# *Mind on Statistics*

## Chapter 12

## Sections 12.1

**Questions 1 to 6:** For each statement, determine if the statement is a typical null hypothesis ($H_0$) or alternative hypothesis ($H_a$).

1. There is no difference between the proportion of overweight men and overweight women in America.
   A. Null hypothesis
   B. Alternative hypothesis

KEY: A

2. The proportion of overweight men is greater than the proportion of overweight women in America.
   A. Null hypothesis
   B. Alternative hypothesis

KEY: B

3. The average time to graduate for undergraduate English majors is less than the average time to graduate for undergraduate history majors.
   A. Null hypothesis
   B. Alternative hypothesis

KEY: B

4. The average price of a particular statistics textbook over the internet is the same as the average price of the textbook sold at all bookstores in a college town.
   A. Null hypothesis
   B. Alternative hypothesis

KEY: A

5. The graduation rate for all division I athletes is not equal to the 85% claimed by the NCAA.
   A. Null hypothesis
   B. Alternative hypothesis

KEY: B

6. The proportion of second year college students who live in a dormitory has decreased from the proportion in 1999, which was known to be 25%.
   A. Null hypothesis
   B. Alternative hypothesis

KEY: B

7. A two-sided or two-tailed hypothesis test is one in which
   A. the null hypothesis includes values in either direction from a specific standard.
   B. the null hypothesis includes values in one direction from a specific standard.
   C. the alternative hypothesis includes values in one direction from a specific standard
   D. the alternative hypothesis includes values in either direction from a specific standard

KEY: D

8. Null and alternative hypotheses are statements about
   A. population parameters.
   B. sample parameters.
   C. sample statistics.
   D. it depends - sometimes population parameters and sometimes sample statistics.

KEY: A

9. Which statement is correct about a *p*-value?
   A. The smaller the *p*-value the stronger the evidence in favor of the alternative hypothesis.
   B. The smaller the *p*-value the stronger the evidence in favor the null hypothesis
   C. Whether a small *p*-value provides evidence in favor of the null hypothesis depends on whether the test is one-sided or two-sided.
   D. Whether a small *p*-value provides evidence in favor of the alternative hypothesis depends on whether the test is one-sided or two-sided.

KEY: A

10. A hypothesis test gives a *p*-value of 0.03. If the significance level $\alpha = 0.05$, the results are said to be
   A. not statistically significant because the *p*-value $\leq \alpha$.
   B. statistically significant because the *p*-value $\leq \alpha$.
   C. practically significant because the *p*-value $\leq \alpha$.
   D. not practically significant because the *p*-value $\leq \alpha$.

KEY: B

11. A hypothesis test gives a *p*-value of 0.050. If the significance level $\alpha = 0.05$, the results are said to be
   A. not statistically significant because the *p*-value is not smaller than $\alpha$.
   B. statistically significant because the *p*-value $\leq \alpha$.
   C. practically significant because the *p*-value is the same as $\alpha$.
   D. inconclusive because the *p*-value is not smaller nor larger than $\alpha$.

KEY: B

12. The likelihood that a statistic would be as extreme or more extreme than what was observed is called a
   A. statistically significant result.
   B. test statistic.
   C. significance level.
   D. *p*-value.

KEY: D

13. The data summary used to decide between the null hypothesis and the alternative hypothesis is called a
   A. statistically significant result.
   B. test statistic.
   C. significance level.
   D. *p*-value.

KEY: B

14. The designated level (typically set at 0.05) to which the *p*-value is compared to, in order to decide whether the alternative hypothesis is accepted or not is called a
   A. statistically significant result.
   B. test statistic.
   C. significance level.
   D. none of the above.

KEY: C

15. When the *p*-value is less than or equal to the designated level of 0.05, the result is called a
    A. statistically significant result.
    B. test statistic.
    C. significance level.
    D. none of the above.

KEY: A

16. Which of the following conclusions is *not* equivalent to rejecting the null hypothesis?
    A. The results are statistically significant.
    B. The results are not statistically significant.
    C. The alternative hypothesis is accepted.
    D. The *p*-value $\leq \alpha$ (the significance level)

KEY: B

17. If the result of a hypothesis test for a proportion is statistically significant, then
    A. the null hypothesis is rejected.
    B. the alternative hypothesis is rejected.
    C. the population proportion must equal the null value.
    D. None of the above.

KEY: A

18. The smaller the *p*-value, the
    A. stronger the evidence against the alternative hypothesis.
    B. stronger the evidence for the null hypothesis.
    C. stronger the evidence against the null hypothesis.
    D. None of the above.

KEY: C

19. Which of the following is not a valid conclusion for a hypothesis test?
    A. Reject the null hypothesis.
    B. Do not reject the null hypothesis.
    C. We have proven the null hypothesis is true.
    D. We have proven the alternative hypothesis is true.

KEY: C and D

20. In hypothesis testing for one proportion, the "null value" is used in which of the following?
    A. The null hypothesis.
    B. The alternative hypothesis.
    C. The computation of the test statistic.
    D. All of the above.

KEY: D

21. A result is called statistically significant whenever
    A. the null hypothesis is true.
    B. the alternative hypothesis is true.
    C. the *p*-value is less than or equal to the significance level.
    D. the *p*-value is larger than the significance level.

KEY: C

22. Which one of the following is *not* true about hypothesis tests?
    A. Hypothesis tests are only valid when the sample is representative of the population for the question of interest.
    B. Hypotheses are statements about the population represented by the samples.
    C. Hypotheses are statements about the sample (or samples) from the population.
    D. Conclusions are statements about the population represented by the samples.

KEY: C

23. In a hypothesis test which of the following can (and should) be determined before collecting data?
    A. The null and alternative hypotheses.
    B. The value of the test statistic.
    C. The *p*-value.
    D. Whether the test statistic will be positive or negative.

KEY: A

24. The level of significance (usually .05) associated with a significance test is the probability
    A. that the null hypothesis is true.
    B. that the alternative hypothesis is true.
    C. of not rejecting a true null hypothesis.
    D. of rejecting a true null hypothesis.

KEY: D

**Questions 25 to 28:** Suppose the significance level for a hypothesis test is $\alpha = 0.05$.

25. If the *p*-value is 0.001, the conclusion is to
    A. reject the null hypothesis.
    B. accept the null hypothesis.
    C. not reject the null hypothesis.
    D. None of the above.

KEY: A

26. If the *p*-value is 0.049, the conclusion is to
    A. reject the null hypothesis.
    B. accept the null hypothesis.
    C. not reject the null hypothesis.
    D. None of the above.

KEY: A

27. If the *p*-value is 0.05, the conclusion is to
    A. reject the null hypothesis.
    B. accept the alternative hypothesis.
    C. not reject the null hypothesis.
    D. None of the above.

KEY: C

28. If the *p*-value is 0.999, the conclusion is to
    A. reject the null hypothesis.
    B. accept the alternative hypothesis.
    C. not reject the null hypothesis.
    D. None of the above.

KEY: C

29. In hypothesis testing, a Type 1 error occurs when
    A. the null hypothesis is not rejected when the null hypothesis is true.
    B. the null hypothesis is rejected when the null hypothesis is true.
    C. the null hypothesis is not rejected when the alternative hypothesis is true.
    D. the null hypothesis is rejected when the alternative hypothesis is true.

KEY: B

30. In hypothesis testing, a Type 2 error occurs when
    A. the null hypothesis is not rejected when the null hypothesis is true.
    B. the null hypothesis is rejected when the null hypothesis is true.
    C. the null hypothesis is not rejected when the alternative hypothesis is true.
    D. the null hypothesis is rejected when the alternative hypothesis is true.

KEY: C

31. In a hypothesis test the decision was made to not reject the null hypothesis. Which type of mistake could have been made?
    A. Type 1.
    B. Type 2.
    C. Type 1 if it's a one-sided test and Type 2 if it's a two-sided test.
    D. Type 2 if it's a one-sided test and Type 1 if it's a two-sided test.

KEY: B

32. If, in a hypothesis test, the null hypothesis is actually true, which type of mistake can be made?
    A. Type 1.
    B. Type 2.
    C. Type 1 if it's a one-sided test and Type 2 if it's a two-sided test.
    D. Type 2 if it's a one-sided test and Type 1 if it's a two-sided test.

KEY: A

33. In an American criminal trial, the null hypothesis is that the defendant is innocent and the alternative hypothesis is that the defendant is guilty. Which of the following describes a Type 2 error for a criminal trial?
    A. A guilty verdict for a person who is innocent.
    B. A guilty verdict for a person who is not innocent.
    C. A not guilty verdict for a person who is guilty
    D. A not guilty verdict for a person who is innocent

KEY: C

34. Explain what the statement of the null hypothesis represents in hypothesis testing. Give an example.

KEY: The null hypothesis is the status quo, or no relationship, or no difference. An example of a null hypothesis is that there is no difference between the proportion of men and women who favor the death penalty.

35. Explain what the statement of the alternative hypothesis represents in hypothesis testing. Give an example.

KEY: The alternative hypothesis is the statement that the assumed status quo is false, or that there is a relationship, or that there is a difference. An example of an alternative hypothesis is that there is a difference between the proportion of men and women who favor the death penalty.

36. Explain what is meant by the power of a hypothesis test and suggest one way a researcher might change their study design to increase the power of the test.

KEY: The power of a hypothesis test is the probability that we decide to reject the null hypothesis given the alternative hypothesis is actually true. One way to increase power is to increase the sample size.

37. A drug shows promise as a new treatment for hay fever. The hypotheses below were tested for $p$ = proportion of patients taking this drug who are cured of hay fever.

$$H_0: p \leq 0.80$$
$$H_a: p > 0.80$$

What are the Type 1 and Type 2 errors for this study?

KEY: A Type 1 error is to wrongly conclude that the proportion cured is greater than 80% when in fact the proportion cured is truly no more than 80%. A Type 2 error is not to conclude that the proportion cured is greater than 80% when in fact the proportion cured is truly greater than 80%.

**Questions 38 to 41:** The null hypothesis for $p$ = proportion of students who own their own car is $H_0$: $p = 0.10$. The significance level is set at $\alpha = 0.05$.

38. The value of 10% was obtained ten years ago. The alternative hypothesis will state that the proportion of students who own their own car has increased from the value ten years ago. What is the alternative hypothesis for $p$?

KEY: $H_a$: $p > 0.10$

39. The results of the study gave a $p$-value of 0.01. What is the decision?

KEY: Reject $H_0$.

40. The results of a study gave a $p$-value of 0.01. State your conclusion.

KEY: The conclusion is that the proportion of students who own their own car seems to be greater than 10%.

41. Based on your decision in question 39, what mistake (error) could have been made?

KEY: Type 1.

**Questions 42 to 44:** The null and alternative hypotheses for $p$ = proportion of students who buy at least 3 textbooks in a semester is given below:

$$H_0: p = 0.80 \text{ (or } p \leq 0.80)$$
$$H_a: p > 0.80$$

The results of a study gave a $p$-value of 0.08. The results of this study also stated that the study results were not statistically significant.

42. Give an example of a significance level the researchers performing the study could have used.

KEY: $\alpha = 0.05$ (any significance level that is *less* than 0.08 would work here).

43. State your conclusion.

KEY: Since the study results were not statistically significant, the null hypothesis is not rejected. The conclusion is that there is not enough evidence to reject the null hypothesis $p \leq 0.80$

44. What mistake could the researchers have made?

KEY: Type 2.

## Section 12.2

45. A Washington Post poll shows that concerns about housing payments have spiked despite some improvements in the overall economy. In all, 53 percent of the 900 American adults surveyed said they are "very concerned" or "somewhat concerned" about having the money to make their monthly payment. Let $p$ represent the population proportion of all American adults who are "very concerned" or "somewhat concerned" about having the money to make their monthly payment. Which are the appropriate hypotheses to assess if a majority of American adults are worried about making their mortgage or rent payments?
    A. $H_0$: $p = 0.50$ versus $H_a$: $p > 0.50$
    B. $H_0$: $p \geq 0.50$ versus $H_a$: $p < 0.50$
    C. $H_0$: $p = 0.53$ versus $H_a$: $p > 0.53$
    D. $H_0$: $p = 0.50$ versus $H_a$: $p = 0.53$

KEY: A

46. A $z$-test for testing hypotheses about a population proportion is to be conducted. True or false: One condition for this $z$-test to be valid is that the population of all responses has a Normal distribution.
    A. True
    B. False

KEY: B

47. A $z$-test for testing hypotheses about a population proportion is to be conducted. True or false: One condition for this $z$-test to be valid is that the sample size is adequately large enough.
    A. True
    B. False

KEY: A

**Questions 48 to 51:** A hypothesis test for a population proportion $p$ is given below:

$$H_0: p = 0.10$$
$$H_a: p \neq 0.10$$

For each sample size $n$ and sample proportion $\hat{p}$ compute the value of the $z$-statistic.

48. Sample size $n = 100$ and sample proportion $\hat{p} = 0.10$. $z$-statistic = ?
    A. –1.00
    B. 0.00
    C. 0.10
    D. 1.00

KEY: B

49. Sample size $n = 100$ and sample proportion $\hat{p} = 0.15$. $z$-statistic = ?
    A. –1.12
    B. 0.04
    C. 1.12
    D. 1.67

KEY: D

50. Sample size $n$ = 500 and sample proportion $\hat{p}$ = 0.04. $z$-statistic = ?
    A. –6.84
    B. –4.47
    C. 4.47
    D. 6.84

KEY: B

51. Sample size $n$ = 500 and sample proportion $\hat{p}$ = 0.20. $z$-statistic = ?
    A. –7.45
    B. –5.59
    C. 5.59
    D. 7.45

KEY: D

**Questions 52 to 55:** A hypothesis test for a population proportion $p$ is given below:

$$H_0: p \geq 0.40$$
$$H_a: p < 0.40$$

For each $z$-statistic, calculate the $p$-value for this hypothesis test.

52. $z$-statistic = 0.50. $p$-value = ?
    A. 0.0000
    B. 0.3085
    C. 0.5000
    D. 0.6915

KEY: D

53. $z$-statistic = 0.00. $p$-value = ?
    A. 0.0000
    B. 0.3085
    C. 0.5000
    D. 0.6915

KEY: C

54. $z$-statistic = –1.50. $p$-value = ?
    A. 0.0668
    B. 0.1469
    C. 0.8531
    D. 0.9332

KEY: A

55. $z$-statistic = 2.00. $p$-value = ?
    A. 0.0228
    B. 0.9332
    C. 0.9545
    D. 0.9772

KEY: D

**Questions 56 to 59:** A hypothesis test for a population proportion $p$ is given below:

$$H_0: p \leq 0.40$$
$$H_a: p > 0.40$$

For each $z$-statistic, calculate the $p$-value for the hypothesis test.

56. $z$-statistic = 0.50. $p$-value = ?
    A. 0.0000
    B. 0.3085
    C. 0.5000
    D. 0.6915

KEY: B

57. $z$-statistic = 0.00. $p$-value = ?
    A. 0.0000
    B. 0.3085
    C. 0.5000
    D. 0.6915

KEY: C

58. $z$-statistic = –1.50. $p$-value = ?
    A. 0.0668
    B. 0.1469
    C. 0.8531
    D. 0.9332

KEY: D

59. $z$-statistic = 2.00. $p$-value = ?
    A. 0.0228
    B. 0.9332
    C. 0.9545
    D. 0.9772

KEY: A

**Questions 60 to 63:** A hypothesis test for a population proportion $p$ is given below:

$$H_0: p = 0.70$$
$$H_a: p \neq 0.70$$

For each $z$-statistic, calculate the $p$-value for the hypothesis test.

60. $z$-statistic = 0.50. $p$-value = ?
    A. 0.0000
    B. 0.3085
    C. 0.6170
    D. 0.6915

KEY: C

61. $z$-statistic = –0.40. $p$-value = ?
    A. 0.3446
    B. 0.4000
    C. 0.6554
    D. 0.6892

KEY: D

62. $z$-statistic = 0.40. $p$-value = ?
    A. 0.3446
    B. 0.4000
    C. 0.6554
    D. 0.6892

KEY: D

63. $z$-statistic = –1.00. $p$-value = ?
    A. 0.1587
    B. 0.3174
    C. 0.6348
    D. 0.8413

KEY: B

64. Past data indicates an 80% (0.8) success rate in treating a certain medical problem. A new treatment is used on 100 patients in a clinical trial. It is successful in 87% (0.87) of the cases. What is the value of the $z$-score that can be used to test the null hypothesis that the success rate is 80%?
    A. 7
    B. 2
    C. 1.75
    D. –1.75

KEY: C

**Questions 65 to 67:** An ESP experiment is done in which a participant guesses which of 4 cards the researcher has randomly picked, where each card is equally likely. This is repeated for 200 trials. The null hypothesis is that the subject is guessing, while the alternative is that the subject has ESP and can guess at higher than the chance rate.

65. What is the correct statement of the null hypothesis that the person does not have ESP?
    A. $H_0$: $p = 0.5$
    B. $H_0$: $p = 4/200$
    C. $H_0$: $p = 1/4$
    D. $H_0$: $p > 1/4$

KEY: C

66. The subject actually gets 70 correct answers. Which of the following describes the probability represented by the $p$-value for this test?
    A. The probability that the subject has ESP
    B. The probability that the subject is just guessing.
    C. The probability of 70 or more correct guesses if the subject has ESP.
    D. The probability of 70 or more correct guesses if the subject is guessing at the chance rate.

KEY: D

67. Which of the following would be a Type 1 error in this situation?
    A. Declaring somebody has ESP when they actually don't have ESP.
    B. Declaring somebody does not have ESP when they actually do.
    C. Analyzing the data with a confidence interval rather than a significance test.
    D. Making a mistake in the calculations of the significance test.

KEY: A

**Questions 68 to 72**: A sample of $n = 200$ college students is asked if they believe in extraterrestrial life and 120 of these students say that they do. The data are used to test $H_0$: $p = 0.5$ versus $H_a$: $p > 0.5$, where $p$ is the population proportion of college students who say they believe in extraterrestrial life. The following Minitab output was obtained:

```
Sample   X   N   Sample p         95.0 % CI           Z-Value  P-Value
1          120  200  0.600000  (0.532105, 0.667895)     2.83    0.002
```

68. What is the correct description of the area that equals the $p$-value for this problem?
    A. The area to the right of 0.60 under a standard normal curve.
    B. The area to the right of 2.83 under a standard normal curve.
    C. The area to the right of –2.83 under the standard normal curve.
    D. The area between 0.532105 and 0.667895 under a standard normal curve.

KEY: B

69. Suppose that the alternative hypothesis had been $H_a$: $p \neq 0.5$. What would have been the $p$-value of the test?
    A. 0.002
    B. 0.001
    C. 0.004
    D. 0.5

KEY: C

70. Using a 5% significance level, what is the correct decision for this significance test?
    A. Fail to reject the null hypothesis because the $p$-value is greater than 0.05.
    B. Fail to reject the null hypothesis because the $p$-value is less than 0.05.
    C. Reject the null hypothesis because the $p$-value is greater than 0.05.
    D. Reject the null hypothesis because the $p$-value is less than 0.05.

KEY: D

71. Using a 5% significance level, what is the correct conclusion for this significance test?
    A. The proportion of college students who say they believe in extraterrestrial life is equal to 50%.
    B. The proportion of college students who say they believe in extraterrestrial life is not equal to 50%.
    C. The proportion of college students who say they believe in extraterrestrial life seems to be greater than 50%.
    D. The proportion of college students who say they believe in extraterrestrial life seems to be equal to 60%.

KEY: C

72. Based on the decision made in question 70, what mistake could have been made?
    A. Type 1.
    B. Type 2.
    C. Neither one; the $p$-value is so small that no mistake could have been made.

KEY: A

73. About 90% of the general population is right-handed. A researcher speculates that artists are less likely to be right-handed than the general population. In a random sample of 100 artists, 83 are right-handed. Which of the following best describes the $p$-value for this situation?
    A. The probability that the population proportion of artists who are right-handed is 0.90.
    B. The probability that the population proportion of artists who are right-handed is 0.83.
    C. The probability the sample proportion would be as small as 0.83, or even smaller, if the population proportion of artists who are right-handed is actually 0.90.
    D. The probability that the population proportion of artists who are right-handed is less than 0.90, given that the sample proportion is 0.83.

KEY: C

74. Consider testing the alternative hypothesis that the proportion of adult Canadians opposed to same-sex marriage in Canada is less than 0.5. The test was conducted based on a poll of $n = 1003$ adults and it had a $p$-value of 0.102. Which of the following describes the probability represented by the $p$-value for this test?
    A. It is the probability that fewer than half of all adults in Canada that year were opposed to same-sex marriage.
    B. It is the probability that more than half of all adult Canadians that year were opposed to same-sex marriage.
    C. It is the probability that a sample of 1003 adults in Canada that year would result in 48% or fewer saying they are opposed to same-sex marriage, given that a majority (over 50%) of Canadian adults actually were opposed that year.
    D. It is the probability that a sample of 1003 adults in Canada that year would result in 48% or fewer saying they are opposed to same-sex marriage, given that 50% of Canadian adults actually were opposed that year.

KEY: D

**Questions 75 and 76:** A researcher examined the folklore that women can predict the sex of their unborn child better than chance would suggest. She asked 104 pregnant women to predict the sex of their unborn child, and 57 guessed correctly. Using these data, the researcher created the following Minitab output.

```
Test of p = 0.5 vs p > 0.5

Sample      X      N  Sample p  95.0% Lower Bound  Z-Value  P-Value
1          57    104  0.548              0.468        0.98    0.163
```

75. Based on the information in the output, what is the appropriate conclusion the researcher can make about $p$ = proportion of pregnant women who can correctly predict the sex of their unborn child?
    A. There is statistically significantly evidence against the null hypothesis that $p = 0.5$.
    B. There is not statistically significant evidence against the null hypothesis that $p = 0.5$.
    C. There is statistically significant evidence against the null hypothesis that $p = 0.548$.
    D. There is not statistically significant evidence against the null hypothesis that $p = 0.548$.

KEY: B

76. Which choice describes how the $p$-value was computed in this situation?
    A. The probability that a z-score would be greater than or equal to 0.98.
    B. The probability that a z-score would be less than or equal to 0.98.
    C. The total of the probabilities that a z-score is greater than or equal to 0.98 and less than or equal to –0.98.
    D. The probability that a z-score would be between –0.98 and 0.98.

KEY: A

77. A null hypothesis is that the probability is 0.7 that a new drug will provide relief in a randomly selected patient. The alternative is that the probability of relief is greater than 0.7. Suppose the treatment is used on 500 patients and there are 380 successes. How would a $p$-value be calculated in this situation?
    A. Find the chance of 380 or more successes, calculated assuming the true success rate is greater than 0.7.
    B. Find the chance of 380 or more successes, calculated assuming the true success rate is 0.7.
    C. Find the chance of fewer than 380 successes, calculated assuming the true success rate is greater than 0.7.
    D. Find the chance of fewer than 380 successes, calculated assuming true success rate is 0.7.

KEY: B

78. The *p*-value for a one-sided test for a population proportion was 0.02. The *p*-value for the corresponding two-sided test would be:
    A. .01
    B. .02
    C. .04
    D. It depends on whether the one-sided test had a "greater than" sign or a "less than" sign in the alternative hypothesis.

KEY: C

79. The *p*-value for a two-sided test for a population proportion was 0.04. The *p*-value for a one-sided test would be:
    A. .02
    B. .04
    C. .08
    D. It depends on whether the one-sided test had a "greater than" sign or a "less than" sign in the alternative hypothesis.

KEY: D

80. Suppose a 95% confidence interval for *p*, the proportion of drivers who admit that they sometimes run red lights when no one is around, is 0.29 to 0.38. Which of the following statements is *false*?
    A. A test of $H_0$: $p = 0.3$ versus $H_a$: $p \neq 0.3$ would not be rejected using $\alpha = 0.05$.
    B. A test of $H_0$: $p = 0.5$ versus $H_a$: $p \neq 0.5$ would be rejected using $\alpha = 0.05$.
    C. It is plausible that about 37% of all drivers would admit that they sometimes run red lights when no one is around.
    D. It is plausible that a majority of all drivers would admit that they sometimes run red lights when no one is around.

KEY: D

**Questions 81 to 83:** A university administrator writes a report in which he states that at least 45% of all students have driven while under the influence of drugs or alcohol. Many others think the correct percent is less than 45%.

81. What are appropriate null and alternative hypothesis in this situation?
    A. $H_0$: $\hat{p} \geq 0.45$ vs. $H_a$: $\hat{p} < 0.45$
    B. $H_0$: $\hat{p} = 0.45$ vs. $H_a$: $\hat{p} \neq 0.45$
    C. $H_0$: $p \geq 0.45$ vs. $H_a$: $p < 0.45$
    D. $H_0$: $p = 0.45$ vs. $H_a$: $p \neq 0.45$

KEY: C

82. To resolve the issue, a random sample of 400 students is obtained and it is found that 156 or 39% admit that they have driven under the influence of drugs or alcohol. Here is some Minitab output:

| X | N | Sample p | Z-Value | P-Value |
|---|---|---|---|---|
| 156 | 400 | 0.390000 | -2.41 | 0.008 |

What conclusion should be made?
    A. Conclude that the true proportion of students that has driven under the influence appears to be less than 39%.
    B. Conclude that the true proportion of students that has driven under the influence appears to be less than 45%.
    C. There is insufficient evidence to conclude that the true proportion of students that has driven under the influence is less than 39%.
    D. There is insufficient evidence to conclude that the true proportion of students that has driven under the influence is less than 45%.

KEY: B

83. Which of the following statements describes the *p*-value that was calculated in this situation?
    A. It is the probability that the sample percent would be 39% or less if the true percent in the population actually is less than 45%.
    B. It is the probability that the sample percent would be 39% of less if the true percent in the population actually is 45%.
    C. It is the probability that the true percent in the population is 45%.
    D. It is the probability that the true percent in the population is 39%.

KEY: B

84. A hypothesis test is done in which the alternative hypothesis states that more than 10% of a population is left-handed. The *p*-value for the test is calculated to be 0.25. Which statement is correct?
    A. We can conclude that more than 10% of the population is left-handed.
    B. We can conclude that more than 25% of the population is left-handed.
    C. We can conclude that exactly 25% of the population is left-handed.
    D. We cannot conclude that more than 10% of the population is left-handed.

KEY: D

**Questions 85 to 89:** A random sample of 850 high school girls showed that 400 had done strenuous exercise over the past year. The researcher wants to test the hypotheses below for $p$ = the proportion of all high school girls who do strenuous exercise.

$$H_0: p \geq 0.50$$
$$H_a: p < 0.50$$

85. State the null hypothesis ($H_0$) and the alternative hypothesis ($H_a$) in words.

KEY: Null hypothesis: At least 50% of high school girls do strenuous exercise. Alternative hypothesis: Less than 50% of high school girls do strenuous exercise.

86. Verify necessary data conditions for a *z*-statistic and calculate the *z*-statistic.

KEY: $np_0 = n(1 - p_0) = 425 > 10$, so the sample size is large enough. The sample is also a random sample (as stated in the introduction). $z = -1.71$.

87. Find the *p*-value.

KEY: *p*-value = 0.044.

88. Are the results statistically significant at a significance level of $\alpha = 0.05$?

KEY: Yes, the results are statistically significant.

89. Report the conclusion in the context of the situation.

KEY: It seems that less than 50% of all high school girls do strenuous exercise.

**Questions 90 to 94:** A random sample of 800 high school boys showed that 420 had done strenuous exercise during the past year. The researcher wants to test the hypotheses below for $p$ = the proportion of all high school boys who do strenuous exercise.

$$H_0: p \leq 0.50$$
$$H_a: p > 0.50$$

90. State the null hypothesis ($H_0$) and the alternative hypothesis ($H_a$) in words.
KEY: Null hypothesis: At most 50% of high school boys do strenuous exercise. Alternative hypothesis: More than 50% of high school boys do strenuous exercise.

91. Verify necessary data conditions for a $z$-statistic and calculate the $z$-statistic.
KEY: $np_0 = n(1 - p_0) = 400 > 10$, so the sample size is large enough. The sample is also a random sample. $z = 1.41$.

92. Find the $p$-value.
KEY: $p$-value = 0.079.

93. Are the results statistically significant at a significance level of $\alpha = 0.05$?
KEY: No, the results are not statistically significant.

94. Report the conclusion in the context of the situation.
KEY: The evidence is not strong enough to discount the possibility that the proportion of boys who do strenuous exercise is 50% or less.

**Questions 95 to 99:** A random sample of 600 high school boys showed that 40 had taken diet pills during the past 30 days to lose weight The researcher wants to test the hypotheses below for $p$ = the proportion of all high school boys who take diet pills to lose weight.

$$H_0: p = 0.10$$
$$H_a: p \neq 0.10$$

95. State the null hypothesis ($H_0$) and the alternative hypothesis ($H_a$) in words.
KEY: Null hypothesis: Ten percent of high school boys take diet pills to lose weight. Alternative hypothesis: The percent of high school boys who take diet pills to lose weight is not 10%.

96. Verify necessary data conditions for a $z$-statistic and calculate the $z$-statistic.
KEY: $np_0 = 60$ and $n(1 - p_0) = 540 > 10$, so the sample size is large enough. The sample is also a random sample (as stated in the introduction). $z = -2.72$.

97. Find the $p$-value.
KEY: $p$-value = 0.0066

98. Are the results statistically significant at a significance level of $\alpha = 0.05$?
KEY: Yes, the results are statistically significant.

99. Report the conclusion in the context of the situation.
KEY: The proportion of boys who take diet pills to lose weight does not appear to be equal to 10% ($p$-value = 0.0066).

**Questions 100 to 105:** Gun control is a sensitive issue in the US. In a survey, 650 people favored a ban on handguns out of a total of 1250 individuals polled. Do the data provide sufficient evidence to conclude that a majority of individuals in the population favor banning handguns?

100. State the appropriate hypotheses about $p$, the population proportion of people who favor banning handguns.
KEY: $H_0$: $p = 0.5$, $H_a$: $p > 0.5$

101. What is the sample proportion of people who favor banning handguns? Include the appropriate symbol in your answer that represents this value.
KEY: $\hat{p} = 0.52$

102. What is the numerical value of the observed test statistic?
KEY: z = 1.414

103. What is the numerical value of the corresponding $p$-value?
KEY: $p$-value = 0.079

104. Using a 5% significance level, does there appear to be a majority of people in the population who favor banning handguns?
KEY: No, the $p$-value is not smaller than 0.05, so we cannot reject the null hypothesis.

105. Could you have made a mistake when making your decision in question 104? If yes, what is this mistake called? If no, explain briefly why not.
KEY: Yes, type 2 error.

**Questions 106 and 107:** Let $p$ represent the population proportion of all employees at a large company who are "very concerned" or "somewhat concerned" about having the money to make their monthly mortgage or rent payment. A local organization would like to assess at a 10% significance level if a majority of all employees are worried about making their mortgage or rent payments, namely, $H_0$: $p = 0.50$ versus $H_a$: $p > 0.50$. A random sample of 20 such employees yields just 8 adults who say they are "very concerned" or "somewhat concerned" about having the money to make their monthly payment.

106. Without actually computing it, will the resulting $p$-value be less than 0.50, equal to 0.50, or more than 0.50?
KEY: The $p$-value will be more than 0.50, as the sample resulted in a minority and these data were to be used to assess if we have a majority.

107. What distribution would have been used to find the exact $p$-value for the test regarding the population of all employees? Provide details to fully specify the distribution.
KEY: A binomial distribution with $n = 20$ and $p = 0.50$.

## Section 12.3

108. A $z$-test to compare two population proportions is to be conducted. True or false: One condition for this $z$-test to be valid is that both populations have Normal distributions.
   A. True
   B. False

KEY: B

109. A $z$-test to compare two population proportions is to be conducted. True or false: One condition for this $z$-test to be valid is that both samples sizes are large.
   A. True
   B. False

KEY: A

**Questions 110 to 114:** An airport official wants to prove that the $p_1$ = proportion of delayed flights after a storm for Airline 1 was *different* from $p_2$ = the proportion of delayed flights for Airline 2. Random samples from the two airlines after a storm showed that 50 out of 100 of Airline 1's flights were delayed, and 70 out of 200 of Airline 2's flights were delayed.

110. What are the appropriate null and alternative hypotheses?
   A. $H_0$: $p_1 - p_2 = 0$ and $H_a$: $p_1 - p_2 \neq 0$
   B. $H_0$: $p_1 - p_2 \neq 0$ and $H_a$: $p_1 - p_2 = 0$
   C. $H_0$: $p_1 - p_2 = 0$ and $H_a$: $p_1 - p_2 < 0$
   D. $H_0$: $p_1 - p_2 = 0$ and $H_a$: $p_1 - p_2 > 0$

KEY: A

111. What is the value of the test statistic?
   A. 0.79
   B. 2.00
   C. 2.50
   D. None of the above

KEY: C

112. What is the $p$-value? (computer or calculator for normal distribution required)
   A. $p$-value = 0.0062
   B. $p$-value = 0.0124
   C. $p$-value = 0.0456
   D. $p$-value = 0.2148

KEY: B

113. For a significance level of $\alpha = 0.05$, are the results statistically significant?
   A. No, the results are not statistically significant because the $p$-value < 0.05.
   B. Yes, the results are statistically significant because the $p$-value < 0.05.
   C. No, the results are not statistically significant because the $p$-value > 0.05
   D. Yes, the results are statistically significant because the $p$-value > 0.05.

KEY: B

114. Report your conclusion in terms of the two airlines.
   A. The proportion of delayed flights after a storm for Airline 1 seems to be different than the proportion of delayed flights after a storm for Airline 2.
   B. The results are not statistically significant: there is not enough evidence to conclude there is a difference between the two proportions.
   C. The difference in proportions of delayed flights is at least 15%.
   D. The proportion of delayed flights after a storm for Airline 1 seems to be the same as the proportion of delayed flights after a storm for Airline 2.

KEY: A

**Questions 115 to 119:** An airport official wants to prove that the $p_1$ = proportion of delayed flights after a storm for Airline A is *less* than $p_2$ = the proportion of delayed flights for Airline B. Random samples from two airlines after a storm showed that 51 out of 200 of Airline A's flights were delayed, and 60 out of 200 of Airline B's flights were delayed.

115. What are the appropriate null and alternative hypotheses?
   A. $H_0$: $p_1 - p_2 = 0$ and $H_a$: $p_1 - p_2 \neq 0$
   B. $H_0$: $p_1 - p_2 \neq 0$ and $H_a$: $p_1 - p_2 = 0$
   C. $H_0$: $p_1 - p_2 = 0$ and $H_a$: $p_1 - p_2 < 0$
   D. $H_0$: $p_1 - p_2 = 0$ and $H_a$: $p_1 - p_2 > 0$

KEY: C

116. What is the value of the test statistic?
   A. –1.00
   B. –1.50
   C. –2.00
   D. None of the above

KEY: A

117. What is the *p*-value? (computer or calculator for normal distribution required)
   A. *p*-value = 0.0228
   B. *p*-value = 0.0668
   C. *p*-value = 0.1587
   D. *p*-value = 0.3174

KEY: C

118. For a significance level of $\alpha = 0.05$, are the results statistically significant?
   A. No, the results are not statistically significant because the *p*-value < 0.05.
   B. Yes, the results are statistically significant because the *p*-value < 0.05.
   C. No, the results are not statistically significant because the *p*-value > 0.05
   D. Yes, the results are statistically significant because the *p*-value > 0.05.

KEY: C

119. Report your conclusion in terms of the two airlines.
   A. The proportion of delayed flights for Airline A seems to be less than the proportion of delayed flights for Airline B.
   B. The results are not statistically significant: there is not enough evidence to conclude that the proportion of delayed flights for Airline A is less than the proportion for Airline B.
   C. The difference in proportions of delayed flights is at least 4%.
   D. The proportion of delayed flights after a storm for Airline A seems to be greater than the proportion of delayed flights after a storm for Airline B.

KEY: B

**Questions 120 to 122:** Data were collected by giving a survey to a random sample of students at a university. One question asked was: "Do you believe in extraterrestrial life?" Here is a comparison of the proportions of males and females that said "yes":

```
Success = Yes

     Gender X   N  Sample p
     female 78 146 0.534247
     male   73 105 0.695238

     Estimate for p(female) - p(male): -0.160992
     95% upper bound for p(female) - p(male): -0.0606390
     Test for p(female) - p(male) = 0 (vs < 0):
     Z = -2.64 P-Value = 0.004
```

Subscripts in these questions are 1 = females, 2 = males.

120. Suppose we wish to know if females at the university are less likely to believe in extraterrestrial life than males. What are the appropriate null and alternative hypotheses?
   A. $H_0$: $\mu_1 - \mu_2 = 0$ and $H_a$: $\mu_1 - \mu_2 < 0$
   B. $H_0$: $\mu_1 - \mu_2 < 0$ and $H_a$: $\mu_1 - \mu_2 = 0$
   C. $H_0$: $p_1 - p_2 < 0$ and $H_a$: $p_1 - p_2 = 0$
   D. $H_0$: $p_1 - p_2 = 0$ and $H_a$: $p_1 - p_2 < 0$

KEY: D

121. Is there statistically significant evidence that females are less likely than males to believe in extraterrestrial life?
   A. Yes, because the *p*-value is < 0.05.
   B. Yes, because the *p*-value is > 0.05.
   C. No, because the *p*-value is < 0.05.
   D. No, because the *p*-value is > 0.05.

KEY: A

122. How is the *p*-value for this test found?
   A. The area to the left of –2.64 under the standard normal distribution.
   B. The area to the right of –2.64 under the standard normal distribution.
   C. The area to the left of –2.64 under a *t* distribution with 72 degrees of freedom.
   D. The area to the right of –2.64 under a *t* distribution with 72 degrees of freedom.

KEY: A

**Questions 123 to 125:** A study was conducted to learn about drinking and driving habits of male and female college students. Independent random samples of 942 female students and 754 male students were obtained. Of those sampled, 181 female and 181 male students admitted that they had driven after consuming an alcoholic beverage. Is this sufficient evidence to conclude that male college students tend to drive after drinking more frequently than female college students? Let #1 = females and #2 = males, so that the appropriate hypotheses to be tested are: $H_0$: $p_1 = p_2$ versus $H_a$: $p_1 < p_2$. Set the significance level to 0.01.

123. Assuming the null hypothesis is true, what is the estimate of the common population proportion *p*?
   A. 0.213
   B. 0.192
   C. 0.240
   D. 0.216

KEY: A

124. The $z$-statistic for testing the hypotheses is $z$ = -2.4. What is the corresponding $p$-value?
   A. 0.0041
   B. 0.0164
   C. 0.0082
   D. 0.9918

KEY: C

125. Based on this study, we can conclude that smoking _____ more popular among men.
   A. is
   B. is not
   C. seems to be
   D. does not appear to be

KEY: C

**Questions 126 to 132:** Time magazine recently polled 500 13-year-olds online to get a glimpse into their world. The results may surprise many people: 13-year-olds in 2005 enjoy their relationships with their parents, are less likely to drink or do drugs than previous generations, and they are highly focused, competitive and determined to succeed. The overscheduled toddlers of the 1990s are now controlling their own schedules, and in many cases, their days are just as jam-packed as ever. It seems today's teens are not only used to being extremely busy, they thrive on it. One result from the Time Poll was that 53 percent of the 13-year-olds polled said their parents are very involved in their lives. Suppose that 200 of the 13-year olds were boys and 300 of them were girls. We wish to find out if the proportion of 13-year old boys and girls who say that their parents are very involved in their lives are the same. Let the boys be represented by subscript #1 and girls by #2.

126. What are the appropriate null and alternative hypotheses?

KEY: $H_0$: $p_1 - p_2 = 0$ and $H_a$: $p_1 - p_2 \neq 0$

127. In the sample, 93 boys and 172 girls said that their parents are very involved in their lives. Under the null hypothesis, what is the numerical value of the estimate for the common population proportion of 13-year olds who say that their parents are very involved in their lives?

KEY: 0.53

128. Calculate the value of the test statistic.

KEY: $z = -2.38$

129. What is the numerical value of the $p$-value for this test?

KEY: $p$-value = 0.0174

130. Are the data statistically significant that the 1% significance level?

KEY: No, the $p$-value > 0.01.

131. Is the probability that we have made a Type 1 error equal to 1% (0.01)?
   A. Yes
   B. No

KEY: B

132. Is the probability that we have made a Type 2 error equal to 1 – 0.01 = 0.99 or 99%?
   A. Yes
   B. No

KEY: B

## Section 12.4

**Questions 133 and 134:** Suppose that two different studies were conducted to determine whether the proportion of overweight men is 30% (null hypothesis) or different from 30% (alternative hypothesis). One study enrolled 100 men, while the other study enrolled 1000 men. Both studies resulted in the same sample proportion of overweight men, 35%. However, the *p*-values were very different: one study gave a *p*-value = 0.275 while the other study gave a *p*-value = 0.0006.

133. Decide which study produced each *p*-value.
KEY: The *p*-value = 0.275 belongs to the study with 100 men, while the *p*-value of 0.0006 belongs to the study with 1000 men.

134. Explain why the *p*-values are so different.
KEY: The *p*-values are different because the standard error of the sample proportion is much smaller for the larger sample size, resulting in a *z*-statistic with a larger absolute value. Confidence intervals are recommended in reporting the results of each study.

**Questions 135 to 140:** Suppose a park ranger wishes to collect some data from the State Park he works in to asses if the proportion of trees in the park that are in need of pruning is significantly higher than 5%. He will test the hypotheses $H_0$: $p = 0.05$ vs. $H_a$: $p > 0.05$. After a week of hard work, randomly selecting and inspecting trees throughout the entire park, the park ranger found that 7% of the trees in the sample were in need of pruning.

135. If the park ranger collected data on 100 trees in the park, what is the value of the test statistic for testing these hypotheses and the corresponding *p*-value?
KEY: $z = 0.92$, *p*-value = 0.1794

136. If the park ranger collected data on 100 trees in the park, is the difference between the observed percentage of 7% and the hypothesized value of 5% statistically significant (use $\alpha = 0.05$)?
KEY: No, the *p*-value is rather large, so we would not be able to reject the hull hypothesis.

137. If the park ranger collected data on 500 trees in the park, what is the value of the test statistic for testing these hypotheses and the corresponding *p*-value?
KEY: $z = 2.05$, *p*-value = 0.0201

138. If the park ranger collected data on 500 trees in the park, is the difference between the observed percentage of 7% and the hypothesized value of 5% statistically significant (use $\alpha = 0.05$)?
KEY: Yes, the *p*-value is rather small, so we would reject the hull hypothesis.

139. Explain in your own words why the results of the test were so different, even though the sample proportion was 7% in both cases.
KEY: The *p*-values for the two tests were very different, therefore resulting in opposite decisions. The sample size plays an important role in hypothesis testing, since it directly affects the standard error. A larger sample size will result in a smaller standard error. With the smaller standard error, the difference between 5% and 7% becomes statistically significant.

140. Think about the park ranger's job when answering the following question. Is the difference between the observed percentage of 7% and the hypothesized value of 5% practically significant?
KEY: Probably not. The park ranger and his crew will have to go out and prune those trees, but the difference between 5 and 7 percent probably does not impact their job. If the percentage were actually, say, 20 percent, they would have to hire more people to accomplish their task.