**[9.1 Null and Alternative Hypotheses](https://openstax.org/books/introductory-statistics/pages/9-1-null-and-alternative-hypotheses)**

[**62**](https://openstax.org/books/introductory-statistics/pages/9-solutions#element-919-solution).

Some of the following statements refer to the null hypothesis, some to the alternate hypothesis.

State the null hypothesis, *H0*, and the alternative hypothesis. *Ha*, in terms of the appropriate parameter (*μ* or *p*).

1. The mean number of years Americans work before retiring is 34.
2. At most 60% of Americans vote in presidential elections.
3. The mean starting salary for San Jose State University graduates is at least $100,000 per year.
4. Twenty-nine percent of high school seniors get drunk each month.
5. Fewer than 5% of adults ride the bus to work in Los Angeles.
6. The mean number of cars a person owns in her lifetime is not more than ten.
7. About half of Americans prefer to live away from cities, given the choice.
8. Europeans have a mean paid vacation each year of six weeks.
9. The chance of developing breast cancer is under 11% for women.
10. Private universities' mean tuition cost is more than $20,000 per year.

**63**.

Over the past few decades, public health officials have examined the link between weight concerns and teen girls' smoking. Researchers surveyed a group of 273 randomly selected teen girls living in Massachusetts (between 12 and 15 years old). After four years the girls were surveyed again. Sixty-three said they smoked to stay thin. Is there good evidence that more than thirty percent of the teen girls smoke to stay thin? The alternative hypothesis is:

1. *p* < 0.30
2. *p* ≤ 0.30
3. *p* ≥ 0.30
4. *p* > 0.30

[**64**](https://openstax.org/books/introductory-statistics/pages/9-solutions#exer13-solution).

A statistics instructor believes that fewer than 20% of Evergreen Valley College (EVC) students attended the opening night midnight showing of the latest Harry Potter movie. She surveys 84 of her students and finds that 11 attended the midnight showing. An appropriate alternative hypothesis is:

1. *p* = 0.20
2. *p* > 0.20
3. *p* < 0.20
4. *p* ≤ 0.20

**65**.

Previously, an organization reported that teenagers spent 4.5 hours per week, on average, on the phone. The organization thinks that, currently, the mean is higher. Fifteen randomly chosen teenagers were asked how many hours per week they spend on the phone. The sample mean was 4.75 hours with a sample standard deviation of 2.0. Conduct a hypothesis test. The null and alternative hypotheses are:

1. *Ho*: x¯�¯ = 4.5, *Ha* : x¯�¯ > 4.5
2. *Ho*: *μ* ≥ 4.5, *Ha*: *μ* < 4.5
3. *Ho*: *μ* = 4.75, *Ha*: *μ* > 4.75
4. *Ho*: *μ* = 4.5, *Ha*: *μ* > 4.5

**[9.2 Outcomes and the Type I and Type II Errors](https://openstax.org/books/introductory-statistics/pages/9-2-outcomes-and-the-type-i-and-type-ii-errors)**

[**66**](https://openstax.org/books/introductory-statistics/pages/9-solutions#element-612-solution).

State the Type I and Type II errors in complete sentences given the following statements.

1. The mean number of years Americans work before retiring is 34.
2. At most 60% of Americans vote in presidential elections.
3. The mean starting salary for San Jose State University graduates is at least $100,000 per year.
4. Twenty-nine percent of high school seniors get drunk each month.
5. Fewer than 5% of adults ride the bus to work in Los Angeles.
6. The mean number of cars a person owns in his or her lifetime is not more than ten.
7. About half of Americans prefer to live away from cities, given the choice.
8. Europeans have a mean paid vacation each year of six weeks.
9. The chance of developing breast cancer is under 11% for women.
10. Private universities mean tuition cost is more than $20,000 per year.

**67**.

For statements a-j in [**Exercise 9.109**](https://openstax.org/books/introductory-statistics/pages/9-homework#element-612), answer the following in complete sentences.

1. State a consequence of committing a Type I error.
2. State a consequence of committing a Type II error.

[**68**](https://openstax.org/books/introductory-statistics/pages/9-solutions#exer10-solution).

When a new drug is created, the pharmaceutical company must subject it to testing before receiving the necessary permission from the Food and Drug Administration (FDA) to market the drug. Suppose the null hypothesis is “the drug is unsafe.” What is the Type II Error?

1. To conclude the drug is safe when in, fact, it is unsafe.
2. Not to conclude the drug is safe when, in fact, it is safe.
3. To conclude the drug is safe when, in fact, it is safe.
4. Not to conclude the drug is unsafe when, in fact, it is unsafe.

**69**.

A statistics instructor believes that fewer than 20% of Evergreen Valley College (EVC) students attended the opening midnight showing of the latest Harry Potter movie. She surveys 84 of her students and finds that 11 of them attended the midnight showing. The Type I error is to conclude that the percent of EVC students who attended is \_\_\_\_\_\_\_\_.

1. at least 20%, when in fact, it is less than 20%.
2. 20%, when in fact, it is 20%.
3. less than 20%, when in fact, it is at least 20%.
4. less than 20%, when in fact, it is less than 20%.

[**70**](https://openstax.org/books/introductory-statistics/pages/9-solutions#exer17-solution).

It is believed that Lake Tahoe Community College (LTCC) Intermediate Algebra students get less than seven hours of sleep per night, on average. A survey of 22 LTCC Intermediate Algebra students generated a mean of 7.24 hours with a standard deviation of 1.93 hours. At a level of significance of 5%, do LTCC Intermediate Algebra students get less than seven hours of sleep per night, on average?

The Type II error is not to reject that the mean number of hours of sleep LTCC students get per night is at least seven when, in fact, the mean number of hours

1. is more than seven hours.
2. is at most seven hours.
3. is at least seven hours.
4. is less than seven hours.

**71**.

Previously, an organization reported that teenagers spent 4.5 hours per week, on average, on the phone. The organization thinks that, currently, the mean is higher. Fifteen randomly chosen teenagers were asked how many hours per week they spend on the phone. The sample mean was 4.75 hours with a sample standard deviation of 2.0. Conduct a hypothesis test, the Type I error is:

1. to conclude that the current mean hours per week is higher than 4.5, when in fact, it is higher
2. to conclude that the current mean hours per week is higher than 4.5, when in fact, it is the same
3. to conclude that the mean hours per week currently is 4.5, when in fact, it is higher
4. to conclude that the mean hours per week currently is no higher than 4.5, when in fact, it is not higher

**9.3 Distribution Needed for Hypothesis Testing**

The National Institute of Mental Health published an article stating that in any one-year period, approximately 9.5 percent of American adults suffer from depression or a depressive illness. Suppose that in a survey of 100 people in a certain town, seven of them suffered from depression or a depressive illness. Conduct a hypothesis test to determine if the true proportion of people in that town suffering from depression or a depressive illness is lower than the percent in the general adult American population.

1. Is this a test of one mean or proportion?
2. State the null and alternative hypotheses.  
   *H0*: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ *Ha*: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
3. Is this a right-tailed, left-tailed, or two-tailed test?
4. What symbol represents the random variable for this test?
5. In words, define the random variable for this test.
6. Calculate the following:
   1. *x* = \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
   2. *n* = \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
   3. p′�′ = \_\_\_\_\_\_\_\_\_\_\_\_\_
7. Calculate *σx* = \_\_\_\_\_\_\_\_\_\_. Show the formula set-up.
8. State the distribution to use for the hypothesis test.
9. Find the *p*-value.
10. At a pre-conceived *α* = 0.05, what is your:
    1. Decision:
    2. Reason for the decision:
    3. Conclusion (write out in a complete sentence):

**[9.5 Additional Information and Full Hypothesis Test Examples](https://openstax.org/books/introductory-statistics/pages/9-5-additional-information-and-full-hypothesis-test-examples)**

*For each of the word problems, use a solution sheet to do the hypothesis test. The solution sheet is found in*[*Appendix E Solution Sheets*](https://openstax.org/books/introductory-statistics/pages/e-solution-sheets)*. Please feel free to make copies of the solution sheets. For the online version of the book, it is suggested that you copy the .doc or the .pdf files.*

**NOTE**

If you are using a Student's-*t* distribution for one of the following homework problems, you may assume that the underlying population is normally distributed. (In general, you must first prove that assumption, however.)

[**74**](https://openstax.org/books/introductory-statistics/pages/9-solutions#element-816-solution).

A particular brand of tires claims that its deluxe tire averages at least 50,000 miles before it needs to be replaced. From past studies of this tire, the standard deviation is known to be 8,000. A survey of owners of that tire design is conducted. From the 28 tires surveyed, the mean lifespan was 46,500 miles with a standard deviation of 9,800 miles. Using alpha = 0.05, is the data highly inconsistent with the claim?

**75**.

From generation to generation, the mean age when smokers first start to smoke varies. However, the standard deviation of that age remains constant of around 2.1 years. A survey of 40 smokers of this generation was done to see if the mean starting age is at least 19. The sample mean was 18.1 with a sample standard deviation of 1.3. Do the data support the claim at the 5% level?

[**76**](https://openstax.org/books/introductory-statistics/pages/9-solutions#element-635-solution).

The cost of a daily newspaper varies from city to city. However, the variation among prices remains steady with a standard deviation of 20¢. A study was done to test the claim that the mean cost of a daily newspaper is $1.00. Twelve costs yield a mean cost of 95¢ with a standard deviation of 18¢. Do the data support the claim at the 1% level?

**77**.

An article in the *San Jose Mercury News* stated that students in the California state university system take 4.5 years, on average, to finish their undergraduate degrees. Suppose you believe that the mean time is longer. You conduct a survey of 49 students and obtain a sample mean of 5.1 with a sample standard deviation of 1.2. Do the data support your claim at the 1% level?

[**78**](https://openstax.org/books/introductory-statistics/pages/9-solutions#element-932a-solution).

The mean number of sick days an employee takes per year is believed to be about ten. Members of a personnel department do not believe this figure. They randomly survey eight employees. The number of sick days they took for the past year are as follows: 12; 4; 15; 3; 11; 8; 6; 8. Let *x* = the number of sick days they took for the past year. Should the personnel team believe that the mean number is ten?

**79**.

In 1955, *Life Magazine* reported that the 25 year-old mother of three worked, on average, an 80 hour week. Recently, many groups have been studying whether or not the women's movement has, in fact, resulted in an increase in the average work week for women (combining employment and at-home work). Suppose a study was done to determine if the mean work week has increased. 81 women were surveyed with the following results. The sample mean was 83; the sample standard deviation was ten. Does it appear that the mean work week has increased for women at the 5% level?

[**80**](https://openstax.org/books/introductory-statistics/pages/9-solutions#element-321-solution).

Your statistics instructor claims that 60 percent of the students who take her Elementary Statistics class go through life feeling more enriched. For some reason that she can't quite figure out, most people don't believe her. You decide to check this out on your own. You randomly survey 64 of her past Elementary Statistics students and find that 34 feel more enriched as a result of her class. Now, what do you think?

**81**.

A Nissan Motor Corporation advertisement read, “The average man’s I.Q. is 107. The average brown trout’s I.Q. is 4. So why can’t man catch brown trout?” Suppose you believe that the brown trout’s mean I.Q. is greater than four. You catch 12 brown trout. A fish psychologist determines the I.Q.s as follows: 5; 4; 7; 3; 6; 4; 5; 3; 6; 3; 8; 5. Conduct a hypothesis test of your belief.

[**82**](https://openstax.org/books/introductory-statistics/pages/9-solutions#element-814-solution).

Refer to [**Exercise 9.119**](https://openstax.org/books/introductory-statistics/pages/9-homework#element-410). Conduct a hypothesis test to see if your decision and conclusion would change if your belief were that the brown trout’s mean I.Q. is **not** four.

**83**.

According to an article in *Newsweek*, the natural ratio of girls to boys is 100:105. In China, the birth ratio is 100: 114 (46.7% girls). Suppose you don’t believe the reported figures of the percent of girls born in China. You conduct a study. In this study, you count the number of girls and boys born in 150 randomly chosen recent births. There are 60 girls and 90 boys born of the 150. Based on your study, do you believe that the percent of girls born in China is 46.7?

[**84**](https://openstax.org/books/introductory-statistics/pages/9-solutions#element-658-solution).

A poll done for *Newsweek* found that 13% of Americans have seen or sensed the presence of an angel. A contingent doubts that the percent is really that high. It conducts its own survey. Out of 76 Americans surveyed, only two had seen or sensed the presence of an angel. As a result of the contingent’s survey, would you agree with the *Newsweek* poll? In complete sentences, also give three reasons why the two polls might give different results.

**85**.

The mean work week for engineers in a start-up company is believed to be about 60 hours. A newly hired engineer hopes that it’s shorter. She asks ten engineering friends in start-ups for the lengths of their mean work weeks. Based on the results that follow, should she count on the mean work week to be shorter than 60 hours?

Data (length of mean work week): 70; 45; 55; 60; 65; 55; 55; 60; 50; 55.

[**86**](https://openstax.org/books/introductory-statistics/pages/9-solutions#element-761-solution).

Use the “Lap time” data for Lap 4 (see [**Appendix C Data Sets**](https://openstax.org/books/introductory-statistics/pages/c-data-sets)) to test the claim that Terri finishes Lap 4, on average, in less than 129 seconds. Use all twenty races given.

**87**.

Use the “Initial Public Offering” data (see [**Appendix C Data Sets**](https://openstax.org/books/introductory-statistics/pages/c-data-sets)) to test the claim that the mean offer price was $18 per share. Do not use all the data. Use your random number generator to randomly survey 15 prices.

**NOTE**

The following questions were written by past students. They are excellent problems!

[**88**](https://openstax.org/books/introductory-statistics/pages/9-solutions#ex1-solution).

"Asian Family Reunion," by Chau Nguyen

Every two years it comes around.

We all get together from different towns.

In my honest opinion,

It's not a typical family reunion.

Not forty, or fifty, or sixty,

But how about seventy companions!

The kids would play, scream, and shout

One minute they're happy, another they'll pout.

The teenagers would look, stare, and compare

From how they look to what they wear.

The men would chat about their business

That they make more, but never less.

Money is always their subject

And there's always talk of more new projects.

The women get tired from all of the chats

They head to the kitchen to set out the mats.

Some would sit and some would stand

Eating and talking with plates in their hands.

Then come the games and the songs

And suddenly, everyone gets along!

With all that laughter, it's sad to say

That it always ends in the same old way.

They hug and kiss and say "good-bye"

And then they all begin to cry!

I say that 60 percent shed their tears

But my mom counted 35 people this year.

She said that boys and men will always have their pride,

So we won't ever see them cry.

I myself don't think she's correct,

So could you please try this problem to see if you object?

**89**.

"The Problem with Angels," by Cyndy Dowling

Although this problem is wholly mine,

The catalyst came from the magazine, Time.

On the magazine cover I did find

The realm of angels tickling my mind.

Inside, 69% I found to be

In angels, Americans do believe.

Then, it was time to rise to the task,

Ninety-five high school and college students I did ask.

Viewing all as one group,

Random sampling to get the scoop.

So, I asked each to be true,

"Do you believe in angels?" Tell me, do!

Hypothesizing at the start,

Totally believing in my heart

That the proportion who said yes

Would be equal on this test.

Lo and behold, seventy-three did arrive,

Out of the sample of ninety-five.

Now your job has just begun,

Solve this problem and have some fun.

[**90**](https://openstax.org/books/introductory-statistics/pages/9-solutions#exer4-solution).

"Blowing Bubbles," by Sondra Prull

Studying stats just made me tense,

I had to find some sane defense.

Some light and lifting simple play

To float my math anxiety away.

Blowing bubbles lifts me high

Takes my troubles to the sky.

POIK! They're gone, with all my stress

Bubble therapy is the best.

The label said each time I blew

The average number of bubbles would be at least 22.

I blew and blew and this I found

From 64 blows, they all are round!

But the number of bubbles in 64 blows

Varied widely, this I know.

20 per blow became the mean

They deviated by 6, and not 16.

From counting bubbles, I sure did relax

But now I give to you your task.

Was 22 a reasonable guess?

Find the answer and pass this test!

**91**.

"Dalmatian Darnation," by Kathy Sparling

A greedy dog breeder named Spreckles

Bred puppies with numerous freckles

The Dalmatians he sought

Possessed spot upon spot

The more spots, he thought, the more shekels.

His competitors did not agree

That freckles would increase the fee.

They said, “Spots are quite nice

But they don't affect price;

One should breed for improved pedigree.”

The breeders decided to prove

This strategy was a wrong move.

Breeding only for spots

Would wreak havoc, they thought.

His theory they want to disprove.

They proposed a contest to Spreckles

Comparing dog prices to freckles.

In records they looked up

One hundred one pups:

Dalmatians that fetched the most shekels.

They asked Mr. Spreckles to name

An average spot count he'd claim

To bring in big bucks.

Said Spreckles, “Well, shucks,

It's for one hundred one that I aim.”

Said an amateur statistician

Who wanted to help with this mission.

“Twenty-one for the sample

Standard deviation's ample:

They examined one hundred and one

Dalmatians that fetched a good sum.

They counted each spot,

Mark, freckle and dot

And tallied up every one.

Instead of one hundred one spots

They averaged ninety six dots

Can they muzzle Spreckles’

Obsession with freckles

Based on all the dog data they've got?

[**92**](https://openstax.org/books/introductory-statistics/pages/9-solutions#exer5-solution).

"Macaroni and Cheese, please!!" by Nedda Misherghi and Rachelle Hall

As a poor starving student I don't have much money to spend for even the bare necessities. So my favorite and main staple food is macaroni and cheese. It's high in taste and low in cost and nutritional value.

One day, as I sat down to determine the meaning of life, I got a serious craving for this, oh, so important, food of my life. So I went down the street to Greatway to get a box of macaroni and cheese, but it was SO expensive! $2.02 !!! Can you believe it? It made me stop and think. The world is changing fast. I had thought that the mean cost of a box (the normal size, not some super-gigantic-family-value-pack) was at most $1, but now I wasn't so sure. However, I was determined to find out. I went to 53 of the closest grocery stores and surveyed the prices of macaroni and cheese. Here are the data I wrote in my notebook:

**Price per box of Mac and Cheese:**

* 5 stores @ $2.02
* 15 stores @ $0.25
* 3 stores @ $1.29
* 6 stores @ $0.35
* 4 stores @ $2.27
* 7 stores @ $1.50
* 5 stores @ $1.89
* 8 stores @ 0.75.

I could see that the cost varied but I had to sit down to figure out whether or not I was right. If it does turn out that this mouth-watering dish is at most $1, then I'll throw a big cheesy party in our next statistics lab, with enough macaroni and cheese for just me. (After all, as a poor starving student I can't be expected to feed our class of animals!)

**93**.

"William Shakespeare: The Tragedy of Hamlet, Prince of Denmark," by Jacqueline Ghodsi

**THE CHARACTERS (in order of appearance):**

* HAMLET, Prince of Denmark and student of Statistics
* POLONIUS, Hamlet’s tutor
* HOROTIO, friend to Hamlet and fellow student

Scene: The great library of the castle, in which Hamlet does his lessons

Act I

(The day is fair, but the face of Hamlet is clouded. He paces the large room. His tutor, Polonius, is reprimanding Hamlet regarding the latter’s recent experience. Horatio is seated at the large table at right stage.)

POLONIUS: My Lord, how cans’t thou admit that thou hast seen a ghost! It is but a figment of your imagination!

HAMLET: I beg to differ; I know of a certainty that five-and-seventy in one hundred of us, condemned to the whips and scorns of time as we are, have gazed upon a spirit of health, or goblin damn’d, be their intents wicked or charitable.

POLONIUS If thou doest insist upon thy wretched vision then let me invest your time; be true to thy work and speak to me through the reason of the null and alternate hypotheses. (He turns to Horatio.) Did not Hamlet himself say, “What piece of work is man, how noble in reason, how infinite in faculties? Then let not this foolishness persist. Go, Horatio, make a survey of three-and-sixty and discover what the true proportion be. For my part, I will never succumb to this fantasy, but deem man to be devoid of all reason should thy proposal of at least five-and-seventy in one hundred hold true.

HORATIO (to Hamlet): What should we do, my Lord?

HAMLET: Go to thy purpose, Horatio.

HORATIO: To what end, my Lord?

HAMLET: That you must teach me. But let me conjure you by the rights of our fellowship, by the consonance of our youth, but the obligation of our ever-preserved love, be even and direct with me, whether I am right or no.

(Horatio exits, followed by Polonius, leaving Hamlet to ponder alone.)

Act II

(The next day, Hamlet awaits anxiously the presence of his friend, Horatio. Polonius enters and places some books upon the table just a moment before Horatio enters.)

POLONIUS: So, Horatio, what is it thou didst reveal through thy deliberations?

HORATIO: In a random survey, for which purpose thou thyself sent me forth, I did discover that one-and-forty believe fervently that the spirits of the dead walk with us. Before my God, I might not this believe, without the sensible and true avouch of mine own eyes.

POLONIUS: Give thine own thoughts no tongue, Horatio. (Polonius turns to Hamlet.) But look to’t I charge you, my Lord. Come Horatio, let us go together, for this is not our test. (Horatio and Polonius leave together.)

HAMLET: To reject, or not reject, that is the question: whether ‘tis nobler in the mind to suffer the slings and arrows of outrageous statistics, or to take arms against a sea of data, and, by opposing, end them. (Hamlet resignedly attends to his task.)

(Curtain falls)

[**94**](https://openstax.org/books/introductory-statistics/pages/9-solutions#exer7-solution).

"Untitled," by Stephen Chen

I've often wondered how software is released and sold to the public. Ironically, I work for a company that sells products with known problems. Unfortunately, most of the problems are difficult to create, which makes them difficult to fix. I usually use the test program X, which tests the product, to try to create a specific problem. When the test program is run to make an error occur, the likelihood of generating an error is 1%.

So, armed with this knowledge, I wrote a new test program Y that will generate the same error that test program X creates, but more often. To find out if my test program is better than the original, so that I can convince the management that I'm right, I ran my test program to find out how often I can generate the same error. When I ran my test program 50 times, I generated the error twice. While this may not seem much better, I think that I can convince the management to use my test program instead of the original test program. Am I right?

**95**.

"Japanese Girls’ Names"

by Kumi Furuichi

It used to be very typical for Japanese girls’ names to end with “ko.” (The trend might have started around my grandmothers’ generation and its peak might have been around my mother’s generation.) “Ko” means “child” in Chinese characters. Parents would name their daughters with “ko” attaching to other Chinese characters which have meanings that they want their daughters to become, such as Sachiko—happy child, Yoshiko—a good child, Yasuko—a healthy child, and so on.

However, I noticed recently that only two out of nine of my Japanese girlfriends at this school have names which end with “ko.” More and more, parents seem to have become creative, modernized, and, sometimes, westernized in naming their children.

I have a feeling that, while 70 percent or more of my mother’s generation would have names with “ko” at the end, the proportion has dropped among my peers. I wrote down all my Japanese friends’, ex-classmates’, co-workers, and acquaintances’ names that I could remember. Following are the names. (Some are repeats.) Test to see if the proportion has dropped for this generation.

Ai, Akemi, Akiko, Ayumi, Chiaki, Chie, Eiko, Eri, Eriko, Fumiko, Harumi, Hitomi, Hiroko, Hiroko, Hidemi, Hisako, Hinako, Izumi, Izumi, Junko, Junko, Kana, Kanako, Kanayo, Kayo, Kayoko, Kazumi, Keiko, Keiko, Kei, Kumi, Kumiko, Kyoko, Kyoko, Madoka, Maho, Mai, Maiko, Maki, Miki, Miki, Mikiko, Mina, Minako, Miyako, Momoko, Nana, Naoko, Naoko, Naoko, Noriko, Rieko, Rika, Rika, Rumiko, Rei, Reiko, Reiko, Sachiko, Sachiko, Sachiyo, Saki, Sayaka, Sayoko, Sayuri, Seiko, Shiho, Shizuka, Sumiko, Takako, Takako, Tomoe, Tomoe, Tomoko, Touko, Yasuko, Yasuko, Yasuyo, Yoko, Yoko, Yoko, Yoshiko, Yoshiko, Yoshiko, Yuka, Yuki, Yuki, Yukiko, Yuko, Yuko.

[**96**](https://openstax.org/books/introductory-statistics/pages/9-solutions#exerrr-solution).

"Phillip’s Wish," by Suzanne Osorio

My nephew likes to play

Chasing the girls makes his day.

He asked his mother

If it is okay

To get his ear pierced.

She said, “No way!”

To poke a hole through your ear,

Is not what I want for you, dear.

He argued his point quite well,

Says even my macho pal, Mel,

Has gotten this done.

It’s all just for fun.

C’mon please, mom, please, what the hell.

Again Phillip complained to his mother,

Saying half his friends (including their brothers)

Are piercing their ears

And they have no fears

He wants to be like the others.

She said, “I think it’s much less.

We must do a hypothesis test.

And if you are right,

I won’t put up a fight.

But, if not, then my case will rest.”

We proceeded to call fifty guys

To see whose prediction would fly.

Nineteen of the fifty

Said piercing was nifty

And earrings they’d occasionally buy.

Then there’s the other thirty-one,

Who said they’d never have this done.

So now this poem’s finished.

Will his hopes be diminished,

Or will my nephew have his fun?

**97**.

"The Craven," by Mark Salangsang

Once upon a morning dreary

In stats class I was weak and weary.

Pondering over last night’s homework

Whose answers were now on the board

This I did and nothing more.

While I nodded nearly napping

Suddenly, there came a tapping.

As someone gently rapping,

Rapping my head as I snore.

Quoth the teacher, “Sleep no more.”

“In every class you fall asleep,”

The teacher said, his voice was deep.

“So a tally I’ve begun to keep

Of every class you nap and snore.

The percentage being forty-four.”

“My dear teacher I must confess,

While sleeping is what I do best.

The percentage, I think, must be less,

A percentage less than forty-four.”

This I said and nothing more.

“We’ll see,” he said and walked away,

And fifty classes from that day

He counted till the month of May

The classes in which I napped and snored.

The number he found was twenty-four.

At a significance level of 0.05,

Please tell me am I still alive?

Or did my grade just take a dive

Plunging down beneath the floor?

Upon thee I hereby implore.

[**98**](https://openstax.org/books/introductory-statistics/pages/9-solutions#element-378-solution).

Toastmasters International cites a report by Gallop Poll that 40% of Americans fear public speaking. A student believes that less than 40% of students at her school fear public speaking. She randomly surveys 361 schoolmates and finds that 135 report they fear public speaking. Conduct a hypothesis test to determine if the percent at her school is less than 40%.

**99**.

Sixty-eight percent of online courses taught at community colleges nationwide were taught by full-time faculty. To test if 68% also represents California’s percent for full-time faculty teaching the online classes, Long Beach City College (LBCC) in California, was randomly selected for comparison. In the same year, 34 of the 44 online courses LBCC offered were taught by full-time faculty. Conduct a hypothesis test to determine if 68% represents California. NOTE: For more accurate results, use more California community colleges and this past year's data.

[**100**](https://openstax.org/books/introductory-statistics/pages/9-solutions#element-874-solution).

According to an article in *Bloomberg Businessweek*, New York City's most recent adult smoking rate is 14%. Suppose that a survey is conducted to determine this year’s rate. Nine out of 70 randomly chosen N.Y. City residents reply that they smoke. Conduct a hypothesis test to determine if the rate is still 14% or if it has decreased.

**101**.

The mean age of De Anza College students in a previous term was 26.6 years old. An instructor thinks the mean age for online students is older than 26.6. She randomly surveys 56 online students and finds that the sample mean is 29.4 with a standard deviation of 2.1. Conduct a hypothesis test.

[**102**](https://openstax.org/books/introductory-statistics/pages/9-solutions#element-408-solution).

Registered nurses earned an average annual salary of $69,110. For that same year, a survey was conducted of 41 California registered nurses to determine if the annual salary is higher than $69,110 for California nurses. The sample average was $71,121 with a sample standard deviation of $7,489. Conduct a hypothesis test.

**103**.

La Leche League International reports that the mean age of weaning a child from breastfeeding is age four to five worldwide. In America, most nursing mothers wean their children much earlier. Suppose a random survey is conducted of 21 U.S. mothers who recently weaned their children. The mean weaning age was nine months (3/4 year) with a standard deviation of 4 months. Conduct a hypothesis test to determine if the mean weaning age in the U.S. is less than four years old.

[**104**](https://openstax.org/books/introductory-statistics/pages/9-solutions#exer12-solution).

Over the past few decades, public health officials have examined the link between weight concerns and teen girls' smoking. Researchers surveyed a group of 273 randomly selected teen girls living in Massachusetts (between 12 and 15 years old). After four years the girls were surveyed again. Sixty-three said they smoked to stay thin. Is there good evidence that more than thirty percent of the teen girls smoke to stay thin?  
After conducting the test, your decision and conclusion are

1. Reject *H0*: There is sufficient evidence to conclude that more than 30% of teen girls smoke to stay thin.
2. Do not reject *H0*: There is not sufficient evidence to conclude that less than 30% of teen girls smoke to stay thin.
3. Do not reject *H0*: There is not sufficient evidence to conclude that more than 30% of teen girls smoke to stay thin.
4. Reject *H0*: There is sufficient evidence to conclude that less than 30% of teen girls smoke to stay thin.

**105**.

A statistics instructor believes that fewer than 20% of Evergreen Valley College (EVC) students attended the opening night midnight showing of the latest Harry Potter movie. She surveys 84 of her students and finds that 11 of them attended the midnight showing.  
At a 1% level of significance, an appropriate conclusion is:

1. There is insufficient evidence to conclude that the percent of EVC students who attended the midnight showing of Harry Potter is less than 20%.
2. There is sufficient evidence to conclude that the percent of EVC students who attended the midnight showing of Harry Potter is more than 20%.
3. There is sufficient evidence to conclude that the percent of EVC students who attended the midnight showing of Harry Potter is less than 20%.
4. There is insufficient evidence to conclude that the percent of EVC students who attended the midnight showing of Harry Potter is at least 20%.

[**106**](https://openstax.org/books/introductory-statistics/pages/9-solutions#exer19-solution).

Previously, an organization reported that teenagers spent 4.5 hours per week, on average, on the phone. The organization thinks that, currently, the mean is higher. Fifteen randomly chosen teenagers were asked how many hours per week they spend on the phone. The sample mean was 4.75 hours with a sample standard deviation of 2.0. Conduct a hypothesis test.  
  
At a significance level of *a* = 0.05, what is the correct conclusion?

1. There is enough evidence to conclude that the mean number of hours is more than 4.75
2. There is enough evidence to conclude that the mean number of hours is more than 4.5
3. There is not enough evidence to conclude that the mean number of hours is more than 4.5
4. There is not enough evidence to conclude that the mean number of hours is more than 4.75

Instructions: For the following ten exercises,  
Hypothesis testing: For the following ten exercises, answer each question.

1. State the null and alternate hypothesis.
2. State the *p*-value.
3. State alpha.
4. What is your decision?
5. Write a conclusion.
6. Answer any other questions asked in the problem.

**107**.

According to the Center for Disease Control website, in 2011 at least 18% of high school students have smoked a cigarette. An Introduction to Statistics class in Davies County, KY conducted a hypothesis test at the local high school (a medium sized–approximately 1,200 students–small city demographic) to determine if the local high school’s percentage was lower. One hundred fifty students were chosen at random and surveyed. Of the 150 students surveyed, 82 have smoked. Use a significance level of 0.05 and using appropriate statistical evidence, conduct a hypothesis test and state the conclusions.

[**108**](https://openstax.org/books/introductory-statistics/pages/9-solutions#eip-40-solution).

A recent survey in the *N.Y. Times Almanac* indicated that 48.8% of families own stock. A broker wanted to determine if this survey could be valid. He surveyed a random sample of 250 families and found that 142 owned some type of stock. At the 0.05 significance level, can the survey be considered to be accurate?

**109**.

Driver error can be listed as the cause of approximately 54% of all fatal auto accidents, according to the American Automobile Association. Thirty randomly selected fatal accidents are examined, and it is determined that 14 were caused by driver error. Using α = 0.05, is the AAA proportion accurate?

[**110**](https://openstax.org/books/introductory-statistics/pages/9-solutions#eip-601-solution).

The US Department of Energy reported that 51.7% of homes were heated by natural gas. A random sample of 221 homes in Kentucky found that 115 were heated by natural gas. Does the evidence support the claim for Kentucky at the α = 0.05 level in Kentucky? Are the results applicable across the country? Why?

**111**.

For Americans using library services, the American Library Association claims that at most 67% of patrons borrow books. The library director in Owensboro, Kentucky feels this is not true, so she asked a local college statistic class to conduct a survey. The class randomly selected 100 patrons and found that 82 borrowed books. Did the class demonstrate that the percentage was higher in Owensboro, KY? Use α = 0.01 level of significance. What is the possible proportion of patrons that do borrow books from the Owensboro Library?

[**112**](https://openstax.org/books/introductory-statistics/pages/9-solutions#eip-715-solution).

The Weather Underground reported that the mean amount of summer rainfall for the northeastern US is at least 11.52 inches. Ten cities in the northeast are randomly selected and the mean rainfall amount is calculated to be 7.42 inches with a standard deviation of 1.3 inches. At the α = 0.05 level, can it be concluded that the mean rainfall was below the reported average? What if α = 0.01? Assume the amount of summer rainfall follows a normal distribution.

**113**.

A survey in the *N.Y. Times Almanac* finds the mean commute time (one way) is 25.4 minutes for the 15 largest US cities. The Austin, TX chamber of commerce feels that Austin’s commute time is less and wants to publicize this fact. The mean for 25 randomly selected commuters is 22.1 minutes with a standard deviation of 5.3 minutes. At the α = 0.10 level, is the Austin, TX commute significantly less than the mean commute time for the 15 largest US cities?

[**114**](https://openstax.org/books/introductory-statistics/pages/9-solutions#eip-192-solution).

A report by the Gallup Poll found that a woman visits her doctor, on average, at most 5.8 times each year. A random sample of 20 women results in these yearly visit totals

3; 2; 1; 3; 7; 2; 9; 4; 6; 6; 8; 0; 5; 6; 4; 2; 1; 3; 4; 1  
At the *α* = 0.05 level can it be concluded that the sample mean is higher than 5.8 visits per year?

**115**.

According to the *N.Y. Times Almanac* the mean family size in the U.S. is 3.18. A sample of a college math class resulted in the following family sizes:  
5; 4; 5; 4; 4; 3; 6; 4; 3; 3; 5; 5; 6; 3; 3; 2; 7; 4; 5; 2; 2; 2; 3; 2  
At *α* = 0.05 level, is the class’ mean family size greater than the national average? Does the Almanac result remain valid? Why?

[**116**](https://openstax.org/books/introductory-statistics/pages/9-solutions#eip-551-solution).

The student academic group on a college campus claims that freshman students study at least 2.5 hours per day, on average. One Introduction to Statistics class was skeptical. The class took a random sample of 30 freshman students and found a mean study time of 137 minutes with a standard deviation of 45 minutes. At *α* = 0.01 level, is the student academic group’s claim correct?

[**1**](https://openstax.org/books/introductory-statistics/pages/9-practice#eip-350).

The random variable is the mean Internet speed in Megabits per second.

[**3**](https://openstax.org/books/introductory-statistics/pages/9-practice#eip-629).

The random variable is the mean number of children an American family has.

[**5**](https://openstax.org/books/introductory-statistics/pages/9-practice#eip-334).

The random variable is the proportion of people picked at random in Times Square visiting the city.

[**7**](https://openstax.org/books/introductory-statistics/pages/9-practice#eip-75).

1. *H0*: *p* = 0.42
2. *Ha*: *p* < 0.42

[**9**](https://openstax.org/books/introductory-statistics/pages/9-practice#element-422).

1. *H0*: *μ* = 15
2. *Ha*: *μ* ≠ 15

[**11**](https://openstax.org/books/introductory-statistics/pages/9-practice#eip-308).

Type I: The mean price of mid-sized cars is $32,000, but we conclude that it is not $32,000.

Type II: The mean price of mid-sized cars is not $32,000, but we conclude that it is $32,000.

[**13**](https://openstax.org/books/introductory-statistics/pages/9-practice#eip-655).

*α* = the probability that you think the bag cannot withstand -15 degrees F, when in fact it can

*β* = the probability that you think the bag can withstand -15 degrees F, when in fact it cannot

[**15**](https://openstax.org/books/introductory-statistics/pages/9-practice#eip-861).

Type I: The procedure will go well, but the doctors think it will not.

Type II: The procedure will not go well, but the doctors think it will.

[**17**](https://openstax.org/books/introductory-statistics/pages/9-practice#eip-404).

0.019

[**19**](https://openstax.org/books/introductory-statistics/pages/9-practice#eip-967).

0.998

[**21**](https://openstax.org/books/introductory-statistics/pages/9-practice#eip-176).

A normal distribution or a Student’s *t*-distribution

[**23**](https://openstax.org/books/introductory-statistics/pages/9-practice#eip-579).

Use a Student’s *t*-distribution

[**25**](https://openstax.org/books/introductory-statistics/pages/9-practice#eip-917).

a normal distribution for a single population mean

[**27**](https://openstax.org/books/introductory-statistics/pages/9-practice#eip-637).

It must be approximately normally distributed.

[**29**](https://openstax.org/books/introductory-statistics/pages/9-practice#eip-254).

They must both be greater than five.

[**31**](https://openstax.org/books/introductory-statistics/pages/9-practice#fs-idp17688688).

binomial distribution

[**33**](https://openstax.org/books/introductory-statistics/pages/9-practice#fs-idp139727506576944).

The outcome of winning is very unlikely.

[**35**](https://openstax.org/books/introductory-statistics/pages/9-practice#fs-idp139727500456320).

*H0*: *μ* > = 73  
*Ha*: *μ* < 73  
The *p*-value is almost zero, which means there is sufficient data to conclude that the mean height of high school students who play basketball on the school team is less than 73 inches at the 5% level. The data do support the claim.

[**37**](https://openstax.org/books/introductory-statistics/pages/9-practice#fs-idp139727497492608).

The shaded region shows a low *p*-value.

[**39**](https://openstax.org/books/introductory-statistics/pages/9-practice#fs-idp139727500288288).

Do not reject *H0*.

[**41**](https://openstax.org/books/introductory-statistics/pages/9-practice#eip-714).

means

[**43**](https://openstax.org/books/introductory-statistics/pages/9-practice#element-126).

the mean time spent in jail for 26 first time convicted burglars

[**45**](https://openstax.org/books/introductory-statistics/pages/9-practice#element-877).

1. 3
2. 1.5
3. 1.8
4. 26

[**47**](https://openstax.org/books/introductory-statistics/pages/9-practice#element-121).

X¯¯¯~N(2.5,1.526√)�¯~�(2.5,1.526)

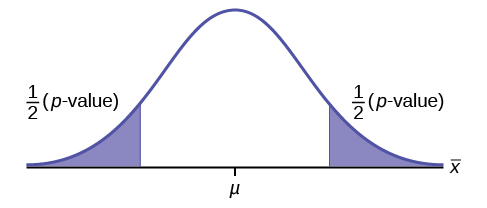
[**49**](https://openstax.org/books/introductory-statistics/pages/9-practice#eip-750).

This is a left-tailed test.

[**51**](https://openstax.org/books/introductory-statistics/pages/9-practice#fs-idp45725152).

This is a two-tailed test.

[**53**](https://openstax.org/books/introductory-statistics/pages/9-practice#eip-18).



**Figure 9.25**

[**55**](https://openstax.org/books/introductory-statistics/pages/9-practice#eip-34).

a right-tailed test

[**57**](https://openstax.org/books/introductory-statistics/pages/9-practice#eip-71).

a left-tailed test

[**59**](https://openstax.org/books/introductory-statistics/pages/9-practice#eip-504).

This is a left-tailed test.

[**61**](https://openstax.org/books/introductory-statistics/pages/9-practice#eip-115).

This is a two-tailed test.

[**62**](https://openstax.org/books/introductory-statistics/pages/9-homework#element-919).

1. *H0*: *μ* = 34; *Ha*: *μ* ≠ 34
2. *H0*: *p* ≤ 0.60; *Ha*: *p* > 0.60
3. *H0*: *μ* ≥ 100,000; *Ha*: *μ* < 100,000
4. *H0*: *p* = 0.29; *Ha*: *p* ≠ 0.29
5. *H0*: *p* = 0.05; *Ha*: *p* < 0.05
6. *H0*: *μ* ≤ 10; *Ha*: *μ* > 10
7. *H0*: *p* = 0.50; *Ha*: *p* ≠ 0.50
8. *H0*: *μ* = 6; *Ha*: *μ* ≠ 6
9. *H0*: *p* ≥ 0.11; *Ha*: *p* < 0.11
10. *H0*: *μ* ≤ 20,000; *Ha*: *μ* > 20,000

[**64**](https://openstax.org/books/introductory-statistics/pages/9-homework#exer13).

c

[**66**](https://openstax.org/books/introductory-statistics/pages/9-homework#element-612).

1. Type I error: We conclude that the mean is not 34 years, when it really is 34 years. Type II error: We conclude that the mean is 34 years, when in fact it really is not 34 years.
2. Type I error: We conclude that more than 60% of Americans vote in presidential elections, when the actual percentage is at most 60%.Type II error: We conclude that at most 60% of Americans vote in presidential elections when, in fact, more than 60% do.
3. Type I error: We conclude that the mean starting salary is less than $100,000, when it really is at least $100,000. Type II error: We conclude that the mean starting salary is at least $100,000 when, in fact, it is less than $100,000.
4. Type I error: We conclude that the proportion of high school seniors who get drunk each month is not 29%, when it really is 29%. Type II error: We conclude that the proportion of high school seniors who get drunk each month is 29% when, in fact, it is not 29%.
5. Type I error: We conclude that fewer than 5% of adults ride the bus to work in Los Angeles, when the percentage that do is really 5% or more. Type II error: We conclude that 5% or more adults ride the bus to work in Los Angeles when, in fact, fewer that 5% do.
6. Type I error: We conclude that the mean number of cars a person owns in his or her lifetime is more than 10, when in reality it is not more than 10. Type II error: We conclude that the mean number of cars a person owns in his or her lifetime is not more than 10 when, in fact, it is more than 10.
7. Type I error: We conclude that the proportion of Americans who prefer to live away from cities is not about half, though the actual proportion is about half. Type II error: We conclude that the proportion of Americans who prefer to live away from cities is half when, in fact, it is not half.
8. Type I error: We conclude that the duration of paid vacations each year for Europeans is not six weeks, when in fact it is six weeks. Type II error: We conclude that the duration of paid vacations each year for Europeans is six weeks when, in fact, it is not.
9. Type I error: We conclude that the proportion is less than 11%, when it is really at least 11%. Type II error: We conclude that the proportion of women who develop breast cancer is at least 11%, when in fact it is less than 11%.
10. Type I error: We conclude that the average tuition cost at private universities is more than $20,000, though in reality it is at most $20,000. Type II error: We conclude that the average tuition cost at private universities is at most $20,000 when, in fact, it is more than $20,000.

[**68**](https://openstax.org/books/introductory-statistics/pages/9-homework#exer10).

b

[**70**](https://openstax.org/books/introductory-statistics/pages/9-homework#exer17).

d

[**72**](https://openstax.org/books/introductory-statistics/pages/9-homework#fs-idm140519760).

d

[**74**](https://openstax.org/books/introductory-statistics/pages/9-homework#element-816).

1. *H0*: *μ* ≥ 50,000
2. *Ha*: *μ* < 50,000
3. Let X¯¯¯�¯ = the average lifespan of a brand of tires.
4. normal distribution
5. *z* = -2.315
6. *p*-value = 0.0103
7. Check student’s solution.
   1. alpha: 0.05
   2. Decision: Reject the null hypothesis.
   3. Reason for decision: The *p*-value is less than 0.05.
   4. Conclusion: There is sufficient evidence to conclude that the mean lifespan of the tires is less than 50,000 miles.
8. (43,537, 49,463)

[**76**](https://openstax.org/books/introductory-statistics/pages/9-homework#element-635).

1. *H0*: *μ* = $1.00
2. *Ha*: *μ* ≠ $1.00
3. Let X¯¯¯�¯ = the average cost of a daily newspaper.
4. normal distribution
5. *z* = –0.866
6. *p*-value = 0.3865
7. Check student’s solution.
   1. Alpha: 0.01
   2. Decision: Do not reject the null hypothesis.
   3. Reason for decision: The *p*-value is greater than 0.01.
   4. Conclusion: There is sufficient evidence to support the claim that the mean cost of daily papers is $1. The mean cost could be $1.
8. ($0.84, $1.06)

[**78**](https://openstax.org/books/introductory-statistics/pages/9-homework#element-932a).

1. *H0*: *μ* = 10
2. *Ha*: *μ* ≠ 10
3. Let X¯¯¯�¯ the mean number of sick days an employee takes per year.
4. Student’s *t*-distribution
5. *t* = –1.12
6. *p*-value = 0.300
7. Check student’s solution.
   1. Alpha: 0.05
   2. Decision: Do not reject the null hypothesis.
   3. Reason for decision: The *p*-value is greater than 0.05.
   4. Conclusion: At the 5% significance level, there is insufficient evidence to conclude that the mean number of sick days is not ten.
8. (4.9443, 11.806)

[**80**](https://openstax.org/books/introductory-statistics/pages/9-homework#element-321).

1. *H0*: *p* ≥ 0.6
2. *Ha*: *p* < 0.6
3. Let *P′* = the proportion of students who feel more enriched as a result of taking Elementary Statistics.
4. normal for a single proportion
5. 1.12
6. *p*-value = 0.1308
7. Check student’s solution.
   1. Alpha: 0.05
   2. Decision: Do not reject the null hypothesis.
   3. Reason for decision: The *p*-value is greater than 0.05.
   4. Conclusion: There is insufficient evidence to conclude that less than 60 percent of her students feel more enriched.
8. Confidence Interval: (0.409, 0.654)  
   The “plus-4s” confidence interval is (0.411, 0.648)

[**82**](https://openstax.org/books/introductory-statistics/pages/9-homework#element-814).

1. *H0*: *μ* = 4
2. *Ha*: *μ* ≠ 4
3. Let X¯¯¯�¯ the average I.Q. of a set of brown trout.
4. two-tailed Student's t-test
5. *t* = 1.95
6. *p*-value = 0.076
7. Check student’s solution.
   1. Alpha: 0.05
   2. Decision: Reject the null hypothesis.
   3. Reason for decision: The *p*-value is greater than 0.05
   4. Conclusion: There is insufficient evidence to conclude that the average IQ of brown trout is not four.
8. (3.8865,5.9468)

[**84**](https://openstax.org/books/introductory-statistics/pages/9-homework#element-658).

1. *H0*: *p* ≥ 0.13
2. *Ha*: *p* < 0.13
3. Let *P′* = the proportion of Americans who have seen or sensed angels
4. normal for a single proportion
5. –2.688
6. *p*-value = 0.0036
7. Check student’s solution.
   1. alpha: 0.05
   2. Decision: Reject the null hypothesis.
   3. Reason for decision: The *p*-value is less than 0.05.
   4. Conclusion: There is sufficient evidence to conclude that the percentage of Americans who have seen or sensed an angel is less than 13%.
8. (0, 0.0623).  
   The“plus-4s” confidence interval is (0.0022, 0.0978)

[**86**](https://openstax.org/books/introductory-statistics/pages/9-homework#element-761).

1. *H0*: *μ* ≥ 129
2. *Ha*: *μ* < 129
3. Let X¯¯¯�¯ = the average time in seconds that Terri finishes Lap 4.
4. Student's *t*-distribution
5. *t* = 1.209
6. 0.8792
7. Check student’s solution.
   1. Alpha: 0.05
   2. Decision: Do not reject the null hypothesis.
   3. Reason for decision: The *p*-value is greater than 0.05.
   4. Conclusion: There is insufficient evidence to conclude that Terri’s mean lap time is less than 129 seconds.
8. (128.63, 130.37)

[**88**](https://openstax.org/books/introductory-statistics/pages/9-homework#ex1).

1. *H0*: *p* = 0.60
2. *Ha*: *p* < 0.60
3. Let *P′* = the proportion of family members who shed tears at a reunion.
4. normal for a single proportion
5. –1.71
6. 0.0438
7. Check student’s solution.
   1. alpha: 0.05
   2. Decision: Reject the null hypothesis.
   3. Reason for decision: *p*-value < alpha
   4. Conclusion: At the 5% significance level, there is sufficient evidence to conclude that the proportion of family members who shed tears at a reunion is less than 0.60. However, the test is weak because the *p*-value and alpha are quite close, so other tests should be done.
8. We are 95% confident that between 38.29% and 61.71% of family members will shed tears at a family reunion. (0.3829, 0.6171). The“plus-4s” confidence interval (see chapter 8) is (0.3861, 0.6139)

Note that here the “large-sample” 1 – PropZTest provides the approximate *p*-value of 0.0438. Whenever a *p*-value based on a normal approximation is close to the level of significance, the exact *p*-value based on binomial probabilities should be calculated whenever possible. This is beyond the scope of this course.

[**90**](https://openstax.org/books/introductory-statistics/pages/9-homework#exer4).

1. *H0*: *μ* ≥ 22
2. *Ha*: *μ* < 22
3. Let X¯¯¯�¯ = the mean number of bubbles per blow.
4. Student's *t*-distribution
5. –2.667
6. *p*-value = 0.00486
7. Check student’s solution.
   1. Alpha: 0.05
   2. Decision: Reject the null hypothesis.
   3. Reason for decision: The *p*-value is less than 0.05.
   4. Conclusion: There is sufficient evidence to conclude that the mean number of bubbles per blow is less than 22.
8. (18.501, 21.499)

[**92**](https://openstax.org/books/introductory-statistics/pages/9-homework#exer5).

1. *H0*: *μ* ≤ 1
2. *Ha*: *μ* > 1
3. Let X¯¯¯�¯ = the mean cost in dollars of macaroni and cheese in a certain town.
4. Student's *t*-distribution
5. *t* = 0.340
6. *p*-value = 0.36756
7. Check student’s solution.
   1. Alpha: 0.05
   2. Decision: Do not reject the null hypothesis.
   3. Reason for decision: The *p*-value is greater than 0.05
   4. Conclusion: The mean cost could be $1, or less. At the 5% significance level, there is insufficient evidence to conclude that the mean price of a box of macaroni and cheese is more than $1.
8. (0.8291, 1.241)

[**94**](https://openstax.org/books/introductory-statistics/pages/9-homework#exer7).

1. *H0*: *p* = 0.01
2. *Ha*: *p* > 0.01
3. Let *P′* = the proportion of errors generated
4. Normal for a single proportion
5. 2.13
6. 0.0165
7. Check student’s solution.
   1. Alpha: 0.05
   2. Decision: Reject the null hypothesis
   3. Reason for decision: The *p*-value is less than 0.05.
   4. Conclusion: At the 5% significance level, there is sufficient evidence to conclude that the proportion of errors generated is more than 0.01.
8. Confidence interval: (0, 0.094).  
   The“plus-4s” confidence interval is (0.004, 0.144).

[**96**](https://openstax.org/books/introductory-statistics/pages/9-homework#exerrr).

1. *H0*: *p* = 0.50
2. *Ha*: *p* < 0.50
3. Let *P′* = the proportion of friends that has a pierced ear.
4. normal for a single proportion
5. –1.70
6. *p*-value = 0.0448
7. Check student’s solution.
   1. Alpha: 0.05
   2. Decision: Reject the null hypothesis
   3. Reason for decision: The *p*-value is less than 0.05. (However, they are very close.)
   4. Conclusion: There is sufficient evidence to support the claim that less than 50% of his friends have pierced ears.
8. Confidence Interval: (0.245, 0.515): The “plus-4s” confidence interval is (0.259, 0.519).

[**98**](https://openstax.org/books/introductory-statistics/pages/9-homework#element-378).

1. *H0*: *p* = 0.40
2. *Ha*: *p* < 0.40
3. Let *P′* = the proportion of schoolmates who fear public speaking.
4. normal for a single proportion
5. –1.01
6. *p*-value = 0.1563
7. Check student’s solution.
   1. Alpha: 0.05
   2. Decision: Do not reject the null hypothesis.
   3. Reason for decision: The *p*-value is greater than 0.05.
   4. Conclusion: There is insufficient evidence to support the claim that less than 40% of students at the school fear public speaking.
8. Confidence Interval: (0.3241, 0.4240): The “plus-4s” confidence interval is (0.3257, 0.4250).

[**100**](https://openstax.org/books/introductory-statistics/pages/9-homework#element-874).

1. *H0*: *p* = 0.14
2. *Ha*: *p* < 0.14
3. Let *P′* = the proportion of NYC residents that smoke.
4. normal for a single proportion
5. –0.2756
6. *p*-value = 0.3914
7. Check student’s solution.
   1. alpha: 0.05
   2. Decision: Do not reject the null hypothesis.
   3. Reason for decision: The *p*-value is greater than 0.05.
   4. At the 5% significance level, there is insufficient evidence to conclude that the proportion of NYC residents who smoke is less than 0.14.
8. Confidence Interval: (0.0502, 0.2070): The “plus-4s” confidence interval (see chapter 8) is (0.0676, 0.2297).

[**102**](https://openstax.org/books/introductory-statistics/pages/9-homework#element-408).

1. *H0*: *μ* = 69,110
2. *Ha*: *μ* > 69,110
3. Let X¯¯¯�¯ = the mean salary in dollars for California registered nurses.
4. Student's *t*-distribution
5. *t* = 1.719
6. *p*-value: 0.0466
7. Check student’s solution.
   1. Alpha: 0.05
   2. Decision: Reject the null hypothesis.
   3. Reason for decision: The *p*-value is less than 0.05.
   4. Conclusion: At the 5% significance level, there is sufficient evidence to conclude that the mean salary of California registered nurses exceeds $69,110.
8. ($68,757, $73,485)

[**104**](https://openstax.org/books/introductory-statistics/pages/9-homework#exer12).

c

[**106**](https://openstax.org/books/introductory-statistics/pages/9-homework#exer19).

c

[**108**](https://openstax.org/books/introductory-statistics/pages/9-homework#eip-40).

1. *H0*: *p* = 0.488 *Ha*: *p* ≠ 0.488
2. *p*-value = 0.0114
3. alpha = 0.05
4. Reject the null hypothesis.
5. At the 5% level of significance, there is enough evidence to conclude that 48.8% of families own stocks.
6. The survey does not appear to be accurate.

[**110**](https://openstax.org/books/introductory-statistics/pages/9-homework#eip-601).

1. *H0*: *p* = 0.517 *Ha*: *p* ≠ 0.517
2. *p*-value = 0.9203.
3. alpha = 0.05.
4. Do not reject the null hypothesis.
5. At the 5% significance level, there is not enough evidence to conclude that the proportion of homes in Kentucky that are heated by natural gas is 0.517.
6. However, we cannot generalize this result to the entire nation. First, the sample’s population is only the state of Kentucky. Second, it is reasonable to assume that homes in the extreme north and south will have extreme high usage and low usage, respectively. We would need to expand our sample base to include these possibilities if we wanted to generalize this claim to the entire nation.

[**112**](https://openstax.org/books/introductory-statistics/pages/9-homework#eip-715).

1. *H0*: *µ* ≥ 11.52 *Ha*: *µ* < 11.52
2. *p*-value = 0.000002 which is almost 0.
3. alpha = 0.05.
4. Reject the null hypothesis.
5. At the 5% significance level, there is enough evidence to conclude that the mean amount of summer rain in the northeaster US is less than 11.52 inches, on average.
6. We would make the same conclusion if alpha was 1% because the *p*-value is almost 0.

[**114**](https://openstax.org/books/introductory-statistics/pages/9-homework#eip-192).

1. *H0*: *µ* ≤ 5.8 *Ha*: *µ* > 5.8
2. *p*-value = 0.9987
3. alpha = 0.05
4. Do not reject the null hypothesis.
5. At the 5% level of significance, there is not enough evidence to conclude that a woman visits her doctor, on average, more than 5.8 times a year.

[**116**](https://openstax.org/books/introductory-statistics/pages/9-homework#eip-551).

1. *H0*: *µ* ≥ 150 *Ha*: *µ* < 150
2. *p*-value = 0.0622
3. alpha = 0.01
4. Do not reject the null hypothesis.
5. At the 1% significance level, there is not enough evidence to conclude that freshmen students study less than 2.5 hours per day, on average.
6. The student academic group’s claim appears to be correct.

*Use the following information to answer the next 15 exercises:* Indicate if the hypothesis test is for

1. independent group means, population standard deviations, and/or variances known
2. independent group means, population standard deviations, and/or variances unknown
3. matched or paired samples
4. single mean
5. two proportions
6. single proportion

[**1**](https://openstax.org/books/introductory-statistics/pages/10-solutions#fs-idm22935904-solution).

It is believed that 70% of males pass their drivers test in the first attempt, while 65% of females pass the test in the first attempt. Of interest is whether the proportions are in fact equal.

**2**.

A new laundry detergent is tested on consumers. Of interest is the proportion of consumers who prefer the new brand over the leading competitor. A study is done to test this.

[**3**](https://openstax.org/books/introductory-statistics/pages/10-solutions#fs-idm161821520-solution).

A new windshield treatment claims to repel water more effectively. Ten windshields are tested by simulating rain without the new treatment. The same windshields are then treated, and the experiment is run again. A hypothesis test is conducted.

**4**.

The known standard deviation in salary for all mid-level professionals in the financial industry is $11,000. Company A and Company B are in the financial industry. Suppose samples are taken of mid-level professionals from Company A and from Company B. The sample mean salary for mid-level professionals in Company A is $80,000. The sample mean salary for mid-level professionals in Company B is $96,000. Company A and Company B management want to know if their mid-level professionals are paid differently, on average.

[**5**](https://openstax.org/books/introductory-statistics/pages/10-solutions#fs-idp21825264-solution).

The average worker in Germany gets eight weeks of paid vacation.

**6**.

According to a television commercial, 80% of dentists agree that Ultrafresh toothpaste is the best on the market.

[**7**](https://openstax.org/books/introductory-statistics/pages/10-solutions#fs-idp3576048-solution).

It is believed that the average grade on an English essay in a particular school system for females is higher than for males. A random sample of 31 females had a mean score of 82 with a standard deviation of three, and a random sample of 25 males had a mean score of 76 with a standard deviation of four.

**8**.

The league mean batting average is 0.280 with a known standard deviation of 0.06. The Rattlers and the Vikings belong to the league. The mean batting average for a sample of eight Rattlers is 0.210, and the mean batting average for a sample of eight Vikings is 0.260. There are 24 players on the Rattlers and 19 players on the Vikings. Are the batting averages of the Rattlers and Vikings statistically different?

[**9**](https://openstax.org/books/introductory-statistics/pages/10-solutions#fs-idm36046944-solution).

In a random sample of 100 forests in the United States, 56 were coniferous or contained conifers. In a random sample of 80 forests in Mexico, 40 were coniferous or contained conifers. Is the proportion of conifers in the United States statistically more than the proportion of conifers in Mexico?

**10**.

A new medicine is said to help improve sleep. Eight subjects are picked at random and given the medicine. The means hours slept for each person were recorded before starting the medication and after.

[**11**](https://openstax.org/books/introductory-statistics/pages/10-solutions#fs-idm111997184-solution).

It is thought that teenagers sleep more than adults on average. A study is done to verify this. A sample of 16 teenagers has a mean of 8.9 hours slept and a standard deviation of 1.2. A sample of 12 adults has a mean of 6.9 hours slept and a standard deviation of 0.6.

**12**.

Varsity athletes practice five times a week, on average.

[**13**](https://openstax.org/books/introductory-statistics/pages/10-solutions#fs-idm155074576-solution).

A sample of 12 in-state graduate school programs at school A has a mean tuition of $64,000 with a standard deviation of $8,000. At school B, a sample of 16 in-state graduate programs has a mean of $80,000 with a standard deviation of $6,000. On average, are the mean tuitions different?

**14**.

A new WiFi range booster is being offered to consumers. A researcher tests the native range of 12 different routers under the same conditions. The ranges are recorded. Then the researcher uses the new WiFi range booster and records the new ranges. Does the new WiFi range booster do a better job?

[**15**](https://openstax.org/books/introductory-statistics/pages/10-solutions#fs-idm152397632-solution).

A high school principal claims that 30% of student athletes drive themselves to school, while 4% of non-athletes drive themselves to school. In a sample of 20 student athletes, 45% drive themselves to school. In a sample of 35 non-athlete students, 6% drive themselves to school. Is the percent of student athletes who drive themselves to school more than the percent of nonathletes?

*Use the following information to answer the next three exercises:* A study is done to determine which of two soft drinks has more sugar. There are 13 cans of Beverage A in a sample and six cans of Beverage B. The mean amount of sugar in Beverage A is 36 grams with a standard deviation of 0.6 grams. The mean amount of sugar in Beverage B is 38 grams with a standard deviation of 0.8 grams. The researchers believe that Beverage B has more sugar than Beverage A, on average. Both populations have normal distributions.

**16**.

Are standard deviations known or unknown?

[**17**](https://openstax.org/books/introductory-statistics/pages/10-solutions#fs-idm213711120-solution).

What is the random variable?

**18**.

Is this a one-tailed or two-tailed test?

*Use the following information to answer the next 12 exercises:* The U.S. Center for Disease Control reports that the mean life expectancy was 47.6 years for White people born in 1900 and 33.0 years for non-White people. Suppose that you randomly survey death records for people born in 1900 in a certain county. Of the 124 White people, the mean life span was 45.3 years with a standard deviation of 12.7 years. Of the 82 non-White people, the mean life span was 34.1 years with a standard deviation of 15.6 years. Conduct a hypothesis test to see if the mean life spans in the county were the same for White and non-White people.

[**19**](https://openstax.org/books/introductory-statistics/pages/10-solutions#fs-idm77134224-solution).

Is this a test of means or proportions?

**20**.

State the null and alternative hypotheses.

1. *H0*: \_\_\_\_\_\_\_\_\_\_
2. *Ha*: \_\_\_\_\_\_\_\_\_\_

[**21**](https://openstax.org/books/introductory-statistics/pages/10-solutions#fs-idp13932064-solution).

Is this a right-tailed, left-tailed, or two-tailed test?

**22**.

In symbols, what is the random variable of interest for this test?

[**23**](https://openstax.org/books/introductory-statistics/pages/10-solutions#fs-idm147822240-solution).

In words, define the random variable of interest for this test.

**24**.

Which distribution (normal or Student's *t*) would you use for this hypothesis test?

[**25**](https://openstax.org/books/introductory-statistics/pages/10-solutions#fs-idm121049024-solution).

Explain why you chose the distribution you did for [**Exercise 10.24**](https://openstax.org/books/introductory-statistics/pages/10-practice#fs-idm17957104).

**26**.

Calculate the test statistic and *p*-value.

[**27**](https://openstax.org/books/introductory-statistics/pages/10-solutions#fs-idm120924688-solution).

Sketch a graph of the situation. Label the horizontal axis. Mark the hypothesized difference and the sample difference. Shade the area corresponding to the *p*-value.

**28**.

Find the *p*-value.

[**29**](https://openstax.org/books/introductory-statistics/pages/10-solutions#fs-idm129306608-solution).

At a pre-conceived *α* = 0.05, what is your:

1. Decision:
2. Reason for the decision:
3. Conclusion (write out in a complete sentence):

**30**.

Does it appear that the means are the same? Why or why not?

**[10.2 Two Population Means with Known Standard Deviations](https://openstax.org/books/introductory-statistics/pages/10-2-two-population-means-with-known-standard-deviations)**

*Use the following information to answer the next five exercises.* The mean speeds of fastball pitches from two different baseball pitchers are to be compared. A sample of 14 fastball pitches is measured from each pitcher. The populations have normal distributions. [Table 10.18](https://openstax.org/books/introductory-statistics/pages/10-practice#fs-idm34247936) shows the result. Scouters believe that Rodriguez pitches a speedier fastball.

| **Pitcher** | **Sample Mean Speed of Pitches (mph)** | **Population Standard Deviation** |
| --- | --- | --- |
| Wesley | 86 | 3 |
| Rodriguez | 91 | 7 |

**Table** **10.18**

[**31**](https://openstax.org/books/introductory-statistics/pages/10-solutions#fs-idm106340640-solution).

What is the random variable?

**32**.

State the null and alternative hypotheses.

[**33**](https://openstax.org/books/introductory-statistics/pages/10-solutions#fs-idm113366480-solution).

What is the test statistic?

**34**.

What is the *p*-value?

[**35**](https://openstax.org/books/introductory-statistics/pages/10-solutions#fs-idm126168192-solution).

At the 1% significance level, what is your conclusion?

*Use the following information to answer the next five exercises.* A researcher is testing the effects of plant food on plant growth. Nine plants have been given the plant food. Another nine plants have not been given the plant food. The heights of the plants are recorded after eight weeks. The populations have normal distributions. The following table is the result. The researcher thinks the food makes the plants grow taller.

| **Plant Group** | **Sample Mean Height of Plants (inches)** | **Population Standard Deviation** |
| --- | --- | --- |
| Food | 16 | 2.5 |
| No food | 14 | 1.5 |

**Table** **10.19**

**36**.

Is the population standard deviation known or unknown?

[**37**](https://openstax.org/books/introductory-statistics/pages/10-solutions#fs-idm92555424-solution).

State the null and alternative hypotheses.

**38**.

What is the *p*-value?

[**39**](https://openstax.org/books/introductory-statistics/pages/10-solutions#fs-idm112309984-solution).

Draw the graph of the *p*-value.

**40**.

At the 1% significance level, what is your conclusion?

*Use the following information to answer the next five exercises.* Two metal alloys are being considered as material for ball bearings. The mean melting point of the two alloys is to be compared. 15 pieces of each metal are being tested. Both populations have normal distributions. The following table is the result. It is believed that Alloy Zeta has a different melting point.

|  | **Sample Mean Melting Temperatures (°F)** | **Population Standard Deviation** |
| --- | --- | --- |
| Alloy Gamma | 800 | 95 |
| Alloy Zeta | 900 | 105 |

**Table** **10.20**

[**41**](https://openstax.org/books/introductory-statistics/pages/10-solutions#fs-idm4478224-solution).

State the null and alternative hypotheses.

**42**.

Is this a right-, left-, or two-tailed test?

[**43**](https://openstax.org/books/introductory-statistics/pages/10-solutions#fs-idm100159520-solution).

What is the *p*-value?

**44**.

Draw the graph of the *p*-value.

[**45**](https://openstax.org/books/introductory-statistics/pages/10-solutions#fs-idm85314992-solution).

At the 1% significance level, what is your conclusion?

**[10.3 Comparing Two Independent Population Proportions](https://openstax.org/books/introductory-statistics/pages/10-3-comparing-two-independent-population-proportions)**

*Use the following information for the next five exercises.* Two types of phone operating system are being tested to determine if there is a difference in the proportions of system failures (crashes). Fifteen out of a random sample of 150 phones with OS1 had system failures within the first eight hours of operation. Nine out of another random sample of 150 phones with OS2 had system failures within the first eight hours of operation. OS2 is believed to be more stable (have fewer crashes) than OS1.

**46**.

Is this a test of means or proportions?

[**47**](https://openstax.org/books/introductory-statistics/pages/10-solutions#eip-964-solution).

What is the random variable?

**48**.

State the null and alternative hypotheses.

[**49**](https://openstax.org/books/introductory-statistics/pages/10-solutions#eip-56-solution).

What is the *p*-value?

**50**.

What can you conclude about the two operating systems?

*Use the following information to answer the next twelve exercises.* In the recent Census, three percent of the U.S. population reported being of two or more races. However, the percent varies tremendously from state to state. Suppose that two random surveys are conducted. In the first random survey, out of 1,000 North Dakotans, only nine people reported being of two or more races. In the second random survey, out of 500 Nevadans, 17 people reported being of two or more races. Conduct a hypothesis test to determine if the population percents are the same for the two states or if the percent for Nevada is statistically higher than for North Dakota.

[**51**](https://openstax.org/books/introductory-statistics/pages/10-solutions#element-385-solution).

Is this a test of means or proportions?

**52**.

State the null and alternative hypotheses.

1. *H0*: \_\_\_\_\_\_\_\_\_
2. *Ha*: \_\_\_\_\_\_\_\_\_

[**53**](https://openstax.org/books/introductory-statistics/pages/10-solutions#element-22-solution).

Is this a right-tailed, left-tailed, or two-tailed test? How do you know?

**54**.

What is the random variable of interest for this test?

[**55**](https://openstax.org/books/introductory-statistics/pages/10-solutions#element-386-solution).

In words, define the random variable for this test.

**56**.

Which distribution (normal or Student's *t*) would you use for this hypothesis test?

[**57**](https://openstax.org/books/introductory-statistics/pages/10-solutions#element-464-solution).

Explain why you chose the distribution you did for the [**Exercise 10.56**](https://openstax.org/books/introductory-statistics/pages/10-practice#element-7).

**58**.

Calculate the test statistic.

[**59**](https://openstax.org/books/introductory-statistics/pages/10-solutions#element-814-solution).

Sketch a graph of the situation. Mark the hypothesized difference and the sample difference. Shade the area corresponding to the *p*-value.

This is a horizontal axis with arrows at each end. The axis is labeled p'N - p'ND

**Figure 10.17**

**60**.

Find the *p*-value.

[**61**](https://openstax.org/books/introductory-statistics/pages/10-solutions#element-723-solution).

At a pre-conceived *α* = 0.05, what is your:

1. Decision:
2. Reason for the decision:
3. Conclusion (write out in a complete sentence):

**62**.

Does it appear that the proportion of Nevadans who are two or more races is higher than the proportion of North Dakotans? Why or why not?

**[10.4 Matched or Paired Samples](https://openstax.org/books/introductory-statistics/pages/10-4-matched-or-paired-samples)**

*Use the following information to answer the next five exercises.* A study was conducted to test the effectiveness of a software patch in reducing system failures over a six-month period. Results for randomly selected installations are shown in [Table 10.21](https://openstax.org/books/introductory-statistics/pages/10-practice#fs-idp116025200). The “before” value is matched to an “after” value, and the differences are calculated. The differences have a normal distribution. Test at the 1% significance level.

| **Installation** | **A** | **B** | **C** | **D** | **E** | **F** | **G** | **H** |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Before | 3 | 6 | 4 | 2 | 5 | 8 | 2 | 6 |
| After | 1 | 5 | 2 | 0 | 1 | 0 | 2 | 2 |

**Table** **10.21**

[**63**](https://openstax.org/books/introductory-statistics/pages/10-solutions#fs-idm5499280-solution).

What is the random variable?

**64**.

State the null and alternative hypotheses.

[**65**](https://openstax.org/books/introductory-statistics/pages/10-solutions#fs-idm10056224-solution).

What is the *p*-value?

**66**.

Draw the graph of the *p*-value.

[**67**](https://openstax.org/books/introductory-statistics/pages/10-solutions#fs-idp92713024-solution).

What conclusion can you draw about the software patch?

*Use the following information to answer next five exercises.* A study was conducted to test the effectiveness of a juggling class. Before the class started, six subjects juggled as many balls as they could at once. After the class, the same six subjects juggled as many balls as they could. The differences in the number of balls are calculated. The differences have a normal distribution. Test at the 1% significance level.

| **Subject** | **A** | **B** | **C** | **D** | **E** | **F** |
| --- | --- | --- | --- | --- | --- | --- |
| Before | 3 | 4 | 3 | 2 | 4 | 5 |
| After | 4 | 5 | 6 | 4 | 5 | 7 |

**Table** **10.22**

**68**.

State the null and alternative hypotheses.

[**69**](https://openstax.org/books/introductory-statistics/pages/10-solutions#fs-idp15011664-solution).

What is the *p*-value?

**70**.

What is the sample mean difference?

[**71**](https://openstax.org/books/introductory-statistics/pages/10-solutions#fs-idp9592768-solution).

Draw the graph of the *p*-value.

**72**.

What conclusion can you draw about the juggling class?

*Use the following information to answer the next five exercises.* A doctor wants to know if a blood pressure medication is effective. Six subjects have their blood pressures recorded. After twelve weeks on the medication, the same six subjects have their blood pressure recorded again. For this test, only systolic pressure is of concern. Test at the 1% significance level.

| **Patient** | **A** | **B** | **C** | **D** | **E** | **F** |
| --- | --- | --- | --- | --- | --- | --- |
| Before | 161 | 162 | 165 | 162 | 166 | 171 |
| After | 158 | 159 | 166 | 160 | 167 | 169 |

**Table** **10.23**

[**73**](https://openstax.org/books/introductory-statistics/pages/10-solutions#fs-idp5612992-solution).

State the null and alternative hypotheses.

**74**.

What is the test statistic?

[**75**](https://openstax.org/books/introductory-statistics/pages/10-solutions#fs-idp69509280-solution).

What is the *p*-value?

**76**.

What is the sample mean difference?

[**77**](https://openstax.org/books/introductory-statistics/pages/10-solutions#fs-idm55198624-solution).

What is the conclusion?

**78**.

The mean number of English courses taken in a two–year time period by male and female college students is believed to be about the same. An experiment is conducted and data are collected from 29 males and 16 females. The males took an average of three English courses with a standard deviation of 0.8. The females took an average of four English courses with a standard deviation of 1.0. Are the means statistically the same?

[**79**](https://openstax.org/books/introductory-statistics/pages/10-solutions#fs-idm8894688-solution).

A student at a four-year college claims that mean enrollment at four–year colleges is higher than at two–year colleges in the United States. Two surveys are conducted. Of the 35 two–year colleges surveyed, the mean enrollment was 5,068 with a standard deviation of 4,777. Of the 35 four-year colleges surveyed, the mean enrollment was 5,466 with a standard deviation of 8,191.

**80**.

At Rachel’s 11th birthday party, eight girls were timed to see how long (in seconds) they could hold their breath in a relaxed position. After a two-minute rest, they timed themselves while jumping. The girls thought that the mean difference between their jumping and relaxed times would be zero. Test their hypothesis.

| **Relaxed time (seconds)** | **Jumping time (seconds)** |
| --- | --- |
| 26 | 21 |
| 47 | 40 |
| 30 | 28 |
| 22 | 21 |
| 23 | 25 |
| 45 | 43 |
| 37 | 35 |
| 29 | 32 |

**Table** **10.24**

[**81**](https://openstax.org/books/introductory-statistics/pages/10-solutions#fs-idm122985232-solution).

Mean entry-level salaries for college graduates with mechanical engineering degrees and electrical engineering degrees are believed to be approximately the same. A recruiting office thinks that the mean mechanical engineering salary is actually lower than the mean electrical engineering salary. The recruiting office randomly surveys 50 entry level mechanical engineers and 60 entry level electrical engineers. Their mean salaries were $46,100 and $46,700, respectively. Their standard deviations were $3,450 and $4,210, respectively. Conduct a hypothesis test to determine if you agree that the mean entry-level mechanical engineering salary is lower than the mean entry-level electrical engineering salary.

**82**.

Marketing companies have collected data implying that teenage girls use more ring tones on their cellular phones than teenage boys do. In one particular study of 40 randomly chosen teenage girls and boys (20 of each) with cellular phones, the mean number of ring tones for the girls was 3.2 with a standard deviation of 1.5. The mean for the boys was 1.7 with a standard deviation of 0.8. Conduct a hypothesis test to determine if the means are approximately the same or if the girls’ mean is higher than the boys’ mean.

*Use the information from*[*Appendix C Data Sets*](https://openstax.org/books/introductory-statistics/pages/c-data-sets)*to answer the next four exercises.*

[**83**](https://openstax.org/books/introductory-statistics/pages/10-solutions#fs-idm50796704-solution).

Using the data from Lap 1 only, conduct a hypothesis test to determine if the mean time for completing a lap in races is the same as it is in practices.

**84**.

Repeat the test in [**Exercise 10.83**](https://openstax.org/books/introductory-statistics/pages/10-homework#fs-idm50796704), but use Lap 5 data this time.

[**85**](https://openstax.org/books/introductory-statistics/pages/10-solutions#fs-idm170930784-solution).

Repeat the test in [**Exercise 10.83**](https://openstax.org/books/introductory-statistics/pages/10-homework#fs-idm50796704), but this time combine the data from Laps 1 and 5.

**86**.

In two to three complete sentences, explain in detail how you might use Terri Vogel’s data to answer the following question. “Does Terri Vogel drive faster in races than she does in practices?”

*Use the following information to answer the next two exercises.* The Eastern and Western Major League Soccer conferences have a new Reserve Division that allows new players to develop their skills. Data for a randomly picked date showed the following annual goals.

| **Western** | **Eastern** |
| --- | --- |
| Los Angeles 9 | D.C. United 9 |
| FC Dallas 3 | Chicago 8 |
| Chivas USA 4 | Columbus 7 |
| Real Salt Lake 3 | New England 6 |
| Colorado 4 | MetroStars 5 |
| San Jose 4 | Kansas City 3 |

**Table** **10.25**

*Conduct a hypothesis test to answer the next two exercises.*

**87**.

The **exact** distribution for the hypothesis test is:

1. the normal distribution
2. the Student's *t*-distribution
3. the uniform distribution
4. the exponential distribution

[**88**](https://openstax.org/books/introductory-statistics/pages/10-solutions#fs-idm3207760-solution).

If the level of significance is 0.05, the conclusion is:

1. There is sufficient evidence to conclude that the **W** Division teams score fewer goals, on average, than the **E** teams
2. There is insufficient evidence to conclude that the **W** Division teams score more goals, on average, than the **E** teams.
3. There is insufficient evidence to conclude that the **W** teams score fewer goals, on average, than the **E** teams score.
4. Unable to determine

**89**.

Suppose a statistics instructor believes that there is no significant difference between the mean class scores of statistics day students on Exam 2 and statistics night students on Exam 2. She takes random samples from each of the populations. The mean and standard deviation for 35 statistics day students were 75.86 and 16.91. The mean and standard deviation for 37 statistics night students were 75.41 and 19.73. The “day” subscript refers to the statistics day students. The “night” subscript refers to the statistics night students. A concluding statement is:

1. There is sufficient evidence to conclude that statistics night students' mean on Exam 2 is better than the statistics day students' mean on Exam 2.
2. There is insufficient evidence to conclude that the statistics day students' mean on Exam 2 is better than the statistics night students' mean on Exam 2.
3. There is insufficient evidence to conclude that there is a significant difference between the means of the statistics day students and night students on Exam 2.
4. There is sufficient evidence to conclude that there is a significant difference between the means of the statistics day students and night students on Exam 2.

[**90**](https://openstax.org/books/introductory-statistics/pages/10-solutions#fs-idm81478720-solution).

Elijah wants to know whether textbook costs are different for different courses of study. He selects a random sample of 33 sociology textbooks offered on a popular online site. The mean price of his sample is $74.64 with a standard deviation of $49.36. He then selects a random sample of 33 math and science textbooks from the same site. The mean price of this sample is $111.56 with a standard deviation of $66.90. Is the mean price of a sociology textbook lower than the mean price of a math or science textbook? Test at a 1% significance level.

**91**.

A powder diet is tested on 49 people, and a liquid diet is tested on 36 different people. Of interest is whether the liquid diet yields a higher mean weight loss than the powder diet. The powder diet group had a mean weight loss of 42 pounds with a standard deviation of 12 pounds. The liquid diet group had a mean weight loss of 45 pounds with a standard deviation of 14 pounds.

[**92**](https://openstax.org/books/introductory-statistics/pages/10-solutions#eip-17-solution).

Suppose a statistics instructor believes that there is no significant difference between the mean class scores of statistics day students on Exam 2 and statistics night students on Exam 2. She takes random samples from each of the populations. The mean and standard deviation for 35 statistics day students were 75.86 and 16.91, respectively. The mean and standard deviation for 37 statistics night students were 75.41 and 19.73. The “day” subscript refers to the statistics day students. The “night” subscript refers to the statistics night students. An appropriate alternative hypothesis for the hypothesis test is:

1. *μ*day > *μ*night
2. *μ*day < *μ*night
3. *μ*day = *μ*night
4. *μ*day ≠ *μ*night

**[10.2 Two Population Means with Known Standard Deviations](https://openstax.org/books/introductory-statistics/pages/10-2-two-population-means-with-known-standard-deviations)**

*DIRECTIONS: For each of the word problems, use a solution sheet to do the hypothesis test. The solution sheet is found in*[*Appendix E Solution Sheets*](https://openstax.org/books/introductory-statistics/pages/e-solution-sheets)*. Please feel free to make copies of the solution sheets. For the online version of the book, it is suggested that you copy the .doc or the .pdf files.*

**NOTE**

If you are using a Student's *t*-distribution for one of the following homework problems, including for paired data, you may assume that the underlying population is normally distributed. (When using these tests in a real situation, you must first prove that assumption, however.)

**93**.

A study is done to determine if students in the California state university system take longer to graduate, on average, than students enrolled in private universities. One hundred students from both the California state university system and private universities are surveyed. Suppose that from years of research, it is known that the population standard deviations are 1.5811 years and 1 year, respectively. The following data are collected. The California state university system students took on average 4.5 years with a standard deviation of 0.8. The private university students took on average 4.1 years with a standard deviation of 0.3.

[**94**](https://openstax.org/books/introductory-statistics/pages/10-solutions#exer29-solution).

Parents of teenage boys often complain that auto insurance costs more, on average, for teenage boys than for teenage girls. A group of concerned parents examines a random sample of insurance bills. The mean annual cost for 36 teenage boys was $679. For 23 teenage girls, it was $559. From past years, it is known that the population standard deviation for each group is $180. Determine whether or not you believe that the mean cost for auto insurance for teenage boys is greater than that for teenage girls.

**95**.

A group of transfer bound students wondered if they will spend the same mean amount on texts and supplies each year at their four-year university as they have at their community college. They conducted a random survey of 54 students at their community college and 66 students at their local four-year university. The sample means were $947 and $1,011, respectively. The population standard deviations are known to be $254 and $87, respectively. Conduct a hypothesis test to determine if the means are statistically the same.

[**96**](https://openstax.org/books/introductory-statistics/pages/10-solutions#exer32-solution).

Some manufacturers claim that non-hybrid sedan cars have a lower mean miles-per-gallon (mpg) than hybrid ones. Suppose that consumers test 21 hybrid sedans and get a mean of 31 mpg with a standard deviation of seven mpg. Thirty-one non-hybrid sedans get a mean of 22 mpg with a standard deviation of four mpg. Suppose that the population standard deviations are known to be six and three, respectively. Conduct a hypothesis test to evaluate the manufacturers claim.

**97**.

A baseball fan wanted to know if there is a difference between the number of games played in a World Series when the American League won the series versus when the National League won the series. From 1922 to 2012, the population standard deviation of games won by the American League was 1.14, and the population standard deviation of games won by the National League was 1.11. Of 19 randomly selected World Series games won by the American League, the mean number of games won was 5.76. The mean number of 17 randomly selected games won by the National League was 5.42. Conduct a hypothesis test.

[**98**](https://openstax.org/books/introductory-statistics/pages/10-solutions#eip-267-solution).

One of the questions in a study of marital satisfaction of dual-career couples was to rate the statement “I’m pleased with the way we divide the responsibilities for childcare.” The ratings went from one (strongly agree) to five (strongly disagree). [**Table 10.26**](https://openstax.org/books/introductory-statistics/pages/10-homework#eip-idm34133008) contains ten of the paired responses for husbands and wives. Conduct a hypothesis test to see if the mean difference in the husband’s versus the wife’s satisfaction level is negative (meaning that, within the partnership, the husband is happier than the wife).

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Wife’s Score** | 2 | 2 | 3 | 3 | 4 | 2 | 1 | 1 | 2 | 4 |
| **Husband’s Score** | 2 | 2 | 1 | 3 | 2 | 1 | 1 | 1 | 2 | 4 |

**Table** **10.26**

**[10.3 Comparing Two Independent Population Proportions](https://openstax.org/books/introductory-statistics/pages/10-3-comparing-two-independent-population-proportions)**

*DIRECTIONS: For each of the word problems, use a solution sheet to do the hypothesis test. The solution sheet is found in*[*Appendix E Solution Sheets*](https://openstax.org/books/introductory-statistics/pages/e-solution-sheets)*. Please feel free to make copies of the solution sheets. For the online version of the book, it is suggested that you copy the .doc or the .pdf files.*

**NOTE**

If you are using a Student's *t*-distribution for one of the following homework problems, including for paired data, you may assume that the underlying population is normally distributed. (In general, you must first prove that assumption, however.)

**99**.

A recent drug survey showed an increase in the use of drugs and alcohol among local high school seniors as compared to the national percent. Suppose that a survey of 100 local seniors and 100 national seniors is conducted to see if the proportion of drug and alcohol use is higher locally than nationally. Locally, 65 seniors reported using drugs or alcohol within the past month, while 60 national seniors reported using them.

[**100**](https://openstax.org/books/introductory-statistics/pages/10-solutions#exer18-solution).

We are interested in whether the proportions of female suicide victims for ages 15 to 24 are the same for White and Black in the United States. We randomly pick one year, 1992, to compare the races. The number of suicides estimated in the United States in 1992 for White females is 4,930. Five hundred eighty were aged 15 to 24. The estimate for Black females is 330. Forty were aged 15 to 24. We will let female suicide victims be our population.

**101**.

Elizabeth Mjelde, an art history professor, was interested in whether the value from the Golden Ratio formula, (larger + smaller dimensionlarger dimension)(larger + smaller dimensionlarger dimension) was the same in the Whitney Exhibit for works from 1900 to 1919 as for works from 1920 to 1942. Thirty-seven early works were sampled, averaging 1.74 with a standard deviation of 0.11. Sixty-five of the later works were sampled, averaging 1.746 with a standard deviation of 0.1064. Do you think that there is a significant difference in the Golden Ratio calculation?

[**102**](https://openstax.org/books/introductory-statistics/pages/10-solutions#exer24-solution).

A recent year was randomly picked from 1985 to the present. In that year, there were 2,051 Hispanic students at Cabrillo College out of a total of 12,328 students. At Lake Tahoe College, there were 321 Hispanic students out of a total of 2,441 students. In general, do you think that the percent of Hispanic students at the two colleges is basically the same or different?

*Use the following information to answer the next three exercises.* Neuroinvasive West Nile virus is a severe disease that affects a person’s nervous system . It is spread by the Culex species of mosquito. In the United States in 2010 there were 629 reported cases of neuroinvasive West Nile virus out of a total of 1,021 reported cases and there were 486 neuroinvasive reported cases out of a total of 712 cases reported in 2011. Is the 2011 proportion of neuroinvasive West Nile virus cases more than the 2010 proportion of neuroinvasive West Nile virus cases? Using a 1% level of significance, conduct an appropriate hypothesis test.

* “2011” subscript: 2011 group.
* “2010” subscript: 2010 group

**103**.

This is:

1. a test of two proportions
2. a test of two independent means
3. a test of a single mean
4. a test of matched pairs.

[**104**](https://openstax.org/books/introductory-statistics/pages/10-solutions#element-552-solution).

An appropriate null hypothesis is:

1. *p2011* ≤ *p2010*
2. *p2011* ≥ *p2010*
3. *μ2011* ≤ *μ2010*
4. *p2011* > *p2010*

**105**.

The *p*-value is 0.0022. At a 1% level of significance, the appropriate conclusion is

1. There is sufficient evidence to conclude that the proportion of people in the United States in 2011 who contracted neuroinvasive West Nile disease is less than the proportion of people in the United States in 2010 who contracted neuroinvasive West Nile disease.
2. There is insufficient evidence to conclude that the proportion of people in the United States in 2011 who contracted neuroinvasive West Nile disease is more than the proportion of people in the United States in 2010 who contracted neuroinvasive West Nile disease.
3. There is insufficient evidence to conclude that the proportion of people in the United States in 2011 who contracted neuroinvasive West Nile disease is less than the proportion of people in the United States in 2010 who contracted neuroinvasive West Nile disease.
4. There is sufficient evidence to conclude that the proportion of people in the United States in 2011 who contracted neuroinvasive West Nile disease is more than the proportion of people in the United States in 2010 who contracted neuroinvasive West Nile disease.

[**106**](https://openstax.org/books/introductory-statistics/pages/10-solutions#fs-idp30249712-solution).

Researchers conducted a study to find out if there is a difference in the use of eReaders by different age groups. Randomly selected participants were divided into two age groups. In the 16- to 29-year-old group, 7% of the 628 surveyed use eReaders, while 11% of the 2,309 participants 30 years old and older use eReaders.

**107**.

Adults aged 18 years old and older were randomly selected for a survey on obesity. Adults are considered obese if their body mass index (BMI) is at least 30. The researchers wanted to determine if the proportion of women who are obese in the south is less than the proportion of southern men who are obese. The results are shown in [**Table 10.27**](https://openstax.org/books/introductory-statistics/pages/10-homework#fs-idp62517488). Test at the 1% level of significance.

|  | **Number who are obese** | **Sample size** |
| --- | --- | --- |
| Men | 42,769 | 155,525 |
| Women | 67,169 | 248,775 |

**Table** **10.27**

[**108**](https://openstax.org/books/introductory-statistics/pages/10-solutions#fs-idm16853120-solution).

Two computer users were discussing tablet computers. A higher proportion of people ages 16 to 29 use tablets than the proportion of people age 30 and older. [**Table 10.28**](https://openstax.org/books/introductory-statistics/pages/10-homework#fs-idp42650880) details the number of tablet owners for each age group. Test at the 1% level of significance.

|  | **16–29 year olds** | **30 years old and older** |
| --- | --- | --- |
| Own a Tablet | 69 | 231 |
| Sample Size | 628 | 2,309 |

**Table** **10.28**

**109**.

A group of friends debated whether more men use smartphones than women. They consulted a research study of smartphone use among adults. The results of the survey indicate that of the 973 men randomly sampled, 379 use smartphones. For women, 404 of the 1,304 who were randomly sampled use smartphones. Test at the 5% level of significance.

[**110**](https://openstax.org/books/introductory-statistics/pages/10-solutions#fs-idm174644848-solution).

While her husband spent 2½ hours picking out new speakers, a statistician decided to determine whether the percent of men who enjoy shopping for electronic equipment is higher than the percent of women who enjoy shopping for electronic equipment. The population was Saturday afternoon shoppers. Out of 67 men, 24 said they enjoyed the activity. Eight of the 24 women surveyed claimed to enjoy the activity. Interpret the results of the survey.

**111**.

We are interested in whether children’s educational computer software costs less, on average, than children’s entertainment software. Thirty-six educational software titles were randomly picked from a catalog. The mean cost was $31.14 with a standard deviation of $4.69. Thirty-five entertainment software titles were randomly picked from the same catalog. The mean cost was $33.86 with a standard deviation of $10.87. Decide whether children’s educational software costs less, on average, than children’s entertainment software.

[**112**](https://openstax.org/books/introductory-statistics/pages/10-solutions#fs-idm98770112-solution).

Joan Nguyen recently claimed that the proportion of college-age males with at least one pierced ear is as high as the proportion of college-age females. She conducted a survey in her classes. Out of 107 males, 20 had at least one pierced ear. Out of 92 females, 47 had at least one pierced ear. Do you believe that the proportion of males has reached the proportion of females?

**113**.

Use the data sets found in [**Appendix C Data Sets**](https://openstax.org/books/introductory-statistics/pages/c-data-sets) to answer this exercise. Is the proportion of race laps Terri completes slower than 130 seconds less than the proportion of practice laps she completes slower than 135 seconds?

[**114**](https://openstax.org/books/introductory-statistics/pages/10-solutions#fs-idm104246192-solution).

"To Breakfast or Not to Breakfast?" by Richard Ayore

In the American society, birthdays are one of those days that everyone looks forward to. People of different ages and peer groups gather to mark the 18th, 20th, …, birthdays. During this time, one looks back to see what he or she has achieved for the past year and also focuses ahead for more to come.

If, by any chance, I am invited to one of these parties, my experience is always different. Instead of dancing around with my friends while the music is booming, I get carried away by memories of my family back home in Kenya. I remember the good times I had with my brothers and sister while we did our daily routine.

Every morning, I remember we went to the shamba (garden) to weed our crops. I remember one day arguing with my brother as to why he always remained behind just to join us an hour later. In his defense, he said that he preferred waiting for breakfast before he came to weed. He said, “This is why I always work more hours than you guys!”

And so, to prove him wrong or right, we decided to give it a try. One day we went to work as usual without breakfast, and recorded the time we could work before getting tired and stopping. On the next day, we all ate breakfast before going to work. We recorded how long we worked again before getting tired and stopping. Of interest was our mean increase in work time. Though not sure, my brother insisted that it was more than two hours. Using the data in [Table 10.29](https://openstax.org/books/introductory-statistics/pages/10-homework#fs-idm167762016), solve our problem.

| **Work hours with breakfast** | **Work hours without breakfast** |
| --- | --- |
| 8 | 6 |
| 7 | 5 |
| 9 | 5 |
| 5 | 4 |
| 9 | 7 |
| 8 | 7 |
| 10 | 7 |
| 7 | 5 |
| 6 | 6 |
| 9 | 5 |

**Table** **10.29**

**[10.4 Matched or Paired Samples](https://openstax.org/books/introductory-statistics/pages/10-4-matched-or-paired-samples)**

*DIRECTIONS: For each of the word problems, use a solution sheet to do the hypothesis test. The solution sheet is found in*[*Appendix E*](https://openstax.org/books/introductory-statistics/pages/e-solution-sheets)*. Please feel free to make copies of the solution sheets. For the online version of the book, it is suggested that you copy the .doc or the .pdf files.*

**NOTE**

If you are using a Student's *t*-distribution for the homework problems, including for paired data, you may assume that the underlying population is normally distributed. (When using these tests in a real situation, you must first prove that assumption, however.)

[**115**](https://openstax.org/books/introductory-statistics/pages/10-solutions#fs-idp64398288-solution).

Ten individuals went on a low–fat diet for 12 weeks to lower their cholesterol. The data are recorded in [**Table 10.30**](https://openstax.org/books/introductory-statistics/pages/10-homework#fs-idp16051952). Do you think that their cholesterol levels were significantly lowered?

| **Starting cholesterol level** | **Ending cholesterol level** |
| --- | --- |
| 140 | 140 |
| 220 | 230 |
| 110 | 120 |
| 240 | 220 |
| 200 | 190 |
| 180 | 150 |
| 190 | 200 |
| 360 | 300 |
| 280 | 300 |
| 260 | 240 |

**Table** **10.30**

*Use the following information to answer the next two exercises.* A new AIDS prevention drug was tried on a group of 224 HIV positive patients. Forty-five patients developed AIDS after four years. In a control group of 224 HIV positive patients, 68 developed AIDS after four years. We want to test whether the method of treatment reduces the proportion of patients that develop AIDS after four years or if the proportions of the treated group and the untreated group stay the same.

Let the subscript *t* = treated patient and *ut* = untreated patient.

**116**.

The appropriate hypotheses are:

1. *H0*: *pt* < *put* and *Ha*: *pt* ≥ *put*
2. *H0*: *pt* ≤ *put* and *Ha*: *pt* > *put*
3. *H0*: *pt* = *put* and *Ha*: *pt* ≠ *put*
4. *H0*: *pt* = *put* and *Ha*: *pt* < *put*

[**117**](https://openstax.org/books/introductory-statistics/pages/10-solutions#element-198-solution).

If the *p*-value is 0.0062 what is the conclusion (use *α* = 0.05)?

1. The method has no effect.
2. There is sufficient evidence to conclude that the method reduces the proportion of HIV positive patients who develop AIDS after four years.
3. There is sufficient evidence to conclude that the method increases the proportion of HIV positive patients who develop AIDS after four years.
4. There is insufficient evidence to conclude that the method reduces the proportion of HIV positive patients who develop AIDS after four years.

*Use the following information to answer the next two exercises.* An experiment is conducted to show that blood pressure can be consciously reduced in people trained in a “biofeedback exercise program.” Six subjects were randomly selected and blood pressure measurements were recorded before and after the training. The difference between blood pressures was calculated (after - before) producing the following results: x¯d�¯� = −10.2 *sd* = 8.4. Using the data, test the hypothesis that the blood pressure has decreased after the training.

**118**.

The distribution for the test is:

1. *t5*
2. *t6*
3. *N*(−10.2, 8.4)
4. N(−10.2, 8.46√8.46)

[**119**](https://openstax.org/books/introductory-statistics/pages/10-solutions#element-954-solution).

If *α* = 0.05, the *p*-value and the conclusion are

1. 0.0014; There is sufficient evidence to conclude that the blood pressure decreased after the training.
2. 0.0014; There is sufficient evidence to conclude that the blood pressure increased after the training.
3. 0.0155; There is sufficient evidence to conclude that the blood pressure decreased after the training.
4. 0.0155; There is sufficient evidence to conclude that the blood pressure increased after the training.

**120**.

A golf instructor is interested in determining if her new technique for improving players’ golf scores is effective. She takes four new students. She records their 18-hole scores before learning the technique and then after having taken her class. She conducts a hypothesis test. The data are as follows.

|  | **Player 1** | **Player 2** | **Player 3** | **Player 4** |
| --- | --- | --- | --- | --- |
| Mean score before class | 83 | 78 | 93 | 87 |
| Mean score after class | 80 | 80 | 86 | 86 |

**Table** **10.31**

The correct decision is:

1. Reject *H0*.
2. Do not reject the *H0*.

[**121**](https://openstax.org/books/introductory-statistics/pages/10-solutions#fs-idp31663264-solution).

A local cancer support group believes that the estimate for new female breast cancer cases in the south is higher in 2013 than in 2012. The group compared the estimates of new female breast cancer cases by southern state in 2012 and in 2013. The results are in [**Table 10.32**](https://openstax.org/books/introductory-statistics/pages/10-homework#fs-idp20856160).

| **Southern States** | **2012** | **2013** |
| --- | --- | --- |
| Alabama | 3,450 | 3,720 |
| Arkansas | 2,150 | 2,280 |
| Florida | 15,540 | 15,710 |
| Georgia | 6,970 | 7,310 |
| Kentucky | 3,160 | 3,300 |
| Louisiana | 3,320 | 3,630 |
| Mississippi | 1,990 | 2,080 |
| North Carolina | 7,090 | 7,430 |
| Oklahoma | 2,630 | 2,690 |
| South Carolina | 3,570 | 3,580 |
| Tennessee | 4,680 | 5,070 |
| Texas | 15,050 | 14,980 |
| Virginia | 6,190 | 6,280 |

**Table** **10.32**

**122**.

A traveler wanted to know if the prices of hotels are different in the ten cities that he visits the most often. The list of the cities with the corresponding hotel prices for his two favorite hotel chains is in [**Table 10.33**](https://openstax.org/books/introductory-statistics/pages/10-homework#fs-idp126693504). Test at the 1% level of significance.

| **Cities** | **Hyatt Regency prices in dollars** | **Hilton prices in dollars** |
| --- | --- | --- |
| Atlanta | 107 | 169 |
| Boston | 358 | 289 |
| Chicago | 209 | 299 |
| Dallas | 209 | 198 |
| Denver | 167 | 169 |
| Indianapolis | 179 | 214 |
| Los Angeles | 179 | 169 |
| New York City | 625 | 459 |
| Philadelphia | 179 | 159 |
| Washington, DC | 245 | 239 |

**Table** **10.33**

[**123**](https://openstax.org/books/introductory-statistics/pages/10-solutions#fs-idp111440192-solution).

A politician asked his staff to determine whether the underemployment rate in the northeast decreased from 2011 to 2012. The results are in [**Table 10.34**](https://openstax.org/books/introductory-statistics/pages/10-homework#fs-idp10131504).

| **Northeastern States** | **2011** | **2012** |
| --- | --- | --- |
| Connecticut | 17.3 | 16.4 |
| Delaware | 17.4 | 13.7 |
| Maine | 19.3 | 16.1 |
| Maryland | 16.0 | 15.5 |
| Massachusetts | 17.6 | 18.2 |
| New Hampshire | 15.4 | 13.5 |
| New Jersey | 19.2 | 18.7 |
| New York | 18.5 | 18.7 |
| Ohio | 18.2 | 18.8 |
| Pennsylvania | 16.5 | 16.9 |
| Rhode Island | 20.7 | 22.4 |
| Vermont | 14.7 | 12.3 |
| West Virginia | 15.5 | 17.3 |

**Table** **10.34**

*Use the following information to answer the next ten exercises.* indicate which of the following choices best identifies the hypothesis test.

1. independent group means, population standard deviations and/or variances known
2. independent group means, population standard deviations and/or variances unknown
3. matched or paired samples
4. single mean
5. two proportions
6. single proportion

**124**.

A powder diet is tested on 49 people, and a liquid diet is tested on 36 different people. The population standard deviations are two pounds and three pounds, respectively. Of interest is whether the liquid diet yields a higher mean weight loss than the powder diet.

[**125**](https://openstax.org/books/introductory-statistics/pages/10-solutions#fs-idm89593504-solution).

A new chocolate bar is taste-tested on consumers. Of interest is whether the proportion of children who like the new chocolate bar is greater than the proportion of adults who like it.

**126**.

The mean number of English courses taken in a two–year time period by male and female college students is believed to be about the same. An experiment is conducted and data are collected from nine males and 16 females.

[**127**](https://openstax.org/books/introductory-statistics/pages/10-solutions#fs-idm53146784-solution).

A football league reported that the mean number of touchdowns per game was five. A study is done to determine if the mean number of touchdowns has decreased.

**128**.

A study is done to determine if students in the California state university system take longer to graduate than students enrolled in private universities. One hundred students from both the California state university system and private universities are surveyed. From years of research, it is known that the population standard deviations are 1.5811 years and one year, respectively.

[**129**](https://openstax.org/books/introductory-statistics/pages/10-solutions#fs-idp12095488-solution).

According to a YWCA Rape Crisis Center newsletter, 75% of rape victims know their attackers. A study is done to verify this.

**130**.

According to a recent study, U.S. companies have a mean maternity-leave of six weeks.

[**131**](https://openstax.org/books/introductory-statistics/pages/10-solutions#fs-idm45776544-solution).

A recent drug survey showed an increase in use of drugs and alcohol among local high school students as compared to the national percent. Suppose that a survey of 100 local youths and 100 national youths is conducted to see if the proportion of drug and alcohol use is higher locally than nationally.

**132**.

A new SAT study course is tested on 12 individuals. Pre-course and post-course scores are recorded. Of interest is the mean increase in SAT scores. The following data are collected:

| **Pre-course score** | **Post-course score** |
| --- | --- |
| 1 | 300 |
| 960 | 920 |
| 1010 | 1100 |
| 840 | 880 |
| 1100 | 1070 |
| 1250 | 1320 |
| 860 | 860 |
| 1330 | 1370 |
| 790 | 770 |
| 990 | 1040 |
| 1110 | 1200 |
| 740 | 850 |

**Table** **10.35**

[**133**](https://openstax.org/books/introductory-statistics/pages/10-solutions#fs-idm28383952-solution).

University of Michigan researchers reported in the *Journal of the National Cancer Institute* that quitting smoking is especially beneficial for those under age 49. In this American Cancer Society study, the risk (probability) of dying of lung cancer was about the same as for those who had never smoked.

**134**.

Lesley E. Tan investigated the relationship between left-handedness vs. right-handedness and motor competence in preschool children. Random samples of 41 left-handed preschool children and 41 right-handed preschool children were given several tests of motor skills to determine if there is evidence of a difference between the children based on this experiment. The experiment produced the means and standard deviations shown [**Table 10.36**](https://openstax.org/books/introductory-statistics/pages/10-bringing-it-together-homework#fs-idp128816944). Determine the appropriate test and best distribution to use for that test.

|  |  |  |
| --- | --- | --- |
|  | Left-handed | Right-handed |
| Sample size | 41 | 41 |
| Sample mean | 97.5 | 98.1 |
| Sample standard deviation | 17.5 | 19.2 |

**Table** **10.36**

1. Two independent means, normal distribution
2. Two independent means, Student’s-t distribution
3. Matched or paired samples, Student’s-t distribution
4. Two population proportions, normal distribution

[**135**](https://openstax.org/books/introductory-statistics/pages/10-solutions#fs-idp144471136-solution).

A golf instructor is interested in determining if her new technique for improving players’ golf scores is effective. She takes four (4) new students. She records their 18-hole scores before learning the technique and then after having taken her class. She conducts a hypothesis test. The data are as [**Table 10.37**](https://openstax.org/books/introductory-statistics/pages/10-bringing-it-together-homework#fs-idp136885584).

|  | **Player 1** | **Player 2** | **Player 3** | **Player 4** |
| --- | --- | --- | --- | --- |
| Mean score before class | 83 | 78 | 93 | 87 |
| Mean score after class | 80 | 80 | 86 | 86 |

**Table** **10.37**

This is:

1. a test of two independent means.
2. a test of two proportions.
3. a test of a single mean.
4. a test of a single proportion.

[**1**](https://openstax.org/books/introductory-statistics/pages/10-practice#fs-idm22935904).

two proportions

[**3**](https://openstax.org/books/introductory-statistics/pages/10-practice#fs-idm161821520).

matched or paired samples

[**5**](https://openstax.org/books/introductory-statistics/pages/10-practice#fs-idp21825264).

single mean

[**7**](https://openstax.org/books/introductory-statistics/pages/10-practice#fs-idp3576048).

independent group means, population standard deviations and/or variances unknown

[**9**](https://openstax.org/books/introductory-statistics/pages/10-practice#fs-idm36046944).

two proportions

[**11**](https://openstax.org/books/introductory-statistics/pages/10-practice#fs-idm111997184).

independent group means, population standard deviations and/or variances unknown

[**13**](https://openstax.org/books/introductory-statistics/pages/10-practice#fs-idm155074576).

independent group means, population standard deviations and/or variances unknown

[**15**](https://openstax.org/books/introductory-statistics/pages/10-practice#fs-idm152397632).

two proportions

[**17**](https://openstax.org/books/introductory-statistics/pages/10-practice#fs-idm213711120).

The random variable is the difference between the mean amounts of sugar in the two soft drinks.

[**19**](https://openstax.org/books/introductory-statistics/pages/10-practice#fs-idm77134224).

means

[**21**](https://openstax.org/books/introductory-statistics/pages/10-practice#fs-idp13932064).

two-tailed

[**23**](https://openstax.org/books/introductory-statistics/pages/10-practice#fs-idm147822240).

the difference between the mean life spans of White and non-White people

[**25**](https://openstax.org/books/introductory-statistics/pages/10-practice#fs-idm121049024).

This is a comparison of two population means with unknown population standard deviations.

[**27**](https://openstax.org/books/introductory-statistics/pages/10-practice#fs-idm120924688).

Check student’s solution.

[**29**](https://openstax.org/books/introductory-statistics/pages/10-practice#fs-idm129306608).

1. Reject the null hypothesis
2. *p*-value < 0.05
3. There is not enough evidence at the 5% level of significance to support the claim that life expectancy in the 1900s is different between White and non-White people.

[**31**](https://openstax.org/books/introductory-statistics/pages/10-practice#fs-idm106340640).

The difference in mean speeds of the fastball pitches of the two pitchers

[**33**](https://openstax.org/books/introductory-statistics/pages/10-practice#fs-idm113366480).

–2.46

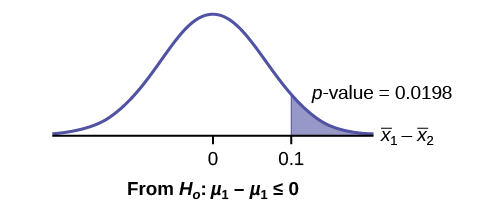
[**35**](https://openstax.org/books/introductory-statistics/pages/10-practice#fs-idm126168192).

At the 1% significance level, we can reject the null hypothesis. There is sufficient data to conclude that the mean speed of Rodriguez’s fastball is faster than Wesley’s.

[**37**](https://openstax.org/books/introductory-statistics/pages/10-practice#fs-idm92555424).

Subscripts: 1 = Food, 2 = No Food  
*H0*: *μ1* ≤ *μ2*  
*Ha*: *μ1* > *μ2*

[**39**](https://openstax.org/books/introductory-statistics/pages/10-practice#fs-idm112309984).



**Figure 10.18**

[**41**](https://openstax.org/books/introductory-statistics/pages/10-practice#fs-idm4478224).

Subscripts: 1 = Gamma, 2 = Zeta  
*H0*: *μ*1 = *μ*2  
*Ha*: *μ*1 ≠ *μ*2

[**43**](https://openstax.org/books/introductory-statistics/pages/10-practice#fs-idm100159520).

0.0062

[**45**](https://openstax.org/books/introductory-statistics/pages/10-practice#fs-idm85314992).

There is sufficient evidence to reject the null hypothesis. The data support that the melting point for Alloy Zeta is different from the melting point of Alloy Gamma.

[**47**](https://openstax.org/books/introductory-statistics/pages/10-practice#eip-964).

*P*′OS1 – *P*′OS2 = difference in the proportions of phones that had system failures within the first eight hours of operation with OS1 and OS2.

[**49**](https://openstax.org/books/introductory-statistics/pages/10-practice#eip-56).

0.1018

[**51**](https://openstax.org/books/introductory-statistics/pages/10-practice#element-385).

proportions

[**53**](https://openstax.org/books/introductory-statistics/pages/10-practice#element-22).

right-tailed

[**55**](https://openstax.org/books/introductory-statistics/pages/10-practice#element-386).

The random variable is the difference in proportions (percents) of the populations that are of two or more races in Nevada and North Dakota.

[**57**](https://openstax.org/books/introductory-statistics/pages/10-practice#element-464).

Our sample sizes are much greater than five each, so we use the normal for two proportions distribution for this hypothesis test.

[**59**](https://openstax.org/books/introductory-statistics/pages/10-practice#element-814).

Check student’s solution.

[**61**](https://openstax.org/books/introductory-statistics/pages/10-practice#element-723).

1. Reject the null hypothesis.
2. *p*-value < alpha
3. At the 5% significance level, there is sufficient evidence to conclude that the proportion (percent) of the population that is of two or more races in Nevada is statistically higher than that in North Dakota.

[**63**](https://openstax.org/books/introductory-statistics/pages/10-practice#fs-idm5499280).

the mean difference of the system failures

[**65**](https://openstax.org/books/introductory-statistics/pages/10-practice#fs-idm10056224).

0.0067

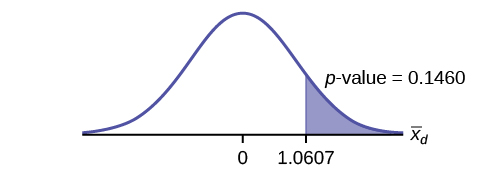
[**67**](https://openstax.org/books/introductory-statistics/pages/10-practice#fs-idp92713024).

With a *p*-value 0.0067, we can reject the null hypothesis. There is enough evidence to support that the software patch is effective in reducing the number of system failures.

[**69**](https://openstax.org/books/introductory-statistics/pages/10-practice#fs-idp15011664).

0.0021

[**71**](https://openstax.org/books/introductory-statistics/pages/10-practice#fs-idp9592768).



**Figure 10.19**

[**73**](https://openstax.org/books/introductory-statistics/pages/10-practice#fs-idp5612992).

*H0*: *μd* ≥ 0

*Ha*: *μd* < 0

[**75**](https://openstax.org/books/introductory-statistics/pages/10-practice#fs-idp69509280).

0.0699

[**77**](https://openstax.org/books/introductory-statistics/pages/10-practice#fs-idm55198624).

We decline to reject the null hypothesis. There is not sufficient evidence to support that the medication is effective.

[**79**](https://openstax.org/books/introductory-statistics/pages/10-homework#fs-idm8894688).

Subscripts: 1: two-year colleges; 2: four-year colleges

1. *H0*: *μ1* ≥ *μ2*
2. *Ha*: *μ1* < *μ2*
3. X¯¯¯1–X¯¯¯2�¯1–�¯2 is the difference between the mean enrollments of the two-year colleges and the four-year colleges.
4. Student’s-*t*
5. test statistic: -0.2480
6. *p*-value: 0.4019
7. Check student’s solution.
   1. Alpha: 0.05
   2. Decision: Do not reject
   3. Reason for Decision: *p*-value > alpha
   4. Conclusion: At the 5% significance level, there is sufficient evidence to conclude that the mean enrollment at four-year colleges is higher than at two-year colleges.

[**81**](https://openstax.org/books/introductory-statistics/pages/10-homework#fs-idm122985232).

Subscripts: 1: mechanical engineering; 2: electrical engineering

1. *H0*: *µ1* ≥ *µ2*
2. *Ha*: *µ1* < *µ2*
3. X¯¯¯1−X¯¯¯2�¯1−�¯2 is the difference between the mean entry level salaries of mechanical engineers and electrical engineers.
4. *t*108
5. test statistic: *t* = –0.82
6. *p*-value: 0.2061
7. Check student’s solution.
   1. Alpha: 0.05
   2. Decision: Do not reject the null hypothesis.
   3. Reason for Decision: *p*-value > alpha
   4. Conclusion: At the 5% significance level, there is insufficient evidence to conclude that the mean entry-level salaries of mechanical engineers is lower than that of electrical engineers.

[**83**](https://openstax.org/books/introductory-statistics/pages/10-homework#fs-idm50796704).

1. *H0*: *µ1* = *µ2*
2. *Ha*: *µ1* ≠ *µ2*
3. X¯¯¯1−X¯¯¯2�¯1−�¯2 is the difference between the mean times for completing a lap in races and in practices.
4. *t*20.32
5. test statistic: –4.70
6. *p*-value: 0.0001
7. Check student’s solution.
   1. Alpha: 0.05
   2. Decision: Reject the null hypothesis.
   3. Reason for Decision: *p*-value < alpha
   4. Conclusion: At the 5% significance level, there is sufficient evidence to conclude that the mean time for completing a lap in races is different from that in practices.

[**85**](https://openstax.org/books/introductory-statistics/pages/10-homework#fs-idm170930784).

1. *H0*: *µ1* = *µ2*
2. *Ha*: *µ1* ≠ *µ2*
3. is the difference between the mean times for completing a lap in races and in practices.
4. *t*40.94
5. test statistic: –5.08
6. *p*-value: zero
7. Check student’s solution.
   1. Alpha: 0.05
   2. Decision: Reject the null hypothesis.
   3. Reason for Decision: *p*-value < alpha
   4. Conclusion: At the 5% significance level, there is sufficient evidence to conclude that the mean time for completing a lap in races is different from that in practices.

[**88**](https://openstax.org/books/introductory-statistics/pages/10-homework#fs-idm3207760).

c

[**90**](https://openstax.org/books/introductory-statistics/pages/10-homework#fs-idm81478720).

Test: two independent sample means, population standard deviations unknown.

μ1�1 = the the mean price of a sociology text on the selected site.

μ2�2 = the mean price of a math/science text on the selected site.

Random variable: X1¯¯¯¯−X1¯¯¯¯�1¯-�1¯ = the difference in the sample mean textbook price between sociology texts and math/science texts.

Hypotheses: H0 : μ1−μ2 = 0, Ha : μ1 − μ2 < μ2�0 : �1-�2 = 0, �� : �1 - �2 < �2 which can be expressed as H0s: μ1−μ2, Ha μ1 < μ2H0s: μ1-μ2, Ha μ1 < μ2.

Distribution for the test: Use tdf���; because each sample has more than 30 observations, df=n1+n2−2=33+33−2=64��=�1+�2-2=33+33-2=64.

Estimate the critical value on the t�-table using the nearest available degrees of freedom, 60. The critical value, 2.660, is found in the .0005 column.

Calculate the test statistic: tc=(X¯¯¯1−X¯¯¯2)−0s12n2+s22n2√=(74.64−111.56)−049.36233+66.90233√=−2.55��=(�¯1-�¯2)-0�12�2+�22�2=(74.64-111.56)-049.36233+66.90233=-2.55.

Using a calculator with tc=−2.55��=-2.55 and df=64��=64, the left-tailed p�-value: Decision: Reject H0�0. Conclusion: At the 1% level of significance, from the sample data, there is sufficient evidence to conclude that the mean price of sociology textbooks is less than the mean price of textbooks for math/science.

[**92**](https://openstax.org/books/introductory-statistics/pages/10-homework#eip-17).

d

[**94**](https://openstax.org/books/introductory-statistics/pages/10-homework#exer29).

Subscripts: 1 = boys, 2 = girls

1. *H0*: *µ1* ≤ *µ2*
2. *Ha*: *µ1* > *µ2*
3. The random variable is the difference in the mean auto insurance costs for boys and girls.
4. normal
5. test statistic: *z* = 2.50
6. *p*-value: 0.0062
7. Check student’s solution.
   1. Alpha: 0.05
   2. Decision: Reject the null hypothesis.
   3. Reason for Decision: *p*-value < alpha
   4. Conclusion: At the 5% significance level, there is sufficient evidence to conclude that the mean cost of auto insurance for teenage boys is greater than that for girls.

[**96**](https://openstax.org/books/introductory-statistics/pages/10-homework#exer32).

Subscripts: 1 = non-hybrid sedans, 2 = hybrid sedans

1. *H0*: *µ1* ≥ *µ2*
2. *Ha*: *µ1* < *µ2*
3. The random variable is the difference in the mean miles per gallon of non-hybrid sedans and hybrid sedans.
4. normal
5. test statistic: 6.36
6. *p*-value: 0
7. Check student’s solution.
   1. Alpha: 0.05
   2. Decision: Reject the null hypothesis.
   3. Reason for decision: *p*-value < alpha
   4. Conclusion: At the 5% significance level, there is sufficient evidence to conclude that the mean miles per gallon of non-hybrid sedans is less than that of hybrid sedans.

[**98**](https://openstax.org/books/introductory-statistics/pages/10-homework#eip-267).

1. *H0*: *µd* = 0
2. *Ha*: *µd* < 0
3. The random variable *Xd* is the average difference between husband’s and wife’s satisfaction level.
4. *t*9
5. test statistic: *t* = –1.86
6. *p*-value: 0.0479
7. Check student’s solution
   1. Alpha: 0.05
   2. Decision: Reject the null hypothesis, but run another test.
   3. Reason for Decision: *p*-value < alpha
   4. Conclusion: This is a weak test because alpha and the *p*-value are close. However, there is insufficient evidence to conclude that the mean difference is negative.

[**100**](https://openstax.org/books/introductory-statistics/pages/10-homework#exer18).

1. *H0*: *PW* = *PB*
2. *Ha*: *PW* ≠ *PB*
3. The random variable is the difference in the proportions of White and Black suicide victims, aged 15 to 24.
4. normal for two proportions
5. test statistic: –0.1944
6. *p*-value: 0.8458
7. Check student’s solution.
   1. Alpha: 0.05
   2. Decision: Reject the null hypothesis.
   3. Reason for decision: *p*-value > alpha
   4. Conclusion: At the 5% significance level, there is insufficient evidence to conclude that the proportions of White and Black female suicide victims, aged 15 to 24, are different.

[**102**](https://openstax.org/books/introductory-statistics/pages/10-homework#exer24).

Subscripts: 1 = Cabrillo College, 2 = Lake Tahoe College

1. *H0*: *p1* = *p2*
2. *Ha*: *p1* ≠ *p2*
3. The random variable is the difference between the proportions of Hispanic students at Cabrillo College and Lake Tahoe College.
4. normal for two proportions
5. test statistic: 4.29
6. *p*-value: 0.00002
7. Check student’s solution.
   1. Alpha: 0.05
   2. Decision: Reject the null hypothesis.
   3. Reason for decision: *p*-value < alpha
   4. Conclusion: There is sufficient evidence to conclude that the proportions of Hispanic students at Cabrillo College and Lake Tahoe College are different.

[**104**](https://openstax.org/books/introductory-statistics/pages/10-homework#element-552).

a

[**106**](https://openstax.org/books/introductory-statistics/pages/10-homework#fs-idp30249712).

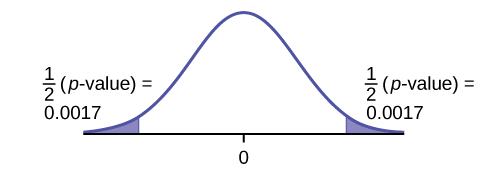
Test: two independent sample proportions.

Random variable: *p*′1 - *p*′2

Distribution:  
*H0*: *p1* = *p2*  
*Ha*: *p1* ≠ *p2*

The proportion of eReader users is different for the 16- to 29-year-old users from that of the 30 and older users.

Graph: two-tailed



**Figure 10.20**

*p*-value : 0.0033

Decision: Reject the null hypothesis.

Conclusion: At the 5% level of significance, from the sample data, there is sufficient evidence to conclude that the proportion of eReader users 16 to 29 years old is different from the proportion of eReader users 30 and older.

[**108**](https://openstax.org/books/introductory-statistics/pages/10-homework#fs-idm16853120).

Test: two independent sample proportions

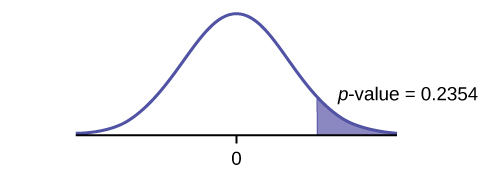
Random variable: *p′1* − *p′2*

Distribution:

*H0*: *p1* = *p2*  
*Ha*: *p1* > *p2*

A higher proportion of tablet owners are aged 16 to 29 years old than are 30 years old and older.

Graph: right-tailed



**Figure 10.21**

*p*-value: 0.2354

Decision: Do not reject the *H0*.

Conclusion: At the 1% level of significance, from the sample data, there is not sufficient evidence to conclude that a higher proportion of tablet owners are aged 16 to 29 years old than are 30 years old and older.

[**110**](https://openstax.org/books/introductory-statistics/pages/10-homework#fs-idm174644848).

Subscripts: 1: men; 2: women

1. *H0*: *p1* ≤ *p2*
2. *Ha*: *p1* > *p2*
3. P′1−P′2�′1−�′2 is the difference between the proportions of men and women who enjoy shopping for electronic equipment.
4. normal for two proportions
5. test statistic: 0.22
6. *p*-value: 0.4133
7. Check student’s solution.
   1. Alpha: 0.05
   2. Decision: Do not reject the null hypothesis.
   3. Reason for Decision: *p*-value > alpha
   4. Conclusion: At the 5% significance level, there is insufficient evidence to conclude that the proportion of men who enjoy shopping for electronic equipment is more than the proportion of women.

[**112**](https://openstax.org/books/introductory-statistics/pages/10-homework#fs-idm98770112).

1. *H0*: *p1* = *p2*
2. *Ha*: *p1* ≠ *p2*
3. P′1−P′2�′1−�′2 is the difference between the proportions of men and women that have at least one pierced ear.
4. normal for two proportions
5. test statistic: –4.82
6. *p*-value: zero
7. Check student’s solution.
   1. Alpha: 0.05
   2. Decision: Reject the null hypothesis.
   3. Reason for Decision: *p*-value < alpha
   4. Conclusion: At the 5% significance level, there is sufficient evidence to conclude that the proportions of males and females with at least one pierced ear is different.

[**114**](https://openstax.org/books/introductory-statistics/pages/10-homework#fs-idm104246192).

1. *H0*: *µd* = 0
2. *Ha*: *µd* > 0
3. The random variable *Xd* is the mean difference in work times on days when eating breakfast and on days when not eating breakfast.
4. *t*9
5. test statistic: 4.8963
6. *p*-value: 0.0004
7. Check student’s solution.
   1. Alpha: 0.05
   2. Decision: Reject the null hypothesis.
   3. Reason for Decision: *p*-value < alpha
   4. Conclusion: At the 5% level of significance, there is sufficient evidence to conclude that the mean difference in work times on days when eating breakfast and on days when not eating breakfast has increased.

[**115**](https://openstax.org/books/introductory-statistics/pages/10-homework#fs-idp64398288).

*p*-value = 0.1494

At the 5% significance level, there is insufficient evidence to conclude that the medication lowered cholesterol levels after 12 weeks.

[**117**](https://openstax.org/books/introductory-statistics/pages/10-homework#element-198).

b

[**119**](https://openstax.org/books/introductory-statistics/pages/10-homework#element-954).

c

[**121**](https://openstax.org/books/introductory-statistics/pages/10-homework#fs-idp31663264).

Test: two matched pairs or paired samples (*t*-test)

Random variable: X¯¯¯d�¯�

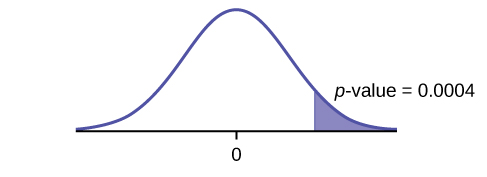
Distribution: *t*12

*H0*: *μd* = 0 *Ha*: *μd* > 0

The mean of the differences of new female breast cancer cases in the south between 2013 and 2012 is greater than zero. The estimate for new female breast cancer cases in the south is higher in 2013 than in 2012.

Graph: right-tailed

*p*-value: 0.0004



**Figure 10.22**

Decision: Reject *H0*

Conclusion: At the 5% level of significance, from the sample data, there is sufficient evidence to conclude that there was a higher estimate of new female breast cancer cases in 2013 than in 2012.

[**123**](https://openstax.org/books/introductory-statistics/pages/10-homework#fs-idp111440192).

Test: matched or paired samples (*t*-test)

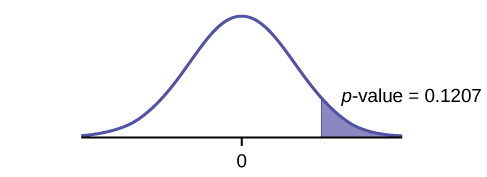
Difference data: {–0.9, –3.7, –3.2, –0.5, 0.6, –1.9, –0.5, 0.2, 0.6, 0.4, 1.7, –2.4, 1.8}

Random Variable: X¯¯¯d�¯�

Distribution: *H0*: *μd* = 0 *Ha*: *μd* < 0

The mean of the differences of the rate of underemployment in the northeastern states between 2012 and 2011 is less than zero. The underemployment rate went down from 2011 to 2012.

Graph: left-tailed.



**Figure 10.23**

*p*-value: 0.1207

Decision: Do not reject *H0*.

Conclusion: At the 5% level of significance, from the sample data, there is not sufficient evidence to conclude that there was a decrease in the underemployment rates of the northeastern states from 2011 to 2012.

[**125**](https://openstax.org/books/introductory-statistics/pages/10-bringing-it-together-homework#fs-idm89593504).

e

[**127**](https://openstax.org/books/introductory-statistics/pages/10-bringing-it-together-homework#fs-idm53146784).

d

[**129**](https://openstax.org/books/introductory-statistics/pages/10-bringing-it-together-homework#fs-idp12095488).

f

[**131**](https://openstax.org/books/introductory-statistics/pages/10-bringing-it-together-homework#fs-idm45776544).

e

[**133**](https://openstax.org/books/introductory-statistics/pages/10-bringing-it-together-homework#fs-idm28383952).

f

[**135**](https://openstax.org/books/introductory-statistics/pages/10-bringing-it-together-homework#fs-idp144471136).

a

In this type of hypothesis test, you determine whether the data **"fit"** a particular distribution or not. For example, you may suspect your unknown data fit a binomial distribution. You use a chi-square test (meaning the distribution for the hypothesis test is chi-square) to determine if there is a fit or not. **The null and the alternative hypotheses for this test may be written in sentences or may be stated as equations or inequalities.**

The test statistic for a goodness-of-fit test is:

Σk(O−E)2E��(�−�)2�

where:

* O = **observed values** (data)
* E = **expected values** (from theory)
* k = the number of different data cells or categories

**The observed values are the data values and the expected values are the values you would expect to get if the null hypothesis were true.** There are n terms of the form (O−E)2E(�−�)2�.

The number of degrees of freedom is df = (number of categories – 1).

**The goodness-of-fit test is almost always right-tailed.** If the observed values and the corresponding expected values are not close to each other, then the test statistic can get very large and will be way out in the right tail of the chi-square curve.

### NOTE

The expected value for each cell needs to be at least five in order for you to use this test.

### EXAMPLE 11.1

Absenteeism of college students from math classes is a major concern to math instructors because missing class appears to increase the drop rate. Suppose that a study was done to determine if the actual student absenteeism rate follows faculty perception. The faculty expected that a group of 100 students would miss class according to [Table 11.1](https://openstax.org/books/introductory-statistics/pages/11-2-goodness-of-fit-test#M03_Ch03_tbl001).

| **Number of absences per term** | **Expected number of students** |
| --- | --- |
| 0–2 | 50 |
| 3–5 | 30 |
| 6–8 | 12 |
| 9–11 | 6 |
| 12+ | 2 |

**Table** **11.1**

A random survey across all mathematics courses was then done to determine the actual number **(observed)** of absences in a course. The chart in [Table 11.2](https://openstax.org/books/introductory-statistics/pages/11-2-goodness-of-fit-test#M03_Ch03_tbl002) displays the results of that survey.

| **Number of absences per term** | **Actual number of students** |
| --- | --- |
| 0–2 | 35 |
| 3–5 | 40 |
| 6–8 | 20 |
| 9–11 | 1 |
| 12+ | 4 |

**Table** **11.2**

Determine the null and alternative hypotheses needed to conduct a goodness-of-fit test.

**H0:** Student absenteeism **fits** faculty perception.

The alternative hypothesis is the opposite of the null hypothesis.

**Ha:** Student absenteeism **does not fit** faculty perception.

#### Problem

a. Can you use the information as it appears in the charts to conduct the goodness-of-fit test?

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#### Problem

b. What is the number of degrees of freedom (df)?

### TRY IT 11.1

A factory manager needs to understand how many products are defective versus how many are produced. The number of expected defects is listed in [Table 11.5](https://openstax.org/books/introductory-statistics/pages/11-2-goodness-of-fit-test#M03_Ch03_tbl005).

| **Number produced** | **Number defective** |
| --- | --- |
| 0–100 | 5 |
| 101–200 | 6 |
| 201–300 | 7 |
| 301–400 | 8 |
| 401–500 | 10 |

**Table** **11.5**

A random sample was taken to determine the actual number of defects. [Table 11.6](https://openstax.org/books/introductory-statistics/pages/11-2-goodness-of-fit-test#M03_Ch03_tbl006) shows the results of the survey.

| **Number produced** | **Number defective** |
| --- | --- |
| 0–100 | 5 |
| 101–200 | 7 |
| 201–300 | 8 |
| 301–400 | 9 |
| 401–500 | 11 |

**Table** **11.6**

State the null and alternative hypotheses needed to conduct a goodness-of-fit test, and state the degrees of freedom.

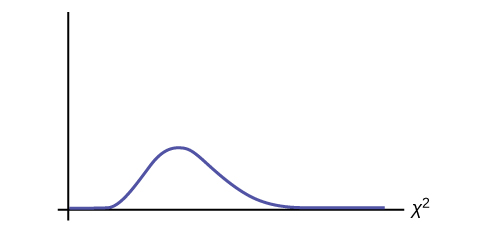
### EXAMPLE 11.2

#### Problem

Employers want to know which days of the week employees are absent in a five-day work week. Most employers would like to believe that employees are absent equally during the week. Suppose a random sample of 60 managers were asked on which day of the week they had the highest number of employee absences. The results were distributed as in [Table 11.7](https://openstax.org/books/introductory-statistics/pages/11-2-goodness-of-fit-test#M03_Ch03_tbl007). For the population of employees, do the days for the highest number of absences occur with equal frequencies during a five-day work week? Test at a 5% significance level.

|  | **Monday** | **Tuesday** | **Wednesday** | **Thursday** | **Friday** |
| --- | --- | --- | --- | --- | --- |
| Number of Absences | 15 | 12 | 9 | 9 | 15 |

**Table** **11.7** Day of the Week Employees were Most Absent



### TRY IT 11.2

Teachers want to know which night each week their students are doing most of their homework. Most teachers think that students do homework equally throughout the week. Suppose a random sample of 56 students were asked on which night of the week they did the most homework. The results were distributed as in [Table 11.8](https://openstax.org/books/introductory-statistics/pages/11-2-goodness-of-fit-test#M03_Ch03_tbl008).

|  | **Sunday** | **Monday** | **Tuesday** | **Wednesday** | **Thursday** | **Friday** | **Saturday** |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Number of Students | 11 | 8 | 10 | 7 | 10 | 5 | 5 |

**Table** **11.8**

From the population of students, do the nights for the highest number of students doing the majority of their homework occur with equal frequencies during a week? What type of hypothesis test should you use?

### EXAMPLE 11.3

One study indicates that the number of televisions that American families have is distributed (this is the **given** distribution for the American population) as in [Table 11.9](https://openstax.org/books/introductory-statistics/pages/11-2-goodness-of-fit-test#M03_Ch03_tbl009).

| **Number of Televisions** | **Percent** |
| --- | --- |
| 0 | 10 |
| 1 | 16 |
| 2 | 55 |
| 3 | 11 |
| 4+ | 8 |

**Table** **11.9**

The table contains expected (E) percents.

A random sample of 600 families in the far western United States resulted in the data in [Table 11.10](https://openstax.org/books/introductory-statistics/pages/11-2-goodness-of-fit-test#M03_Ch03_tbl010).

| **Number of Televisions** | **Frequency** |
| --- | --- |
| 0 | 66 |
| 1 | 119 |
| 2 | 340 |
| 3 | 60 |
| 4+ | 15 |
|  | Total = 600 |

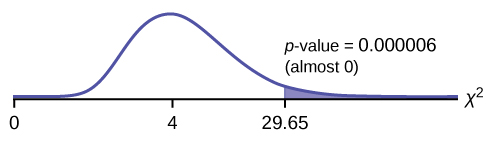
**Table** **11.10**

The table contains observed (O) frequency values.

#### Problem

At the 1% significance level, does it appear that the distribution "number of televisions" of far western United States families is different from the distribution for the American population as a whole?

|  |  |  |
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### TRY IT 11.3

The expected percentage of the number of pets students have in their homes is distributed (this is the given distribution for the student population of the United States) as in [Table 11.12](https://openstax.org/books/introductory-statistics/pages/11-2-goodness-of-fit-test#fs-idm147763264).

| **Number of Pets** | **Percent** |
| --- | --- |
| 0 | 18 |
| 1 | 25 |
| 2 | 30 |
| 3 | 18 |
| 4+ | 9 |

**Table** **11.12**

A random sample of 1,000 students from the Eastern United States resulted in the data in [Table 11.13](https://openstax.org/books/introductory-statistics/pages/11-2-goodness-of-fit-test#fs-idm64242624).

| **Number of Pets** | **Frequency** |
| --- | --- |
| 0 | 210 |
| 1 | 240 |
| 2 | 320 |
| 3 | 140 |
| 4+ | 90 |

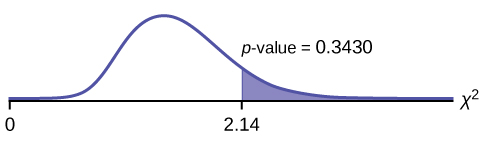
**Table** **11.13**

At the 1% significance level, does it appear that the distribution “number of pets” of students in the Eastern United States is different from the distribution for the United States student population as a whole? What is the p-value?

### EXAMPLE 11.4

#### Problem

Suppose you flip two coins 100 times. The results are 20 HH, 27 HT, 30 TH, and 23 TT. Are the coins fair? Test at a 5% significance level.



### TRY IT 11.4

Students in a social studies class hypothesize that the literacy rates across the world for every region are 82%. [Table 11.14](https://openstax.org/books/introductory-statistics/pages/11-2-goodness-of-fit-test#fs-idm84960960) shows the actual literacy rates across the world broken down by region. What are the test statistic and the degrees of freedom?

| **MDG Region** | **Adult Literacy Rate (%)** |
| --- | --- |
| Developed Regions | 99.0 |
| Commonwealth of Independent States | 99.5 |
| Northern Africa | 67.3 |
| Sub-Saharan Africa | 62.5 |
| Latin America and the Caribbean | 91.0 |
| Eastern Asia | 93.8 |
| Southern Asia | 61.9 |
| South-Eastern Asia | 91.9 |
| Western Asia | 84.5 |
| Oceania | 66.4 |

**Table** **11.14**

Tests of independence involve using a **contingency table** of observed (data) values.

The test statistic for a **test of independence** is similar to that of a goodness-of-fit test:

Σ(i⋅j)(O–E)2E�(�⋅�)(�–�)2�

where:

* O = observed values
* E = expected values
* i = the number of rows in the table
* j = the number of columns in the table

There are i⋅j�⋅� terms of the form (O–E)2E(�–�)2�.

**A test of independence determines whether two factors are independent or not.** You first encountered the term independence in [Probability Topics](https://openstax.org/books/introductory-statistics/pages/3-introduction). As a review, consider the following example.

### NOTE

The expected value for each cell needs to be at least five in order for you to use this test.

### EXAMPLE 11.5

Suppose A = a speeding violation in the last year and B = a cell phone user while driving. If A and B are independent then P(A AND B) = P(A)P(B). A AND B is the event that a driver received a speeding violation last year and also used a cell phone while driving. Suppose, in a study of drivers who received speeding violations in the last year, and who used cell phone while driving, that 755 people were surveyed. Out of the 755, 70 had a speeding violation and 685 did not; 305 used cell phones while driving and 450 did not.

Let y = expected number of drivers who used a cell phone while driving and received speeding violations.

If A and B are independent, then P(A AND B) = P(A)P(B). By substitution,

y755=(70755)(305755)�755=(70755)(305755)

Solve for y: y = (70)(305)755=28.3(70)(305)755=28.3

About 28 people from the sample are expected to use cell phones while driving and to receive speeding violations.

In a test of independence, we state the null and alternative hypotheses in words. Since the contingency table consists of **two factors**, the null hypothesis states that the factors are **independent** and the alternative hypothesis states that they are **not independent (dependent)**. If we do a test of independence using the example, then the null hypothesis is:

H0: Being a cell phone user while driving and receiving a speeding violation are independent events.

If the null hypothesis were true, we would expect about 28 people to use cell phones while driving and to receive a speeding violation.

**The test of independence is always right-tailed** because of the calculation of the test statistic. If the expected and observed values are not close together, then the test statistic is very large and way out in the right tail of the chi-square curve, as it is in a goodness-of-fit.

The number of degrees of freedom for the test of independence is:

df = (number of columns - 1)(number of rows - 1)

The following formula calculates the **expected number** (E):

E=(row total)(column total)total number surveyed�=(row total)(column total)total number surveyed

### TRY IT 11.5

A sample of 300 students is taken. Of the students surveyed, 50 were music students, while 250 were not. Ninety-seven were on the honor roll, while 203 were not. If we assume being a music student and being on the honor roll are independent events, what is the expected number of music students who are also on the honor roll?

### EXAMPLE 11.6

In a volunteer group, adults 21 and older volunteer from one to nine hours each week to spend time with a disabled senior citizen. The program recruits among community college students, four-year college students, and nonstudents. In [Table 11.15](https://openstax.org/books/introductory-statistics/pages/11-3-test-of-independence#table-73248) is a **sample** of the adult volunteers and the number of hours they volunteer per week.

| **Type of Volunteer** | **1–3 Hours** | **4–6 Hours** | **7–9 Hours** | **Row Total** |
| --- | --- | --- | --- | --- |
| Community College Students | 111 | 96 | 48 | 255 |
| Four-Year College Students | 96 | 133 | 61 | 290 |
| Nonstudents | 91 | 150 | 53 | 294 |
| Column Total | 298 | 379 | 162 | 839 |

**Table** **11.15** Number of Hours Worked Per Week by Volunteer Type (Observed) The table contains **observed (O)** values (data).

#### Problem

Is the number of hours volunteered **independent** of the type of volunteer?

#### Solution 1

The **observed table** and the question at the end of the problem, "Is the number of hours volunteered independent of the type of volunteer?" tell you this is a test of independence. The two factors are **number of hours volunteered** and **type of volunteer**. This test is always right-tailed.

H0: The number of hours volunteered is **independent** of the type of volunteer.

Ha: The number of hours volunteered is **dependent** on the type of volunteer.

The expected results are in [Table 11.16](https://openstax.org/books/introductory-statistics/pages/11-3-test-of-independence#table-73248a).

| **Type of Volunteer** | **1-3 Hours** | **4-6 Hours** | **7-9 Hours** |
| --- | --- | --- | --- |
| Community College Students | 90.57 | 115.19 | 49.24 |
| Four-Year College Students | 103.00 | 131.00 | 56.00 |
| Nonstudents | 104.42 | 132.81 | 56.77 |

**Table** **11.16** Number of Hours Worked Per Week by Volunteer Type (Expected) The table contains **expected** (E) values (data).

For example, the calculation for the expected frequency for the top left cell is

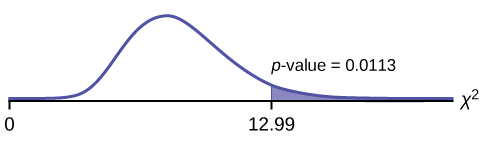
E=(row total)(column total)total number surveyed=(255)(298)839=90.57�=(row total)(column total)total number surveyed=(255)(298)839=90.57

**Calculate the test statistic:** χ2 = 12.99 (calculator or computer)

**Distribution for the test:** χ24�42

df = (3 columns – 1)(3 rows – 1) = (2)(2) = 4

**Graph:**



**Figure 11.7**

**Probability statement:** p-value=P(χ2 > 12.99) = 0.0113

**Compare α and the p-value:** Since no α is given, assume α = 0.05. p-value = 0.0113. α > p-value.

**Make a decision:** Since α > p-value, reject H0. This means that the factors are not independent.

**Conclusion:** At a 5% level of significance, from the data, there is sufficient evidence to conclude that the number of hours volunteered and the type of volunteer are dependent on one another.

For the example in [Table 11.15](https://openstax.org/books/introductory-statistics/pages/11-3-test-of-independence#table-73248), if there had been another type of volunteer, teenagers, what would the degrees of freedom be?

### USING THE TI-83, 83+, 84, 84+ CALCULATOR

Press the MATRX key and arrow over to EDIT. Press 1:[A]. Press 3 ENTER 3 ENTER. Enter the table values by row from [Table 11.15](https://openstax.org/books/introductory-statistics/pages/11-3-test-of-independence#table-73248). Press ENTER after each. Press 2nd QUIT. Press STAT and arrow over to TESTS. Arrow down to C:χ2-TEST. Press ENTER. You should see Observed:[A] and Expected:[B]. If necessary, use the arrow keys to move the cursor after Observed: and press 2nd MATRX. Press 1:[A] to select matrix A. It is not necessary to enter expected values. The matrix listed after Expected: can be blank. Arrow down to Calculate. Press ENTER. The test statistic is 12.9909 and the p-value = 0.0113. Do the procedure a second time, but arrow down to Draw instead of calculate.

### TRY IT 11.6

The Bureau of Labor Statistics gathers data about employment in the United States. A sample is taken to calculate the number of U.S. citizens working in one of several industry sectors over time. [Table 11.17](https://openstax.org/books/introductory-statistics/pages/11-3-test-of-independence#fs-idp61742592) shows the results:

| **Industry Sector** | **2000** | **2010** | **2020** | **Total** |
| --- | --- | --- | --- | --- |
| Nonagriculture wage and salary | 13,243 | 13,044 | 15,018 | 41,305 |
| Goods-producing, excluding agriculture | 2,457 | 1,771 | 1,950 | 6,178 |
| Services-providing | 10,786 | 11,273 | 13,068 | 35,127 |
| Agriculture, forestry, fishing, and hunting | 240 | 214 | 201 | 655 |
| Nonagriculture self-employed and unpaid family worker | 931 | 894 | 972 | 2,797 |
| Secondary wage and salary jobs in agriculture and private household industries | 14 | 11 | 11 | 36 |
| Secondary jobs as a self-employed or unpaid family worker | 196 | 144 | 152 | 492 |
| Total | 27,867 | 27,351 | 31,372 | 86,590 |

**Table** **11.17**

We want to know if the change in the number of jobs is independent of the change in years. State the null and alternative hypotheses and the degrees of freedom.

### EXAMPLE 11.7

De Anza College is interested in the relationship between anxiety level and the need to succeed in school. A random sample of 400 students took a test that measured anxiety level and need to succeed in school. [Table 11.18](https://openstax.org/books/introductory-statistics/pages/11-3-test-of-independence#element-875) shows the results. De Anza College wants to know if anxiety level and need to succeed in school are independent events.

| **Need to Succeed in School** | **High Anxiety** | **Med-high Anxiety** | **Medium Anxiety** | **Med-low Anxiety** | **Low Anxiety** | **Row Total** |
| --- | --- | --- | --- | --- | --- | --- |
| High Need | 35 | 42 | 53 | 15 | 10 | 155 |
| Medium Need | 18 | 48 | 63 | 33 | 31 | 193 |
| Low Need | 4 | 5 | 11 | 15 | 17 | 52 |
| Column Total | 57 | 95 | 127 | 63 | 58 | 400 |

**Table** **11.18** Need to Succeed in School vs. Anxiety Level

#### Problem

a. How many high anxiety level students are expected to have a high need to succeed in school?

#### Solution 1

a. The column total for a high anxiety level is 57. The row total for high need to succeed in school is 155. The sample size or total surveyed is 400.

E=(row total)(column total)total surveyed=155⋅57400=22.09�=(row total)(column total)total surveyed=155⋅57400=22.09

The expected number of students who have a high anxiety level and a high need to succeed in school is about 22.

#### Problem

b. If the two variables are independent, how many students do you expect to have a low need to succeed in school and a med-low level of anxiety?

#### Solution 2

b. The column total for a med-low anxiety level is 63. The row total for a low need to succeed in school is 52. The sample size or total surveyed is 400.

#### Problem

c. E=(row total)(column total)total surveyed�=(row total)(column total)total surveyed = \_\_\_\_\_\_\_\_

#### Solution 3

c. E=(row total)(column total)total surveyed=8.19�=(row total)(column total)total surveyed=8.19

#### Problem

d. The expected number of students who have a med-low anxiety level and a low need to succeed in school is about \_\_\_\_\_\_\_\_.

#### Solution 4

d. 8

### TRY IT 11.7

Refer back to the information in [Try It 11.6](https://openstax.org/books/introductory-statistics/pages/11-3-test-of-independence#fs-idm24618832). How many service providing jobs are there expected to be in 2020? How many nonagriculture wage and salary jobs are there expected to be in 2020?

The goodness–of–fit test can be used to decide whether a population fits a given distribution, but it will not suffice to decide whether two populations follow the same unknown distribution. A different test, called the **test for homogeneity**, can be used to draw a conclusion about whether two populations have the same distribution. To calculate the test statistic for a test for homogeneity, follow the same procedure as with the test of independence.

### NOTE

The expected value for each cell needs to be at least five in order for you to use this test.

**Hypotheses**  
H0: The distributions of the two populations are the same.  
  
Ha: The distributions of the two populations are not the same.

**Test Statistic**Use a χ2�2 test statistic. It is computed in the same way as the test for independence.

**Degrees of Freedom (df)**df = number of columns - 1

**Requirements**All values in the table must be greater than or equal to five.

**Common Uses**Comparing two populations. For example: men vs. women, before vs. after, east vs. west. The variable is categorical with more than two possible response values.

### EXAMPLE 11.8

#### Problem

Do male and female college students have the same distribution of living arrangements? Use a level of significance of 0.05. Suppose that 250 randomly selected male college students and 300 randomly selected female college students were asked about their living arrangements: dormitory, apartment, with parents, other. The results are shown in [Table 11.19](https://openstax.org/books/introductory-statistics/pages/11-4-test-for-homogeneity#eip-924). Do male and female college students have the same distribution of living arrangements?

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | **Dormitory** | **Apartment** | **With Parents** | **Other** |
| **Males** | 72 | 84 | 49 | 45 |
| **Females** | 91 | 86 | 88 | 35 |

**Table** **11.19** Distribution of Living Arragements for College Males and College Females

#### Solution 1

H0: The distribution of living arrangements for male college students is the same as the distribution of living arrangements for female college students.  
  
Ha: The distribution of living arrangements for male college students is not the same as the distribution of living arrangements for female college students.  
  
**Degrees of Freedom (df):**  
df = number of columns – 1 = 4 – 1 = 3  
  
**Distribution for the test:**χ23�32  
  
**Calculate the test statistic:** χ2 = 10.1287 (calculator or computer)  
  
**Probability statement:** p-value = P(χ2 >10.1287) = 0.0175

### USING THE TI-83, 83+, 84, 84+ CALCULATOR

Press the MATRX key and arrow over to EDIT. Press 1:[A]. Press 2 ENTER 4 ENTER. Enter the table values by row. Press ENTER after each. Press 2nd QUIT. Press STAT and arrow over to TESTS. Arrow down to C:χ2-TEST. Press ENTER. You should see Observed:[A] and Expected:[B]. Arrow down to Calculate. Press ENTER. The test statistic is 10.1287 and the p-value = 0.0175. Do the procedure a second time but arrow down to Draw instead of calculate.

**Compare α and the p-value:** Since no α is given, assume α = 0.05. p-value = 0.0175. α > p-value.  
  
**Make a decision:** Since α > p-value, reject H0. This means that the distributions are not the same.  
  
**Conclusion:** At a 5% level of significance, from the data, there is sufficient evidence to conclude that the distributions of living arrangements for male and female college students are not the same.  
  
Notice that the conclusion is only that the distributions are not the same. We cannot use the test for homogeneity to draw any conclusions about how they differ.

### TRY IT 11.8

Do families and singles have the same distribution of cars? Use a level of significance of 0.05. Suppose that 100 randomly selected families and 200 randomly selected singles were asked what type of car they drove: sport, sedan, hatchback, truck, van/SUV. The results are shown in [Table 11.20](https://openstax.org/books/introductory-statistics/pages/11-4-test-for-homogeneity#eip-idm93309648). Do families and singles have the same distribution of cars? Test at a level of significance of 0.05.

|  | **Sport** | **Sedan** | **Hatchback** | **Truck** | **Van/SUV** |
| --- | --- | --- | --- | --- | --- |
| Family | 5 | 15 | 35 | 17 | 28 |
| Single | 45 | 65 | 37 | 46 | 7 |

**Table** **11.20**

### EXAMPLE 11.9

#### Problem

Both before and after a recent earthquake, surveys were conducted asking voters which of the three candidates they planned on voting for in the upcoming city council election. Has there been a change since the earthquake? Use a level of significance of 0.05. [Table 11.21](https://openstax.org/books/introductory-statistics/pages/11-4-test-for-homogeneity#eip-422) shows the results of the survey. Has there been a change in the distribution of voter preferences since the earthquake?

|  |  |  |  |
| --- | --- | --- | --- |
|  | **Perez** | **Chung** | **Stevens** |
| **Before** | 167 | 128 | 135 |
| **After** | 214 | 197 | 225 |

**Table** **11.21**

#### Solution 1

H0: The distribution of voter preferences was the same before and after the earthquake.  
  
Ha: The distribution of voter preferences was not the same before and after the earthquake.  
  
**Degrees of Freedom (df):**  
df = number of columns – 1 = 3 – 1 = 2  
  
**Distribution for the test:** χ22�22  
  
**Calculate the test statistic**: χ2 = 3.2603 (calculator or computer)  
  
**Probability statement:** p-value=P(χ2 > 3.2603) = 0.1959

### USING THE TI-83, 83+, 84, 84+ CALCULATOR

Press the MATRX key and arrow over to EDIT. Press 1:[A]. Press 2 ENTER 3 ENTER. Enter the table values by row. Press ENTER after each. Press 2nd QUIT. Press STAT and arrow over to TESTS. Arrow down to C:χ2-TEST. Press ENTER. You should see Observed:[A] and Expected:[B]. Arrow down to Calculate. Press ENTER. The test statistic is 3.2603 and the p-value = 0.1959. Do the procedure a second time but arrow down to Draw instead of calculate.

**Compare α and the p-value:** α = 0.05 and the p-value = 0.1959. α < p-value.

**Make a decision:** Since α < p-value, do not reject Ho.

**Conclusion:** At a 5% level of significance, from the data, there is insufficient evidence to conclude that the distribution of voter preferences was not the same before and after the earthquake.

### TRY IT 11.9

Ivy League schools receive many applications, but only some can be accepted. At the schools listed in [Table 11.22](https://openstax.org/books/introductory-statistics/pages/11-4-test-for-homogeneity#fs-idm19368736), two types of applications are accepted: regular and early decision.

| **Application Type Accepted** | **Brown** | **Columbia** | **Cornell** | **Dartmouth** | **Penn** | **Yale** |
| --- | --- | --- | --- | --- | --- | --- |
| Regular | 2,115 | 1,792 | 5,306 | 1,734 | 2,685 | 1,245 |
| Early Decision | 577 | 627 | 1,228 | 444 | 1,195 | 761 |

**Table** **11.22**

We want to know if the number of regular applications accepted follows the same distribution as the number of early applications accepted. State the null and alternative hypotheses, the degrees of freedom and the test statistic, sketch the graph of the p-value, and draw a conclusion about the test of homogeneity.