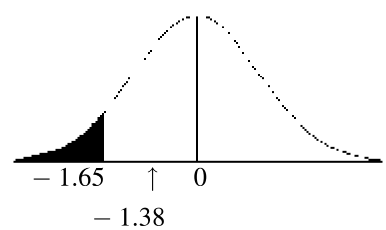
H_0: $p = 0.83$

H_1: $p < 0.83$ (claim)

$\hat{p} = \frac{240}{300} = 0.8 \quad p = 0.83 \quad q = 0.17$

C. V. $= -1.65$

$z = \frac{\hat{p} - p}{\sqrt{\frac{pq}{n}}} = \frac{0.8 - 0.83}{\sqrt{\frac{(0.83)(0.17)}{300}}} = -1.38$



Do not reject the null hypothesis. There is not enough evidence to support the claim that the percentage is less than 83%.

13.

H_0: $p = 0.54$ (claim)

H_1: $p \neq 0.54$

$\hat{p} = \frac{36}{60} = 0.6 \quad p = 0.54 \quad q = 0.46$

$z = \frac{\hat{p} - p}{\sqrt{\frac{pq}{n}}} = \frac{0.6 - 0.54}{\sqrt{\frac{(0.54)(0.46)}{60}}} = 0.93$

Area = 0.8238

P-value = 2(1 − 0.8238) = 0.3524

Since P-value > 0.01, do not reject the null hypothesis.

13. continued

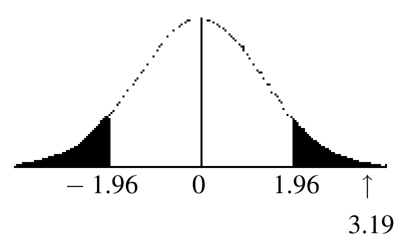
There is enough evidence to support the claim that 54% of kids had a snack after school. Yes, a healthy snack should be made available for children to eat after school.
(TI: P-value œ 0.3511)

14.
H_0: $p = 0.517$ (claim)
H_1: $p \neq 0.517$
$\widehat{p} = \frac{115}{200} = 0.575 \quad p = 0.517 \quad q = 0.483$
$z = \frac{\widehat{p}-p}{\sqrt{\frac{pq}{n}}} = \frac{0.575-0.517}{\sqrt{\frac{(0.517)(0.483)}{200}}} = 1.64$
Area $= 0.9495$
P-value $= 2(1 - 0.9495) = 0.101$
Since P-value > 0.05, do not reject the null hypothesis. There is not enough evidence to reject the claim that 51.7% of homes in America were heated by natural gas. The evidence supports the claim. The conclusion could be different if the sample is taken in an area where natural gas is not commonly used to heat homes.

15.
H_0: $p = 0.18$ (claim)
H_1: $p < 0.18$
$\widehat{p} = \frac{50}{300} = 0.1667 \quad p = 0.18 \quad q = 0.82$
$z = \frac{\widehat{p}-p}{\sqrt{\frac{pq}{n}}} = \frac{0.1667-0.18}{\sqrt{\frac{(0.18)(0.82)}{300}}} = -0.60$
P-value $= 0.2743$ (TI: P-value $= 0.2739$)
Since P-value > 0.05, do not reject the null hypothesis. There is not enough evidence to reject the claim that 18% of all high school students smoke at least a pack of cigarettes a day.

16.
H_0: $p = 0.14$ (claim)
H_1: $p \neq 0.14$
$\widehat{p} = \frac{10}{100} = 0.10 \quad p = 0.14 \quad q = 0.86$
$z = \frac{\widehat{p}-p}{\sqrt{\frac{pq}{n}}} = \frac{0.10-0.14}{\sqrt{\frac{(0.14)(0.86)}{100}}} = -1.15$
Area $= 0.1251$
P-value $= 2(0.1251) = 0.2502$
Since P-value > 0.10, do not reject the null hypothesis. There is not enough evidence to reject the claim that 14% of men use exercise to relieve stress. The results cannot be generalized to all adults since only men were surveyed.

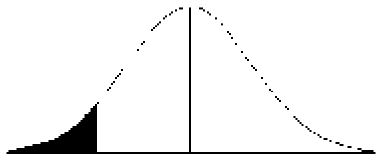
17.
H_0: $p = 0.67$
H_1: $p \neq 0.67$ (claim)
$\hat{p} = \frac{82}{100} = 0.82 \quad p = 0.67 \quad q = 0.33$
C. V. $= \pm 1.96$
$z = \frac{\widehat{p}-p}{\sqrt{\frac{pq}{n}}} = \frac{0.82-0.67}{\sqrt{\frac{(0.67)(0.33)}{100}}} = 3.19$



Reject the null hypothesis. There is enough evidence to support the claim that the percentage is not 67%.

18.
H_0: $p = 0.6$
H_1: $p < 0.6$ (claim)
$\hat{p} = \frac{26}{50} = 0.52 \quad p = 0.6 \quad q = 0.4$
C. V. $= -1.65$
$z = \frac{\widehat{p}-p}{\sqrt{\frac{pq}{n}}} = \frac{0.52-0.6}{\sqrt{\frac{(0.6)(0.4}{50}}} = -1.15$

18. continued



Do not reject the null hypothesis. There is not enough evidence to support the claim that the percentage of paid assistantships is less than 60%.

19.

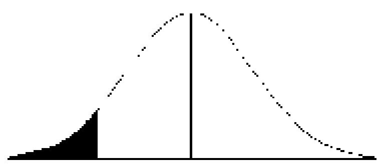
H_0: $p = 0.576$

H_1: $p < 0.576$ (claim)

$\hat{p} = \frac{17}{36} = 0.472 \quad p = 0.576 \quad q = 0.424$

C. V. $= -1.65$

$z = \frac{\hat{p}-p}{\sqrt{\frac{pq}{n}}} = \frac{0.472-0.576}{\sqrt{\frac{(0.576)(0.424)}{36}}} = -1.26$



Do not reject the null hypothesis. There is not enough evidence to support the claim that the percentage of injuries during practice is less than 57.6%.

20.

H_0: $p = 0.7$

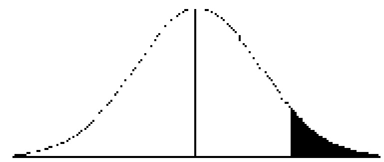
H_1: $p > 0.7$ (claim)

$\hat{p} = \frac{204}{250} = 0.816 \quad p = 0.7 \quad q = 0.3$

C. V. $= 2.33$

$z = \frac{\hat{p}-p}{\sqrt{\frac{pq}{n}}} = \frac{0.816-0.7}{\sqrt{\frac{(0.7)(0.3)}{250}}} = 4.00$

20. continued



Reject the null hypothesis. There is enough evidence to support the claim that the percentage of college students who recycle is greater than 70%.

21.

This represents a binomial distribution with $p = 0.50$ and $n = 9$. The P-value is $2 \cdot P(X \le 3) = 2(0.254) = 0.508$.

Since P-value < 0.10, the conclusion that the coin is not balanced is probably false. The answer is no.

22.

This represents a binomial distribution with $p = 0.20$ and $n = 15$. The P-value is $2 \cdot P(X<5) = 2(0.061) = 0.122$, which is greater than $\alpha = 0.10$. Do not reject the null hypothesis. There is not enough evidence to conclude that the proportions have changed.

23.

$z = \frac{X-\mu}{\sigma}$

$z = \frac{X-np}{\sqrt{npq}}$

$z = \frac{\frac{X}{n}-\frac{np}{n}}{\frac{1}{n}\sqrt{npq}}$

$z = \frac{\frac{X}{n}-\frac{np}{n}}{\sqrt{\frac{npq}{n^2}}}$

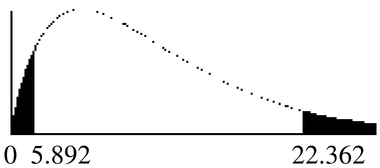
$z = \frac{\hat{p}-p}{\sqrt{\frac{pq}{n}}}$

EXERCISE SET 8-5

1.

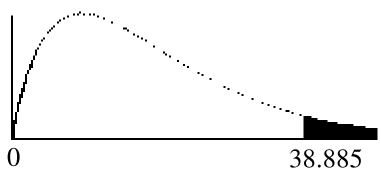
a. H_0: $\sigma^2 = 225$
H_1: $\sigma^2 \neq 225$

C. V. = 5.892, 22.362 d. f. = 13



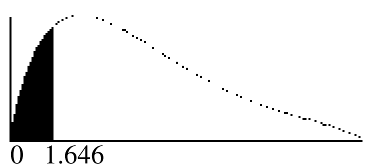
b. H_0: $\sigma^2 = 225$
H_1: $\sigma^2 > 225$

C. V. = 38.885 d. f. = 26



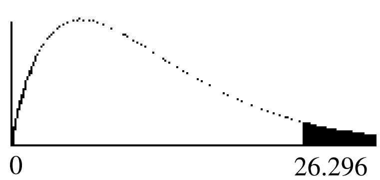
c. H_0: $\sigma^2 = 225$
H_1: $\sigma^2 < 225$

C. V. = 1.646 d. f. = 8



d. H_0: $\sigma^2 = 225$
H_1: $\sigma^2 > 225$

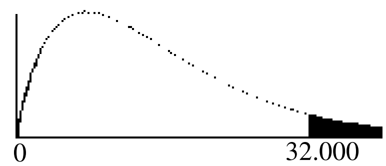
C. V. = 26.296 d. f. = 16



2.

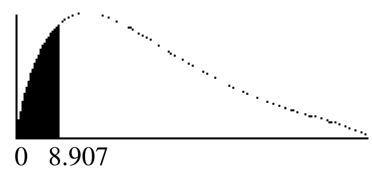
a. H_0: $\sigma^2 = 225$
H_1: $\sigma^2 > 225$

C. V. = 32.000 d. f. = 16



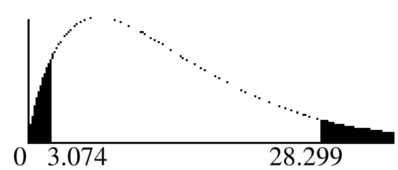
b. H_0: $\sigma^2 = 225$
H_1: $\sigma^2 < 225$

C. V. = 8.907 d. f. = 19



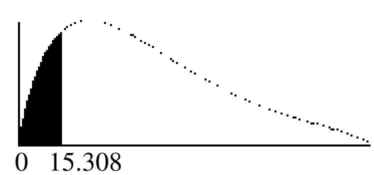
c. H_0: $\sigma^2 = 225$
H_1: $\sigma^2 \neq 225$

C. V. = 3.074, 28.299 d. f. = 12



d. H_0: $\sigma^2 = 225$
H_1: $\sigma^2 < 225$

C. V. = 15.308 d. f. = 28



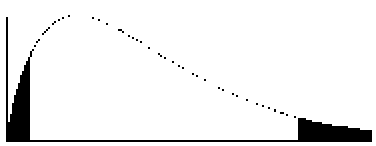
3.
a. $0.01 < \text{P-value} < 0.025$ (0.015)
b. $0.005 < \text{P-value} < 0.01$ (0.006)
c. $0.01 < \text{P-value} < 0.02$ (0.012)
d. $\text{P-value} < 0.005$ (0.003)

4
a. $0.02 < \text{P-value} < 0.05$ (0.037)
b. $0.05 < \text{P-value} < 0.10$ (0.088)
c. $0.05 < \text{P-value} < 0.10$ (0.066)
d. $\text{P-value} < 0.01$ (0.007)

5.
H_0: $\sigma = 8.6$ (claim)
H_1: $\sigma \neq 8.6$

$s^2 = 86.49$
C. V. = 3.816, 21.920 $\alpha = 0.05$
d. f. = 11

$\chi^2 = \frac{(n-1)s^2}{\sigma^2} = \frac{(12-1)(86.49)}{73.96} = 12.864$



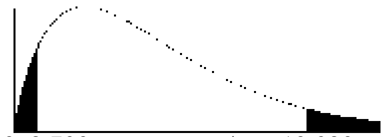
Do not reject the null hypothesis. There is not enough evidence to reject the claim that the standard deviation of the ages is 8.6 years.

6.
H_0: $\sigma^2 = 100$
H_1: $\sigma^2 \neq 100$ (claim)

$s^2 = 135.4333$
C. V. = 2.700, 19.023 $\alpha = 0.05$ d. f. = 9

$\chi^2 = \frac{(n-1)s^2}{\sigma^2} = \frac{(10-1)(135.4333)}{100} = 12.189$

6. continued



Do not reject the null hypothesis. There is not enough evidence to support the claim that the variance differs from 100.

7.
H_0: $\sigma = 1.2$ (claim)
H_1: $\sigma > 1.2$

$\alpha = 0.01$ d. f. = 14

$\chi^2 = \frac{(n-1)s^2}{\sigma^2} = \frac{(15-1)(1.8)^2}{(1.2)^2} = 31.5$

$\text{P-value} < 0.005$ (0.0047)
Since P-value < 0.01, reject the null hypothesis. There is enough evidence to reject the claim that the standard deviation is less than or equal to 1.2 minutes.

8.
H_0: $\sigma = 0.03$ (claim)
H_1: $\sigma > 0.03$

$s = 0.043$
$\alpha = 0.05$ d. f. = 7

$\chi^2 = \frac{(n-1)s^2}{\sigma^2} = \frac{(7(0.043)^2}{0.03^2} = 14.381$

$0.025 < \text{P-value} < 0.05$ (0.045)
Since P-value < 0.05, reject the null hypothesis. There is enough evidence to reject the claim that the standard deviation is less than or equal to 0.03 ounce.

9.

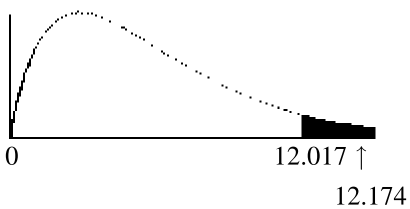
H_0: $\sigma = 2$

H_1: $\sigma > 2$ (claim)

$s = 2.6375$

C. V. $= 12.017$ $\alpha = 0.10$ d. f. $= 7$

$$\chi^2 = \frac{(n-1)s^2}{\sigma^2} = \frac{(8-1)(2.6375)^2}{2^2} = 12.174$$



Reject the null hypothesis. There is enough evidence to support the claim that the standard deviation is greater than two miles.

10.

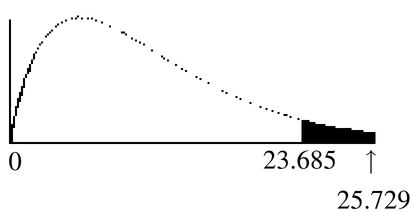
H_0: $\sigma^2 = 100$

H_1: $\sigma^2 > 100$ (claim)

$s^2 = 183.7755$

C. V. $= 23.685$ $\alpha = 0.05$ d. f. $= 14$

$$\chi^2 = \frac{(n-1)s^2}{\sigma^2} = \frac{(15-1)(183.7755)}{100} = 25.729$$



Reject the null hypothesis. There is enough evidence to support the claim that the variance is more than 100.

11.

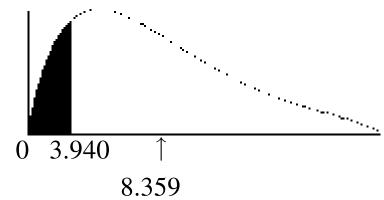
H_0: $\sigma = 35$

H_1: $\sigma > 35$ (claim)

C. V. $= 3.940$ $\alpha = 0.05$ d. f. $= 10$

$$\chi^2 = \frac{(n-1)s^2}{\sigma^2} = \frac{(11-1)(32)^2}{35^2} = 8.359$$

11. continued



Do not reject the null hypothesis. There is not enough evidence to support the claim that the standard deviation is less than 35.

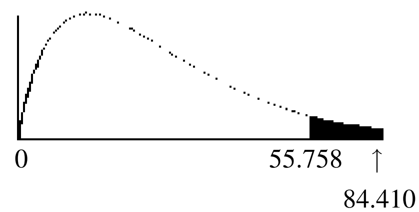
12.

H_0: $\sigma = 8$

H_1: $\sigma > 8$ (claim)

C. V. $= 55.758$ $\alpha = 0.05$ d. f. $= 49$

$$\chi^2 = \frac{(n-1)s^2}{\sigma^2} = \frac{(50-1)(10.5)^2}{8^2} = 84.410$$



Reject the null hypothesis. There is enough evidence to support the claim that the standard deviation is more than 8.

13.

H_0: $\sigma^2 = 0.638$ (claim)

H_1: $\sigma^2 \neq 0.638$

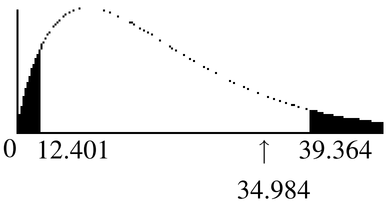
C. V. $= 12.401, 39.364$ $\alpha = 0.05$

d. f. $= 24$

$s^2 = 0.930$

$$\chi^2 = \frac{(n-1)s^2}{\sigma^2} = \frac{(25-1)(0.930)}{0.638} = 34.984$$

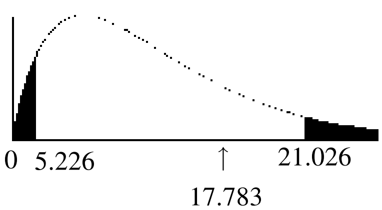
13. continued



Do not reject the null hypothesis. There is not enough evidence to reject the claim that the variance is equal to 0.638.

14.
H_0: $\sigma = 12$
H_1: $\sigma \neq 12$ (claim)

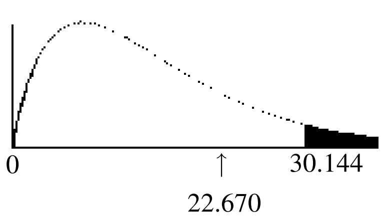
s = 14.608
C. V. = 5.226, 21.026 $\alpha = 0.10$ d.f. = 12
$\chi^2 = \frac{(n-1)s^2}{\sigma^2} = \frac{(13-1)(14.608)^2}{12^2} = 17.783$



Do not reject the null hypothesis. There is not enough evidence to support the claim that the standard deviation differs from 12 mg.

15.
H_0: $\sigma = 0.52$
H_1: $\sigma > 0.52$ (claim)

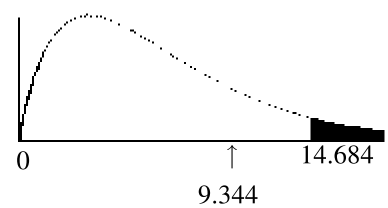
C. V. = 30.144 $\alpha = 0.05$ d. f. = 19
$\chi^2 = \frac{(n-1)s^2}{\sigma^2} = \frac{(20-1)(0.568)^2}{(0.52)^2} = 22.670$



15. continued

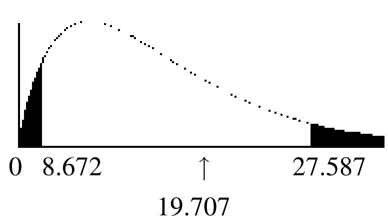
Do not reject the null hypothesis. There is not enough evidence to support the claim that the standard deviation is more than 0.52 mm.

16.
H_0: $\sigma^2 = 9$
H_1: $\sigma^2 > 9$ (claim)
$s^2 = 9.344$
C. V. = 14.684 $\alpha = 0.10$ d. f. = 9
$\chi^2 = \frac{(n-1)s^2}{\sigma^2} = \frac{(10-1)(9.344)}{9} = 9.344$



Do not reject the null hypothesis. There is not enough evidence to support the claim that the variance is more than 9.

17.
H_0: $\sigma = 60$ (claim)
H_1: $\sigma \neq 60$
C. V. = 8.672, 27.587 $\alpha = 0.10$
d. f. = 17
s = 64.6
$\chi^2 = \frac{(n-1)s^2}{\sigma^2} = \frac{(18-1)(64.6)^2}{(60)^2} = 19.707$



Do not reject the null hypothesis. There is not enough evidence to reject the claim that the standard deviation is 60.

18.

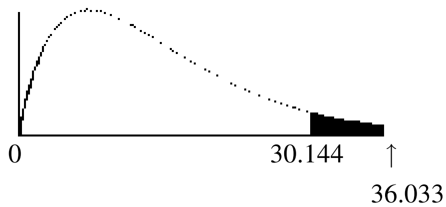
H_0: $\sigma = 8$

H_1: $\sigma > 8$ (claim)

C. V. $= 30.144$ $\alpha = 0.05$ d. f. $= 19$

$\overline{X} = 46.3$ s $= 11.017$

$\chi^2 = \frac{(n-1)s^2}{\sigma^2} = \frac{(20-1)(11.017)^2}{8^2} = 36.033$



Reject the null hypothesis. There is enough evidence to support the claim that the standard deviation is higher than 8 degrees.

19.

$\sigma \approx \frac{\text{Range}}{4}$

$\sigma \approx \frac{\$9500-\$6782}{4} = \$679.50$

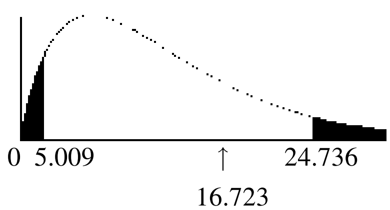
H_0: $\sigma = \$679.50$

H_1: $\sigma \neq \$679.50$ (claim)

s $= 770.67$

C. V. $= 5.009, 24.736$ $\alpha = 0.05$ d. f. $= 13$

$\chi^2 = \frac{(n-1)s^2}{\sigma^2} = \frac{(14-1)(770.67)^2}{679.5^2} = 16.723$



Do not reject the null hypothesis. There is not enough evidence to support the claim that the standard deviation differs from$679.50.

20.

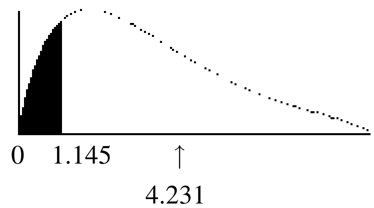
H_0: $\sigma = 2385.9$

H_1: $\sigma < 2385.9$ (claim)

s $= 2194.845$

C. V. $= 1.145$ $\alpha = 0.05$ d. f. $= 5$

$\chi^2 = \frac{(n-1)s^2}{\sigma^2} = \frac{(6-1)(2194.845)^2}{2385.9^2} = 4.231$



Do not reject the null hypothesis. There is not enough evidence to support the claim that the standard deviation is less than 2385.9 feet.

EXERCISE SET 8-6

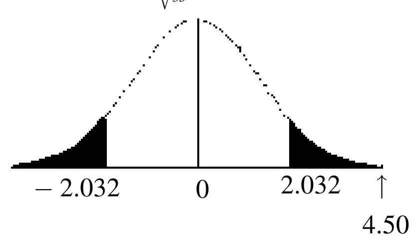
1.

H_0: $\mu = 25.2$

H_1: $\mu \neq 25.2$ (claim)

C. V. $= \pm 2.032$

$t = \frac{\overline{X}-\mu}{\frac{s}{\sqrt{n}}} = \frac{28.7-25.2}{\frac{4.6}{\sqrt{35}}} = 4.50$



Reject the null hypothesis. There is enough evidence to support the claim that the average age differs from 25.2.

The 95% confidence interval of the mean is:

$\overline{X} - t_{\frac{\alpha}{2}} \frac{s}{\sqrt{n}} < \mu < \overline{X} + t_{\frac{\alpha}{2}} \frac{s}{\sqrt{n}}$

$28.7 - 2.032\left(\frac{4.6}{\sqrt{35}}\right) < \mu < 28.7 + 2.032\left(\frac{4.6}{\sqrt{35}}\right)$

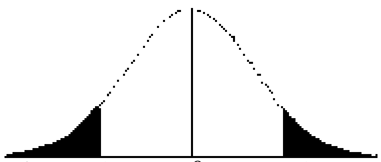
1. continued

$27.1 < \mu < 30.3$
(TI: $27.2 < \mu < 30.2$)
The confidence interval does not contain the hypothesized mean age of 25.2.

2.
H_0: $\mu = \$236$
H_1: $\mu \neq \$236$ (claim)

C. V. $= \pm 2.539$ d.f. $= 19$

$$t = \frac{\overline{X} - \mu}{\frac{s}{\sqrt{n}}} = \frac{210 - 236}{\frac{43}{\sqrt{20}}} = -2.704$$



$\uparrow$ -2.539 0 2.539
-2.704

Reject the null hypothesis. There is enough evidence to support the claim that the average airfare differs from \$236.

The 98% confidence interval of the mean is:

$$\overline{X} - z_{\frac{\alpha}{2}} \frac{s}{\sqrt{n}} < \mu < \overline{X} + z_{\frac{\alpha}{2}} \frac{s}{\sqrt{n}}$$

$$210 - 2.539 \cdot \frac{43}{\sqrt{20}} < \mu < 210 + 2.539 \cdot \frac{43}{\sqrt{20}}$$

$\$185.59 < \mu < \$234.41$

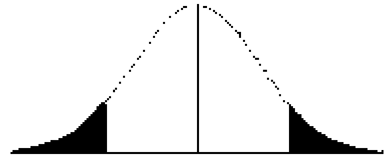
There is agreement between the z-test and the confidence interval because the interval does not contain the mean of \$236.

3.
H_0: $\mu = \$19{,}150$
H_1: $\mu \neq \$19{,}150$ (claim)

C. V. $= \pm 1.96$

$$z = \frac{\overline{X} - \mu}{\frac{\sigma}{\sqrt{n}}} = \frac{\$17{,}020 - \$19{,}150}{\frac{4080}{\sqrt{50}}} = -3.69$$

3. continued



$\uparrow$ -1.96 0 1.96
-3.69

Reject the null hypothesis. There is enough evidence to support the claim that the mean is not \$19,150.

$$\overline{X} - z_{\frac{\alpha}{2}} \frac{\sigma}{\sqrt{n}} < \mu < \overline{X} + z_{\frac{\alpha}{2}} \frac{\sigma}{\sqrt{n}}$$

$$\$17{,}020 - 1.96\left(\frac{4080}{\sqrt{50}}\right) < \mu < \$17{,}020 + 1.96\left(\frac{4080}{\sqrt{50}}\right)$$

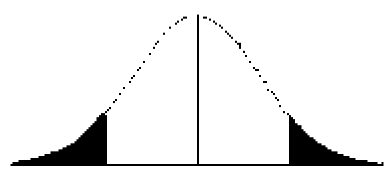
$\$15{,}889 < \mu < \$18{,}151$
The 95% confidence interval supports the conclusion because it does not contain the hypothesized mean.

4.
H_0: $p = 0.694$
H_1: $p \neq 0.694$ (claim)

C. V. $= \pm 1.96$

$\hat{p} = \frac{120}{165} = 0.727$ $p = 0.694$ $q = 0.306$

$$z = \frac{\hat{p} - p}{\sqrt{\frac{pq}{n}}} = \frac{0.727 - 0.694}{\sqrt{\frac{(0.694)(0.306)}{165}}} = 0.920$$



-1.96 0 $\uparrow$ 1.96
0.920

The 95% confidence interval of the proportion is:

$$\hat{p} - (z_{\frac{\alpha}{2}})\sqrt{\frac{\hat{p}\hat{q}}{n}} < p < \hat{p} + (z_{\frac{\alpha}{2}})\sqrt{\frac{\hat{p}\hat{q}}{n}}$$

$$0.727 - 1.96 \cdot \sqrt{\frac{(0.727)(0.273)}{165}} < p < 0.727 + 1.96 \cdot \sqrt{\frac{(0.727)(0.273)}{165}}$$

$0.659 < p < 0.795$

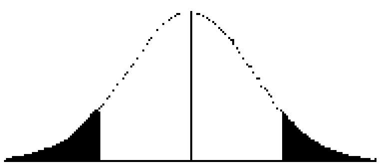
4. continued

Do not reject the null hypothesis. There is not enough evidence to support the claim that the proportion of white collar criminals who serve time differs from 69.4%. The confidence interval does contain the hypothesized percentage of 69.4%.

5.
H_0: $\mu = 19$
H_1: $\mu \neq 19$ (claim)

C. V. $= \pm 2.145$

$t = \frac{\overline{X} - \mu}{\frac{s}{\sqrt{n}}} = \frac{21.3 - 19}{\frac{6.5}{\sqrt{15}}} = 1.37$



− 2.145 0 ↑ 2.145
1.37

The 99% confidence interval of the mean is:

$\overline{X} - z_{\frac{\alpha}{2}} \frac{\sigma}{\sqrt{n}} < \mu < \overline{X} + z_{\frac{\alpha}{2}} \frac{\sigma}{\sqrt{n}}$

$21.3 - 2.145 \cdot \frac{6.5}{\sqrt{15}} < \mu < 21.3 + 2.145 \cdot \frac{6.5}{\sqrt{15}}$

$17.7 < \mu < 24.9$

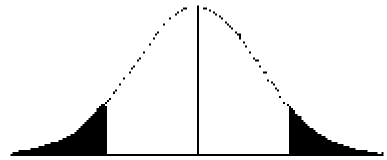
The decision is do not reject the null hypothesis since $1.37 < 2.145$ and the 99% confidence interval does contain the hypothesized mean of 19. The conclusion is that there is not enough evidence to support the claim that the average time worked at home is not 19 hours per week.

6.
H_0: $\mu = 10.8$ (claim)
H_1: $\mu \neq 10.8$

C. V. $= \pm 2.33$

$z = \frac{\overline{X} - \mu}{\frac{\sigma}{\sqrt{n}}} = \frac{12.2 - 10.8}{\frac{3}{\sqrt{36}}} = 2.80$

6. continued



− 2.33 0 2.33 ↑
2.80

$\overline{X} - z_{\frac{\alpha}{2}} \frac{\sigma}{\sqrt{n}} < \mu < \overline{X} + z_{\frac{\alpha}{2}} \frac{\sigma}{\sqrt{n}}$

$12.2 - 2.33 \cdot \frac{3}{\sqrt{36}} < \mu < 12.2 + 2.33 \cdot \frac{3}{\sqrt{36}}$

$11.0 < \mu < 13.4$

The decision is to reject the null hypothesis since $2.80 > 2.33$ and the confidence interval does not contain the hypothesized mean of 10.8. The conclusion is that there is enough evidence to reject the claim that the average time a person spends reading a newspaper is 10.8 minutes.

7.
The power of a statistical test is the probability of rejecting the null hypothesis when it is false.

8.
The power of a test is equal to $1 - \beta$ where β is the probability of a type II error.

9.
The power of a test can be increased by increasing α or selecting a larger sample size.

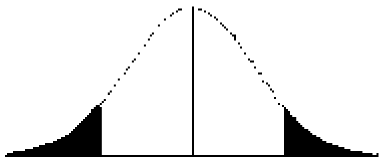
REVIEW EXERCISES - CHAPTER 8

1.
H_0: $\mu = 18$
H_1: $\mu \neq 18$ (claim)

C. V. $= \pm 2.33$
$\sigma = 2.8$

1. continued

$$z = \frac{\overline{X} - \mu}{\frac{\sigma}{\sqrt{n}}} = \frac{18.8 - 18}{\frac{2.8}{\sqrt{50}}} = 2.02$$



-2.33 0 ↑ 2.33

2.02

Do not reject the null hypothesis. There is not enough evidence to support the claim that the average lifetime of a \$1.00 bill is not 18 months.

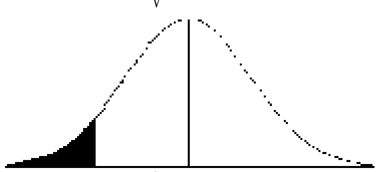
2.

H_0: $\mu = 25.3$

H_1: $\mu < 25.3$ (claim)

C. V. $= -2.33$

$$z = \frac{\overline{X} - \mu}{\frac{\sigma}{\sqrt{n}}} = \frac{23.9 - 25.3}{\frac{6.39}{\sqrt{100}}} = -2.19$$



-2.33 ↑ 0

-2.19

Do not reject the null hypothesis. There is not enough evidence to support the claim that the average commute time is less than 25.3 minutes.

3.

H_0: $\mu = 18{,}000$

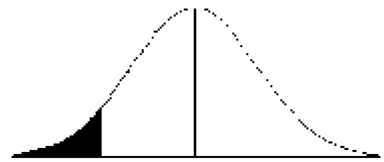
H_1: $\mu < 18{,}000$ (claim)

$\overline{X} = 16{,}298.37$ $s = 2604.82$

C. V. $= -2.33$

$$z = \frac{\overline{X} - \mu}{\frac{s}{\sqrt{n}}} = \frac{16{,}298.37 - 18{,}000}{\frac{2604.82}{\sqrt{30}}} = -3.58$$

3. continued



↑ -2.33 0

-3.58

Reject the null hypothesis. There is enough evidence to support the claim that average debt is less than \$18,000.

4.

H_0: $\mu = 10$

H_1: $\mu < 10$ (claim)

$$z = \frac{\overline{X} - \mu}{\frac{\sigma}{\sqrt{n}}} = \frac{9.25 - 10}{\frac{2}{\sqrt{35}}} = -2.22$$

P-value $= 0.0132$

Since $0.0132 < 0.05$, reject the null hypothesis. The conclusion is that there is enough evidence to support the claim that the average time is less than 10 minutes.

5.

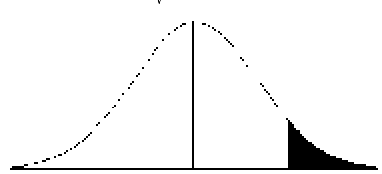
H_0: $\mu = 22$

H_1: $\mu > 22$ (claim)

C. V. $= 1.65$

$\overline{X} = 23.2$ $\sigma = 3.7$

$$z = \frac{\overline{X} - \mu}{\frac{\sigma}{\sqrt{n}}} = \frac{23.2 - 22}{\frac{3.7}{\sqrt{36}}} = 1.95$$



0 1.65 ↑

1.95

Reject the null hypothesis. There is enough evidence to support the claim that the mean is greater than 22 items.

6.

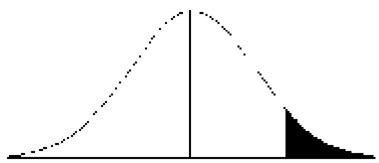
H_0: $\mu = \$50$

H_1: $\mu > \$50$ (claim)

C. V. $= 1.356$ d. f. $= 12$

$\overline{X} = 64.962$ $s = 51.929$

$t = \frac{\overline{X}-\mu}{\frac{s}{\sqrt{n}}} = \frac{64.962-50}{\frac{51.929}{\sqrt{13}}} = 1.04$



0 ↑ 1.356

1.04

Do not reject the null hypothesis. There is not enough evidence to support the claim that the average winnings exceed \$50.

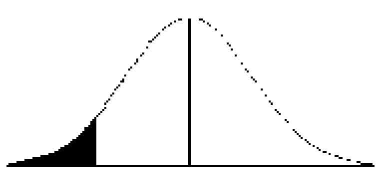
7.

H_0: $\mu = 10$

H_1: $\mu < 10$ (claim)

C. V. $= -1.782$ $\overline{X} = 9.6385$ $s = 0.5853$

$t = \frac{\overline{X}-\mu}{\frac{s}{\sqrt{n}}} = \frac{9.6385-10}{\frac{0.5853}{\sqrt{13}}} = -2.227$ or -2.230



↑ -1.782 0

-2.230

Reject the null hypothesis. There is enough evidence to support the claim that average weight is less than 10 ounces.

8.

H_0: $\mu = 208$

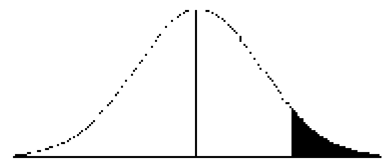
H_1: $\mu > 208$ (claim)

C. V. $= 2.896$ d. f. $= 8$

8. continued

$\overline{X} = 209.74$ $s = 1.67$

$t = \frac{\overline{X}-\mu}{\frac{s}{\sqrt{n}}} = \frac{209.74-208}{\frac{1.67}{\sqrt{9}}} = 3.13$



0 2.896 ↑

3.13

Reject the null hypothesis. There is enough evidence to support the claim that weight is greater than 208 grams.

9.

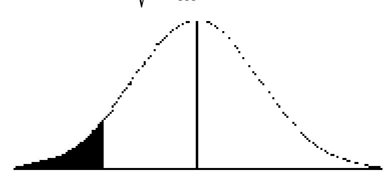
H_0: $p = 0.25$

H_1: $p > 0.25$ (claim)

C. V. $= -1.65$

$\hat{p} = 0.19$ $p = 0.25$ $q = 0.75$

$z = \frac{\hat{p}-p}{\sqrt{\frac{pq}{n}}} = \frac{0.19-0.25}{\sqrt{\frac{(0.25)(0.75)}{100}}} = -1.39$



-1.65 ↑ 0

-1.39

Do not reject the null hypothesis. There is not enough evidence to support the claim that less than 25% medical doctors received their degrees from foreign schools.

10.

H_0: $p = 0.602$

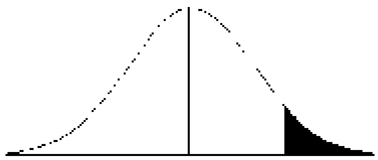
H_1: $p > 0.602$ (claim)

C. V. $= 1.65$

$\hat{p} = 0.65$ $p = 0.602$ $q = 0.398$

$z = \frac{\hat{p}-p}{\sqrt{\frac{pq}{n}}} = \frac{0.65-0.602}{\sqrt{\frac{(0.602)(0.398)}{400}}} = 1.96$

10. continued



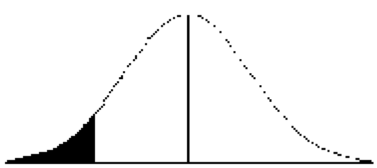
Reject the null hypothesis. There is enough evidence to support the claim that the percentage of drug offenders is higher than 60.2%.

11.
H_0: $p = 0.593$
H_1: $p < 0.593$ (claim)

C. V. $= -2.33$

$\widehat{p} = \frac{156}{300} = 0.52 \quad p = 0.593 \quad q = 0.407$

$z = \frac{\widehat{p}-p}{\sqrt{\frac{pq}{n}}} = \frac{0.52-0.593}{\sqrt{\frac{(0.593)(0.407)}{300}}} = -2.57$



Reject the null hypothesis. There is enough evidence to support the claim that less than 59.3% of school lunches are free or at a reduced price.

12.
H_0: $p = 0.65$ (claim)
H_1: $p \neq 0.65$

$\widehat{p} = \frac{57}{80} = 0.7125 \quad p = 0.65 \quad q = 0.35$

$z = \frac{\widehat{p}-p}{\sqrt{\frac{pq}{n}}} = \frac{0.7125-0.65}{\sqrt{\frac{(0.65)(0.35)}{80}}} = 1.17$

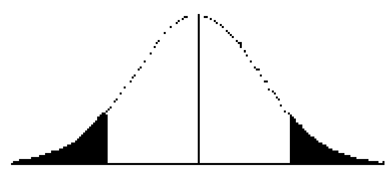
12. continued

Area $= 0.8790$
P-value $= 2(1 - 0.8790) = 0.242$ (0.2412)
Since P-value > 0.05, do not reject the null hypothesis. There is not enough evidence to reject the claim that 65% of the teenagers own their own MP3 players.

13.
H_0: $p = 0.204$
H_1: $p \neq 0.204$ (claim)

$\widehat{p} = 0.18 \quad p = 0.204 \quad q = 0.796$
C. V. $= \pm 1.96$

$z = \frac{\widehat{p}-p}{\sqrt{\frac{pq}{n}}} = \frac{0.18-0.204}{\sqrt{\frac{(0.204)(0.796)}{300}}} = -1.03$



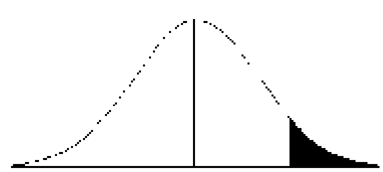
Do not reject the null hypothesis. There is not enough evidence to support the claim that the proportion of high school smokers differs from 20.4%.

14.
H_0: $p = 0.205$
H_1: $p < 0.205$ (claim)

C. V. $= 1.28$

$\widehat{p} = \frac{38}{120} = 0.3167 \quad p = 0.205$
$q = 0.795$

$z = \frac{\widehat{p}-p}{\sqrt{\frac{pq}{n}}} = \frac{0.3167-0.205}{\sqrt{\frac{(0.205)(0.795)}{120}}} = 3.03$



14. continued

Reject the null hypothesis. There is enough evidence to support the claim that the percentage of men over the age of 65 still working is greater than 20.5%.

15.

H_0: $\sigma = 4.3$ (claim)

H_1: $\sigma < 4.3$

d. f. = 19

$\chi^2 = \frac{(n-1)s^2}{\sigma^2} = \frac{(20-1)(2.6)^2}{(4.3^2} = 6.95$

0.005 < P-value < 0.01 (0.006)

Since P-value < 0.05, reject the null hypothesis. There is enough evidence to reject the claim that the standard deviation is greater than or equal to 4.3 miles per gallon.

16.

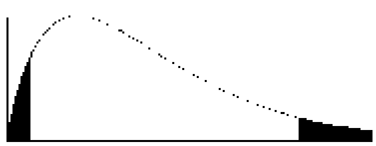
H_0: $\sigma^2 = 3.81$

H_1: $\sigma^2 \neq 3.81$ (claim)

$s^2 = (2.08)^2 = 4.3264$

C. V. = 5.629, 26.119 d. f. = 14

$\chi^2 = \frac{(n-1)s^2}{\sigma^2} = \frac{(15-1)(4.3264)}{3.81} = 15.898$



5.629 ↑ 26.119

15.898

Do not reject the null hypothesis. There is not enough evidence to support the claim that the variance of admission prices differs from 3.81.

17.

H_0: $\sigma^2 = 40$

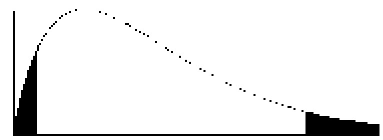
H_1: $\sigma^2 \neq 40$ (claim)

17. continued

s = 6.6 $s^2 = (6.6)^2 = 43.56$ C.

V. = 2.700, 19.023 d. f. = 9

$\chi^2 = \frac{(n-1)s^2}{\sigma^2} = \frac{(10-1)(43.56)}{40} = 9.801$



2.700 ↑ 19.023

9.801

Do not reject the null hypothesis. There is not enough evidence to support the claim that the variance differs from 40.

18.

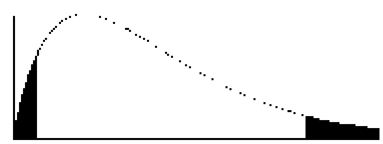
H_0: $\sigma = 3.3$ (claim)

H_1: $\sigma \neq 3.3$

s = 2.8

C. V. = 8.672, 27.587 d. f. = 17

$\chi^2 = \frac{(n-1)s^2}{\sigma^2} = \frac{(18-1)(2.8)^2}{(3.3)^2} = 12.239$



8.672 ↑ 27.587

12.239

Do not reject the null hypothesis. There is enough evidence to support the claim that the standard deviation of fuel consumption of a manufacturer's sport utility vehicle is hypothesized to be 3.3 miles per gallon.

19.

H_0: $\mu = 4$

H_1: $\mu \neq 4$ (claim)

C. V. = ± 2.58

$z = \frac{\overline{X}-\mu}{\frac{s}{\sqrt{n}}} = \frac{4.2-4}{\frac{0.6}{\sqrt{20}}} = 1.49$

19. continued

The 99% confidence interval of the mean is:

$\overline{X} - z_{\frac{\alpha}{2}}\frac{\sigma}{\sqrt{n}} < \mu < \overline{X} + z_{\frac{\alpha}{2}}\frac{\sigma}{\sqrt{n}}$

$4.2 - 2.58 \cdot \frac{0.6}{\sqrt{20}} < \mu < 4.2 + 2.58 \cdot \frac{0.6}{\sqrt{20}}$

$3.85 < \mu < 4.55$

The decision is do not reject the null hypothesis since $1.49 < 2.58$ and the confidence interval does contain the hypothesized mean of 4. There is not enough evidence to support the claim that the growth has changed. Yes, the results agree. The hypothesized mean is contained in the interval.

20.

H_0: $\mu = 35$ (claim)

H_1: $\mu \neq 35$

C. V. $= \pm 1.65$

$z = \frac{\overline{X} - \mu}{\frac{s}{\sqrt{n}}} = \frac{33.5 - 35}{\frac{3}{\sqrt{36}}} = -3.00$

The 90% confidence interval of the mean is:

$\overline{X} - z_{\frac{\alpha}{2}}\frac{\sigma}{\sqrt{n}} < \mu < \overline{X} + z_{\frac{\alpha}{2}}\frac{\sigma}{\sqrt{n}}$

$33.5 - 1.65 \cdot \frac{3}{\sqrt{36}} < \mu < 33.5 + 1.65 \cdot \frac{3}{\sqrt{36}}$

$32.675 < \mu < 34.325$

The decision is to reject the null hypothesis since $-3.00 < -1.65$ and the 90% confidence interval does not contain the hypothesized mean of 35. The conclusion is that there is enough evidence to reject the claim that the mean is 35 pounds.

CHAPTER 8 QUIZ

1. True
2. True
3. False, the critical value separates the critical region from the noncritical region.
4. True
5. False, it can be one-tailed or two-tailed.
6. b
7. d
8. c
9. b
10. Type I
11. β
12. Statistical hypothesis
13. Right
14. $n - 1$

15. H_0: $\mu = 28.6$ (claim)

H_1: $\mu \neq 28.6$

C. V. $= \pm 1.96$

$z = 2.15$

Reject the null hypothesis. There is enough evidence to reject the claim that the average age is 28.6.

16. H_0: $\mu = \$6,500$ (claim)

H_1: $\mu \neq \$6,500$

C. V. $= \pm 1.96$

$z = 5.27$

Reject the null hypothesis. There is enough evidence to reject the agent's claim.

17. H_0: $\mu = 8$
H_1: $\mu > 8$ (claim)
C. V. = 1.65
z = 6.00
Reject the null hypothesis. There is enough evidence to support the claim that the average is greater than 8.

18. H_0: $\mu = 500$ (claim)
H_1: $\mu \neq 500$
C. V. = $\pm$ 3.707
t = $-$ 0.571
Do not reject the null hypothesis. There is not enough evidence to reject the claim that the average is 500.

19. H_0: $\mu = 67$
H_1: $\mu > 67$ (claim)
t = $-$ 3.1568
P-value < 0.005 (0.003)
Since P-value < 0.05, reject the null hypothesis. There is enough evidence to support the claim that the average height is less than 67 inches.

20. H_0: $\mu = 12.4$
H_1: $\mu < 12.4$ (claim)
C. V. = $-$ 1.345
t = $-$ 2.324
Reject the null hypothesis. There is enough evidence to support the claim that the average is less than what the company claimed.

21. H_0: $\mu = 63.5$
H_1: $\mu < 63.5$ (claim)
t = 0.47075
P-value > 0.25 (0.322)
Since P-value > 0.05, do not reject the null hypothesis. There is not enough evidence to support the claim that the average is greater than 63.5.

22. H_0: $\mu = 26$ (claim)
H_1: $\mu \neq 26$
C. V. = $\pm$ 2.492
t = $-$ 1.5

Do not reject the null hypothesis. There is not enough evidence to reject the claim that the average is 26.

23. H_0: p = 0.39 (claim)
H_1: p $\neq$ 0.39
C. V. = $\pm$ 1.96
z = $-$ 0.62
Do not reject the null hypothesis. There is not enough evidence to reject the claim that 39% took supplements. The study supports the results of the previous study.

24. H_0: p = 0.55 (claim)
H_1: p< 0.55
C. V. = $-$ 1.28
z = $-$ 0.8989
Do not reject the null hypothesis. There is not enough evidence to reject the survey's claim.

25. H_0: p = 0.35 (claim)
H_1: p $\neq$ 0.35
C. V. = $\pm$ 2.33
z = 0.666
Do not reject the null hypothesis. There is not enough evidence to reject the claim that the proportion is 35%.

26. H_0: p = 0.75 (claim)
H_1: p $\neq$ 0.75
C. V. = $\pm$ 2.58
z = 2.6833
Reject the null hypothesis. There is enough evidence to reject the claim.

27. The area corresponding to z = 2.15 is 0.9842.
P-value = 2(1 $-$ 0.9842) = 0.0316

28. The area corresponding to $z = 5.27$ is greater than 0.9999.
Thus, P-value $\leq 2(1 - 0.9999) \leq 0.0002$.
(TI: P-value< 0.0001)

29. H_0: $\sigma = 6$
H_1: $\sigma < 6$ (claim)
C. V. $= 36.415$
$\chi^2 = 54$

Reject the null hypothesis. There is enough evidence to support the claim that the standard deviation is more than 6.

30. H_0: $\sigma = 8$ (claim)
H_1: $\sigma \neq 8$
C. V. $= 27.991, 79.490$
$\chi^2 = 33.2$
Do not reject the null hypothesis. There is not enough evidence to reject the claim that $\sigma = 8$.

31. H_0: $\sigma = 2.3$
H_1: $\sigma < 2.3$ (claim)
C. V. $= 10.117$
$\chi^2 = 13$
Do not reject the null hypothesis. There is not enough evidence to support the claim that the standard deviation is less than 2.3.

32. H_0: $\sigma = 9$ (claim)
H_1: $\sigma \neq 9$
$\chi^2 = 13.4$

P-value > 0.20 (0.291)
Since P-value > 0.05, do not reject the null hypothesis. There is not enough evidence to reject the claim that $\sigma = 9$.

33. $28.9 < \mu < 31.2$; no

34. $\$6562.81 < \mu < \$6{,}637.19$; no