CHAPTER PROBLEM

Does the MicroSort method of gender selection increase the likelihood that a baby will be a girl?

Gender-selection methods are somewhat controversial. Some people believe that use of such methods should be prohibited, regardless of the reason. Others believe that limited use should be allowed for medical reasons, such as to prevent gender-specific hereditary disorders. For example, some couples carry X-linked recessive genes, so that a male child has a 50% chance of inheriting aa serious disorder and a female child has no chance of inheriting the disorder. These couples may want to use a gender-selection method to increase the likelihood of having a baby girl so that none of their children inherit the disorder.

Methods of gender-selection have been around for many years. In the 1980s, ProCare Industries sold a product called Gender Choice. The product cost only $49.95, but the FDA told the company to stop distributing Gender Choice because there was no evidence to support the claim that it was 80% reliable.

The Genetics and IVF Institute developed a newer gender-selection method called MicroSort. The MicroSort XSORT method is designed to increase the likelihood of a baby girl, and the YSORT method is designed to increase the likelihood of a boy. Here is a statement from the MicroSort web site: "The Genetics and IVF Institute is offering couples the ability to increase the chance of having a child of the desired gender to reduce the probability of X-linked diseases or for family balancing." Stated simply, for a cost exceeding $3000, The Genetics and IVF Institute claims that it can increase the probability of having a baby of the gender that a couple prefers. As of this writing, the MicroSort method is undergoing clinical trials, but these results are available: Among 726 couples who used the XSORT method in trying to have a baby girl, 668 couples did have baby girsl, for a success rate of 92.0%. Under normal circumstances with no special treatment, girls occur in 50% of the births. (Actually the current birth rate of girls is 48.79%, but we will use 50% to keep things simple.) These results provide us with an interesting question: Given that 668 out of 726 couples had girls, can we actually support the claim that the XSORT technique is effective in increasing the probability of a girl? Do we now have an effective method of gender selection?

MATH 103 CHAPTER 8 HOMEWORK	
8.2	1-15 odd, 17-24, 27, 29-35 odd, 37, 41, 43, 45
8.3	1-5, 7, 11, 13-16, 19, 24, 25, 26, 29, 32
8.4	1-5, 7, 9, 10, 11, 14, 16, 17, 19
8.5	1-5, 7, 9, 11, 13, 15, 16, 19, 23, 27

8.1 REVIEW AND PREVIEW

In Chapters 2 and 3 we used "________________________________ ________________________________" when we ________________________________ data using tools such as the ________________, and ________________ ________________________. Methods of ________________________ statistics use ________________ data to make an ________________ or ________________________ about a ________________________.

The two main activities of ________________________ ________________________ are using sample data to (1) ________________ a ________________________ ________________________ and (2) ________________ a ________________________ or ________________ about a ________________________ ________________________. In Chapter 7 we presented methods for ________________________ a ________________________ ________________________ with a

___________________________ _________________________, and in this chapter we present the method of __________________ ________________.

DEFINITION

In statistics, a **hypothesis** is a ________________ or ________________________ about a ________________________ of the ________________________________.

A **hypothesis test (aka test of significance)** is a _________________________ for testing a ________________________ about a __________________________ of a ________________________________.

The main objective of this chapter is to ________________________ the _______________ to __________________ ____________________ tests for claims made about a population _______________________ ______, a population ___________________ _____, or a population ________________________ ________________________ ______.

8.2 BASICS OF HYPOTHESIS TESTING

Key Concept…

In this section we present individual _________________________ of a ________________________ _______________________. In Part 1 we discuss the basic _______________________ of ___________________ testing. Because these concepts are used in the following sections and chapters, we should ________________________ and ________________________ the following:

- How to ____________________________ the ________________ ________________________ and ______________________ ________________________ from a given _______________, and how to ______________________ both in _________________ form
- How to ______________________ the _______________ of the ____________________ ______________________, given a _____________________ and ______________ ______________
- How to _______________________ the _________________ ______________________, given a _________________________ ______________________
- How to ______________________ the _________________, given a ___________________ of the ______________ ______________________
- How to __________________ the ___________________ about a

__________________ in ____________________ and

_____________________ terms

In Part 2 we discuss the _____________ of a _________________

__________________.

PART 1: BASICS CONCEPTS OF HYPOTHESIS TESTING

The methods presented in this chapter are based on the ________ ___________

_________ for ____________________ ____________________.

RARE EVENT RULE FOR INFERENTIAL STATISTICS

If, under a given assumption, the _________________________ of a particular observed is extremely _______________________, we conclude that the _____________________________ is probably not ______________________.

Following this rule, we ________________ a __________________ by

_______________________ sample data in an attempt to __________________

between results that can __________________ ________________ by

_______________ and results that are _______________ __________________

to ___________________ by __________________. We can explain the

occurrence of ___________________ ______________________ results by

saying that either a _____________ ________________ has indeed occurred or that the ________________________ _________________________ is _______

_____________________.

WORKING WITH THE STATED CLAIM: NULL AND ALTERNATIVE HYPOTHESES

The **null hypothesis** denoted by _______ is a ____________________ that the

value of a ________________________ _____________________________ is

__________________ to some __________________ value. The term _______

is used to _____________________ _______ _________________ or ______

___________________ or ______ ___________________________.

The **alternative hypothesis** denoted by ________ or _______ or _______ is the

________________________ that the _____________________ has a value that

somehow ________________ from the ___________ _______________________.

For the methods of this chapter, the _______________________ form of the

______________________ ______________________ must use one of these

symbols: _____, _____, _____.

NOTE ABOUT FORMING YOUR OWN CLAIMS (HYPOTHESES)

If you are _________________________ a study and want to use a

_____________________ ________________ to ____________________ your

____________________, the ___________________ must be worded so that it becomes the _________________________ ________________________. You can _______________________ _________________________ a ____________ that some parameter is ________________________ to some _______________ value.

IDENTIFYING ______ AND ______

START

1

- Identify the specific ___________ or__________________ to be tested
- Express it in ________________ form

2

- Give the symbolic form that must be _________ when the _______________ ____________ is ________________

3

- Using the two _____________________ expressions obtained so far, identify the ____________ __________________ ______ and the __________________ ______________________ ________
  - ______ is the symbolic expression that ________ _________ contain __________________
  - ______ is the symbolic expression that the ______________________ _________________the ____________ value being _______________________

Example 1: Examine the given statement, then express the null hypothesis and the alternative hypothesis in symbolic form.

a. The proportion of people aged 18-25 who currently use illicit drugs is equal to 0.20.

b. The majority of college students have credit cards.

c. The standard deviation of daily rainfall amounts in San Francisco is 0.66 cm.

d. The mean weight of plastic discarded by households in one week is less than 1 kg.

CONVERTING SAMPLE DATA TO A TEST STATISTIC

The ____________________________ required for a ________________________ test typically involve __________________________ a ______________________ ________________________ to a _______________ ________________________.

The **test statistic** is a ____________________ used in making a _______________ about the ______________ ______________________. It is found by converting the ____________________ ______________________ (such as ______, ______, or ______) to a _______________ (such as ________, ________, or _________) with the ___________________________ that the ___________ ___________________ is ______________. In this chapter we use the following _______________ statistics:

Test statistic for proportion:

Test statistic for mean:

Test statistic for standard deviation

Example 2: Find the value of the test statistic. The claim is that less than $\frac{1}{2}$ of adults in the United States have carbon monoxide detectors. A KRC Research survey of 1005 adults resulted in 462 who have carbon monoxide detectors.

TOOLS FOR ASSESSING THE TEST STATISTIC: CRITICAL REGION, SIGNIFICANCE LEVEL, CRITICAL VALUE, AND *P*-VALUE

The _______________ ________________________ alone usually _________ _______ give us enough information to make a decision about the ___________ being _________________. The following tools can be used to ______________ and ________________________ the __________ ________________________.

- The **critical region (aka rejection region)** is the __________ of all ______________ of the _____________ _______________ that cause us to ________________ the __________________ ____________________ _____
- The **significance level (denoted by ____)** is the ______________ that the ________________ ___________________ will fall in the _____________________ ___________________ when the ____________ _______________________ is actually ______.

If the ________________ ___________________ falls in the

__________________ ______________________, we _________

the ________________ ____________________, so _______ is

the ____________________ of making the __________________

of __________________ the ___________ __________________

when it is ________________.

π A **critical value** is any value that __________________ the

____________________ ______________________ from the

________________ of the _____________ ________________

that _______ ___________ lead to ________________________

of the ____________ _______________________. The

________________ _____________________ depend on the

nature of the ________________ ______________________, the

__________________ ____________________ that applies, and

the __________________ _____________ of _____.

π The ***P*-value (aka *p*-value or probability value)** is the

____________________ of getting a ________________ of the

________________ ___________________ that is _____

____________ _____ ________________ as the one

representing the _______________ __________, assuming that

the ___________ __________________ is ______________.

P-values can be found ________________ finding the _______

_________________ the ______________ ________________.

The procedure can be summarized as follows:

Critical region in the left tail:

Critical region in the right tail:

Critical region in two tails:

The ________________ __________________ is ______________ if

the ___________________ is very ______________, such as

_______________ or _____________.

DECISIONS AND CONCLUSIONS

***P*-value method:** Using the ___________________ ___________ _____:

If *P*-value ______ ______, ___________ ______

If *P*-value ______ ______, ________to __________ _____

Traditional method: If the ________________ ________________ falls

_______________ the _________________

__________________, _______________ _____. If the

____________ ________________ _______

____________ fall ________________ the

_________________ ___________, ______________ to

_______________ ______.

Another option: Instead of using a ___________________ __________

such as ___________, simply identify the

_______________ and leave the _____________________

to the _________________.

Confidence intervals: A ______________ _________________ ______________

of a _________________ _________________ contains

the _____________ values of that

______________________. If a _______________

____________________ does __________

________________ a _____________ value of a

_______________ __________________,

________________ that _____________.

Example 3: Use the given information to find *P*-value.

a. The test statistic in a right-tailed test is $z = 2.50$

c. With $H_1: p \neq \frac{3}{4}$, the test statistic is $z = 0.35$

b. The test statistic in a two-tailed test is $z = -0.55$

d. With $H_1: p < 0.777$, the test statistic is $z = -2.95$

Example 4: State the final conclusion in simple non-technical terms. Be sure to address the original claim.

a. Original claim: The percentage of on-time U.S. airline flights is less than 75%. Initial conclusion: Reject the null hypothesis.

b. Original claim: The percentage of Americans who believe in heaven is equal to 90%. Initial conclusion: Reject the null hypothesis.

ERRORS IN HYPOTHESIS TESTS

When testing a null hypothesis, we arrive at a ______________________ of ________________________ it or ________________ to ______________ it.

Such conclusions are sometimes ____________________ and sometimes _____________________ (even if we do everything ______________________).

- **Type I error**: The ____________________ of ______________ the ________________ ____________________ when it is actually ______________. The symbol ______ is used to represent the ____________________ of a _________ ____ error.

π **Type II error**: The ________________ of ________________ to

____________________ the __________ ___________________

when it is actually ______________. The symbol ______ is used

to represent the ____________________ of a ________ ____

error.

NOTATION

α (alpha) = ________________________ of a ________ __ ____________ (the

________________________ of __________________ the ______________

___________________ when it is ________)

β (beta) = ________________________ of a ________ __ ____________ (the

________________________ of ____________ to __________________ the

______________ ___________________ when it is ________)

CONTROLLING TYPE I AND TYPE II ERRORS

One step in our standard procedure for testing __________________________

involves the _____________________ of the ____________________ level ___,

which is the _____________________ of a _________ ___ error. The values of

____, ____, and the sample size ____ are all _______________, so when you choose or ____________________ any ______ of them, the ___________ is automatically _______________________. One common practice is to select the _______________________ level ____, then select a _______________ size that is _________________, so the value of _____ is ____________________. Generally, try to use the ______________________ ____ that you can tolerate, but for __________ ___ errors with more serious consequences, select ________ values of ____. Then choose a _________ __________ ___ as __________ as is ______________________, based on considerations of __________, _________, and other relevant factors. Another common practice is to select ____ and ____, so the required sample size ____ is automatically determined.

		TRUE STATE OF NATURE	
		THE NULL HYPOTHESIS IS TRUE	THE NULL HYPOTHESIS IS FALSE
DECISION	We decide to reject H_0	TYPE I ERROR	CORRECT DECISION
	We fail to reject H_0	CORRECT DECISION	TYPE II ERROR

Example 5: Identify the type I error and the type II error that correspond to the given hypothesis.

a. The percentage of Americans who believe that life exists only on earth is equal to 20%.

b. The percentage of households with at least two cell phones is less than 60%.

COMPREHENSIVE HYPOTHESIS TEST

In this section we describe the ____________________ __________________ used in a _______________________ test, but the following sections will combine those components in ____________________ ___________________.

We can __________ claims about _________________ _________________ by using the ________________ method, the __________________ method, or we can use a ____________________ _____________________.

CONFIDENCE INTERVAL METHOD

For _______________ hypothesis tests _____________ a __________________ interval with a __________________ _______________ of _____________; but for a ___________________ hypothesis test with _____________________

________________ ____, construct a ___________________ _______________ of

___________.

A ___________________ ____________________ _________________ of a

___________________ _____________________ contains the

______________ values of that parameter. We should therefore

________________ a __________ that the population parameter has a

______________ that is ________ included in the _________________

_____________________.

PART 2: BEYOND THE BASICS OF HYPOTHESIS TESTING: THE POWER OF A TEST

We use _____ to denote the ___________________ of _____________ to

________________ a ___________ ___________ __________________, so

$P(\text{type II error}) = \beta$. It follows that ___________ is the ___________________ of

___________________ a _____________ __________ ___________________, and

statisticians refer to this probability as the ___________________ of a

________, and they often use it to ______________ the ____________________

of a hypothesis test in allowing us to recognize that a ____________

______________ is ____________.

DEFINITION

The **power** of a ________________________ test is the ________________ ______ of ___________________ a ____________ ____________ hypothesis. The __________ of the ______________ is _________________ by using a particular __________________ _________ _____ and a _________________ value of the __________________ _________________ that is an _____________________ to the value assumed ______________ in the __________ __________________.

POWER AND THE DESIGN OF EXPERIMENTS

Just as ________ is a common choice for a ________________ level, a power of at least _________ is a common requirement for _____________________ that a _____________________ test is ___________________. When _____________ an ______________________, a goal of having a __________________ value of _____ ________________ ________ can often be used in ____________________ the ________________________ _______________ __________.

Example 6: Chantix tablets are used as an aid to help people stop smoking. In a clinical trial, 129 subjects were treated with Chantix twice a day for 12 weeks, and 16 subjects experienced abdominal pain. If someone claims that more than 8% of Chantix users experience abdominal pain, that claim is supported with a hypothesis test conducted with a 0.05 significance level. Using 0.18 as an alternative value of *p*, the power of the test is 0.96. Interpret this value of the power of the test.

8.3 TESTING A CLAIM ABOUT A PROPORTION

Key Concept…

In section 8.2 we presented the individual __________________________ of

a ______________________________ ______________________. In this

section we present _______________________ _____________________ for

________________________ a __________________________ (or

_______________) made about a ___________________ _________________.

We illustrate _________________________ testing with the ____________

method, the _______________________ method, and the use of

____________________________ ____________________________. In addition to testing ______________________ about population proportions,

we can use the ________________ procedure for testing claims about

________________________ or the ________________ ________________

of ____________________.

Two common methods for testing a claim about a _________________

proportion are (1) to use a _________________

__________________________ as an _______________________ to the

_____________________ distribution, and (2) to use an

_________________ method based on the _________________

_____________________ ____________________.

PART 1: BASIC METHODS OF TESTING CLAIMS ABOUT A POPULATION PROPORTION *p*

REQUIREMENTS
OBJECTIVE
NOTATION
$n =$ $\qquad\qquad$ $p =$
$\hat{p} = \frac{\quad}{\quad}$ $\qquad\qquad$ $q =$

REQUIREMENTS

1. The _______________ observations are a __________ __________ sample.
2. The _________________ for a ______________ ________________ are satisfied.

3. The conditions __________ and ___________ are ________ satisfied so

the ______________ ___________________ of ______________

proportions can be __________________ by a ____________ ____________

with _____________ and _______________. Note that ____ is the

_______________ _________________ used in the __________________.

TEST STATISTIC FOR TESTING A CLAIM ABOUT A PROPORTION

$z = \underline{\hspace{4cm}}$

$P-$values:

Critical values:

FINDING THE NUMBER OF SUCCESSES x

Computer software and ________________ designed for ______________

tests of ____________________ usually require ____________ consisting of

the ________________ __________ ____ and the number of ___________

____, but the __________________ __________________ is often given

instead of ____.

Example 1: Identify the indicated values. Use the normal distribution as an approximation to the binomial distribution. In a survey, 1864 out of 2246 randomly selected adults in the United States said that texting while driving should be illegal (based on data from Zogby International). Consider a hypothesis test that uses a 0.05 significance level to test the claim that more than 80% of adults believe that texting while driving should be illegal.

a. What is the test statistic?

c. What is the P-value?

b. What is the critical value?

d. What is the conclusion?

Example 2: The company Drug Test Success provides a "1-Panel-THC" test for marijuana usage. Among 300 tested subjects, results from 27 subjects were wrong (either a false positive or a false negative). Use a 0.05 significance level to test the claim that less than 10% of the test results are wrong. Does the test appear to be good for most purposes?

a. Identify the null hypothesis

b. Identify the alternative hypothesis

c. Identify the test statistic

d. Identify the *P*-value or critical value(s)

e. What is your conclusion about the null hypothesis?

f. What is your final conclusion?

Example 3: In recent years, the town of Newport experienced an arrest rate of 25% for robberies (based on FBI data). The new sheriff compiles records showing that among 30 recent robberies, the arrest rate is 30%, so she claims that her arrest rate is greater than the 25% rate in the past. Is there sufficient evidence to support her claim that the arrest rate is greater than 25%?

a. Identify the null hypothesis

b. Identify the alternative hypothesis

c. Identify the test statistic

d. Identify the *P*-value or critical value(s)

e. What is your conclusion about the null hypothesis?

f. What is your final conclusion?

PART 2: EXACT METHOD FOR TESTING CLAIMS ABOUT A POPULATION PROPORTION *p*

Instead of using the ________________________ distribution as an

________________________ to the ____________________ __________________,

we can get ____________________ results by using the _____________________

___________________________ ______________________ itself. This exact

approach _____________ __________ require that ___________ and

__________, so we have a method that applies when the requirement is not

satisfied.

Left-tailed test: The *P*-value is the ________________ of getting ___ or __________________ ________________ among ___ trials.

Right-tailed test: The *P*-value is the ________________ of getting ___ or __________________ ________________ among ___ trials.

8.4 TESTING A CLAIM ABOUT A MEAN: SIGMA KNOWN

Key Concept…

In this section, we discuss ____________________ ____________________

methods for _________________ made about a ______________________

_______________, assuming the _________________ ________________

________________ is a ___________________ value. Here we use the

_________________ __________________ with the ____________

components of _________________ _____________ that were introduced

in Section 8.2.

TESTING CLAIMS ABOUT A POPULATION MEAN (WITH σ KNOWN)	
OBJECTIVE	
NOTATION	
$n =$	$\mu_{\overline{x}} =$
$\overline{x} =$	$\sigma =$
REQUIREMENTS	
1. The ________________ is a ______________ ____________ ___________ (______).	
2. The __________________ of the _______________ _________________ ___________________ ________ is ______________.	
3. The _____________________ is __________________ _________________ and/or _________.	

TEST STATISTIC FOR TESTING A CLAIM ABOUT A MEAN (WITH σ KNOWN)

$z = \rule{3cm}{0.4pt}$

$P-$values:

Critical values:

Example 1: When a fair die is rolled many times, the outcomes of 1, 2, 3, 4, 5, and 6 are equally likely, so the mean of the outcomes should be 3.5. The author drilled holes into a die and loaded it by inserting lead weights, then rolled it 40 times to obtain a mean of 2.9375. Assume that the standard deviation of the outcomes is 1.7078, which is the standard deviation for a fair die. Use a 0.05 significance level to test the claim that outcomes from the loaded die have a mean different from the value of 3.5 expected with a fair die.

a. Identify the null hypothesis

b. Identify the alternative hypothesis

c. Identify the test statistic

d. Identify the P-value or critical value(s)

e. What is your conclusion about the null hypothesis?

f. What is your final conclusion?

Example 2: Listed below are recorded speeds (in mi/h) of randomly selected cars traveling on a section of Highway 405 in Los Angeles (based on data from Sigalert). That part of the highway has a posted speed limit of 65 mi/h. Assume that the standard deviation of speeds is 5.7 mi/h and use a 0.01 significance level to test the claim that the sample data is from a population with a mean greater than 65 mi/h.

68 68 72 73 65 74 73 72 68 65 65 73 66 71 68 74 66 71 65 73
59 75 70 56 66 75 68 75 62 72 60 73 61 75 58 74 60 73 58 75

a. Identify the null hypothesis

b. Identify the alternative hypothesis

c. Identify the test statistic

d. Identify the *P*-value or critical value(s)

e. What is your conclusion about the null hypothesis?

f. What is your final conclusion?

8.5 TESTING A CLAIM ABOUT A MEAN: SIGMA NOT KNOWN

Key Concept…

In Section 8.4 we discussed methods for testing a ________________

about a _____________________ ___________________, but that section

is based on the _______________________ assumption that the value of

the ____________________ __________________ ______________ ___ is ____________________. In this section, we present methods for testing a claim about a ________________________ ____________________, but we ______ ________ require that _______ is known. The methods of this section are referred to as a _____ ___________ because they use the ___________________ _____ ___________________ that was introduced in Section 7.4.

TESTING CLAIMS ABOUT A POPULATION MEAN (WITH σ NOT KNOWN)

OBJECTIVE

NOTATION

$n =$

$\mu_{\bar{x}} =$

$\bar{x} =$

$s =$

REQUIREMENTS

1. The _________________ is a _______________ _____________ ____________ (______).

2. The ____________________ of the ________________ __________________

______________________ _________ is _______ _____________.

3. The _______________________ is _____________________ ____________________ and/or _________.

TEST STATISTIC FOR TESTING A CLAIM ABOUT A MEAN (WITH σ KNOWN)

$t = \rule{3cm}{0.4pt}$

$P-$values:

Critical values:

IMPORTANT PROPERTIES OF THE STUDENT *t* DISTRIBUTION

1. The ________________________ _____ _______________________ is __________________ for ______________________ sample sizes.
2. The Student ______ distribution has the same general __________ ___________ as the ___________________ _______________________ distribution; its ___________________ shape reflects the ________________ ____________________ that is expected when ______ is used to estimate ______.
3. The ______________________ ______ ______________________ has a mean of ______________.

4. The ________________ ________________ of the

________________ ________ ____________________ ______________ with

the ________________ ___________ and is ________________ than _____.

5. As the ________________ _____________ _____ gets ________________,

the _____________________ ______ ____________________ gets ________

to the _____________________ ____________________ ______________.

CHOOSING THE CORRECT METHOD

When ________________ a _____________ about a ________________

__________, first be sure that the sample data have been collected with an

appropriate ______________________ method. If we have a ________________

______________________ ________________, a ________________ test of a

_____________ about _____ might use the _________________ _______

________________________, the ______________________ distribution, or it

might require _________________________ methods or __________________

resampling techniques.

To test a _____________ about a ____________________ ___________,

use the __________________ _____ ____________________ when the

sample is a ____________________ ______________________

________________, _____ is __________ _________________, and

______________________ or _____________ of these conditions is

satisfied:

The ______________________ is _______________________

distributed or _________________.

Example 1: Determine whether the hypothesis test involves a sampling distribution of means that is a normal distribution, Student *t* distribution, or neither.

a. Claim about FICO credit scores of adults: $\mu = 678,\ n = 12,\ \overline{x} = 719,\ s = 92.$ The sample data appear to come from a population with a distribution that is not normal and σ is not known.

b. Claim about daily rainfall amounts in Boston: $\mu < 0.20 \text{ in.},\ n = 52,\ \overline{x} = 0.10 \text{ in.},\ s = 0.26 \text{ in.}$ The sample data appear to come from a population with a distribution that is very far from normal, and σ is known.

FINDING *P*-VALUES WITH THE STUDENT *t* DISTRIBUTION

1. Use software or a ____________________ _____________________.

2. If ______________________ is not available, use Table A-3 to identify a ____________ of _____________ as follows: Use the number of ____________ of _______________ to _____________ the ______________ row of Table A-3, then determine where the _________ _________________ lies _______________ to the _________________ in that ___________. Based on a comparison of the _____ ______________ ____________________ and the _____ _____________ in the row of Table A-3, ________________ a ______________ of _______________ by referring to the _____________ ________________ given at the ________ of Table A-3.

Example 2: Either use technology to find the *P*-value or use Table A-3 to find a range of values for the *P*-value.

a. Movie Viewer Ratings: Two-tailed test with $n = 15$, and test statistic $t = 1.495$.

b. Body Temperatures: Test a claim about the mean body temperature of healthy adults. Left-tailed test with $n = 11$ and test statistic $t = -3.518$.

Example 3: Assume that a SRS has been selected from a normally distributed population and test the given claim. A SRS of 40 recorded speeds (in mi/h) is observed from cars traveling on a section of Highway 405 in Los Angeles. The sample has a mean of 68.4 mi/h and a standard deviation of 5.7 mi/h (based on data from Sigalert). Use a 0.05 significance level to test the claim that the mean speed of all cars is greater that the posted speed limit of 65 mi/h.

a. Identify the null hypothesis

b. Identify the alternative hypothesis

c. Identify the test statistic

d. Identify the *P*-value or critical value(s)

e. What is your conclusion about the null hypothesis?

f. What is your final conclusion?

Example 2: Assume that a SRS has been selected from a normally distributed population and test the given claim. The trend of thinner Miss America winners has generated charges that the contest encourages unhealthy diet habits among young women. Listed below are body mass indexes (BMI) of recent Miss America winners. Use a 0.01 significance level to test the claim that recent Miss America winners are from a population with a mean BMI less than 20.16, which was the BMI for winners from the 1920s and 1930s.

19.5 20.3 19.6 20.2 17.8 17.9 19.1 18.8 17.6 16.8

a. Identify the null hypothesis

b. Identify the alternative hypothesis

c. Identify the test statistic

d. Identify the *P*-value or critical value(s)

e. What is your conclusion about the null hypothesis?

f. What is your final conclusion?

TABLE A-3 *t* Distribution: Critical *t* Values

	Area in One Tail				
	0.005	0.01	0.025	0.05	0.10
Degrees of Freedom	**Area in Two Tails**				
	0.01	0.02	0.05	0.10	0.20
1	63.657	31.821	12.706	6.314	3.078
2	9.925	6.965	4.303	2.920	1.886
3	5.841	4.541	3.182	2.353	1.638
4	4.604	3.747	2.776	2.132	1.533
5	4.032	3.365	2.571	2.015	1.476
6	3.707	3.143	2.447	1.943	1.440
7	3.499	2.998	2.365	1.895	1.415
8	3.355	2.896	2.306	1.860	1.397
9	3.250	2.821	2.262	1.833	1.383
10	3.169	2.764	2.228	1.812	1.372
11	3.106	2.718	2.201	1.796	1.363
12	3.055	2.681	2.179	1.782	1.356
13	3.012	2.650	2.160	1.771	1.350
14	2.977	2.624	2.145	1.761	1.345
15	2.947	2.602	2.131	1.753	1.341
16	2.921	2.583	2.120	1.746	1.337
17	2.898	2.567	2.110	1.740	1.333
18	2.878	2.552	2.101	1.734	1.330
19	2.861	2.539	2.093	1.729	1.328
20	2.845	2.528	2.086	1.725	1.325
21	2.831	2.518	2.080	1.721	1.323
22	2.819	2.508	2.074	1.717	1.321
23	2.807	2.500	2.069	1.714	1.319
24	2.797	2.492	2.064	1.711	1.318
25	2.787	2.485	2.060	1.708	1.316
26	2.779	2.479	2.056	1.706	1.315
27	2.771	2.473	2.052	1.703	1.314
28	2.763	2.467	2.048	1.701	1.313
29	2.756	2.462	2.045	1.699	1.311
30	2.750	2.457	2.042	1.697	1.310
31	2.744	2.453	2.040	1.696	1.309
32	2.738	2.449	2.037	1.694	1.309
34	2.728	2.441	2.032	1.691	1.307
36	2.719	2.434	2.028	1.688	1.306
38	2.712	2.429	2.024	1.686	1.304
40	2.704	2.423	2.021	1.684	1.303
45	2.690	2.412	2.014	1.679	1.301
50	2.678	2.403	2.009	1.676	1.299
55	2.668	2.396	2.004	1.673	1.297
60	2.660	2.390	2.000	1.671	1.296
65	2.654	2.385	1.997	1.669	1.295
70	2.648	2.381	1.994	1.667	1.294
75	2.643	2.377	1.992	1.665	1.293
80	2.639	2.374	1.990	1.664	1.292
90	2.632	2.368	1.987	1.662	1.291
100	2.626	2.364	1.984	1.660	1.290
200	2.601	2.345	1.972	1.653	1.286
300	2.592	2.339	1.968	1.650	1.284
400	2.588	2.336	1.966	1.649	1.284
500	2.586	2.334	1.965	1.648	1.283
750	2.582	2.331	1.963	1.647	1.283
1000	2.581	2.330	1.962	1.646	1.282
2000	2.578	2.328	1.961	1.646	1.282
[illegible]	[illegible]	2.326	[illegible]	1.645	[illegible]