In Exercises 33 and 34, check that the conditions for carrying out a one-sample z test for the population proportion \( p \) are met.

33. **Lefties** Simon reads a newspaper report claiming that 12% of all adults in the United States are left-handed. He wonders if 12% of the students at his large public high school are left-handed. Simon chooses an SRS of 100 students and records whether each student is right- or left-handed.

34. **Don’t argue!** A Gallup Poll report on a national survey of 1028 teenagers revealed that 72% of teens said they rarely or never argue with their friends.12 Yvonne wonders whether this national result would be true in her large high school, so she surveys a random sample of 150 students at her school.

In Exercises 35 and 36, explain why we aren’t safe carrying out a one-sample z test for the population proportion \( p \).

35. **No test** You toss a coin 10 times to test the hypothesis \( H_0: p = 0.5 \) that the coin is balanced.

36. **NO test** A college president says, "99% of the alumni support my firing of Coach Boggs." You contact an SRS of 200 of the college’s 15,000 living alumni to test the hypothesis \( H_0: p = 0.99 \).

37. **Lefties** Refer to **Exercise 33**. In Simon’s SRS, 16 of the students were left-handed.

   - (a) Calculate the test statistic.
   - (b) Find the \( P \)-value using **Table A**. Show this result as an area under a standard Normal curve.

38. **Don’t argue!** Refer to **Exercise 34**. For Yvonne’s survey, 96 students in the sample said they seldom or never argue with friends.

   - (a) Calculate the test statistic.
   - (b) Find the \( P \)-value using **Table A**. Show this result as an area under a standard Normal curve.

39. **Significance tests** A test of \( H_0: p = 0.5 \) versus \( H_a: p > 0.5 \) has test statistic \( z = 2.19 \).

   - (a) What conclusion would you draw at the 5% significance level? At the 1%
(b) If the alternative hypothesis were $H_a: p \neq 0.5$, what conclusion would you draw at the 5% significance level? At the 1% level?

**Show Answer**

### 40. Significance tests

A test of $H_0: p = 0.65$ against $H_a: p < 0.65$ has test statistic $z = -1.78$.

- (a) What conclusion would you draw at the 5% significance level? At the 1% level?
- (b) If the alternative hypothesis were $H_a: p \neq 0.65$, what conclusion would you draw at the 5% significance level? At the 1% level?

### 41. Better parking

A local high school makes a change that should improve student satisfaction with the parking situation. Before the change, 37% of the school’s students approved of the parking that was provided. After the change, the principal surveys an SRS of 200 of the over 2500 students at the school. In all, 83 students say that they approve of the new parking arrangement. The principal cites this as evidence that the change was effective. Perform a test of the principal’s claim at the $\alpha = 0.05$ significance level.

**Show Answer**

### 42. Side effects

A drug manufacturer claims that less than 10% of patients who take its new drug for treating Alzheimer’s disease will experience nausea. To test this claim, researchers conduct an experiment. They give the new drug to a random sample of 300 out of 5000 Alzheimer’s patients whose families have given informed consent for the patients to participate in the study. In all, 25 of the subjects experience nausea. Use these data to perform a test of the drug manufacturer’s claim at the $\alpha = 0.05$ significance level.

### 43. Better parking

Refer to Exercise 41.

- (a) Describe a Type I error and a Type II error in this setting, and explain the consequences of each.
- (b) The test has a power of 0.75 to detect that $p = 0.45$. Explain what this means.
- (c) Identify two ways to increase the power in part (b).

**Show Answer**

### 44. Side effects

Refer to Exercise 42.

- (a) Describe a Type I error and a Type II error in this setting, and explain the consequences of each.
- (b) The test has a power of 0.54 to detect that $p = 0.07$. Explain what this means.
means.

- (c) Identify two ways to increase the power in part (b).

45. **Are boys more likely?** We hear that newborn babies are more likely to be boys than girls. Is this true? A random sample of 25,468 firstborn children included 13,173 boys. Boys do make up more than half of the sample, but of course we don’t expect a perfect 50-50 split in a random sample.

- (a) To what population can the results of this study be generalized: all children or all firstborn children? Justify your answer.

- (b) Do these data give convincing evidence that boys are more common than girls in the population? Carry out a significance test to help answer this question.

46. **Fresh coffee** People of taste are supposed to prefer fresh-brewed coffee to the instant variety. On the other hand, perhaps many coffee drinkers just want their caffeine fix. A skeptic claims that only half of all coffee drinkers prefer fresh-brewed coffee. To test this claim, we ask a random sample of 50 coffee drinkers in a small city to take part in a study. Each person tastes two unmarked cups—one containing instant coffee and one containing fresh-brewed coffee—and says which he or she prefers. We find that 36 of the 50 choose the fresh coffee.

- (a) We presented the two cups to each coffee drinker in a random order, so that some people tasted the fresh coffee first, while others drank the instant coffee first. Why do you think we did this?

- (b) Do these results give convincing evidence that coffee drinkers favor fresh-brewed over instant coffee? Carry out a significance test to help answer this question.

47. **Bullies in middle school** A University of Illinois study on aggressive behavior surveyed a random sample of 558 middle school students. When asked to describe their behavior in the last 30 days, 445 students said their behavior included physical aggression, social ridicule, teasing, name-calling, and issuing threats. This behavior was not defined as bullying in the questionnaire. Is this evidence that more than three-quarters of the students at that middle school engage in bullying behavior? To find out, Maurice decides to perform a significance test. Unfortunately, he made a few errors along the way. Your job is to spot the mistakes and correct them.

\[ H_0: p = 0.75 \]

\[ H_a: \delta p > 0.797 \]

where \( p \) = the true mean proportion of middle school students who engaged in bullying.

- A random sample of 558 middle school students was surveyed.
• 558(0.797) = 444.73 is at least 10.

\[ z = \frac{0.75 - 0.797}{\sqrt{0.797(0.203)}} = -2.46; \text{ P-value} = 2(0.0069) = 0.0138 \]

• The probability that the null hypothesis is true is only 0.0138, so we reject \( H_0 \). This proves that more than three-quarters of the school engaged in bullying behavior.

**Show Answer**

48. **Is this coin fair?** The French naturalist Count Buffon (1707–1788) tossed a coin 4040 times. He got 2048 heads. That’s a bit more than one-half. Is this evidence that Count Buffon’s coin was not balanced? To find out, Luisa decides to perform a significance test. Unfortunately, she made a few errors along the way. Your job is to spot the mistakes and correct them.

\[ H_0: \mu > 0.5 \]

\[ H_a: \mu = 0.5 \]

• **Independent** 4040(0.5) = 2020 and 4040(1 – 0.5) = 2020 are both at least 10.

• **Normal** There are at least 40,400 coins in the world.

Reject \( H_0 \) because the \( P \)-value is so large and conclude that the coin is fair.

49. **Teen drivers** A state’s Division of Motor Vehicles (DMV) claims that 60% of teens pass their driving test on the first attempt. An investigative reporter examines an SRS of the DMV records for 125 teens; 86 of them passed the test on their first try. Is this good evidence that the DMV’s claim is incorrect? Carry out a test at the \( \alpha = 0.05 \) significance level to help answer this question.

**Show Answer**

50. **We want to be rich** In a recent year, 73% of first-year college students responding to a national survey identified "being very well-off financially" as an important personal goal. A state university finds that 132 of an SRS of 200 of its first-year students say that this goal is important. Is there good evidence that the proportion of all first-year students at this university who think being very well-off is important differs from the national value, 73%? Carry out a test at the \( \alpha = 0.05 \) significance level to help answer this question.

51. **Teen drivers** Refer to **Exercise 49**.

• (a) Construct and interpret a 95% confidence interval for the proportion of all teens in the state who passed their driving test on the first attempt.
• (b) Explain what the interval in part (a) tells you about the DMV's claim.

Show Answer

52. We want to be rich Refer to Exercise 50.

• (a) Construct and interpret a 95% confidence interval for the true proportion \( p \) of all first-year students at the university who would identify being well-off as an important personal goal.

• (b) Explain what the interval in part (a) tells you about whether the national value holds at this university.

53. Do you Twitter? In late 2009, the Pew Internet and American Life Project asked a random sample of U.S. adults, "Do you ever...use Twitter or another service to share updates about yourself or to see updates about others?" According to Pew, the resulting 95% confidence interval is (0.167, 0.213). Can we use this interval to conclude that the actual proportion of U.S. adults who would say they Twitter differs from 0.20? Justify your answer.

Show Answer

54. Losing weight A Gallup Poll found that 59% of the people in its sample said "Yes" when asked, "Would you like to lose weight?" Gallup announced: "For results based on the total sample of national adults, one can say with 95% confidence that the margin of (sampling) error is ±3 percentage points." Can we use this interval to conclude that the actual proportion of U.S. adults who would say they want to lose weight differs from 0.55? Justify your answer.

55. Teens and sex The Gallup Youth Survey asked a random sample of U.S. teens aged 13 to 17 whether they thought that young people should wait to have sex until marriage. The Minitab output below shows the results of a significance test and a 95% confidence interval based on the survey data.

Show Answer

• (a) Define the parameter of interest.

• (b) Check that the conditions for performing the significance test are met in this case.

• (c) Interpret the \( P \)-value in context.

• (d) Do these data give convincing evidence that the actual population
proportion differs from 0.5? Justify your answer with appropriate evidence.

56. Reporting cheating What proportion of students are willing to report cheating by other students? A student project put this question to an SRS of 172 undergraduates at a large university: "You witness two students cheating on a quiz. Do you go to the professor?" The Minitab output below shows the results of a significance test and a 95% confidence interval based on the survey data.

![Minitab output for one proportion test and confidence interval]

- (a) Define the parameter of interest.
- (b) Check that the conditions for performing the significance test are met in this case.
- (c) Interpret the P-value in context.
- (d) Do these data give convincing evidence that the actual population proportion differs from 0.15? Justify your answer with appropriate evidence.

Multiple choice: Select the best answer for Exercises 57 to 60.

57. After once again losing a football game to the archrival, a college’s alumni association conducted a survey to see if alumni were in favor of firing the coach. An SRS of 100 alumni from the population of all living alumni was taken, and 64 of the alumni in the sample were in favor of firing the coach. Suppose you wish to see if a majority of living alumni are in favor of firing the coach. The appropriate test statistic is

- (a) 
- (b) 
- (c)
58. Which of the following is not a condition for performing a significance test about an unknown population proportion \( p \)?

- (a) The data should come from a random sample or randomized experiment.
- (b) Individual measurements should be independent of one another.
- (c) The population distribution should be approximately Normal, unless the sample size is large.
- (d) Both \( np \) and \( n(1 - p) \) should be at least 10.
- (e) If you are sampling without replacement from a finite population, then you should sample no more than 10% of the population.

59. The \( z \) statistic for a test of \( H_0: p = 0.4 \) versus \( H_a: p > 0.4 \) is \( z = 2.43 \). This test is

- (a) not significant at either \( \alpha = 0.05 \) or \( \alpha = 0.01 \).
- (b) significant at \( \alpha = 0.05 \) but not at \( \alpha = 0.01 \).
- (c) significant at \( \alpha = 0.01 \) but not at \( \alpha = 0.05 \).
- (d) significant at both \( \alpha = 0.05 \) and \( \alpha = 0.01 \).
- (e) inconclusive because we don’t know the value of \( \sigma \) \( p \).

60. Which of the following 95% confidence intervals would lead us to reject \( H_0: p = 0.30 \) in favor of \( H_a: p \neq 0.30 \) at the 5% significance level?

- (a) (0.29, 0.38)
- (b) (0.19, 0.27)
- (c) (0.27, 0.31)
- (d) (0.24, 0.30)
61.

**Packaging CDs (6.2, 5.3)** A manufacturer of compact discs (CDs) wants to be sure that their CDs will fit inside the plastic cases they have bought for packaging. Both the CDs and the cases are circular. According to the supplier, the plastic cases vary Normally with mean diameter $\mu = 4.2$ inches and standard deviation $\sigma = 0.05$ inches. The CD manufacturer decides to produce CDs with mean diameter $\mu = 4$ inches. Their diameters follow a Normal distribution with $\sigma = 0.1$ inches.

- (a) Let $X =$ the diameter of a randomly selected CD and $Y =$ the diameter of a randomly selected case. Describe the shape, center, and spread of the distribution of the random variable $X - Y$. What is the importance of this random variable to the CD manufacturer?

- (b) Compute the probability that a randomly selected CD will fit inside a randomly selected case.

- (c) The production process actually runs in batches of 100 CDs. If each of these CDs is paired with a randomly chosen plastic case, find the probability that all the CDs fit in their cases.

62.

**Cash to find work? (5.2)** Will cash bonuses speed the return to work of unemployed people? The Illinois Department of Employment Security designed an experiment to find out. The subjects were 10,065 people aged 20 to 54 who were filing claims for unemployment insurance. Some were offered $500 if they found a job within 11 weeks and held it for at least 4 months. Others could tell potential employers that the state would pay the employer $500 for hiring them. A control group got neither kind of bonus.19

- (a) Describe a completely randomized design for this experiment.

- (b) How will you label the subjects for random assignment? Use Table D at line 127 to choose the first 3 subjects for the first treatment.

- (c) Explain the purpose of a control group in this setting.

In Exercises 33 and 34, check that the conditions for carrying out a one-sample $z$ test for the population proportion $p$ are met.
33. **Lefties** Simon reads a newspaper report claiming that 12% of all adults in the United States are left-handed. He wonders if 12% of the students at his large public high school are left-handed. Simon chooses an SRS of 100 students and records whether each student is right or left-handed.

**Correct Answer**

*Random:* The sample was randomly selected. *Normal:* The expected numbers of successes (12) and failures (88) are at least 10. *Independent:* It is very likely that there are more than 10(100) = 1000 students in the population.

34. **Don’t argue!** A Gallup Poll report on a national survey of 1028 teenagers revealed that 72% of teens said they rarely or never argue with their friends. Yvonne wonders whether this national result would be true in her large high school, so she surveys a random sample of 150 students at her school.

In Exercises 35 and 36, explain why we aren’t safe carrying out a one-sample z test for the population proportion p.

35. **No test** You toss a coin 10 times to test the hypothesis \( H_0: p = 0.5 \) that the coin is balanced.

**Correct Answer**

Normal condition not met.

36. **NO test** A college president says, “99% of the alumni support my firing of Coach Boggs.” You contact an SRS of 200 of the college’s 15,000 living alumni to test the hypothesis \( H_0: p = 0.99 \).

37. **Lefties** Refer to Exercise 33. In Simon’s SRS, 16 of the students were left-handed.

- (a) Calculate the test statistic.
- (b) Find the \( P \)-value using Table A. Show this result as an area under a standard Normal curve.

**Correct Answer**

(a) \( z = 1.23 \) (b) 0.2186

38. **Don’t argue!** Refer to Exercise 34. For Yvonne’s survey, 96 students in the sample said they seldom or never argue with friends.

- (a) Calculate the test statistic.
- (b) Find the \( P \)-value using Table A. Show this result as an area under a
39. **Significance tests** A test of $H_0: p = 0.5$ versus $H_a: p > 0.5$ has test statistic $z = 2.19$.

- (a) What conclusion would you draw at the 5% significance level? At the 1% level?
- (b) If the alternative hypothesis were $H_a: p \neq 0.5$, what conclusion would you draw at the 5% significance level? At the 1% level?

Correct Answer

(a) Reject at the 5% significance level. Fail to reject the null hypothesis at the 1% significance level. (b) Same as part (a).

40. **Significance tests** A test of $H_0: p = 0.65$ against $H_a: p < 0.65$ has test statistic $z = -1.78$.

- (a) What conclusion would you draw at the 5% significance level? At the 1% level?
- (b) If the alternative hypothesis were $H_a: p \neq 0.65$, what conclusion would you draw at the 5% significance level? At the 1% level?

41. **Better parking** A local high school makes a change that should improve student satisfaction with the parking situation. Before the change, 37% of the school’s students approved of the parking that was provided. After the change, the principal surveys an SRS of 200 of the over 2500 students at the school. In all, 83 students say that they approve of the new parking arrangement. The principal cites this as evidence that the change was effective. Perform a test of the principal’s claim at the $\alpha = 0.05$ significance level.

Correct Answer

State: $H_0: p = 0.37$ versus $H_a: p > 0.37$, where $p$ is the actual proportion of students who are satisfied with the parking situation. Plan: One-sample $z$ test for $p$. Random: The sample was randomly selected. Normal: The expected number of successes $np_0 = 74$ and failures $n (1 - p_0) = 126$ are both at least 10. Independent: There were 200 in the sample, and since there are 2500 students in the population, the sample is less than 10% of the population. Do: $z = 1.32$, $P$-value = 0.0934. Conclude: Since our $P$-value is greater than 0.05, we fail to reject the null hypothesis. We do not have enough evidence to conclude that the new parking arrangement increased student satisfaction with parking at this school.

42. **Side effects** A drug manufacturer claims that less than 10% of patients who take its new drug for treating Alzheimer’s disease will experience nausea. To test this claim, researchers conduct an experiment. They give the new drug to a random sample of
300 out of 5000 Alzheimer’s patients whose families have given informed consent for the patients to participate in the study. In all, 25 of the subjects experience nausea. Use these data to perform a test of the drug manufacturer’s claim at the $\alpha = 0.05$ significance level.

43. **Better parking** Refer to Exercise 41.

- (a) Describe a Type I error and a Type II error in this setting, and explain the consequences of each.
- (b) The test has a power of 0.75 to detect that $p = 0.45$. Explain what this means.
- (c) Identify two ways to increase the power in part (b).

**Correct Answer**

(a) Type I error: Conclude that more than 37% of students were satisfied with the new parking arrangement when, in reality, only 37% were satisfied. **Consequence:** the principal believes that students are satisfied and takes no further action. Type II error: Say that we do not have enough evidence to conclude that more than 37% are satisfied with the parking arrangements when, in fact, more than 37% are satisfied. **Consequence:** the principal takes further action on parking when none is needed. (b) If $p = 0.45$, the probability of (correctly) rejecting the null hypothesis is 0.75. (c) Increase the sample size or the significance level.

44. **Side effects** Refer to Exercise 42.

- (a) Describe a Type I error and a Type II error in this setting, and explain the consequences of each.
- (b) The test has a power of 0.54 to detect that $p = 0.07$. Explain what this means.
- (c) Identify two ways to increase the power in part (b).

45. **Are boys more likely?** We hear that newborn babies are more likely to be boys than girls. Is this true? A random sample of 25,468 firstborn children included 13,173 boys. Boys do make up more than half of the sample, but of course we don’t expect a perfect 50-50 split in a random sample.

- (a) To what population can the results of this study be generalized: all children or all firstborn children? Justify your answer.
- (b) Do these data give convincing evidence that boys are more common than girls in the population? Carry out a significance test to help answer this question.

46. **Fresh coffee** People of taste are supposed to prefer fresh-brewed coffee to the
instant variety. On the other hand, perhaps many coffee drinkers just want their caffeine fix. A skeptic claims that only half of all coffee drinkers prefer fresh-brewed coffee. To test this claim, we ask a random sample of 50 coffee drinkers in a small city to take part in a study. Each person tastes two unmarked cups — one containing instant coffee and one containing fresh-brewed coffee—and says which he or she prefers. We find that 36 of the 50 choose the fresh coffee.

- (a) We presented the two cups to each coffee drinker in a random order, so that some people tasted the fresh coffee first, while others drank the instant coffee first. Why do you think we did this?
- (b) Do these results give convincing evidence that coffee drinkers favor fresh-brewed over instant coffee? Carry out a significance test to help answer this question.

47. Bullies in middle school A University of Illinois study on aggressive behavior surveyed a random sample of 558 middle school students. When asked to describe their behavior in the last 30 days, 445 students said their behavior included physical aggression, social ridicule, teasing, name-calling, and issuing threats. This behavior was not defined as bullying in the questionnaire. Is this evidence that more than three-quarters of the students at that middle school engage in bullying behavior? To find out, Maurice decides to perform a significance test. Unfortunately, he made a few errors along the way. Your job is to spot the mistakes and correct them.

\[ H_0: p = 0.75 \]
\[ H_a: \hat{p} > 0.797 \]

where \( p \) = the true mean proportion of middle school students who engaged in bullying.

- A random sample of 558 middle school students was surveyed.
- \( 558(0.797) = 444.73 \) is at least 10.
- \( \frac{0.75 - 0.797}{0.797(0.203)} = -2.46; \ P\text{-value} = 2(0.0069) = 0.0138 \)

- The probability that the null hypothesis is true is only 0.0138, so we reject \( H_0 \). This proves that more than three-quarters of the school engaged in bullying behavior.

Correct Answer

Corrections: Let \( p \) = the true proportion of middle school students who engage in bullying behavior. \( H_0: p = 0.75 \) and \( H_a: p > 0.75 \). Random: The sample was randomly selected. Normal: \( np_0 = 418.5 \) and \( n(1 - p_0) = 139.5 \) are at least 10. Independent: Population more than 5580. \( z = 2.59, \ P\text{-value} = 0.0048 \). Since the \( P\text{-value} \) is small, we reject \( H_0 \) and conclude that more than 75% of middle school students engage in bullying behavior.
48. **Is this coin fair?** The French naturalist Count Buffon (1707–1788) tossed a coin 4040 times. He got 2048 heads. That’s a bit more than one-half. Is this evidence that Count Buffon’s coin was not balanced? To find out, Luisa decides to perform a significance test. Unfortunately, she made a few errors along the way. Your job is to spot the mistakes and correct them.

\[ H_0: \mu > 0.5 \]

\[ H_a: x = 0.5 \]

- **Independent** 4040(0.5) = 2020 and 4040(1 − 0.5) = 2020 are both at least 10.

- **Normal** There are at least 40,400 coins in the world.

Reject \( H_0 \) because the \( P \)-value is so large and conclude that the coin is fair.

49. **Teen drivers** A state’s Division of Motor Vehicles (DMV) claims that 60% of teens pass their driving test on the first attempt. An investigative reporter examines an SRS of the DMV records for 125 teens; 86 of them passed the test on their first try. Is this good evidence that the DMV’s claim is incorrect? Carry out a test at the \( \alpha = 0.05 \) significance level to help answer this question.

**Correct Answer**

**State:** \( H_0: p = 0.60, H_a: p \neq 0.60 \)

**Plan:** One-sample \( z \) test for \( p \)

**Random:** The sample was randomly selected.

**Normal:** \( np_0 = 75 \) and \( n(1 - p_0) = 50 \) are at least 10.

**Independent:** Population more than 1250.

**Do:** \( z = 2.01, P\)-value = 0.0444.

**Conclude:** Since our \( P \)-value is less than 0.05, we reject \( H_0 \). It appears that a proportion other than 0.60 of teens pass the driving test on their first attempt.

50. **We want to be rich** In a recent year, 73% of first-year college students responding to a national survey identified “being very well-off financially” as an important personal goal. A state university finds that 132 of an SRS of 200 of its first-year students say that this goal is important. Is there good evidence that the proportion of all first-year students at this university who think being very well-off is important differs from the national value, 73%? Carry out a test at the \( \alpha = 0.05 \) significance level to help answer this question.

51. **Teen drivers** Refer to Exercise 49.

- **(a)** Construct and interpret a 95% confidence interval for the proportion of all teens in the state who passed their driving test on the first attempt.

- **(b)** Explain what the interval in part (a) tells you about the DMV’s claim.
Correct Answer

(a) State: We want to estimate the actual proportion \( p \) of all teens who pass the driving test on the first try at a 95% confidence level. Plan: One-sample \( z \) interval for \( p \). Random: The teens were selected randomly. Normal: 86 successes and 39 failures are both at least 10. Independent: Population more than 1250. Do: (0.607, 0.769). Conclude: We are 95% confident that the interval from 0.607 to 0.769 captures the true proportion of teens who pass the driving test on the first try. (b) The interval doesn’t contain 0.60 as a plausible value of \( p \), which gives convincing evidence against the DMV’s claim.

52. We want to be rich Refer to Exercise 50.
- (a) Construct and interpret a 95% confidence interval for the true proportion \( p \) of all first-year students at the university who would identify being well-off as an important personal goal.
- (b) Explain what the interval in part (a) tells you about whether the national value holds at this university.

53. Do you Twitter? In late 2009, the Pew Internet and American Life Project asked a random sample of U.S. adults, "Do you ever...use Twitter or another service to share updates about yourself or to see updates about others?" According to Pew, the resulting 95% confidence interval is (0.167, 0.213). Can we use this interval to conclude that the actual proportion of U.S. adults who would say they Twitter differs from 0.20? Justify your answer.

Correct Answer
No, because 0.20 is contained in the interval.

54. Losing weight A Gallup Poll found that 59% of the people in its sample said "Yes" when asked, "Would you like to lose weight?" Gallup announced: "For results based on the total sample of national adults, one can say with 95% confidence that the margin of (sampling) error is ±3 percentage points." Can we use this interval to conclude that the actual proportion of U.S. adults who would say they want to lose weight differs from 0.55? Justify your answer.

55. Teens and sex The Gallup Youth Survey asked a random sample of U.S. teens aged 13 to 17 whether they thought that young people should wait to have sex until marriage. The Minitab output below shows the results of a significance test and a 95% confidence interval based on the survey data.
• (a) Define the parameter of interest.
• (b) Check that the conditions for performing the significance test are met in this case.
• (c) Interpret the $P$-value in context.
• (d) Do these data give convincing evidence that the actual population proportion differs from 0.5? Justify your answer with appropriate evidence.

Correct Answer

(a) $p$ = the true proportion of teens who think that young people should wait to have sex until marriage. (b) Random: The sample was randomly selected. Normal: $np_0 = 219.5$ and $n(1 - p_0) = 219.5$ are at least 10. Independent: There are more than 4390 U.S. teens. (c) If the true proportion of teens who think that young people should wait to have sex until marriage is 0.50, there is a 1.1% chance of getting a sample of 439 teens that is as different from that proportion as the sample we found. (d) Yes. Since the $P$-value is less than 0.05, we reject the null hypothesis and conclude that the actual proportion of teens who think that young people should wait is not 0.50.

56. Reporting cheating What proportion of students are willing to report cheating by other students? A student project put this question to an SRS of 172 undergraduates at a large university: "You witness two students cheating on a quiz. Do you go to the professor?" The Minitab output below shows the results of a significance test and a 95% confidence interval based on the survey data.

Multiple choice: Select the best answer for Exercises 57 to 60.
57. After once again losing a football game to the archrival, a college’s alumni association conducted a survey to see if alumni were in favor of firing the coach. An SRS of 100 alumni from the population of all living alumni was taken, and 64 of the alumni in the sample were in favor of firing the coach. Suppose you wish to see if a majority of living alumni are in favor of firing the coach. The appropriate test statistic is

\[ z = \frac{0.64 - 0.5}{\sqrt{\frac{0.64(0.36)}{100}}} \]

- (a)

\[ t = \frac{0.64 - 0.5}{\sqrt{\frac{0.64(0.36)}{100}}} \]

- (b)

\[ z = \frac{0.64 - 0.5}{\sqrt{0.5(0.5)}} \]

- (c)

\[ z = \frac{0.64 - 0.5}{\sqrt{\frac{0.64(0.36)}{64}}} \]

- (d)

\[ z = \frac{0.5 - 0.64}{\sqrt{\frac{0.5(0.5)}{100}}} \]

- (e)

Correct Answer: c

58. Which of the following is not a condition for performing a significance test about an unknown population proportion \( p \)?

- (a) The data should come from a random sample or randomized experiment.
- (b) Individual measurements should be independent of one another.
- (c) The population distribution should be approximately Normal, unless the sample size is large.
- (d) Both \( np \) and \( n(1 - p) \) should be at least 10.
- (e) If you are sampling without replacement from a finite population, then you should sample no more than 10% of the population.
59. The z statistic for a test of $H_0: p = 0.4$ versus $H_a: p > 0.4$ is $z = 2.43$. This test is

- (a) not significant at either $\alpha = 0.05$ or $\alpha = 0.01$.
- (b) significant at $\alpha = 0.05$ but not at $\alpha = 0.01$.
- (c) significant at $\alpha = 0.01$ but not at $\alpha = 0.05$.
- (d) significant at both $\alpha = 0.05$ and $\alpha = 0.01$.
- (e) inconclusive because we don’t know the value of $\hat{p}$.

Correct Answer: d

60. Which of the following 95% confidence intervals would lead us to reject $H_0: p = 0.30$ in favor of $H_a: p \neq 0.30$ at the 5% significance level?

- (a) (0.29, 0.38)
- (b) (0.19, 0.27)
- (c) (0.27, 0.31)
- (d) (0.24, 0.30)
- (e) None of these

61. **Packaging CDs (6.2, 5.3)** A manufacturer of compact discs (CDs) wants to be sure that their CDs will fit inside the plastic cases they have bought for packaging. Both the CDs and the cases are circular. According to the supplier, the plastic cases vary Normally with mean diameter $\mu = 4.2$ inches and standard deviation $\sigma = 0.05$ inches. The CD manufacturer decides to produce CDs with mean diameter $\mu = 4$ inches. Their diameters follow a Normal distribution with $\sigma = 0.1$ inches.

- (a) Let $X = \text{the diameter of a randomly selected CD}$ and $Y = \text{the diameter of a randomly selected case}$. Describe the shape, center, and spread of the distribution of the random variable $X - Y$. What is the importance of this random variable to the CD manufacturer?

- (b) Compute the probability that a randomly selected CD will fit inside a randomly selected case.

- (c) The production process actually runs in batches of 100 CDs. If each of these CDs is paired with a randomly chosen plastic case, find the probability
that all the CDs fit in their cases.

(a) The random variable $X - Y$ has a Normal distribution with mean $\mu_{X - Y} = -0.2$ and standard deviation $\sigma_{X - Y} = 0.112$. This random variable is important because for a CD to fit in the case, the variable must take on a negative number. (b) $P(X - Y < 0) = P(z < 1.79) = 0.9633$. (c) $(0.9633)^{100} = 0.0238$

62.

**Cash to find work? (5.2)** Will cash bonuses speed the return to work of unemployed people? The Illinois Department of Employment Security designed an experiment to find out. The subjects were 10,065 people aged 20 to 54 who were filing claims for unemployment insurance. Some were offered $500 if they found a job within 11 weeks and held it for at least 4 months. Others could tell potential employers that the state would pay the employer $500 for hiring them. A control group got neither kind of bonus.19

- (a) Describe a completely randomized design for this experiment.
- (b) How will you label the subjects for random assignment? Use Table D at line 127 to choose the first 3 subjects for the first treatment.
- (c) Explain the purpose of a control group in this setting.

**SECTION 9.2 Exercises**