MULTIPLE CHOICE. Choose the one alternative that best completes the statement or answers the question.

1) The manufacturer of a refrigerator system for beer kegs produces refrigerators that are supposed to maintain a mean temperature, \( \mu \), of 44°F, ideal for a certain type of German pilsner. The owner of the brewery does not agree with the refrigerator manufacturer, and wants to conduct a hypothesis test to determine whether the true mean temperature differs from this value.

A) \( H_0 : \mu \neq 44°F \)  \( H_a : \mu = 44°F \)
B) \( H_0 : \mu = 44°F \)  \( H_a : \mu \neq 44°F \)
C) \( H_0 : \mu \leq 44°F \)  \( H_a : \mu > 44°F \)
D) \( H_0 : \mu \geq 44°F \)  \( H_a : \mu < 44°F \)

Answer: B

Objective: (9.1) Determine Null and Alternative Hypotheses

2) \( x = 137, n = 20, \sigma = 14.2 \), \( H_0 : \mu = 132 \), \( H_a : \mu \neq 132 \), \( \alpha = 0.05 \)

A) \( z = 2.57; \) P-value = 0.0101; Reject \( H_0 \). The evidence against the null hypothesis is strong.
B) \( z = 1.57; \) P-value = 0.1164; Do not reject \( H_0 \). The evidence against the null hypothesis is weak or none.
C) \( z = 0.35; \) P-value = 0.7263; Do not reject \( H_0 \). The evidence against the null hypothesis is weak or none.
D) \( z = 1.57; \) P-value = 0.0582; Do not reject \( H_0 \). The evidence against the null hypothesis is moderate

Answer: B

Objective: (9.5) Perform One Mean z-Test Given Statistics

3) A left-tailed test:
\( z = -2.65 \)

A) 0.0040  B) 0.0080  C) 0.9920  D) 0.9960

Answer: A

Objective: (9.5) Find P-Value Given Test Statistic
Provide an appropriate answer.

4) A high school biology student wishes to test the hypothesis that hummingbird feeders can affect the mean mass of ruby-throated hummingbirds in the area surrounding the feeder. She captures and weighs several of the hummingbirds near a science museum where several feeders are located. She obtains the following masses in grams:

\[
\begin{array}{cccccccc}
4.2 & 3.9 & 3.6 & 3.5 & 3.9 & 3.8 \\
3.8 & 4.1 & 3.9 & 3.8 & 3.2 & 3.4
\end{array}
\]

The student’s hypotheses are:

- \( H_0: \mu = 3.65 \text{ g} \)
- \( H_1: \mu > 3.65 \text{ g} \)

Use technology to calculate \( P \), then determine whether the data provide sufficient evidence to conclude that the mean mass of the birds in the area surrounding the feeder is greater than the mean mass of the general population. Test at the 5\% significance level and assume that the population standard deviation is 0.35 g. Also, assess the strength of the evidence against the null hypothesis.

A) \( P = 0.1418 \); since \( P > 0.05 \), do not reject the null hypothesis.

At the 5\% significance level, the data do not provide sufficient evidence to conclude that the mean mass of the birds in the area surrounding the feeder is greater than the mean mass of the general population. The evidence against the null hypothesis is weak or none.

B) \( P = 0.745 \); since \( P > 0.05 \), do not reject the null hypothesis.

At the 5\% significance level, the data do not provide sufficient evidence to conclude that the mean mass of the birds in the area surrounding the feeder is greater than the mean mass of the general population. The evidence against the null hypothesis is weak or none.

C) \( P = 0.255 \); since \( P > 0.05 \), reject the null hypothesis.

At the 5\% significance level, the data do provide sufficient evidence to conclude that the mean mass of the birds in the area surrounding the feeder is greater than the mean mass of the general population. The evidence against the null hypothesis is moderate.

D) \( P = 0.509 \); since \( P > 0.05 \), reject the null hypothesis.

At the 5\% significance level, the data do provide sufficient evidence to conclude that the mean mass of the birds in the area surrounding the feeder is greater than the mean mass of the general population. The evidence against the null hypothesis is strong.

Answer: A

Objective: (9.5) Tech: Hypothesis Test for Mean (P-Value Method)

A one-sample z-test for a population mean is to be performed. The value obtained for the test statistic, \( z = \frac{\bar{x} - \mu_0}{\sigma / \sqrt{n}} \), is given. The nature of the test (right-tailed, left-tailed, or two-tailed) is also specified. Determine the \( P \)-value.

5) A left-tailed test:

\[ z = -0.58 \]

A) 0.4380  B) 0.7190  C) 0.5620  D) 0.2810

Answer: D

Objective: (9.5) Find P-Value Given Test Statistic

The significance level and \( P \)-value of a hypothesis test are given. Decide whether the null hypothesis should be rejected.

6) \( \alpha = 0.01 \); \( P \)-value = 0.004

A) Reject the null hypothesis.  B) Do not reject the null hypothesis.

Answer: A

Objective: (9.5) Determine Conclusion Given P-Value and Alpha
A one-sample z-test for a population mean is to be performed. The value obtained for the test statistic, \( z = \frac{\bar{x} - \mu_0}{\sigma/\sqrt{n}} \), is given. The nature of the test (right-tailed, left-tailed, or two-tailed) is also specified. Determine the P-value.

7) A right-tailed test:
   \[ z = 2.38 \]
   A) 0.9913  B) 0.9826  C) 0.0087  D) 0.0174
   Answer: C
   Objective: (9.5) Find P-Value Given Test Statistic

Use a table of t-values to estimate the P-value for the specified one-mean t-test.

8) Two-tailed test, \( n = 21, t = -2.509 \)
   A) 0.005 < P < 0.01  B) 0.05 < P < 0.10  C) 0.01 < P < 0.02  D) 0.02 < P < 0.05
   Answer: D
   Objective: (9.6) Find p-Value Given Type of Test, n, and Test Statistic

9) Right-tailed test, \( n = 4, t = 2.525 \)
   A) 0.005 < P < 0.01  B) 0.05 < P < 0.10  C) 0.025 < P < 0.05  D) 0.01 < P < 0.025
   Answer: C
   Objective: (9.6) Find p-Value Given Type of Test, n, and Test Statistic

A hypothesis test is to be performed. Determine the null and alternative hypotheses.

10) At one school, the average amount of time that tenth-graders spend watching television each week is 21.6 hours. The principal introduces a campaign to encourage the students to watch less television. One year later, the principal wants to perform a hypothesis test to determine whether the average amount of time spent watching television per week has decreased.
   \[ A) H_0 : \mu < 21.6 \text{ hours} \quad H_a : \mu > 21.6 \text{ hours} \quad B) H_0 : \mu < 21.6 \text{ hours} \quad H_a : \mu = 21.6 \text{ hours} \]
   \[ C) H_0 : \mu = 21.6 \text{ hours} \quad H_a : \mu < 21.6 \text{ hours} \quad D) H_0 : \mu = 21.6 \text{ hours} \quad H_a : \mu \leq 21.6 \text{ hours} \]
   Answer: C
   Objective: (9.1) Determine Null and Alternative Hypotheses

Classify the hypothesis test as two-tailed, left-tailed, or right-tailed.

11) A psychologist has designed a test to measure stress levels in adults. She has determined that nationwide the mean score on her test is 24. A hypothesis test is to be conducted to determine whether the mean score for trial lawyers exceeds the national mean score.
   \[ A) \text{Two-tailed} \quad B) \text{Left-tailed} \quad C) \text{Right-tailed} \]
   Answer: C
   Objective: (9.1) Classify Test as Two-, Left-, or Right-Tailed
A hypothesis test is to be performed. Determine the null and alternative hypotheses.

12) A manufacturer claims that the mean amount of juice in its 16 ounce bottles is 16.1 ounces. A consumer advocacy group wants to perform a hypothesis test to determine whether the mean amount is actually less than this.

A) $H_0 : \mu = 16.1$ ounces
   $H_a : \mu \leq 16.1$ ounces
B) $H_0 : \mu < 16.1$ ounces
   $H_a : \mu = 16.1$ ounces
C) $H_0 : \mu > 16.1$ ounces
   $H_a : \mu < 16.1$ ounces
D) $H_0 : \mu = 16.1$ ounces
   $H_a : \mu < 16.1$ ounces

Answer: D

Objective: (9.1) Determine Null and Alternative Hypotheses

For the given hypothesis test, explain the meaning of a Type I error, a Type II error, or a correct decision as specified.

13) A psychologist has designed a test to measure stress levels in adults. She has determined that nationwide the mean score on her test is 27. A hypothesis test is to be conducted to determine whether the mean score for trial lawyers exceeds the national mean score. The hypotheses are

$H_0 : \mu = 27$
$H_a : \mu > 27$

where $\mu$ is the mean score for all trial lawyers. Explain the meaning of a Type I error.

A) A Type I error would occur if, in fact, $\mu = 27$, but the results of the sampling lead to the conclusion that $\mu > 27$.
B) A Type I error would occur if, in fact, $\mu > 27$, but the results of the sampling fail to lead to that conclusion.
C) A Type I error would occur if, in fact, $\mu > 27$, but the results of the sampling lead to rejection of the null hypothesis that $\mu = 27$.
D) A Type I error would occur if, in fact, $\mu = 27$, but the results of the sampling fail to lead to rejection of that fact.

Answer: A

Objective: (9.2) Explain Meaning of Type I/Type II/No Error II

14) A man is on trial accused of murder in the first degree. The prosecutor presents evidence that he hopes will convince the jury to reject the hypothesis that the man is innocent. This situation can be modeled as a hypothesis test with the following hypotheses:

$H_0 : \text{The defendant is innocent.}$
$H_a : \text{The defendant is guilty.}$

Explain the meaning of a Type II error.

A) A Type II error would occur if, in fact, the defendant is innocent and the jury fails to reject the null hypothesis that he is innocent.
B) A Type II error would occur if, in fact, the defendant is guilty but the jury fails to conclude that he is guilty.
C) A Type II error would occur if, in fact, the defendant is guilty and the jury rejects the null hypothesis that he is innocent.
D) A Type II error would occur if, in fact, the defendant is innocent but the jury concludes that he is guilty.

Answer: B

Objective: (9.2) Explain Meaning of Type I/Type II/No Error II
15) In 2000, the average duration of long-distance telephone calls originating in one town was 9.4 minutes. Five years later, in 2005, a long-distance telephone company wants to perform a hypothesis test to determine whether the average duration of long-distance phone calls has changed from the 2000 mean of 9.4 minutes. The hypotheses are:

\[ H_0 : \mu = 9.4 \text{ minutes} \]
\[ H_a : \mu \neq 9.4 \text{ minutes} \]

where \( \mu \) is the mean duration, in 2005, of long-distance telephone calls originating in the town.

Explain the meaning of a correct decision.

A) A correct decision would occur if, in fact, \( \mu = 9.4 \) minutes, and the results of the sampling do not lead to rejection of that fact; or if, in fact, \( \mu \neq 9.4 \) minutes and the results of the sampling lead to that conclusion.

B) A correct decision would occur if, in fact, \( \mu \neq 9.4 \) minutes and the results of the sampling do not lead to rejection of the null hypothesis that \( \mu = 9.4 \) minutes.

C) A correct decision would occur if, in fact, \( \mu = 9.4 \) minutes, and the results of the sampling do not lead to rejection of that fact; or if, in fact, \( \mu \neq 9.4 \) minutes and the results of the sampling do not lead to rejection of the null hypothesis.

D) A correct decision would occur if, in fact, \( \mu = 9.4 \) minutes, and the results of the sampling lead to rejection of the null hypothesis; or if, in fact, \( \mu \neq 9.4 \) minutes and the results of the sampling lead to that conclusion.

Answer: A

Objective: (9.2) Explain Meaning of Type I/Type II/No Error I

The graph portrays the decision criterion for a hypothesis test for a population mean. The null hypothesis is \( H_0 : \mu = \mu_0 \). The curve is the normal curve for the test statistic under the assumption that the null hypothesis is true. Use the graph to solve the problem.

16) A graphical display of the decision criterion follows.

Determine the nonrejection region.

A) \( z \geq -1.96 \)  \hspace{1cm}  B) \( z \geq 0.025 \)  \hspace{1cm}  C) \( z \leq -1.96 \)  \hspace{1cm}  D) \( -1.96 \leq z \leq 1.96 \)

Answer: A

Objective: (9.2) Use Graph to Identify Statistical Terms I
For the given hypothesis test, explain the meaning of a Type I error, a Type II error, or a correct decision as specified.

17) The maximum acceptable level of a certain toxic chemical in vegetables has been set at 0.3 parts per million (ppm). A consumer health group measured the level of the chemical in a random sample of tomatoes obtained from one producer to determine whether the mean level of the chemical in these tomatoes exceeds the recommended limit.

The hypotheses are

\[ H_0 : \mu = 0.3 \text{ ppm} \]
\[ H_a : \mu > 0.3 \text{ ppm} \]

where \( \mu \) is the mean level of the chemical in tomatoes from this producer. Explain the meaning of a Type I error.

A) A Type I error would occur if, in fact, \( \mu = 0.3 \) ppm, but the results of the sampling fail to lead to rejection of that fact.
B) A Type I error would occur if, in fact, \( \mu = 0.3 \) ppm, but the results of the sampling lead to the conclusion that \( \mu > 0.3 \) ppm.
C) A Type I error would occur if, in fact, \( \mu > 0.3 \) ppm, and the results of the sampling lead to rejection of the null hypothesis that \( \mu = 0.3 \) ppm.
D) A Type I error would occur if, in fact, \( \mu > 0.3 \) ppm, but the results of the sampling fail to lead to that conclusion.

Answer: B

Objective: (9.2) Explain Meaning of Type I/Type II/No Error II

A hypothesis test is to be performed for a population mean with null hypothesis \( H_0 : \mu = \mu_0 \). The test statistic used will be \( z = \frac{x - \mu_0}{\sigma/\sqrt{n}} \). Find the required critical value(s).

18) A right-tailed test with \( \alpha = 0.09 \).

A) \( \pm 1.96 \)  
B) 1.96  
C) 1.3546  
D) \( \pm 1.3546 \)

Answer: C

Objective: (9.3) Find Critical Value

A sample mean, sample size, and population standard deviation are given. Use the one-mean z-test to perform the required hypothesis test about the mean, \( \mu \), of the population from which the sample was drawn.

19) \( x = 21, n = 11, \sigma = 7.5, H_0: \mu = 18.7; H_a: \mu \neq 18.7, \alpha = 0.01 \)

A) Reject \( H_0 \) if \( z < -2.575 \) or \( z > 2.575 \); \( z = -1.02 \); therefore do not reject \( H_0 \). The data do not provide sufficient evidence to support \( H_a: \mu \neq 18.7 \).
B) Reject \( H_0 \) if \( -2.575 < z < 2.575 \); \( z = 1.02 \); therefore reject \( H_0 \) and conclude that \( \mu \neq 18.7 \).
C) Reject \( H_0 \) if \( z < -1.96 \) or \( z > 1.96 \); \( z = 1.02 \); therefore do not reject \( H_0 \). The data do not provide sufficient evidence to support \( H_a: \mu \neq 18.7 \).
D) Reject \( H_0 \) if \( z < -2.575 \) or \( z > 2.575 \); \( z = 1.02 \); therefore do not reject \( H_0 \). The data do not provide sufficient evidence to support \( H_a: \mu \neq 18.7 \).

Answer: D

Objective: (9.3) Perform Hypothesis Test Given Statistics
20) \( x = 7.3, \ n = 18, \ \sigma = 1.9, \ H_0: \mu = 10; \ H_a: \mu < 10, \ \alpha = 0.01 \)

A) Reject \( H_0 \) if \( z > 1.96; \ z = -6.03 \); therefore do not reject \( H_0 \). The data do not provide sufficient evidence to support \( H_a: \mu < 10 \).

B) Reject \( H_0 \) if \( z > -2.33; \ z = -6.03 \); therefore do not reject \( H_0 \). The data do not provide sufficient evidence to support \( H_a: \mu < 10 \).

C) Reject \( H_0 \) if \( z < -1.96; \ z = -6.03 \); therefore reject \( H_0 \) and conclude that \( \mu < 10 \).

D) Reject \( H_0 \) if \( z < -2.33; \ z = -6.03 \); therefore reject \( H_0 \) and conclude that \( \mu < 10 \).

Answer: \( D \)

Objective: (9.3) Perform Hypothesis Test Given Statistics